Building Information Modeling Drives Lean Construction Management

3-D Model Facilitates Installation of Pre-Fabricated Mechanical Systems

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The construction industry is embracing the increased use of three-dimensional modeling as a powerful tool to enhance project delivery. Being able to virtually design a building before the first shovel of dirt is moved results in a higher return on investment with improved productivity and reduced downtime.

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Creating a virtual image with the innovative Building Information Modeling (BIM) is becoming more common as the industry searches for ways to lower costs while providing higher quality. Complex construction projects, such as healthcare facilities, are ideal for the use of BIM because it enables all members of the project team to work together to resolve discrepancies in the design phase rather than in the field. The virtual modeling is also critical to determining the exact specifications for equipment. As a result, mechanical systems can be pre-fabricated off-site and installed at the most optimum time.

"Three-dimensional modeling is the default for us on complex projects because it increases accuracy," says Victor Sanvido, senior vice president of Southland Industries, a mechanical contractor in Irvine, Calif. "The 3-D concept allows you to take the designs of the other disciplines and ours, and make sure nothing clashes in terms of equipment installation or systems logistics. This is important since 75 percent of building costs are fixed at the schematic design phase. Changes can be made and problems can be resolved during the design, rather than in the field during construction."

Benefits of BIM and Pre-Fabricated Systems

The construction of the Camino Medical Center for Sutter Health in Northern California represents a project where BIM was used from start to finish, making it easy to install pre-fabricated mechanical systems. Construction of the $100-million, 250,000-sf medical office building with a surgery center and urgent care clinic began in February 2004 and is now complete. The project also included 420,000 sf of parking space. Developing the BIM blueprint for the Sutter building cost approximately $500,000.

The mechanical systems were pre-fabricated off-site in Southland's assembly facility based on design specifications outlined in the model. The systems

Biography

Victor Sanvido, Ph.D., is senior vice president at Southland Industries. He is responsible for developing specific end-users in the company's target markets in California and for their service business. He is active in the Design-Build Institute of America (DBIA).

For more information

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Fig. 3

Dramatic Reduction in Field Questions

were pre-fabricated so they could be installed before the walls were erected. The pre-assembled sections were tested at Southland's shop before being delivered to the Sutter facility. The sections were also complete with wheels, which facilitated a quicker installation with less manpower. In fact, 30 percent fewer sheet metal workers and 55 percent fewer pipe fitters than originally estimated were necessary.

Using the pre-fabricated mechanical, electrical, and plumbing systems resulted in minimal Requests for Information (RFIs) regarding conflicts between the MEP systems in the BIM. However, it is remarkable that there were only six RFIs related to the MEP and fire protection systems conflicting with other equipment. Only six equipment components had to be moved, a significant accomplishment, considering that there can sometimes be hundreds of RFIs on a project of this magnitude. Completing the rework took 43 hours, which equates to only 0.2 percent of the total 25,000 hours of project labor.

The HVAC contractor reported more than $400,000 in labor savings on a $9 million Guaranteed Maximum Price (GMP) contract. In addition, a 2-to-1 net return on investment of $415,000 was realized by using BIM.

Motivation to Use BIM

Although Southland has been using three-dimensional CAD modeling since the 1990s, the concept is just beginning to gain momentum in the construction industry. BIM is a pioneering visualization tool that can enhance communication between professionals in the architectural, engineering, and construction industries. Digital images are created to accurately depict all aspects of a construction project and to simulate real-world performance and operation of a facility.

The growing complexity of buildings makes it imperative for all stakeholders in the construction industry to streamline every aspect of project delivery from the design phase to completion. Using the model facilitates precise documentation, faster decision-making, improved communication between parties, optimization of resources, more efficient workflow, increased productivity, and decreased errors. BIM plays a critical role in being able to communicate necessary design changes between the architect, construction manager, mechanical, electrical and plumbing engineers, subcontractors, and other project team members.

BIM, which represents an improvement over the more traditional computer-aided drafting, is capable of showing extremely specific information relevant to the entire life cycle of a particular building from conception through construction and actual operation. The BIM drawings can feature spatial relationships, the properties of building components, the scope of work, all included systems, interoperability of the equipment, and the most suitable installation sequence. Being able to visualize each component of the building and using a conflict-detection system makes BIM a powerful tool for significantly reducing project errors. Each team member, including specialty contractors and subcontractors, can analyze their work in relationship to that of other trades in order to avoid conflicts.

"It's important to have the model created by the people who will be completing the work. The architect usually takes the first look at the model, then the structural people look at it, and then the mechanical load calculations are determined, as well as how to distribute the air and water throughout the building," notes Sanvido. "It's also critical to have an exact replica of a piece of material or equipment that will be used. A model that doesn't show an exact piece of equipment could have the wrong values, the wrong voltage, improper seismic supports, or not enough operational clearances."

Putting BIM into Action

"BIM worked well for Sutter because the people who drew the model also installed the equipment," says Sanvido. "It also helped that all of the project team members were located on the job site so we could easily communicate with each other if there was a problem."

There were zero RFIs regarding conflicts between the mechanical, electrical, and plumbing systems on the construction of the Camino Medical Center in California. The use of Building Information Modeling (BIM) resulted in a dramatic reduction in field questions and change orders.

Fig. 4

Coordination of Work

Building Information Modeling (BIM) was helpful in coordinating the proper sequencing of work and equipment installation on the Sutter Health project.

DPR Construction Inc. of Redwood City, Calif., served as the general contractor for the Sutter Health project. DPR had used BIM on other buildings, but this marked the first time the company had used the modeling technique for every aspect of the project.

“By the beginning of this job, technology had gotten to a point where this entire project was executed in BIM,” says Eric Lamb, executive vice president of DPR. “The subcontractors, like Southland, were using it and the architect had the capabilities. The structural engineer had to learn it, but we got everybody on board early. Working on the model enabled everybody to collaborate and to accomplish Sutter’s lean practices.”

Collaboration and communication among subcontractors was vital for the proper sequencing of work and equipment installation. The model took six months to complete and a project overseer managed the coordination between all parties. Regular meetings were helpful in ensuring that everyone understood the importance of adhering to the BIM blueprint and paying special attention to the order in which equipment and supporting structures, such as interior walls, mechanical, electrical, and plumbing systems, were installed.

“People produced the sequencing, but the model enabled us to see the consequences of our decisions because we could see it in three dimensions. There was a lot of learning going on, but results were amazing, considering that we were really learning, experimenting, and perfecting,” says Dean Reed, a lean/virtual building coordinator for DPR. “There was very little rework on this project and everybody who came on site was amazed at how quiet and how orderly it was.”

The critical walls, such as the full-height wall, were identified and color-coded on the model. These walls were erected before any of the piping and drywall was installed. A full-height wall, which is usually fire-rated, is considered a priority and, therefore, the drywall contractor must work on this particular wall first. Work sequencing was a top concern to reduce the need for rework, to minimize errors, and to keep the fast-paced project on schedule.

The designation of priority walls benefits the project as a whole, but may interfere with the productivity of specialty contractors. For example, the drywall contractor may experience a decrease in productivity by having to install priority drywall in different locations and at different times, making it difficult to complete all of the work at once.

Conclusions

“The most difficult aspect of using BIM is having team members who never used it and trying to get them to use it correctly,” says Sanvido. “You can spend a lot of time supervising them in the field. This technology is still in its infancy. The industry is probably 15 to 20 percent of the way to where it needs to be.”

When using BIM, it is important to involve all team members, including the field staff, in the early stages of the modeling process. Doing so will reduce errors and enhance workflow. BIM, which is expected to become fairly routine over the next few years, helps prevent misunderstandings between trades and conflicts between systems.

“The end users and facility managers can see and understand the spaces,” notes Sanvido. “The model helps to plan logistics and to sequence the proper installation of equipment.”

Using pre-fabricated materials can shave a significant amount of time off projects. As for the future of pre-fabrication, more and more components are expected to be assembled off-site and then be “dropped” into place as the building is being erected.

By Tracy Carbasho

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