Collaborate - Adapt - Innovate

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Abstract

BIM has the potential to facilitate smart design, innovation, and collaboration, all of which are traits that we look for when seeking out new members to join our team. With the fast pace of changing technologies, the challenge is not to find individuals who know how to use the latest BIM product, but to find those who have a clear understanding of the fundamentals and are able to adapt. Recognizing that it is the methodologies, not necessarily the software that is important, how do we as an industry teach principles instead of commands?

Through integrated design and partnerships with universities, we aim to foster an approach that looks to technology as way to aid and enrich our problem solving explorations. We will illustrate several examples of projects in which architects and engineers within our firm have taken the lead in developing innovative design through new technologies, with emphasis placed on the processes and methodologies developed. In addition we will also look at several collaborations we have had with Academia including the University of Pennsylvania, Stevens Institute of Technology, and Rensselaer Polytechnic Institute. We will analyze both of these areas to identify several core educational principles.

Keywords

BIM, Education, Collaboration

1. INTRODUCTION

The question of how to integrate BIM into Academia has recently become a focus for many universities. New graduates have the opportunity to enter the profession with skills that are not commonplace in many firms. In this regard, this gives Academia the opportunity to help shape the future of BIM. New working methods and design methodologies are in the process of taking shape which should be studied and scrutinized. On the industry side, being able to hire individuals who can take the lead in helping firms grow and adapt to these new technologies is an important part of the evolution. These individuals not only need to possess the technical skills, but also must be able to examine the fundamentals behind them.

BIM is a framework for organizing the data needed to design, coordinate, and build. This framework has the potential to facilitate new methods of working, analyzing, and designing. The research oriented nature of academia allows for the development of these new methods. Pairing this research with practical application in industry allows both a test bed for academia and innovative opportunity for firms. Below we present three case studies in which BIM has been incorporated into the process. In each of these case studies we have also partnered with Academia for specific portions of the projects. From these case studies we will identify several core skills that are important for graduates entering the field.

2. LOTTE WORLD II

2.1 Background

Lotte World II tower in Seoul, South Korea was designed as a 555 meter tall mixed use tower including retail, office, hotel, and observation deck. The geometry transforms from a square at the base to a circle at the crown through the use a structural diagrid, creating a system of triangular facets at varying angles.

The transforming geometry proved a challenge in the design and development of the tower. Many factors had to be considered such as aesthetics, area, program, structure, environment, life safety, and constructability among others. The geometry had to be tuned so that each of these design considerations could be met. Several methodologies were developed by the team to meet these challenges. The overall geometry of the tower was managed through parametric scripts developed in LISP for AutoCad, which allowed for the automation of design options. Other platforms were employed to analyze these options including fabrication and constructability analysis in Digital Project, environmental analysis in Ecotect, and Panelization analysis in Excel.

A performative feedback loop was established through an interactive workflow in which the geometry schemes could quickly be analyzed, and the results used to inform the design.

Figure 1: Lotte World II, SOM

2.2 Academic Partnership

One challenge faced during the design development of the tower involved the entrance sequence of occupants during the morning rush. To investigate this, the team partnered with the Building Simulation Group at the University of Pennsylvania, which among other things, simulates and studies pedestrian movement through spaces. The largest influx of occupants were those travelling to the office floors, whom arrived by both subway and by car. The entrance sequence consisted of several revolving doors, ID turnstiles, escalators, as well as local and express elevators. Each of these played a role in determining at what speed occupants could be moved and also presented potential points of congestion. Using STEPS simulation software the researchers developed algorithms that simulated a cross section of the population, took into account the different speeds of individuals, and adjusted their speeds based on crowd density.

The Architecture team met several times with the researchers to share the design intent, and to provide feedback on the research. The end product of this collaboration was an academic paper which detailed their research and findings, as well as the theories and methods used to produce the simulations. Through their research, the Architecture team was able to determine how design decisions would impact the efficiency of the entrance sequence, and if the throughput of each element in the sequence was sufficient.

Although a software such as STEPS may not be considered a typical BIM application, it is actually a Building Information Model that incorporates both the intelligence of the proposed equipment and the building occupants. Using this building data, analysis and simulations can be performed that directly impact the performance and design of the building.

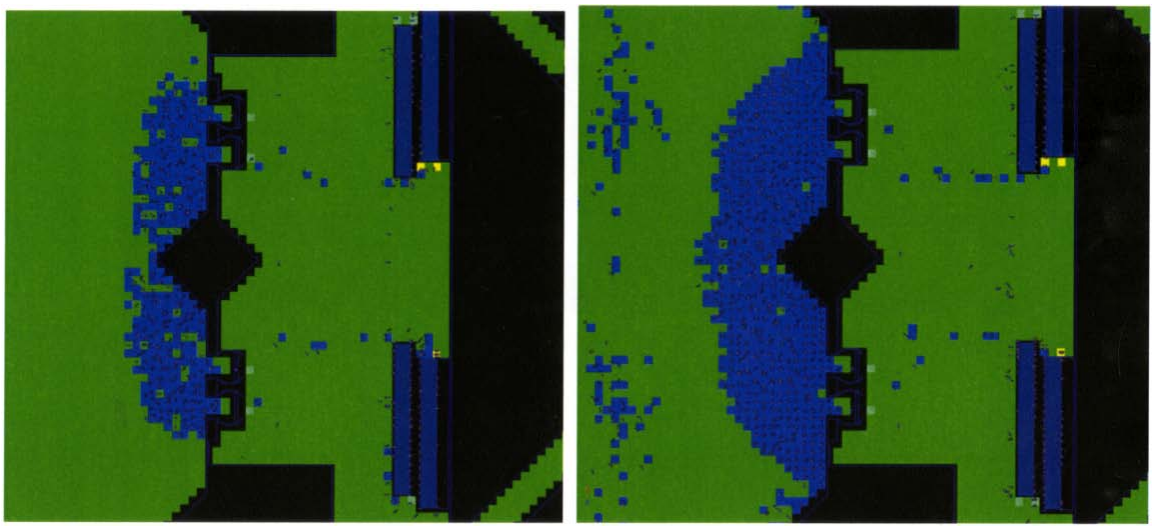

Figure 2: Entrance simulations, Building Simulation Group

3. 250 EAST 57TH

3.1 Background

250 East 57th street is a 335,000 sf, mixed-used development located in Midtown Manhattan. The project consists of a residential tower, two new public schools, and retail space. It is being developed in two phases, the first including the schools, and the second phase including the residential tower. The first phase is currently under development, and has implemented Revit as the BIM platform. When the project kicked-off only a few of the team members had backgrounds in BIM, and project standards had yet to be implemented. This required that the team work collaboratively to organize the model, divide work, and establish protocols. The team held weekly BIM meeting in which they would establish the standards necessary to move forward. The model was used for documentation as well as a tool to manage the area, zoning, and code issues through the use of scheduling. Several of the consultants also adopted BIM for the project, which facilitated in identifying and resolving conflicts among disciplines.

Figure 3: 250 East 57th Street, SOM

3.2 Academic Partnership

During schematic design for the phase two tower, the design team was interested in studying the metrics that could influence and drive the form of a residential tower. To investigate, an academic partnership was developed with the Product Architecture and Engineering (PAE) Lab at Stevens Institute of Technology for two semesters. The Architecture team and students met at the beginning of the process and discussed several criteria that could influence the design of the tower. Quality of view is a strong driver of property values in Manhattan, and it was collectively decided that PAE would investigate the relationship between view and form. The Architecture team and students met on a weekly basis at the office to review the progress of the research, provide feedback, and discuss the next steps.

The first semester research focused on developing methods to analyze quality of view for the design options being considered. Using a digital model of New York City the students developed an analysis tool that would measure the distance value from each apartment to the closest obstruction, as well as if the apartment had a view of the East River or Central Park. These values could then be combined to give each apartment and the overall tower a score for view. The system was developed through parametric scripts in Rhino that automated the analysis and recorded the scores for each design option in a database. During the second semester the research team focused on how these analysis models and databases could influence the design of the tower. A series of geometric rules and parameters were developed through close collaboration with the design team. Using these parameters the students developed parametric models using Rhino scripting and Excel to optimize the geometry of the tower. The final product of the partnership was a new tool and methodology for analyzing the relationship between form and value.

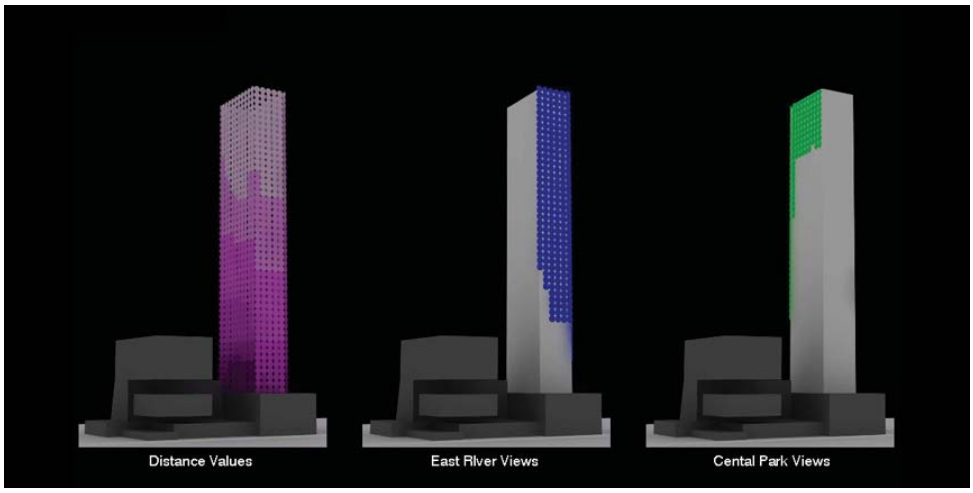

Figure 4: View Quality Analysis, PAE

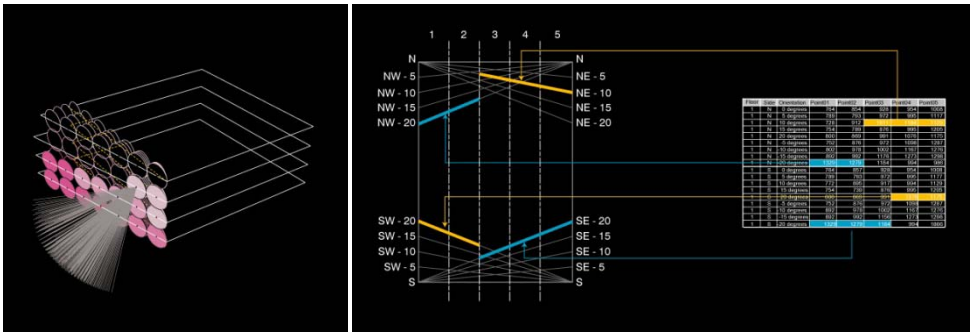

Figure 5: Geometry Optimization of Floor Plate, PAE

4. PSAC II

4.1 Background

The Public Safety Answering Centre (PSAC II) in the City of New York is a 550,000 sf center that will augment and provide redundancy to the City's current emergency 911 response services for use by the Fire and Police departments. The center needed to be designed to operate 24/7 without interruption under extremely adverse conditions. Interdisciplinary design and close collaboration between all parties involved was critical to this goal.

The client, the New York Department of Design and Construction, the Architecture team, and all consultants were co-located in a dedicated office space to facilitate coordination. The Architectural, Structural, and MEP teams have developed the project through use of integrated discipline-specific Revit models. These models, owned by their respective disciplines, are linked together and elements are monitored for changes. By virtue of the workflow, changes made by a team are automatically reflected and in many cases alerted, supporting smooth coordination.

Figure 6: PSAC II, SOM

4.2 Academic Partnership

The centrepiece of the lobby for PSAC II will be an Active Phytoremediation Wall System developed by the Center for Architecture, Science, and Ecology (CASE). A research and development collaboration between Rensselear Polytechnic Institute and Skidmore Owings and Merrill, CASE engages scientists, engineers, and architects from the professional and academic worlds toward a common goal of redefining how to build sustainable cities and environments. The center is co-located on the Rennselear campus and at SOM, where students studying toward a Master or PhD in Built Ecologies, have a dedicated studio space.

The Phytoremediation system developed works with the building's HVAC system to improve air quality and reduce energy loads. Hydroponic plants in bio- and phyto-filtrations pods are installed on a modular screen which acts as a plenum. The vacuum formed pods are designed to maximize the air flow to the roots of the plants, while minimizing the amount of material needed. During the ongoing research and development of the system, the CASE research team employed several environmental computational technologies as well as rigorous prototype testing.

CASE's collaborative involvement in the project started in schematic design and continues through the development of construction documents. A researcher is co-located with the project team and works side by side in coordinating the system with the architects, MEP, and structural consultants. They are also responsible for developing a wall-specific building information model that is fully integrated into the BIM. The result of this partnership is the simultaneous development of an innovative product and an integrated building system.

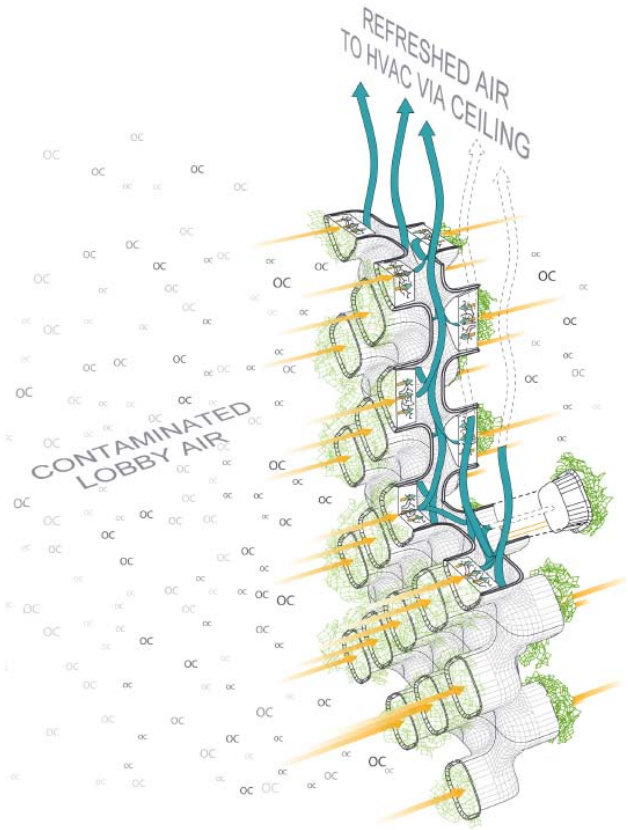

Figure 7: Building-Integrated Active Modular Phytoremediation System, CASE

5. CORE PRINCIPLES

5.1 Collaborate

In the case studies above collaboration was always a key component and priority. It occurred on several different levels including within the team, with consultants, and with Academia. Collaboration between members on the Architectural teams was critical. In BIM projects, responsibilities cannot be as clearly and artificially segregated as with conventional 2D methods. In a unified environment each move that a team member makes has an immediate effect on the work of others. Projects which developed clear working methods and organizational strategies were the most successful. Understanding how to collaborate within a team structure, and how to collectively design are valuable skills that were reinforced continually.

Projects that included close collaboration with consultants were able to develop creative solutions for the building structure and systems. Early collaboration yielded integrated buildings in which contributions from the whole team defined the overall design. Interdisciplinary design and shared ownership throughout the process fostered innovative solutions that otherwise would not have developed.

Collaboration with academia allowed for the research of new technologies and methods while simultaneously developing them for practical real world applications. From the industry side the partnerships offered the opportunity to examine the design methods already in place, and explore how these new methodologies can impact the design process. On the academic side it provided a test bed for the students to further their research and to gain knowledge from those experienced in the field.

5.2 Adapt

Each project presented the teams with a different set of constraints and design opportunities. One tool was often insufficient to explore the design and analyze a project, and the teams shifted between different platforms and methodologies. Understanding the fundamentals, being able to critically examine the parameters and constraints of each project, and adapting new methodologies proved to be key principles in the continued development of building information modelling.

BIM also presents the opportunity to develop new methods of working and collaboration, both within the team structure and with consultants. Integrated design is accomplished through input from all disciplines, and this model requires that conventional team structures be examined and adapted.

5.3 Innovate

BIM provides a platform in which building geometry and data can be stored and accessed. The potential is in how this information is harnessed to inform design and where the design information resides.

The case studies above presented several uses for this data including fabrication, pedestrian movement, code, value metrics, and environmental analysis - a small selection of the possibilities. The research-oriented nature of Academia provides a platform in which the boundaries of BIM and analysis can be pushed, and innovative new tools and methodologies developed. We should continue to examine how these new methods can accelerate innovation and integrated design.

The industry is at a critical point in determining new working methodologies for integrated design. Academia has the unique opportunity to critically examine these methods and help shape the future of this process of working

6. CONCLUSION

A solid basis of fundamentals is needed to harness the potential BIM. Many of these are not new and include good design, knowledge in construction, environmental, structural, and life safety issues among others. Pairing this knowledge with the skills of data management, critical thinking, group work, and interdisciplinary teams elevates design to the next level.

BIM is more than a building information model, it is also a platform on which new methods of working, analyzing, and designing can be developed. Understanding these principles is the most valuable skill a new graduate can bring to industry.

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