2013 AIA TAP BIM AWARD

Delivery Process Innovation

Outstanding Project Success Through Collaboration

BIM Facilitates Achievement of Owner Success Factors

The customer on this iconic justice center project sought a 100-year facility that both honored the revered legacy of the state court system and also represented and accommodated its future. Ensuring the integrity of the intricate design intent required innovative methods and presented a daunting challenge for the design and construction team.

The solution came in developing a project plan that incorporated virtual design and construction (VDC) in every aspect of the delivery process possible. The need to deliver outstanding architectural detailing on the project drove a cultural shift that elevated the use of BIM to new levels. The team collaboratively focused technology use and innovative processes to achieve key project success factors defined by the customer, and deliver an outstanding experience along the way.

PROJECT SCOPE

- **695,000 square feet**
- **State Courthouse**
- **12-story office tower**
- **$200M construction budget**
- **27-month construction schedule**
- **LEED-Gold target (pending)**

SUCCESS FACTORS

100-year
building symbolizing the
Rule of Law

Integrating
ALL users in the design-build
process

Paying
Attention to **detail**

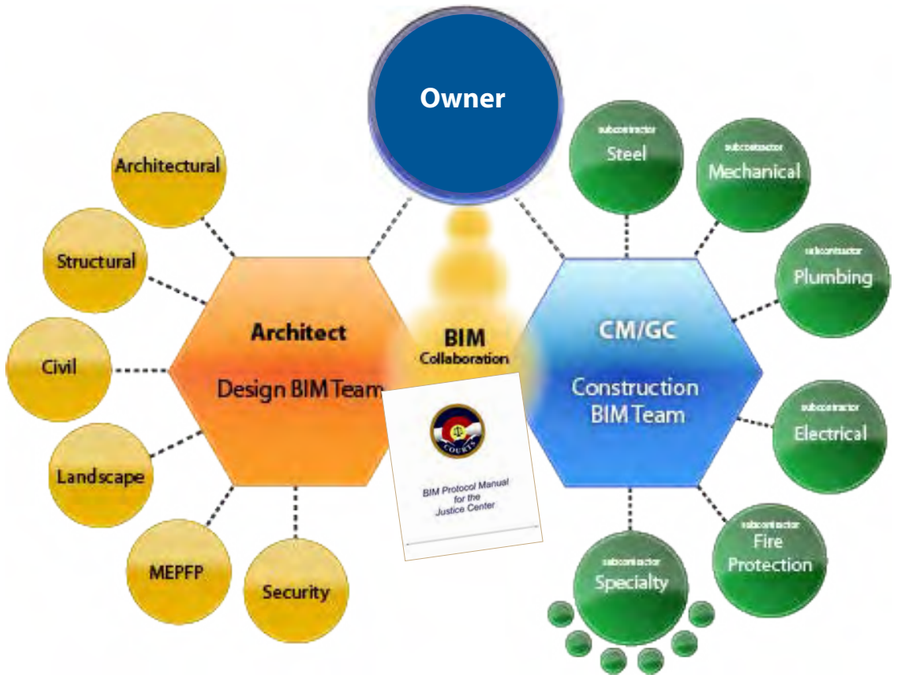
Significance
of **decisions**
in the design process

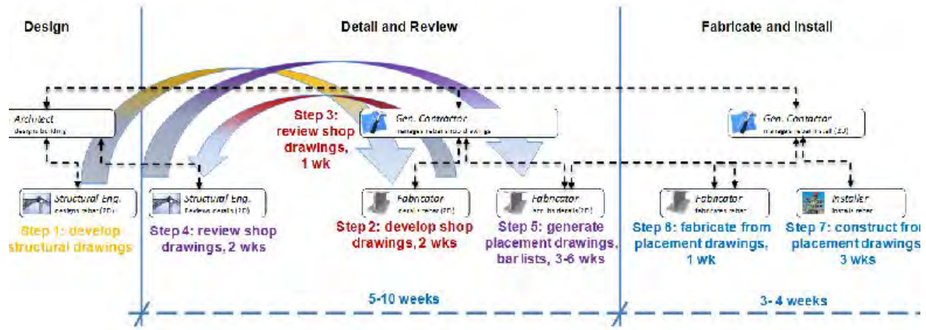
Construct a building
for **today**
while considering the **future**

Planning for Intelligent BIM Usage

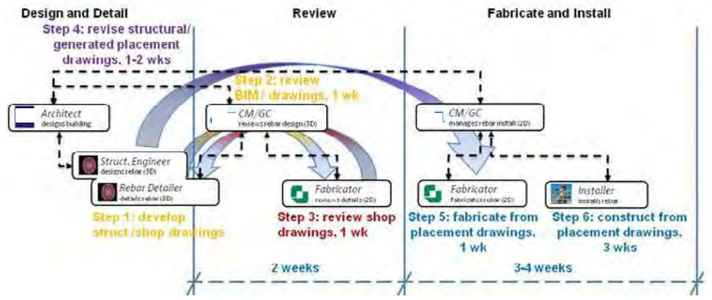
Though contracted via separate CM/GC and design services contracts, the entire team approached the project as an integrated design-build process from day one, proving that people drive collaboration, not contracts or technology. Key trade partners were brought on board early and collocated with the CM/GC to foster open and efficient team communications.

To make the challenging design a reality, the team realized VDC and 3D Building Information Models (BIM) must be utilized to a greater extent than ever before. BIM must not only be the central design intent communication tool, but its use must be strategically planned to optimize integration and efficiency. Key processes were mapped to identify and eliminate sources of inefficiency. A highly detailed BIM execution plan was jointly developed, describing the team's agreed-upon processes, centered around improving collaborative communication through BIM usage.





Traditional cumbersome procurement process



Streamlined procurement process provides time savings

SUCCESS FACTORS

Integrating ALL users in the design-build process

VDC was central tool

Integrated into all business processes

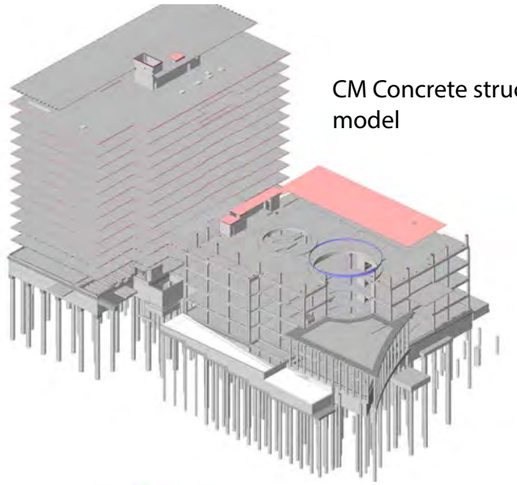
BIM Execution Plan set the rules

Key trade partners involved early in design

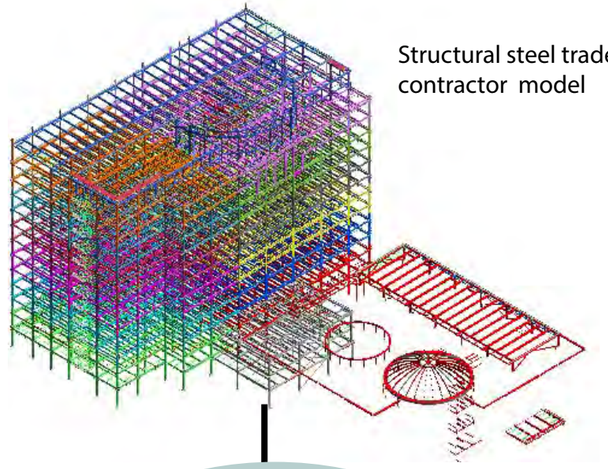
Co-location of project partners

Academia was solicited to focus on process improvement. A leading local university studied the concrete reinforcing procurement process suggesting concrete reinforcing drawings could be created by the structural engineer of record directly from their structural model, eliminating the need for a 3rd party detailer. Digital fabrication proceeded directly from the model. This removed two full steps from the traditional rebar shop drawing and fabrication process.

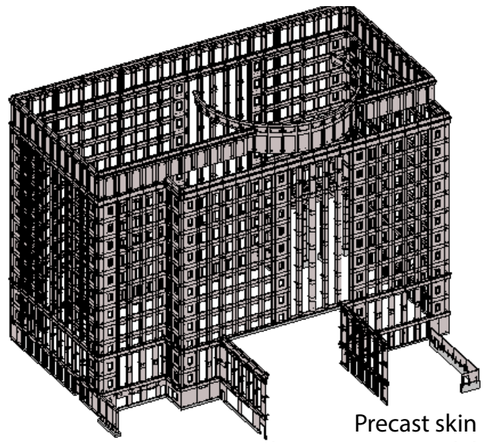
Expanded Collaboration Through Broad BIM Use



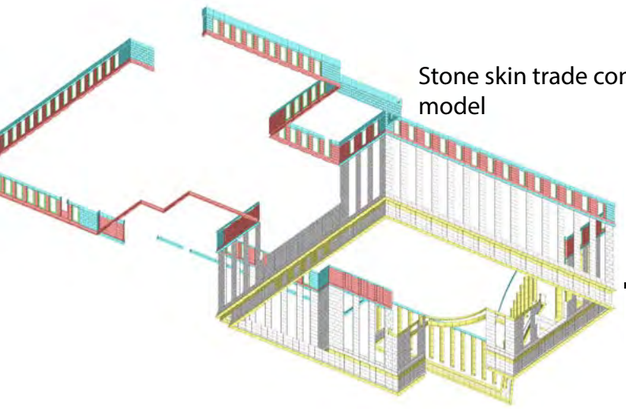
CM Concrete structural model



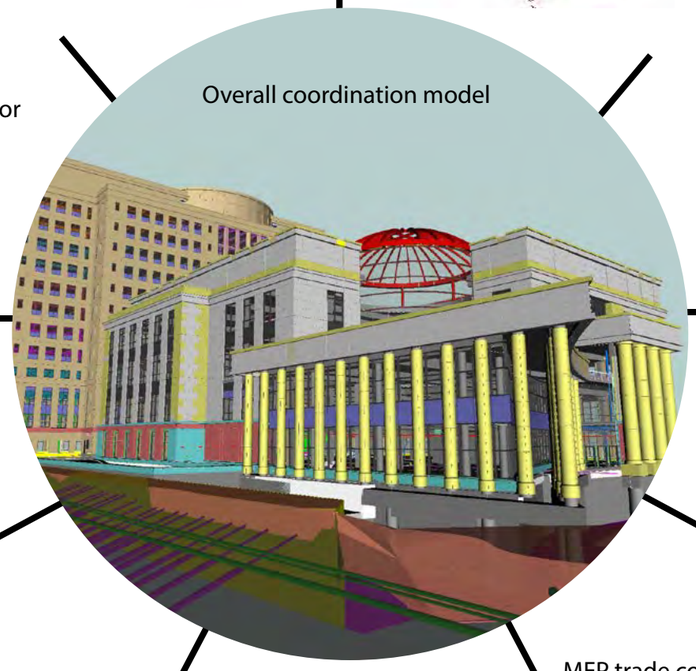
Structural steel trade contractor model



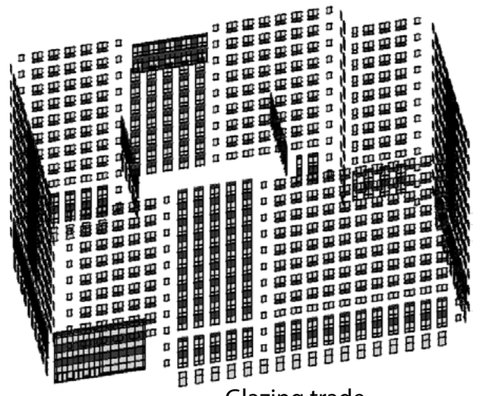
Precast skin trade contractor model



Stone skin trade contractor model

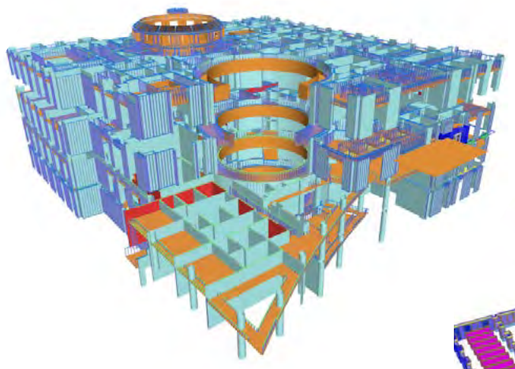


Overall coordination model



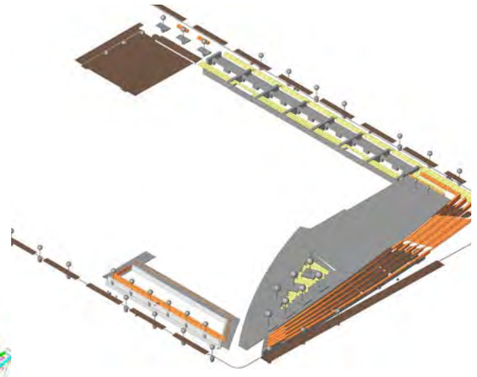
Glazing trade contractor model

Drywall/metal studs trade contractor model



Millwork trade contractor model

MEP trade contractor model



Site concrete and stone trade contractor model

SUCCESS FACTORS

Integrating ALL users in the design-build process

Faced with the need to address project risks more effectively, the team agreed that the more parties that used model information, the better the collaboration. Project leadership pushed for a paradigm shift, spurring nearly all major subcontractors to utilize BIM in their processes.

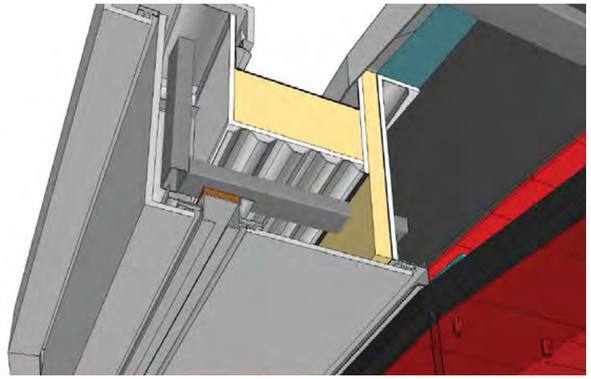
Going beyond the traditional adopters such as MEP and structural trades, model development and use was expanded to include other key subcontractors including:

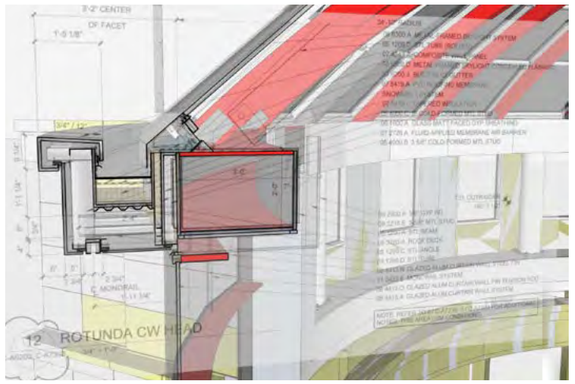
- Concrete
- Steel
- MEP
- Architectural Precast
- Glazing
- Interior drywall/metal studs
- Exterior framing/sheathing
- Millwork
- Stone
- Masonry
- Landscaping and site
- Utilities
- Spray foam insulation

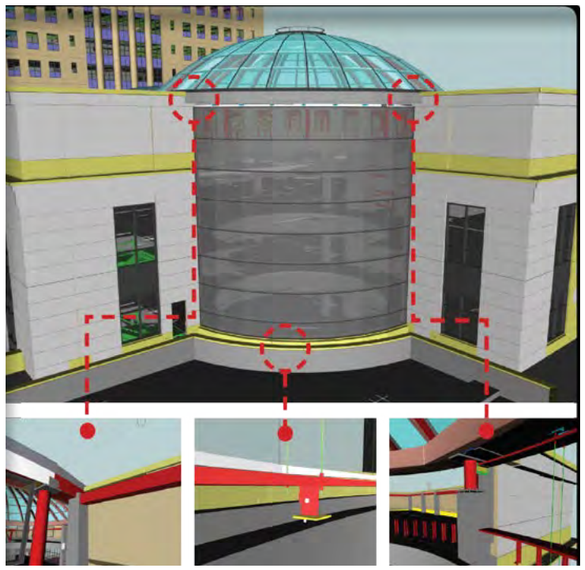
Delivering Design Intent Through Virtual Mockups

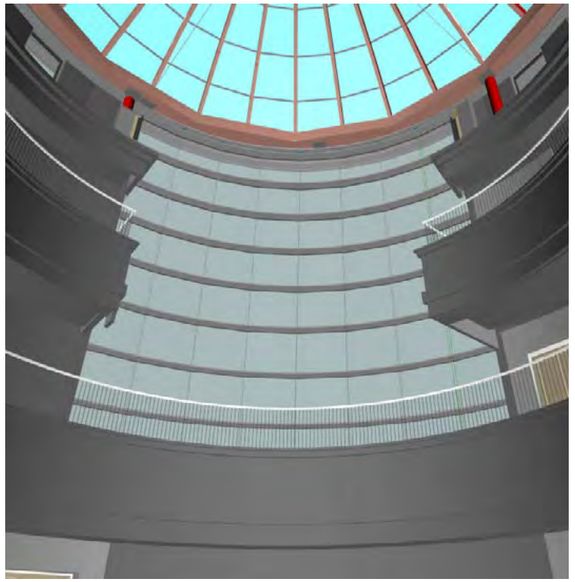
A key challenge for the project team was preserving the intricate design intent on the exterior of the building. The model was used to identify key risk areas, iteratively explore design options, and finalize key details efficiently and collaboratively. The extensive use of BIM based virtual mockups focused on exterior detailing proved to be a vital asset to the team in solving this critical challenge.

Multiple trade contractors' detailing models actually became a part of the initial design BIM, including constructability knowledge and actual means and methods to the maximum possible extent. Extensive installation instructions were generated via the virtual mockup process, ensuring design intent was completely and effectively communicated. The effective use of BIM guaranteed that the installation in the field matched the design intent exactly.









SUCCESS FACTORS

Paying Attention to detail

Field installation = Design intent

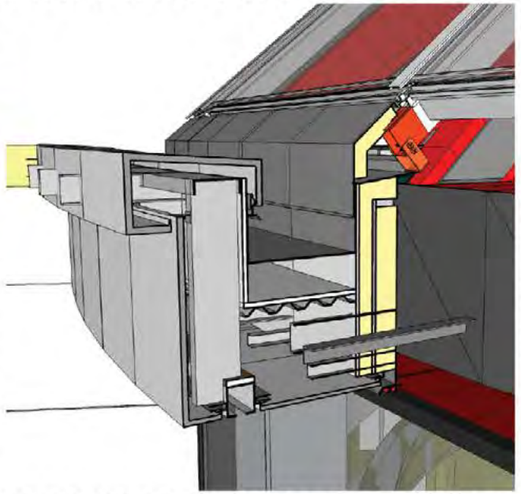
The virtual mockups proved to be an invaluable coordination tool in many areas of the buildings. By overlaying the design model with subcontractors' models, numerous deficiencies were identified and solved before becoming problems in the field, greatly reducing the number of RFIs required.

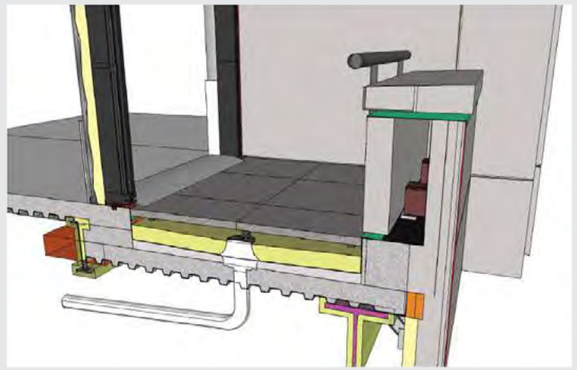
The most complicated part of the building, the atrium and the dome that sits on top of it, was analyzed in great detail, from flashing and sealant to geometric alignments. This was a collaborative process, allowing the design team the opportunity to clarify complicated design intents while hearing how the subcontractors planned to actually construct the various elements. All in all, the process was a resounding success."

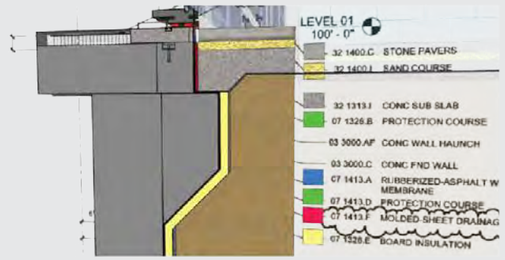
Project Architect

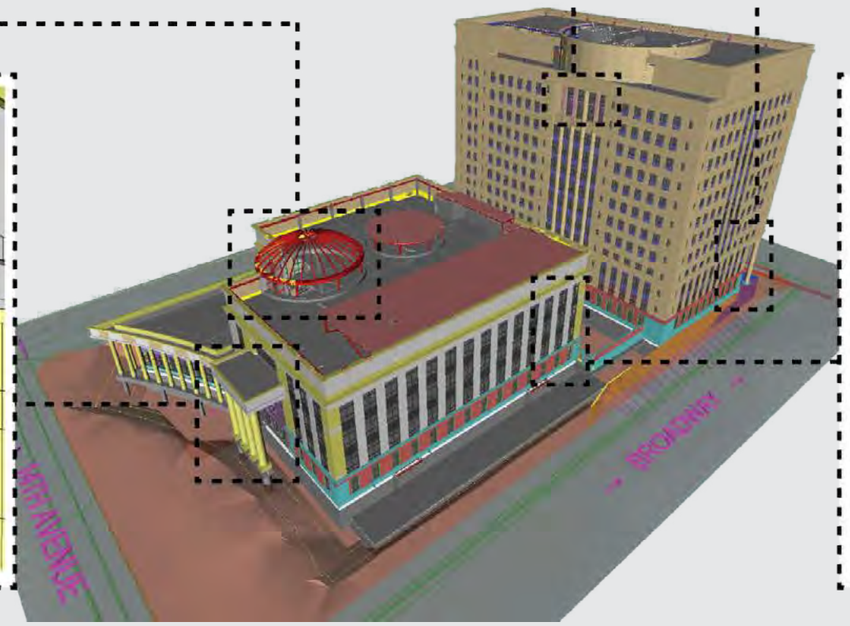
Expedited Detail Resolution Reduces Project Risk

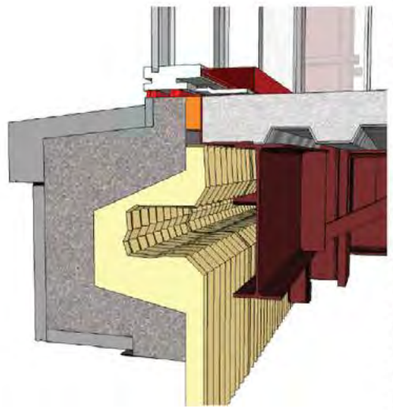
The team delivered design intent through holistic building enclosure coordination, which reduced project risk and cost of delivery by averting the potential for late and costly design clarifications. By virtually expediting and communicating key detail finalization, rework on the exterior skin was virtually eliminated, and additional costs typically associated with detail modifications during fabrication or installation were avoided. Complete coordination of independent building system interfaces between steel, concrete and precast skin ensured maximized efficiency during installation, further driving reduced project cost.











SUCCESS FACTORS

Paying Attention to detail

60% of building envelope design clarifications were generated early in design

Overall cost aversion = $2.44M
Investment =$52,000!

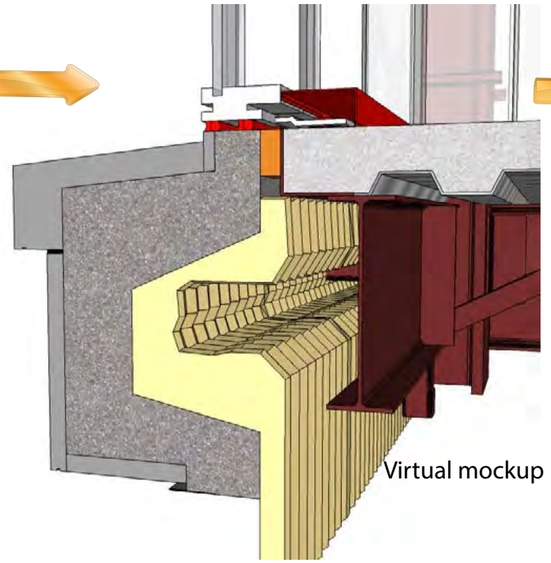
"The precast subcontractor used the model to digitally fabricate all the precast pieces to tolerances much higher than typical industry standard. It gave us a cleaner, tighter building with less lines in it. This was totally in sync with our mission."

Project Architect

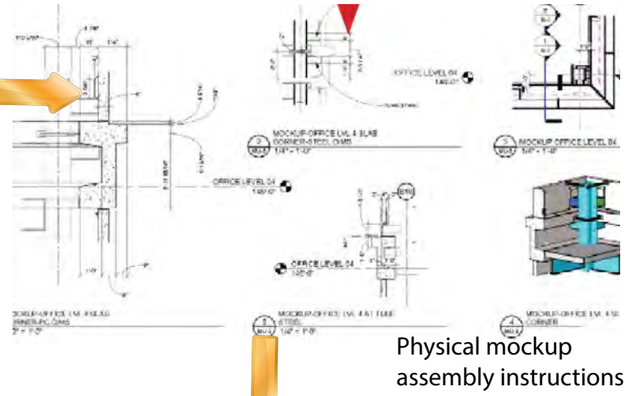
Improving Building Performance through Proof of Concept

The team chose to proactively pursue the use of virtual planning to achieve risk reduction and ensure constructability of the building's enclosure system. Through this process, the intended application method for the building's spray applied foam insulation was identified as a potential concern. A series of virtual mockups created a digital proof of concept. This was followed by construction and destructive testing of physical mockups. The process verified the team's concerns, and led to the development of revised details and an alternate solution to preapply the spray foam insulation on the back of the exterior precast panels before installation. At a cost of $41,000, this process averted field repairs of $755,000 which could have delayed the project by several months. Added value was delivered via a higher-quality, higher-performing envelope which is more energy efficient and less susceptible to air and water infiltration.

Risk areas identified



Virtual mockup



Physical mockup assembly instructions

Physical mockup

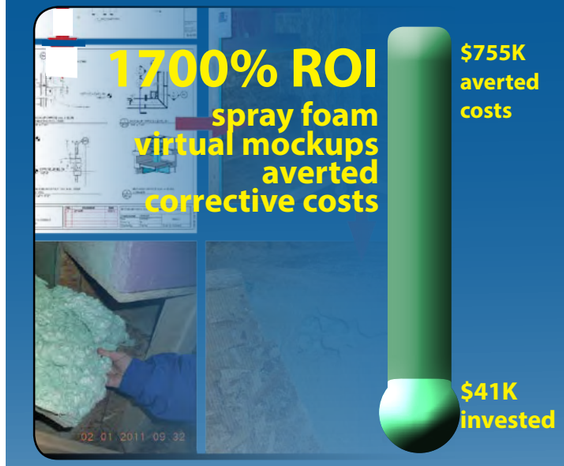
Destructive testing

SUCCESS FACTORS

Paying Attention to detail

Virtual mockups provided proof of concept

Result: Higher performing envelope; Averted rework costs

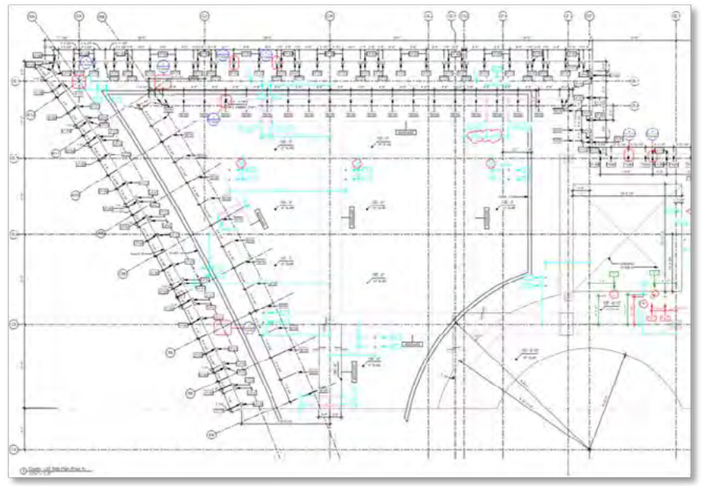


Improving Construction Efficiency, Delivering Cost Savings

The project's aggressive schedule demanded efficiency on critical path concrete work. This meant getting it right in the field the first time. Highly detailed work instructions were produced directly from the BIM. Significant productivity cost and schedule savings were realized as a result of this process.

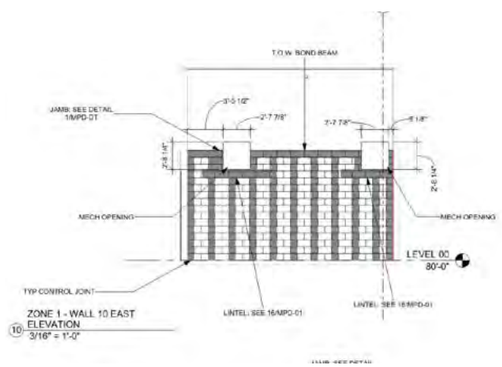
Lift drawings for CM/GC self-performed concrete work also ensured the highest efficiency and lowest installation cost possible.

How did this specifically affect the project? In one example, 100% of the 2242 embedded steel plates in the cast-in-place elevator cores were placed in the correct location with no required rework!

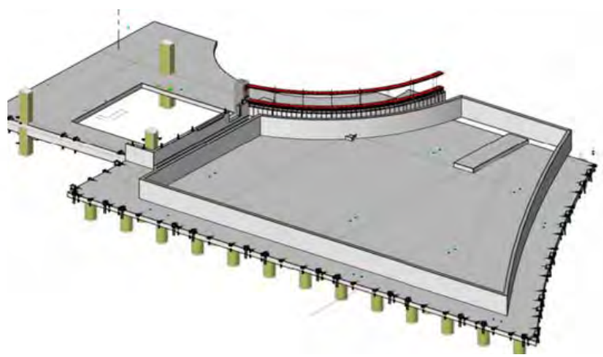


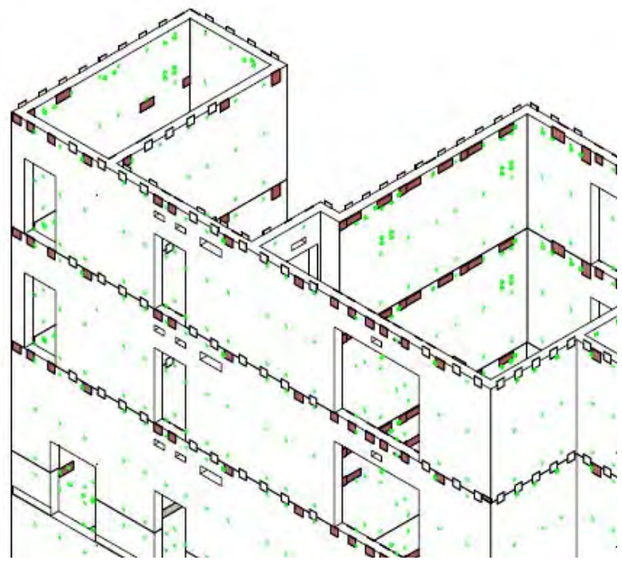
Concrete deck lift drawings

Phasing plans



CMU lift drawings

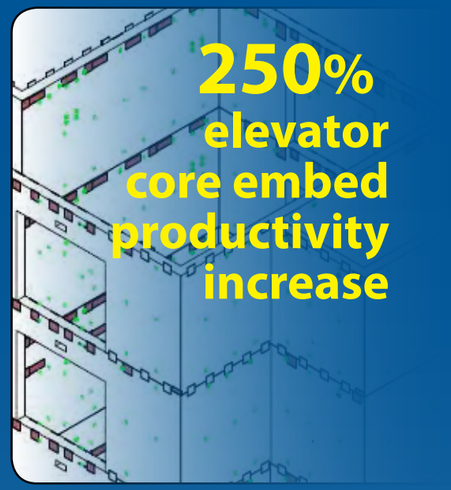




Concrete elevator core model

SUCCESS FACTORS

Paying Attention to detail



The elevator core forming and placement cycle improved from 7 days to 4 days, enabling a 17% reduction in the elevator core installation schedule and a resulting project cost savings of $120,000 without any recordable injuries.

Digital Fabrication Made Possible with BIM

One of the largest interior challenges on the project was to effectively create intricately detailed millwork for the project. The millwork trade contractor came on board early, helping develop the construction details. The model became the means of shop drawing creation and review and generated instructions that electronically drove the fabricator's direct digital CNC fabrication process.

Additional trade contractors took this approach, including precast, glazing, reinforcing steel and MEP.

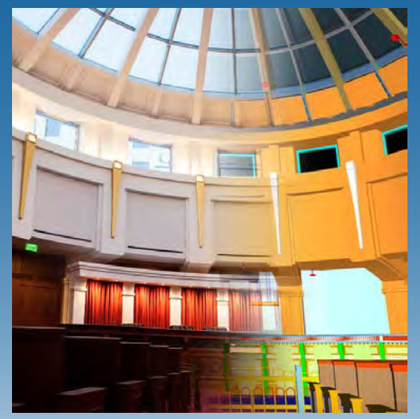
SUCCESS FACTORS

Paying Attention to detail

"We essentially told the millwork subcontractor what we wanted for the end result. They were able to work out the detail to an excruciating level, even allowing them to feed the model into their machinery and extrude it into the actual wood.

This was the beauty of the BIM process to us. For a subcontractor to have that level of influence, well that was just unheard of before."

Project Architect



Developing Processes that Connect People to Information

Efficiently connecting field personnel with the right information at the right time is a major challenge especially with the enhanced reliance upon BIM for this project. Remote access to the BIM became the solution. A project dashboard was created that linked anyone with internet access to the entire project information library. Touch screen plan room computer interfaces all but replaced paper drawings in the project site office, reducing printing costs by over 50%. All models and plans were uploaded and all details were linked electronically to speed access.

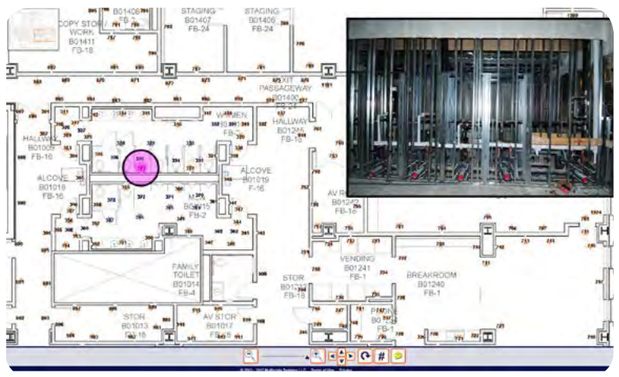
Information made it to the field quickly through touch screen terminals and tablet computer interfaces. An immense project information wall containing the digitally produced site logistics plan was reviewed by all tradespersons in a daily planning meeting. This plan graphically communicated deliveries and work planned for the day, helping to deliver 400,000 CM self-performed work hours without a single recordable safety incident.

Plan room computer dashboard interface

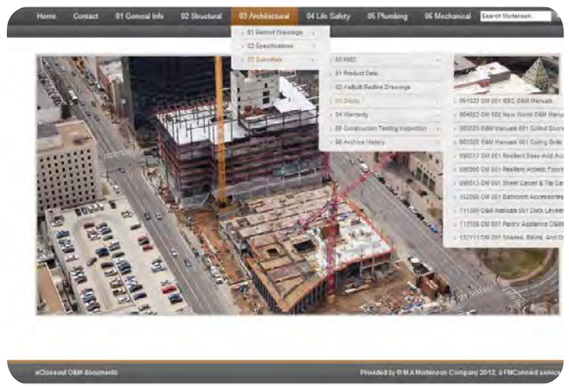
Touch screen plan room computers replace paper drawings

Field tablets connect directly to the cloud

Field computer dashboard interface



In-wall documentation for facilities maintenance



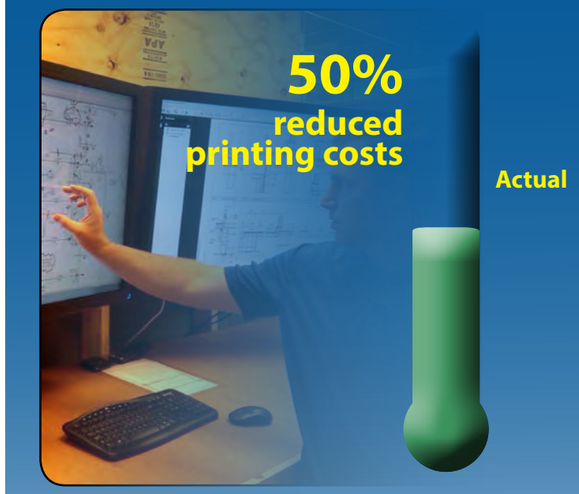
Electronic closeout and O&M interface for facilities maintenance

SUCCESS FACTORS

Integrating ALL users in the design-build process

Technology tools, not paper, provided expanded access to real time information.

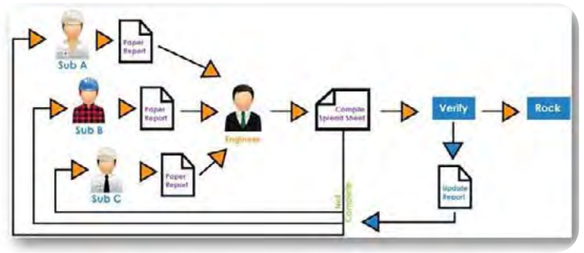
Provided added sustainability benefit, reducing paper and printing costs.



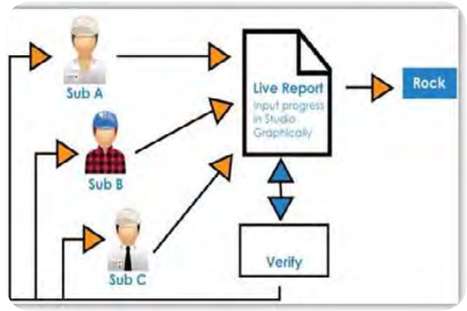
Leveraging the Cloud to Share and Streamline

Graphically tracking the installation status and inspections of above-ceiling and in-wall rough-in directly on an electronic plan set simplified a typically cumbersome process. A graphical interface replaced volumes of cumbersome spreadsheets. Cloud hosting and access via mobile devices streamlined information collection and sharing. Working in the cloud ensured all stakeholders were seeing the same real-time information.

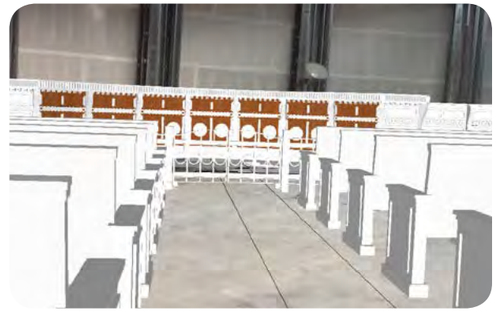
The process was so successful that it was also applied to generation and sign off of the design team punchlist and the material tracking, installation, and inspection of contractor performed doors, frames and hardware installation.



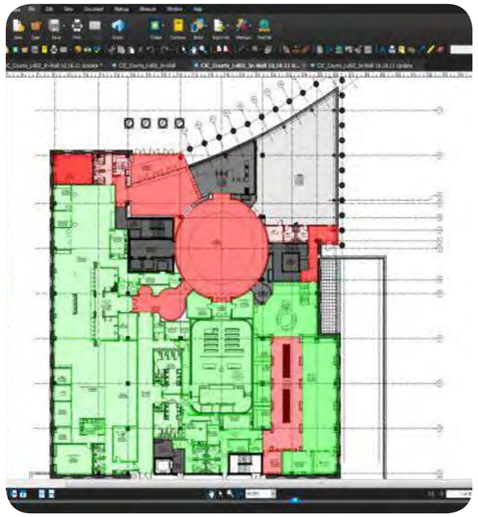
Typical inspection sign off process



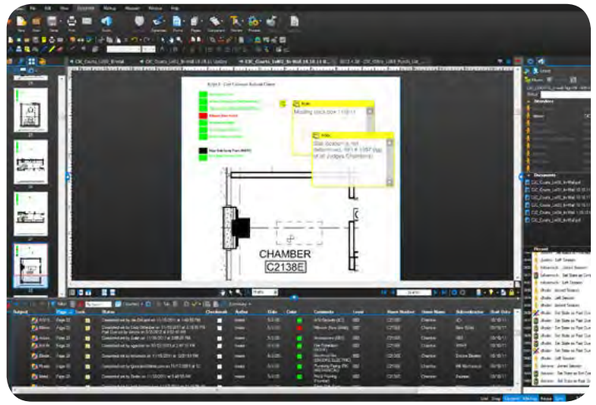
Streamlined team inspection sign off process



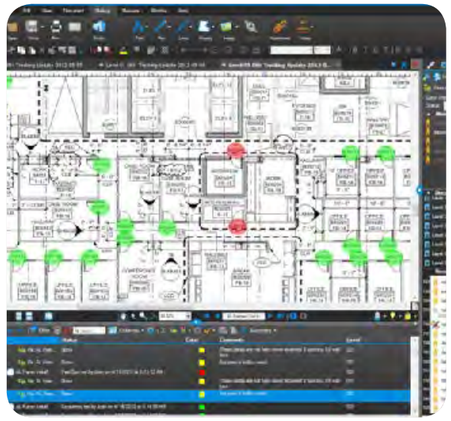
Courtroom millwork viewed on site through augmented reality



Interatctive graphical interface representing tabular data on inspection sign-off status



Detailed room status interface linked to plan view (as shown at left)



Interactive graphic material tracking and installation status interface

SUCCESS FACTORS

Construct a building for today while considering the future

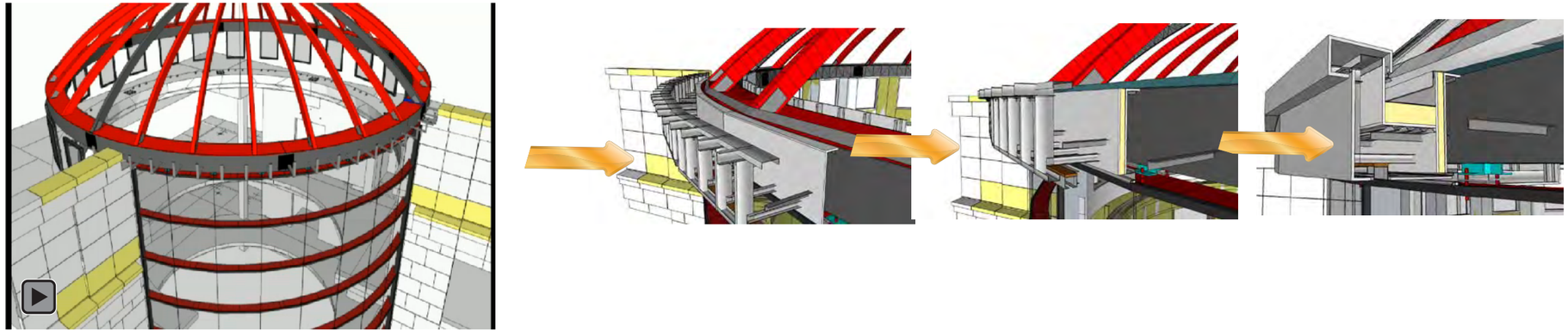
Graphic visualization enabled quick sign offs

The Cloud eliminated redundancies

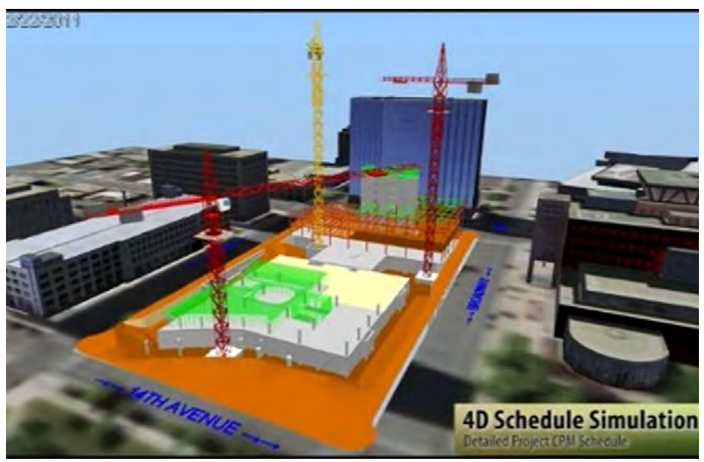
Optimizing Schedule Performance + Communication with 4D

To improve communication of the project schedule with all stakeholders, the team used graphical 4D schedule simulations, driving efficiencies in performance and cost. The team developed macro level 4Ds to enable the entire project team and the surrounding neighbors to visualize and participate in developing the project plan.

To ensure design intent was executed, highly detailed micro level 4D simulations were created to communicate key installation sequences for critical project components such as the rotunda gutter installation. This ensured a higher-quality, better building capable of lasting 100 years.



Video and images of rotunda gutter installation sequence



Macro 4D: Overall project sequencing simulation

SUCCESS FACTORS

Significance of decisions in the design process

Macro level 4Ds enabled both team members and neighbors to visualize the construction sequence.

Results:

Certainty of delivery

Minimized contingencies

Eliminated field surprises

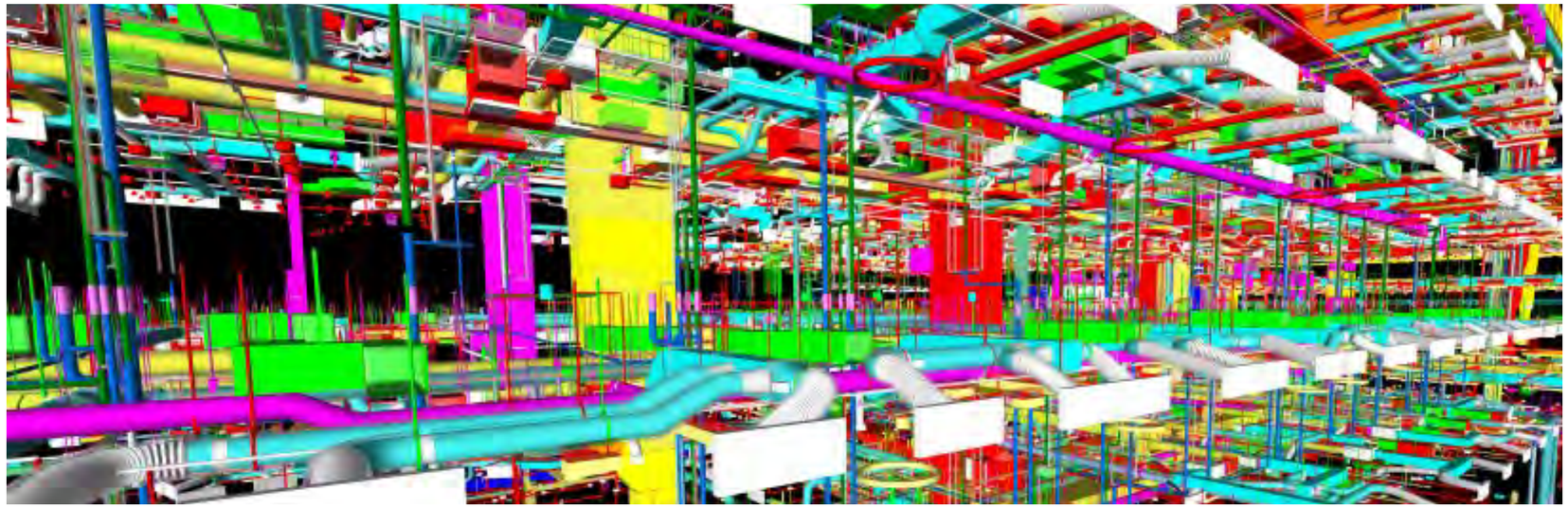
Two months savings on the project schedule

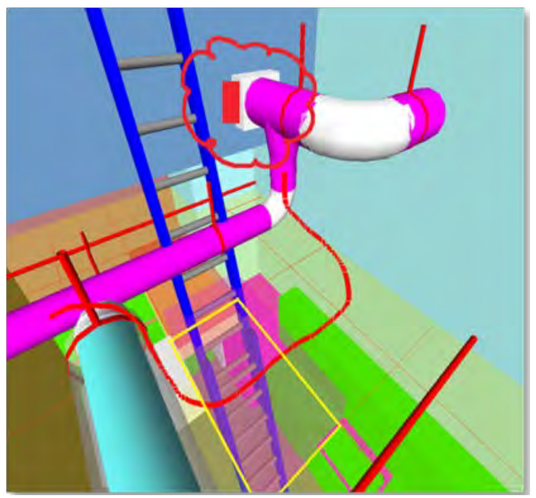
Allowed for early owner move-in.

Beyond Typical MEP Clash Detection to Owner FM

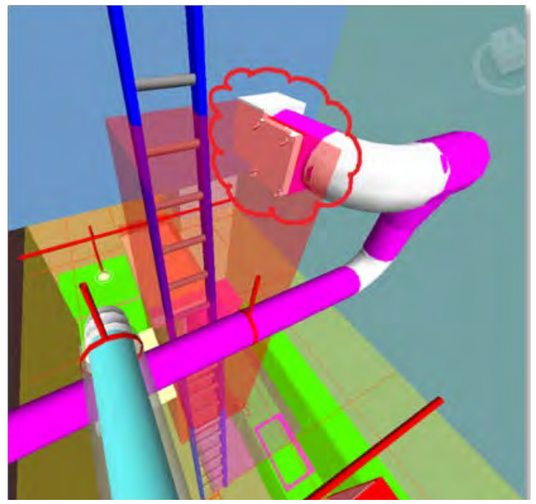
The team added value by going beyond traditional clash detection in the MEP coordination process. They enlisted the owner's facility maintenance personnel to participate in coordination meetings, jointly identifying and ensuring access to all pieces of serviceable equipment.

Actual ladders used by service personnel and required access zones were modeled to improve the customers operations experience.





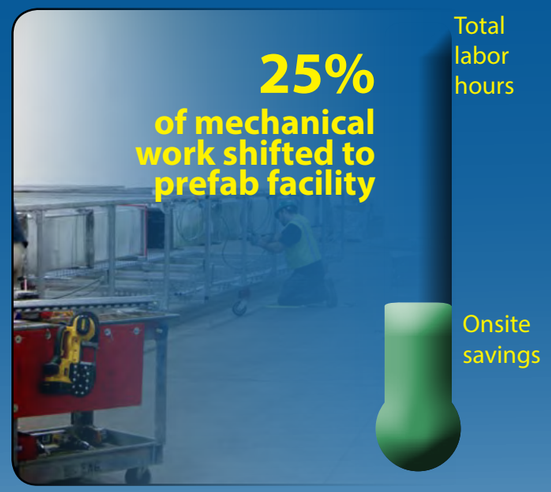
The model showed the original MEP layout would not provide ladder access to service equipment



The resulting adjustment ensured spatial coordination and ease of facilties maintenance.

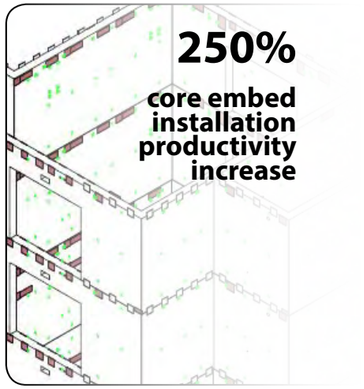
SUCCESS FACTORS

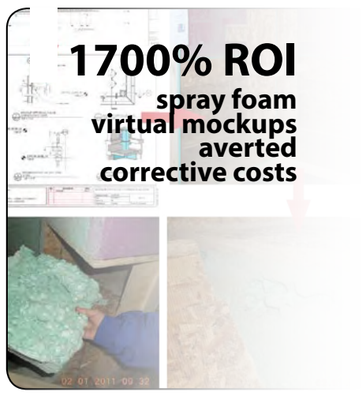
Construct a building for today while considering the future

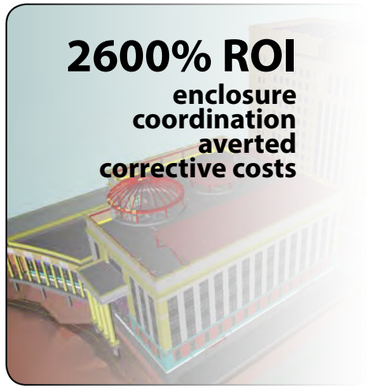


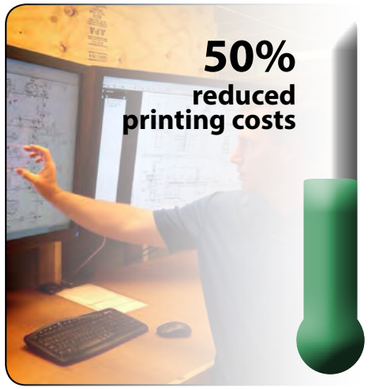
Measured Return on Investment

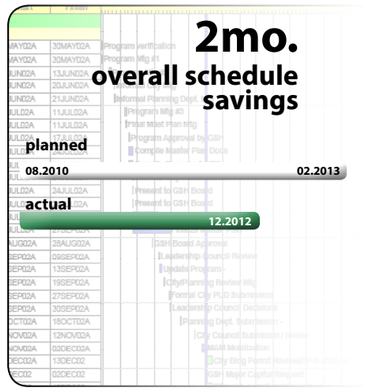
The team didn't just talk about effective BIM use, but delivered outstanding results through its innovative use of BIM- centric collaboration. Significant cost and schedule savings in many areas of the project allowed for an underrun in project expenditures, which enabled additional customer desired scope to be included in the project. Rewards at many levels were derived from the use of VDC on this project, and the project is being used as a model for effective BIM implementation.

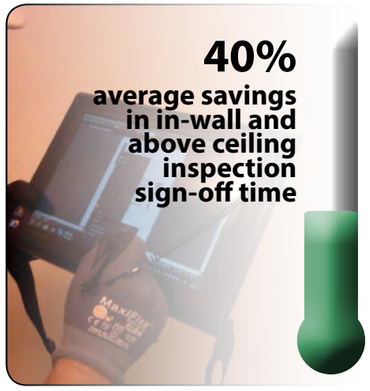


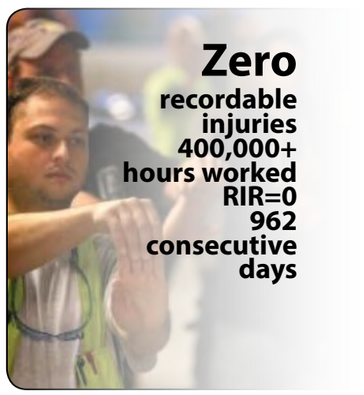


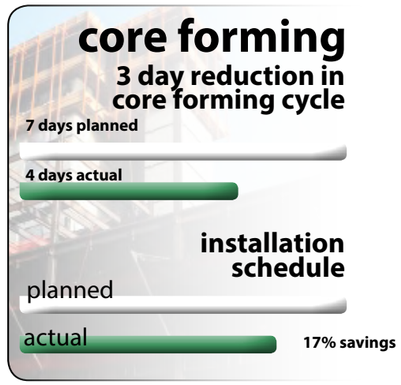












SUCCESS FACTORS

100-year
building symbolizing the
Rule of Law

4.5% **OVERALL PROJECT COSTS SAVINGS**

This was reinvested in the project in customer-deferred project enhancements.

"Your company totally understands customer service. I am extremely pleased with each and every person that I have dealt with. What a classy firm. Knowledge of the work and commitment is very high. Great job!"

Owner Project Manager,
State Court System

THE RESULT

Owner's Statement

[The team members] are experts at creating and maintaining the spirit of teamwork and collaboration between all parties.

BIM coordination between design team and construction groups has been exceptional. We expect the modeling information will be equally valuable for ongoing facilities management use.

Architect's Statement

This has been one of the best projects I have worked on! From preconstruction through nearing the finish line [the team] has dedicated the resources, ensured the highest level of quality and safety, and maintained the highest level of professionalism and teamwork.

Of particular note is the advances in technology and integration of BIM with a majority of the subcontractors. Coordination was significantly enhanced and field issues minimized as a result. The high standards for quality and conscientiousness has been unparalled in my 30 years of experience. It has been a sincere pleasure and honor to be on this team.

Contractor's Statement

This project is the definition of how coordination should be implemented. It balanced the use of technology, physical mockups, in person meetings as well as online, and hand-drawn sketches on paper when needed. The team understood immediately that investing hundreds of hours coordinating together in a meeting room was going to save thousands of hours on the project site once the materials arrived because we all knew they were going to fit perfectly. The exterior of this building went together so effortlessly that we all had to step back and pause to realize what our team accomplished. A truly amazing team that utilized all our own individual tools and technologies to benefit the projects vision of a 100-year building delivered two months ahead of schedule."

SUCCESS FACTORS

100-year
building symbolizing the
Rule of Law

Integrating
ALL users in the design-build
process

Paying
Attention to **detail**

Significance
of **decisions**
in the design process

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