Benjamin D. Hall Interdisciplinary Research Building

Design. Build. Operate. Maintain.

2007 BIM AWARDS

AIA Technology in Architectural Practice

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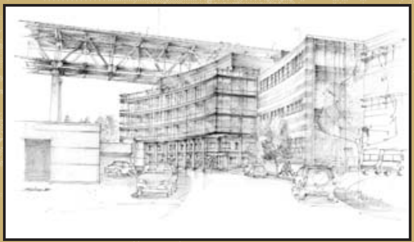
Architect's Statement

The University of Washington needed to design and build a lab facility to accommodate numerous science initiatives that didn't fit neatly into the traditional university environment. They wanted to deliver this building more quickly and cost effectively than usual, with a 30-year fixed cost of operations.

Through their detailed Design-Build-Operate-Maintain RFP, the University extensively defined building performance levels. Program requirements meant a large design team had to work closely together from the outset, especially given the building site's curved shape, significant slope and shallow water table. Other concerns included noise and vibration from an overhead interstate highway bridge, on-site parking requirements, and building access.

Although zoning regulations implied a maximum of five stories, the team delivered a six-story building by careful integration of MEP systems. BIM technology allowed development of appropriate building set-backs to meet zoning requirements; it also assisted in development of a 1½-story below-grade parking garage with entries on two grade levels.

By enabling the team to confront problems early, foresee problems before they developed, and rapidly solve problems that did arise, BIM was a key factor in the project's end result—an aesthetically pleasing, cost effective, and functional building that superbly meets the University's needs.



BIM was a key factor in the project, enabling the team to foresee problems before they developed

DESCRIPTIVE DATA FORM

Submission Categories:
B: Design/Design Delivery Process Innovation Using BIM
D: Outstanding Design for Fabrication Using BIM

Type of Construction: New

Site Area: 42,705 sf **Acres:** 1

Building Area	New	Renovated	Total
Total Gross Square Feet (GSF)	150,989	N/A	150,989
Net Assignable Area (NAA)	98,991	N/A	98,991
Building Efficiency Ratio (GSF/NAA)	1.52	N/A	1.52

Project Delivery Type: Other: Design-Build-Operate-Maintain

Costs: Estimated (actual costs are confidential)

Site Development Costs:	$322,762
Building Costs:	$24,228,636
Total Construction Cost:	$24,551,398
Building Cost/GSF:	$162.60 (shell and core)

Status of Project: Completed (shell and core)

Year of Completion: 2006

Contractor's Statement

The University of Washington sponsored a Design-Build-Operate-Maintain, or DBOM, competition to address their need for a building to house scientific research to be delivered more quickly and cost effectively than their conventional process allowed, and with fixed costs of operations for 30 years. The result was a first-of-its-kind, landmark delivery model for the University. As winner of the DBOM competition, the contractor collaborated with the architect and operations and maintenance partners to deliver the new $25 million Benjamin D. Hall Interdisciplinary Research Building.

The core-and-shell project was completed in March 2006, and tenant improvements are being phased over the next three years as space is leased. The contractor-led DBOM team is also fulfilling the 30-year operations and maintenance needs in the facility. The building is able to accommodate tenants of practically any size and research need, and its systems allow any tenant the flexibility of choosing a research space that fits their needs.

The DBOM team has been truly innovative in, and remains committed to, exploiting Building Information Modeling in all aspects of the project. The model has proven comprehensive and durable enough to assist in all phases of the project lifecycle—from conception, through design and construction, to operations and maintenance.

DBOM team has been truly innovative in exploiting BIM in all aspects of the project

Owner's Statement

The University of Washington congratulates the project team on the successful delivery of the Benjamin Hall Interdisciplinary Research Building, the University's first Design-Build-Operate-Maintain project. The team delivered the project ahead of our schedule and within budget, while exceeding our quality and scope expectations.

Traditionally, the University offers research space at no charge to the tenant. Learning from the private sector, we constructed the building core and shell, while tenants pay for their own improvements. This approach enables tenants to design their own space, encourages integration of long-term building operation and maintenance issues early in the project design, incorporates sustainability, and substantially reduces costs and risks to the University.

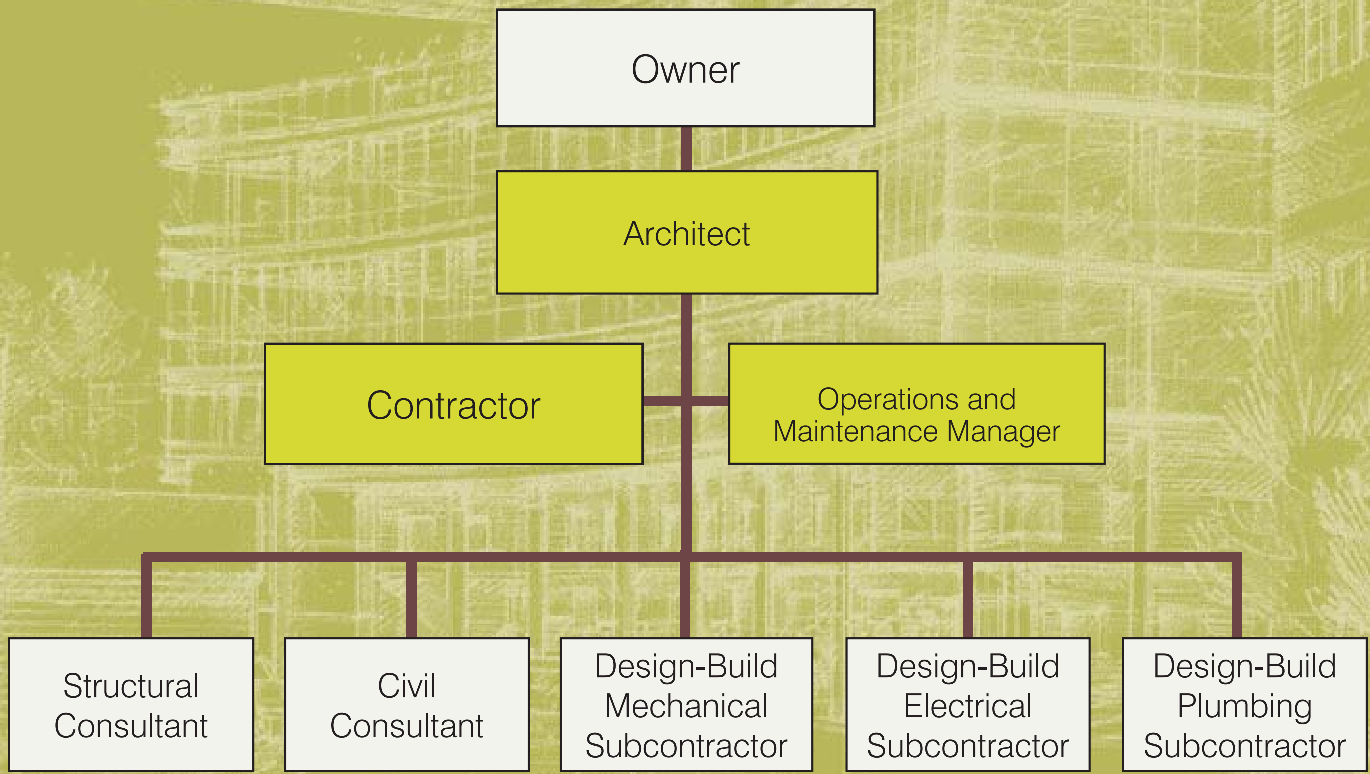
The DBOM approach challenged traditional design and construction methods, and fostered innovation with new technologies. Nothing illustrates this more dramatically than the project team's dedication to BIM, and its exhaustive application towards every aspect of design and construction.

The University is now focused on building occupancy and operations, and we are very pleased with the outcome. The collaborative effort exhibited by the contractor, architect, and maintenance partners reflects a genuine team spirit. Working together with the University, the DBOM team has made this project a success in every way.

the DBOM approach fostered innovation with new technologies

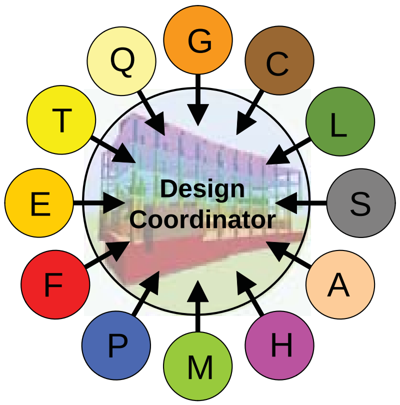
The Design-Build-Operate-Maintain project team exhibited a strong, interdisciplinary, collaborative spirit—always focused on doing what was best for the project. BIM played an effective, regular part in project team collaboration, fostering communication and understanding in owner's meetings, design discussions, trade/subcontractor meetings, and in operations and maintenance today.

Benjamin D. Hall Interdisciplinary Building
Design-Build-Operate-Maintain
Team Organization



BIM played an effective, regular part in project team collaboration

BIM Scope



G	General Conditions
C	Civil/Site
L	Landscape
S	Structural
A	Architectural
H	HVAC/Sheet Metal
M	Mechanical Piping
P	Plumbing
F	Fire Protection
E	Electrical
T	Telecom
Q	Furniture, Fixtures, & Equipment

The Design Coordinator resides at the hub of BIM on the project, managing all interdisciplinary model creation, coordination, and interoperability.

Design Coordinator Role

The DBOM team used 3-D models as a primary medium in construction, augmenting and sometimes replacing traditional 2-D construction drawings. To be successful with BIM, the team developed and maintained strong project processes and standards to ensure data interoperability among a plethora of software applications. To manage BIM and apply it across the lifecycle of the building, the contractor created the role of the Design Coordinator.

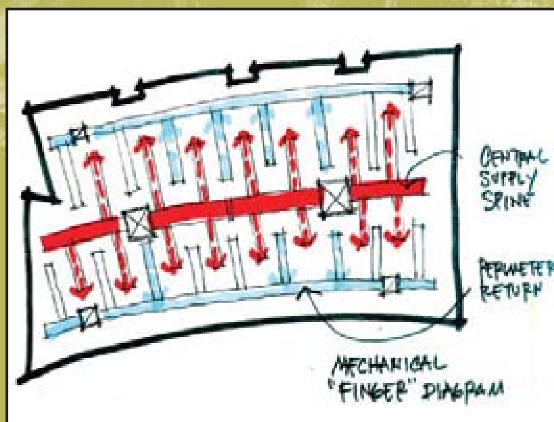
The Design Coordinator, a registered architect, leveraged BIM:

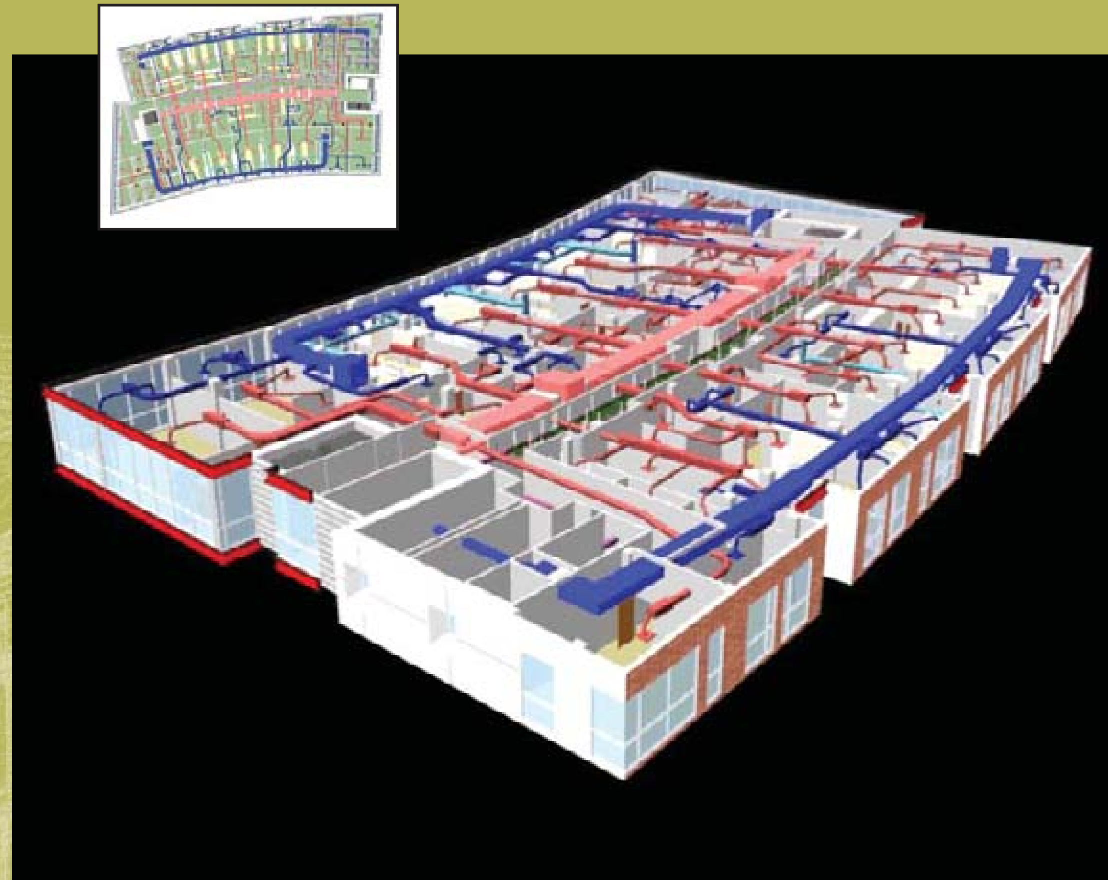
1. To ensure the constructability of the project during design, and
2. To protect the integrity of the design during construction.

models augmented and replaced construction drawings

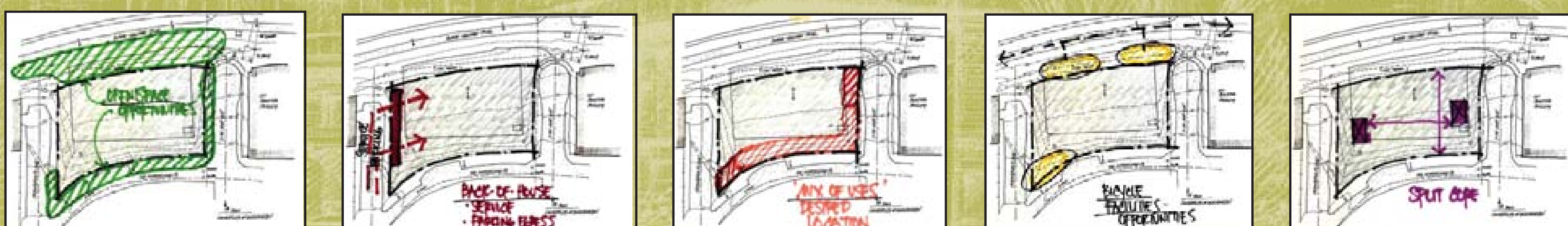
Conceptual Design

The DBOM team proposed a project with a tight floor-to-floor height and an extra floor in the building, providing 14% more leasable floor area than was requested. They analyzed and established this concept with a 3D model, which addressed the owner's concerns with the team's approach and gave them the confidence to select the proposal.





An innovative approach to mechanical systems layout was demonstrated early in the project with a 3D model.



14% more leasable area was established with a 3D model

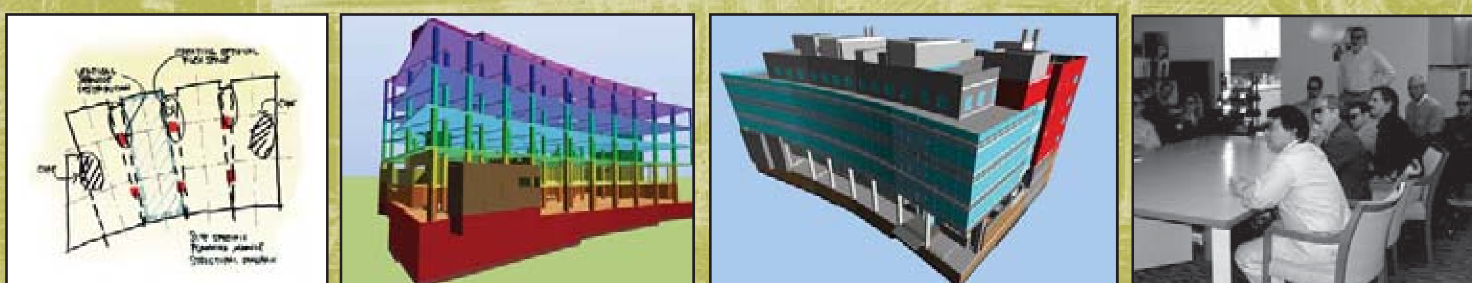
2 Design Visualization

By visualizing the model, the team gained rapid comprehension of complex spatial conditions. BIM enabled early and collaborative decision-making, lowering the impact to project costs. Design expertise was embedded in the model to shape and control the design by verifying zoning envelopes and code clearances volumetrically. Also, BIM supported the study of various solutions for sustainability, contributing to LEED Gold certification for the project.

the team gained rapid comprehension of complex spatial conditions

BIM enabled early and collaborative decision-making

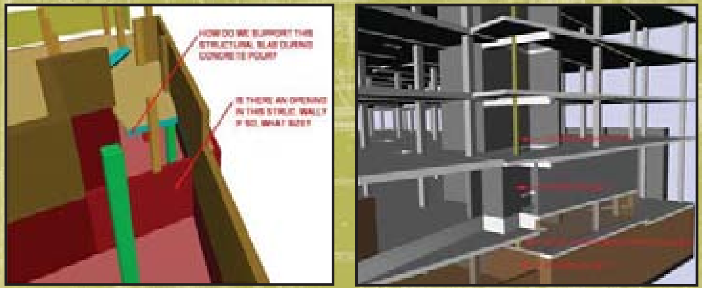
Real-time design visualization of the model provides end-users with an understanding of their proposed tenant improvements, and enables them to revise the design before it is built.



The project team used stereoscopic tools to visualize the design spatially, immersively, and in real-time.

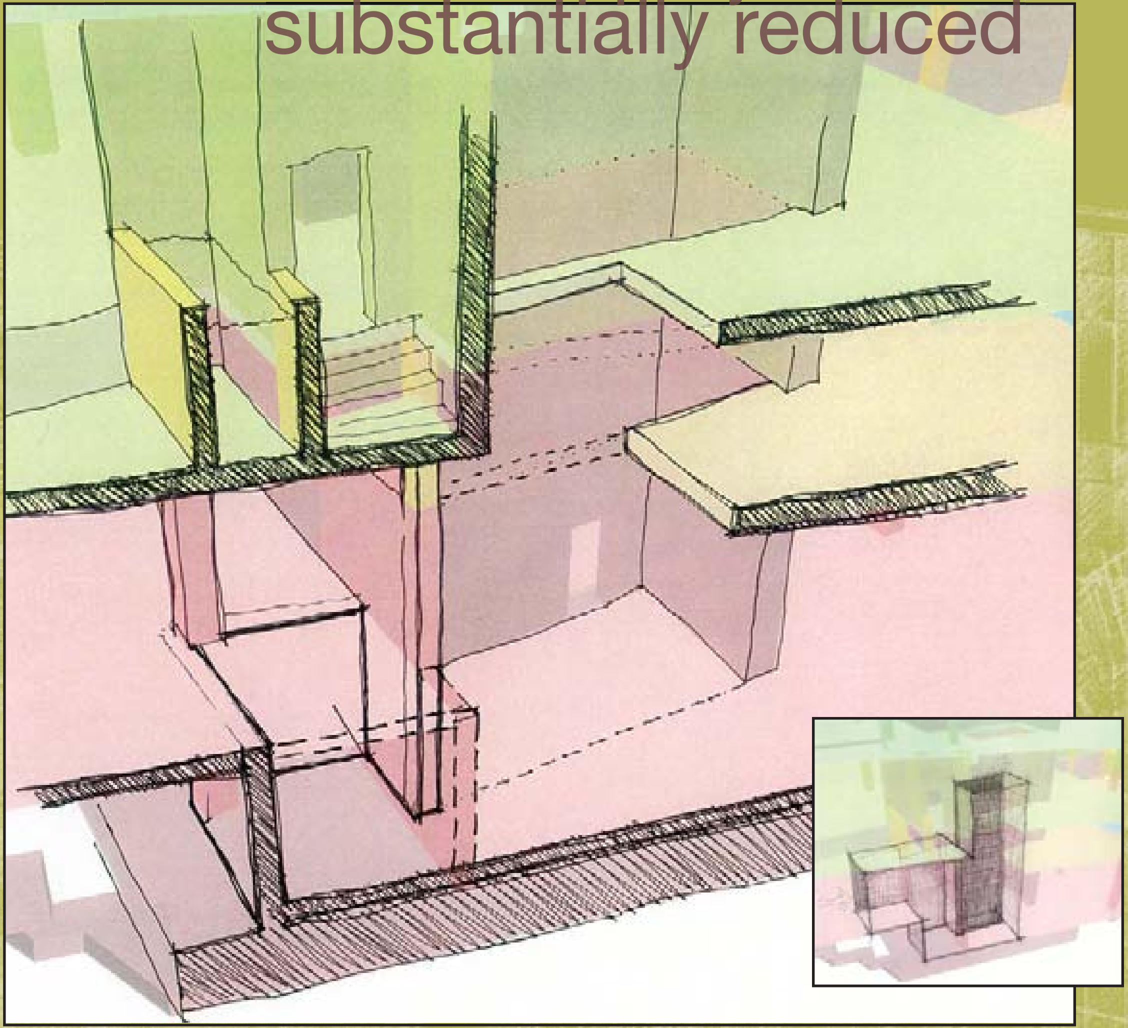
3 Constructability Review

The team relied on BIM to analyze various construction methods and techniques, which enabled them to inform the design team members of potential opportunities for efficiency while maintaining design intent. They also relied on the BIM to quickly communicate last-minute design revisions while work was underway in the field. Because of this, rework on the project was substantially reduced. This reduction in rework greatly contributed towards increased safety on the project, where the construction team worked over 162,000 hours without a single lost-time incident.



The project team used the model to analyze constructability, ensuring high-quality construction in a safe working environment.

rework on the project was substantially reduced

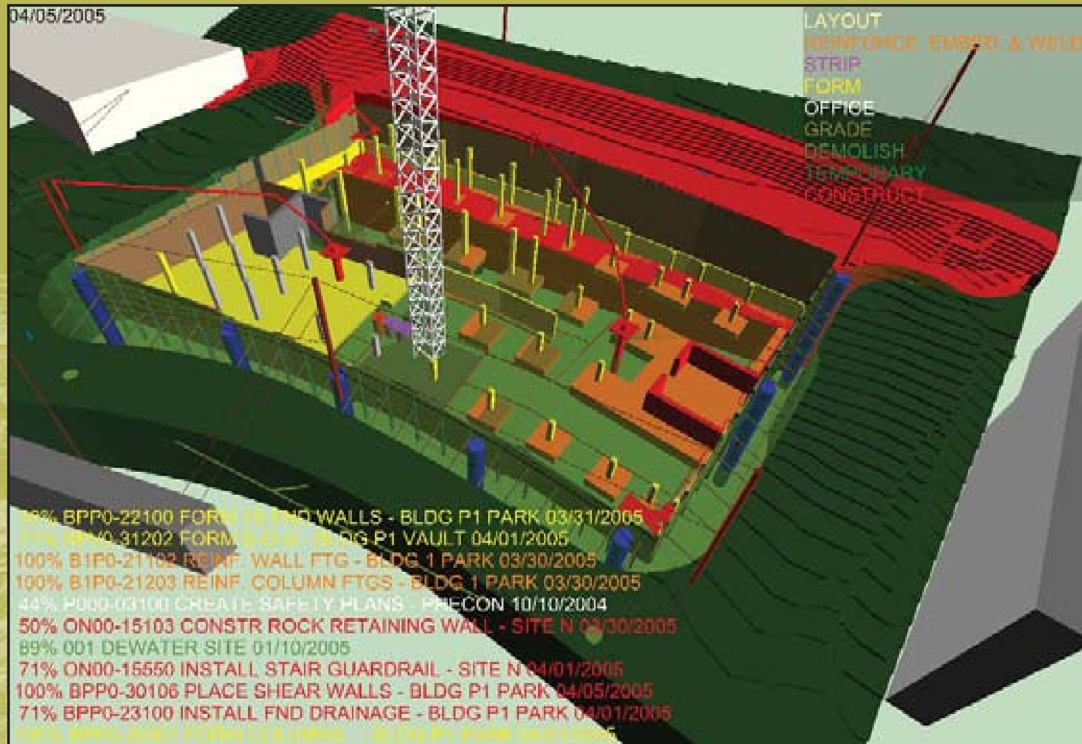


BIM was used to support and communicate last-minute design changes to this ventilation shaft, while concrete work was underway.

over 162,000 hours without a single lost-time incident

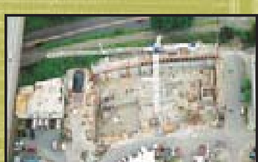
4D Scheduling

The project team integrated BIM with time to develop "4D" simulations of the project schedule. These simulations enabled optimization of the schedule and reduction of the project construction time. They also enabled the communication of detailed work sequencing to particular trades working around each other. With the help of 4D simulation, the project was completed 40% faster than the owner's traditional delivery schedule.

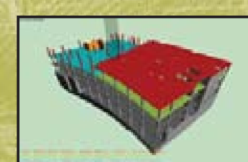
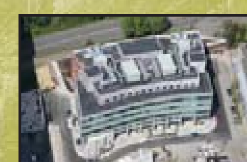


BIM was integrated with a detailed project schedule to communicate sequence of work to subcontractors.

with the help of 4D simulations, the project was completed 40% faster

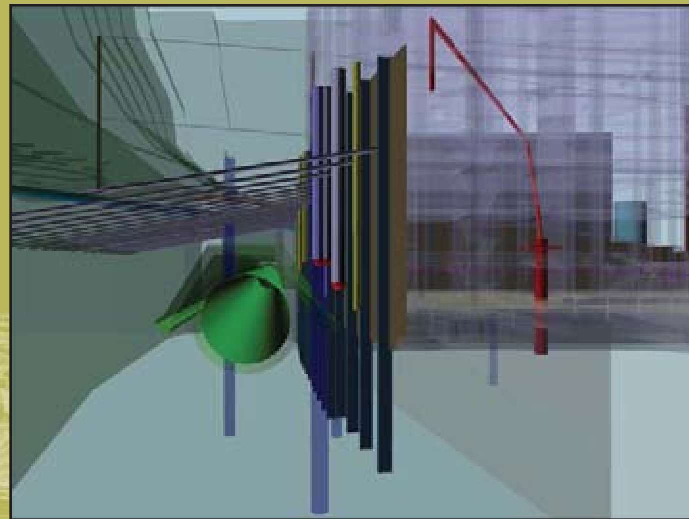




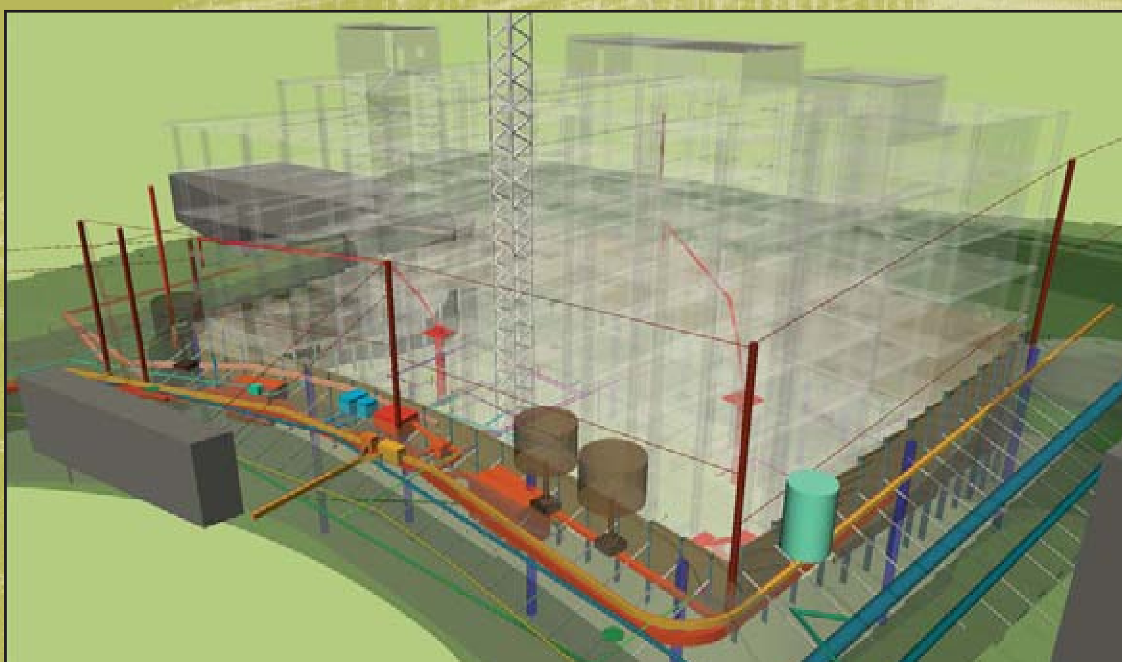
Site Utilization and Civil Work

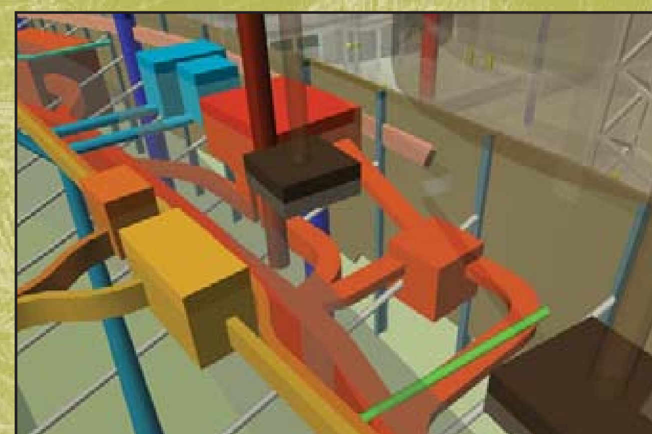
The detailed BIM featured complex underground conditions, including existing and proposed utilities, dewatering, excavation, shoring, tiebacks, laydown zones, hoisting, and placing. This allowed coordination and communication with local review agencies and utility companies who struggled to understand intricate routing of underground work from their own 2-D documents, and enabled the project to proceed without costly delays.



Site work was precariously close to a major sanitary sewer line, and the team's ability to communicate with review agencies using BIM decreased the dewatering and shoring schedule from months to just days.

BIM allowed coordination and communication with local review agencies, enabling the project to proceed without costly delays



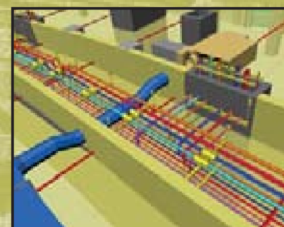


The BIM illustrated complex routing of underground utilities and enabled agencies to revise their plans to route their work before it became a problem in the field.

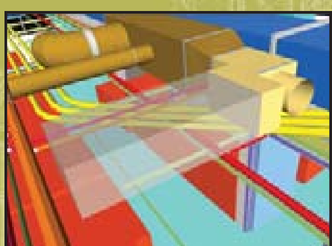
6 Building Coordination

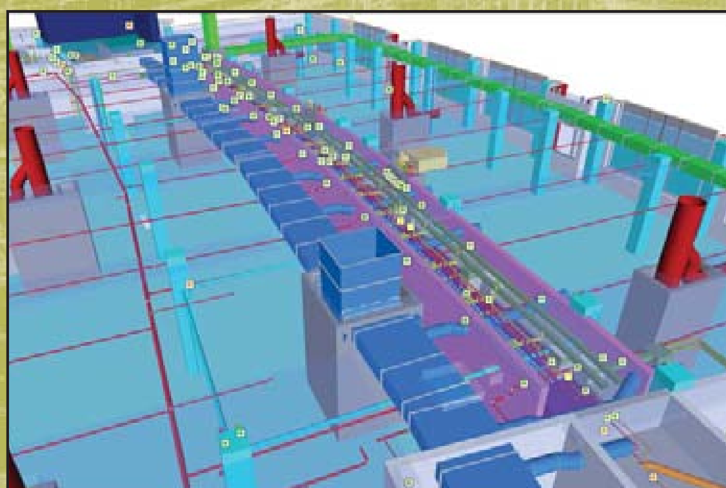
In lieu of a detailed set of 2-D construction documents, the team relied heavily on BIM to develop detailed simulation to coordinate all building trades and systems, including architectural, structural, and MEP systems. With an emphasis on face-to-face collaboration, designers and detailers solved problems in real time, and worked with interoperable clash-detection tools to sift through potential conflicts in the building. Using BIM, over 1,500 systems conflicts were discovered and resolved before they became problems in the field. This intense, collaborative effort with BIM resulted in an 80% reduction in RFIs per dollar of construction compared to non-BIM projects.

80% reduction in RFIs with BIM



Designers and detailers representing civil, structural, architectural, interiors, landscaping, sheet metal HVAC, mechanical piping, electrical, and fire protection used clash-detection tools and face-to-face collaboration to coordinate building systems.



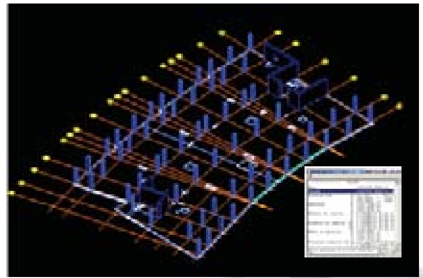


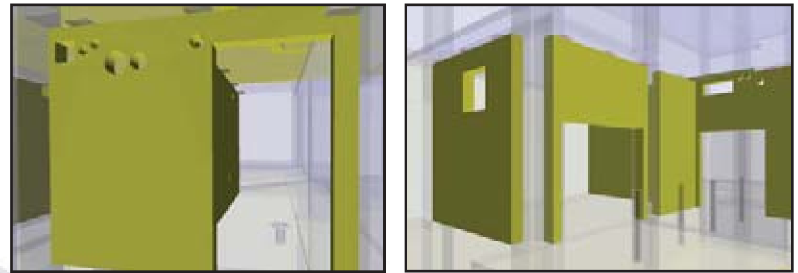
Our BIM simulations included volumetric representation of all sleeves, blockouts, clearances, and access zones to protect the design intent and balance it with the future needs of operations and maintenance.

resolved over 1,500 systems conflicts using BIM, before they became problems in the field

7 Quantity Takeoffs and Procurement

The team used the BIM to survey quantities of building materials, elements, and system components, as well as to quantify the volume of concrete for each pour. Some work was procured directly from these estimates, and subcontractors were able to confidently and accurately bid on their scopes of work upon reviewing the BIM.





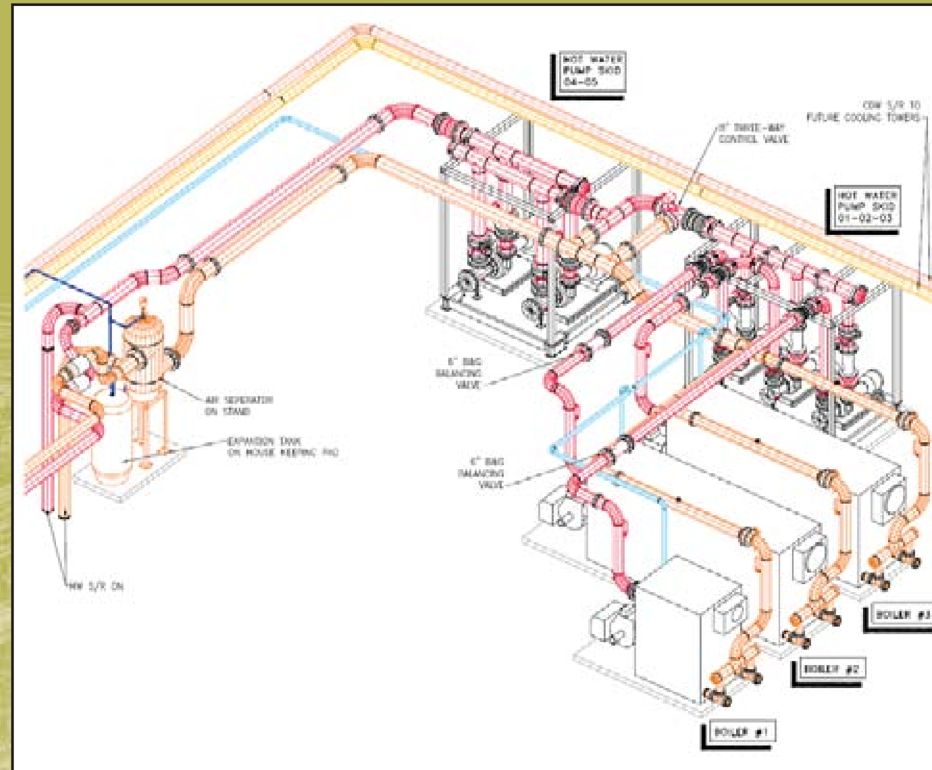
The masonry subcontractor reviewed the model to understand and estimate the masonry scope of work, and provided valuable feedback about constructability and placement of embeds, sleeves, and blockouts.

subcontractors were able to confidently and accurately bid on their scopes of work

8

Shop Drawings and Layout

With a fully coordinated BIM, the team developed techniques to communicate the model with the craftworkers in the field to achieve flawless layout and installation. These techniques included extracting shop drawings from the model, developing “concrete lift drawings” to provide field crews with clear instructions for concrete formwork and layout of decks, and translating model coordinates directly to survey equipment.



Subcontractors fabricated, assembled, and installed building systems using shop drawings extracted directly from the coordinated model.

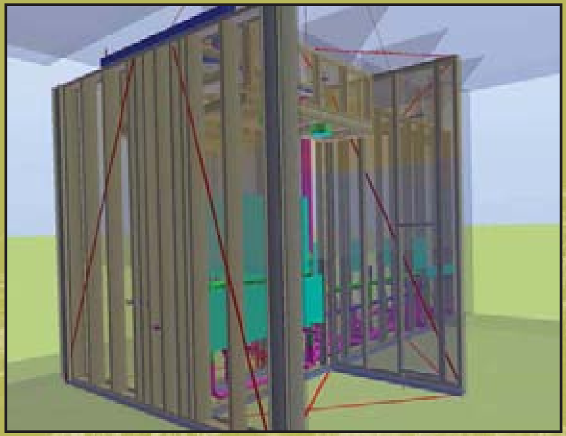
with a fully coordinated BIM, the team developed techniques to achieve flawless layout and installation

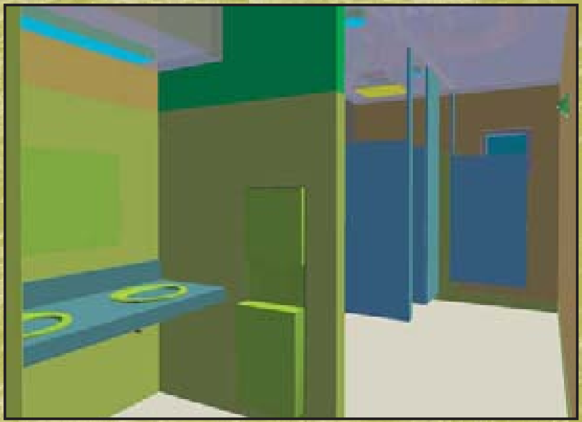
Translating X, Y, and Z coordinates from the BIM to northing, easting, and elevation points for the survey crew enabled direct, paperless use of 3D BIM data in the field to layout sleeves and embeds in the concrete.

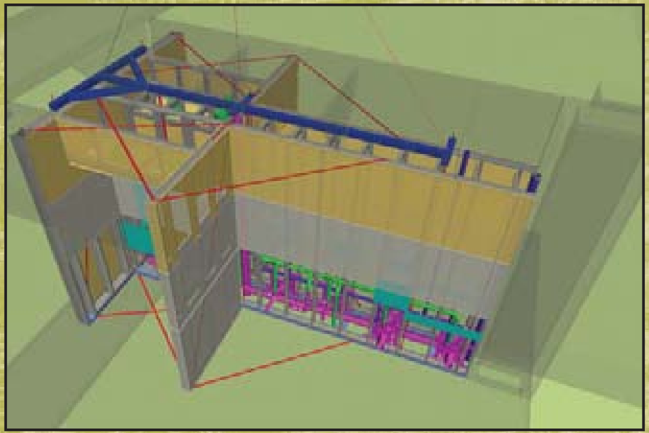
9

Prefabrication

With a fully coordinated model, the team was able to isolate and analyze any scope or area of the building in detail. They then refined the design to prefabricate and assemble complex building systems and components in the subcontractors' shops. Prefabricated components included rooftop mechanical equipment, multi-trade corridor pipe racks, plumbing carriers, framed wet-walls between toilet rooms, and entire electrical closets. Such intense prefabrication would not have been possible without BIM, which enabled a reduction in field labor and construction time, and flawless installation of components while maintaining the owner's high quality standards.







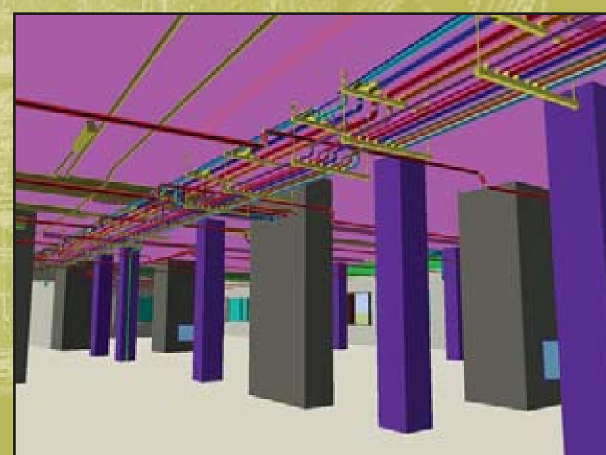
BIM was used to control the multi-trade prefabrication of a wet-wall—including framing, finishes, plumbing, mechanical, and electrical systems—before installation and completion in the field.

BIM enabled a reduction in field labor and construction time, and flawless installation of components

9 Prefabrication

able to isolate and analyze any scope or area of the building in detail

An entire electrical closet—complete with framing, finishes, door, conduits, panels, mechanical shafts and grilles—was prefabricated in the shop and hoisted into place on the project site.



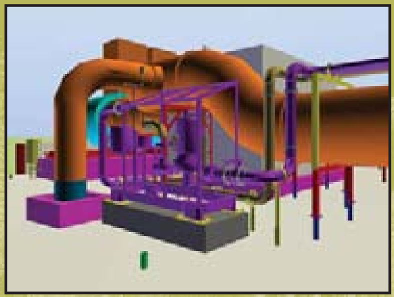
Corridor pipe racks were pre-fabricated and assembled in the shop in 40-foot lengths, and were flawlessly installed and connected in the field.

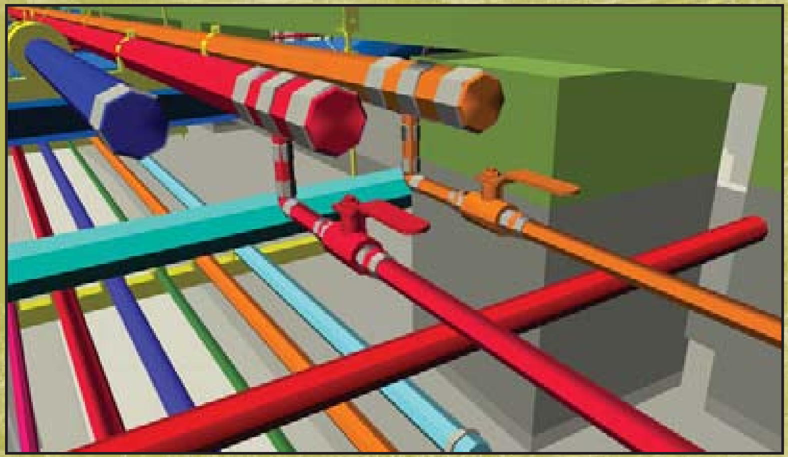
10

As-Builts, Operations, and Maintenance

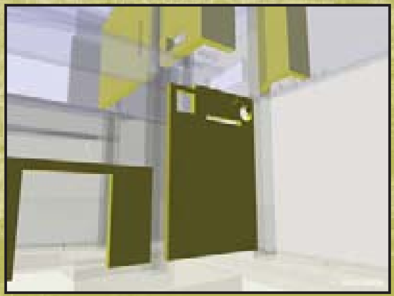
During construction, all revisions to the work were documented in real time in the model, developing a 3-D, as-built record of the project. The team continues to use and update this as-built model today when inserting new tenant improvement work into the facility. With an accurate model supporting thirty years of operations and maintenance, BIM is a valuable factor in the total cost of ownership of the facility, which is 26% below the owner's proforma.

the total cost of ownership is 26% below the owner's proforma





BIM serves as a spatial database, simulating actual physical conditions in support of facility operations and maintenance.



The model is continuously updated to be an as-built record of construction conditions, from the core and shell to all ongoing tenant improvements.

Design-Build-Operate-Maintain
The DBOM approach fostered innovation in all facets of project delivery, including concept, design, construction, and maintenance.

Focus on Total Cost of Ownership
Total cost of ownership across entire facility lifecycle factored in heavily towards smart selection of building systems and enabled LEED Gold certification.

Team Incentives
Project team contracts reinforced doing what is best for the project, ahead of individual concerns, by establishing shared project savings.

New University Business Model
A flexible facility mimics the private sector with tenant space assigned by research project, rather than by department.

"Kaizen" Continuous Improvement
The project was a training ground for a continuous improvement program, empowering labor crews to innovate and develop greater efficiencies.

The use of BIM was central to innovation on the project, yet it was only one of several factors that led to its success. The DBOM team embodied a culture of innovation and constant improvement across the board, evoking cultural change in several design and delivery services.