

Adrian Smith + Gordon Gill
Architecture
Thornton Tomasetti
Environmental Systems Design

Customer Success Story

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A BIM process helped us evaluate different strategies and capitalize on the true value of sustainable opportunities at the beginning of the design process—long before systems and design decisions are locked in place.

—Robert Forest, Partner
Adrian Smith + Gordon Gill
Architecture

Capitalize on green design.

Project team led by AS+GG designs world's first large-scale positive-energy building with help from BIM.



Rendering of Masdar Headquarters at night. © Adrian Smith + Gordon Gill Architecture.

Project Summary

The Masdar Headquarters will be the world's first positive-energy building, producing more energy than it consumes and surpassing the standards for LEED Platinum™ sustainable design certification. Located near the city of Abu Dhabi in the United Arab Emirates, this groundbreaking building is part of the much larger Masdar City project, a zero-waste, zero-carbon-emission development designed to showcase advanced energy and waste-efficiency technologies. When complete, Masdar City will position Abu Dhabi as a global leader in the research and development of renewable energy technologies. Preliminary work on the fast-track Masdar Headquarters project began in 2007, when the owner sponsored an international design competition that attracted 159 participants from some of the world's most prestigious architectural firms. After careful review, the owner selected an integrated design team that comprises lead architects from Adrian Smith + Gordon Gill Architecture (AS+GG), structural engineers from Thornton Tomasetti, and mechanical, electrical, and plumbing (MEP) engineers from Environmental Systems Design (ESD).

The Challenge

During the competition, these three firms worked from offices in Chicago to design a visually appealing, high-performance building that blended traditional building methodologies, indigenous Middle Eastern architectural styles, and 21st-century sustainable design systems and strategies, such as real-time tracking of the project's total carbon content. "Our goal was to use an integrated design approach, where we shared ideas before drawing a single line," says Mehdi Jalayerian, P.E., LEED AP, managing principal in charge of the international and special projects division at ESD.

This approach gained additional significance after the award. "We won based upon the quality of our presentation and our zero-energy goal," says Robert Sinn, P.E., LEED AP, a principal at Thornton Tomasetti. "Once work began, the client held us to the vision we presented in the competition." A collaborative, building information modeling (BIM) approach enabled the team members to integrate architectural, structural, and building systems from the project outset, thereby increasing the efficiency and constructability of the entire system.

Designers exported the model to analysis software to optimize the building's form for reduced energy consumption.

"When all the team members are involved from the start, we can look at much more than just aesthetics," says Robert Forest, AIA, OAA, RIBA, LEED AP, a management partner at AS+GG. "A BIM process helped us evaluate different strategies and capitalize on the true value of sustainable opportunities at the beginning of the design process—long before systems and design decisions are locked in place."

An Ambitious, High-Performance Building

The eight-story, 964,000-square-foot Masdar Headquarters building will include office and retail spaces, shaded public gardens, a prayer hall, and direct access to the city's transportation systems. When complete, it will consume 70 percent less water than comparable buildings and incorporate numerous eco-friendly components, including a 7-acre roof canopy that will provide shade and serve as an armature for one of the world's largest photovoltaic panel arrays.

The building's signature architectural feature is a collection of 11 cones that will support the massive rooftop trellis and facilitate natural ventilation and cooling by drawing warm air up to roof level, where it will dissipate in the wind. The cones will also provide daylighting for the building and form attractive, oasis-like interior courtyards. "Basically, these cones function like interdisciplinary machines for architecture and engineering," says Sinn. "They do so many things at once."

The Solution

To facilitate this integrated approach and connect the design team with the client and builder in Abu Dhabi, the project team used a variety of Autodesk building information modeling solutions, including Autodesk® Revit® Architecture software, Autodesk® Revit® Structure software, and Autodesk® Revit® MEP software, as well as the complementary applications Autodesk® Ecotect® Analysis software and Autodesk® Navisworks® Manage software. On this project, the design team used the BIM process primarily as a tool for documentation, discovery, coordination, and conflict resolution.

Before beginning the Masdar Headquarters project, all three firms had considerable experience with BIM. AS+GG led the design team. "We practice a holistic, integrated design approach that emphasizes symbiosis with the natural environment and the creation of high-performance, energy-efficient buildings," says Forest. "By facilitating early collaboration and real-time analysis of design scenarios, BIM and Revit Architecture software work hand-in-hand with that philosophy and help us deliver sustainable projects."

Thornton Tomasetti adopted Revit Structure in 2006. The firm has completed numerous projects with the software, and now has a companywide policy to use it on all new construction. ESD began its Revit MEP implementation in 2005 and has also standardized on the BIM process for all new projects. "We have completed approximately 15 projects

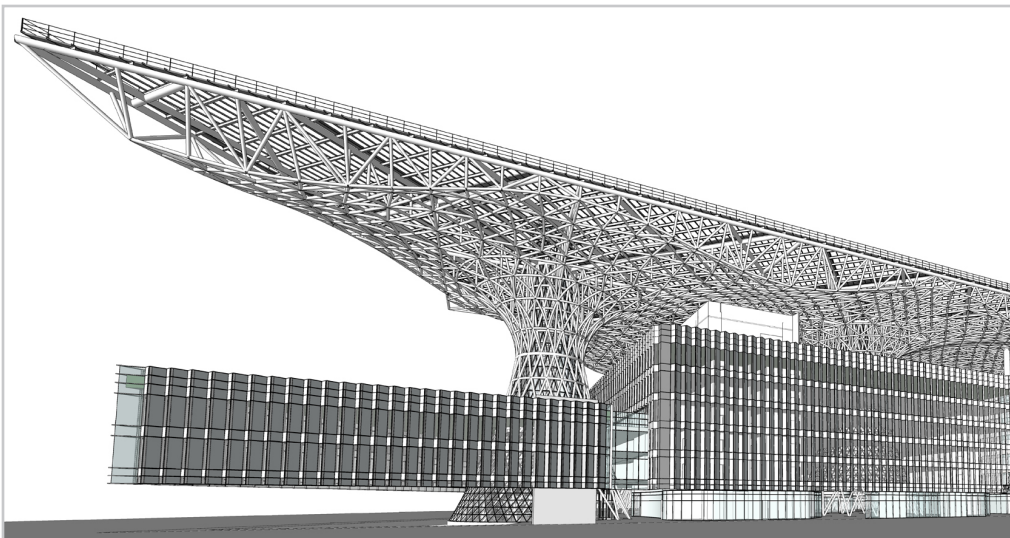
Autodesk BIM solutions offer valuable insight and help enhance the decision-making process significantly. Now, we can have a conference call, put the model up, and make decisions about sustainability and project costs almost instantaneously.

—Gordon Gill, Partner
Adrian Smith + Gordon Gill
Architecture

using the BIM process," says Jalayerian. "The Masdar Headquarters project is the first on which we used BIM from start to finish; we produced 100 percent of the building systems' construction documents with Revit MEP—more than 800 drawing sheets."

Make Better, More-Informed Decisions

BIM enabled the architects to rationalize the building's complex geometries much faster than was previously possible using a traditional 2D approach, which often required a tremendous amount of back-and-forth between team members to achieve a buildable product. "Using BIM, the same process still occurs, but it happens much more simultaneously," says Gordon Gill, AIA, a design partner at AS+GG. "Autodesk BIM solutions do not make our decisions for us, but they do offer valuable insight and help enhance the decision-making process significantly. Now, we can have a conference call, put the model up, and make decisions about sustainability and project costs almost instantaneously."



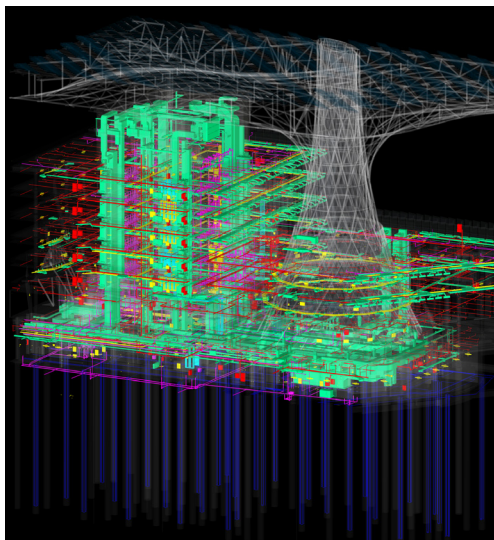
BIM diagram. © Adrian Smith + Gordon Gill Architecture.

Using BIM, the design team could quickly create multiple design scenarios and see their implications. For example, to encourage lowering the project's overall carbon footprint, the architects and engineers devised two alternative construction scenarios. The first followed a traditional construction sequence. The second proposed building the cones and rooftop trellis first, enabling the project to produce electricity during construction and provide shade to the workers on all subsequent phases of construction. "The Revit model assisted with the review of the complex geometry interfaces, helping us to see that this construction strategy was possible," says Forest.

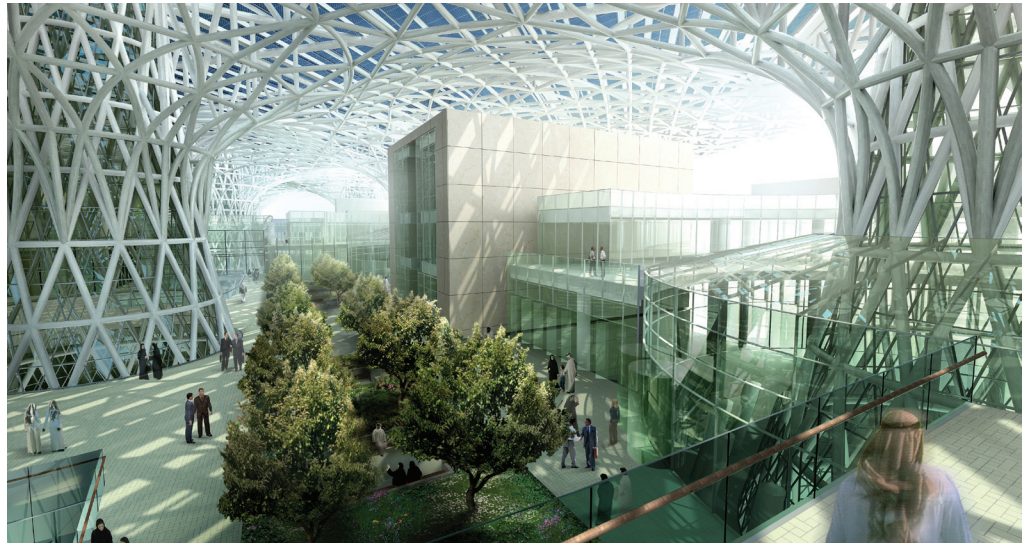
Improve Efficiency, Coordination, and Speed

BIM and the Autodesk® Revit® software products also helped improve coordination and collaboration among the team members. "From a coordination standpoint, the Autodesk tools are a tremendous benefit in terms of the efficiency of design," says Gill. "The continuous interaction among the team members drove us to consider things more holistically."

It also blurred the lines between phases, enabling the team to begin many processes much earlier than it could with traditional 2D approaches. For example, the BIM process enabled the team to issue for tender piling and steel packages early in the process—during the schematic design phase—thereby accelerating the design process. "Using the BIM approach, as soon as we draw an element, we can quantify it and prepare initial quantities," says Forest.



Color-coded MEP/fire protection systems. Image courtesy of Environmental Systems Design.



Roof garden. © Adrian Smith + Gordon Gill Architecture.

The parametric nature of Autodesk BIM solutions assisted the team in viewing the real-time cost impacts of any design changes it made to the model. "That helped us prepare more accurate cost and budget models," says Forest. BIM also helped the team to track items such as total recycled content and embodied carbon dioxide levels, setting carbon targets for specific project elements, comparing options, and validating design decisions. "We can actually see real-time updates on the project's total carbon content."

Achieve the Highest Green Standards

Sustainability is a core principle at AS+GG. "BIM enabled us to advance various sustainable aspects of the project beyond what we would have been able to do with a non-BIM process," says Forest. "Sustainability is all about efficiency, collaboration, and an integrated process. BIM helped us achieve all of those things."

For example, the design team used the model to study building orientation, daylighting, and other factors in the early stages of design, optimizing the building's form to help reduce energy consumption. The team used takeoffs generated from the model to quantify consumption of natural resources and aid in forecasting the use of sustainable materials. "BIM essentially enabled us to have a very detailed and accurate assessment of the building components and their impact on the building's carbon footprint," says Jalayerian.

Close integration of the BIM tools with a variety of analysis applications enhanced the project team's ability to evaluate its design assumptions. For example, ESD used Ecotect Analysis to perform a photovoltaic study to optimize panel layout. "Ecotect Analysis is simple to use and was very well suited to studying the shading effects of the building components," says Jalayerian.

The project team also exported data from the model into a third-party analysis application to study wind cone flow, greatly enhancing the design process. "We discovered that we could best achieve the desired wind flow throughout the cones by creating diagonal openings at their bases," says Forest.

Increase Accuracy

"By bringing together intelligent models from different disciplines, we are able to run conflicts and interference checks at an early stage in the process," says Forest. Early detection and resolution of conflicts makes the process more responsive and can help reduce costly mistakes.

The Masdar Headquarters will achieve 103 percent positive energy—higher than any other building in the world.

For example, ESD used Navisworks Manage to create 3D views of the building's systems, as well as animations of selected components. In addition, ESD used Navisworks Manage to help identify clashes among the MEP, structural, and architectural systems. "Seeing how the various systems overlapped was very helpful to the overall coordinated effort," says Jalayerian.

Both Thornton Tomasetti and ESD used Revit Structure and Revit MEP, respectively, to create more compelling project renderings. "Being able to visualize the structure in 3D was good for everyone on the design team," says Suzanne Provanzana of Thornton Tomasetti. "Revit Structure software's visualization capabilities helped make explaining the structure to the architects and mechanical engineers much easier. We believe that will help lead to fewer RFIs during field work and improve the pace of construction."

The Result

Construction is now underway on the Masdar Headquarters building. "The completed building will be an integrated part of Masdar City and a net-positive energy contributor, achieving approximately 103 percent positive energy," says Gill. "That is a direct result of our team's commitment to energy-efficiency, collaboration, and an integrated BIM approach; it is also unprecedented in the industry." In fact, when the owner charted all claims of zero- and positive-energy buildings, it discovered that not a single one outperformed the Masdar Headquarters building.

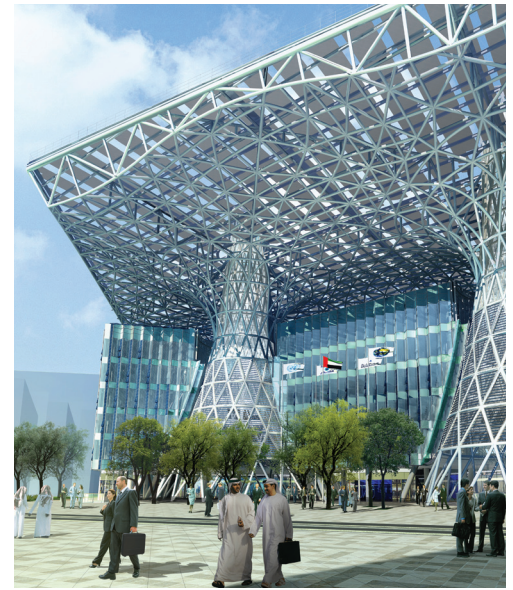
The building also came in within budget. "We were told that our conceptual cost estimates for the building track almost exactly with what the general contractors are bringing in for the estimate of the final product," says Gill. "The whole team gets credit for that, as do the BIM tools that helped us make our design decisions."

"Our goal was to look at the project very holistically and be able to integrate all of our thoughts into one collective effort," says Jalayerian. "That is really the primary reason for the success of this project as I see it. It takes everybody's ideas to make a successful project. Improved coordination and collaboration were the hallmarks of this project."

The Future of Building

Ultimately, the owner hopes to integrate the Masdar Headquarters model into an intelligent, citywide database. Using this new tool will help residents of Masdar City track their individual carbon footprint and energy usage in real time, as well as the city's overall performance.

For more information, visit www.autodesk.com/BIM and www.autodesk.com/sustainable-design.



Plaza view. © Adrian Smith + Gordon Gill Architecture.



Masdar Headquarters at dusk. © Adrian Smith + Gordon Gill Architecture.

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