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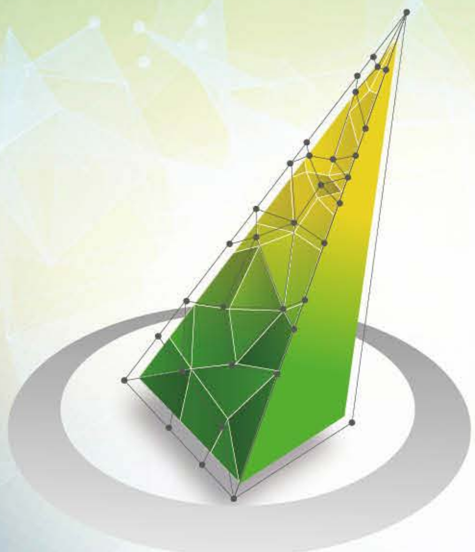


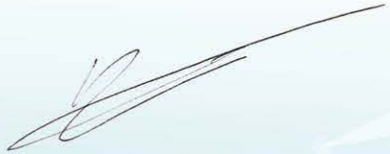
AEC
Excellence
Awards
2017

FOREWORD

From skyscrapers to airports, net-zero buildings, tunnels, and more, the 5th annual AEC Excellence Awards competition received 145 incredible entries for projects that are transforming cities and communities around the world. Every submission showcased innovation and embodied the future of making things, with pioneering uses of BIM enabled by the cloud and emerging technologies such as augmented reality, virtual reality, drones, generative design, and more.

Sponsored by Autodesk, HP, Construction Dive, and Smart Cities Dive, the AEC Excellence Awards recognize achievements in design, engineering, and construction across the Building, Infrastructure, Construction, and Sustainability segments. An international panel of independent judges, selected for their industry expertise, evaluated the entries based on criteria including project complexity, sustainability, collaboration, innovative processes and workflows, use of emerging technologies, and integrated analysis and simulation.

The award-winning projects featured in the following pages shine a bright light on the future of making things. We're proud to help celebrate these achievements and continue to encourage innovation toward designing and making a better world.



Nicolas Mangon

Vice President, AEC Business Strategy and Marketing, Autodesk

Judges

BOB DRAKE
Editor-in-Chief
Civil + Structural Zweig Group

LIMING SHENG
Chief Engineer and Deputy Director
China Railway Corporation Engineering Management Division

TODD DANIELSON
Editorial Director
V1 Media

KYLE FRAZIER
Managing Director, Research & Blueprint 2025
CG/LA Infrastructure

JEAN-BAPTISTE VALETTE
Civil Engineer and Chief of BIM Strategy
VINCI Construction France

1st

NUEVO AEROPUERTO INTERNACIONAL DE LA CIUDAD DE MEXICO

Foster + Partners, FR-EE

2nd

EAST SIDE ACCESS

LiRo Group

3rd

ARNA-BERGEN, ULRIKEN TUNNEL

Norconsult AS

1st PLACE

Project:
Nuevo Aeropuerto Internacional de la Ciudad de Mexico

Firm:
Foster + Partners, FR-EE

Owner:
Grupo Aeroportuario de la Ciudad de Mexico

Location:
Texcoco, Mexico City, Mexico

Software:
Autodesk Revit,
Autodesk Dynamo Studio,
Autodesk Navisworks

> *There is no doubt that the BIM models and the general workflow helps the communication and collaboration on this project–not only within our own design team, but also between all the various consultants. It allowed us to navigate through the model with real-time rendering, giving us a better understanding of existing issues and to evolve collaborative solutions with the various project teams.*
>
> *Jesus Perucho Alcalde,*
> *BIM Coordinator,*
> *Foster + Partners*

Taking Off With BIM

For Mexico City's New International Airport (Nuevo Aeropuerto Internacional de la Ciudad de Mexico - NAICM), Foster + Partners and FR-EE had one core goal in mind: Put people first.

At 470,000 square meters, it will be one of the world's largest airports; its flowing form is inspired by flight. But its primary design focus is the passenger experience. With an open air concept, travelers will be able to see the gates and where they are heading in a space full of daylight. The design also anticipates the predicted increase in passenger numbers by 2028 and beyond, along with an expansion plan through 2062 for an eventual six runways.

The terminal itself is almost 1.5 kilometers in length and a single, continuous gridshell with an innovative roof and fixed boarding bridges in one enclosure. The computational design approach for the roof is unique in the world for its complexity of generating a double curvature light structure with long spans of 160 meters, serving as a roof, façade, and structure at the same time. With spans of more than 100 meters, the lightweight glass and steel structure is designed for challenging soil conditions as well.

"We believe that regardless of the size of the airport, people should always come first," says Martha Tsigkari, Partner, Applied Research and Development team, Foster + Partners. "Therefore, the primacy of passenger experience is a consistent theme throughout all our work. A complex building such as the passenger terminal building, involving collaboration with multiple disciplines, would not have been possible without the appropriate coordination workflows, procedures, tools, and technology."

First net-zero airport

From its inception, Foster + Partners and FR-EE also set out to design one of the most sustainable airports in the world. NAICM aims to become the first net-zero airport and achieve LEED Platinum certification for the terminal building and LEED Gold for the ground transportation center and control tower.

Check-in area. Image courtesy of Foster + Partners.

As part of the project, the surrounding natural landscape will be restored, improving the quality of life in the Valley of Mexico and the eastern half of the city. The airport will run on 100 percent renewable energy, using biogas generated from a sewage treatment center nearby and photovoltaic roof panels.

Water will be 100 percent reutilized. Rainwater will be harvested to support water supplies; wastewater will be treated to be reused in external areas. Three thousand hectares of greenery will be also created around the airport to offset the loss of vegetation due to construction. The biodiversity of the area will be maintained in collaboration with a group of specialists who will facilitate the management of plant and animal species.

Improving design decisions with BIM

With the ambitious sustainability and terminal design goals, BIM became crucial to making it happen. The sharing of the models from the very early stages made it possible for all teams to access updated information, enabling a smooth transition from the concept stage to a more detailed stage of the design as well as construction.

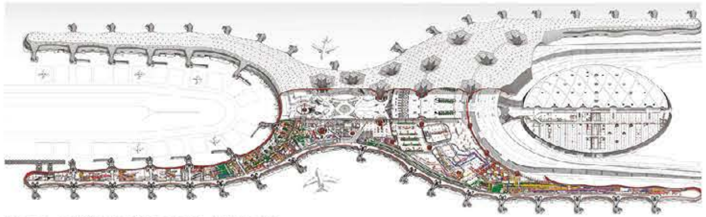


Image courtesy of Foster + Partners.

In the design stage of the terminal's interior, BIM was key for coordination and bringing together several options from different disciplines. The data extraction from the model provided more control when scheduling all of the elements as well as efficient quality auditing. The design teams solved both large and small clashes in the model while also identifying and eliminating duplicates and missing elements. A greater level of model analysis assisted design decisions, including the studies of lighting, wind, and energy.

15,000 drawings created with BIM

The documentation for the terminal building was similar in scale to an urban-planning exercise. The team created directly from the model more than 10,000 construction documents and 5,000 data sheets for each of the rooms in the buildings. It's estimated that they would have had to hire 1.5 times more staff to produce the same amount of drawings without BIM.

A weekly BIM coordination schedule helped create an even faster workflow for collaboration, coordination, and production. This process included sharing and receiving multiple discipline models; processing, navigating, and analyzing the models; creating issue reports and collecting viewpoints; communicating the issues to the consultants sharing the viewpoints; and solving the issues–all in the same week. This workflow was repeated every week of the design stage and made it possible to achieve a better, more coordinated model.


Image courtesy of Foster + Partners

INFRASTRUCTURE

2nd PLACE

Project:
East Side Access

Firm:
LiRo Group

Owner:
Metropolitan Transit Authority
Capital Construction

Location:
New York, USA

Software:
Autodesk ReCap,
Autodesk InfraWorks,
Autodesk Revit

“Connecting data with geometry and delivering these to the wider project team has brought about better-informed decision-making and reduction of risk, which is invaluable considering the size of this megaproject. The benefits are palpable in the changing culture and attitude towards BIM as more people and teams on East Side Access understand its value and request its integration in other aspects of the job.”

Luis Tormenta,
CEO,
LiRo Group

BIM Takes Manhattan: Megaproject Goes 3D

Taking place underneath the bustling streets of Manhattan is one of the largest infrastructure projects in the United States. The Metropolitan Transportation Authority’s East Side Access—first discussed in the 1950s and finally initiated in the late 1990s—will connect trains from Long Island and Queens to the east side of Manhattan. This includes an eight city-block long concourse and multiple train platforms 150 feet beneath Grand Central Station as well as major renovations of Harold Interlocking, the busiest railway junction in the country.

Slated for completion in 2022, the $10.2 billion project must constantly adapt to the ever-changing city, requiring a dynamic planning structure to match. But when design and construction first started on East Side Access, BIM wasn’t even in existence.

In 2011—and in the middle of the actual construction—LiRo Group’s Virtual Design and Construction team came on board to successfully implement BIM to analyze, visualize, and communicate project geometry, data, and workflows. Integrating BIM mid-stream in a long-term project was a challenge as it was designed in 2D CAD and contracts had to be amended to include BIM. In fact, the project is so large it requires more than 25 contracts.

Introducing BIM mid-stream

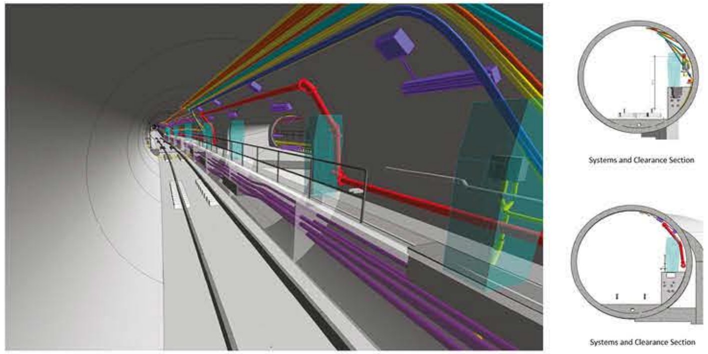
Prior to the BIM integration, the design team spent years without the ability to see the project in its entirety. When BIM was first introduced, thousands of fragmented documents were converted into one centralized and comprehensive BIM model for visualization and analysis. Having a complete model of the project enabled better communication, informed decision-making, and unprecedented coordination and collaboration capabilities across multiple stakeholders. With more than 150 connected models, the whole team could view the project in 3D and its entire 6 miles, while being able to zoom into specific design details.

“With everything I have on my plate, I must admit that when I go over to the BIM group I feel like I walk into a different corner of the ship here,” says Mark Debarnardo, Deputy Program Executive - Harold, Systems & Start-up, MTA Capital Construction. “I can go in there thinking of a potential problem, and I can convey this problem. I have the tools to replicate the problem and demonstrate it to everyone. That’s refreshing because it’s very hard to do that sometimes on a project like this. It’s been very effective.”

Putting BIM into action

As a way to visualize the project completely, existing conditions were scanned and coordinated with the proposed design model for East Side Access. This resulted in exposing hundreds of design issues that could be addressed prior to the contractors coming on board. When simulating an installation through animations and 3D printed models, it proved that many hundreds of vertical precast elements were too large and difficult to install so they were redesigned to be cast in place.

East Side Access also used BIM to determine the feasibility of operations such as moving large mechanical and electrical equipment through a ventilation facility and managing and mitigating access restraint between the various contractors.



Systems were modeled throughout the entire project, including tunnels. Here the model was used to visualize tunnel clearances. It became clear that there was not enough clearance with the previous design of mechanical, electrical, and plumbing services. Image courtesy of LiRo Group Virtual Design and Construction.

4D BIM helped to visualize schedules with thousands of activities, verifying the feasibility of timing, labor density, and mobilization of materials. Contractors received “Scope Models” depicting the scope of work on their respective contracts. Thanks to the models’ detail and accuracy the contractors could hit the ground running with construction coordination starting six months earlier than expected.

The progress tracking system also allows data collection from the field to be directly routed into the project controls system and model, removing redundant work of transposing paper-based information provided by the inspection staff. This cuts time spent on weekly reporting by 30 hours per week and per contract. Furthermore, it improves quality and transparency of data from the field to management.

Taking a virtual view of the Grand Central Concourse and Madison Yard

Large portions of the East Side Access facilities were scanned, resulting in rapid updates of models that could easily be shared with the project team. More than 800 serious issues were uncovered when reality capture was used to generate the existing conditions model of the Grand Central concourse. The current conditions, web-based models will be used by the facility management group.

Existing conditions for Madison Yard outfit were also scanned using LiDAR in order to create a complete model in BIM. The model was used to perform preliminary clash analysis and rectify many major coordination issues during design.

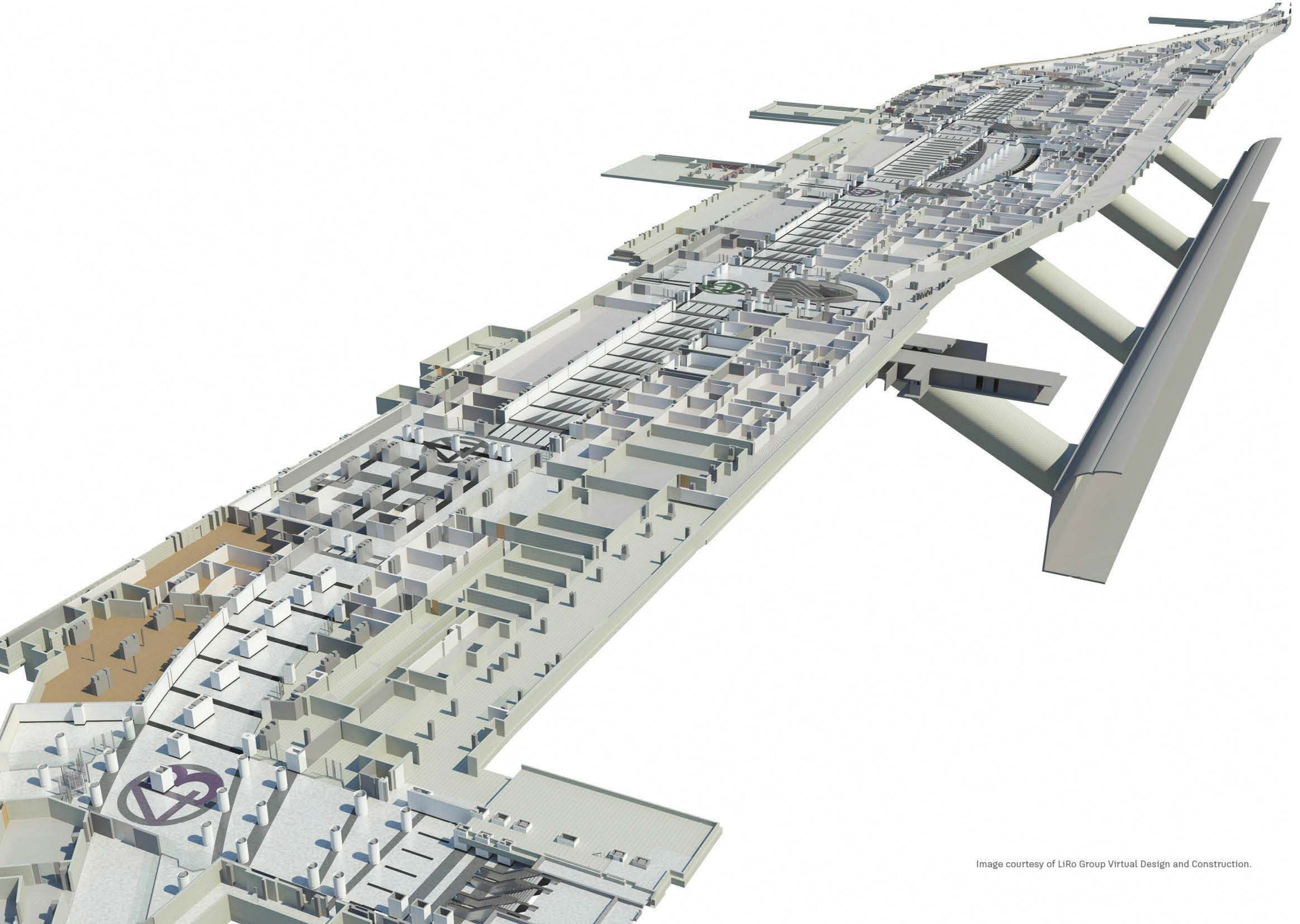


Image courtesy of LiRo Group Virtual Design and Construction.

INFRASTRUCTURE

3rd PLACE

Project:
Arna-Bergen, Ulriken Tunnel

Firm:
Norconsult AS

Owner:
Bane NOR

Location:
Sandvika, Oslo, Norway

Software:
Autodesk ReCap,
Autodesk InfraWorks,
Autodesk AutoCAD Civil 3D

> *"The use of BIM for construction and design alone has saved us half the time. The virtual reality experience transformed the way we approached the projects and how we can communicate with clients and stakeholders moving forward. It's truly a game changer."*
>
> *Thomas Angeltveit,*
> *BIM Coordinator,*
> *Norconsult AS*

Game On: Bringing a Tunnel to Life

For Norconsult AS, it's game time.

Norconsult AS chose BIM for not only coordination and collaboration with design and construction of the new Arna-Bergen, Ulriken Tunnel in Norway, but also to create a fully immersive game and virtual reality experience.

As Northern Europe's most-trafficked, single-track tunnel, the Norwegian railway between Fløen and Arna required increased capacity and safety. This meant boring through Mount Ulriken to build a new, parallel 7.8 kilometer tunnel and upgrading existing stations that are already tight on space within two city centers. And this all had to be done without disrupting any of the current railway traffic.

Arna station. Image courtesy of Bane Nor, Norconsult AS, and Baezeni.

Accessible gaming environment

The Arna-Bergen, Ulriken Tunnel is the first use of a tunnel boring machine in Norway. When Bane NOR's new parallel tunnel is finished, double tracks will run between Arna and Bergen, providing more frequent departures between the cities and updated stations to accommodate the new trains. The route will be safer with the creation of 16 evacuation cross passages every 500 meters between the tunnel tubes. Ten technical rooms will also be built throughout the tunnel.

With this massive project, Norconsult AS took a decidedly different route. Design validation, maintainability, and training could be easily achieved through the innovative use of immersive technology and interactive virtual reality. The virtual environment also enabled the firm to execute signal and sign placement verification and simulations of emergency scenarios in a new way.

Disrupting the status quo

Creating this purpose-built environment served as a platform for real-time, immersive design evaluation and communication. By virtually designing the tunnel before it's built, Norconsult AS could minimize the necessity of changes and adjustments after the construction work is complete and in operation.

"Delivering an interactive virtual-reality experience with our BIM models truly disrupts the status quo in a traditionally conservative industry," said Thomas Angeltveit, BIM coordinator, Norconsult AS. "BIM improved coordination and phase planning by enabling us to visualize, and we found a significant reduction in the amount of time for approvals, stakeholder buy-in, and review cycles. Through an intuitive experience, the design was fully understandable for even non-professionals. In the end, we can help to deliver a better, safer tunnel and stations than ever before."

Fløen. Image courtesy of Bane Nor, Norconsult AS, and Baezeni.

Laser scanning was also key for the BIM models and transferring the data into the gaming engine. Robust, real-time virtual reality gave all of the stakeholders deeper insights and enabled them to make better decisions earlier in the design processes. Those involved ran the gamut from the project owners to actual train operators who could virtually drive trains in the tunnel and provide the feedback necessary for a better design and use once constructed.

Image courtesy of Bane Nor, Norconsult AS, and Baezeni.

Image courtesy of Bane Nor, Norconsult AS, and Baezeni.

BUILDING

Judges

MARK SCACCO
AEC Technology Consulting Executive
Engineered Efficiency, Inc.

STEPHEN VAN DYCK
Partner
LMN Architects

CHENGYONG GAO
Chief Engineer
Shanghai Xian Dai Architectural Design (Group) Co., Ltd.

KEINICHI IIJIMA
General Manager, Design Process and Quality Management Unit
Yasui Architect & Engineering

REBECCA DE CICCO
Director
Digital Node

1st

MUSEUM OF THE FUTURE

Dubai Future Foundation, BuroHappold Engineering, Killa Design, BAM Higgs & Hill, Transgulf

2nd

HOHHOT CITY SAIHAN DISTRICT NATIONAL FITNESS CENTER PROJECT

Tianjin Architecture Design Institute

3rd

EXPO 2020 DUBAI

Dubai Expo 2020 Bureau

BUILDING

1st PLACE

Project:
Museum of the Future

Firm:
BuroHappold Engineering, Killa Design, BAM Higgs & Hill, Transgulf

Owner:
Dubai Future Foundation

Location:
Dubai, United Arab Emirates

Software:
Autodesk Revit, Autodesk Dynamo Studio, Autodesk Navisworks Manage, Autodesk Robot Structural Analysis Professional, Autodesk 3ds Max

> *The future belongs to those who can imagine it, design it, and execute it. While others try to predict the future, we create it. Museum of the Future will be an integrated environment empowering creative minds to test, fund, and market ideas for futuristic prototypes and services.*
>
> *His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai*

"See the Future, Create the Future"

While the interior of many museums look at the past, the Museum of the Future will be everything its name embodies: exhibitions of innovation and incubation of new ideas. The building itself reflects this completely.

Located adjacent to Emirates Towers in Dubai, the $136 million, 30,000 square meter iconic building will have an instantly recognizable distorted torus shape, epitomized by its futuristic stainless steel façade with illuminated glazed Arabic calligraphy. Seven floors of exhibition space will showcase innovative and futuristic concepts, services, and products for the future of cities, healthcare, and education along with areas devoted to labs and a 400-seat auditorium.

BIM as a requirement

The futuristic vision and focus on innovation also extends to Museum of the Future's design and construction. From the very beginning, Dubai Future Foundation required BIM and a fully developed digital workflow across the project lifecycle for BuroHappold Engineering (lead consultant); Killa Design (architect); and BAM Higgs & Hill and Transgulf (contractors).

Internal view of the main foyer within the Museum of the Future showing the Arabic calligraphy on the inner skin. Image courtesy of Killa Design.

The design and client teams meet regularly, allowing mark-ups of the current designs to be done by anyone at any time. This shift to agile project delivery replaces the creation of deliverables for milestone meetings. Instead, everyone contributes continuously and moves the project forward based on the most up-to-date information.

The accessibility of 3D coordination, clash resolution, and decision-making with all stakeholders have made a tremendous impact as well. The handover of models at each stage from stakeholder to stakeholder has ensured that model maturity continues and is developed from design to construction. This is reflected in real time in the progress from the team's LOD 300 models and the contractor's LOD 400 models. In addition, areas in the model have been identified where prefabricated MEP modules manufactured off-site can be developed and installed to reduce installation time and labor cost—and it's only possible due to a high level of confidence in the accuracy and quality of the virtual model.

Generative design at the heart

Design rationalization and generative design are at the center of the iterative analysis process adopted for the optimization of the project's more complex elements.

For example, when it came to the complex steel diagrid geometry, the steel contractors based iterations for the connection design, constructability, element length, angles, and nodes on the required for strength analysis and serviceability requirements. Generative design helped with the creation of bespoke scripts to drive multi-variable optimization as well as increased definition and predictability. The diagrid geometry was generated with an in-house parametric script, allowing the team to quickly manipulate and study numerous iterations to accommodate architectural and structural requirements. Scripts were also used to assign the naming convention for the members and nodes as well as generate geometry for drawing production.

"There is no project that epitomizes a full-scale digital project delivery more than the extraordinarily complex design of the Museum of the Future," says Tobias Bauly, Project Director, BuroHappold Engineering. "It sets the benchmark for how all projects will be delivered in the future: collaboration, generative design for high-speed design optimizations, and complete construction views. Through technology, this building has been designed as a fully resolved, fully optimized product and represents the future of making buildings."

Construction savings add up

With construction now underway, the use of QR codes for quality control, safety, and material tracking contribute to a 65 percent reduction in rework on site. The construction management team and inspectors save substantial time each day with BIM, and see a potential 50 percent improvement in productivity.

Due to the geometric form and complexity of the building, construction risk is mitigated by modeling the temporary framework. Now the main contractor can view construction activities, along with collaboration and coordination for the critical construction challenges. Waste material levels are reduced and controlled due to spatial coordination prior to construction. And with the optimal design in 3D, the teams experience less design issues during construction, enabling minimal changes overall and on-schedule delivery.

"BIM is the medium, without which, this project would have been impossible," says Bauly. "From the museum's incredibly complex design to the actual construction, only BIM could turn this vision for the future into a reality today."

Image courtesy of Killa Design

BUILDING

2nd PLACE

Project:
Hohhot City Saihan District National Fitness Center Project

Firm:
Tianjin Architecture Design Institute

Owner:
Bureau of Culture, Sports, Media, Sanhan District, Hohhot City

Location:
Hohhot City, Inner Mongolia, China

Software:
Autodesk Revit, Autodesk Insight, Autodesk 3ds Max

> *"BIM is being applied in our whole design process, and we are achieving our 3D design goals for a very complex building. Drawings from the BIM model fully express the entire project to avoid misunderstanding, and the extracted parametric model information instructs the construction with pre-cast fabrication and on-site assembly efficiently and economically."*
>
> *Lu Wanmei,*
> *BIM Design Center Vice Director,*
> *Tianjin Architecture Design Institute*

Getting Fit With BIM

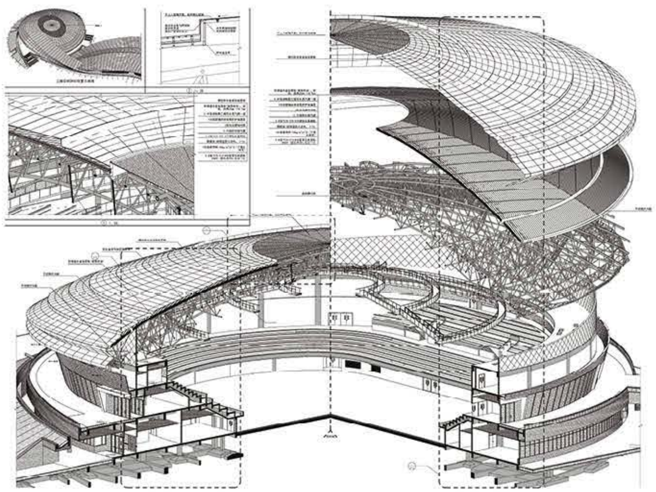
In 2016, China approved its 2016-2020 National Fitness Plan that targets increased sports participation and fitness throughout the country as well as growing the sports industry. The plan also includes ambitious construction for fitness facilities and infrastructure to provide closer proximity and accessibility for both urban and rural residents.

With an expected completion date in 2019, the Hohhot City Saihan District National Fitness Center Project in Inner Mongolia is being designed and constructed as part of the country's plan and to encourage participation. With a site consisting of 91,437 square meters and a total construction area of 33,000 square meters, the building is divided into two zones. Zone A is a multi-functional gymnasium with 5,000 seats for sports events and Zone B houses the fitness center with a swimming pool, basketball courts, tennis courts, and more.

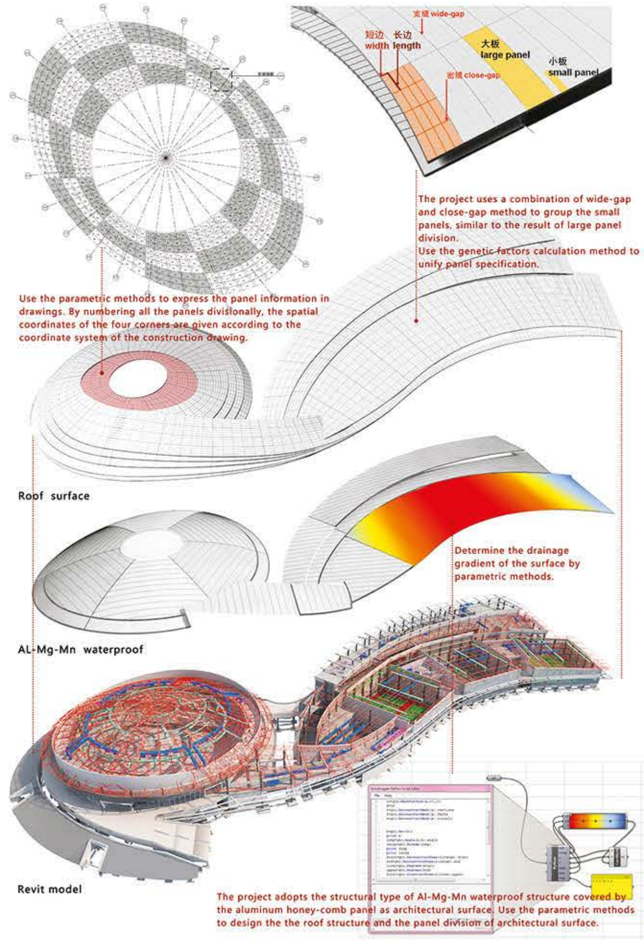
Taking advantage of generative design

The entire project embraces BIM. Tianjin Architecture Design Institute placed a large focus on the use of generative design to orientate structural components to tightly fit the finished surface, reducing material waste. The non-linear design and optimization of the fitness center was made possible through parametric modeling.

For example, at the junction of the steel roof truss and column top, a truss support structure was generated by compiling scripts in generative design software to automatically align the angle and complete the support design below the truss node. The panel design for the roof was optimized to unify the size, reduce panel variety, and lower the cost. Generative design was also used to quickly place stadium seats and classify them for different functions. Pipes and electrical installation optimization were completed as well.



Architectural details of the stadium zone of the project. Image courtesy of BIM Design Center, TADI.



Detailed structure of the roof, panel division, and panel drawing. Image courtesy of BIM Design Center, TADI.

Achieving goals with BIM

A key priority for the project was to enhance collaboration within a very complex space for many different uses. This included identifying negative space to take advantage of every part of the building. By continuously improving the BIM model and working in 3D, the team achieved coordination across disciplines and reduced design errors and on-site design changes.

At the same time, this project adopts an open ceiling that highlights the structural and MEP systems while reducing costs. Computational fluid dynamics (CFD) was effectively utilized to analyze environmental simulation factors and optimize the layout. The interior CFD analysis improved HVAC selection and the layout of the sports buildings, which are sensitive to airflow.

Image courtesy of BIM Design Center, TADI.

BUILDING

3rd PLACE

Project:
Expo 2020 Dubai

Firm:
Dubai Expo 2020 Bureau

Owner:
Dubai Expo 2020 Bureau

Location:
Dubai, United Arab Emirates

Software:
Autodesk Revit,
Autodesk Dynamo Studio,
Autodesk Navisworks Manage,
Autodesk AutoCAD,
Autodesk 3ds Max

"Expo 2020 Dubai is one of the biggest events to be held in this region. It will be a celebration of innovation and ingenuity that brings together over 200 countries, companies, and NGOs as well as millions of visitors from around the world. It is a large-scale, complex project with many stakeholders, and the amount of information—which we need to manage in order to deliver the project on time, to budget, and safely—is huge. We committed to the extensive use of BIM early on, and we have already seen it paying dividends across Expo 2020."

Ahmed Al Khatib
Vice President – Real Estate and Delivery, Expo 2020 Dubai

Bringing the World Together

World expos capture the imagination and innovation of the entire planet, debuting the technologies that will change lives as well as providing the opportunity for collaboration on an international scale. Expo 2020 Dubai will do the same along with a stunning architectural contribution to the city.

Between its opening day on October 20, 2020 and its close on April 10, 2021, the $6.8 billion project will bring together 180 countries (each with its own pavilion) and the capacity to welcome up to 270,000 visitors per day. The enclosed area of the expo will occupy 2,000,000 square meters with the remaining 2,400,000 square meters for amenities and facilities. The open space of Al Wasl Plaza is at the center of the project, including an intricate, domed trellis that provides an immersive projection experience. The Expo 2020 Dubai site itself is designed for legacy, with over 80 percent destined to be reused or repurposed.

Determining a BIM strategy

The BIM strategy for Expo 2020 Dubai focuses on the delivery of intelligent 3D models and Industry Foundation Classes (IFC) data to be used throughout the project life cycle, from conceptual design through operation and legacy. The considerable size of the overall project is significant when combined with the many interlinking projects and potential interfaces from a design and construction perspective. These dynamics are even further intensified since portions of the project are at different stages with varying procurement methods and requirements.

The use of BIM by more than 200 registered users enables site-wide stakeholders to effectively understand, communicate, and manage coordination initiatives. The solution provides a simplified approach for users to log-in and navigate the federated site-wide model or individual project models without the need for extensive software installation and training requirements. The solution to date has been used across numerous internal departments within the Expo organization. In addition, as design teams work from locations around the world, BIM provides a means for 24/7 model access, ultimately reducing reliance on manual and offline processes for sharing information.

Design coordination and clash detection has saved the project millions and continues to reduce schedule delays. For example, the clashes between structural elements and utilities were identified and coordinating complex utility design was enhanced. The design of building basement areas coupled with dynamic changes occurring with the model for surface levels required a robust coordination approach. Without BIM, the numerous projects across the Expo site would have found it more difficult to coordinate the designs, resulting in construction delays and cost impact.

Design based on intelligent analysis and visualization

Using integrated and intelligent analysis tools are key components to ensuring more informed design decisions. The Expo's distinctive districts leveraged BIM data to perform computational fluid dynamics, simulations, and solar and energy modeling analysis. Integrating BIM models with cloud-connected software helped the team to analyze pedestrian behaviors, crowd flows, bottleneck identification, and scenario testing.

BIM modeling and visualization tools have also provided increased understanding of design and construction constraints; risks and opportunities; communication and resolution of design coordination issues and clashes; construction schedules; and much more. Virtual and augmented reality have also been used on specific projects to help key stakeholders interact with the design in a more dynamic and immersive environment. The use of such technologies provides them with a better understanding of design intent that will ultimately identify any issues and support informed decision-making.

Image courtesy of Dubai Expo 2020 Bureau.

Image courtesy of Dubai Expo 2020 Bureau.

CONSTRUCTION

Judges

MICHAEL D. BELLAMAN
President and Chief Executive Officer
Associated Builders and Contractors

WALKER THISTED
Producer
BuiltWorlds

JUN OKOSHI
Design Division, Structural Planning
Taisei Corp.

DENISE CHEVIN
Editor
Construction Magazine

IR FRANCIS LEUNG
Associate Director (Assets Information Management)
New World Construction, Construction Department
of New World Development

1st

TIANJIN CHOW TAI FOOK FINANCIAL CENTER PROJECT
China Construction Eighth Engineering Division Corp., Ltd.

2nd

CHINA ZUN TOWER
China Construction Third Engineering Bureau Group Co., Ltd.

3rd

MIKUSA TUNNEL ON THE KINKI HIGHWAY KISE LINE
Obayashi Corporation and ITOCHU Techno-Solutions Corporation

CONSTRUCTION

1st PLACE

Project:
Tianjin Chow Tai Fook Financial Center Project

Firm:
China Construction Eighth Engineering Division Corp., Ltd.

Owner:
NW Project Management Limited (Developer)

Location:
Binhai New District, Tianjin, China

Software:
Autodesk Revit,
Autodesk Navisworks,
Autodesk ReCap

> *"Only by using BIM and the latest technologies throughout the entire construction process, we can finish a building 530 meters in height in five years. BIM has not only changed the way we work, but also clarifies how we think about and meet new challenges."*
>
> *Yawu Su,*
> *Project Manager,*
> *China Construction Eighth Engineering Division Corp., Ltd.*

Lofty Goals for a New Skyscraper

For China Construction Eighth Engineering Division Corp., Ltd., BIM was integral to success on a complex tower project.

At the outset of the Tianjin Chow Tai Fook Financial Center project, the goal was set for the use of BIM with all employees, specialties, and processes. Not only that, the contract requires the delivery of BIM models to serve the operation and maintenance upon completion (in the precision of LOD500).

For the past three years, more than 100 members of the BIM team have worked and collaborated on the design and construction. Expected for completion in the fall of 2019, Tianjin Chow Tai Fook Financial Center will be a striking new landmark and integrate business and commercial space; luxury apartments; and a five-star hotel. It has a 390,000-square-meter total construction area, constituting a four-story basement, a five-story podium, and a 103-story tower, reaching a total height of 530 meters.

Image courtesy of China Construction Eighth Engineering Division Corp., Ltd.

Complexity by the numbers

The team set out to achieve high production precision, no storage on the construction site, no rework in construction, and low cost in operation and maintenance.

In a project this size, the numbers don't lie. BIM has helped adjust 20,000 wall layouts and more than 8,000 door heights for ceilings of different elevations and types in more than 50,000 square meters. By avoiding the modification and rework ahead of time, the project saved 30 days and $10 million RMB. With an output of nearly 4,000 drawings for the models of masonry panels, light partition walls, piping shafts, doors, and more, contractors could prepare their work precisely. This helped to cut the amount of materials needed for delivery, saving 60 days of construction work and material and labor costs of more than $14 million RMB.

Beyond the construction work, generative design was used to program and import the 3D coordinates to create an accurate façade. 14,800 pieces of façade components were finished three times faster than the typical process and ensured 100 percent accuracy.

Data is everywhere and accessible

BIM has transformed the project management of the tower. Before construction, 932 models were compressed into 12.21G and stored in an accessible, private server. The total number of models to be tracked reached 184,504 with 763,552 logistics updates.

All information—from ordering and transportation to entry, installation, and acceptance—is updated via mobile phones or iPads and stored on the BIM platform so it's easily accessible for everyone at any time. Currently the project has created 2,950 QR codes for major equipment and prefabrication components. By easily scanning the QR code, the status of logistics can be updated automatically, creating greater collaboration and ensuring the accuracy of data. Approval processes are also streamlined with mobile.

Automation and virtual reality improves safety

Emerging technologies are prevalent on the construction site of the Tianjin Chow Tai Fook Financial Center. Robots are used to locate the position of pipe supports accurately, improving the speed of measurement and reducing errors during installation. Above the tower, drones fly to capture images of the construction site each day to compare and analyze the schedules within the different areas.

Through the combined application of BIM models with virtual reality devices, workers experience safety simulations about the risk of working at high heights, such as feeling the actual danger and fear when falling and working far above the ground with no protection. The scenarios also include machinery and equipment operation in order to improve their safety awareness on the construction site. In addition, virtual reality is used for the owners, designers, and construction team to visualize the interiors of the apartments and hotel and experience the different materials for décor and design.

Image courtesy of China Construction Eighth Engineering Division Corp., Ltd.

Image courtesy of China Construction Eighth Engineering Division Corp., Ltd.

CONSTRUCTION

2nd PLACE

Project:
China Zun Tower

Firm:
China Construction Third Engineering Bureau Group Co., Ltd

Owner:
CITIC Heye Investment Co., Ltd.

Location:
Chaoyang District, Beijing, China

Software:
Autodesk BIM 360, Autodesk Revit, Autodesk Navisworks

"As the general contractor of China Zun Tower, we focus on technical innovation. We have applied more than 20 new technologies on this project, among which BIM provides us evolutional experience. We work deeply with designers and subcontractors based on BIM models. With BIM's advantage of information integration, we significantly increase efficiency and construction quality. And it also improves the team's capability to handle a super complicated project like this."

Xu Lishan,
Executive Chief Engineer and Construction Director for China Zun Tower, China Construction Third Engineering Bureau Group Co., Ltd.

Construction Technology Goes Sky High with Beijing's Tallest Skyscraper

Set to become the tallest structure in the city and in an area prone to 8.0 seismic intensity, CITIC Group's new $3.5 billion China Zun Tower in Beijing—with a gross floor area of 43.7 million square meters—will reach 528 meters with 108 floors and seven floors underground.

Technical innovation from start to finish—and beyond

Even with the sheer size of the tower, the project management team had other ambitious goals for China Construction Third Engineering Bureau Group Co., Ltd: Build the highest quality skyscraper with advanced technology and operational reliability. China Zun would also apply a connected BIM process, enabling all stakeholders to work together and all disciplines to be aligned throughout the entire lifecycle from design to operations.

With more than 100 members on the team, over 5,000 issues were detected during the design phase and over 6,000 were found in the construction phase, which achieved a significant reduction in errors and demolitions. Passive change orders were 80 percent less compared to that of other similar projects. Detailing design and coordination in a BIM workflow also saved 7,200 square meters of floor area, creating space optimization and an additional value of more than 100 million yuan ($1.5 million).

806 rounds of construction drawing reviews have also been updated and shared in this collaborative environment. 652 BIM models and more than 800 components families were created and updated with 20 subcontractors. The inherent accuracy of the models and design drawings makes it much easier for construction workers to understand and creates a strong foundation for construction coordination and collision checks.

The Intelligent Construction Equipment Integration Platform was developed by China Construction Third Engineering Bureau Group Co., Ltd. It is 22m in height, its gross area exceeds 1,800m², and has the highest loading capacity in the world. With the assistance of this platform, one single structural floor can be completed in three days. Image courtesy of China Construction Third Engineering Bureau Group Co., Ltd.

Saving time from the ground up

China Construction Third Engineering Bureau Group Co., Ltd also faced an aggressive timeline for construction: 62 months for completion (a speed 1.4 times that of similar projects).

Saving time with construction started from the ground up—literally. With the base slab of China Zun tower measuring 6.5 meters in thickness, 56,000 cubic meters of concrete were required to be poured all at once. The BIM workflow helped simulate the entire pouring process as well as optimize the concrete truck vehicle movement, equipment, and staff. With this coordination and simulations, the entire pouring process only took 93 hours, seven hours less than originally estimated.

Digitizing the construction site

The BIM model helped to achieve mobile office automation, improving the overall efficiency and digitizing the construction site. The low technical barriers to the cloud and mobile device tools democratized data throughout all of the working groups on the site.

Aside from smart phones, more than 40 iPads are used for construction quality management along with the arrangement of 30 large, site inspections. As a result, nearly 400 issues and inconsistencies between the model and the site were solved.

Industrialized construction

The project also heavily relies on prefabrication to achieve energy efficiency, sustainability, and cost savings. With prefabrication, quality and speed in the construction are greatly improved with an estimated 90 percent reduction in construction waste. Water and electricity consumed are only 20 percent of those in conventional projects.

From Floor 7 to Floor 102, 192 sets of prefabricated pipelines designed with BIM were installed, including air conditioning and water and fire-fighting systems. The work load of on-site welding is cut by 30 percent in addition to large savings in labor.

The interior design team also prefabricated intricate parts for decoration in the lobby and premium offices. The team used generative design and imported the parameters to CNC for production. Virtual reality was also used in the lobby in order to truly immerse different parties in the environment and evaluate the look and feel.

Every data point collected

After each floor's completion, the BIM team used high-precision 3D laser scanners with up to 25 scanning points per floor. With the ability to verify and analyze the data stored in a server and accessed remotely, the team could identify defects or quality issues. Before construction is completed, mechanical and electrical pipelines in the ceiling in installation and equipment rooms are scanned to document data and location information for operation and maintenance. In the end, the entire China Zun Tower's point cloud data will be collected and centrally located, helping to achieve the goal of a full BIM lifecycle from design to occupancy.


Image courtesy of CITIC Heye Investment CO., Ltd.

CONSTRUCTION

3rd PLACE

Project:
Mikusa tunnel
on the Kinki Highway Kise Line

Firm:
Obayashi Corporation and
ITOCHU Techno-Solutions Corporation

Owner:
Ministry of Land, Infrastructure,
Transport, and Tourism

Location:
Wakamaya Prefecture, Japan

Software:
Autodesk Revit,
Autodesk Navisworks,
Autodesk AutoCAD Civil 3D

> *This project was the first Japanese use of 3D models and attribution for construction management. The use of data and BIM made an incredible impact on the project.*
>
> *Shinya Sugiura,*
> *Manager of Information Planning Section, Division Management Dept., Civil Engineering Division, Obayashi Corporation*

3D Models, Drones, and IoT Shape Tunnel Construction

As a country of islands, Japan is especially susceptible to the devastation of tsunamis. Since many areas are connected by a single road, there is a high risk of isolation during a disaster. A new highway was recently built to serve for additional transportation, including the construction of the 2,380-meter Mikusa tunnel on the Kinki Highway Kise Line.

Obayashi Corporation and ITOCHU Techno-Solutions Corporation introduced the use of BIM for New Austrian Tunneling Method (NATM) and the construction management of the tunnel project. By managing attributes with BIM and Excel, they created a tool that made it easy to add and delete attributes as well as store the data for future maintenance. Simultaneous visualization of NATM tunnel drilling, geology, layers, and image analysis were also achieved.

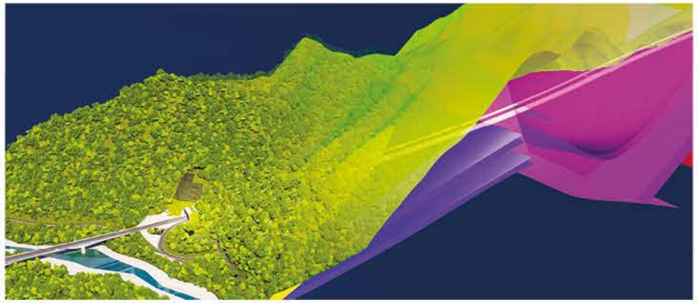


Image courtesy of Obayashi Corporation.

Emerging technologies

The team took advantage of the Internet of Things (IoT) to create the model automatically using IoT sensors for displacement measurement and information during the tunnel excavation. Since the vicinity of the tunnel was different from the topography used at the time of design, they used UAVs (Unmanned Aerial Vehicle) to capture real-time data for a 3D model of the terrain. A robot with a diameter of 20 cm explored and acquired geological information and conditions, providing images of excavation ahead of time that was then compared with assumed geology during the design stage.

Image courtesy of Obayashi Corporation.

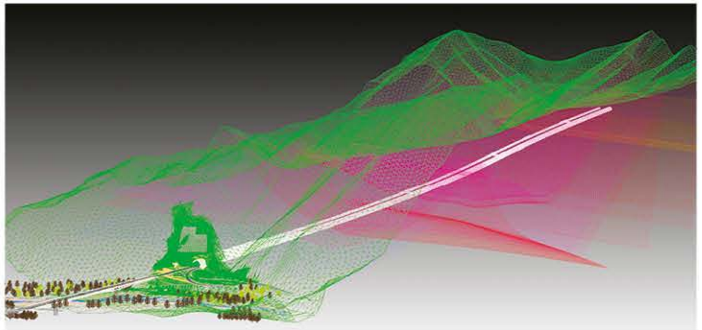


Image courtesy of Obayashi Corporation.

Less meeting time

By developing and using CIM-LINK, the team could easily share data and attributes during construction between the site and the head office. With this new collaboration, they reduced the time for meetings and decisions. Documents, photos, videos, 3D objects, and attribute management all took place with CIM-LINK. Even with meetings between stakeholders in Tokyo, Osaka, and Wakayama, the time involved for conventional meetings and decision-making was reduced by 25 percent. By promoting the use of more efficient meetings throughout the project, the time spent was further reduced to 37 percent. Overall, the efficiency of the construction management was raised by 35 percent.

Benefits post-construction

With the project now complete and the road and tunnel in service, the BIM models created during the construction were used afterward, reducing the inspection work by 50 percent compared to confirmation with conventional drawings. As a result of this project and in order to accelerate the use of BIM for infrastructure projects in Japan, the infrastructure BIM introduction guidelines were established by the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) in FY 2016 and included a chapter on the tunnel project.

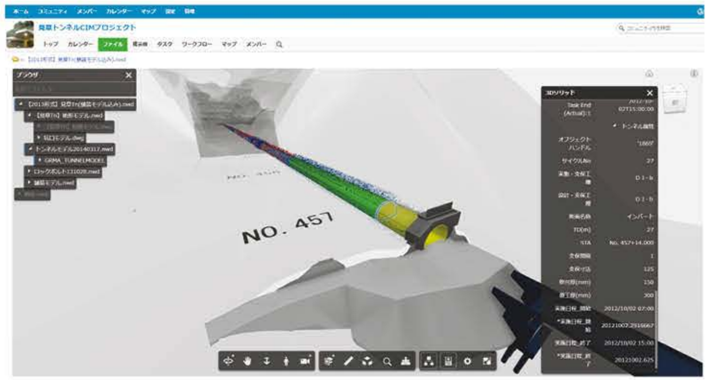


Image courtesy of Obayashi Corporation.


Image courtesy of Obayashi Corporation

Judges

NINA BORGSTRÖM
Director Digital Design
White Arkitekter AB

DAN STINE
BIM Administrator at LHB
Author, Lecturer at NDSU

BARBRA BATSHALOM
Founder and Executive Director
Sustainable Performance Institute

JULIA SIPLE
Manager of Sustainable Practice and Knowledge
American Institute of Architects

QING GE
Vice-General Manager and Chief Engineer of Shanghai Tower
Shanghai Tower Construction and Development Co., Ltd.

1st

THE PORTER SCHOOL OF ENVIRONMENTAL STUDIES

Geotectura, Axelrod-Grobman Architects, NCA,
Assa Aharoni Consulting Engineers

2nd

JIE FANG NAN LU COMMUNITY CULTURE AND SPORTS CENTER

Tianjin Architecture Design Institute

3rd

WHIZDOM 101 BANGKOK

Magnolia Quality Development Corporation Limited

SUSTAINABILITY

1st PLACE

Project:
The Porter School
of Environmental Studies

Firm:
Geotectura, Axelrod-Grobman Architects, NCA, Assa Aharoni Consulting Engineers

Owner:
Tel Aviv University

Location:
Tel Aviv, Israel

Software:
Autodesk Revit, Autodesk A360, Autodesk ReCap

> *"BIM helped us to fulfill the vision of building one of the greenest projects in the world. The Porter School of Environmental Studies shows the power of BIM to improve the design and sustainability aspects during the planning and after completion of building. No matter the scale, budget, or program of your next project it should share the same sustainable values and adopt BIM to meet the current and upcoming challenges."*
>
> *Joseph Cory,*
> *Professor and Architect,*
> *Geotectura*

A Green Education: First LEED Platinum Building in Israel

As a place for environmental education, The Porter School of Environmental Studies at Tel Aviv University truly embodies what is taught and researched both within and outside of its walls.

Designed and constructed by Geotectura, Axelrod-Grobman Architects, NCA, and Assa Aharoni Consulting Engineers, the 4,000 square-meter building is the first of its kind in Israel, achieving both LEED Platinum certification (92 points) and 5 stars in the Israeli Green Code 5281. Each aspect of the building includes an "eco-conscious" design and each side serves a purpose as well. The north brings in natural light; the west is shaped like a funnel to increase air flow to the main atrium; and the east blocks heat during the winter and noise from the highway. The south side's Eco-Wall—an iconic portion of the building—absorbs the hot southern sun with thermo solar fields heated by glass-evacuated tubes, producing the energy source for the mechanical ventilation and air conditioning of the building. As a result, this saves 60 percent of the energy and reduces carbon emissions.

The mechanical room on the building's roof contains one 60-ton refrigeration absorption chiller (operating from the thermo solar fields) and one 70-ton refrigeration air-cooled chiller operating with electricity. In total, a cooling capacity of 130-ton refrigeration was installed, compared to a standard building where 170 tons would be required. Additionally, the building chiller produces 25-30 tons of water cooling after four hours of work.

BIM from the start

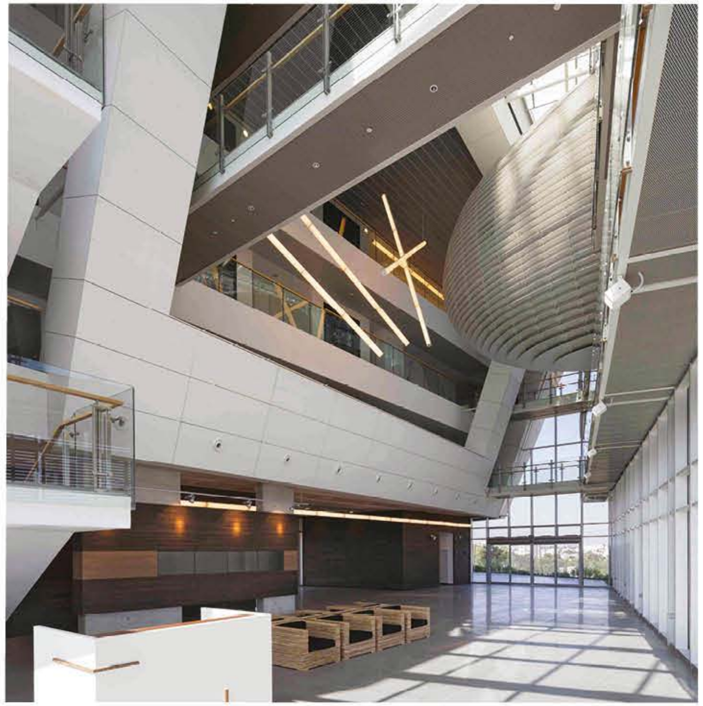
To achieve their sustainable goals and improve collaboration and communication, the project team used BIM from the very start in order to complete the project with a tight schedule and on a historical site—all without compromising the design qualities. The digital model helped make it much easier to discuss important decisions with all of the stakeholders and synchronize the structure, architecture, and MEP in an effortless way. And, by knowing right from the beginning the potential costs, they could uncover the insights where the design might exceed the budget.

BIM was crucial to improve the design with energy and natural and artificial light simulations. This included a passive ventilation strategy after studying wind directions and temperatures based on meteorological data during different seasons and times of day. By conducting computational fluid dynamics simulations, they could improve the geometry of the building as well as optimize the ventilation pipes. All of the energy simulations in the cloud made the entire process extremely fast and accurate.

Parametric design was also incorporated to solve a complex, double-curved geometry of the floating capsule, allowing the inner cladding of this double-curved space with flat bamboo boards.

Constructing a sustainable design

Point cloud data from laser scanning was incorporated and served as a basis for the as-built architectural drawings. The digital information highlighted issues with the geometry during the construction phase and enabled real-time solutions and adjustments to those structural elements. By using the point cloud data in the BIM model, they could readily see inaccuracies as well as the need to redesign the façade's cladding.



The Porter School of Environmental Studies. Image courtesy of Shai Epstein.

Prefabrication was integral to construction with many parts of the building designed in a detailed way, built in advance, and then brought to the site. The entire steel structure and floating capsule were prefabricated; work could be done in parallel and the project finished ahead of schedule.

BIM guides material use

Another benefit was the ability to configure materials in a very detailed way. Green standards directed the use of local, recycled, and renewable materials in the project. The team could create those materials in BIM and add information properties for each, such as cost, thermal insulation, strength, durability, life cycle assessment, and much more.

Lighting itself became a major factor in saving both costs and meeting sustainability criteria. In order to deliver the optimal light for occupants in relation to the use of the space (working, relaxing, studying, and more), shaping the design of the windows and all of the curtain walls was imperative. Doing so helped to let in natural light or block direct sun during the hot season.

Image courtesy of Shai Epstein.

SUSTAINABILITY

2nd PLACE

Project:
Jie Fang Nan Lu Community Culture and Sports Center

Firm:
Tianjin Architecture Design Institute

Owner:
Tianjin Chengtouzhidi Investment and Development Co. Ltd.

Location:
Tianjin, China

Software:
Autodesk Revit, Autodesk CFD, Autodesk Insight

> *"Only by using BIM could we reach our core goal of zero energy consumption. The inspiring design and purpose of the center, combined with the commitment to sustainability, makes the project an important contribution to the community."*
>
> *Zhang Jinyi,*
> *Vice President,*
> *Tianjin Architecture Design Institute*

Reaching Net-Zero With BIM

Jie Fang Nan Lu Community Culture and Sports Center is dedicated to public welfare—both physically and culturally. With a total construction area of 11,659.5 square meters, it includes a natatorium, badminton courts, lecture and multi-functional halls, gymnasium, conference halls, a community school, and more. The center is also designed for maximum sustainability and to operate as a net-zero building, obtaining both LEED Platinum and China's Three Star certifications.

Built for the community's residents, the center must not only operate at a low cost and with zero energy consumption, but also serve as an inspiration to build more sustainably for other projects in the area. To meet these goals, Tianjin Architecture Design Institute used BIM from the very beginning to realize the most sustainable building possible with energy consumption reduced to 765 MWh/year and renewable energy production reaching 870 MWh/year.

Achieving sustainable design

With BIM, the team could set out to design a building suitable for the area's climate, the location, and function for low-impact development as well as an innovative MEP system to reduce energy consumption.

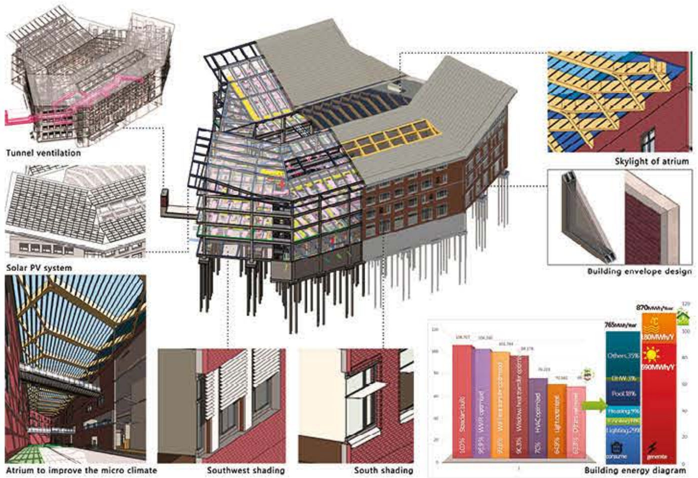


Image courtesy of BIM Design Center, TADI.

They first started with four different designs. Based on the evaluation of lighting, wind, heat, topography, and more, the ideal design was chosen along with the use of renewable energy sources such as solar and geothermal energy to reach their targets. All stakeholders could also be provided direct updates to the model, including any analysis data from each specialty in real time.

The simulations and analysis were crucial to improving the design. Field simulation and analysis of light guided the climate response design. By the analysis of interior functions and indoor lighting, the window openings were optimized. Shading and lighting uniformity determined the elevation. Based on IES analysis data through the energy consumption simulation, the window-to-wall ratio alone was calculated and determined for an interval of 30-40 percent and energy consumption reduced by 4.1 percent after optimizing that ratio.

Through the simulation of wind outside the building, a tunnel was created in the atrium to bring air inside. The atrium itself creates its own microclimate that also supports the temperature of other rooms. The data of solar photovoltaic panel power generation were also calculated; a detailed analysis model was built for a 15-degree sloping roof, along with the total monthly electricity output in a year calculated according to the local climate conditions.

West and southwest elevation. Image courtesy of BIM Design Center, TADI.

Central model drives collaboration

From start to finish, the Jie Fang Nan Lu Community Culture and Sports Center makes full use of BIM across all specialties to share information. The 3D collaborative design of the complex space helped to overcome information barriers and improve the design in a visual environment. With all of the simulation data vividly expressed in the model, the architecture team could quickly understand it and update the model easily.

Through the continuous improvement of the model, negative space and design errors were reduced. With the complete expression of the model information in the drawings, it has eliminated most of the rework and demolition issues typically encountered. Construction costs were significantly reduced through this single look at the project as well as the use or recycled and local materials with the end goal of the most sustainable project possible for the community.


Image courtesy of BIM Design Center, TADI

SUSTAINABILITY

3rd PLACE

Project:
WHIZDOM 101 Bangkok

Firm:
Magnolia Quality Development Corporation Limited

Owner:
Magnolia Quality Development Corporation Limited

Location:
Bangkok, Thailand

Software:
Autodesk Revit, Autodesk CFD, Autodesk BIM 360 Team

> *At MQDC, we have both the challenge and responsibility to minimize the impact on the Earth from our project development. WHIZDOM 101 is designed to be a vibrant, active campus that meets the ultimate in sustainability standards. Our continued focus on sustainovation guides our design and construction.*

Suttha Ruengchaipaiboon, President, Magnolia Quality Development Corporation Limited

BIM Brings Smart City Model to Bangkok

Smart cities don't have to start from scratch–they can be built within metropolitan cities right now.

Take WHIZDOM 101 in Bangkok as a prime example. Its mission is to transform an urban, 17-acre plot into a smart city model with a fully integrated, digital, mixed-use development with both commercial space and residential towers. By minimizing environmental impacts, saving energy, and reducing carbon emissions, the $1 billion project with a gross floor area of 3,842,716 square feet is designed not only to improve quality of life, but also boost sustainable development for the community.

Image courtesy of Magnolia Quality Development Corporation Limited.

Image courtesy of Magnolia Quality Development Corporation Limited.

The project itself features forward-thinking applications for sustainability. This includes its accessibility to the public train station; outdoor and the world's first indoor bike paths; solar use; and an innovative pathway that generates power from footsteps and then used to light the walkways at night.

From the very beginning, WHIZDOM 101 was designed with sustainability goals in mind: reduce energy consumption by 32 percent, water usage by 40 percent, and CO_2 emissions by 15,000 tons per year. In order to make this happen, Magnolia Quality Development Corporation Limited (MQDC) is relying on BIM.

Image courtesy of Magnolia Quality Development Corporation Limited.

BIM and sustainovation

MQDC placed an emphasis on "sutainovation" and finding new ways to create opportunities and applications for sustainability. The firm created their own standards and framework from design all the way through construction to meet the requirements for certification by LEED GOLD and TREES Gold and Platinum (Thai's Rating of Energy and Environmental Sustainability). They put a great deal of focus on green space areas; designing high-performance buildings and high-efficient MEP systems; maximizing natural ventilation and daylight; selecting non-toxic and low VOC materials; and providing an uplifting and creative atmosphere.

Computer fluid dynamics software was used in the early stage of design to analyze storm water runoff as well as outdoor natural ventilation and indoor air quality through the façade design ventilation. With the BIM model, MQDC analyzed the design and energy consumption in order to change the project's orientation, building mass, or building envelope as necessary to meet their sustainable goals. The team is also improving collaboration between architectural, MEP, and structural for visualization, interference checking, and crash detections, reducing construction waste and cost by 10 percent.

Image courtesy of Magnolia Quality Development Corporation Limited.

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