Meeting the Challenges of Infrastructure Growth by Leveraging 4D Building Information Modeling (BIM)
Executive Overview

Although the vertical construction world has experienced years of success incorporating Building Information Modeling (BIM) into the design and construction process, the infrastructure industry is still in the early stages of adopting a model-based approach.

As highway, railway, port, and utility construction is poised for considerable growth during the next few years, infrastructure organizations would be well advised to leverage 3D BIM technologies to improve communications, accelerate workflow, and reduce rework. But that is only the beginning. In an industry particularly vigilant of budgets and schedules, forward-thinking construction organizations should consider taking BIM to the next level: 4D BIM.

4D BIM not only provides construction project visualization; the technology uses embedded data within the 3D model to produce construction schedules, cost estimates, and can even enable the 3D model to become a virtual search engine for building parts and materials that can be accessed after the facility is built.

The purpose of this white paper is to explore how a 4D approach can have wide-ranging advantages for all players in the infrastructure industry: owners, contractors, and architects.
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The Infrastructure Market

Built during the mid-twentieth century, America’s once first-class infrastructure has seen better days. From crumbling highways to overtaxed electrical grids to aging railways, the facilities that power and move the nation can no longer accommodate the technological and societal demands of a new generation.

As communities across the country start to address the critical need to repair, refurbish, and rebuild these aging facilities, infrastructure construction is predicted to experience a significant jump in growth. Yet, organizations hoping to capitalize on this growth will face key challenges. Although the need for infrastructure improvements continues to grow, there is a new layer of accountability. As publically funded projects, infrastructure construction has traditionally been built with tight budgets and strong oversight. The recent economic downturn has slashed public funds still further. For the communities that will be paying for these projects, affordability is the new normal.

As a result, engineering, architecture, and construction companies must adapt their practices and processes accordingly. They must work more efficiently and effectively to deliver projects within this new paradigm of affordability in the public sector.

BIM Use in Infrastructure

Clearly, organizations seeking infrastructure work will need new approaches that enable them to do more with less. To increase the efficiency and profitability of their projects, more and more organizations are adopting a methodology already in widespread use throughout the commercial construction world: BIM.

The use of 3D data-rich models has helped commercial construction companies facilitate better design, enhance construction efficiency, and improve collaboration. Although the level of BIM adoption in the infrastructure sector lags a few years behind vertical construction, the use of BIM technologies for infrastructure projects is growing.

According to a study conducted by McGraw-Hill Construction, “The Business Value of BIM for Infrastructure,” BIM is poised to transform the infrastructure marketplace. The study surveyed 466 owners, contractors, architects, and engineering professionals involved in infrastructure projects in 2011. Almost half (46 percent) of the firms surveyed are currently using BIM technologies and processes on some part of their infrastructure portfolio. Considering that only 27 percent reported
using it in 2009, it is evident that BIM adoption is growing at an accelerated rate in the infrastructure industry.  

A 3D model-driven approach seems to be well suited to the requirements of the budget-conscious infrastructure sector. Of the firms that are currently using BIM, a vast majority (89 percent) said that they are receiving value from it. Indeed, 67 percent of BIM users report a positive ROI on infrastructure projects.2

The study also shows an increase in the level of BIM use, demonstrating the value that BIM is bringing to infrastructure projects. For example, of the current BIM users, 79 percent expect to be using BIM on more than 25 percent of their infrastructure projects by 20133. The group of companies using BIM at a very high level (on over three quarters of their infrastructure projects) has experienced the most rapid increase—from seven percent in 2009 to a predicted 31 percent by 20134.

BIM Demand by Player

Who is the main driver of BIM adoption in the industry? According to the McGraw Hill study, owners are the biggest champions of BIM. In 2009, 42 percent of infrastructure owners did not use BIM. That figure jumped in 2011 to 100 percent saying that they will be doing some amount of BIM within two years5. Additionally, over a quarter, (26 percent) plan to be at a very high level of implementation at that time6. In the study, owner demand was cited as a top factor that will encourage BIM adoption among non-users. As more owners increase the number projects that leverage BIM, the rest of the industry will follow.

The Benefits of BIM for Infrastructure

As infrastructure companies work to enhance construction efficiency, the business value of BIM becomes even more tangible and fundamental. The top benefits of BIM for infrastructure companies are discussed below:

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2 Ibid

3 Ibid

4 Ibid

5 Ibid

6 Ibid
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- Reduced risk
- Better project outcomes
- Reduced rework and errors

Reduced Risk

With public finances facing even more scrutiny, infrastructure construction companies will be expected to build increasingly complex projects under low profit margins. Avoiding risk is paramount. BIM is a powerful visualization tool that enables all project stakeholders to explore virtual project models before physical construction begins. With BIM, project teams can identify complex construction issues and resolve utility conflicts during the design phase and bring projects to completion, helping prevent projects from going over budget or falling behind schedule. BIM models also help engage the public when designs need to go through the public approval process.

Better Project Outcomes

3D BIM models are essentially virtual shared data resources that support decision-making throughout the project lifecycle. When all project team members are given access to the visual model the result is an improved project outcome for all parties. In the McGraw-Hill study, all player types (architecture/engineering firms, contractors, and owners) cited reduced conflicts and changes during construction as the most important benefit of BIM (58 percent)\(^7\). With digitally based collaborative processes, BIM reduces the total amount of change that a project can expect. There are fewer RFIs and field coordination problems, and more trouble-free projects.

Reduced Errors

Realistic 3D models convey the design intent and provide more accurate construction documents—a key advantage that reduces errors and enhances construction efficiency. The collaborative aspects of BIM bring all project stakeholders together to fix construction issues. By accessing a virtual model of the complete facility, engineers and designers can resolve issues and clashes more quickly and accurately than before. Construction details are worked out virtually, rather than in the field, resulting in far fewer errors.

\(^7\) Ibid.
The Next Dimension: 4D BIM

The benefits of BIM go far beyond its use as a visualization and collaboration tool. Leveraging the depth, accuracy, and consistency of the data available in the 3D BIM model, 4D BIM takes the technology to the next level by adding the fourth dimension of time to enable project team members to visualize the progression of construction activities.

When the 3D BIM data is integrated with visualization and scheduling software, the resulting 4D BIM model enables organizations to optimize construction project management, with streamlined workflows, improved productivity, and enhanced collaboration. A lot of the work on infrastructure projects happens out at the construction site; 4D BIM ensures that work is completed on time and budgets don’t slip. By linking the BIM model to the production schedule, organizations can view the workflow of all scheduled tasks throughout the entire construction site and monitor the progress of specific activities. 4D BIM also incorporates human resources, equipment, and materials into the model, for enhanced workforce scheduling, procurement tracking, and cost estimating.

With 4D BIM, organizations can monitor construction progress with a real-time knowledge database. Specific activities can be tracked and analyzed. If deadlines start to fall behind, 4D BIM enables decision-makers to explore all available resources of labor, materials, and budget to make up the difference.

The visualization capabilities of 4D BIM allow all stakeholders to view and digitally collaborate on construction, engineering, procurement, and contract documents. 4D BIM unlocks the data within the 3D model giving crews access to the information they need to complete their work, along with an audit trail of approvals, decisions, and comments.
Diagrams showing the 4D visualization and construction scheduling process:
4D BIM with Primavera and AutoVue

Oracle’s Primavera and AutoVue solutions complete 4D BIM with robust, web-based visualization and project management solutions that enable infrastructure organizations to visualize project documents and activities at a glance, schedule work, and proactively oversee the entire construction lifecycle. Using graphical, intuitive interfaces, Primavera P6 Enterprise Project Portfolio Management automates labor scheduling and provides project team members with required information about their assignments and the ability to provide feedback. Project Managers can monitor and visualize project performance versus plan and balance incoming demand with available resources. AutoVue solutions deliver visualization and digital collaboration of project documents within Primavera, allowing all stakeholders to access and review documents, such as floor plans, piping and instrumentation diagrams (P&ID), and process flow diagrams.
Taking BIM into Operations & Maintenance

After an infrastructure facility is designed and built, it remains in operation for many decades. Its virtual BIM model continues to offer significant value as well.

Throughout the design and build process, the BIM model serves as a data repository for the multitude of architecture, engineering, electrical, and utilities decisions and details involved in construction—down to the manufacturer and part number of the door hinges. At the operations and maintenance phase of a project, it becomes an “as found” and “as maintained” data model that provides the owner with a content library that makes this data easily accessible for years to come.

Primavera and Autovue remain central components for facilities management and maintenance operations enabling planners and technicians to have easy access to the accurate documentation they require to perform maintenance activities. Integrating operations & maintenance systems with Primavera and Autovue aligns scheduling and resource demands with the model, so workers can instantly view diagrams and layouts and find out key information, such as what size pipes or what kind of valves are needed to make the necessary repairs.

When integrated with Primavera and Autovue, Oracle Enterprise Asset Management (Oracle eAM) improves both the responsiveness and accuracy of contracted maintenance. With a complete view of assets and equipment, owners of infrastructure facilities can automate maintenance workflow throughout the full asset lifecycle.
Conclusion

Although infrastructure lags behind commercial construction in its adoption of BIM, there’s no doubt that BIM will soon transform the industry. Given BIM’s clear benefits and widespread popularity, it’s not hard to imagine that very soon clients be asking organizations for electronic deliverables, instead of 2D drawings.

Forward-thinking organizations would be well advised to prepare for this change by adopting BIM into their design and build processes as soon as they can manage.
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by Extending the Value of Building Information
Modeling
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Author: Bobbie Hartman

Oracle Corporation
World Headquarters
500 Oracle Parkway
Redwood Shores, CA 94065
U.S.A.

Worldwide Inquiries:
Phone: +1.650.506.7000
Fax: +1.650.506.7200
oracle.com

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