AIA Technology in Architectural Practice

2010 BIM Award

A Cohesive Team: Integrating Technology

The Medical Center

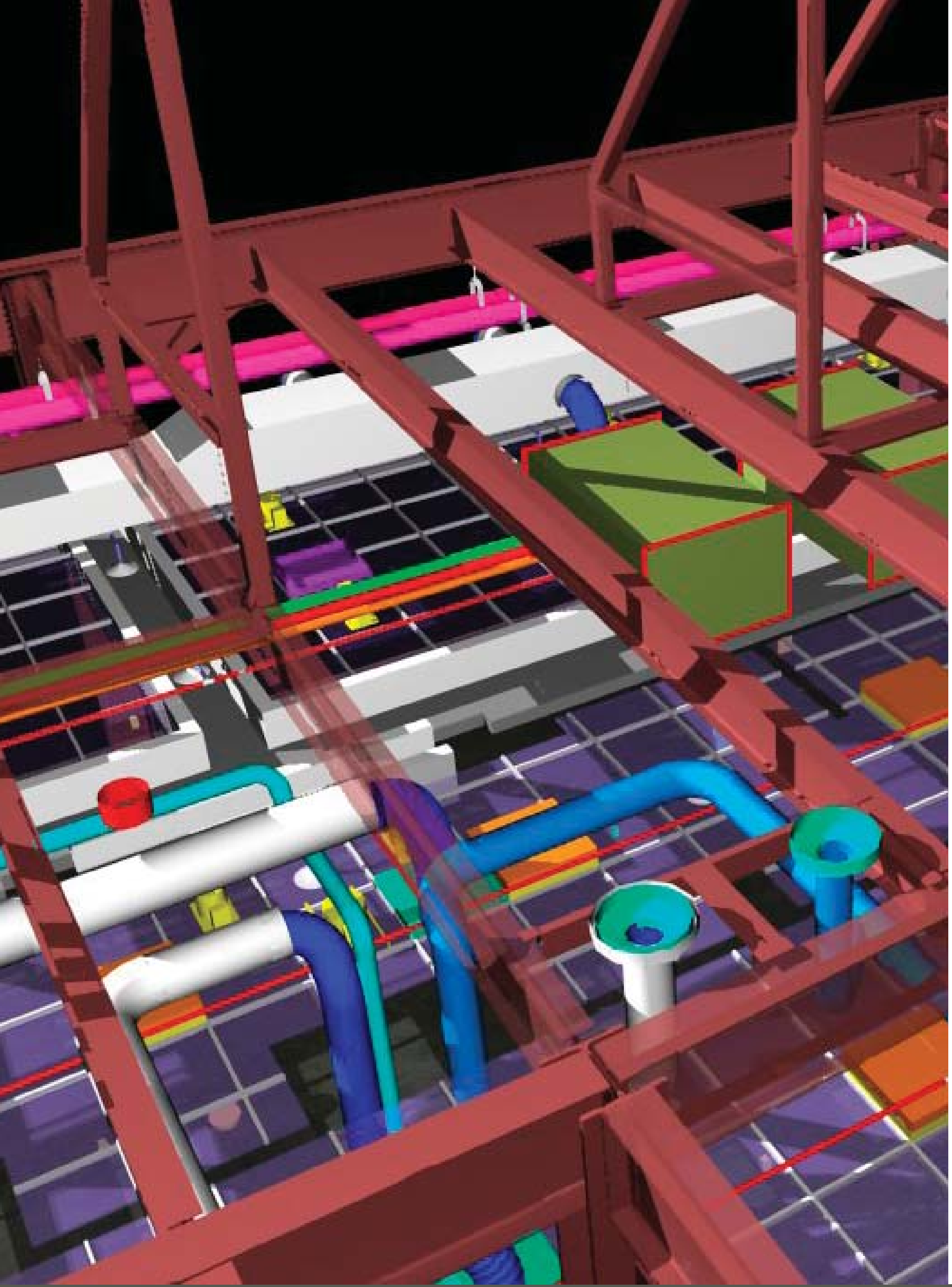


Table of Contents

Delivering a facility focused on providing the highest level of care to patients.

This 802,000-square-foot Medical Campus includes a 508,000-square-foot hospital, 225,000-square-foot medical office building, and a 69,000-square-foot cancer center. The hospital consists of 117 inpatient beds, with emergency, urgent-care, two hyperbaric chambers, surgery, cysto procedure room, c-section rooms, endoscopy procedure rooms, and diagnostic imaging and testing. Hospital areas are dedicated to cardiology care, women's imaging, sleep studies, ICU, NICU, pediatrics, pain management, radiation

Healing Garden

and medical oncology, laboratory, food service/dining, administrative, and a healing garden.

The hospital's design includes a rehabilitation unit that provides a life-like rehabilitation setting, a pediatric courtyard with whimsical zoo animals, and a tranquil healing garden. The building combines steel and concrete structural systems with a customized precast, brick, and glazed curtainwall enclosure system that addresses the hospital's high humidity requirements and challenging climate fluctuations. Vibration isolation in specific areas far exceeds code requirements for treatment spaces.

The most significant green/sustainable features include a storm water management plan that prevents rain water from leaving the site with a man-made pond reconfigured for optimal size, a "Green Machine" natural filtration water treatment process, automatic shut-off faucets, and natural daylighting with expansive windows. During construction, the project recycled 84% of waste materials.

MEP Building Components
Modeled, Delivered, Installed

Project Manager Statement

With a passion for delivering superior care to the community, we embarked on the construction of one of the area's largest hospital facilities. In the early planning stages of the Medical Center, we realized as the Project Manager a facility of this size required an integrated team of industry-leading design and construction professionals whose processes, programs, and state-of-the-art tools would contribute to the overall success of our project.

We assembled a team continually focused on an innovative and collaborative spirit to enhance the design and building process. Utilizing the latest building tools and technology, including Building Information Modeling (BIM), the team consistently developed and pioneered new ways to communicate with key stakeholders. This commitment to continuous improvement, as well as BIM, was crucial to the overall success of our project. In the future, we will use the As-Built BIM Model for managing our facility.

We set high standards for our project partners and held them accountable to deliver a facility that would meet our needs. The honest, concrete solutions, and technologically advanced solutions our team brought to the project were invaluable. They consistently exceeded our expectations with their effective project management, partnership with project's sub-consultants and subcontractors, and continuous communication.

Architect's Statement

Development of this Medical Center was driven by the client's commitment to serve a growing community with patient-centered care.

BIM was maximized from site selection through occupancy. When siting this 802,000-square-foot Center, modeling and community feedback guided environmental and branding options. BIM fed and confirmed data for reconfiguration of an existing man-made pond. Enclosure elements were refined for local scale and performance.

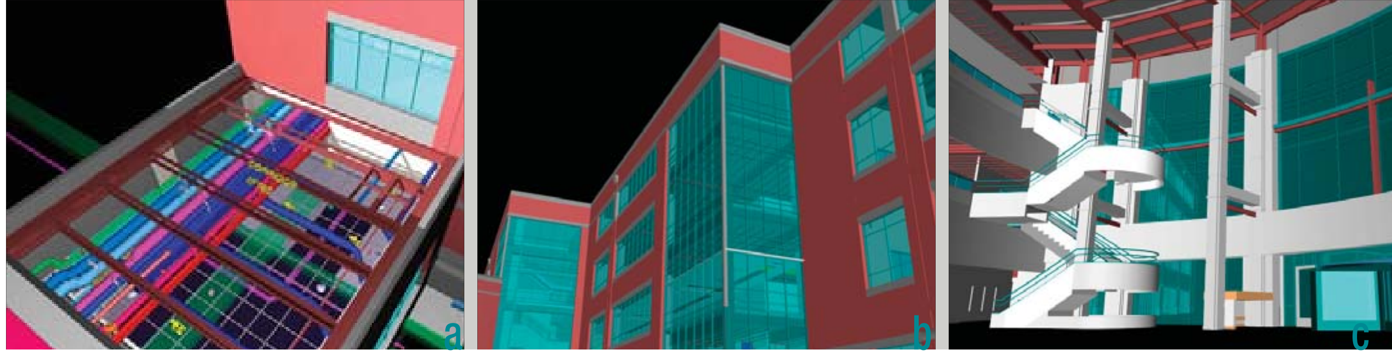
For coordinated patient care, BIM integrated unique, interdependent structures. Centered within the site, the hospital, medical office building and cancer center connect to a services building via a tunnel. Planning for future expansion utilizing BIM minimized potential environmental and operational disruption.

Area and space objects in CAD constructs ensured that departmental and room allocations were maintained as the program translated into plans. Through BIM, spatial transitions and workflow came to life for employees, thus enhancing patient care. BIM helped map vehicular, pedestrian and building systems for optimal function and cost effectiveness.

BIM fostered and confirmed visual delights and therapeutic experiences that are dependent on complex building systems interwoven with care and expertise. The resulting product is a vibrant Medical Center of innovation with the best personnel and medical technology, interwoven into this thriving community.

Early design renderings of the Medical Center

a.. Connector Corridor
b. Corner Detail
c. Lobby



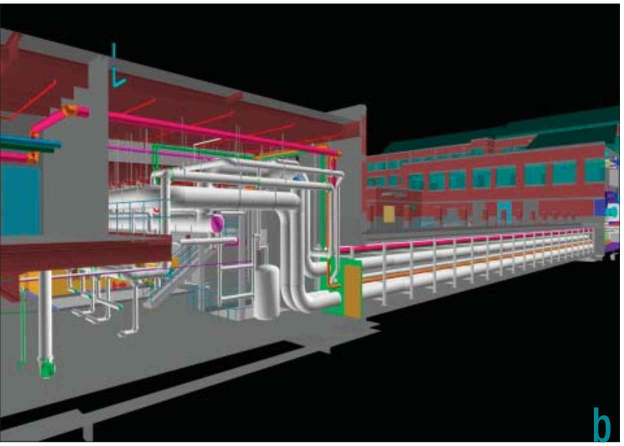
Contractor's Statement

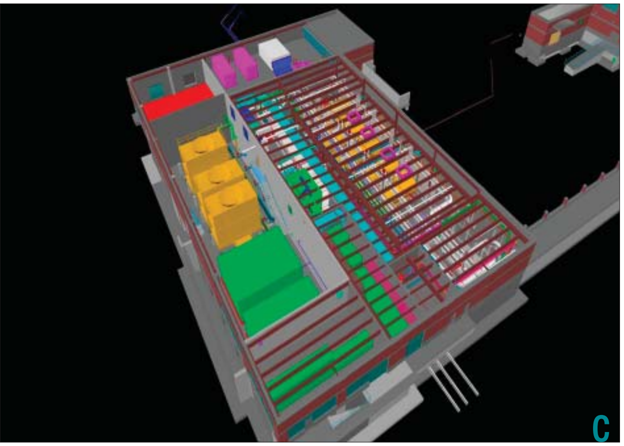
The Medical Center project presented our team with the fastest-paced schedule we have ever been tasked with for a project of this magnitude. Always willing to take on new challenges, our team was excited at the opportunity to provide industry-leading construction services through the use of Building Information Modeling (BIM). From the onset of our selection, it became apparent we needed to partner with each individual stakeholder to collectively understand the overall vision for the project and use BIM to communicate this vision. Using BIM and a team approach, we delivered a high-quality facility, met the extremely fast-paced schedule, and exceeded expectations.

At the heart of delivering this project on time was the need for industry-leading building tools and processes, specifically BIM. BIM was used to effectively communicate during all phases of the project and with all levels of the team, whether with the project manager, owner, architect or craftsworkers. BIM produced quantifiable solutions that enhanced the overall project and helped maintain the schedule and budget.

We are honored to have been a driving force in the success of this project.

A Cohesive Team:
INTEGRATING TECHNOLOGY

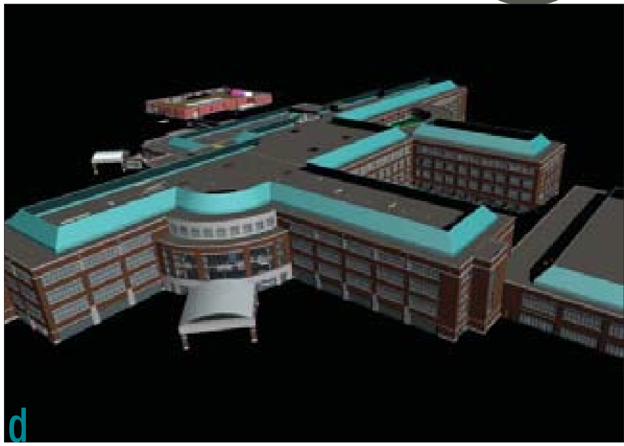




a. Central Utility Plant interior
b. Central Utility Plant exterior with mechanical systems visible
c. MEP systems and equipment within Central Utility Plant
d. Exterior model of the Medical Center
e. Exterior photo of Medical Center under construction

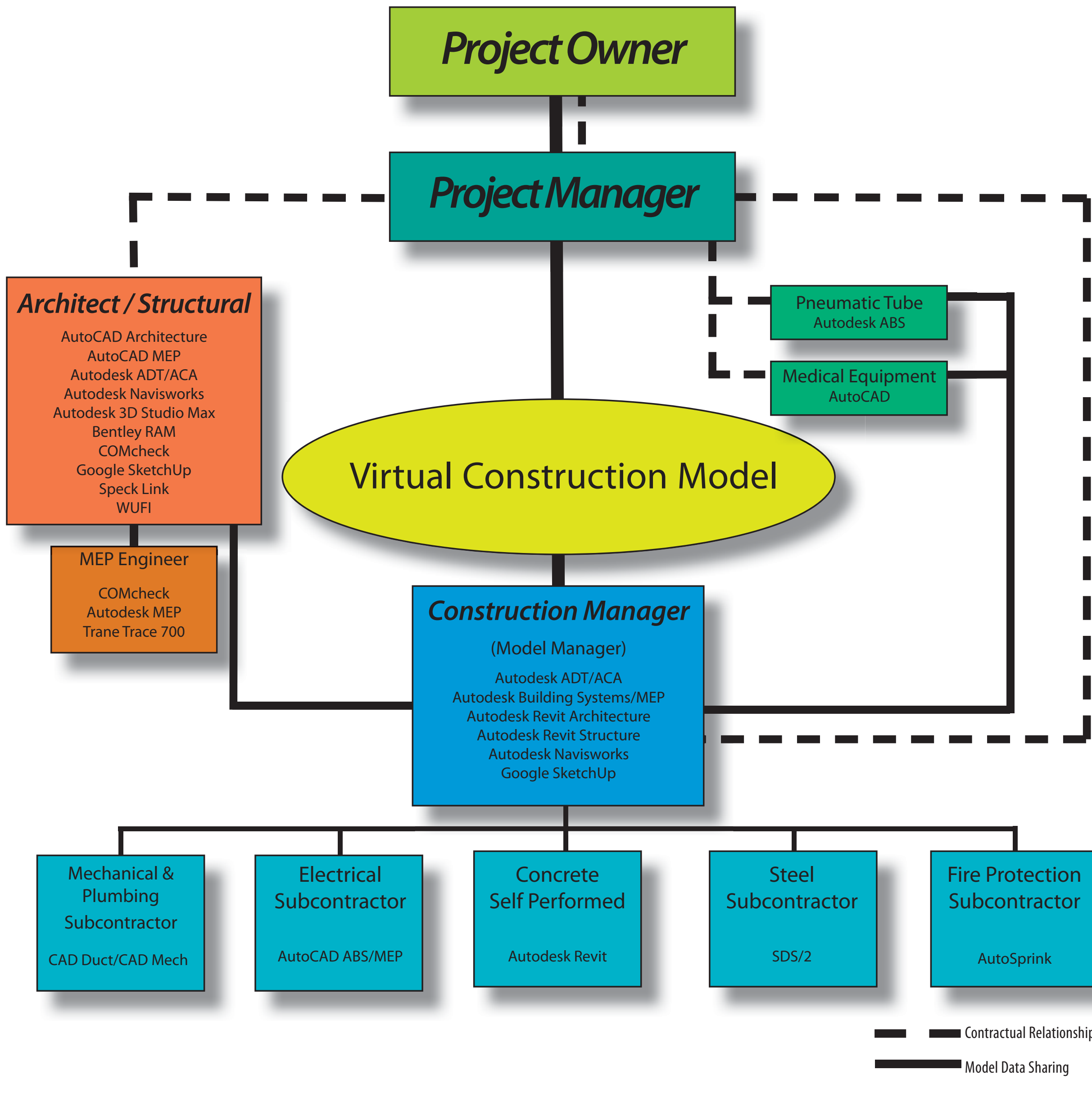
Essential to the overall success of any project are open lines of communication, a common level of understanding, and a willingness to partner with all stakeholders. **Building Information Modeling (BIM) is the process that integrated the project team and proved crucial in the overall design and construction of the medical campus.** Led by the project manager, team members on the Medical Center whether architects, engineers, construction managers, or subcontractors, integrated themselves into a cohesive, collaborative, solution-driven project team focused on delivering this high-end facility to the . Using BIM, the team visually communicated and connected all project partners.

From design to close-out, BIM established a common level of understanding through visual representations of what the final facility would entail. Each component of the design and construction of the Medical Center was meticulously modeled while new and improved techniques were developed and implemented to successfully design and deliver this project in an extremely fast-paced schedule. Similar-sized projects not utilizing BIM had a construction schedule of 36 months. This project took 23 months.



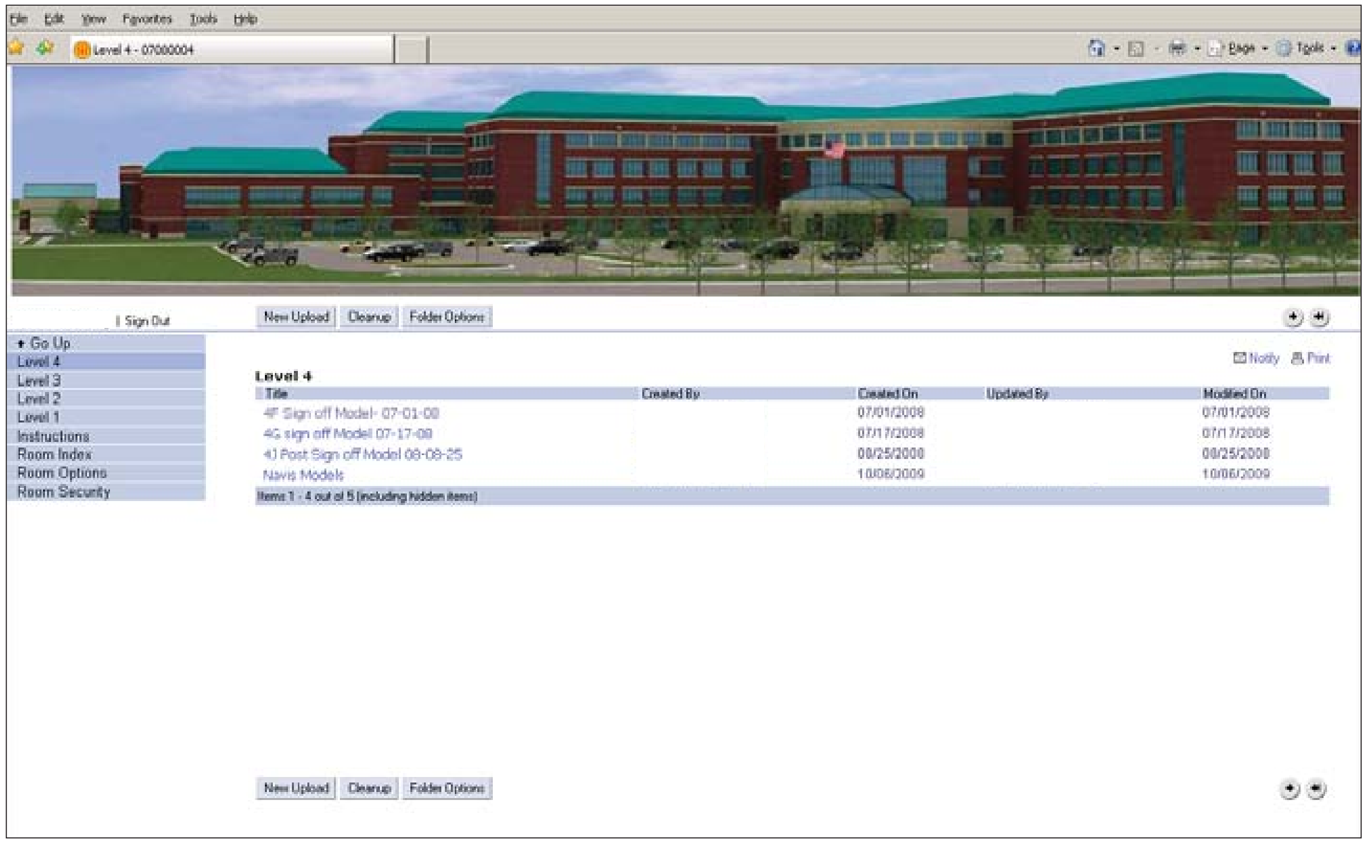
A Cohesive Team: INTEGRATING TECHNOLOGY

Building Information Modeling served as the communication tool that tied all project stakeholders together. With a common goal in mind and an awareness of data sync requirements, each team member utilized their preferred software platform to create their own drawings and virtual representations. These drawings and models were then collectively integrated. The initial and ongoing coordination process was managed by the Construction Manager. All aspects of the design and construction phases were incorporated into BIM and the virtual building environment. The team worked virtually through design, system coordination, and construction challenges prior to construction to successfully deliver the Medical Center project.



A Cohesive Team: INTEGRATING TECHNOLOGY

The team shared files via a share point site where information was freely exchanged among all parties. RFIs, construction bulletins, and virtual models including design revisions and coordination updates were continuously uploaded and available for all project team members.



Construction Manager's "Quickplace" site

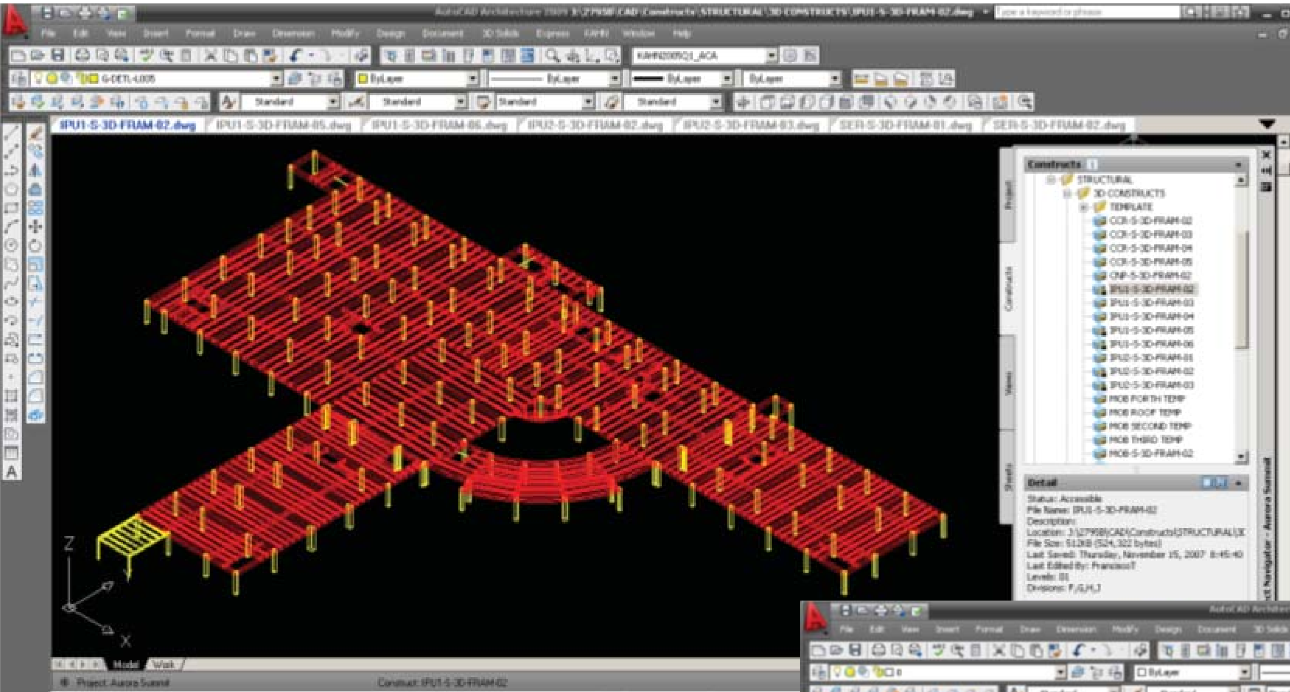
Design: Model Based Renderings

Exterior rendering of the Medical Center

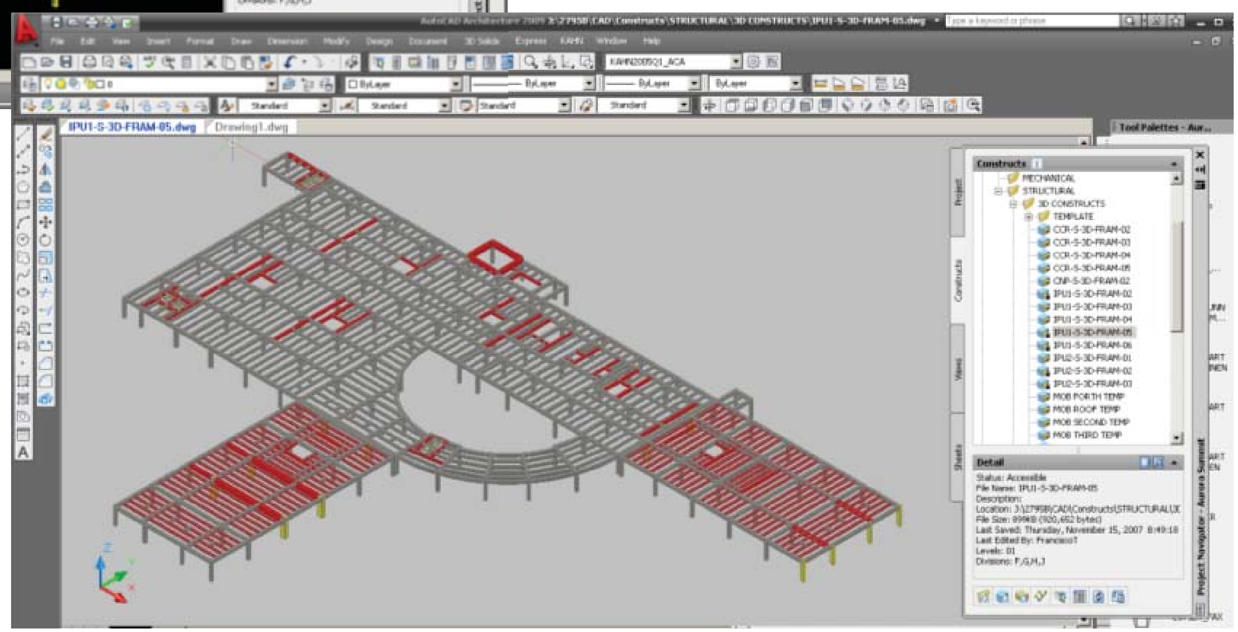
During the initial design phase, the Architect updated several virtual models to convey design options to the Project Manager and Owner. BIM data was linked to the Architect's rendering "farm" visualization solution (based on Autodesk 3Ds Max Software) to maintain a parallel process with the design team. As the BIM datasets were updated, a live link allowed instant updating of the render files. Unchanged and altered objects maintained all assigned material characteristics, leaving only new objects for processing into the rendering environment. This process provided real-time updates to the Project Manager and Owner in a deliverable that communicated well with all project stakeholders. The model that was utilized for these initial design discussions was carried into the construction phase, thereby eliminating the need to produce separate models for different deliverables.

a. Inpatient Unit Patient Room
b. Medical Office Building Entrance
c. Nurse Station

The structural 3D model was built to assist in the design and analysis of the structural systems. As files were updated by the design team, they were uploaded to an FTP site to share with other team members. Specific structural information such as bracing locations, deep beams, and oversized non-typical columns, etc. were included in these models. To ensure that interferences were identified and resolved during the early stages of the job, this information was utilized by other disciplines and contractors to coordinate utility locations, ceilings heights, soffits, and column enclosures.



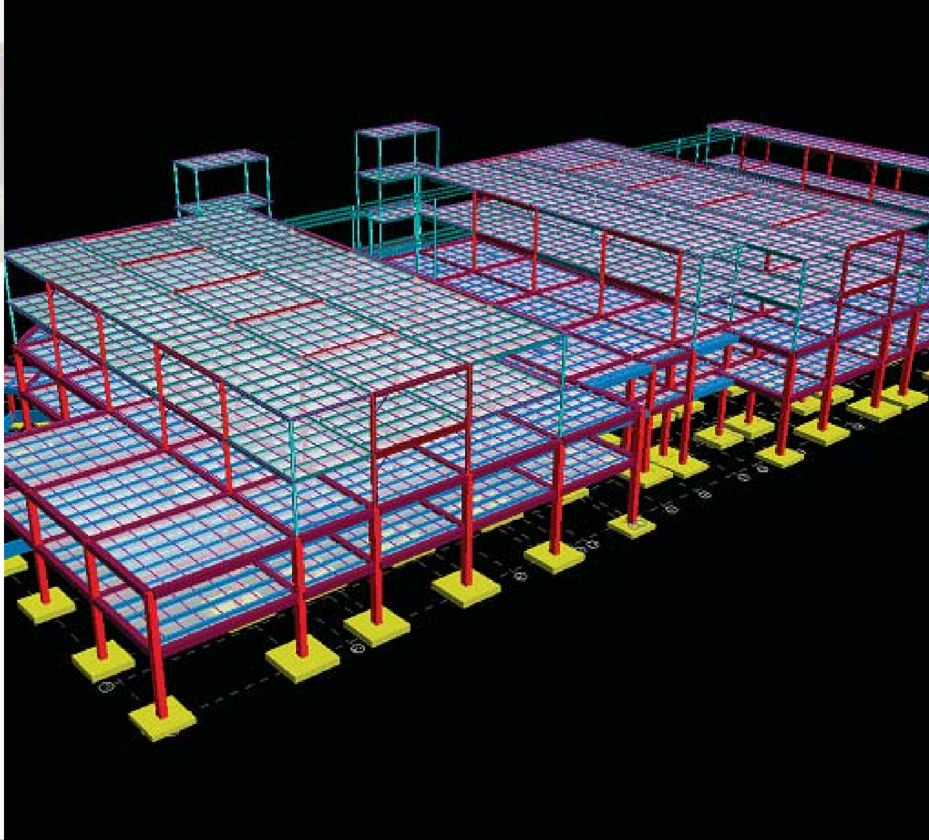
Inpatient Unit 1 Level 2 - Concrete Design Model



Inpatient Unit 1, Level 5 - Concrete Structural Analytical Model

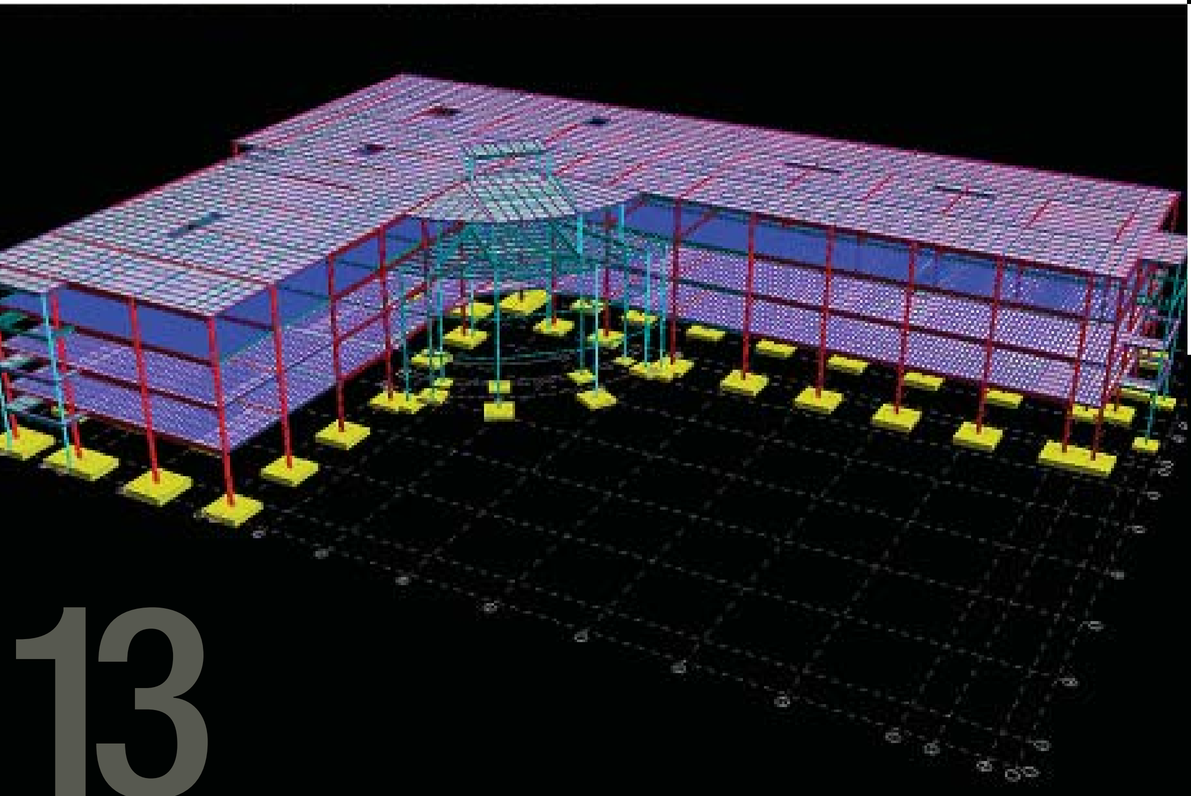
Design: Structural Analysis

Structural development for the 3D model was based in AutoCAD Architecture, with analytical iterations performed in Bentley RAM Structural System. BIM served as an evolving 3D data exchange tool during the iterative design process, integration with the other trades, and ultimately generation of construction documents. The BIM content was collaboratively shared with the Construction Manager as well as the steel detailer for further development and shop drawing creation.

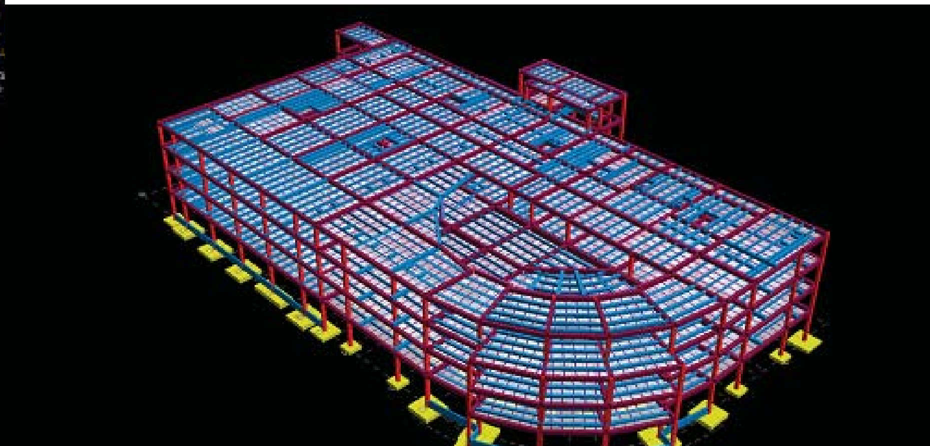


Inpatient Unit 2 with future expansion components 3D RAM Analytical Model

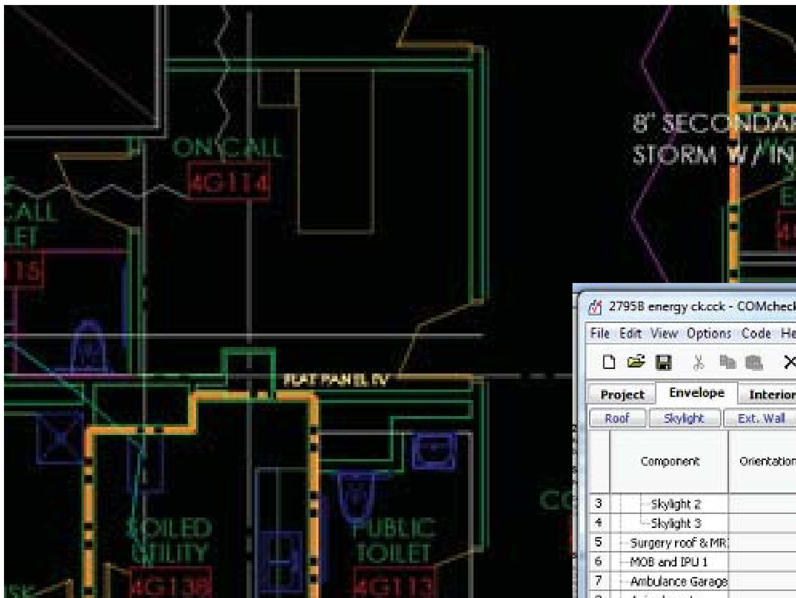
Medical Office Building 3D RAM Analytical Model



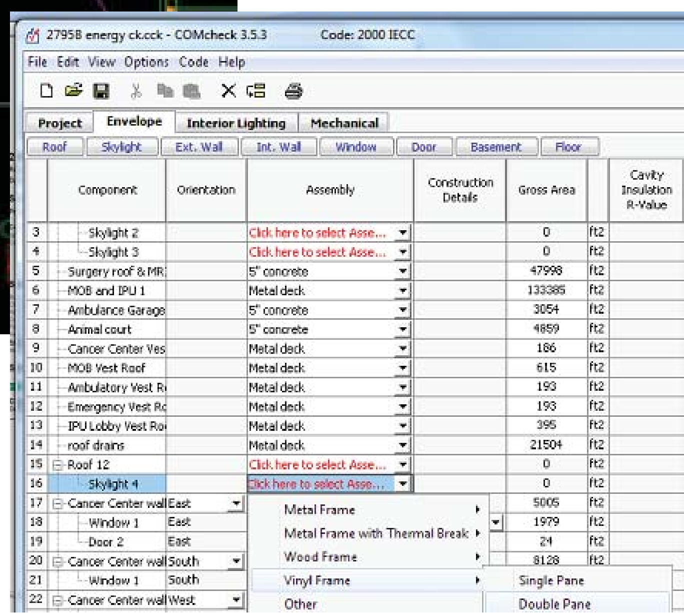
Inpatient Unit 1 3D Ram Analytical Model



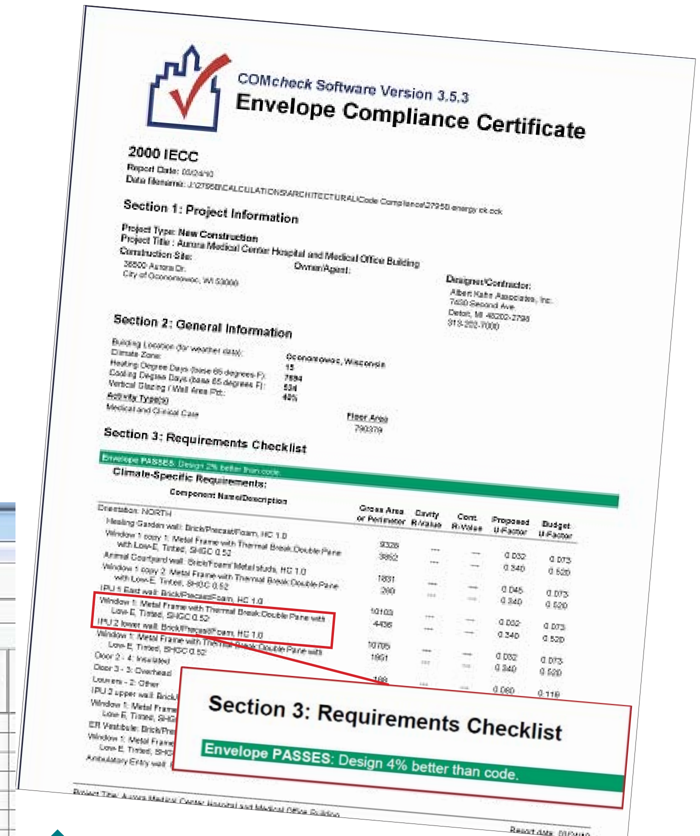
COMcheck is a software tool developed by the U.S. Department of Energy's Building Energy Codes Program. This software simplifies the process of demonstrating compliance with energy code requirements for envelope, lighting, and mechanical systems. Building enclosure elements from BIM were tested and refined in coordination with COMcheck analyses.



The floor plans developed from the 3D Model provided the basis for extracting information for the COMcheck software.



COMcheck input screen: Specific envelope, interior lighting and mechanical data are input into the COMcheck software. This includes specific material components such as skylights and roof drains. Material composition, area, U-Factors are also included.

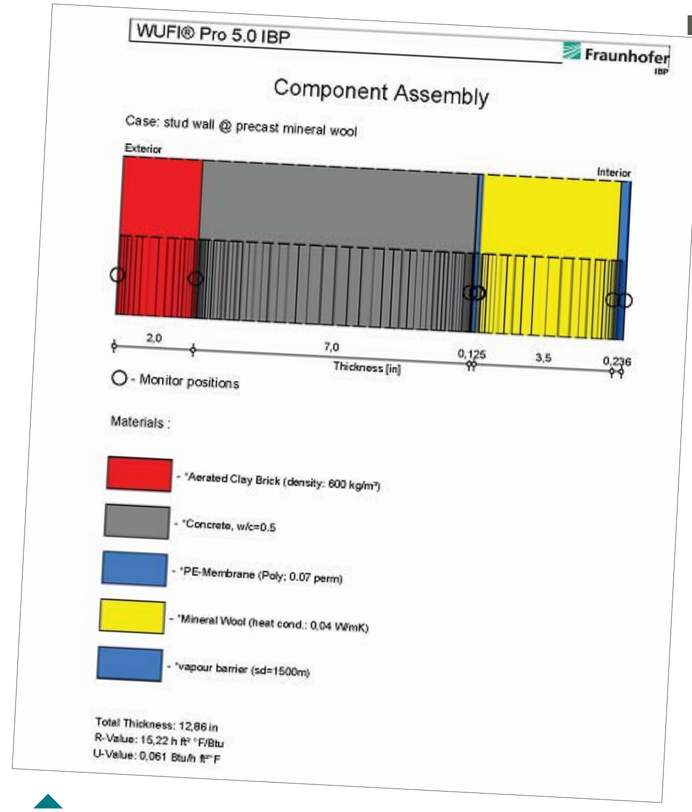


COMcheck Compliance Certificate: This final multi-page report was submitted to the local energy code authority to substantiate code compliance. The Medical Center envelope design exceeded code requirements by 4%.

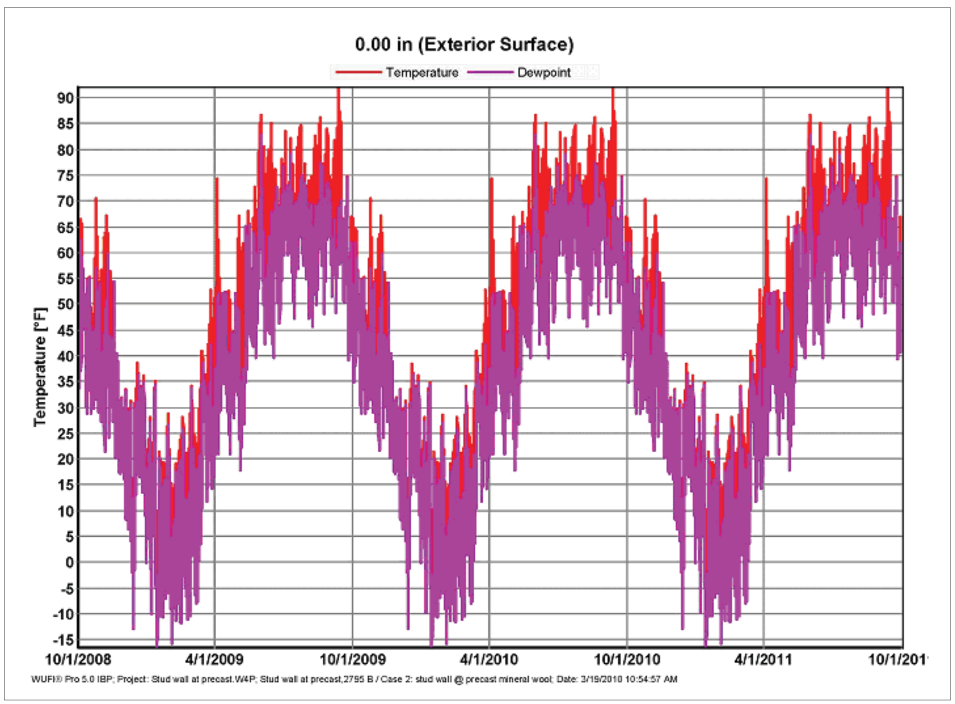
Design: Design Studies

During the design phase, the design team utilized WUFI®, a software for calculating the coupled heat and moisture transfer in building components.

WUFI® (Wärme und Feuchte instationär) is a software family developed by Fraunhofer Institute for Building Physics (IBP) which allows realistic calculation of the transient coupled one- and two-dimensional heat and moisture transport in multi-layer building components exposed to natural weather. It is based on the newest findings regarding vapor diffusion and liquid transport in building materials and has been validated by detailed comparison with measurements obtained in the laboratory and on IBP's outdoor testing field.

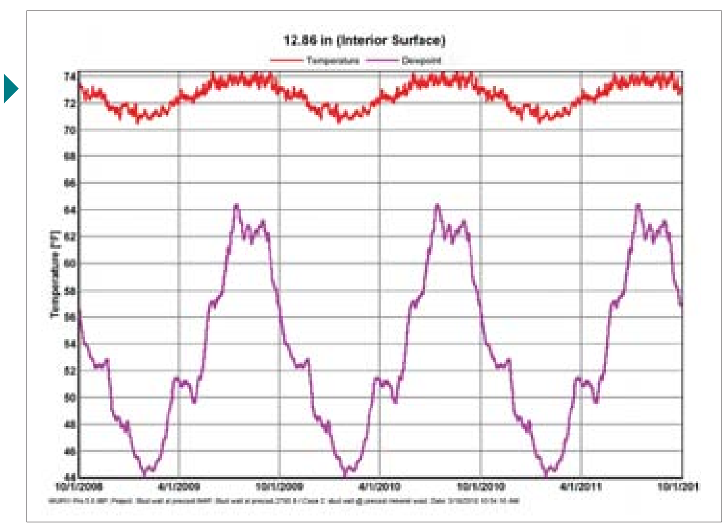


This typical wall assembly used in the project is modeled in WUFI 5.0. Each wall component is assigned a material and thickness. The circles represent monitoring points for determining temperature, relative humidity, moisture content and dewpoint throughout the assembly at any given time. Additionally, WUFI calculates the R-value for the assembly which helped in the selection of energy efficient wall systems. The Medical Center has achieved R-values in excess of 30 at certain locations.



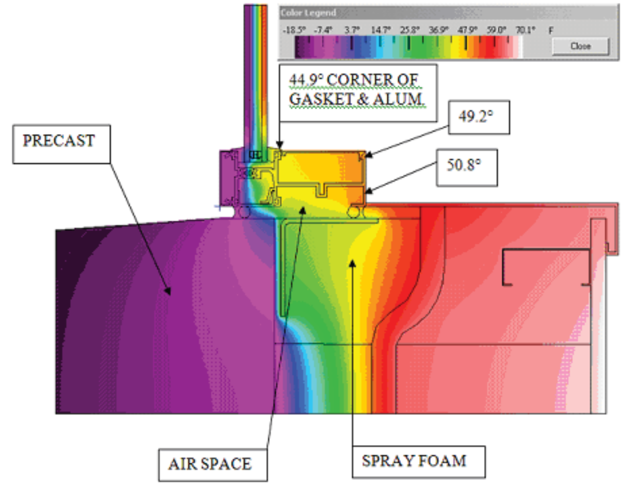
The typical wall assembly is analyzed over a period of years. Inputs include material data, indoor and outdoor weather conditions, inclination and orientation. Outputs include this graph showing the temperature and dewpoint at the exterior face of the wall.

This graphical output at the interior surface of the wall assembly indicates that the temperature is always higher than the dewpoint – this means that there is little potential for condensation on this surface.

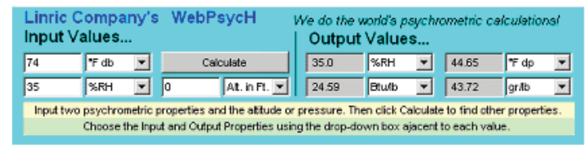


Design: Design Studies

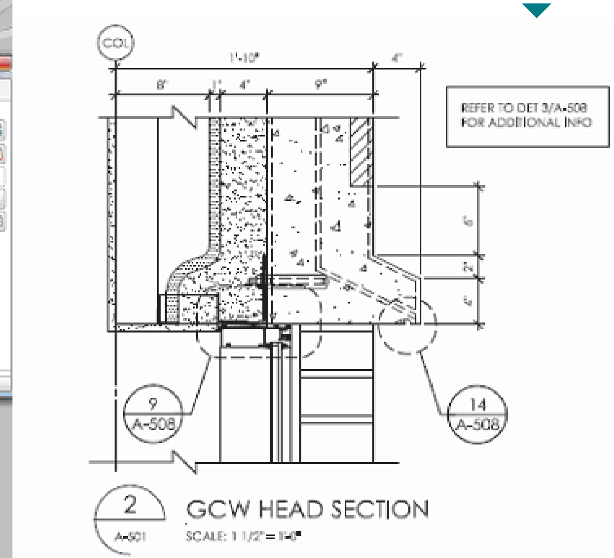
The BIM enclosure model was created and modified to reflect various design studies for the building envelope and energy compliance data coordinates. The modeled exterior wall was refined within the parameters of the building footprint by adjusting components of that wall based on the WUFI data. Vendor input resulted in design adjustments to insulation, glazed curtain wall, precast, and air barriers. Each of these were tested for impact on wall thickness, structure, appearance, and constructability/sequencing. BIM components were also critical in quickly and accurately seeding wall and roof material areas and ratios, even on complex multi-faceted facades, thus enabling COMcheck to function as an integrated design tool to explore multiple design options.

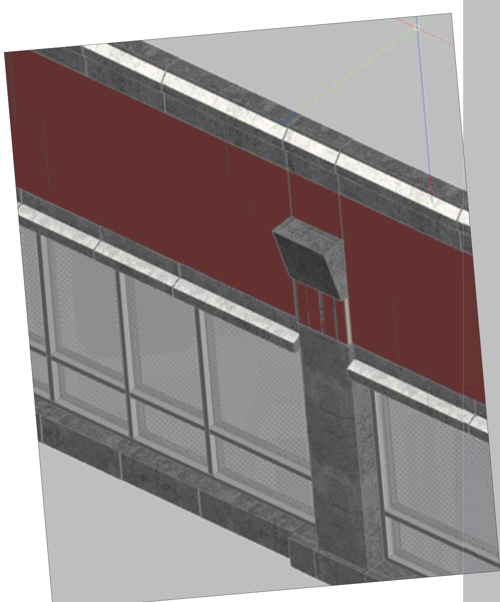


Therm5 Analysis: 3D model is translated into additional analysis software to validate thermal and moisture designs.

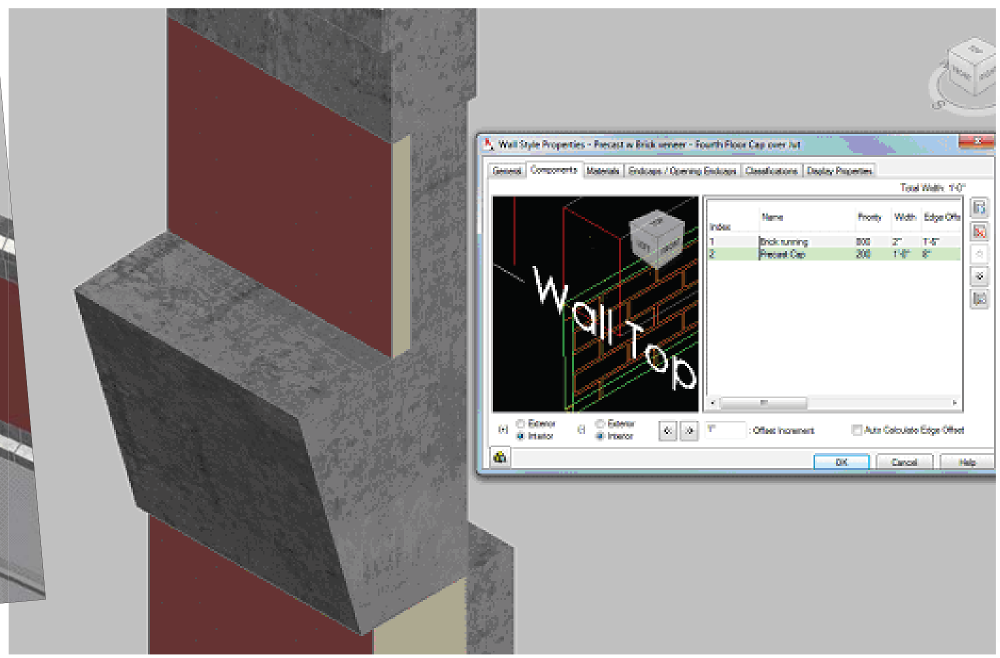


2D detail: 3D model is translated into 2D details for use in construction documents and analysis software.



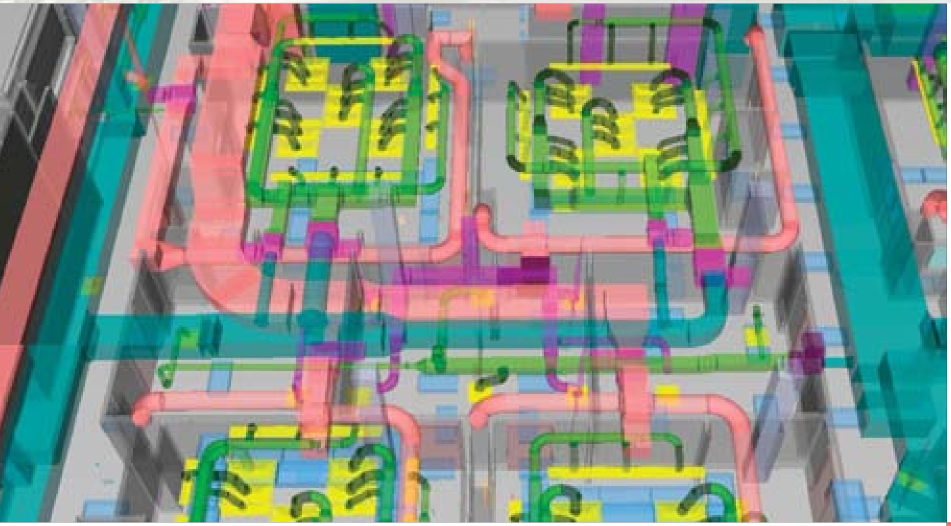


3D Model: Specific components including parapet, glazing and brick configuration were modeled in 3D and informed the envelope analysis software.



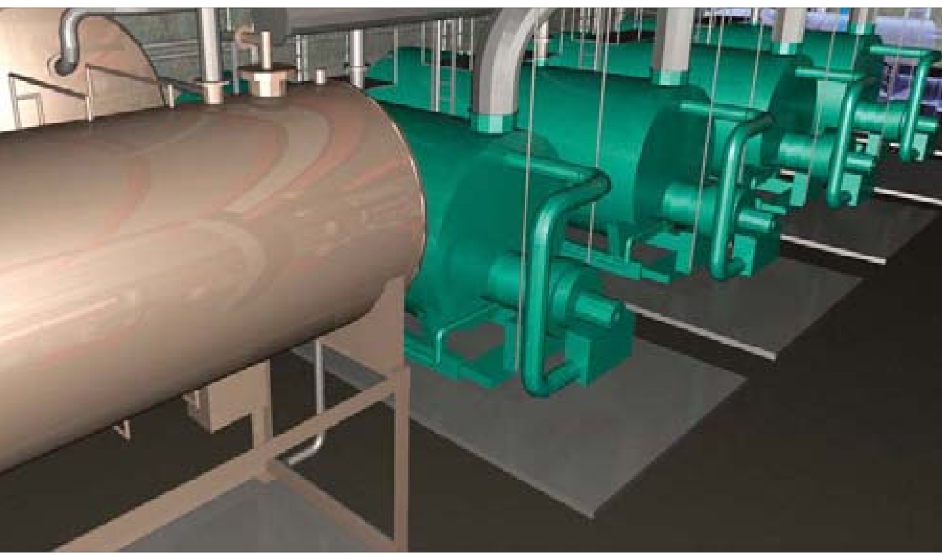
3D Model Detail: Exact details of exterior components are modeled.

Design: Utilizing Building Information Modeling

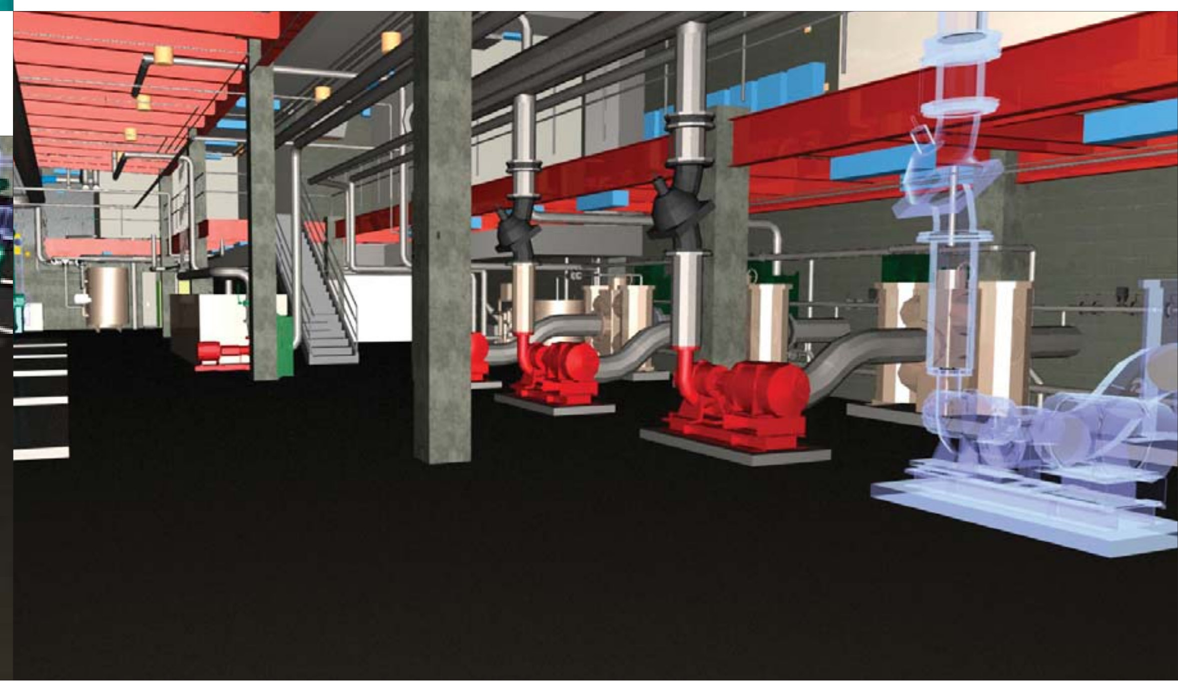


Design team coordination models of the Operating Rooms

The Engineer Consultant applied BIM to design configurations and locations of equipment within the central plant. Using BIM to design the central plant streamlined the field placement of structural, architectural, mechanical, electrical, and plumbing engineering systems in the facility. The team modeled design intent efficiently and accurately. The Architect then utilized Autodesk Navisworks to perform overall cross-discipline coordination with the engineering consultant. The BIM process included regular model reviews by the project team to determine potential conflicts during schematic design. This allowed for conflicts to be reconciled in a structured way, ensuring high-quality deliverables and constructable design intent as the project began to take shape in the field.

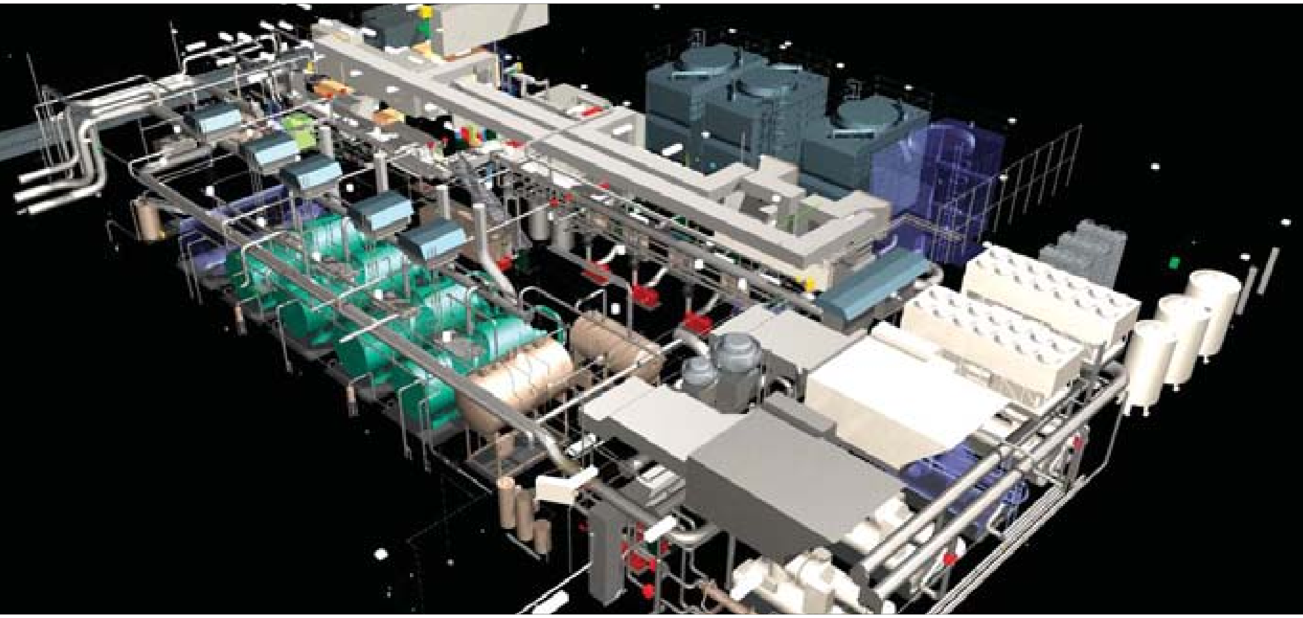


BIM assured precision placement of equipment and piping within the design phase. This initial modeling laid the groundwork for improved safety, a faster schedule, and off-site fabrication of assemblies.



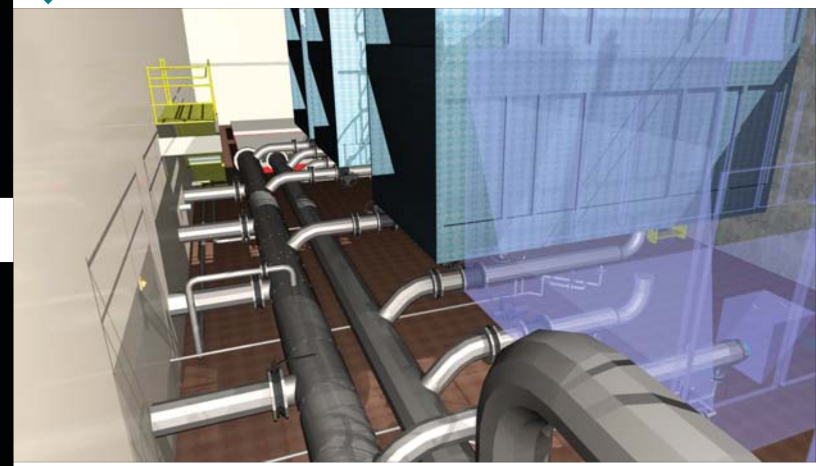
BIM streamlined the design and construction process and conveyed configuration and location of equipment accurately for installation as well as for future equipment needs.

Design: Utilizing Building Information Modeling

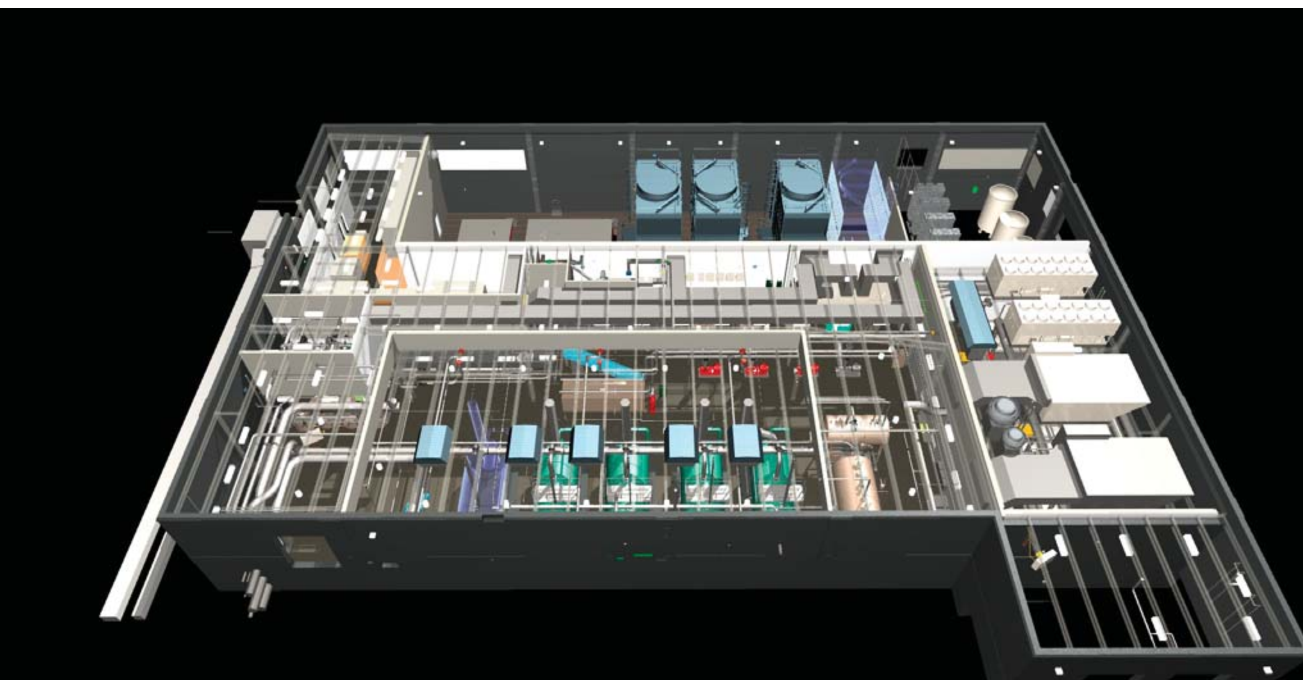


During design of the systems, BIM allowed for better coordination of all disciplines and more flexibility to accommodate scope changes.

The Engineering Consultant utilized BIM to identify design conflicts prior to construction. BIM also allowed for space planning for future equipment.

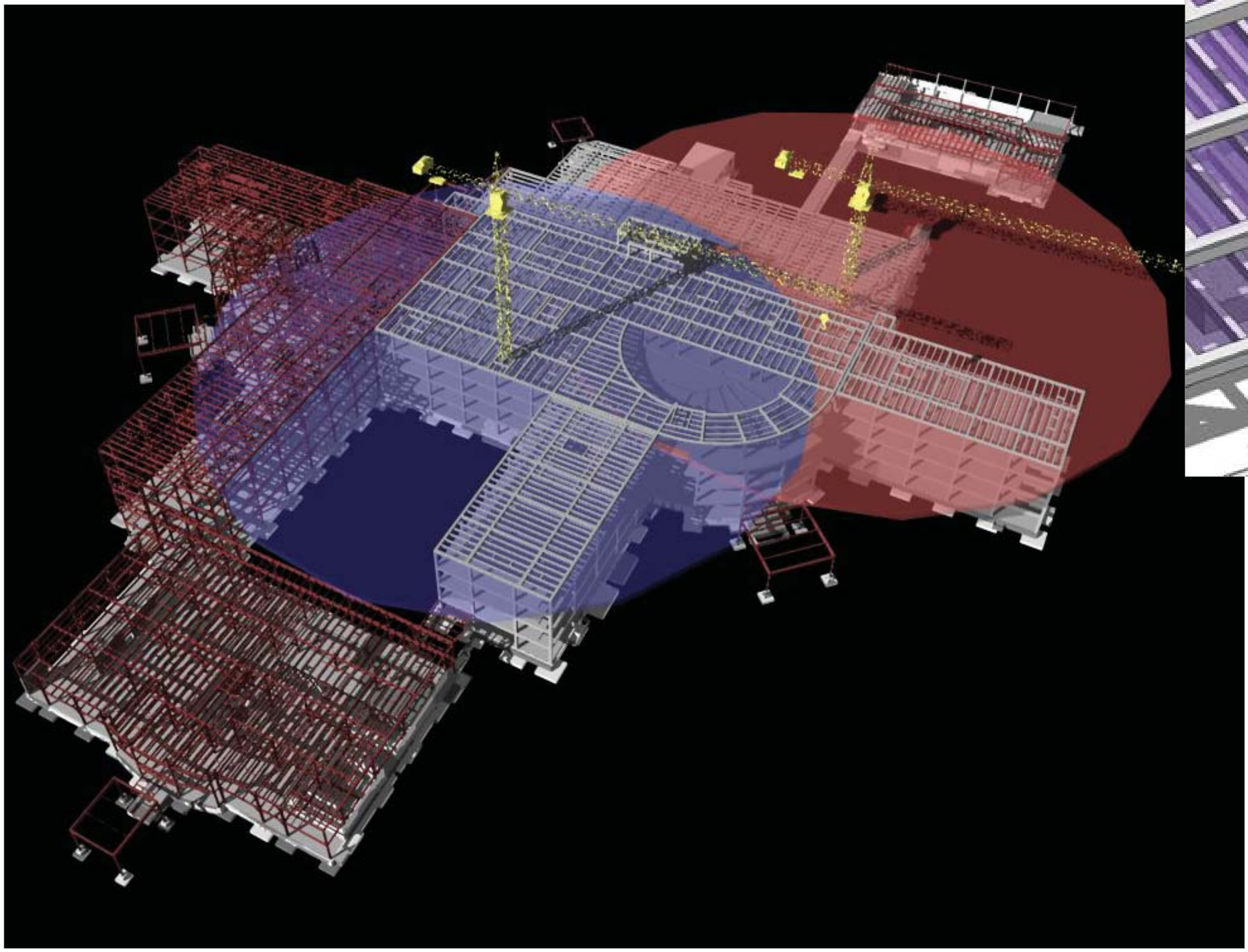


From the start of the project, the BIM model was built with the intention of producing information to support the owner's maintenance team after completion.

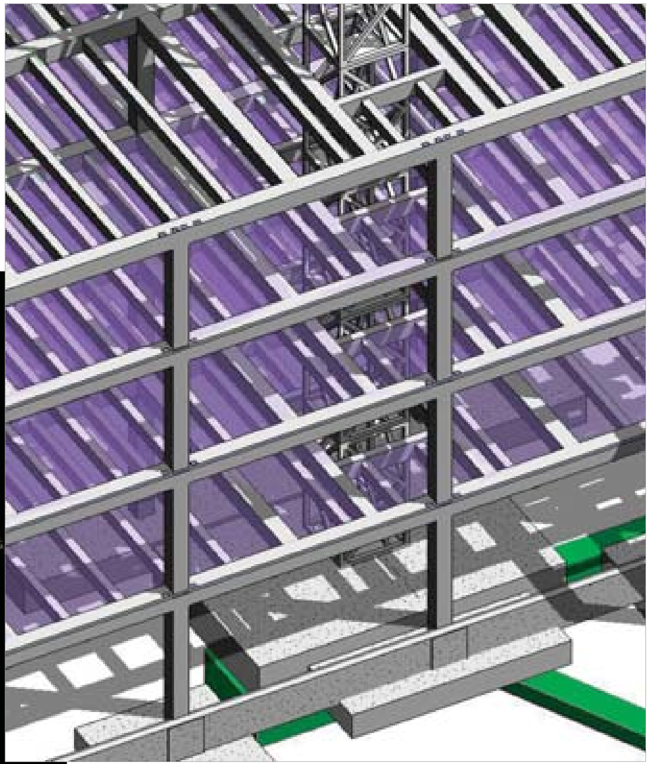


Construction: Site Planning

Prior to the onset of construction, the Construction Manager began building the site planning and coordination model using BIM. The team modeled the necessary locations for each tower crane and determined the best size and placement for each crane. The model ensured the cranes would be able to accommodate all concrete and precast picks for the project as well as logistic phasing for the large equipment.



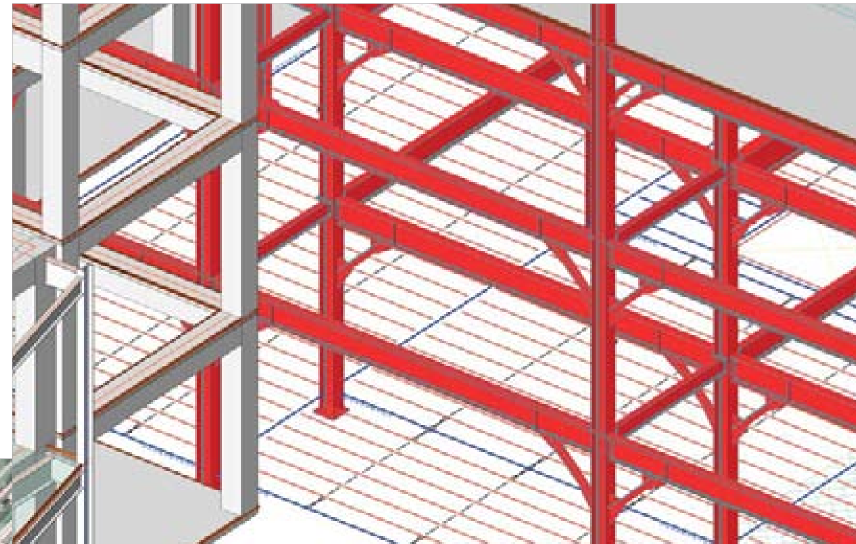
The radii of the tower crane boom swings were incorporated to help visualize and select the proper crane sizes.



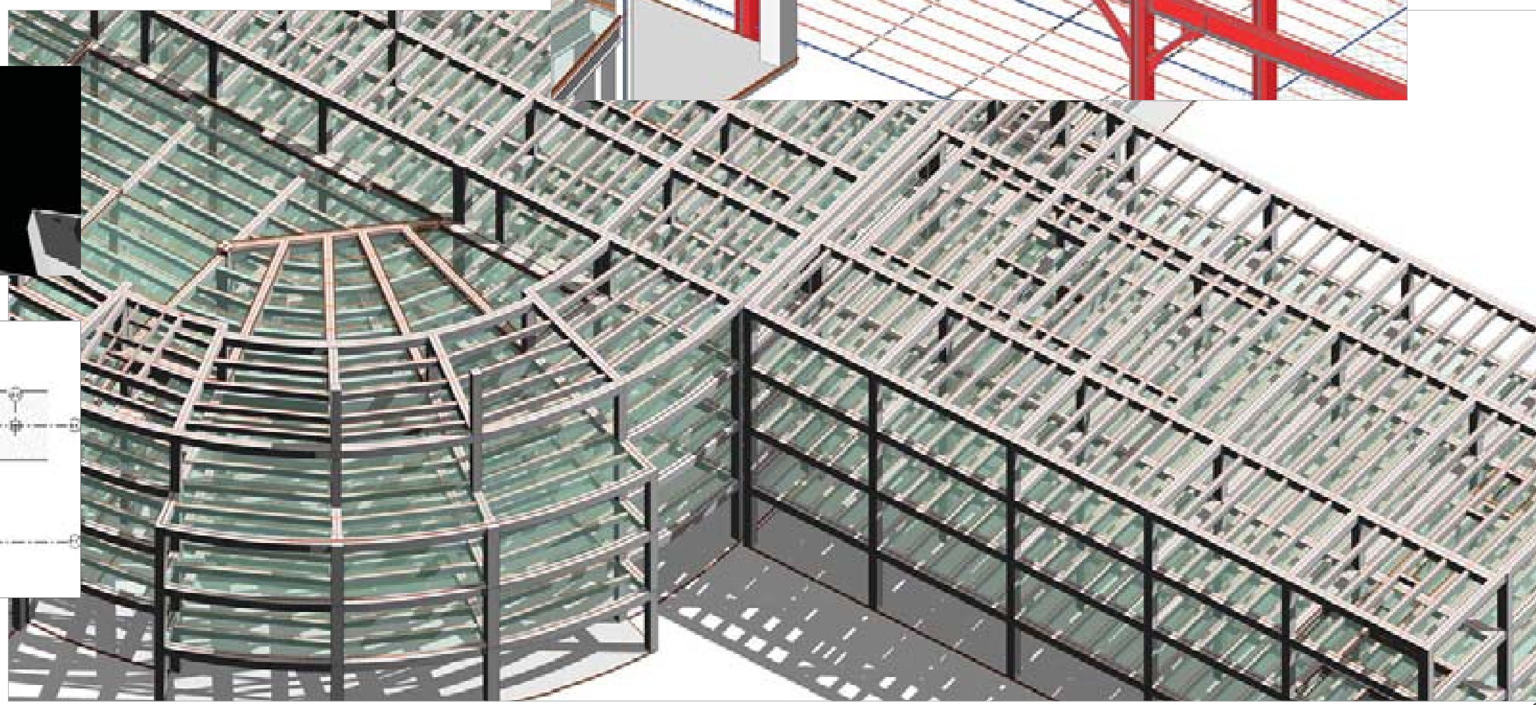
Early in the construction phase, the tower crane footings and temporary power supply were added to the model for analysis and as-built documentation.

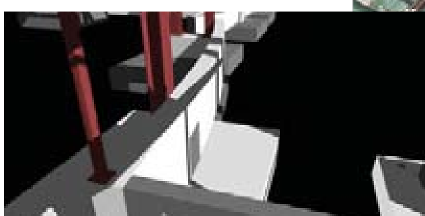
Construction: Concrete & Steel Model

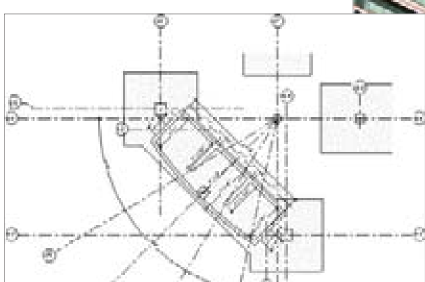
The virtual construction of the Medical Center allowed for a seamless transition from design to construction. During the early stages of the design phase, the concrete structure model was used to ensure that the design incorporated future components and that construction crews could begin to pour the building's footings and foundations while the design was being further developed. Concurrently, the team incorporated the structural steel, concrete superstructure models, and the underground utility models into the Navisworks Central Model.



Revit structure model with steel fabrication model incorporated.





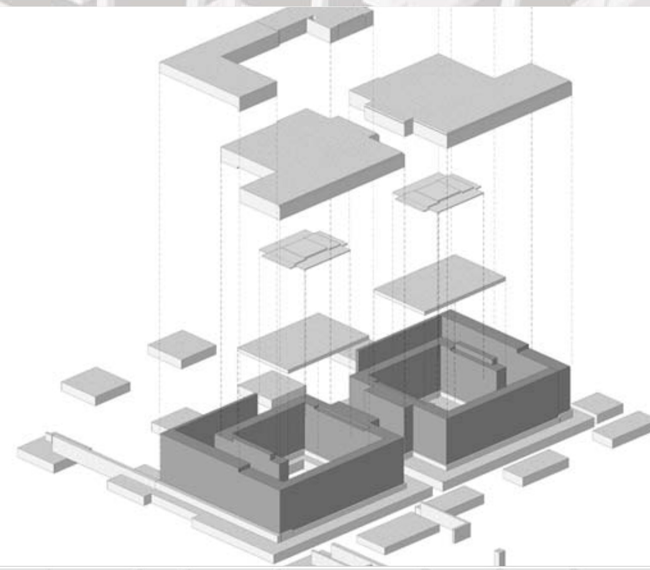


Radius structure layouts were provided directly to the field from the Revit Structure model.

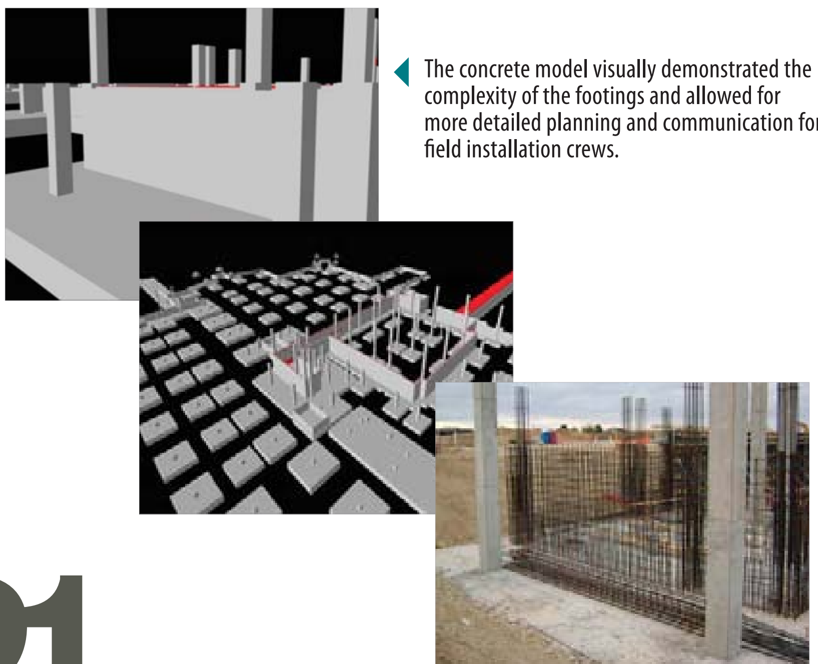
Revit Structure concrete model.

Construction: Concrete Lift Drawings

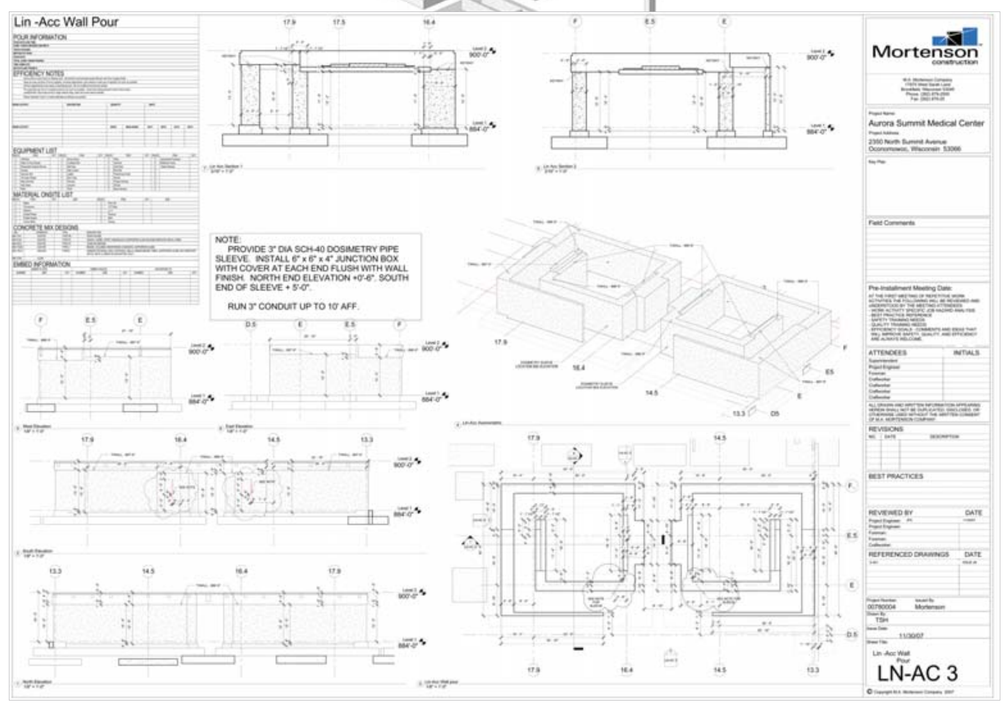
With the incorporation of future design considerations, over 120 concrete lift drawings were published from the Revit Structure model and served as a single source of information for the foremen. This process allowed for quick mobilization and expedited concrete pours prior to the building's final design. When applicable, the lift drawings also included specific placement of piping sleeves directly into the concrete pour, specifically those through the grade walls and decks. This direct placement during the concrete pour eliminated the potential need for costly sleeve coring after the initial concrete pour.



Concrete assembly model for Linear Accelerator chambers.



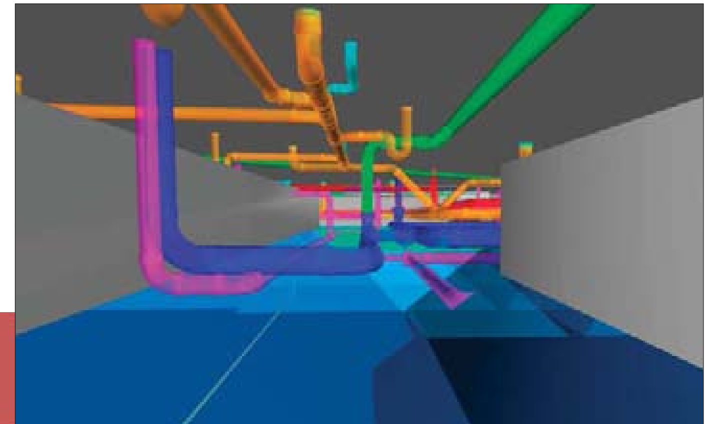
The concrete model visually demonstrated the complexity of the footings and allowed for more detailed planning and communication for field installation crews.

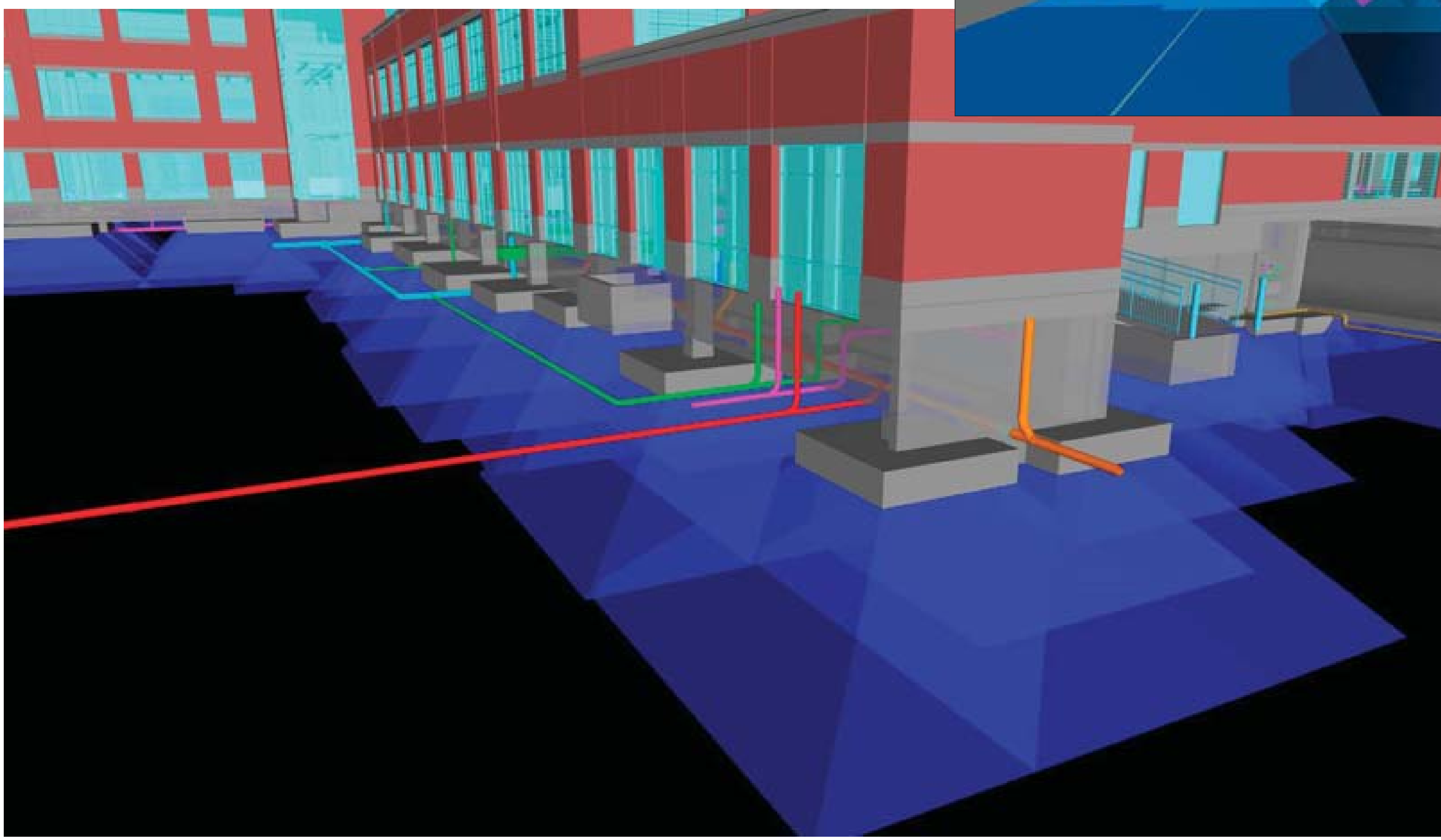


Example of lift drawing developed for Linear Accelerator concrete pour.

Construction: Angle of Repose

During the planning stages of construction, the angle of repose was modeled to accommodate underground electrical duct banks and plumbing piping. The model ensured all concrete footings remained structurally sound while underground utilities were being installed.



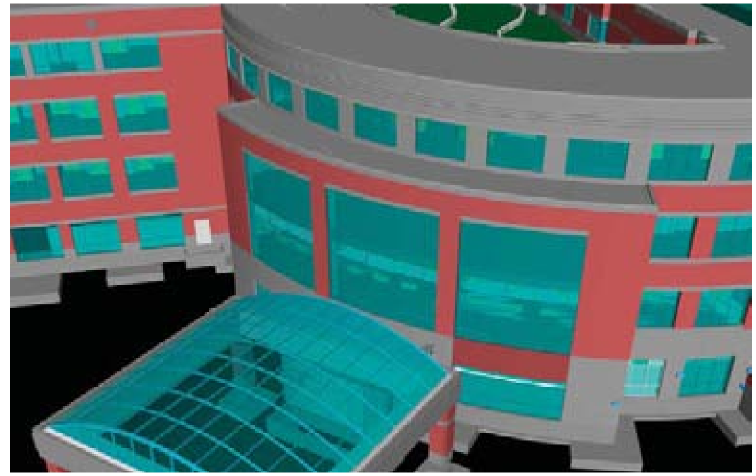


Example of angle of repose model highlighting concrete footings and underground utilities.

Construction: Enclosure

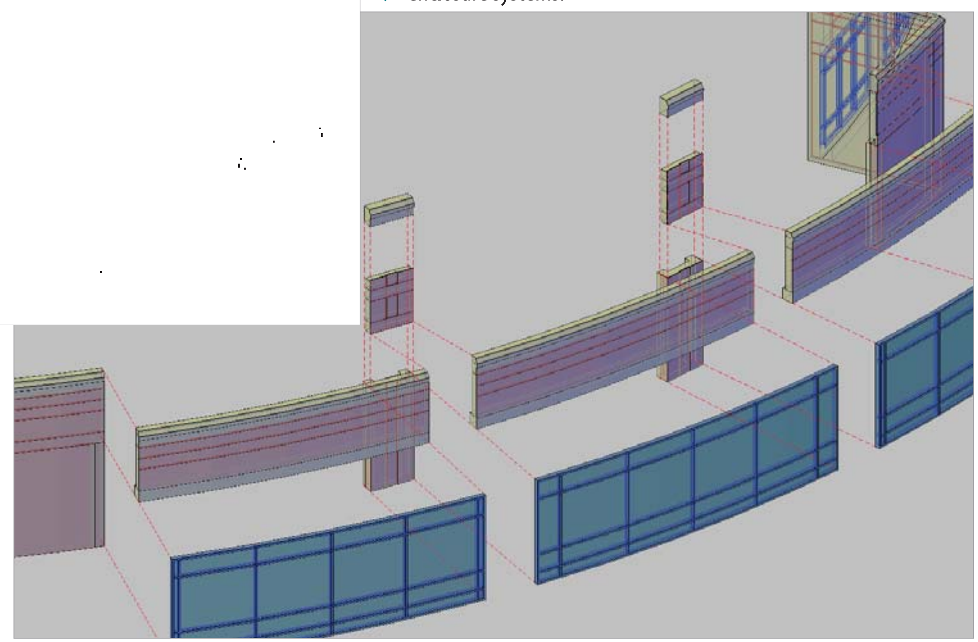
All 3D model components were developed into physical shop drawings to ensure that construction matched the design intent. 3D drawings of the enclosure systems provided construction crews with a road map for both verification and quick installation of the building's prefabricated precast panel enclosure system. The off-site prefabrication, craftworkers verification, and quick installation of the building's enclosure saved crucial time in the construction schedule.

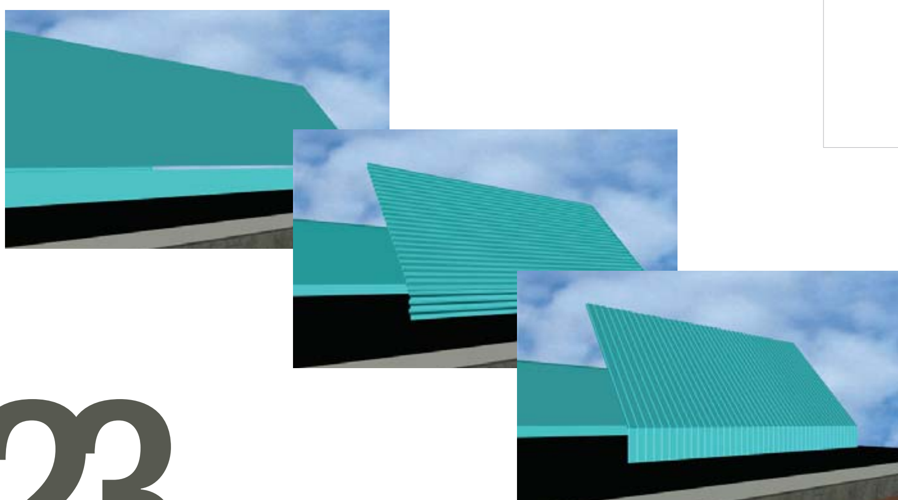
As the design and HVAC requirements evolved, modeling of the building's trademark screen wall confirmed that the air intake to the air handling units might be compromised if not properly coordinated. Using BIM, a variety of solutions were proposed and presented to the project manager and owner. Based on the modeled options, they selected the most aesthetically appealing option.



The precast enclosure system was modeled for true panel dimension and shape.

Shop drawings outlined the construction of the exterior enclosure systems.

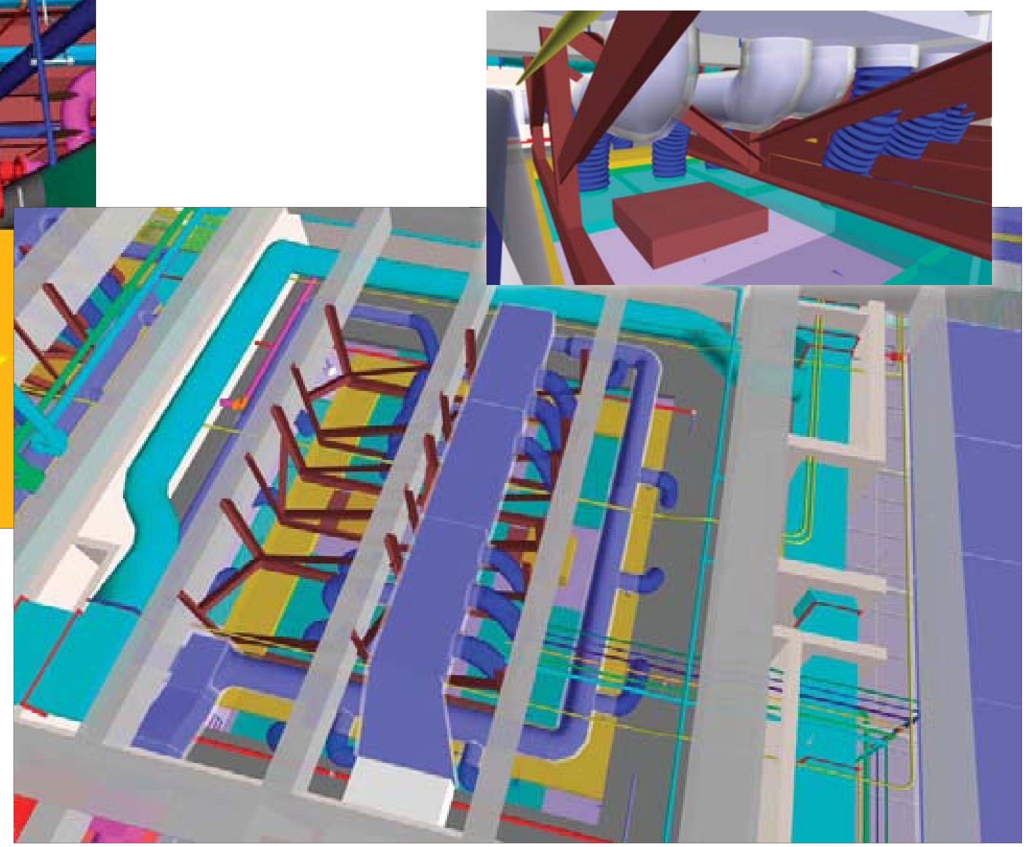




Construction: MEP/FP Systems

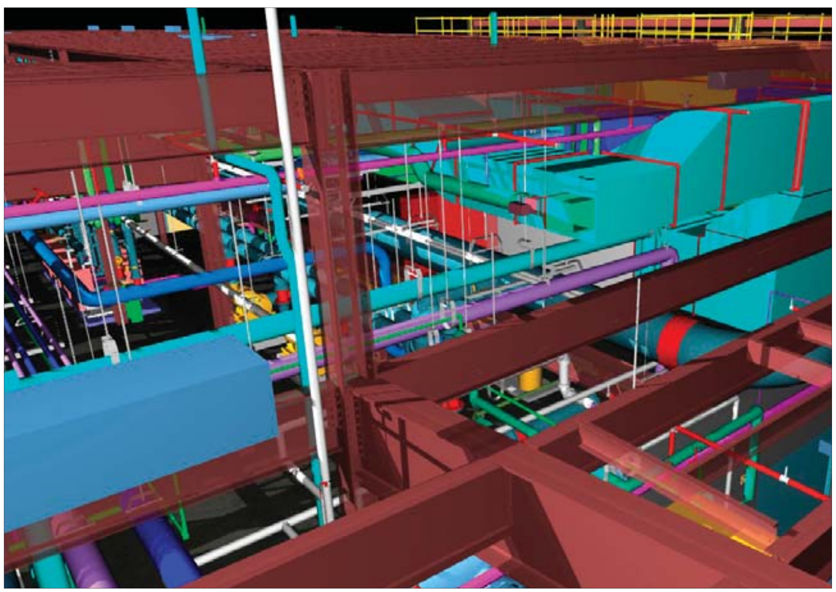
The Construction Manager's BIM coordinators managed the precise incorporation of the architect's, engineering consultants', and subcontractor models and their respective building components into one Central Model. Once integrated, a significant coordination effort was implemented, clash detection programs were run, and modifications were made when necessary.

View of Central Utility Plant including "Green Machine" filtration system, boilers, and structure mounted piping with coordinated hangers.

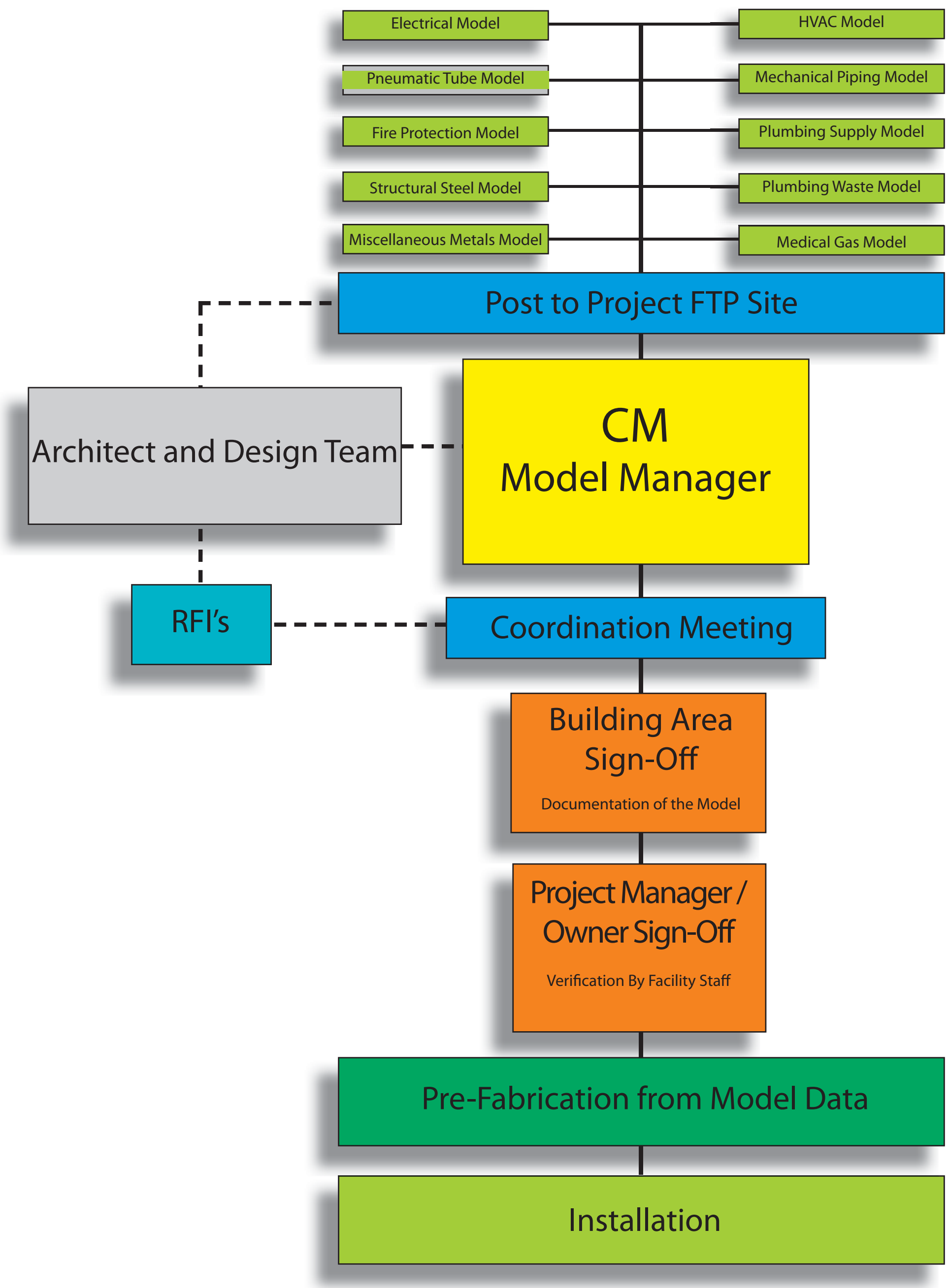


Structural steel supporting operating room equipment with mechanical systems incorporated.

Very unique to this project, BIM professionals from the design, engineering, and construction team, as well as all major subcontractors, were centrally located on-site. This centralized, collaborative team was in daily communication throughout the 9-month coordination effort. The team divided the building into 39 manageable areas to complete the overall coordination and to facilitate the fast-paced 23-month construction schedule. The on-site accessibility to each other allowed for easier coordination efforts and model modifications. Additionally, the Medical Center's future facility manager was on-site throughout construction and was able to work directly with the design and construction BIM teams to map out future maintenance needs of building systems.

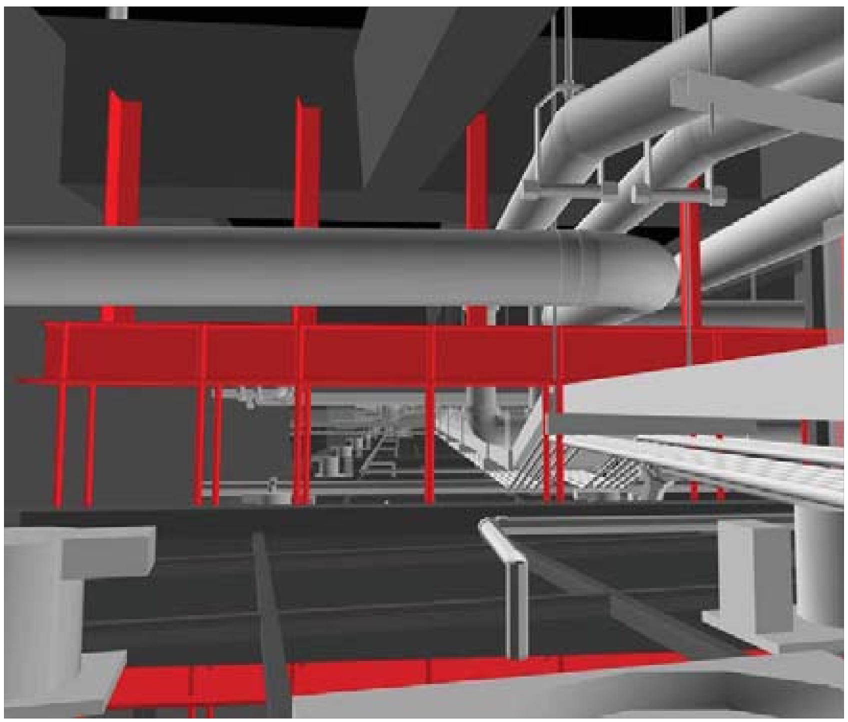


The constant coordination and collaboration of all team members in the modeling and installation of all MEP/FP systems was absolutely essential given the magnitude of MEP systems on this project.



Construction: Interiors

The coordination methodology utilized for the above ceiling systems was also carried through to the interior finishes of the Medical Center. Finish ceiling elements and owner provided equipment were incorporated into the model to ensure design aesthetics coincided with system requirements. Light fixtures, wall-mounted equipment, select furniture items, and life safety equipment were all verified within the coordination model prior to installation.



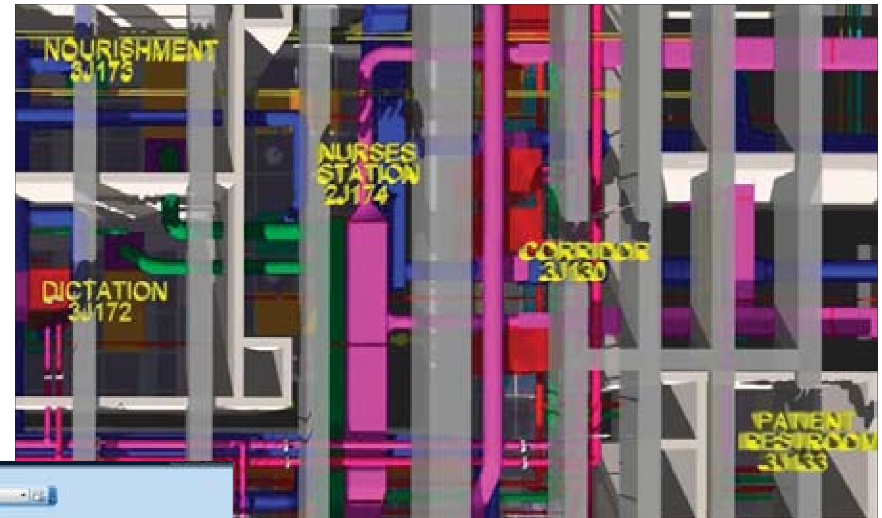
WON Doors were coordinated with both MEP/FP systems and architectural elements that would be seen by end users.

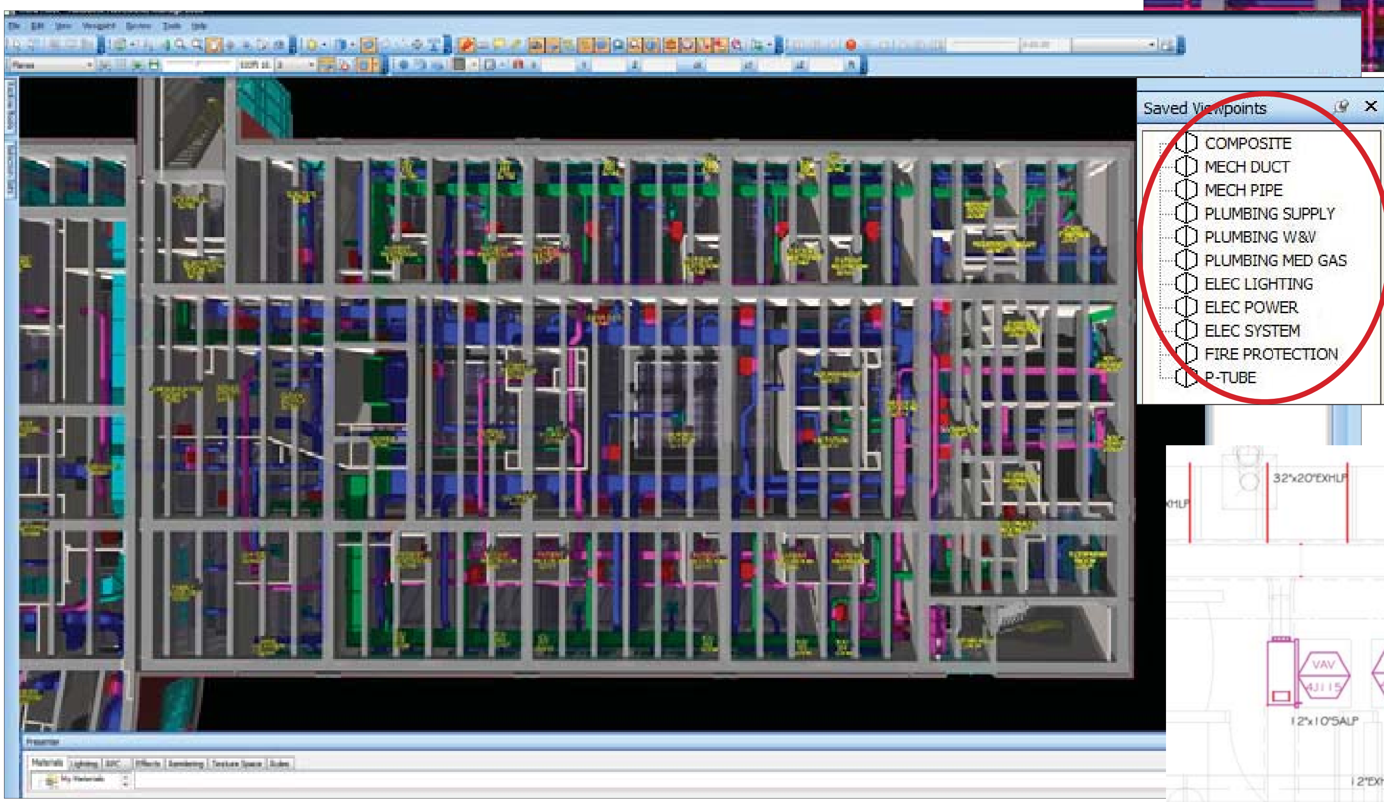
By incorporating architectural elements such as ceiling soffits, types, and fixtures, the coordination of the Medical Center design was taken to a level of detail not yet seen for this size of project.

Building Maintenance: 27

Future Model Use

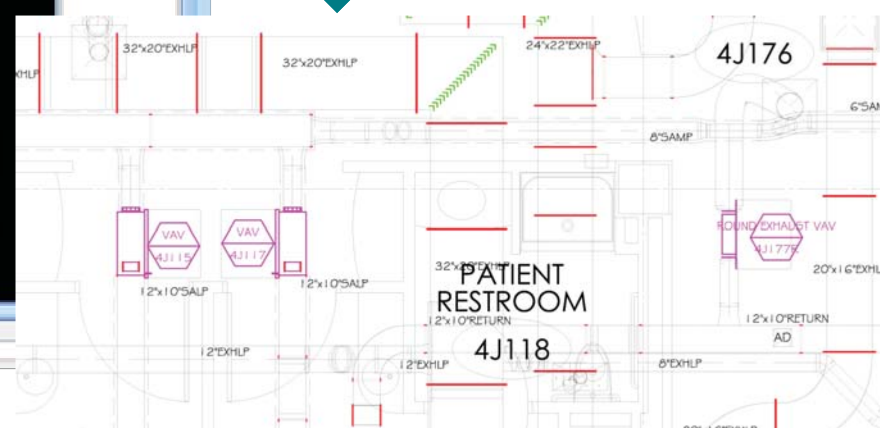
Coupled with the architect's on-site training that provided an overview of code and regulatory requirements to the Owner's facilities staff, BIM seamlessly linked pre- and post-occupancy life safety and maintenance strategies. In addition to BIM use throughout the design and construction phases, the Owner received and will utilize the final as-built model in their day-to-day facility management of the Medical Center. The model enables facility and maintenance professionals to identify MEP Systems. This will serve as a valuable resource for future renovations and expansions, their location, and their relationship to other building components.



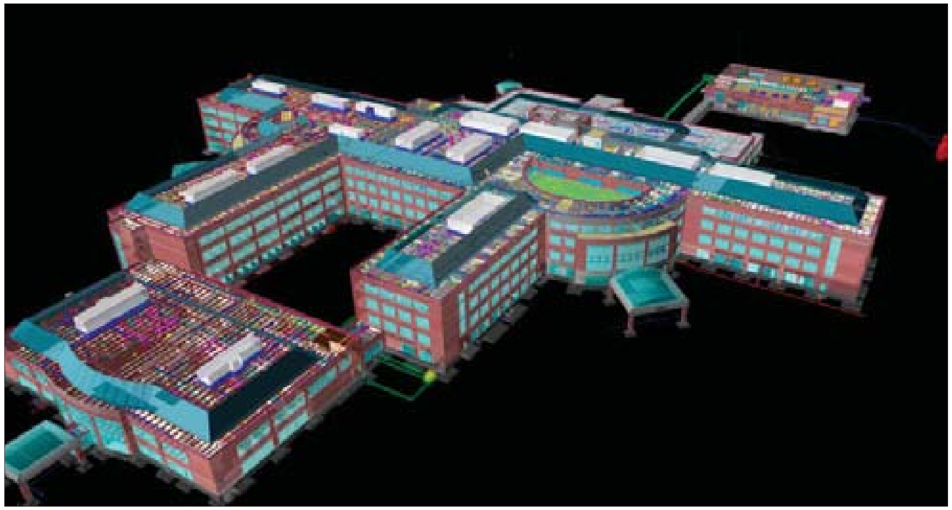


Based on early discussions with facility staff and the BIM model, custom model view points were created to enable the project owner to select viewable systems and components depending on their need.

Final as-built documentation provided the owner with accurate model information communicating the location of vital maintenance points such as VAV units and valves.



Summary: Tangible Benefits of BIM



BIM proved critical in the overall success of the Medical Center project. With BIM processes and technologies in place from the start of design through occupancy, the project team was able to develop innovative solutions, implement technology-based techniques to increase productivity, ensure quality, and meet the project schedule. A large factor that attributed to this success was the collaboration and co-location of the BIM staff from the design and construction teams. By being able to readily access model information, provide fast and innovative solutions for the field crews, and ensure design intent early throughout the project, the Medical Center is a prime example of how utilizing BIM can be beneficial during all phases of a project.

BIM PRODUCED QUANTITATIVE, MEASURABLE RESULTS INCLUDING:

- **Meeting an accelerated fast-track schedule:** Conventional construction schedules would have taken on average approximately 36 months to construct without the use of BIM; This team delivered this facility in 23 months. The faster delivery is a direct result of BIM and the project team collaboration.
- **Increased concrete installation efficiency:** In total, the team produced more than 100 lift drawings which significantly decreased the industry standard of concrete installation and saved the Owner an estimated $200,000 to $225,000.
- **Design option visualization:** Various visualization options were created for this project. One example included screen wall visualizations. These were proposed to the Project Manager and Owner to successfully accommodate the air intake to air handling units while maintaining the trademark screen wall. The Owner selected an option that met the design intent with significant savings in potential material and design time.
- **Accessibility and clearance zones:** Clearance zones were coordinated around the 1200 VAV boxes of the project to ensure ample room for preventative maintenance; A clear path to each device along with the as-built BIM model will save the owner significant time and money each year .
- **Production Savings through Prefabrication:** Due to the model geometry and data being transferred directly into the subcontractor's fabrication equipment, an overall savings of 10% of the MEP/FP cost was seen from eliminating in-field waste, direct field installation of components, and faster production due to prefabrication.
- **Built Right the First Time:** The use of BIM on the project allowed for design changes and systems coordination to be incorporated and proven early. By providing this level of detail within the model, the amount of re-work based on misinterpretation of documents or systems coordination was eliminated.