Realizing the Benefits of BIM

Building Information Modeling (BIM) is an intelligent model–based design process that adds value across the entire lifecycle of building and infrastructure projects. This white paper summarizes the benefits of BIM and provides an overview of the steps your firm can take to help reap the full benefits of a BIM implementation.

An Executive Overview of BIM

The reliance on digital design models has been a common practice in the manufacturing industry for decades. Project teams at companies such as Boeing and Toyota have placed digital models at the core of their collaborative, concurrent engineering processes for years, using them to support the entire project lifecycle—from design and documentation to manufacturing and field support.

BIM helps architecture, engineering, and construction (AEC) service providers apply the same approach to building and infrastructure projects. Unlike CAD, which uses software tools to generate digital 2D and/or 3D drawings, BIM facilitates a new way of working: creating designs with intelligent objects. Regardless of how many times the design changes—or who changes it—the data remains consistent, coordinated, and more accurate across all stakeholders. Cross-functional project teams in the building and infrastructure industries use these model-based designs as the basis for new, more efficient collaborative workflows that give all stakeholders a clearer vision of the project and increase their ability to make more informed decisions faster. Models created using software for BIM are “intelligent” because of the relationships and information that are automatically built into the model. Components within the model know how to act and interact with one another. A room, for example, is more than an abstract concept. It is a unique space contained by other building components (such as walls, floors, and ceilings) that define the room’s boundary. With BIM, the model is actually a complex database and the room is a database element that contains both geometric information and nongraphic data. Drawings, views, schedules, and so on are “live” views of the underlying building database. If designers change a model element, the BIM software automatically coordinates the change in all views that display that element—including 2D views, such as drawings, and informational views, such as schedules—because they are all views of the same underlying information.

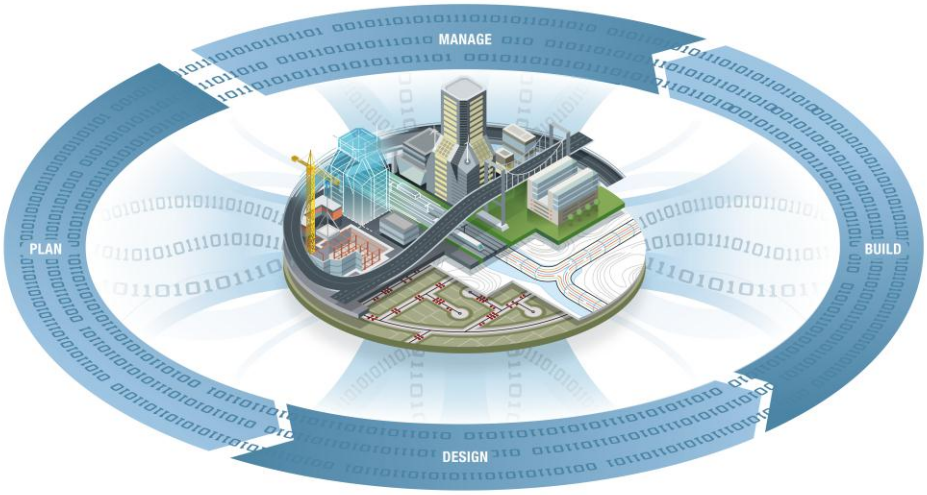


Figure 1: With BIM, cross-functional project teams share intelligent models to better plan, design, build, and manage building and infrastructure projects.

Project teams can also use information contained in the models to perform a variety of complementary tasks, including energy or environmental analysis, visualization, construction simulation, and improving the accuracy of documentation. In addition, BIM helps enable project teams to engage in innovative new contractual relationships and project delivery strategies, such as Integrated Project Delivery (IPD).

Early access to the rich information in the models helps everyone on the project team gain more insight into their projects. As a result, the team can make more-informed decisions much earlier in the planning, design, construction, or renovation process—when decisions can have the greatest impact on project cost, schedule, and sustainability.

BIM Adoption

BIM is firmly entrenched in the building industry and expanding in the infrastructure industry, as recent studies conducted within the United States and Western Europe confirm. For example:

- **Building industry overall**: The 2009 McGraw-Hill Construction SmartMarket Report[1], *The Business Value of BIM: Getting Building Information Modeling to the Bottom Line* (2009 SmartMarket Report), states that nearly half of the U.S. building industry is using BIM, a 75 percent increase since 2007. According to the 2010 McGraw-Hill Construction SmartMarket Report, *The Business Value of BIM in Europe: Getting Building Information Modeling to the Bottom Line in the United Kingdom, France, and Germany (2010 SmartMarket Report on BIM in Europe)*[2], 36 percent of the industry in Western Europe has adopted BIM.
- **Architects**: The 2009 SmartMarket Report reports that six out of ten architects in the United States create BIM models, with half of those users also performing analysis on the models. According to the 2010 SmartMarket Report on BIM in Europe, in Western Europe 70 percent of architects that use BIM believe that it leads to better-designed projects.
- **Engineers**: The 2009 SmartMarket Report states that over the next two years, the use of BIM is expected to double by structural engineers, triple by mechanical, electrical, and plumbing (MEP) engineers, and quadruple by civil engineers. The 2010 SmartMarket Report on BIM in Europe states that in Western Europe nearly 70 percent of engineers report positive ROI and 62 percent found BIM to be of high or very high value during the construction phase.
- **Contractors**: According to the 2009 SmartMarket Report, the use of BIM among U.S. contractors has almost quadrupled in the past two years, with half of all contractors currently using BIM. The 2010 SmartMarket Report on BIM in Europe reports that 52 percent of contractors in Western Europe found BIM to be of high or very high value during the construction phase.
- **Owners**: Fully 70 percent of the U.S. owners surveyed by the 2009 SmartMarket Report reported a positive ROI from using BIM. In Western Europe, 65 percent of the owners surveyed report asking for BIM, according to the 2010 SmartMarket Report on BIM in Europe.
- **Green BIM Professionals:** According to the 2010 McGraw-Hill Construction SmartMarket Report, *Green BIM: How Building Information Modeling is Contributing to Green Design and Construction* (2010 SmartMarket Report on Green BIM) [3], the use of BIM on sustainable or "green" projects is poised for great growth, with 78 percent of BIM users

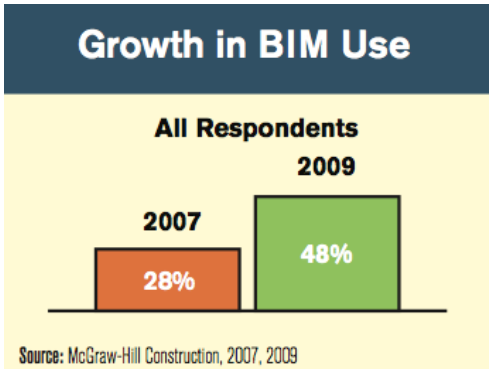
[1] Norbert W. Young, Stephen A. Jones, Harvey M. Bernstein, and John E. Gudgel, *The Business Value of BIM: Getting Building Information Modeling to the Bottom Line*, McGraw Hill Construction, 2009.

[2] Harvey M. Bernstein, Stephen A. Jones, and John E. Gudgel, *The Business Value of BIM in Europe: Getting Building Information Modeling to the Bottom Line in the United Kingdom, France, and Germany*, McGraw Hill Construction, 2010.

[3] Harvey M. Bernstein, Stephen A. Jones, and Michele A. Russo, *Green BIM: How Building Information Modeling is Contributing to Green Design and Construction*, McGraw Hill Construction, 2010.

who do not currently use it on green projects planning to do so within the next three years.

The change occurring in the global economy has presented architects, engineers, and contractors with a window of opportunity to retool their businesses and adopt new tools and workflows that will help them deliver higher-quality building and infrastructure projects at a lower cost and, thereby, help them differentiate themselves in the marketplace and stay competitive in challenging times.



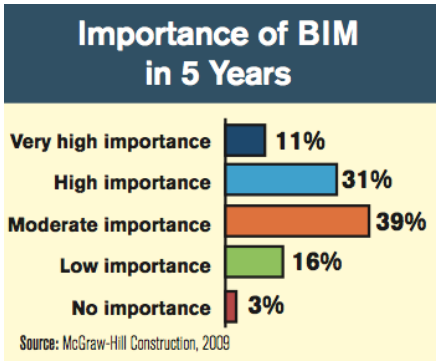


Figure 2: BIM use is on the rise. A recent study reports that 42 percent of nonusers believe that BIM will be highly or very highly important in five years.

2009 SmartMarket Report.

Key Considerations When Moving to BIM

Some people mistakenly think of BIM as just a new variety of software. BIM is actually a *process* that relies on information-rich models to help owners and AEC service providers to more efficiently plan, design, construct, and manage building and infrastructure projects. Implementing BIM will impact your business and your processes, as well as your technology toolset. As you move to BIM you should be aware of how your organization's business, processes, and technology might change, so you can better position your firm to reap the benefits of BIM.

BIM and Your Business

BIM changes the way companies work—both internally and externally. Projects have become more and more complex, requiring firms to manage and share immense amounts of data across diverse and distributed teams. By enabling greater insight into the project at any point in its lifecycle, BIM helps AEC service providers to improve accuracy, efficiency, and productivity, resulting in time and cost savings. The significant value-added benefits that BIM-ready firms can provide include: faster project approvals, more predictable outcomes, sustainable design and analysis services, and improved collaboration and information sharing for integrated project delivery strategies.

49 percent of users say that the ability to offer new services as the result of BIM adoption is a significant business benefit.

2009 SmartMarket Report.

IPD requires intense multidisciplinary collaboration, especially at the onset of projects. Because BIM provides greater potential for early collaboration and information sharing than traditional methods, it helps project teams make better, more-informed decisions throughout the project lifecycle. "BIM and IPD assist us because they bring a level of predictability to projects," says Mervin Dixon, senior project manager at Sutter Health/CPMC. "We know the schedule. We know the cost. We have also been able to drive costs down with

BIM because we get input from the various trades regarding the optimal way of doing things."

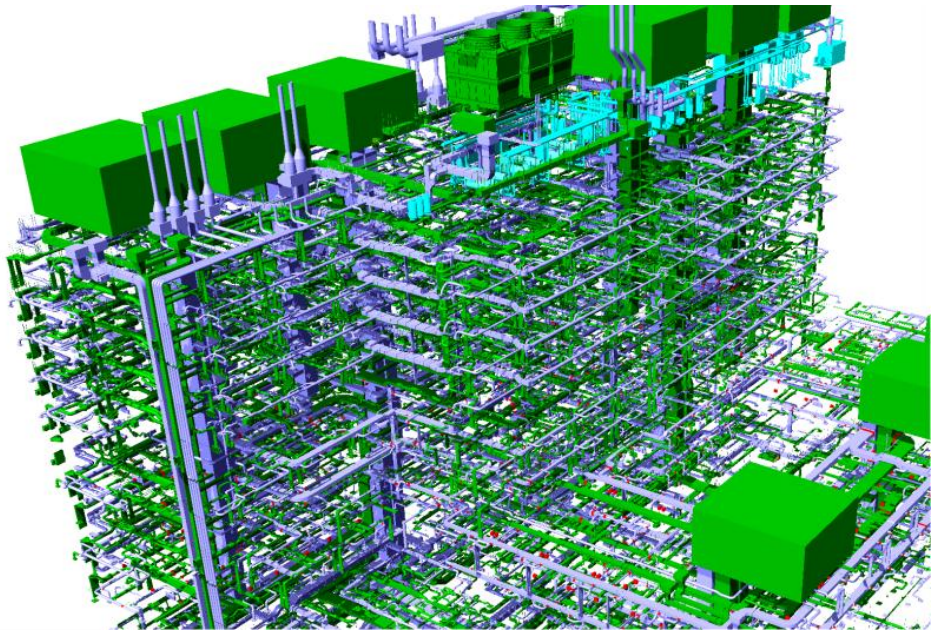


Figure 3: On complex projects, BIM provides greater potential for early collaboration and information sharing than traditional methods.

Image courtesy of HerreroBoldt.

The increased potential for collaboration that comes with BIM, as well as the alternative project delivery methods that it enables, can have a great impact on your business models, the types of projects on which you bid, and the partners, clients, and consultants with whom you choose to work. The ability to digitally collaborate on a building's physical and functional characteristics strengthens and deepens existing partnerships—and forges new ones—between architects, engineers, contractors, and owners. "BIM allows us to work on much more complicated structural engineering projects than were attempted in the past," says Suzanne Provanzana, associate at Thornton Tomasetti. "Architects are using more and more complicated geometries; BIM allows us to share the geometries back and forth among the design team members much more easily." The ramifications of that new level of collaboration are felt across all the organizations involved in a project, reaching far beyond the design groups and affecting most aspects of each firm's business.

BIM can also affect the way a company delivers its products, enabling AEC service providers to deliver more 3D views, sections, schedules, and realistic renderings in construction documents. BIM also improves the quality of the final product. "There's no doubt that BIM is helping us to deliver a better product to our client," says John Townsend, executive vice president at Hatch Mott MacDonald, a consulting engineering firm providing services to clients engaged in infrastructure and building projects. "We know from the model that everything's going to fit; the interfaces are resolved; the clash detection has been sorted out. At the end of the day, we have a product that we know the client has seen as a 3D model and has bought off on. That reduces the risk for us as engineers."

Figure 4: High-resolution rendering of the Crum Creek Water Treatment Plant before construction.

Image courtesy of Hatch Mott MacDonald.

Figure 5: Photograph of the Crum Creek Water Treatment Plant after construction.

Image courtesy of Hatch Mott MacDonald.

BIM can also improve the way firms deliver existing services and give them the ability to offer new ones. In fact, in the 2009 SmartMarket Report, half of the users surveyed report that the ability to offer new services as the result of BIM adoption is a significant business benefit. For example, civil engineers and contractors can use the BIM process to significantly improve and automate the grading process by loading information from the model into the onboard computer of a GPS-equipped bulldozer or excavator, thereby drastically reducing the need for staking. “With machine control, we’ve achieved, on average, about a 30-percent time savings on finishing of mass grading projects,” says Glenn Fereday, project manager/estimator at Sureway Construction Group in Edmonton, Alberta. Contractors can use BIM to increase the range of construction management services they provide by dynamically linking the intelligent 3D model to the project schedule. Even when these enhanced abilities don’t result in additional service offerings, they do represent new expertise that firms can capitalize on.

One of the benefits of the BIM process is real-time sustainable design and analysis early in the design phase. “We do a significant amount of analysis at the early stage of most of our projects,” says Mehdi Jalayerian, P.E., LEED AP, managing principal in charge of the international division at Environmental

Systems Design, Inc. “BIM allows us to quickly transport very accurate information into the information models and be able to analyze our energy models and practice various techniques that are required at the early stage of a project to confirm massing and help the architectural design process to progress.”

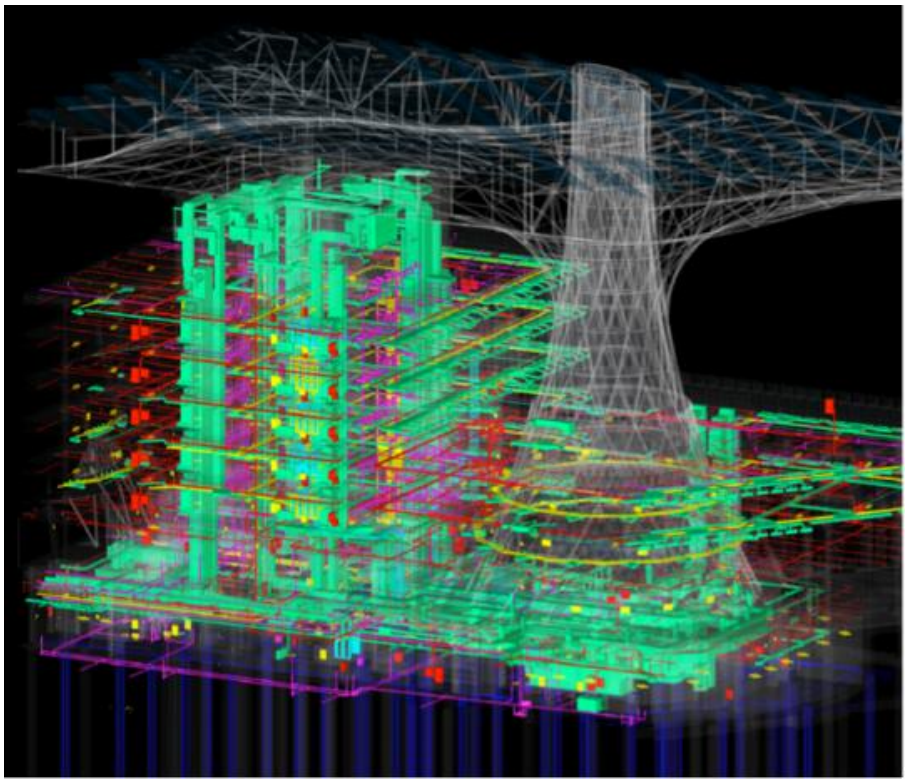


Figure 6: BIM capitalizes on the information in the model to enable additional capabilities, such as sustainable design and analysis.

Image courtesy of Environmental Systems Design, Inc.

BIM Implementation

The strategic business issues cited above require top-down support for implementation. BIM is a strategic initiative that requires a corporate will to succeed to its fullest extent. As is the case with many truly transformative concepts, BIM will alter your staffing needs, your processes, and your technology requirements. The executives in your firm need to understand that, but they are also the ones who can appreciate the strategic value of BIM. Education and awareness about BIM, the benefits it can bring as well as the workflow changes it requires, are often necessary to garner this executive support.

Once executive sponsorship is established, many companies assemble a motivated group of evangelists to spearhead the transition to BIM. That group works on a BIM pilot project to demonstrate success and then uses that success as a launch pad to rollout BIM to the rest of the organization.

“Don’t jump in head first and don’t expect to see success right away,” cautions John Tobin, principal at Einhorn Yaffee Prescott Architecture & Engineering PC. “We took small steps at the beginning, incubating BIM on a pilot project to minimize risk.” With each new project success, BIM gains momentum and company support—until it spreads exponentially throughout the organization. And be prepared for setbacks along the way. “We had a pretty steep learning curve and enthusiasm for BIM waned in direct proportion,” says Chuck

Blackford, design applications manager at Corgan Associates. “But once we got past that learning curve, the excitement came back.”

Internally, BIM adoption usually results in broad organizational changes based on new and/or different staffing needs. BIM increases efficiency, especially for construction documentation, enabling firms to do more with less. As a result, project staffing tends to shrink slightly (usually in the drafting ranks) and more effort is expended on value-added activities during design. In many cases, the expertise needed for the value-added tasks may be different than what your firm currently employs. For example, digital design models can be used for very sophisticated energy modeling and environmental analysis—facilitating sustainable design. To capitalize on that new opportunity, your firm may decide to hire additional LEED-accredited analysts. BIM designs can also be used for construction cost estimating, procurement, and even digital fabrication. These enhanced capabilities typically need specialized expertise and may lead to staffing changes.

BIM is a strategic initiative that requires top-down executive support to succeed. BIM changes the way companies work. Externally, it enables companies to engage in innovative new project delivery methods; provide more affordable, more efficient sustainable design and analysis services; and offer a range of new services. Internally, the transition to BIM may result in broad organizational changes based on new and/or different staffing needs.

BIM and Your Processes

Implementing BIM will result in changes to your design process, drawing production, and project team organization. Collaboration will become even more important.

Perhaps the biggest process change that firms encounter has to do with the very act of designing. Design representations are no longer 2D drawings. Instead, designers are using 3D digital models that are assembled in the same way a building is constructed. “Using BIM, we’re able to overlap information from all of the different disciplines to come up with an integrated solution,” says Robert Forest, AIA, LEED AP, a management partner at Adrian Smith + Gordon Gill Architecture. “The ability to look at all these aspects together in a holistic manner is of tremendous value.” Although the use of BIM tools tends to increase the level of effort during early design, it speeds up your back-end production processes and—more importantly—results in a higher quality, more sustainable building with fewer requests for information and construction change orders.

68 percent of BIM users say that BIM pushes more key decisions to the earlier stages of the design process.

2009 SmartMarket Report.

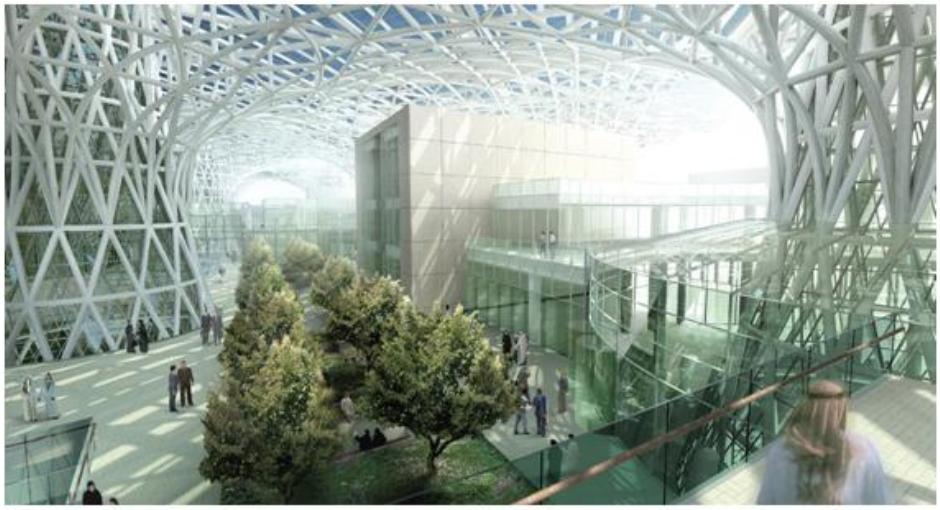


Figure 7: By using a holistic design approach, BIM helps designers investigate how an entire building comes together, and it helps reduce the amount of design changes during construction.

© Adrian Smith + Gordon Gill Architecture.

"Teams need to get together and plan the process of how to exchange information, what to do with the data, how often to update the model, and how to integrate the plotting process," says Jalayerian. Designers need to understand how a building goes together as well as how design data is used by other disciplines, other workflows, and other stakeholders (outside your department and maybe outside your organization). In addition, as digital design-to-fabrication strategies become an integral part of lean building design, extended design teams need to incorporate construction information and expertise much earlier in the design cycle.

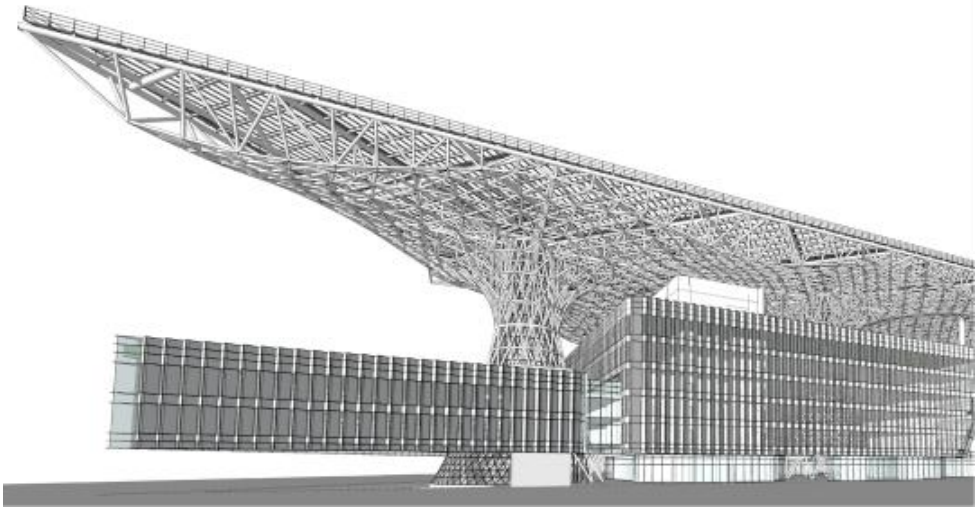


Figure 8: The BIM process helps team members to coordinate with each other early in the project to determine how they will build the model.

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There are many questions that need to be addressed and planned for on a per-project basis. How will costing personnel use BIM in their estimates? Can MEP engineers use the architect's model for energy analysis? Will the discipline-specific design models be used by the builder for construction coordination and simulation? Or will the model be used for digital design to fabrication, as happens more and more often during construction? "We're able to create our plan using a model, and then to pull pieces of that model out for fabrication in a controlled environment," says John Mack, VDC/BIM manager, Herrero Contractors, Inc. "We can make very large assemblies and deliver them to the job."

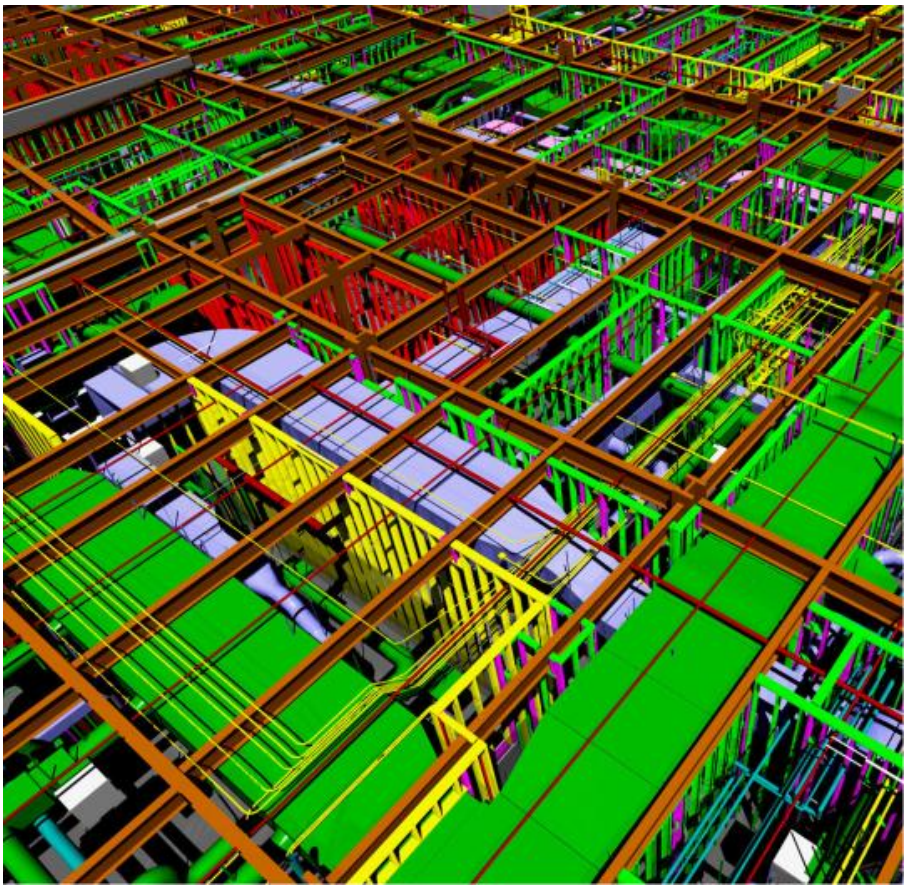

Figure 9:

Contractors can pull pieces out of the aggregated model for fabrication in a controlled environment.

Image courtesy of HerreroBoldt.

Another major impact of BIM is the emphasis on early design versus construction documentation. BIM shifts the overall level of effort to earlier in the project—potentially influencing an organization's project workflows and staffing needs. The traditional makeup of a design team is governed by the huge effort required to produce a construction document set, with roles corresponding to drawing types: plans, elevations, sections, details, and so on. Using BIM, the reduced documentation effort renders this traditional project structure obsolete.

Instead, BIM teams tend to be organized around functions such as project management, content creation, building design, and documentation. This shift in production methods could prove disorienting to a staff experienced with traditional design workflows, so firms must be prepared to address the resistance to change sometimes encountered by pointing out the productivity and quality gains possible with BIM.

If your firm relies on "follow the sun" scheduling that uses geographically dispersed design teams, then it is also important to incorporate new strategies and workflows to partition, distribute, and aggregate the project model. File sizes tend to be large and require attentive management of information sharing. If a partner's model will be utilized for your own design, it needs to be incorporated into your process as well.

For information sharing among geographically dispersed teams, some firms employ the strategy of a central project model in a single office location and multiple local servers. This approach helps enable team members to work

more effectively as a single unit over a distributed wide area network (WAN). Multiple team members around the world can work simultaneously on local models stored on their computers, updating them periodically with up-to-date information from the central model—most of which is already stored on the local servers. This approach represents one aspect of a larger phenomenon known as cloud computing, in which data and, with increasing frequency, software resides in a remote location.

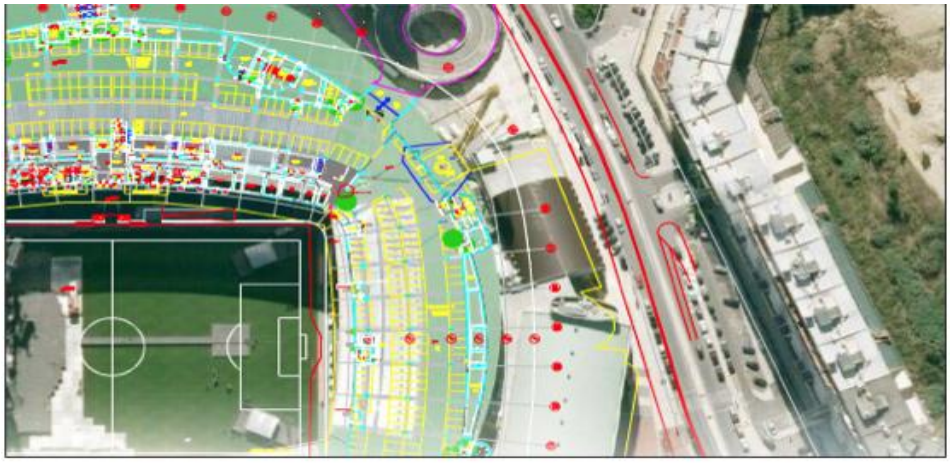

Figure 10:

Using a web browser and software as a service (SaaS), design team members can view and edit a cloud-based model.

Image courtesy of Autodesk.

Some firms choose to use remote access technology that enables them to access the central model using a "thin" client. Using this approach, design team members access the project model remotely and use cloud-based design Software as a Service (SaaS) to work on it. Other firms use project collaboration websites—where the software and models reside in the individual offices and a project collaboration site is updated on a daily or weekly basis for coordination. This approach is common for cross-discipline collaboration between different firms.

Once a firm has figured out how to partition and distribute the information, it will need to revamp its design review and collaboration processes. One of the benefits of BIM is the ability of cross-functional project teams to collaborate on a project's design and construction using digital models. In many situations, BIM makes the traditional review-comment-response process out of date, with successful implementations taking advantage of digital design charrettes and virtual project review workflows. "The BIM process allows people to experiment and to get quantifiable feedback. It allows them to go outside of their boundaries and explore more creative solutions," says Forest. But it can also be a challenge to determine how best to organize, coordinate, and collaborate on all the digital data that stems from BIM. Higher levels of communication are required, enhanced by collaborative technology and workflows.

BIM changes the design process, increasing the level of effort during early design, but speeding up your back-end production processes and—more importantly—resulting in a higher-quality outcome with fewer requests for information and construction change orders. Workflows for design reviews, collaboration, and information sharing will need to be overhauled.

BIM and the Toolset

Firms should devise a well–thought-out BIM implementation plan that addresses the business and process issues mentioned earlier, as well as software, pilot project(s), software training, and rollout. The key is to use the right people, on the right project, with the right plan. Plan carefully, execute nimbly, and be open to changing the plan based on the incremental lessons learned and the situation on the ground. When moving to BIM, it is important to remember that it is more than a lateral move; it is a change in process, too. There will be issues that pop up frequently that you will need to address with an open mind, seeking new approaches and new tools to solve them efficiently and productively.

To support BIM, firms typically require hardware and networking upgrades: more powerful CPUs, more memory, WAN devices, and even bigger monitors. Firms should commit to using top of the line hardware, connectivity, and communication devices, since the technology often used for CAD may be insufficient for BIM.

Firms cannot forget about other technology needed to take full advantage of the power of BIM: technology for collaboration, analysis, visualization, design review, data management, and so on. For example, enhanced collaboration may require additional investment in the form of video conferencing technology and large display screens. The increase in the sheer amount of information being shared may require a data management solution. In some cases, additional computing power might be required, although advances in cloud computing and SaaS mean that much of the heavy lifting can be done in “the cloud,” limiting upgrades. All of these investments can be important to realizing the full value of BIM.

In some cases, existing software is still relevant—it is just used differently. CAD software can still be used for detailing and documentation at the end of a project. Visualization software can still be used for advanced design visualizations, but will be better integrated into your workflow, using the BIM-based design models as the starting point instead of creating the model from scratch using the visualization software.

Finally, there is training. On this point, there is total agreement: on the job, off the job, in-house, out of house, over the shoulder, formal classes, luncheon roundtables, project-based, web-based—it is all good. Firms need to train well, train often, and train continuously.

The transition to BIM requires planning, training, and flexibility. Using the right people, on the right project, with the right plan will be critical to success. Firms should be prepared for upgrades to their technology infrastructure and supporting software, as these investments are crucial to realizing the value of BIM.

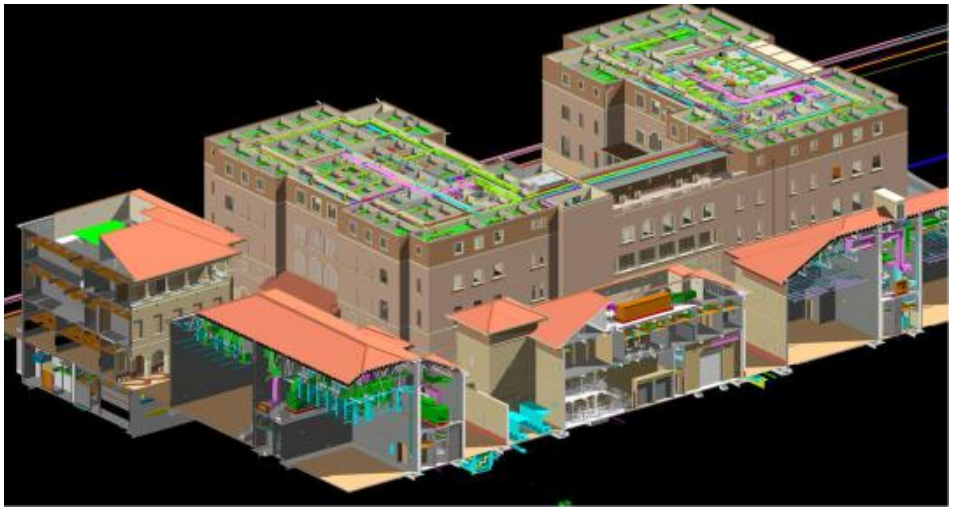

Figure 11: BIM offers organizations a competitive advantage in the marketplace and gives owners higher-quality, predictable outcomes. Adapting to the advantages BIM offers requires investment in staff, processes, and technology.

Image courtesy of View By View.

Summary

The transformative power of BIM is worth the effort. It is already a boon for many in the industry who are realizing increased efficiency, productivity, and quality. Equally as important, according to the 2009 SmartMarket Report, the vast majority of users report seeing positive returns on their investment in BIM.

Even more powerful than the productivity gains is the potential that BIM offers to help enable AEC professionals and owners design, visualize, simulate, and analyze the key physical and functional characteristics of a project digitally—before they build it. Using information within the model, everyone on the project team can make better, more-informed decisions across the entire project lifecycle of building and infrastructure projects.

Planners can select optimum sites. Architects can produce more accurate designs with fewer errors, less waste, and closer alignment to the owner's vision. Engineers can increase coordination with architects and other engineering disciplines, improving the reliability of their designs. Contractors can make sure that constructability issues are flagged early on when changes are less expensive to make. Ultimately, owners will be able to use the models far into the future as the basis of a comprehensive facilities and asset management program. "The use of BIM results in data-rich as-built models that contain a wealth of information for smarter building operations," says Mitch Boryslawski, co-founder of EcoDomus, Inc.

Adapting to the advantages BIM offers requires investment in staff, processes, and technology. Approaching these changes with a positive attitude will speed the transition and allow firms to quickly realize the productivity and quality gains possible with BIM.

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