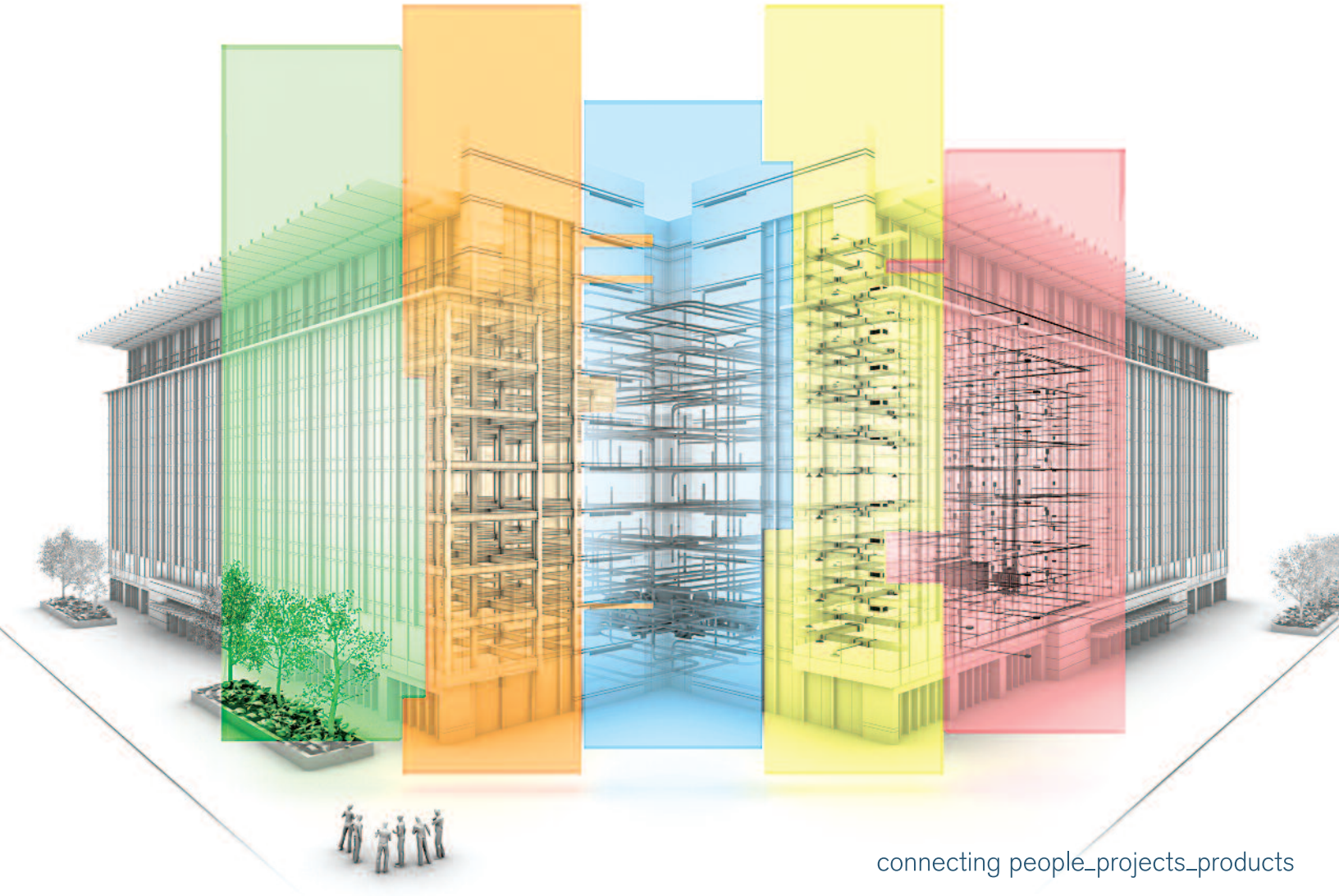
McGraw_Hill CONSTRUCTION

SmartMarket Report

Design & Construction Intelligence

THE BUSINESS VALUE OF BIM

Getting Building Information Modeling to the Bottom Line



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Introduction

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Who's using BIM, and where are they getting the real business value? These are the two questions we hear all the time. Like any innovation trying to gain traction, its actual business benefits are what will make it successful. And their impact on users' bottom line is what will drive adoption. There are enough people now using BIM that we can start to answer these questions.

That is the purpose of this **SmartMarket Report: The Business Value of BIM**.

By surveying thousands of AEC participants in North America from the full spectrum of roles and disciplines we learned that:

- **Almost 50% of the industry is now using BIM.**
- **All BIM users plan significant increases in their use.**
- **The vast majority are experiencing real business benefits directly attributable to BIM.**

We asked nonadopters why they hadn't adopted BIM and what they will need to start. With users we examined the many ways they are experiencing business value, from hard-nosed ROI calculations to qualitative process improvements and enhanced project outcomes.

In addition, there are six in-depth case studies showing how BIM is solving real problems on actual projects. We also have special features, including closer looks at BIM's role with green design, marketing, infrastructure and industrial projects.

As we move ahead through uncertain times, the research clearly shows that BIM adoption will increase, and we can expect new practitioners to build on the successes of earlier implementers, accelerating our industry's exciting transformation to a more productive digital project lifecycle environment.

We want to thank the many busy professionals who responded to our surveys and our supportive partners who, by making this research possible, are tangibly expressing their commitment to the improvement of the entire AEC industry.

Norbert Young, FAIA, is a registered architect, with professional affiliations including The American Institute of Architects and the International Alliance for Interoperability, where he served as Chairman of the IAI-NA Board of Directors and was instrumental in IAI's evolution into the buildingSMART Alliance at the National Institute of Building Sciences. A true leader and innovator in his profession, Norbert is a strong advocate for the development and adoption of global standards for data to enable true interoperability in the design and construction industry. He is an active, recognized speaker nationally and internationally, addressing such topics as "Interoperability and Its Impact on Our Industry," and "Current Trends in Interoperability." Norbert is a Fellow of The American Institute of Architects and in 2008 he was inducted into the National Academy of Construction.

Steve Jones leads McGraw-Hill Construction's initiatives in Building Information Modeling, Interoperability and Integrated Project Delivery as well as developing alliance relationships with major corporations for technology and content. Before joining McGraw-Hill, Steve was a vice president with Primavera Systems, the world's leading provider of project management software. Prior to that, Steve spent 19 years in a variety of design and management roles with architecture firms. Most recently he was a principal and board of directors member with Burt Hill, one of the largest architectural/engineering firms in the world. Steve holds an M.B.A. from Wharton and a B.A. from Johns Hopkins.

Harvey M. Bernstein, F.ASCE, LEED AP, has been a leader in the engineering and construction industry for over 30 years. He serves as Vice President of Industry Analytics, Alliances and Strategic Initiatives for McGraw-Hill Construction, where he has lead responsibility for MHC's research on thought leadership and green building initiatives. This includes research studies on future industry trends in areas such as interoperability, BIM, the global construction marketplace sustainability and innovation. He also is a visiting professor at the University of Reading (UK) School of Construction Management and Engineering. Harvey has an M.B.A in Corporate Marketing from Loyola College, an M.S. in Engineering from Princeton University and a B.S. in Civil Engineering from the New Jersey Institute of Technology.

John Gudgel currently serves as the Director of Industry Alliances. In this capacity, he is responsible for managing McGraw-Hill Construction's relationships with both national and regional industry associations. He also produces and offers thought leadership on construction technology topics and has been the Editor-in-Chief of past SmartMarket Reports on BIM (2008) and Interoperability (2007). He has over 17 years of experience in technology project management in the computer and telecommunications industries. John has an M.S. in eCommerce from George Mason University, an MS in Telecommunications from the University of Colorado and a B.S. in Geological Engineering from the Colorado School of Mines.

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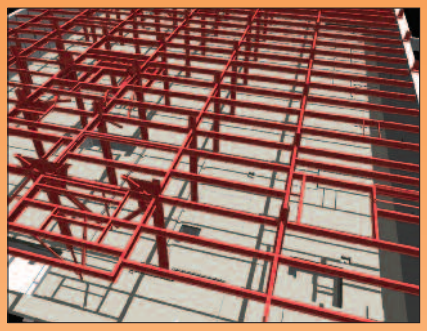

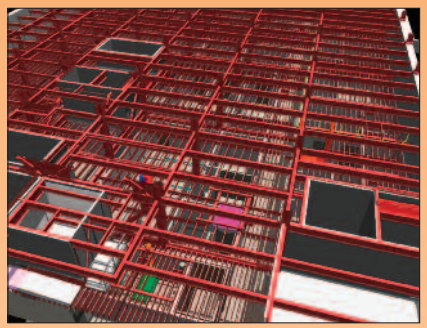

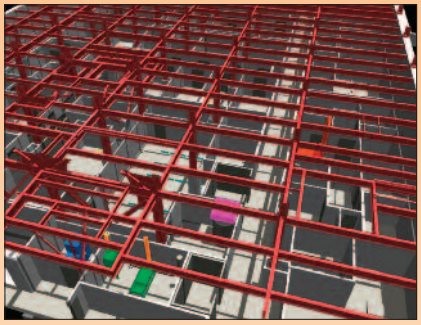

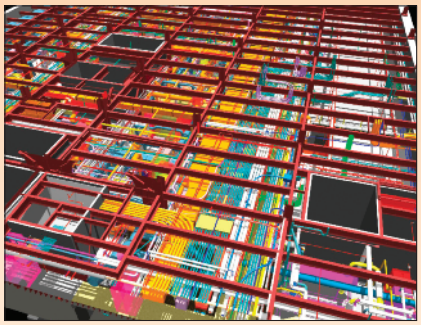

Images courtesy of Mortenson Construction

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SmartMarket Report Executive Summary

Reaping Higher Returns During Lean Times

Even as the design and construction industry confronts a down economy, most BIM users are seeing positive payback from their use of the technology, according to McGraw-Hill Construction research. Users gain bankable benefits that enhance productivity, improve their ability to integrate teams and give them an edge on the competition. The value from BIM grows as users gain experience, offering them an opportunity to reap greater returns even during an economic recession.

Key Findings

- **Two-thirds of BIM users say they see positive ROI on their overall investment in BIM.**
- **87% of expert users are experiencing positive ROI with BIM.**
- **93% of BIM users believe there is potential to gain more value from BIM in the future.**

Better Than Expected Value

Return on investment can be calculated in various ways, but those who take a data-driven approach see more upside to BIM. Users who formally measure their ROI report better returns than those who estimate ROI based on perception.

- **Seven in ten BIM users who measure ROI see positive returns**, compared to half of those who only go by their perception of value.
- **One in five BIM users who measure ROI see returns greater than 50%**—double the perceived value.

Competitive Advantage

BIM is seen as a way to get a leg up on the competition. This is particularly true among less experienced users who are promoting a new service.

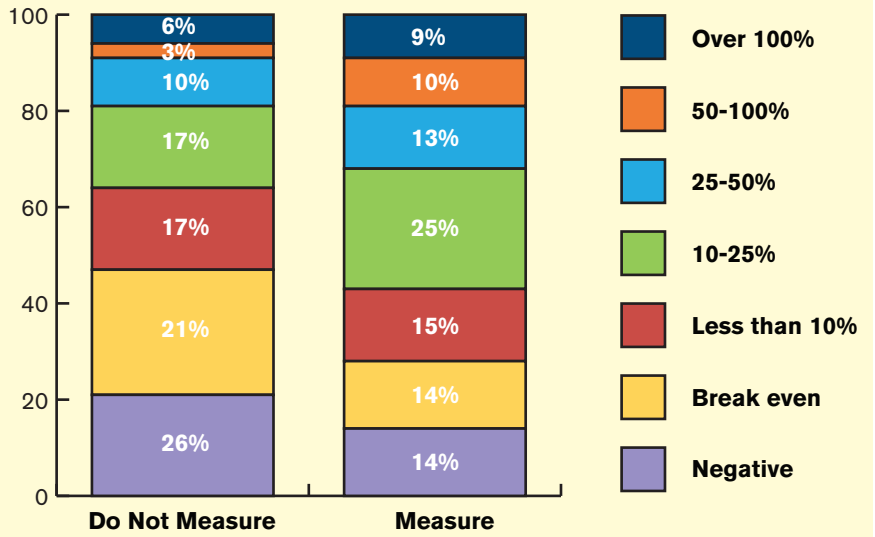
- **Marketing new business to new clients** is the top rated business benefit of BIM.
- Half of users say **offering new services** with BIM is a significant business benefit.
- Two-thirds of users say BIM's ability to help a company **maintain repeat business with past clients** brings at least a moderate level of value.

Improved Productivity

BIM creates efficiencies. Users realize some of the greatest value of BIM through its potential to cut down on rework, such as rekeying information into models or making changes in the field. As users become more proficient, the opportunities to improve productivity are more pronounced.

- **Reducing rework** is the highest-rated business benefit among experts. Four in five experts say it brings high to very high value, compared to 23% of beginners.
- The potential of BIM to **improve productivity** is ranked by architects as the top way to improve their return on investment in the technology.
- **Reduced conflicts and changes during construction** are among the top rated ways engineers say BIM adds value to a project.
- **Clash detection and avoiding rework** are the top rated ways owners say BIM saves time and money.

Perceived ROI Versus Formally Measured ROI



Source: McGraw-Hill Construction, 2009

BIM Defined

For purposes of this report, McGraw-Hill Construction defines BIM as: **The process of creating and using digital models for design, construction and/or operations of projects.**

Investing in the Team

Users recognize that BIM brings build teams together. Whether they aim to seamlessly exchange project data or communicate ideas more effectively, BIM adds additional value when used to integrate project processes. Likewise, obstacles that affect teamwork rank among the greatest challenges faced by users.

- **Better multiparty communication and understanding from 3D visualization** is the BIM benefit rated most likely to improve ROI. 80% of users give it high to very high importance.
- **Improved project process outcomes, such as fewer RFIs and field coordination problems**, is the second-highest rated way to improve value with BIM. Communication of project data is critical to meeting this goal.
- **The number of BIM-knowledgeable companies on a project** is a top rated factor affecting value on a project. Three in four users see this as highly to very highly important.
- **Presentation and visualization of architectural design** is the top task that benefits owners during a project. Owners also say improved collective understanding of design intent is the top way that projects can gain value.

Obstacles

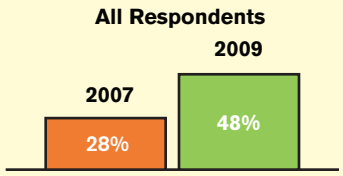
- **Improved interoperability between software applications** is the top industry improvement that will increase BIM value.
- Seventy percent of users say **more clearly defined BIM deliverables between parties** is highly to very highly important to increasing the value of BIM.

Fewer Legal Issues

In past studies, users raised concerns about legal issues, such as liability in an environment of open data exchange. As the legal framework for working in BIM has developed, those concerns appear to be fading.

- Two-thirds of non-users say **concerns about liability have little to no impact** on their consideration of BIM.

Growth in BIM Use



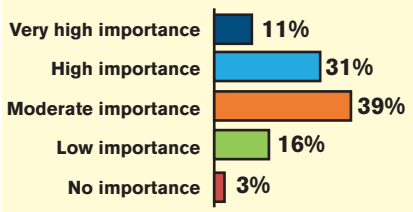
Source: McGraw-Hill Construction, 2007, 2009

Rapid Adoption

BIM has quickly gained momentum that is expected to continue in the coming years.

- Half of the industry is using BIM or BIM-related tools today. This represents a **75% increase in usage in the last two years.**
- 42% of users are at an expert or advanced level—**three times the amount reported in 2007.**
- Half of contractors report using BIM or BIM-related tools—**four times the level reported two years ago.**
- Two-thirds of experts use it on **more than 60% of their projects today.**
- One-third of all users utilize BIM on 60% or more projects today, but **twice as many expect to be using it at that level in two years**.
- 42% of **non-users believe that BIM will be highly or very highly important to the industry in five years.**
- Nearly half of non-users haven't tried BIM, but are **open to exploring its potential value.**

Importance of BIM in 5 Years



Source: McGraw-Hill Construction, 2009

Owner Demand

Owners see that BIM creates value.

- **70% report positive ROI from BIM.**
- **Lower project cost** is among the top rated ways users expect BIM to bring high value.
- Half of owners say **overall better construction project outcomes** is a significant benefit of BIM.

The AEC community looks to clients when deciding to use BIM:

- **Not enough demand from clients** is the top rated reason non-users have not adopted it.
- Seven in ten non-users say **owners demanding BIM use on projects** would significantly impact their decision to adopt BIM.

Recommendations

- **Beginners: Value is on the horizon.** New users see limited value initially, but additional opportunities materialize with experience.
- **Non-Users: Don't delay your decision.** BIM users are seeing positive returns today and expect those benefits to grow over time. Delaying adoption will leave you farther behind.
- **Owners: Take charge.** A large majority of owners recognize that BIM is valuable, and AEC companies say client demand is a top motivating factor in the decision to use BIM. If you demand its use, firms will follow.
- **Software companies: Speed delivery of solutions.** Users have quickly gained experience and become acutely aware of software interoperability and functionality limitations. Tools need to keep pace with rising demand.
- **All users: Don't hold back.** The gut reaction in a down economy is to cut back. BIM is a tool that helps experienced users find value. Continue to invest today or else you may find yourself behind the competition when market conditions improve.

Overall Value of BIM

Overview: The Value Proposition of BIM

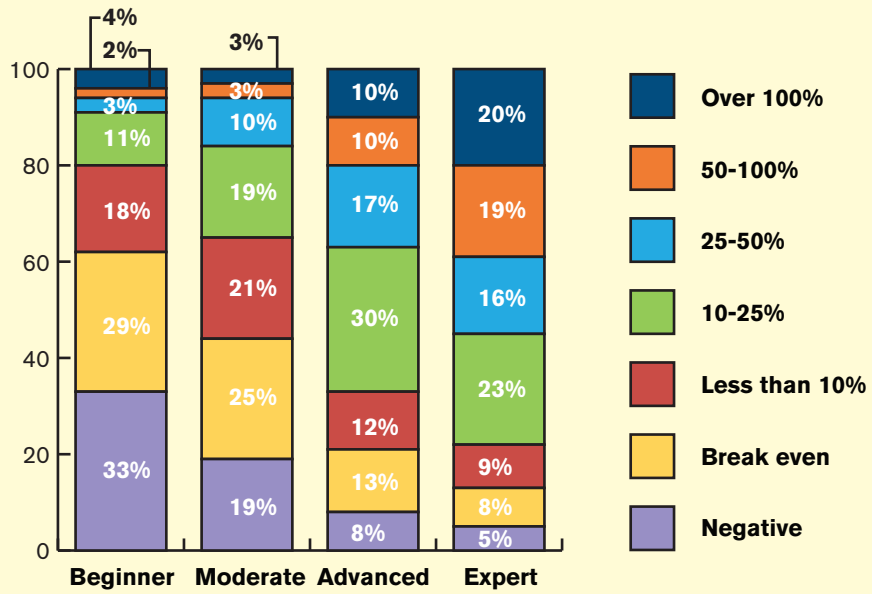
For champions of building information modeling, the value proposition is clear. **The vast majority of users report seeing positive returns on their investment in BIM.** For the time and expense put into making BIM part of their practice, **users gain a range of benefits that could include improved productivity, enhanced quality, increased opportunities for new business and overall better project outcomes.** The more benefits a user reaps, the higher the perceived value.

The benefits gained from BIM are greater than many users believe. Those who formally measure ROI on BIM report higher returns than those who estimate returns based on perception.

With experience, users can see more value. Experts prove that, as users gain proficiency, they will find ways to leverage the technology to their benefit. Given that BIM is still an emerging process, this trend should gain momentum as more users master it and software providers develop additional tools.

- 63% of BIM users say they see positive ROI on their overall investment in BIM.
- 72% of users who formally measure their ROI on BIM report positive returns, compared to 53% of users who estimate returns based on perception.
- 87% of expert users see positive ROI with BIM compared to 38% of beginners.
- 93% of BIM users believe that, compared to today, there is potential to gain more value from BIM in the future.

Perceived ROI by Experience Level



Source: McGraw-Hill Construction, 2009

BIM Reaps Returns

BIM is paying off for a solid majority of users—particularly the most experienced ones. Whether it's through budget items that can be tracked or less tangible benefits, BIM users largely believe that they are experiencing a positive return on investment. **Nearly two-thirds (63%) of BIM users say they see positive ROI on their overall investment in BIM, with 15% reporting an ROI of 50% or more.** Another 20 percent believe they are breaking even.

Experience Yields Results

Users report that they realize significantly better ROI as they gain experience with the technology. **Eighty-seven percent of expert users see positive ROI with BIM compared to 38% of beginners.** The progression is a steady one. Many of today's beginners can expect to see better results over time as they deepen their knowledge and use of the technology.

ROI Exceeds Estimates

The ROI for BIM is higher than many users think. **Users who formally measure their ROI on BIM using project data report higher returns than those who estimate returns based on perceived outcomes.** Half of those who do not formally track ROI (53%) perceive that they garner positive results, while three-quarters of those who do measure ROI (72%) report positive returns. BIM is shown to provide a broad range of opportunities to realize value, and those who formally measure it may see a more complete picture regarding returns.

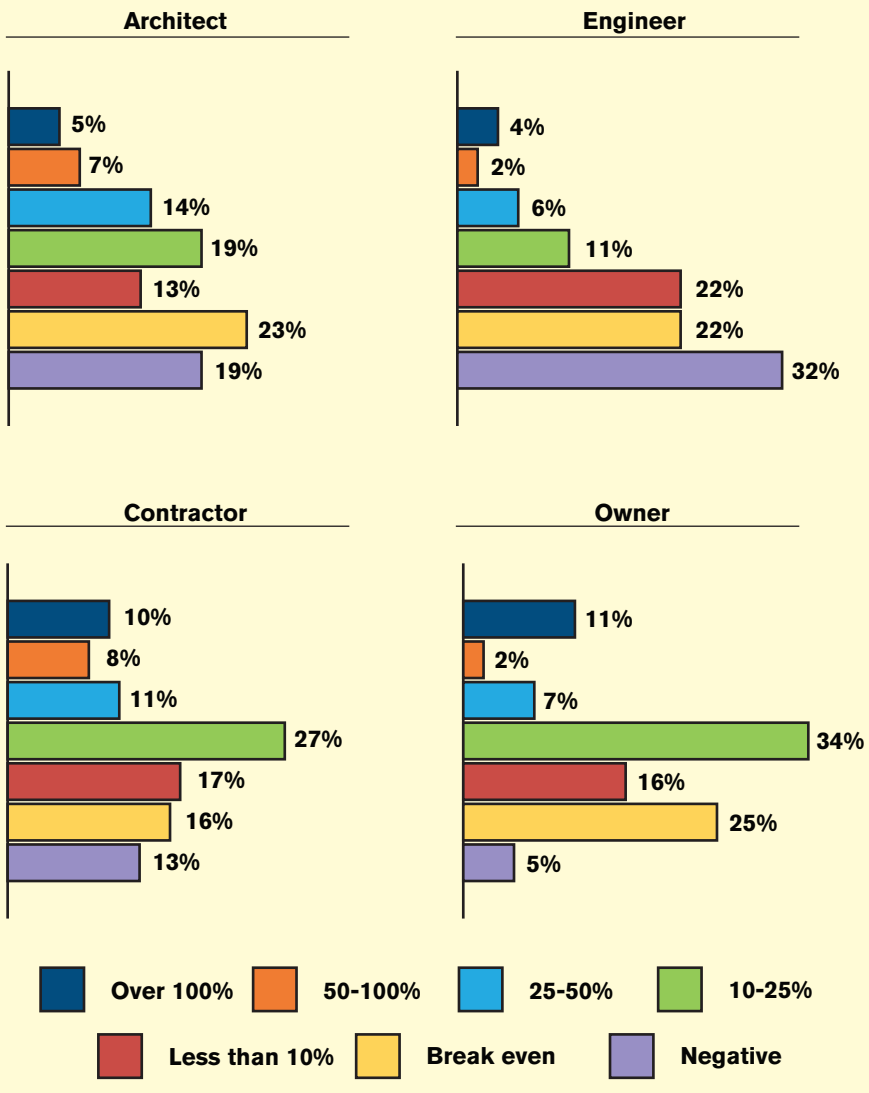
- **One in five users who formally measure ROI see returns above 50%**, twice the rate of those who don't measure it.
- **9% of users who formally measure ROI see returns above 100%**, compared to 6% of those who don't measure it.

Key Findings

- Most users see positive ROI in BIM.
- Returns improve with experience.
- Owners and contractors see the highest returns on BIM.
- Nearly all users believe there are greater future opportunities to gain value from BIM.
- Top rated areas of BIM investment: 1) software, 2) developing internal collaborative BIM procedures, 3) marketing a firm's BIM capability, 4) BIM training, 5) new/upgraded hardware

Editor's note: Return on investment figures from survey results reflect respondents' perceived ROI and are not the result of a prescribed approach to calculation.

Perceived ROI on Overall Investment in BIM



Source: McGraw-Hill Construction, 2009

User Differences

- **Contractors see the highest ROI, with seven out of ten (71%) reporting positive results.** Contractors are likely to see more tangible benefits, such as savings realized through clash detection. Because BIM was initially developed with a focus on designers, contractors as a group are relatively new to the technology and its expanding range of tools. The fact that so many contractors see positive results today suggests that additional value could be realized in the future as they gain more experience.
- **Owners are as likely as contractors to see a high ROI with seven out of ten (70%) reporting positive results.** As the ultimate client, owners realize the combined benefits from all team members that experience positive ROI. The fact that a large majority of owners believe BIM yields positive results bodes well for expansion of BIM use in the coming years. Team members say client demand is the primary driver for adoption of BIM. If owners ask for it, team members will follow.
- **Around six in 10 architects (58%) using BIM see positive ROI.** As designers, they experience less of the direct cost savings seen in the field and realize many intangible benefits such as improved coordination of drawings and documents.
- **Less than one half of engineers (46%) experience positive ROI when using BIM.** One-third of users say they see negative ROI. Engineers say they are less likely to see savings in time and costs from BIM than other team members. These views can differ by discipline (see Player Value chapter). Many engineers also report that BIM does not have sufficient functionality for their practice. Expansion of the technology offerings for engineers could help improve their outlook on its value in the future.

Quantifying Results

In order to better understand the potential of BIM, many users have made formally measuring ROI a part of their internal processes. Tracking ROI on BIM projects can be a tricky proposition. **Although possible, (see Research 2 Case Study) the numerous variables and unique aspects of every project typically make it a challenge to compare results of one BIM project to a similar completed project where BIM wasn't used.** Users often need to gather a wide range of data from various sources and have a sufficient library of data on similar projects that can be used for comparison. As more industry-standard metrics are developed, the ability to track ROI could improve in the coming years.

Level of Measurement

Half (54%) of BIM users formally measure ROI on BIM. Few users (13%) measure it on a majority of BIM projects. This reflects the challenge posed when users search for measurable and comparable data. Architects are most likely to formally measure ROI. Engineers are least likely to measure it. Although experienced users are far more likely to measure ROI—with at least two-thirds doing so compared to 40% of beginners—even these experts are not currently tracking it on more than 30% of their projects.

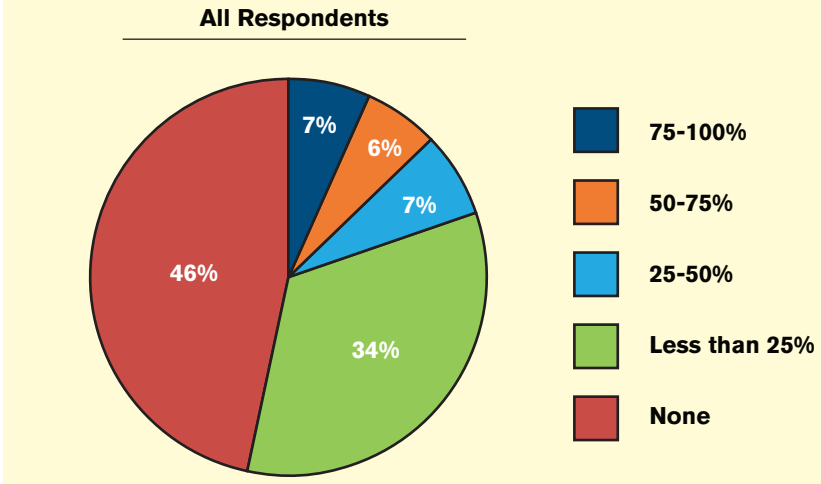
Experience

Measuring ROI on BIM is an emerging skill. **The majority (77%) of those formally measuring ROI on BIM have been doing so for two years or less.** Logically, those with more experience have been tracking it longer, with nearly half of experts saying they have measured ROI for more than two years.

Future Outlook

Many who do not formally track ROI are open to doing so in the future. Two-thirds of them say they probably will in the future (39%) or haven't decided if they will (27%). **Those with more expertise with BIM are most likely to indicate that they will probably never measure their ROI if they have not been doing so thus far.** These users have made the decision to pursue BIM and don't need more definitive proof of its value.

Percentage of Projects on Which BIM ROI Is Measured



Source: McGraw-Hill Construction, 2009

Where Users Invest

Gaining BIM capabilities and expertise requires investments in a broad range of products and processes. **These areas of investment change over time, as some initial investments take a backseat to ones that will deepen a user's BIM competency.** Contractors are the most likely to see a need to focus on nearly all areas of investment, today and five years from now. Owners report little need to focus on BIM investments today, but see rising demand within five years.

Areas of BIM Investment

- **BIM software.** Software is the tool that drives building information modeling. **Architects** and **contractors** lead the way, with half focusing on software investment. As software is an initial cost of entry to BIM, **beginners** rank it as their highest-priority investment, while experienced users rank it lower. A large percentage of **expert** users (68%) say software is a primary focus, but more as a continuing investment. Half of all users expect software to be a priority investment in five years, but less of a focus compared to other options.
- **Developing internal collaborative BIM procedures.** Creating a collaborative BIM environment is always a priority. Half of **architects** and **contractors** focus on investing in these procedures today, and at least half of all users say the development of these procedures will be a significant focus in five years. This is a top rated priority for the most experienced users, but less for more recent entrants.
- **Marketing your BIM capability.** As an emerging technology, BIM is generating a buzz. Many firms (43%) focus on investing in efforts to make sure clients are aware of their BIM capabilities. A large majority (69%) of **experts** are eager to market themselves as such, while few **beginners** (18%) are ready to promote their BIM readiness. In five years, all users expect marketing to be the highest-priority investment, including today's beginners.

- **BIM training.** Training is a critical investment, particularly for new users. Less experienced users rank training among their highest priorities, while it is comparatively less important for advanced users. In five years, training will be a strong focus for half of all users, but a lower priority than other investments. Two-thirds of **contractors** expect it to be a strong focus, while less than half of other users see that in their own practices.
- **New/upgraded hardware.** Some users (37%) focus on addressing hardware issues, but it is less of a priority than other possible investment areas. All users believe this will be true in the coming years as well.
- **Developing collaborative BIM processes with external parties.** Establishing a collaborative environment among team members is by far the highest-priority investment for **owners** today. As many owners look to other team members to generate BIM content, they are acutely interested in the ability to work with that data. It also reflects owners' desire for teamwork. **Experts** also rank this among their top priorities, showing that they have moved beyond development of basic internal processes and now are looking to integrate with others. All users say collaboration with other team members will be among their highest-priority investments in five years.
- **Software customization/interoperability solutions.** When software programs or platforms are incompatible, productivity in the BIM world can suffer. However, few users say they are making significant investments toward solving such issues.
- **Developing custom 3D libraries.** Investment in developing custom 3D libraries is most important to the design community, but even those players rank it among their lowest priorities.

Value on the Horizon

A majority of BIM users say they see value in BIM today, but the full potential of its benefits has yet to be realized. **Very few BIM users say they are getting everything out of BIM that they believe it can provide.**

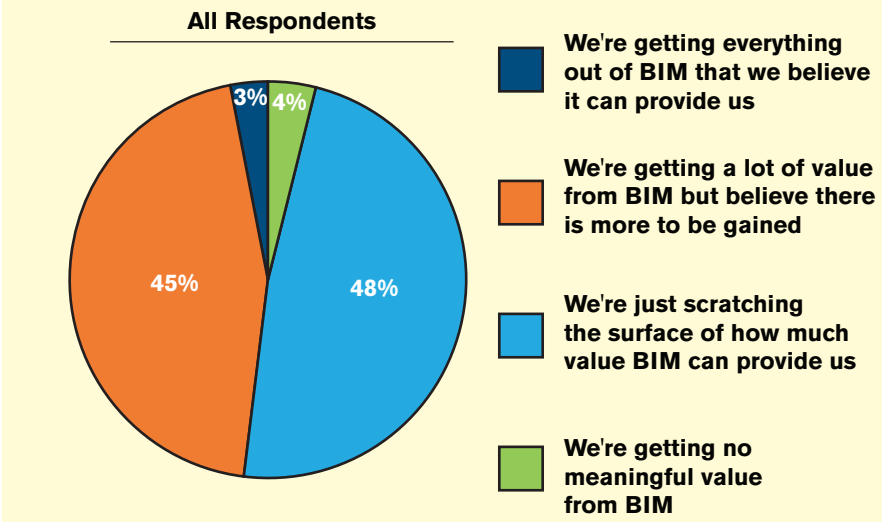
Most of the remaining users are evenly split between those saying they are getting a great deal of value out of BIM but believe there is more to be gained (45%) and those who believe they are just scratching the surface of what BIM can provide to them (48%).

Experience weighs heavily in users' accounting of the business value of BIM. **Eighty-eight percent of experts believe they are either getting everything out of BIM that they can, or that they are getting a lot of value compared to only 9% of beginners.**

User Differences

- A majority of **contractors** (52%) already see value in BIM and believe more can be gained. They are the most likely group to believe this.
- Although seven in ten **owners** say they are experiencing positive ROI today, a majority of them (61%) believe they are just scratching the surface when considering the value of BIM. They are the most likely group to believe this.
- Six in ten **architects** report seeing positive ROI on BIM. A third of those claim returns in the 10-25% range, and half claim greater than 25%. Only 2% feel they are currently experiencing its maximum value.
- **Engineers** are the most pessimistic about the value of BIM, with 12% saying they see no meaningful value from it. Around three in five engineers say they are just scratching the surface when considering the value of BIM. In part, this represents the struggle of engineers to find sufficient BIM content or functionality of software for their purposes. As software development catches up with demand, this attitude would likely change.

Level of Business Value of BIM



Source: McGraw-Hill Construction, 2009

Case Study:
Research 2

In building the $201 million Research 2 project for the University of Colorado-Denver Health Sciences Center, Mortenson Construction of Minneapolis ended up developing a research project of its own. The 11-story 540,000 square-feet biomedical facility was a follow-up to the similar 650,000 square-feet Research 1 tower built by a different contractor on an adjacent site at the UCDHSC Anschutz Medical Campus in Aurora, Colorado. The R2 project, as it came to be known, presented Mortenson with a rare opportunity to compare its performance against data from R1. The exercise enabled Mortenson to quantify the potential upsides of BIM and expose the challenges of finding usable performance metrics.

When Mortenson was selected for R2 in 2003, the company had employed virtual design and construction on several projects, but lacked hard performance data. Despite this, the company believed it could deliver benefits on complex projects, says Derek Cunz, director of project development at Mortenson.

"We knew going into this job that R1 had problems dealing with the very complex mechanical systems and making things fit," he recalls. "R2 would be just as complex and we knew we could do better with BIM."

In order to better leverage the benefits of the technology, Mortenson pursued an integrated approach, engaging early with the design team, led by Denver-based Fentress Architects. The design team, which also designed R1, had never included a general contractor in early virtual coordination before. The team worked together on a nearly two-year design and preconstruction process to fine-tune how data would be shared, how subcontractors would be procurred, and how the models would be used all the way through the project.

Image courtesy of Mortenson Construction

Research 2, Denver, Colorado

Owner Involvement

The owner's team was also asked for early input. The design called for multiple complex systems to be packed into tight spaces. Instead of focusing only on construction coordination issues, the team brought in owner representatives to ensure that the project would also be maintenance-friendly upon completion.

BIM was used throughout most phases of the project, ranging from work planning for concrete placement to 3D MEP coordination to assembly instruction models.

Since integrated virtual design and construction (VDC) was not in the R2 contract and the approach was new to the designers, the team had to address model ownership issues for liability reasons. Mortenson verified the accuracy of the designers' model for constructibility issues and then took ownership of the model when construction documents were complete.

Although significant planning and verification took place up front, the team started to see significant time savings once the construction model took shape. The structural engineers, Martin & Martin Engineers of Lakewood, Colorado, were able to transfer the 3D structural-steel design model to the steel subcontractor, LPR Construction of Loveland, Colorado. LPR then turned around 3D shop drawings for review in one package. The structural engineers, who had never received a single submittal all at once before, were able to speed through review and approve it for fabrication. This contributed to the structural steel being erected six weeks ahead of schedule.

Evaluation Opportunity

By the time the team was halfway through construction in mid-2007, the execution was already paying off. A variety of design and construction teams were building multiple projects on the campus at the time, and Cunz says the owners noted that R2 was outperforming those other projects, none of which was using BIM. Specifically, the owner noted that R2 was doing better than R1.

"He told us that our change orders were much lower than R1's were at the same point in the job," he recalls. "He laughed and said, 'I just thought your project manager was behind in submitting them.'"

Both parties were intrigued by the differences between the similar projects and together they hatched a plan to better quantify the results. The Pasadena, California, firm Jacobs, which served as program manager of the R1 and R2 projects, was able to provide access to the change order logs, request for information logs, the critical path method schedule and other relevant data from both jobs.

A University of Colorado graduate student conducted independent analysis of the data. Cunz says the student read every RFI and classified whether or not each was related to issues that could be resolved with BIM. At that point, the job was nearly 75% complete, allowing the student to break the analysis into performance by phase.

The study spotlighted a range of savings and benefits on the R2 project compared to R1. Through use of BIM in VDC, more decisions were made early in the project, causing an increase in RFIs during preconstruction. However, the early VDC review during design led to a reduction in construction RFIs of 74% during the foundation phase and 47% during the steel erection phase.

Overall, R2 experienced a 37% reduction in coordination RFIs and a 32% reduction in coordination change orders compared to R1. As a result, Cunz estimates that the team was able to save enough in administrative costs to more than cover the cost of using BIM.

Schedule Improvements

Significant schedule gains were also realized. When completed in June 2008, the R2 project was two months ahead of schedule and six months ahead of R1. In addition to a reduction in rework enabled by early coordination efforts with BIM, Cunz also credits 4D simulation during the job for helping improve the schedule. The mechanical sub, U.S. Engineering of Denver, estimated a 50% reduction in labor and a 50% reduction in schedule thanks to the VDC approach.

Mortenson was aiming to extract as much hard data as possible to quantify its results, but Cunz admits that productivity was tough to gauge. In order to do a full schedule analysis, Cunz says analysts would need to take a deep look at data from project to project, such as manpower by trade.

"You can't quantify definitely that BIM saves time because the only way to do that is if you had every hour of every craftworker mapped," he explains. "We'd like more information on exact dollar values with change orders, schedule and productivity, but everyone protects their production rates. That makes it hard to do. The subcontractors won't share their company's productivity factors, because that's part of their competitive advantage. It's hard to get true metrics."

Regardless, Cunz says it's important for companies to track performance data on BIM projects to understand its true impact on their own business and the team as a whole.

"Contractors are too busy building to track all of the data," he says. "We were fortunate to have a student help us. Those kinds of partnerships are beneficial. You have to find a way to get your arms around this stuff."

Images courtesy of Mortenson Construction

Shown above, layers of complex systems that surround the vivarium in the Research 2 tower at the University of Colorado-Denver Health Sciences Center campus in Aurora, Colorado.

Industry Issue:
Impact of BIM on Productivity

Building information modeling could play a vital role in improving construction productivity, according to a 2009 study commissioned by the National Institute of Standards and Technology. The report, titled "Advancing the Competitiveness and Efficiency of the U.S. Construction Industry," examines concerns over lagging productivity and recommends ways to reverse the trend.

Widespread deployment and use of BIM is one of five "breakthrough" opportunities outlined in the study that could improve efficiency and productivity in two to 10 years. The report notes that BIM is particularly beneficial because it is intended to be interoperable among all team members, enabling modeling techniques and processes that "integrate design, production and operations activities."

Fears that inefficiency is costing owners and construction firms billions of dollars annually have fueled the productivity debate in recent years. A 2004 analysis by Dr. Paul Teicholz of Stanford University suggested that construction labor productivity declined by nearly 20% between 1964 and 2003, while other non farm industries improved by more than 200%.

The report also claims BIM could help improve the quality and speed of project-related decision making; manage supply chains; sequence workflow; improve data accuracy; reduce time spent on data entry; reduce design and engineering conflicts and subsequent rework; and improve lifecycle management of buildings and infrastructure.

The report culls research from several other studies that have shown how projects with interoperable technology can yield better results than projects that don't utilize it, especially cost and schedule improvements.

Other breakthrough opportunities suggested in the study include:

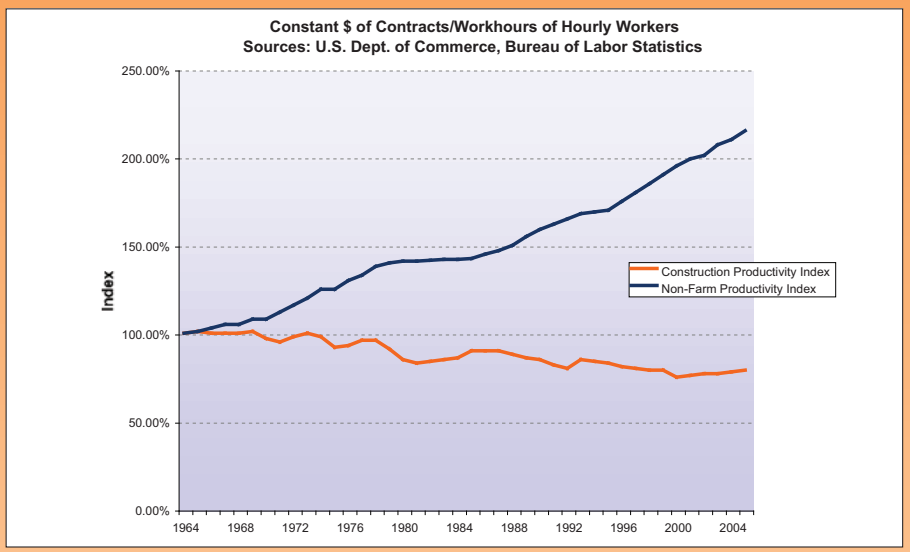


Chart courtesy of Paul Teicholz

- Improved jobsite efficiency through more effective interfacing of people, processes, materials, equipment and information
- Greater use of prefabrication, preassembly, modularization, and off-site fabrication techniques and processes
- Innovative, widespread use of demonstration installations
- Effective performance measurement to drive efficiency and support innovation

BIM could help make many of the report's other recommendations a reality, says Ted Kennedy, founder of the Birmingham, Alabama, firm BE&K and the study committee chairman.

"BIM is a catch all in a lot of ways," he says. "It allows us to address many of the issues we have in improving productivity."

Kennedy notes that BIM could help multiple team members communicate project information effectively, thereby improving jobsite efficiency. Data from models could also be used to aid in prefabrication and preassembly.

Kennedy adds that models of completed projects could provide a detailed database of project information for use in performance measurement, as data from one project is benchmarked against others.

The committee's goals aren't without their challenges. While BIM is envisioned as interoperable, data does not always flow seamlessly between the various software applications used in the industry today. A 2004 NIST study raised concerns over the issue, estimating that a lack of interoperability led to $15.8 billion in annual losses.

The report points to efforts by industry groups, including the buildingSMART Alliance, to make software more interoperable and suggests that with "concerted effort, those challenges…can be solved in two to five years."

Perhaps the most daunting task is getting the highly fragmented construction industry to make a collective effort to seek solutions, Kennedy says.

"People get used to their own systems and processes," he says. "It will take a while to get people to change their methods."

Other barriers mentioned to the widespread deployment of interoperable technologies include legal issues, data-storage capacities, and the need for "intelligent" search applications to sort quickly through thousands of data elements and make real-time information available for on-site decision making.

Industry Issue:
Return on Investment in BIM

Many of the issues covered in this SmartMarket Report were also explored in a study by Burcin Becerik-Gerber and Samara Rice at the University of Southern California's Department of Civil and Environmental Engineering in early 2009. The team's report, titled "A Benchmarking Study on the Use and Value of Building Information Modeling in Architecture, Engineering and Construction," discussed the costs and benefits of using BIM. The focus was on the most tangible benefits that could be most definitively tracked. In providing data, the respondents were asked to reference one particular project that they had completed, rather than looking at a body of work.

Costs

Most firms handle BIM duties in-house. The study shows that relatively little is being spent on outside BIM consultants, with 59% saying that no consultants were hired at all. Nineteen percent said consultant hiring added less than 1% to total job cost. Ten percent said it equaled between 1% and 2.9% of total job cost. Contractors and construction managers were more likely to outsource BIM work than architects and engineers.

A large portion of respondents said BIM use had no impact on staff or office space requirements. A majority (59%) said office space needs were unchanged by using BIM, while 11% said they used less space and 9% required more. While 41% said staffing needs were unchanged by BIM use, 21% reported needing less staff. Thirteen percent needed more staff to work in BIM.

The majority of respondents spent less than 0.5% of overall net revenue on software, software upgrades, hardware, hardware maintenance and training. Comparatively, hardware contributed the most costs, with 39% saying it added between 0.5% and 1.49%, followed by software (34% in that range).

The vast majority of firms are absorbing each of these costs, while roughly one in ten pass the costs on to owners through fees. Around 3% to 4% said the owner provided the items or services to them, therefore covering these costs directly.

Benefits

BIM has a largely positive impact on project schedule and costs, according to the report. A majority of respondents (55%) said BIM helped cut project costs, with 39% saying costs were reduced by up to 25%. Three in ten said BIM made no change in project costs.

Schedule impact was even more pronounced, with 63% saying schedule was reduced. Forty-five percent said schedule was reduced by up to 25%, while 28% of respondents said there was no change to schedule.

While most saw overall schedules reduced, there were differences over when those savings were realized. When asked about changes in project phase durations because of BIM use, respondents generally showed work increasing early in the life of a project and decreasing later. Respondents were more likely to say BIM added time to the schematic design and conceptual design phases, with 20% saying it increase duration by up to 25% and 13% saying it was between 25% and 50%.

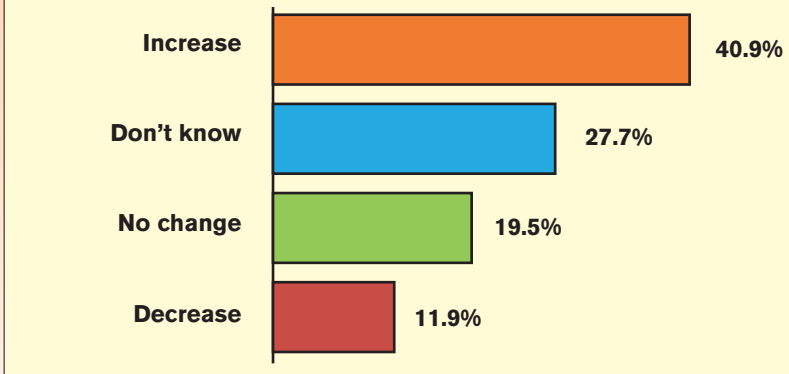
As the project shifted to detailed design, respondents were more likely to see time begin to decrease, with 26% saying duration dropped by up to 25% and 16% saying it dropped between 25% and 50%. The majority (58%) said time was saved during construction, with 41% saying it trimmed duration by up to 25%.

Printing, document shipping and travel costs were generally reduced or unchanged when using BIM instead of traditional processes. Around half of respondents reported no change in these categories. Nearly all other respondents said these costs were reduced, typically by 25% or less.

Returns

When adding it all up, respondent were most likely to report that project profitability increased as a result of using BIM. Two in five respondents (41%) said that their project profitability increased, while 12% said it decreased.

Effect of BIM Use on Project Profitability



Source: McGraw-Hill Construction, 2009

Chart courtesy of Burcin Becerik-Gerber

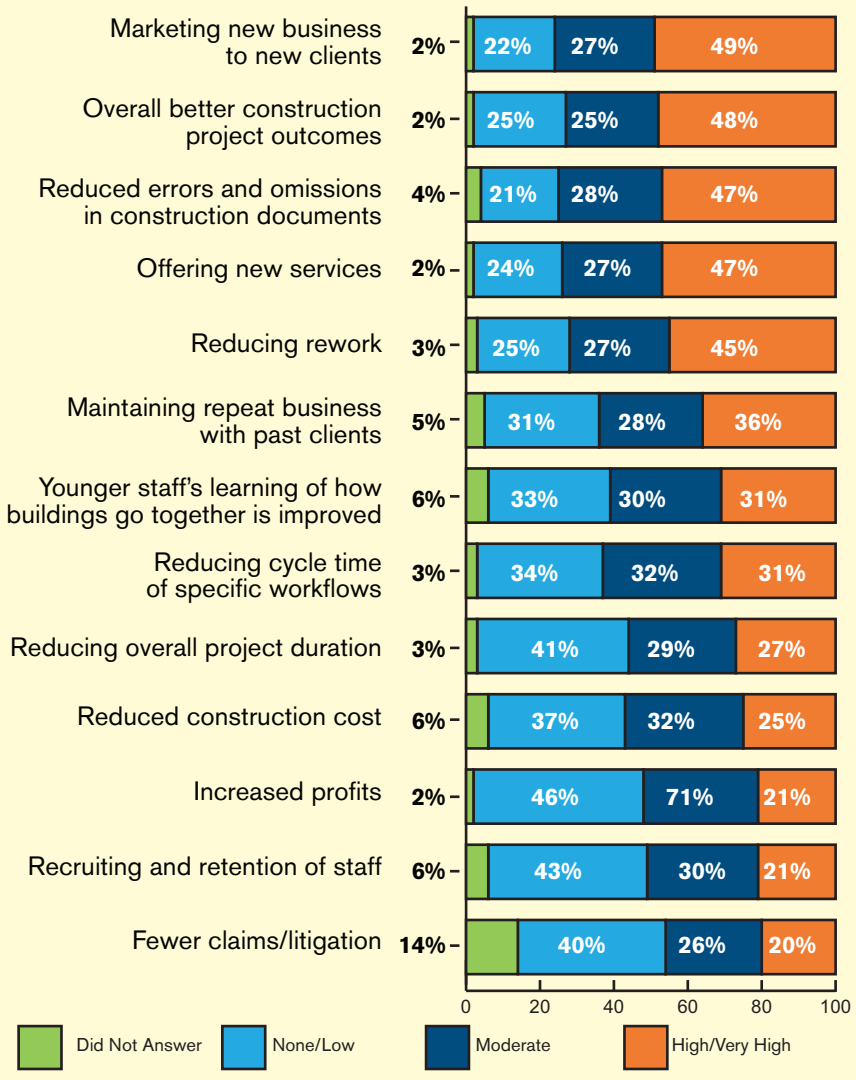
Internal Business Value of BIM

Overview: Internal Interests

Beyond simply keeping up with industry trends, BIM users are looking for repeatable business value from their investment in the technology. **The payoff could come in the form of improved staff productivity, increased profits or new business opportunities for the company.** But internal business benefits aren't gained overnight. With experience, users begin to see how BIM can offer considerable value to their companies.

- Experts are three to four times more likely than beginners to see a high level of internal benefits.
- Eight in ten experts say reduced rework brings high to very high value.
- Half of all users say marketing new business to clients brings significant value. Seven in ten experts believe this.

Relative Importance of Internal Benefits



Source: McGraw-Hill Construction, 2009

Business Benefits

Within their own practices, BIM users see numerous opportunities to realize value. **Since BIM is an emerging process that has started to capture the attention of the building community at large, users are eager to bank its buzz**. Marketing and the ability to promote new BIM-related services are among the top benefits reported. The sense that BIM creates an overall better product is also very beneficial.

Productivity issues, such as reducing rework and errors, ranked higher than benefits related directly to time savings and cost reduction. This reflects the fact that users of all levels could see BIM as helping them work better, but cost savings are more likely to be realized by experienced users.

Top Rated Business Benefits

1) Marketing new business to new clients. BIM opens doors for companies in the built environment. As more clients begin to require BIM on jobs, team members need to have BIM skills to capture that business. On the flip side, companies can also introduce the technology to new clients that aren't requiring BIM and use it as a marketing feature to get a leg up in their bid to land a job. All team members—other than owners who are also clients—rate this as a top benefits. **This is particularly true for less experienced users who are promoting this new skill.** Experts believe it is important, but less than some other top benefits.

2) Overall better construction project outcomes. Half of owners (48%) say that BIM's impact on the overall project outcome is a high benefit

Top Rated Ways BIM Saves Time and/or Money

- **Avoiding rework/changes**
- **Conflict avoidance/resolution**
- **Increased productivity/efficiency**

for them. Owners who are less experienced with BIM see this as their top benefit, while expert owners rank it slightly lower. The internal value of this to the other build team members is experienced as reduced problems, improved client relationships and more personal satisfaction.

4) Reduced errors and omissions in construction documents. Virtual design and construction with BIM creates the potential to identify problems earlier in the building process. **With interoperable exchange of models and data, team players can better ensure that information is complete and accurate.** Half of all users (47%) see this as a significant benefit, particularly contractors. More experienced users recognize its value compared to others.

3) Offering new services. BIM is a way to bring new offerings to an old business. **Many users (47%) say adding BIM to their toolbox brings a high level of benefit to their practices.** Naturally, this is more important to more recent adopters of the technology. **Contractors**, who as a group have adopted BIM later than many in the design community, are far more likely to see this as significantly beneficial.

5) Reducing rework. Fixing problems early means fewer issues in the plans and ultimately fewer hassles in the field. **A majority of contractors (57%) see the potential of BIM to reduce rework as a significant benefit.** This is the highest-ranked benefit reported by expert users (77%), compared to fewer beginners who see it that way (23%).

Top Rated Benefits Other Than Saving Time or Money

- **Better understanding of project in any/all stages**
- **Better collaboration**
- **Visualization**

Key Findings

- Marketing new business to new clients is the top rated business value of BIM.
- More experienced users reap far greater benefits.
- Half of owners believe BIM is highly effective in creating better construction project outcomes.
- Avoiding rework/changes is the top rated way to save time and/or money.
- Better multiparty communication and understanding from 3D visualization is the top rated way value can be added.
- Lack of software interoperability and functionality are rated as the greatest obstacles to improving value.

Valuable Experience

Internal business benefits increase as BIM users gain experience. There is a vast divide between novices and seasoned users in how they perceive the value BIM brings to their own practices. Among a broad range of possible benefits, **experts are roughly three to four times more likely than beginners to report seeing high to very high levels of value.** This is a natural, but dramatic, progression. As users get started with BIM, they make investments in software, hardware, training and other related initial costs. Meanwhile, they are likely to be less productive with the technology until they gain proficiency. Once users learn how they can leverage the technology to their advantage, they begin to bank those benefits.

When comparing expert and beginner opinions about what aspects bring high to very high value:

- **BIM increases profits**: 43% of experts versus 7% of beginners.
- **BIM reduces rework**: 77% of experts versus 23% of beginners.
- **BIM reduces errors and omissions in construction documents**: 76% of experts versus 26% of beginners.
- **BIM helps in marketing new business to new clients**: 71% of experts versus 28% of beginners.
- **BIM helps in maintaining business with past clients**: 61% of experts versus 19% of beginners.

Resetting Project Delivery

In 2007, the Weitz Company began an ambitious Plan for 2013 to "reset" its project delivery processes over six years by leveraging the benefits of virtual design and construction within the principles of lean construction. COO Len Martling saw that "reducing waste and rework would add significant competitive advantage."

Vice President Mike Sullivan's Operational Excellence (OE) group began encouraging a cultural shift from "the typical heroic problem solving, to problem seeking" that identified riskier aspects of projects and developed tools to address them much earlier.

Bruce Cousins, Weitz's senior manager of VDC, worked with field personnel to find specific ways BIM could cut costs, optimize schedule and reduce risk. Cousins scored early success by modeling the embeds on a self-performed concrete project, reducing errors from a historical rate of 1% to 2% down to 2 in 5,000.

With 35 projects underway using OE tools in 2009, Weitz is delivering 10% to 20% schedule reductions to clients and logging significant ROI per project on their Plan for 2013 investments. They are also winning new work in very competitive settings by demonstrating the value of these capabilities to prospective clients.

Improving Business Value

Although most BIM users see positive ROI, they also see room for improvement. Users report a variety of ways that they could see better returns on BIM, ranging from less tangible benefits—such as improved communication and marketing—to more defined savings, such as reduced requests for information and improved productivity.

Top Rated Ways to Improve Value

1) Better multiparty communication and understanding from 3D visualization. By sharing information through BIM, the team can better communicate its actions and ideas. Three-quarters (77%) of users see this as highly important, with **contractors** ranking it as their top improvement.

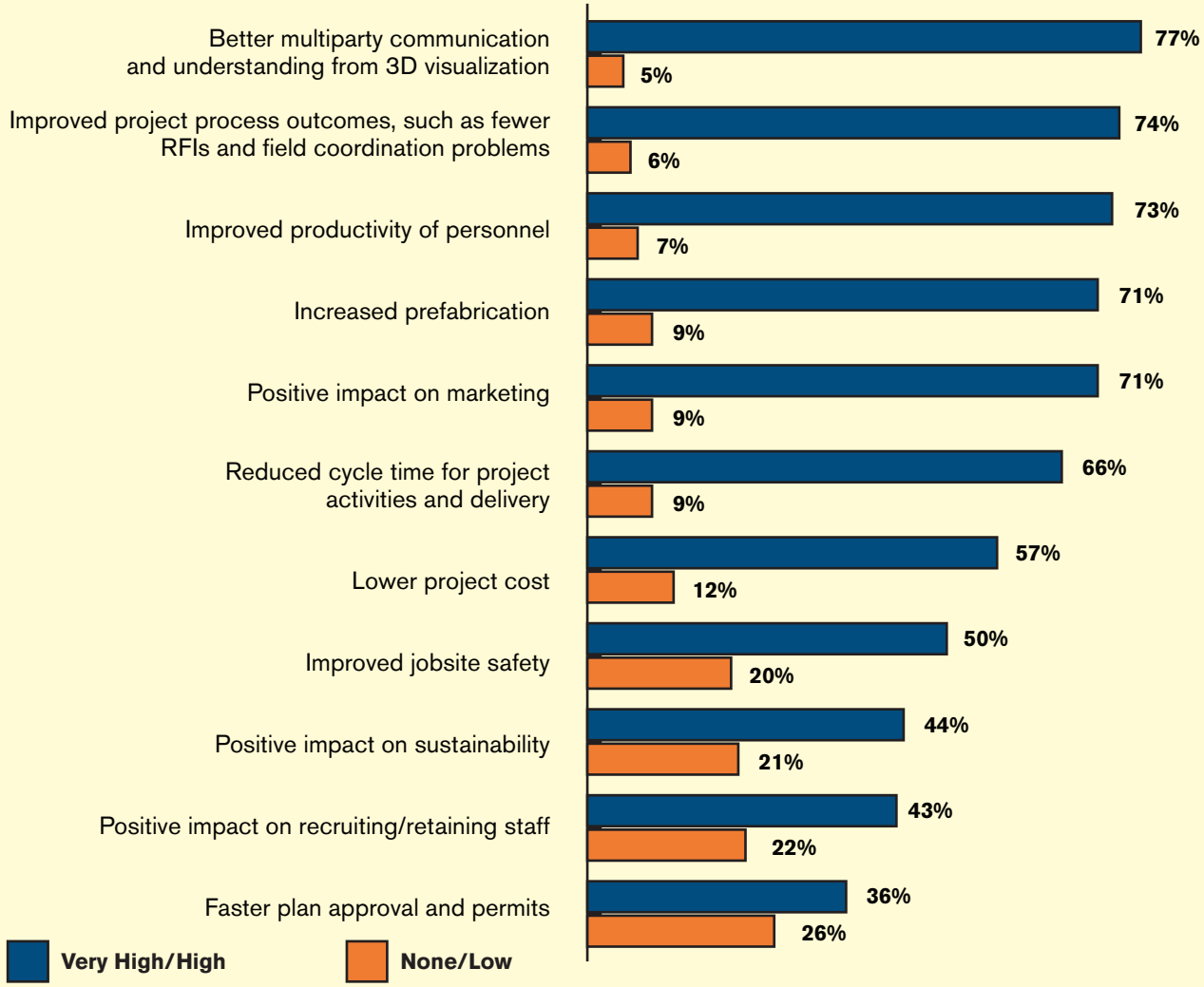
2) Improved project process outcomes, such as fewer RFIs and field coordination problems. By identifying issues before they show up in the field, users can prevent costly mistakes. Three-quarters of all users (74%) see this as highly important, with **engineers** ranking it at the top of their list.

3) Improved productivity of personnel. One of the top rated ways that BIM users can be more productive is by sharing data seamlessly with other users, eliminating the need to reenter data. Seven in ten users (73%) see this as highly important, with **architects** ranking it as their top improvement.

4) Increased prefabrication. When BIM is used to coordinate shop drawings and eliminate clashes before they could happen in the field, users can employ prefabrication with more confidence. A large majority of **contractors** (73%) forecast that more model-driven prefabrication will improve their returns.

5) Positive impact on marketing. BIM could be seen as a differentiator when bidding or negotiating for work, especially if a client recognizes its value. Seven in ten users (71%) see this as a highly important area of improvement, especially **engineers.**

Relative Importance of BIM Benefits to Improving ROI



Source: McGraw-Hill Construction, 2009

Challenges to Value

Most users see value in BIM, but several factors limit their ability to realize better results. A majority of BIM users report several areas that they think are highly important to increasing their business benefits with the technology. **Software-related issues top the list of areas that need to be addressed to improve business value, including better interoperability between software applications and enhanced functionality of BIM software.** These concerns aren't limited to novices. Users of all levels report that these issues need to be addressed if they are to improve the benefits they hope to gain.

Top Rated Areas for Improvement

1) Improved interoperability between software applications. Non-interoperability limits the potential of BIM, especially in an environment where data is exchanged between various build team members. As BIM has developed and new tools have been introduced, interoperability has become an increasingly important issue. Although efforts to create standards are underway, issues remain. **Eight in ten BIM users say there is a significant need to improve interoperability.** This need is expressed by a majority of all users at all experience levels.

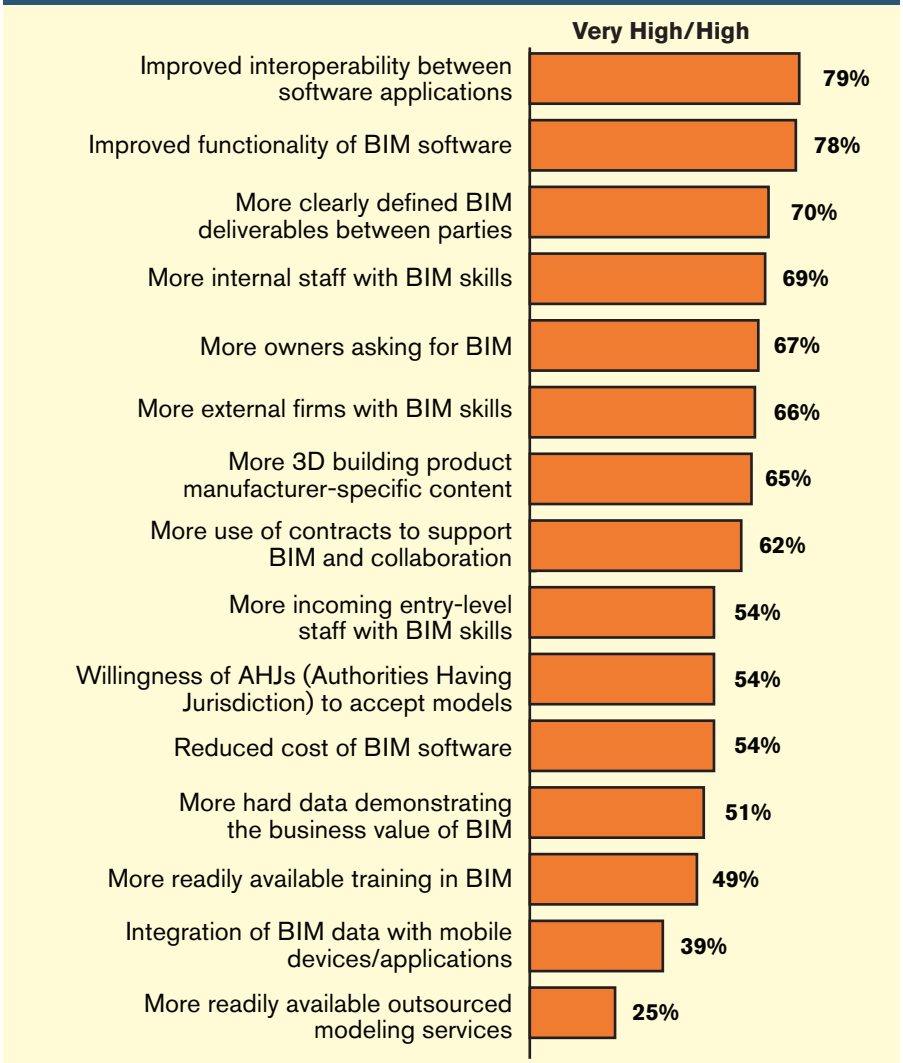
2) Improved functionality of BIM software. Functionality is a typical struggle for emerging technologies. As software companies develop BIM tools and users put them into practice, new demands arise. Users are looking for additional ways to leverage benefits from BIM. **More than three-quarters of users (78%) say improved functionality would greatly enhance value.** Beginners rank this as their top demand.

3) More clearly defined BIM deliverables between parties. Just like with interoperability between software applications, different players need to know that they can exchange the right types of information among team members. **Seven in ten users say it is highly important to have more clearly defined BIM deliverables between parties.** In some cases, this issue could be solved by meeting early in the project schedule to define future deliverables.

4) More internal staff with BIM skills. To gain value, adopting BIM goes beyond creating a group of users within a company. **As more staff members develop BIM skills within a company, that company can experience its benefits more deeply.** Architects are the most interested in seeing this improvement. Naturally, beginners see a greater need to expand BIM use within a company than more experienced users.

5) More owners asking for BIM. Demand for BIM starts at the top. If the client wants BIM on a job, it immediately gains a level of value to users. **While BIM may be used largely by the design and construction community, BIM users are looking for owners to take the initiative on whether the technology should be utilized on a project.** Contractors are particularly swayed by owner demand—three-quarters say this is highly important.

Top Ways to Improve Value of BIM



Source: McGraw-Hill Construction, 2009

Industry Issue:
Impact of BIM on Marketing

Leveraging BIM capability to win new business was reported as the top internal business benefit in the main research conducted for this SmartMarket Report. To take a closer look at the dynamics of this trend, McGraw-Hill Construction partnered with the Society for Marketing Professional Services (SMPS) for a special survey of hundreds of its members in August 2009 about how BIM capability is perceived and marketed. The group included BIM users and non-users from a wide range of company sizes across the U.S. Selected findings are summarized below.

Winning New Work

While non-users report that BIM is currently of little importance to new business, 98% of BIM users indicate that BIM capability is having an impact on their companies winning new work. Half of these users characterize the impact as moderate, and another quarter rate it high or very high.

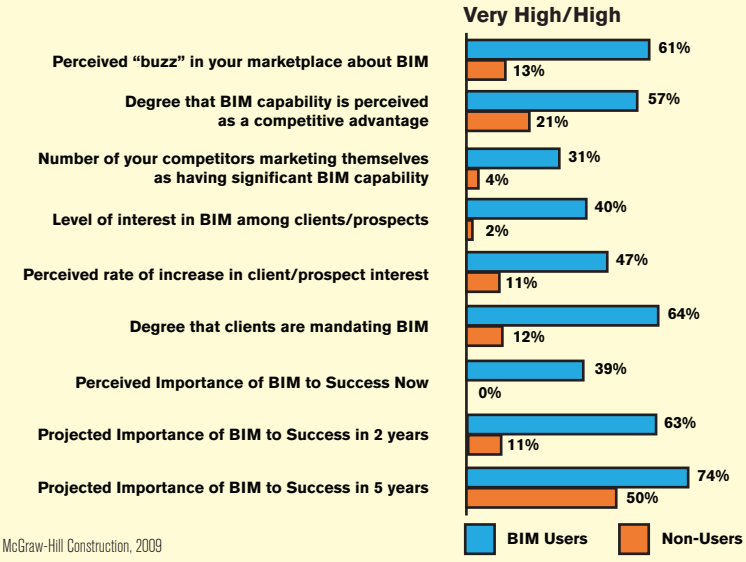
Other Differences in Perspectives between BIM Users and Non-Users

As shown by the chart on this page, BIM users have a distinctly different perspective compared to non-users on the interest level, usage and competitive importance of BIM in their marketplace. This is especially striking in the differing perceptions about how many clients are now mandating BIM.

Future Importance

One area in which both BIM users and non-users agree strongly is the future importance of BIM to their success. Users that rate it high or very high double from the current level of 39% to 74% in five years. And even though no non-users attribute high or very high importance to BIM today, half of them agree that it will reach that level of criticality within five years.

BIM User and Non-User Viewpoints



Source: McGraw-Hill Construction, 2009

Plans for Adoption by Non-Users

Though 39% still aren't sure about when they will acquire BIM capability, one-third of non-users indicate plans to get on board within two years:

- **Next 12 months 19%**
- **Next 1-2 years 14%**
- **More than 2 years 25%**
- **Never 3%**
- **Not Sure 39%**

Fastest Growing Market Segments

Respondents were asked which market segments seem to be adopting BIM the fastest:

- **Public work 35%**
- **Health care 28%**
- **Education 24%**
- **Private and other 13%**

Promotion of BIM Capability

Half of BIM users responded high or very high when asked how actively they are promoting their BIM capability. Three in five forecast they will be increasing their BIM promotion by significant amounts in the next 12 months.

Verbal presentations scored highest in response to questions about where and how users are currently promoting their BIM capability:

- **In verbal communications (speeches, etc) 53%**
- **In printed communications (brochures, etc) 37%**
- **In physical office space 35%**
- **On company website 25%**
- **Electronic communications (e-newsletters, etc) 17%**

In new business meetings and presentations, half report that they proactively talk to prospects and clients about BIM, even if not asked about it. In fact, 63% of users say they are closely aligning their company image with BIM, characterizing it as either a "major factor" or "critical" to their identity in the marketplace.(See Resetting Project Delivery on page 15)

Clearly the impact of BIM capability on the pursuit of new business is being felt by BIM users and non-users alike, and this trend will accelerate as adoption and implementation expand.

Case Study:

Texas A&M Health Science Center

Satterfield & Pontikes Construction sees BIM as a sure bet. In 2008, the company, based on Houston, Texas, chose to invest $250,000 worth of resources into modeling a prospective project that Texas A&M Health Science Center had put out for sealed-competitive bid. When bids were read in October 2008, the company's gamble paid off. Satterfield & Pontikes was awarded a contract to build two new-facilities at the client's campus in Bryan, Texas, for $103.5 million—nearly $10 million below the next closest bidder.

John Marshall, vice president of marketing at Satterfield & Pontikes, says the company saw BIM as a way to drive the risk out of its bid and give it an edge on the competition. By modeling the project in advance of the bid, the company had a firm understanding of quantities and costs, allowing the team to get comfortable with a price that was well below client estimates.

"It was a leap of faith, but it was a fairly well-informed risk to take on our part," he recalls. "We didn't believe any other bidder would dig into it with the same approach that we did. Turns out we were right."

The award was a second go-round for the project. The facilities, which include the 128,000 square feet Health Professions Education Building and the 127,500 square feet Medical Research and Education Building, had originally been awarded through a CM-at-risk delivery method. After months of preconstruction, the contractor came back to the client with a price that was above budget, Marshall says. The contract was terminated and the project was put back out to the market as a hard bid job.

Prior to bid, the designer, FKP Architects of Houston, provided 60 percent-complete architectural, structural and MEP plans. Satterfield & Pontikes dedicated a crew of modelers and estimators to dig through the details for six weeks. The team modeled exterior and interior elements, including exterior walls, interior partitions, floors, foundations, elevated slabs, beams, girders, columns, ceilings, windows, doors and other elements that would bring the most benefit to estimating.

In the end, Marshall says the bid came down to a better understanding of key quantities and pricing.

"We reduced the unknowns and could be more aggressive with pricing," he says.

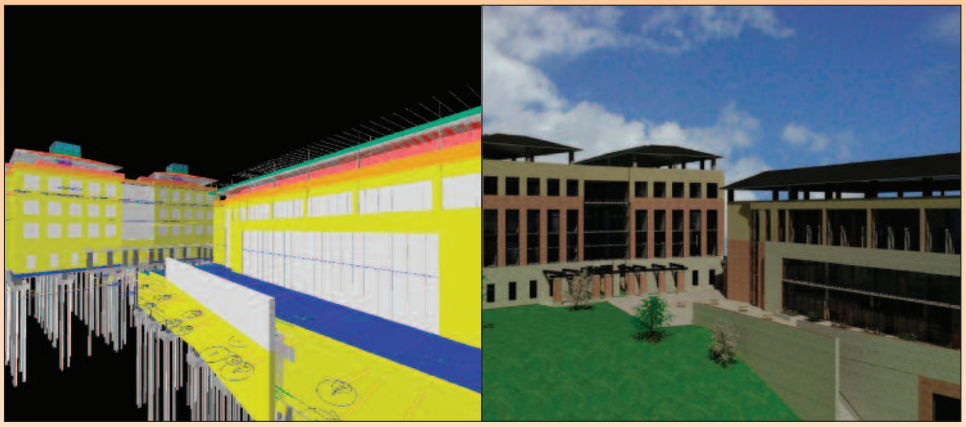
After winning the project, Marshall adds, the team had a head start and could begin to mobilize early.

"We'd done the preconstruction work," he says. "It wasn't like the clock started ticking when we won—it had already begun."

The Medical Research and Education Building is scheduled for occupancy in July 2010 with the other facilities to follow in April 2011; however, Marshall says the company expects to wrap up its work in December 2010.

Although the company invested nearly ten times the resources upfront that it would normally put into a similar hard bid job, Marshall says the company opted for the same approach it would use on a CM-at-risk or design-build proposal.

"We grew up as a hard bid contractor, but when alternative deliveries starting hitting, we had to get smarter," he recalls. "This is taking those lessons and applying them to the hard bid environment. We had an approach that we knew others wouldn't take and it gave us the boost we needed."



Images courtesy of Satterfield & Pontikes Construction

Satterfield & Pontikes Construction took plans and renderings of the Texas A&M Health Science Center project from designer FKP Architects and built BIM models that the company used to prepare its bid.

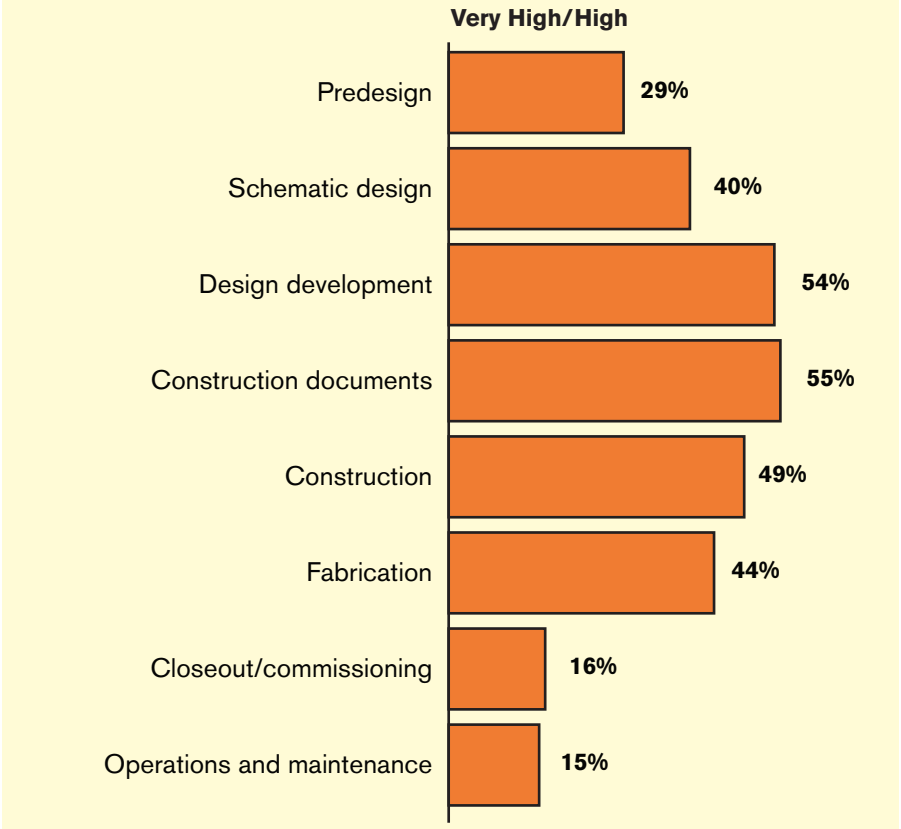
Project Value of BIM

Overview: Gaining Value Collectively

While BIM can provide benefits to individual build team members, **most users recognize that its collective use on projects can drive better results.** To leverage the highest potential of BIM, teams often institute a collaborative—or integrated—approach to design and construction. In these scenarios, **teams are rethinking traditional roles and workflows to find better and faster ways to communicate ideas, reduce errors and improve productivity.** Users recognize that having other BIM-savvy team members on a project and being able to share data from models with them can benefit a job overall.

- Six in ten users say the number of BIM-knowledgeable companies on a project is highly important to a project's success.
- Two-thirds of users recognize that interoperability between software applications used by team members has a significant impact on the value gained during a project.
- Most BIM users say that the combined benefits recognized by team members across the life of a project add up to a highly valuable end result for the owner.
- Two-thirds forecast that, five years from now, lower risks and better predictability of outcomes will be the top rated benefits for project teams.

Perceived Value of BIM by Phase



Source: McGraw-Hill Construction, 2009

Value by Project Phase

Users can reap benefits throughout the life of a project, but are experiencing more value in some phases than others. **Users see the greatest value as designs are fully developed and construction moves forward.**

Construction Documents. BIM pays off as designs become rich with data. With the addition of specifications for contractors, BIM aids in improving communication between the design world and the building team.

Design Development. The design capabilities of BIM are among its most obvious and immediately understood aspects, particularly as more detailed models are created.

Construction. BIM can save time and money—a benefit that becomes clear during construction. For example, reducing systems clashes can help budget and schedule.

Fabrication. Accuracy is critical for fabrication, and a data-rich BIM model can have a positive impact. By using BIM, many fabricators can extract data rather than draw specifications that feed directly into their existing systems.

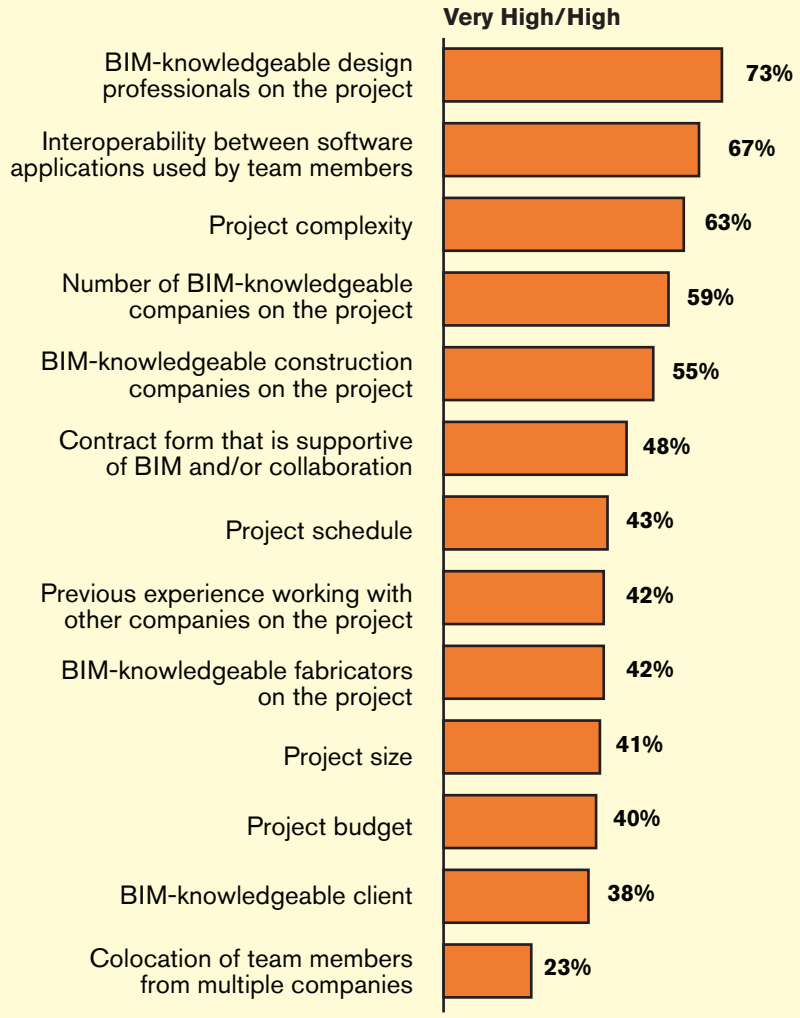
User Differences

- Two-thirds of **architects** see high value during design development and construction documents, when models are populated with higher levels of project data.
- Almost seven in ten **contractors** experience high value during construction and fabrication, when the bulk of costs are generated and opportunities to save time and money arise.
- Nearly half of **engineers** see high value during the construction documents phase, while four in ten say BIM can be highly beneficial during design development and fabrication. Engineers are most heavily engaged during these phases of a project.
- The later phases of a project, such as closeout or operations and maintenance, are not seen as valuable opportunities for BIM by any users, including **owners**. As those capabilities improve with the continued development of BIM, the potential value during such phases should improve.

Key Findings

- Factors with the greatest impact on BIM success on a project: 1) having BIM-knowledgeable designers on the project, 2) software interoperability
- Phases that experience the most BIM value during a project: 1) construction documents, 2) design development
- Top rated overall project benefits of BIM: 1) presentation/visualization of architectural design, 2) spatial coordination
- BIM Benefit that generates the highest returns: reduced conflicts during construction
- Few users currently experience value from 4D scheduling and energy analysis.
- Top rated future benefits of BIM: 1) better designed projects, 2) lower risk and better predictability of outcomes, 3) prefabrication

Impact of Project Factors on BIM Value



Source: McGraw-Hill Construction, 2009

Factors Affecting Value

The success of a project lies in the capabilities of its team members. Although a wide range of project factors can influence value, **users recognize that BIM knowledge is the key to leveraging its true benefits.** This may be particularly true today, when many companies are still learning how to use the BIM and more firms continue to adopt it. Many BIM users working in a team environment have already discovered that a lack of interoperability between software applications can limit success. Most also recognize that BIM can showcase its potential on complex jobs.

Top Rated Factors

BIM-knowledgeable design professionals on the project. More modeling during design improves everyone's process. Three-quarters of all users say this factor is highly important to the success of a project.

Interoperability between software used by team members. The ability to exchange project data between various team members is among the top rated potential benefits of using BIM. Although some team members could use it solely for their own tasks, sharing data adds a new and valuable dimension to the process. Interoperability is key to making this exchange seamless. Two-thirds of all users recognize this as a highly important factor.

Project complexity. 63% of users see project complexity having a major impact on BIM value. This is especially true for construction firms (72%). Skill level influences this view also, with only 54% of beginners versus 70% of experts rating it highly or very highly important.

Number of BIM-knowledgeable companies on the project. Six in ten users feel strongly that a project benefits from more BIM-capable team members. Contractors (67%) and experts (68%) feel this most strongly.

BIM-knowledgeable construction companies on the project. The ability of construction firms to contribute time and money savings on a project can have a significant impact on BIM value. More than half of users (55%) see this as a highly important project factor.

Banking on the Benefits

Numerous benefits can be gained from BIM use, but there is concensus about which ones bring the most value to a project.

- **Reduced conflicts during construction.** Conflicts in the field are costly, affecting both budget and schedule. A large majority of users (68%) recognize that reducing conflicts produces the highest rewards on a project, particularly **contractors** (83%). **Engineers** also ranked this as the greatest benefit on a project.
- **Improved collective understanding of design intent.** With BIM offering 3D visualization and a rich database of project information, two-thirds of users (65%) say collective understanding of design intent provides a high level of value. Most **owners** (73%) believe this and rank it as the highest area of value, as they can use models to better understand and monitor ideas that carry through the lifecycle of a project.
- **Improved overall project quality.** The proof is in the finished product. Most BIM users (54%) see that the combined benefits across the life of a project add up to a highly valuable end result for the owner. **Contractors** (58%) and **architects** (53%) are the most likely to believe this.
- **Reduced changes during construction.** When BIM reduces conflicts, it helps teams avoid costly changes in the field. All users rank this among their top benefits, including a majority of **contractors** (64%) and **owners** (68%).
- **Reduced number of RFIs.** Complete and conflict-free data shared across multiple users helps clarify intent. All users rank this among their top benefits.

Impact of Experience

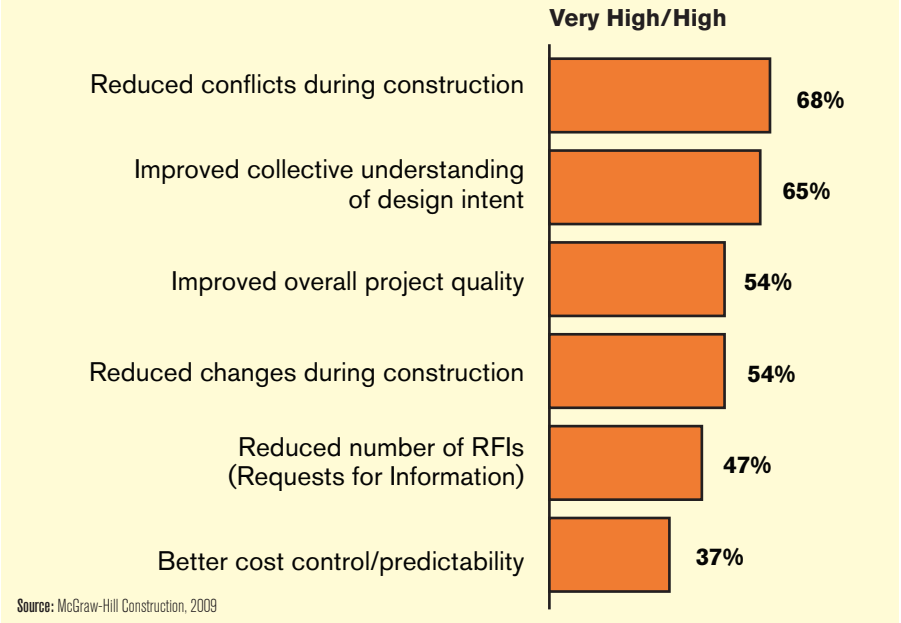
Users are evenly split over BIM's ability to reduce total project cost and overall schedule. Roughly one-third believe BIM contributes highly to these, while one third believe it brings little to no value. **Experts** are almost twice as likely as **beginners** to see these BIM benefits bring significant value, suggesting that with experience they can eventually pay big dividends.

Benefits With Limited Value

Few say these are contributing high value:

- **Improved jobsite safety (14%)**
- **Faster regulatory approval (14%)**
- **Improved commissioning, close-out and turnover (19%)**

BIM Benefits Contributing the Most Value



Source: McGraw-Hill Construction, 2009

BIM at Work

As BIM software developers continue to expand its capabilities, users are learning how to best apply these tools to project tasks. The visual aspects of BIM, which provide a 3D understanding of design and coordination issues, remain among its most approachable opportunities for users. **As users apply BIM to more complex tasks, expertise plays a big role in their ability to experience value.** Still other tasks have yet to be improved by BIM, but could do so in the future.

Most Valuable Uses Today

- **Presentation/visualization of architectural design.** Two-thirds of users (67%) see high value, especially **architects** (76%) and **owners** (66%).
- **Spatial coordination.** Two-thirds (64%) see high value, especially **contractors** (78%). **Engineers** (52%) rank it second to presentation/visualization.

Emerging Values

Experience drives the ability to reap rewards. A large portion of **experts** see these tasks gaining high value when done in BIM today, while less than half as many **beginners** see that level of value.

- **Client engagement** (72% of experts)
- **Drive shop fabrication equipment** (54% of experts)
- **Quantity takeoff** (52% of experts)
- **Less time documenting, more time designing** (45% of experts)
- **Shop drawing process** (50% of experts)
- **Cost estimation** (41% of experts)

Future Developments

Few users of any expertise level see high value in using BIM on the following tasks today. In some cases, users may not see BIM as an improvement over current methods. As software is further developed, outlook on BIM's impact on these tasks could change.

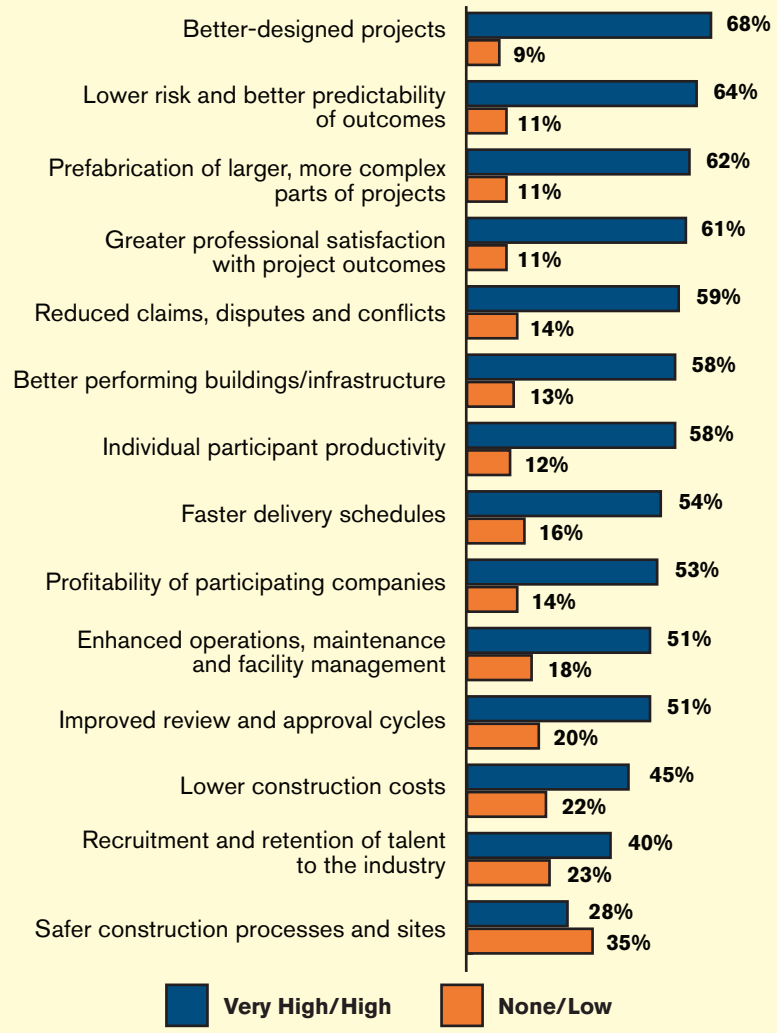
- **4D scheduling** (17%)
- **Energy analysis** (16%)
- **Submittals (other than shops)** (14%)
- **Operations & Maintenance** (14%)
- **Project turnover & closeout** (12%)

Future Opportunities

Users have an upbeat outlook on BIM. Most have yet to unlock its full potential, but see significant improvement on the horizon. **Drawing from a list of potential benefits, a majority of experts believe that all of them would create high value in five years** with the exception of BIM's impact on safety issues and recruitment and retention of talent. At least four in ten **beginners** also believe those opportunities will be very valuable. **Contractors** are generally the most optimistic that they will see higher value in the future.

- **Better-designed projects.** BIM can help integrated teams push more of the key decisions to the earlier stages of the process, allowing for smarter designs that capture a more detailed view of the entire project. Seven in ten users (68%) believe this will prove to have high value in the future, especially **contractors** (74%).
- **Lower risk and better predictability of outcomes.** As more users share information across models in the future, the ability to lower risk will improve. Two-thirds of users (64%) see this having high value five years from now, with two-thirds of **contractors** reporting it.
- **Prefabrication of larger, more complex parts of projects.** BIM is helping push the movement toward more prefabrication. Six in ten users (62%) say prefabrication will bring high value to projects in the coming years. A large majority of **contractors** (77%) see this as very beneficial.
- **Greater professional satisfaction with project outcomes.** Predictability and improved performance go a long way toward making a company feel good about its work on a project. Six in ten (61%) see this benefit as having a high value in the future.
- **Reduced claims, disputes and conflicts.** The more questions you can answer up front, the more you can eliminate the gray area that will cause problems later. Increasing predictability of projects can help reduce future claims and disputes. Fifty-nine percent of users say this will prove to have high value in five years, especially **contractors** (68%).

Perceived Value of BIM – Five Years from Now



Source: McGraw-Hill Construction, 2009

Blurring the Lines

The ability of teams to create richer models and share more data with BIM has helped foster more collaborative decision making on projects. Through integrated project delivery, key construction firms, fabricators, suppliers and others can work earlier in the process with designers to enhance quality, constructibility, timeliness and affordability. BIM has proven an effective tool for this delivery method, breaking from the tradition of handing off completed work from one team member to the next with little or no input from others.

Survey data shows that two critical design phases—design development and construction documents—are seen as times when projects can gain considerable value. As designers add detail to models, these phases represent an opportunity for others to provide input before costly decisions that impact the project are made. Although conventionally considered design phases, at least half of contractors and owners see these phases as highly valuable opportunities to gain value on a project.

Case Study:

Sutter Health Medical Center Castro Valley

When the Sacramento, California, firm Sutter Health first looked into building the new Sutter Medical Center Castro Valley, it saw no room for error. The $320 million project would replace the existing 55-year-old Eden Medical Center in Castro Valley, California, with a seismically safe facility designed in compliance with current earthquake safety laws. Using a team assembled in 2007, the project would need to be completed in time to meet a state-mandated 2013 seismic compliance deadline. Budgets also had little wiggle room, as Sutter Health would finance the entire project without public funds.

From the early planning stages, Digby Christian, senior project manager with Sutter Health's facility planning and development department, wasn't convinced that traditional delivery methods or even emerging integrated approaches would keep the project on track. Although Sutter Health has successfully used three-party integrated project delivery methods in the past, Christian decided to tear down the walls even further. The result was a 10-party IPD contract that brought together all major players, including those who usually would be hired as subconsultants or subcontractors. In addition to the architect—Phoenix-based Devenney Group—and the general contractor—DPR Construction of Redwood City, California—the team includes key MEP engineers and trade contractors; fire protection services; and a lean/BIM project integrator, Ghafari Associates of Dearborn, Michigan.

"I didn't see any point in the old hierarchy," Christian says. "It's baggage from this splintered environment we've always worked in. If you're committed as a team, why have a hierarchy?"

Given the level of early input available for the project, the team invested in extensive planning from the outset. It conducted a 7-week $350,000 validation study to ensure the project could come in at cost and budget. Next, the team strategized about how best to facilitate a seamless flow of ideas and communication among multiple parties.

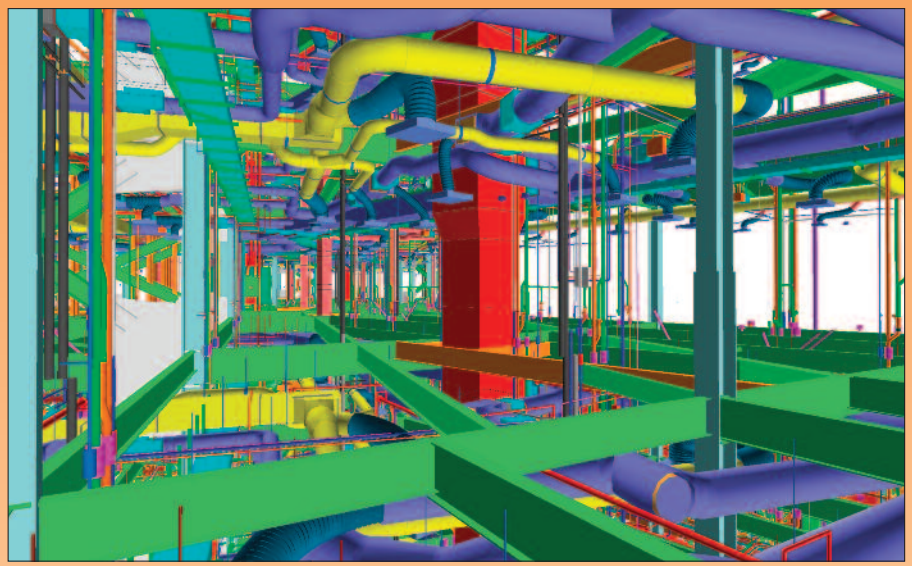


Image courtesy of GHAFARI Associates

Floor-level view of systems designed for Sutter Medical Center Castro Valley

Christian says the method requires more thinking up front, but leads to less time in production later.

"We're trying to change the way people think about design and construction," he adds. "It's not just executing—it's figuring out how best to work together. We spent a lot of time figuring out how decisions should be made. It feels wasteful initially, but it's a lot less frustrating in the end."

Adding BIM to IPD

To speed decisions and streamline processes, BIM and BIM-related tools played a vital role within the team. The design of all systems was performed and coordinated using 3D modeling software. Although everyone knew technology would drive the project's success, Ghafari's strategy was to avoid specifying which programs should be used.

Samir Emdanat, manager of advanced technologies at Ghafari, says that too often, specifying technology can limit creativity and reduce productivity.

"It can be a hindrance when you have a set of constraints that are not well conceived from the beginning and you have to live within those constraints," he says. "If the plan is flexible, we can build on everyone's core strengths and competencies to come up with the ideal approach."

Emdanat says the main goal was to find effective discipline-based chains of data exchange that would allow building information to flow easily from each designer to the appropriate trade contractors and on to the fabricators.

"Whenever there's an opportunity to pursue design-to-fabrication exchange, we push that as hard as we can," Emdanat says. "That means you create the information once and use it downstream for construction."

From there, interdisciplinary exchange methods were developed to keep the project tightly coordinated. In all cases, 3D is standard. For example, the MEP team supported the structural deliverables by coordinating entirely in 3D without producing any 2D documentation.

By the time the project broke ground in June 2009, the team had produced in excess of 25,000 electronic design documents. With hundreds of team members located in offices around the country, the more than 50 companies creating files have access to all data in real time from any location, using a series of eight servers.

Emdanat says files are considered "live," not copies that are uploaded to the site, so users don't have to worry if they are accessing the latest version of a file.

"It was a huge challenge, but once we implemented it and the teams began working with it, everything became transparent," he adds. "They could see who worked on what file and when, so they knew everyone's progress. It helped them feel like one big team instead of a number of different ones."

Communication didn't migrate entirely to the servers, however. The team meets every week to review the design using 3D models. Integration will remain a critical strategy going forward as designs are still in the works until February 2010—eight months after groundbreaking.

Early results

By the time construction got underway, Sutter Health started to realize the benefits of its approach. Early in the project, team members were asked to provide resource-loaded work plans to forecast how they expected to spend their time and money during design. Ghafari tracked each team's actual spending—or burn rate—against the original September 2007 budget until December 2008. While each team's results may vary, the overall budget against actual spending for the preconstruction costs showed a savings of $1.2 million.

Although significant time was spent early in planning, Emdanat says the project has outpaced projects executed under traditional delivery methods. He estimates that in California, projects of this magnitude take two and a half to three years from beginning of design to completed design, followed by two years in permitting, and up to four years in construction. The Castro Valley design started in October 2007 and the team had submitted fully permitable construction documents by December 2008—a one-year-and-three-month process. Permit for construction was received six months later in June 2009.

Emdanat says that all benefits combined create a project that is "faster, better and less expensive."

"This is not only the fastest designed large-scale health care project [in California], it was done at no added cost and resulted in higher-quality and better-coordinated deliverables," he says. "In the traditional process, the owner has to pick two out of the three [benefits] when the schedule is significantly accelerated.

Still more savings are expected on the horizon. Hundreds of multidiscipline design coordination issues that are typically resolved during construction have also been identified and resolved early in design, including detailed coordination of the elevator equipment, stair details, plumbing wall coordination, underground utility coordination, and coordination against steel braces and plates. With those issues coordinated early, Emdanat says the design has proceeded with much more certainty, leading the team to expect reduced rework or changes during construction. Ghafari is monitoring the impact and potential savings from this early coordination as the project transitions into construction to help better understand the ultimate savings in cost and time once the project is completed in 2013.

Given the initial results, Christian says Sutter Health expects to continue using its expanded view of IPD on future projects, and Emdanat forecasts the trend could spread.

"Owners are not satisfied with the traditional way of designing and delivering projects," Emdanat said. "They see projects run behind schedule and budget, and know that the old way doesn't work. The silo perspective might make sense for some in the design and construction world, but owners believe there's a better way to do things."

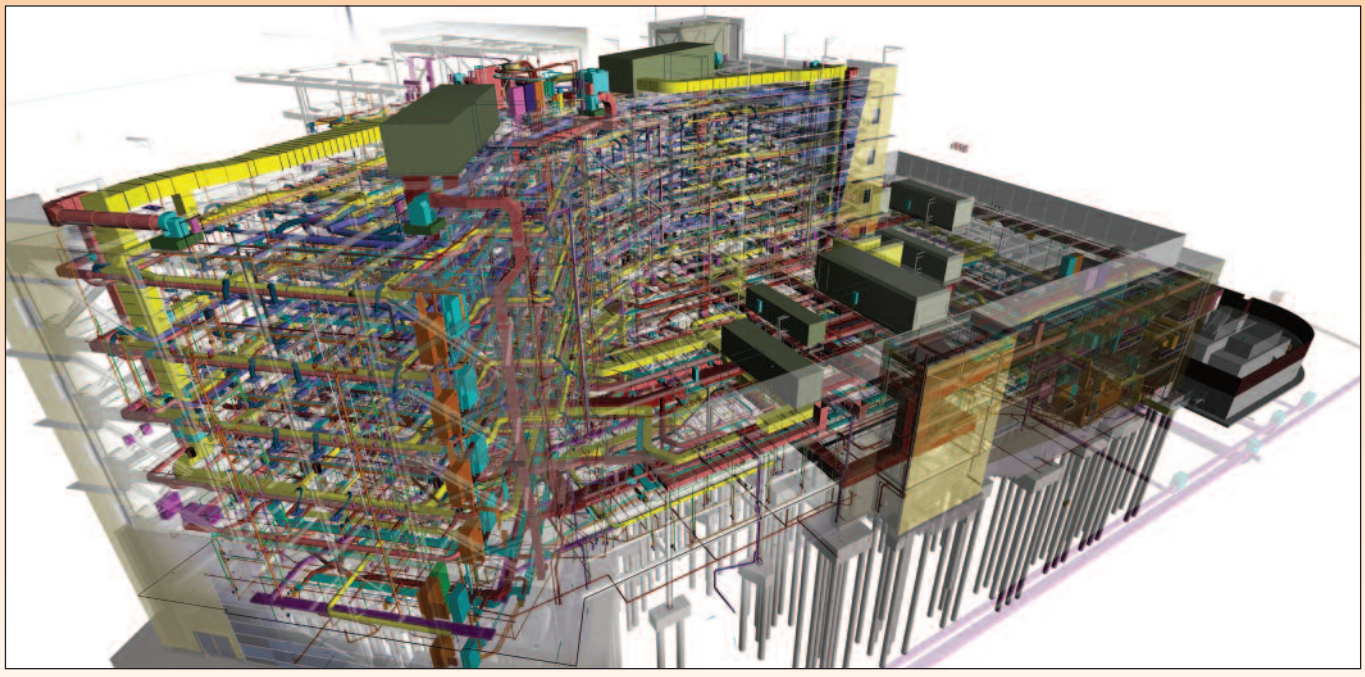


Image courtesy of GHAFARI Associates

Bird's-eye view of the Sutter Medical Center Castro Valley model

Industry Issue:
BIM and Green Building

Green building experts are searching for ways that BIM can help deliver sustainable facilities in the future. Research shows that BIM has limited impact on green building processes today, but many predict it could be a valuable tool in the coming years.

Results of this SmartMarket Report reveal that one-third of users say BIM is highly to very highly beneficial in delivering better-performing completed buildings, ranking it well below other potential benefits. More specifically, few users (15%) are currently getting a high level of value from using BIM for energy analysis—a key process in gauging building performance.

However, users see its impact increasing on the horizon. Three in five users say BIM will be highly to very highly valuable in producing better-performing buildings in five years, especially experts (69%).

Expert Perspectives

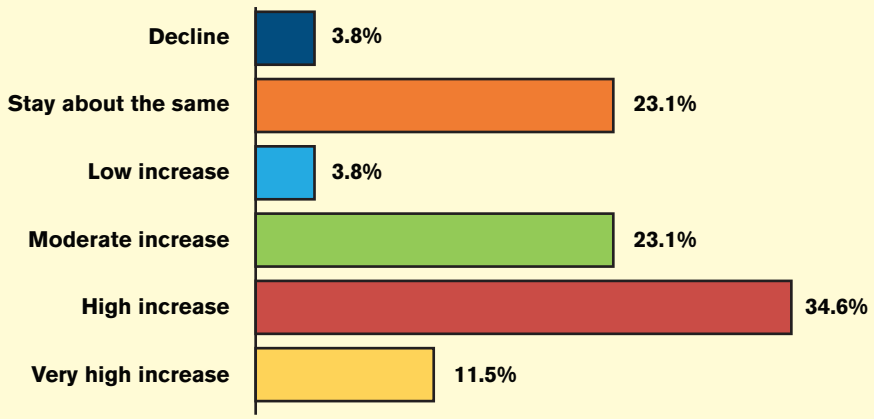
In a separate study, McGraw-Hill Construction surveyed firms involved in projects that had achieved U.S. Green Building Council LEED Platinum certification about the impact of BIM on green projects. Again, the snapshot of today is far different than the future outlook.

Among respondents, less than one in ten used BIM on LEED platinum projects. Most of these projects were certified in 2007 and 2008, suggesting that much of the design and analysis had been done years in advance when BIM was still in limited use industry wide.

One-third of those who hadn't used BIM on a LEED platinum project still are not using it on LEED projects today. Another third are light users, utilizing it on less than 15% of projects.

However, 69% are forecasting their use of BIM on such projects to increase by at least a moderate amount in the next two years—with 35% predicting a high increase.

Expected Growth in BIM Use on LEED Projects



Source: McGraw-Hill Construction, 2009

More Analysis Capabilities Needed

When reporting current concerns, some respondents noted that BIM is still a nascent technology that needs further development, particularly in the MEP fields.

In order for BIM to better apply to sustainable projects, many respondents specifically cite the need for improved energy modeling and analysis capabilities to test design alternatives and budgets against performance.

Additionally, some see the need for broader applications of the technology in the future, especially if it is to be embraced by owners seeking LEED certification.

A respondent from an architecture and engineering firm says that—despite the fact that BIM implementation has been "expensive and difficult" at his company—he sees opportunities down the road.

"We believe it will actually reduce the size of project teams, and make those teams more nimble," he says. "We believe BIM will facilitate smarter but simpler buildings, less reliant on technology and taking better advantage of site-specific design."

An owner's representative says he thinks that BIM could help with "the integrated design process that LEED projects encourage."

"I see every project in the future using BIM, but until it is integrated into the design process from the beginning of a project it will not [be] fully accepted by owners and the industry," he says.

Still others hope that one day BIM can play a role in ensuring that green projects continue to meet their efficiency goals throughout the ongoing operation and maintenance of a facility.

"While BIM aids in the design process and recording the predicted energy usage of a building, BIM should help integrate ongoing measurement and verification of actual building energy use and compare it to the predicted model," says one sustainability consultant. "This could help inform project [members] that their building may or may not be performing to their assumed designed energy standard."

Case Study:
Virtual Mock-Ups

Design documents convey a project's finished state. Typically, contractors have to determine the means and methods by which it will be built. Full-scale physical mock-ups of complex aspects, especially exterior envelope conditions, are a common way to visualize the end result and test the constructibility of a proposed design. Though extremely useful, these physical mock-ups are expensive, so a team will usually only study a small fraction of the total project.

Jim Bostic, vice president of construction at St. Joseph Health System in Orange, California, typically budgets $250,000 to $500,000 for a single exterior envelope mock-up, focused on a project's most potentially problematic condition. On the new Mission Hospital facility, his design team proposed all-metal cladding, a new approach for St. Joseph, and he was concerned about its constructibility.

Modeling Mock-Ups

Having successfully deployed BIM on several recent projects, Jim decided to retain an outsourcing company to model five critical areas of the exterior cladding design at a high level of detail for closer examination.

At this point, one physical mock-up had been built; the fabricator's shop drawings for the exterior cladding had been produced and approved; and phased fabrication had been scheduled and was underway. But this modeling exercise uncovered enough problems in the five critical areas that Jim stopped the process and invested an additional $150,000 to fully model each piece of every condition on the building envelope. This took three months, but was phased to match the fabrication schedule so issues were resolved in a timely, sequential manner that minimized the schedule impact.

Added Costs Averted

As a result, 45% of all panels were modified, affecting over 20,000 square feet of building surface. Jim estimates that the potential extra cost of not having identified these issues in advance would have been $1,387,500.

"The core team [designers and contractors] really came together and worked out the problems," he says.

Mission Hospital is scheduled for substantial completion in September 2009, and Jim is now requiring BIM for the design and construction of all his future projects, as well as involving more team members earlier in the process. Although the ROI can be challenging to calculate because, as he says, "you can't always put a dollar figure on costs you avoided," from his 40 years of building experience he is sure BIM will save significant time and money for St. Joseph Health System.

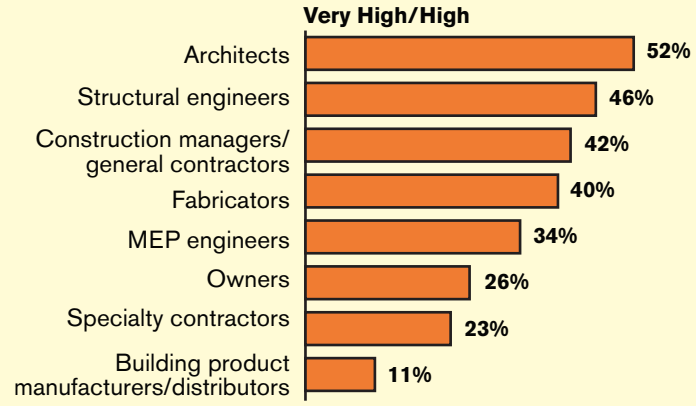
Images courtesy of St. Joseph Health System

Player Value of BIM

Overview: Adding It All Up

Just as with buildings themselves, a build team's value is the sum of its parts. **When using BIM across an entire project, each firm has an opportunity to realize its own distinct benefits.** Companies may see savings individually that collectively create significant value. These could be tangible benefits that improve productivity, reduce costs and save time. Although each player sees its own opportunities, most recognize that value can also be gained by improving the ability of every build team member to share data and become more integrated.

Project Participants Who are Perceived to Experience the Most Value



Source: McGraw-Hill Construction, 2009

Who Gets Most Value?

Architects

The evolution of BIM started with architects, and many still see its value emerging from its use in the design phases. Most in the design community, along with many contractors (43%) and owners (41%), say that architects experience a high level of value.

Structural Engineers

Nearly half of all users recognize that structural engineers can garner a high level of value from BIM. Such elements as steel columns, beams and trusses are frequently modeled by users. Contractors are the most likely (47%) to see structural engineers realizing significant benefits.

Construction Managers and General Contractors

Money is largely spent and saved during construction. Reducing rework can help keep budgets in line. Owners are the most likely (57%) to see a CM or GC as gaining high value on a project, most likely because that savings could be passed on.

Fabricators

As BIM reduces conflicts and creates confidence in building plans, many team members see opportunities for value in fabrication. Accurate fabrication of materials reduces waste while preassembly can save time. Contractors (56%) are far more likely to see fabricators as experiencing high value than architects (23%), engineers (38%) or owners (30%).

MEP Engineers

There is a range of opportunities for MEP engineers to use BIM. Modeling larger elements such as duct systems and air handlers are approachable options, while smaller elements such as electrical switches and outlets might prove more challenging. Notably, very few engineers (22%) collectively see MEP engineers reaping high value. Nearly half of contractors (45%) believe MEP engineers see significant value.

Owners

Owners ultimately experience all value collectively gained on a project. More than half (52%) of owners say they experience high value, but less than 30% of all other users believe this. This could be because other team members recognize that owners have yet to see much value from BIM for use in operations and maintenance. Still, most owners believe they can bank on the value of BIM during design and construction.

Specialty Contractors

Although specialty contractors are charged with executing the complexities of a project, few team members (23%) believe they are experiencing high value from BIM. On the whole, subcontractors are smaller firms relative to general contractors and the costs of adopting BIM would be more pronounced. As BIM users employ a wide range of software applications, subcontractors may face interoperability issues and incur added expenses to work within various models.

Building Product Manufacturers

Very few (11%) of build team members see building product manufacturers as gaining high value from BIM. This could reflect team members' belief that BPMs are not supplying sufficient BIM-related information yet.

Key Findings

- Architects are perceived to reap the highest value from BIM.
- Engineers see the most value in marketing BIM services and the productivity gains created by BIM.
- Civil engineers lag behind structural and MEP engineers in adoption.
- Contractors reap the highest value from benefits related to costs.
- MEP contractors rank among the top BIM adopters.
- Owners see BIM as a valuable communication tool.

Architects

Architects recognize BIM's value in both definitive and more intangible ways. Productivity can be improved as designers spend less time rekeying information or addressing the concerns of other build team members. At the same time, BIM adds new dimension to design and allows expanded levels of creativity and communication. BIM gained an early reputation as being design software, but architects see the need for an expanded community of build team members to enter the BIM environment.

Efficiency

Architects see BIM as an opportunity to be more efficient. Among their top benefits reported, architects point to improved coordination of documents and drawings through BIM. In part, this also helps free up designers' time so that they can focus on being creative, rather than being bogged down with documentation. As their work gets passed on to other team members, they recognize that BIM can save time by reducing errors and requests for information that could hamper the schedule.

The potential to **improve productivity of personnel** by using BIM is ranked by architects as the top way that they can improve their ROI with the technology. Three-quarters of architects (74%) report this is a highly important factor, more than all other users.

Visual Impact

Architects sell ideas, and being able to effectively communicate is critical to winning a job and bringing vision to reality. **Presentation and visualization of architectural design** are reported as key benefits realized through BIM. Although users can create data-rich models, the 3D aspects of BIM remain a critical part of how the technology brings value to architects.

Architects say:

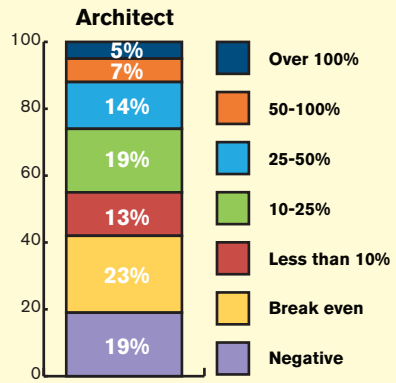
- **Better multiparty communication and understanding from 3D visualization** is the top way that their firms currently see ROI on BIM. Eight in ten architects (79%) rank it as highly important.
- **Improved collective understanding of design intent** is the top way that BIM brings value to a project. Two-thirds of architects (65%) rank it as highly important.

Teamwork

Architects realize that how they experience value through BIM extends well beyond their individual workstations. More than any other users, architects see a greater need for more of the industry to have BIM skills. Architects say their firms would see more value from BIM if:

- **There were more external firms with BIM skills** (77%)
- **There was more internal staff with BIM skills** (73%)
- **There was more incoming entry-level staff with BIM skills** (59%)

Perceived ROI



Source: McGraw-Hill Construction, 2009

Architect Perspectives

David Ivey, BIM manager for HOK in Chicago, is bullish on higher productivity from BIM, though "most current gains are still being re-invested in learning." He also noted, "We're way ahead of traditional billing on our BIM projects. Clients need to allow shifting fees to earlier phases."

Design Group was working 100% in CAD in 2005. The firm, based in Columbus, Ohio, is now working entirely in BIM with 2.5 million square feet of BIM work in design, under construction or completed. BIM Technology Manager Brian Skripac cites interoperability as the top inhibitor of greater productivity gains at the firm. Still, it is seeing success with BIM. A recent in-house BIM survey showed an 84% positive rating for "Overall Impact of Adoption," compared to 57 percent industry-wide, as shown in McGraw-Hill Construction's 2008 SmartMarket Report on BIM.

Top Rated Business Benefits

- **Reduced errors and omissions in construction documents**
- **Marketing new business to new clients**
- **Offering new services**

Engineers

Many engineers believe they can leverage BIM to their benefit. Given that engineers are more likely to report challenges with BIM, those who have become proficient at the technology are using it to get a leg up on the competition. To reap more benefits from BIM, engineers seek improvements. Insufficient software functionality and interoperability issues can create challenges for some, hindering their ability to see value. Many engineers also report that there is insufficient BIM content to meet their needs and that they don't see its application to their practice.

Marketing

Engineers who use BIM believe they are in demand. The ability of some to use analysis tools with BIM has the potential to bring value to an entire project. **Those who can leverage those benefits see it as giving them an edge on the competition.** As such, BIM can be an asset as firms look to drum up business.

Engineers say:

- **Marketing new business to new clients** is the top way that BIM benefits their business. Four in ten (43%) see this as highly beneficial.
- **Offering new services** is the second ranked way that BIM benefits their business. Nearly four in ten (38%) see this as highly beneficial.
- **Positive impact on marketing** is among the top three ways that engineering firms say they see positive ROI.

Productivity

Engineers see BIM saving time and money. For them the analysis is simple: less problems equals more profit.

- **Reduced errors and omissions in construction documents** is the third ranked way that BIM benefits their business.
- **Reduced conflicts and changes during construction** are among the top three ways that engineers say BIM adds value to a project.

Challenges

For engineers to maximize the value of BIM, they need to see improvements to software platforms and how they interoperate.

The top factors that would increase an engineering firm's ability to see business benefits are:

- **Improved interoperability between software applications.** Eighty-three percent rated this as highly important, more than any other user group.
- **Improved functionality of BIM software.** Seventy-eight percent rated this as highly important.
- **More clearly defined BIM deliverables between parties.** Two-thirds (65%) rated this as highly important.

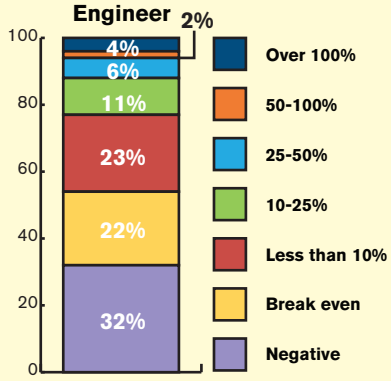
Most Beneficial Tasks with BIM

- Presentation/visualization of architectural design
- Spatial coordination
- Structural analysis

Project Factors Affecting Value

- Project complexity
- BIM-knowledgeable design professionals on the project
- Interoperability between software applications used by team members

Perceived ROI



Source: McGraw-Hill Construction, 2009

Engineer Perspectives

Large multidisciplinary engineering firms—such as Parsons Brinckerhoff, Arup, Flack & Kurtz and JB&B—are leveraging BIM successfully on high-profile projects around the globe. But BIM is also providing real business value for midsize regional and small local engineering firms.

Well-established MEP firms such as Spectrum Engineers in Salt Lake City and Dunham Engineering in Minneapolis have adopted BIM as a strategic differentiator in their competitive markets and are winning work as a direct result.

EMC Structural Engineers, a small Nashville-based firm, uses BIM for steel, concrete and timber frame construction. Even though it is often the only team member doing models, EMC is experiencing a number of internal and project benefits."BIM reduces repetitive tasks, improves quality control, promotes thinking in 3D and improves communication with architects", says Ben Beurgler, senior engineer at EMC. "We're just a small firm, doing small projects, but we see the value and we've made the commitment."

Engineers by Discipline

Structural Engineers

Structural engineers who use BIM do so to varying degrees. A survey of structural engineers in the 2008 SmartMarket Report on BIM showed that four out of five BIM users frequently model steel columns, beams, trusses and concrete. More detailed elements pose a greater challenge. Three in ten frequently model steel details and reinforcing, while 6% model framework, according to the report.

Today, **structural engineers who use BIM see benefits both internally and at the project level.** Compared to other engineers, structural engineers are much more likely to say BIM brings value by:

- **Helping maintain repeat business with past customers**. This is their top-ranked internal benefit.
- **Reducing overall project duration**

Other highly ranked benefits:

- **Presentation/visualization of architectural design**
- **Spatial coordination**

MEP Engineers

Mechanical, electrical and plumbing engineers often work in great detail. A survey of mechanical engineers in the 2008 SmartMarket Report on BIM showed that a large majority of BIM users frequently model duct systems, air handlers, grilles, diffusers and other major equipment, while one in five modeled energy management systems and controls. Electrical engineers see more challenges. Very few electrical engineers who use BIM reported frequently modeling any elements.

Competitive advantage

The level of challenge posed by modeling detail in BIM could favor those who have adopted it. **MEP engineers who use BIM recognize that it can be a competitive advantage.**

The top rated internal business benefits for MEP engineers are:

- **Marketing new business to new clients**
- **Offering new services**

Project Value

- MEP engineers are more likely to see high value from **cost estimation** than other disciplines.
- As with other engineers, users in the MEP fields rank **presentation/visualization of architectural design** and **spatial coordination** among the top benefits of BIM.

Civil Engineers

BIM is an **emerging tool** for civil engineers. Few civil engineers use BIM today, but they believe it will be valuable in the future (see "Adoption of BIM" chapter).

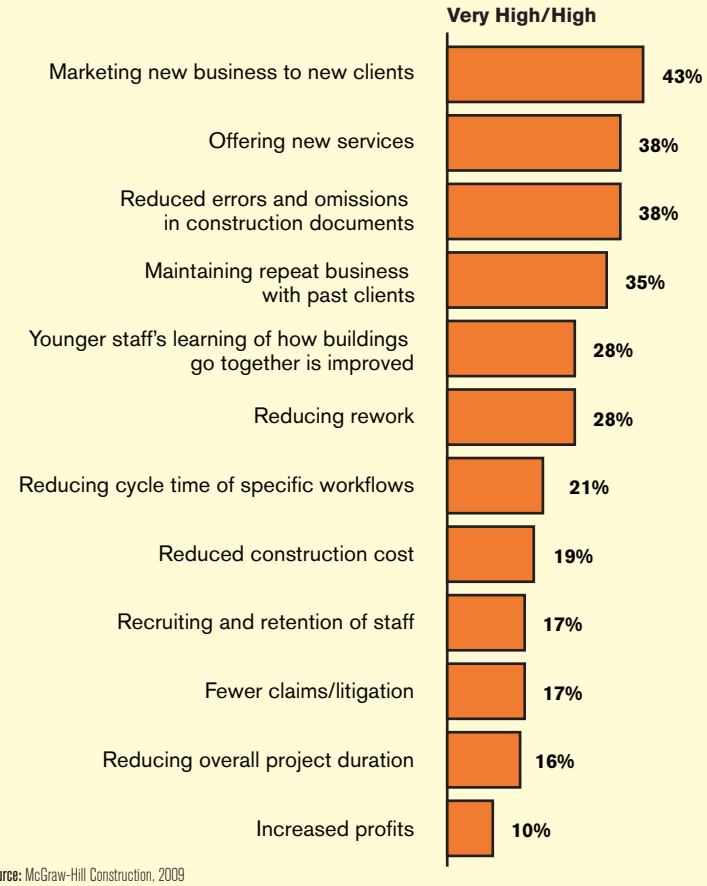
Those civil engineers who use BIM today see multiple opportunities for benefits. Compared to other engineers, civil engineers who use BIM are most likely to say they see value in:

- **Greater client engagement**
- **Greater community engagement**
- **Quantity takeoffs**
- **Spatial coordination**

Although they do see project value, civil engineers lag behind in discovering some productivity and marketing opportunities. Compared to others, civil engineers are far less likely to say BIM helps:

- **Market new business to new clients**
- **Reduce rework**

Most Important Internal Benefits for Engineers



Source: McGraw-Hill Construction, 2009

Contractors

Contractors see many of the most obvious and dramatic benefits of BIM. **With the vast majority of a project's cost dedicated to the construction phase, real savings of time and money can be experienced in the field.** By pre-planning thier sequencing and reducing conflicts and changes during construction, contractors can avoid many of the mistakes that erode budgets and schedules.

Cost Savings

Change is bad—at least during construction. As change orders add up on a job, schedules and budgets suffer. Contractors see that BIM can help reduce errors before they lead to rework in the field. Using BIM for clash detection while coordinating various subcontractors has proven highly effective for many users. Contractors report that avoiding conflicts and changes are the top two ways that they save time and money on a project. . (see "A Model is Worth a Thousand Drawings" in Conclusions chapter)

- **Reduced conflicts** during construction is the top way that contractors say projects gain value with BIM. The vast majority (83%) say this brings high value.
- Contractors point to **spatial coordination** as the specific task that shows the most value. Eight in ten (78%) rated this at a high level of value.

Problem Solver

BIM can bring clarity to a complex project. Given that effective coordination brings value, contractors see more opportunities to realize benefits as the level of complexity increases. With greater confidence in the coordination process, many contractors are pushing for more prefabrication of systems and other building elements to help ease schedules.

- **Project complexity** is the top rated factor affecting value in a project for contractors. Seven in ten (72%) rated this as highly important.
- **Prefabrication of larger, more complex parts** of projects will be the area where contractors expect to see the greatest value in the future. Nearly eight in ten (78%) expect prefabrication to bring high value in five years.

Individual Effort

Although many contractors using BIM see big benefits, working as a team can be a challenge. As contractors see significant savings through their own tasks, many may make the decision to use BIM regardless of whether others are able to share BIM data on a project. These issues will need to be addressed if BIM is to be broadly used in an integrated environment.

- The vast majority of contractors (82%) say that **better multiparty communication and understanding from 3D visualization** are top ways that BIM can improve value.
- **Improving interoperability between software applications** is the top way that contractors say they could increase the business value of BIM. Eight in ten contractors (78%) ranked it as highly important.

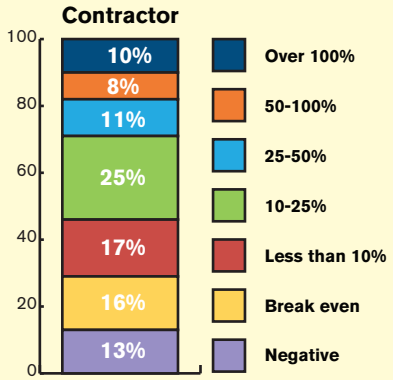
Top Rated Benefits Other Than Saving Time or Money

- Gives a competitive edge
- Visualization
- Marketing

Future Opportunities for Value

- Prefabrication of larger, more complex parts of projects
- Better-designed projects
- Lower risk and better predictability of outcomes

Perceived ROI



Source: McGraw-Hill Construction, 2009

Contractor Perspectives

"Who should model what?" is a key question for contractors.

"We do almost no modeling ourselves," says Jim Barrett, national BIM manager at Turner Construction in New York. The company typically mandates BIM to trade contractors because "it unlocks their creative juices and generates ownership of the solution."

At PCL Construction of Denver, a large internal staff extensively models all of its projects, with a special focus on self-performed concrete work. The firm believes strongly in the ROI of in-house BIM capability and plans to expand it.

Holder Construction Vice President Mike LeFevre uses BIM tactically to solve specific problems that help avoid risks from what he calls "GMPs with teeth." He also asks trades to model for prefabrication, citing lean construction and green benefits.

David Morris, director of virtual construction at EMCOR, a national contractor based in Norwalk, Connecticut, says he wants modeling on every job by "leveraging expertise across our offices and sharing files and content libraries. The benefits are just too outstanding."

Contractors By Discipline

MEP Contractors

MEP contractors are champions of BIM in the building industry. **Four in five MEP contractors who use BIM say they are seeing positive ROI** in the technology, more than other contractors and all other team members.

In light of those results, three in five MEP contractors say they have adopted BIM. That rate ranks above other contractors and matches the adoption rate of architects.

- 44% are **creating and analyzing models**
- By comparison, 10% are **using BIM tools to analyze existing models**, showing that they are much more likely to work in their own models, either by preference or necessity.

MEP contractors are reaping benefits in many of the areas that most directly apply to their trades. More than any other contractors, the MEP trades place a high value on:

- **Spatial coordination**
- **Shop drawing process**
- **Driving shop fabrication equipment**

MEP contractors are also much more likely to find value in **quantity takeoff** with BIM compared to others, although at a moderate level.

General Contractors

A large majority of general contractors who use BIM are reaping rewards today. More than seven in ten general contractors are seeing positive ROI in BIM. Compared to others, they are most likely to see ROI above 100%, with 14% of general contractors reporting returns at that level.

The GC community sees a broad range of business benefits, especially those related to productivity and communication.

- **Spatial coordination** holds the highest value for general contractors.
- **Presentation/visualization of architectural design** is of high value to them, more so than other contractors.
- **Reducing rework** is also seen as providing high value.
- General contractors are more likely than others to say that BIM **improves younger staff's learning of how buildings go together.**

Construction Managers

Construction managers are searching for value. Among all contractors, construction managers are least likely to see BIM pay off, with 43% saying they see positive returns on investment. Among those who do experience positive ROI, most see returns below 10%.

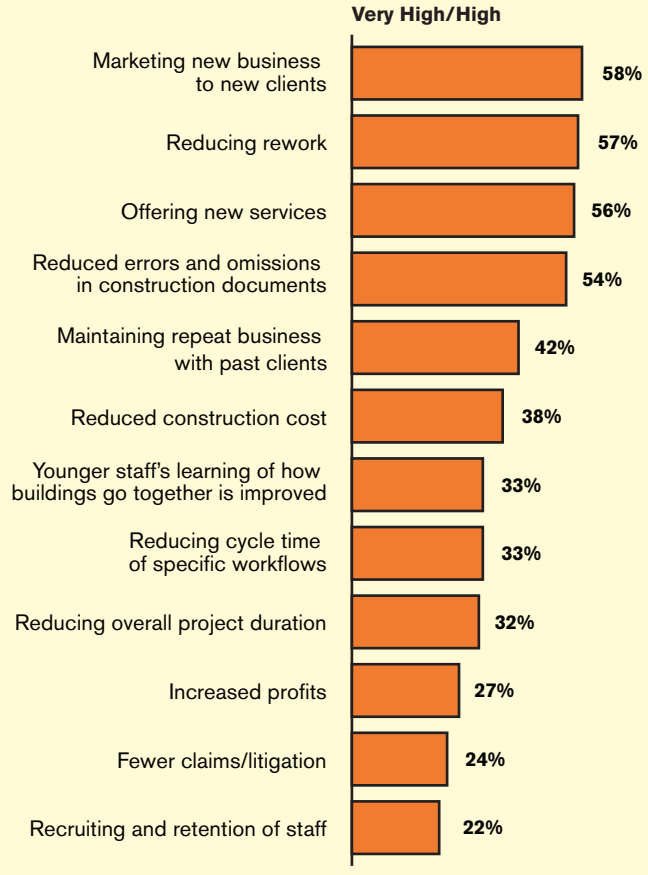
Construction managers are adopting BIM at levels on par with the industry as a whole (49%), but trail other contractors.

- **30% create and analyze models, less than other contractors**
- **16% use BIM tools to analyze existing models, more than other contractors.**

Like other contractors, construction managers see value in:

- **Presentation/visualization of architectural design**
- **Spatial coordination**
- **Offering new services**
- **Marketing new business to new clients**

Most Important Internal Benefits for Contractors



Source: McGraw-Hill Construction, 2009

Owners

Owners see the big picture. Even the most involved owner can't be in the trenches during every phase and individual task of a project. **Owners are looking for BIM to deliver results that can be seen in the project cost, speed of delivery and quality of the finished product.** While owners ultimately could realize benefits that extend into the operations and maintenance aspects of a project, few are seeing those opportunities materialize yet.

Communication

Owners want to be kept in the loop. BIM expands the ways that project plans and progress can be communicated to owners. **Owners report that better understanding of projects in any or all stages is the top benefit beyond those that save time and money.** Likewise, owners want to see other team members improve their communication to keep projects on track.

Owners say:

- **Presentation and visualization of architectural design** is the top task that benefits them during a project. Two-thirds rate this as providing high value.
- **Improved collective understanding of design intent** is the top way that projects can gain value. Two-thirds rate this as contributing high value.
- **Better multiparty communication and understanding from 3D visualization** is the second most important factor that could improve ROI in BIM. Three-quarters (76%) rate this as highly important.

Cost Savings

In the end, it all comes down to budget. Owners bear the ultimate cost of a project and are highly interested in any opportunities for savings.

Owners say:

- **Clash detection and avoiding rework** are the top ways that BIM saves time and money.
- **Lower project cost** is the third-highest way that they could see improved value of BIM.

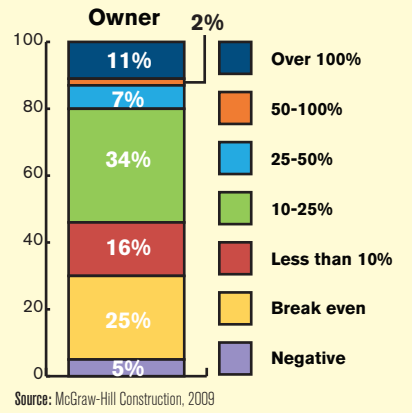
Better Projects

Whether one or all team members on a project saw benefits by using BIM, owners see big-picture value.

Owners say:

- **Overall better construction project outcomes** is the top business benefit for them. Half of owners (48%) see this as generating high value.
- **Improved project process outcomes**, such as fewer RFIs and field coordination problems, is the top way value could be improved. Half of owners (52%) see this as generating high value.
- **Better-designed projects and better-performing buildings** are the top two ways they expect to gain value from BIM in the future.

Perceived ROI



Source: McGraw-Hill Construction, 2009

Owners Perception

Owners who use BIM see a very high rate of ROI, with seven in ten reporting positive results. Given those results, many owners expect the firms that work for them to use BIM.

This is also true among those owners who have not adopted BIM themselves:

-Among owners who do not use BIM, **only one in five estimate that design and construction firms working for them are not using BIM at all.**

-Nearly half (44%) of owners who do not use BIM believe that firms working for them are using it on at least a moderate number of their projects.

Owners' view of BIM use on projects appears to be higher than reality, given that half of the industry claims to use BIM or BIM-related tools today. Whether owners use BIM or not, many see value today and expect the firms they hire to use it.

Top Rated Ways BIM Saves Time and/or Money

- Increased productivity/efficiency
- Improved coordination of drawings/documents
- Avoiding rework/changes

How Projects Gain Value

- Improved collective understanding of design intent
- Reduced conflicts during construction
- Improved overall project quality

Project Factors Affecting Value

- BIM-knowledgeable design professionals on the project
- Interoperability between software applications used by team members
- Project complexity

Software Industry Perspective:

Interview with Jay Bhatt, Autodesk

Jay Bhatt, senior vice president of Autodesk, AEC Industry Group, shares his outlook on current and future trends in BIM.

Client demand is cited as the top factor that drives the decision to use BIM, yet many owners have yet to adopt it themselves. How can client-driven demand be created under those circumstances?

Spreading the value proposition of BIM in the building industry is counterintuitive to the way change typically happens. A lot of time change is top-down driven. The BIM movement is more viral. Architects picked it up first. Then contractors and engineers began to see value in it and started creating models. Owners, who are seen as the directing force [in project decisions], have now started to see the value gained from those models. They are trying to figure out how best to apply this to their businesses and decide how aggressive they need to be in specifying BIM…Some owner segments, such as retail, have been very aggressive around BIM and do drive adoption. Other owner segments haven't because they are more focused on operations and maintenance and the long-term lifecycle issues, but you're starting to see them get very visible around BIM because they believe it will ultimately return [value] to the lifecycle of a facility.

Contractors have rapidly adopted BIM in recent years. What is driving that trend and how will it impact the future outlook of BIM on projects?

[The contractor segment] are the fastest growing BIM adoption group that we see. For architects, it was a grassroots adoption that they saw as a better way to design…Contractors look at analytical aspects, simulation and cost technologies that leverage the database in the design model. If they can connect this rich information that represents a building being created and connect it to a timeline so that the team can better understand how it all goes together, they see obvious returns from that…As contractors are becoming more savvy about BIM and can show results, the owners now start to wake up. It becomes a domino effect.

As a whole, engineers lag behind architects and contractors. What factors do you see contributing to that?

Some engineers, like structural engineers, are in many ways on the leading edge of modeling, but MEP seems to be the most challenged. There are several factors driving this. Unlike in architecture, the draftsmen still exist very strongly in MEP firms. In architecture you don't see the draftsmen. They are designers. They let the model help with the drafts. That is a process change for them. Secondly, MEP engineers are very returns-centric. They are more like contractors. They are into function and looking for returns. Architects took a visionary stance early. Engineers are very practical. They want proof, just like contractors. Thirdly, they need analytical tools. They don't create a piping design because they appreciate the beauty of pipe. They need to perform analysis. Until a few years ago when the industry started to provide analytical tools [in BIM] that allowed them to be proficient, it would have been very difficult for them to transition from the old workflow.

Many users believe that BIM is not as effective on smaller projects. How do you view the application of BIM beyond the realm of large complex projects?

There's a lot of visibility around large projects with BIM. The perception exists that…BIM is really only applicable to big projects because it's a complicated paradigm shift. But BIM is not that complicated. When we first pushed Revit out to the market, we wanted to show how it was different from CAD. Since then, the industry has embraced BIM as a process change, not just a technology application. People tend to affiliate process change with complex projects…The fact is, most of our users fall in the sub-10-person firm category. We don't see a difference in adoption between small, medium and large firms.

Users and non-users continue to raise concerns about interoperability. How is that being addressed?

Vendors are working hard on this issue. The biggest initiative here is to make our own platforms—and most competitive platforms—have seamless data exchange. The industry has talked about different formats that make it easier to [exchange] sets of information. I'd love to see that idea work, but it's not clear if it will or won't. We're not waiting for that. We want to say, "Let's not have software vendors or tool providers constrain the change toward BIM and integrated projects. Let's make sure it works."

Like BIM, sustainability is a hot topic in the industry. Sustainability has yet to prove very valuable for a large portion of users. In the future, what will be the place for BIM in a sustainable world?

Until recently, analytical and simulation technologies haven't existed to understand how a building could be sustainable. Meanwhile, [green] standards have continued to evolve and are being worked out…In the absence of a return argument [because of new technology], you need top-down direction. We're starting to see that with the public sector mandating [green building]. We have a perfect storm gathering for the green building movement and BIM is there with it.

Adoption of BIM

Overview: Two Year Rise in BIM Use

Building information modeling has quickly gained momentum, and much of the industry is adding it to their toolboxes. **Half of respondents (49%) report using BIM or BIM-related tools.**

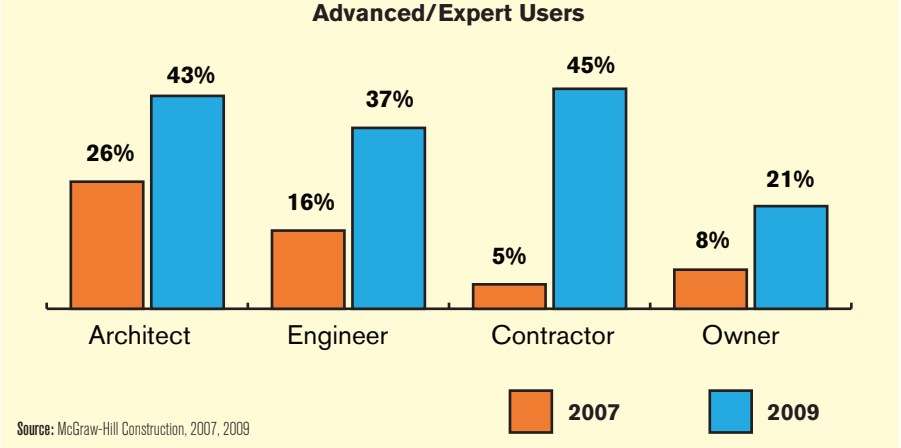
The move into BIM is relatively recent with two-thirds of users adopting it within the last three years. Data from the 2007 McGraw-Hill Construction SmartMarket Report on Interoperability backs up this trend, showing that 28% of the industry was using BIM or BIM-related tools at that time. **This represents a 75% increase in use in the last two years.**

Meanwhile, users have quickly gained proficiency. In 2007, 14% of users categorized themselves as expert or advanced. **Today, 42% are expert or advanced users—three times the amount in 2007.**

User Differences

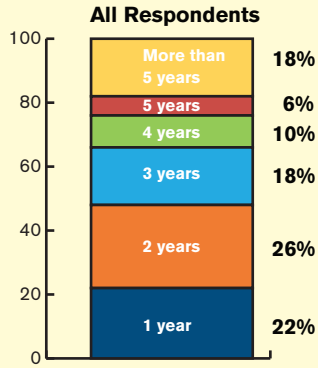
- Architects, who were early adopters of the technology, remain the highest users of BIM. **Six in ten of all architects create BIM models with half of users also analyzing them.** Today, 43% of architects who use BIM consider themselves advanced or expert users compared to 26% in 2007.
- Contractors are gaining ground faster than any other group, as more users discover the value of the technology beyond the pure design process. **Half (50%) of contractors report using BIM or BIM-related tools—four times the level reported in 2007 (13%).**
- **Four in ten engineers (42%) use BIM, but they continue to lag behind architects and have been surpassed by contractors in use.** Many engineers report that they struggle to find sufficient BIM-compatible content to meet their needs or they don't see BIM's application to their practice.
- **Owners are gaining ground with more than one-third (37%) using it today—approaching the usage rate of engineers.** This growth comes despite the fact that owners have yet to realize a significant impact from BIM on their own operations and maintenance needs.

Growth in Expertise



Source: McGraw-Hill Construction, 2007, 2009

Years Using BIM



Source: McGraw-Hill Construction, 2009

Authoring Versus Analysis

Users typically create models, rather than working with existing ones. Although some team members, such as contractors and owners, use tools to analyze existing models, **a majority of players author their own models**. In some cases, this could be because the team member is the only one using BIM on a project. In other scenarios, multiple team members may choose to create their own models that focus on their individual needs rather than alter or add to an existing model.

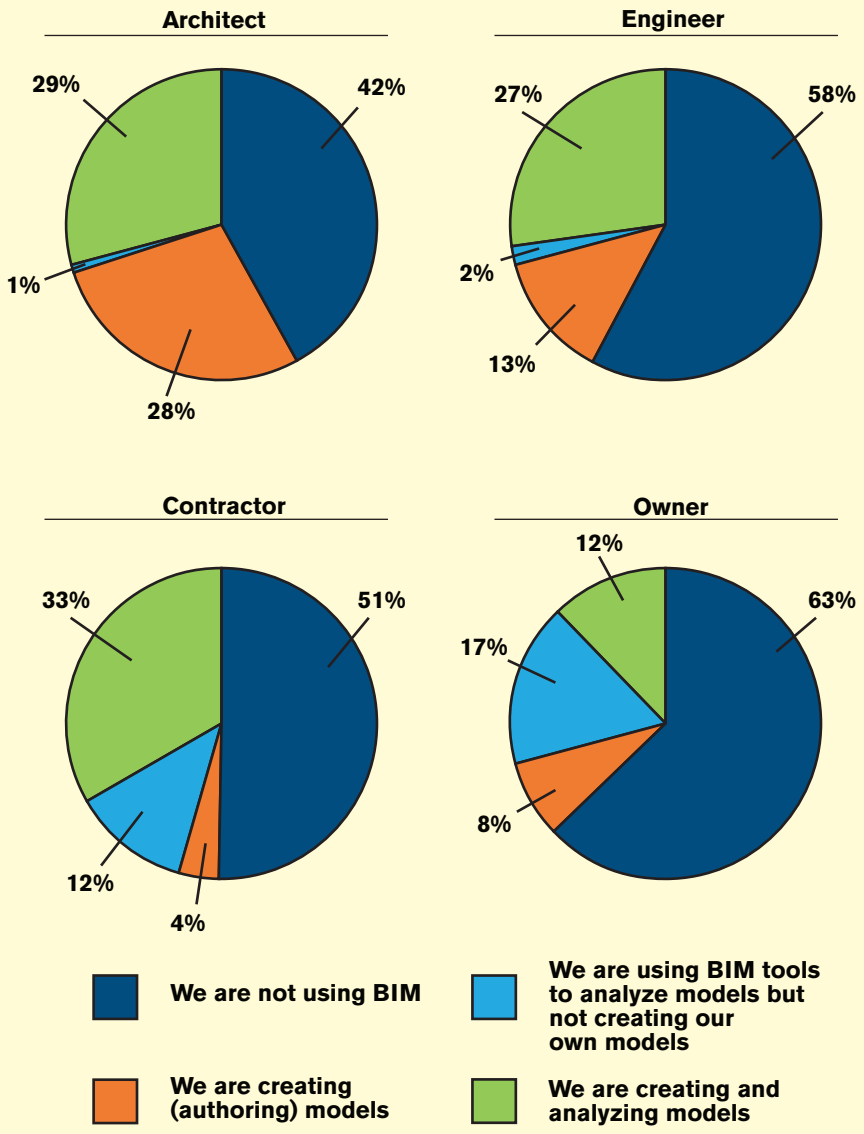
User Differences

- Six in ten **architects** create BIM models with half of users also analyzing them.
- **Engineers** tend to author their own models, although at a lower level than architects (40%).
- While 12% of **contractors** use tools to analyze existing models, one-third create and analyze their own models. This could be because models from other team members either don't exist, aren't being shared or don't provide sufficient information for a contractor's needs.
- **Owners** are the least likely to create models (12%) and most likely to analyze existing models (17%).

Key Findings

- Half of the industry has adopted BIM, a 75% increase from two years ago.
- BIM use by contractors has quadrupled in the last two years.
- The rate at which BIM users utilize it on projects will double in two years.
- The U.S. West Coast has the highest concentration of BIM users.
- Non-users are open to adopting BIM in the future.
- Greatest challenges for non-users: 1) not enough time to evaluate BIM, 2) software/hardware upgrades, 3) functionality doesn't apply well to their practice

BIM Adoption and Usage



Source: McGraw-Hill Construction, 2009

Depth of Involvement

As building team members begin to adopt BIM, use of the technology is becoming more commonplace on projects. Its frequency of use can vary greatly depending on the need and the expertise of the user.

- Two-thirds of **experts** use it on more than 60% of projects.
- One in five **beginners** use BIM on more than 15% of their projects.
- Among all users, a majority (55%) use BIM on less than 30% of projects, while a quarter (27%) use it frequently, on 60% or more of their projects. In part, this reflects that BIM is still a new technology to many users.

Differences in Disciplines

Engineers, as a group, trail other main team players in their adoption of BIM, but there are notable differences between disciplines.

- **Structural** and **MEP engineers** are using BIM at levels similar to industry-wide averages, while **civil engineers** lag far behind. More than four in five civil engineers are not using BIM.

Looking toward the future, many engineers see significant changes ahead.

- Among BIM users, one quarter of **structural engineers** utilize it on more than 60% of projects today. Twice as many of them expect to use it at that level in two years.
- Among BIM users, one in ten **civil engineers** utilize it on more than 60% of projects today. That level of involvement is forecast to almost quadruple in two years.
- Among BIM users, one in eight **MEP engineers** utilize it on more than 60% of projects today. That level of involvement is expected to almost triple in two years.

Significant Future Growth

With gains in expertise, many of today's new users will expand their use of BIM to more projects in the future.

- Two-thirds of users have adopted it within the last three years, and **frequency of use is expected to grow considerably in the near future.**
- While nearly a quarter of users employ BIM frequently on their projects today, the number using it at **that level could double in two years**.

User Differences

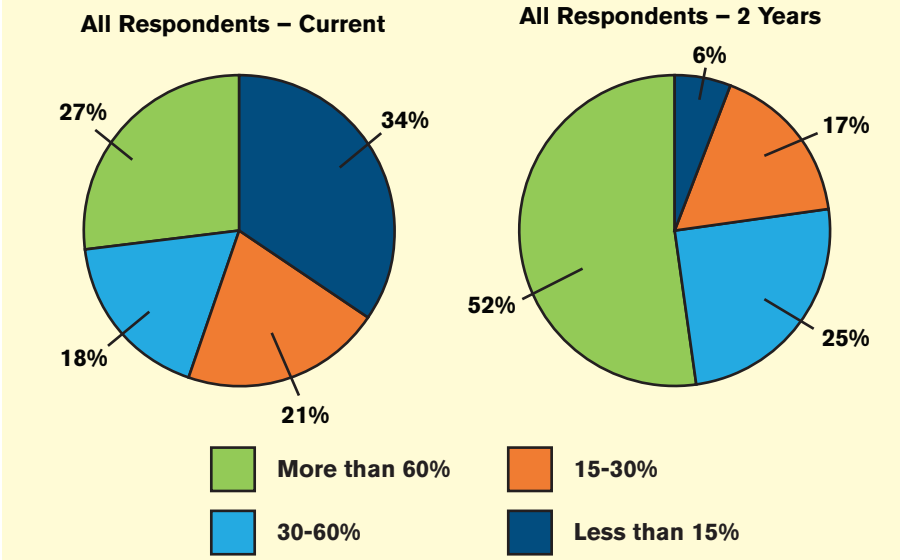
- **Beginners** are optimistic that they will expand its use quickly. While 80% use it on 15% or less of projects today, only 14% expect to use it at that level in two years.
- Today's **moderate users** will be tomorrow's **heavy users**. One in ten moderate users employ BIM on a majority (60% or more) of projects, but nearly half expect to use it at that level in two years.
- **Architects** expect the largest rise in BIM use with two-thirds saying it will be used on a majority of projects, compared to 37% who use it at that level today.
- Roughly two out of ten **engineers**, **contractors** and **owners** who use BIM employ it on a majority of their projects. Four in ten expect to use it at that level in two years.

Steady Progression

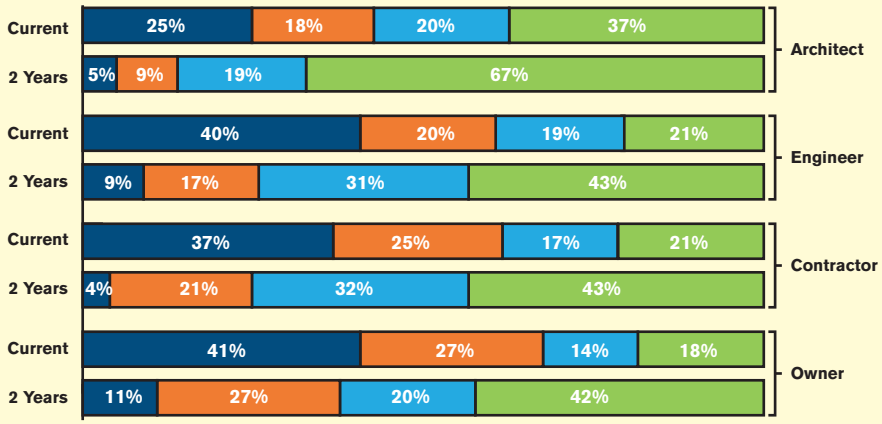
BIM proficiency will improve steadily, as users advance to the next level in two years.

- 15% of beginners expect to use BIM on 60% or more of projects in two years—nearly the same level (13%) that moderate users are at today.
- 44% of moderate users expect to use BIM on 60% or more of projects in two years—the same level (44%) that advanced users are at today.
- 74% of advanced users expect to use BIM on 60% or more of projects in two years—more than experts are at today (67%).

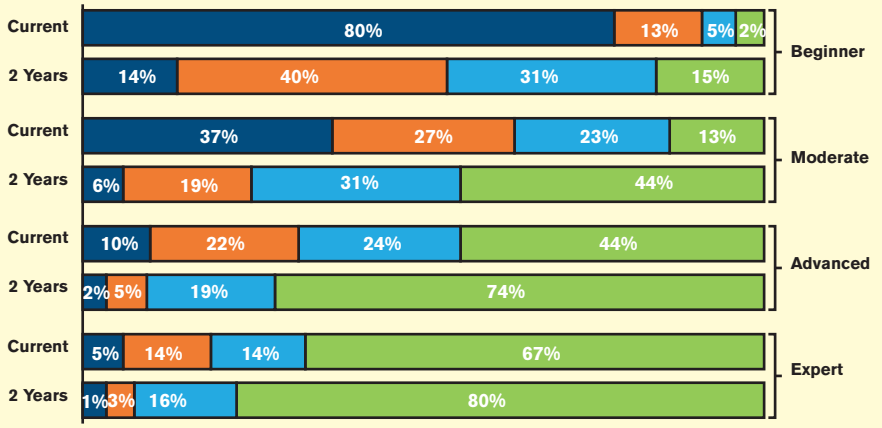
Current and Future BIM Use



By Respondent Type



By Level of BIM Expertise



Source: McGraw-Hill Construction, 2009

Adoption of BIM by Region

Although nearly half of the industry in North America is using BIM or BIM-related tools, there are strong regional differences in adoption levels. Research conducted for the SmartMarket Report shows that the West Coast of the U.S. is outpacing other regions of the United States and Canada.

Fifty-six percent of respondents in the western U.S. said they are using BIM, tallying far ahead of the Northeast (38%). Canada has a 48% adoption rate.

Kevin Bredeson, director of virtual construction at Providence, R.I.-based Gilbane, says that a combination of sophisticated clients and the level of the competition is driving BIM use to higher levels in the West.

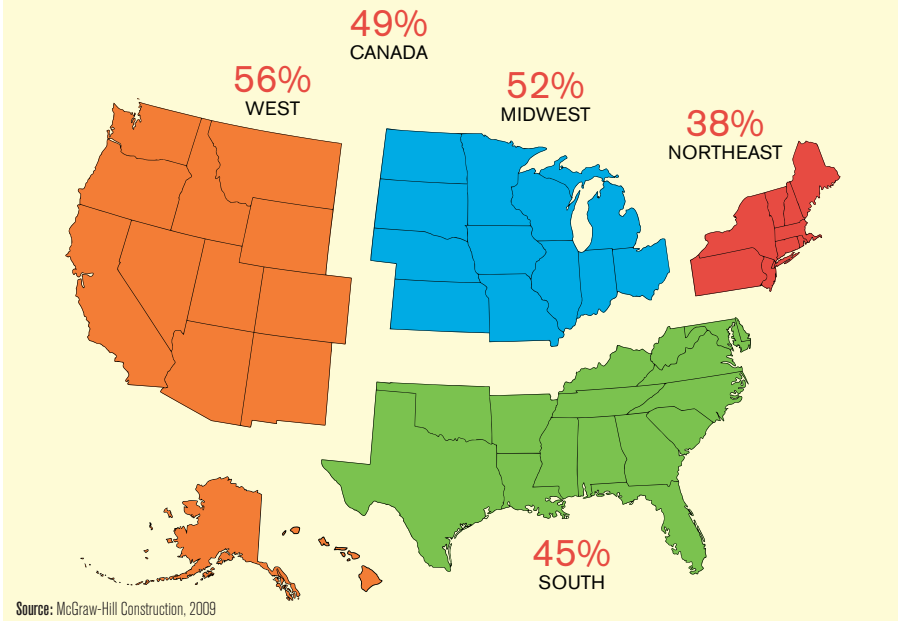
"There are a lot of savvy owners as well as more forward-thinking contractors and architects on the West Coast," he says. "A lot of it is owner driven and it trickles down from there."

James Barrett, regional manager of Construction Technologies at Turner Construction in New York, agrees, noting that northern California and the northwestern states are particularly interested in BIM.

Additionally, Barrett says there are strong pockets of activity around the country, such as Texas, Chicago and Washington, D.C. Much of the activity in the Mid-Atlantic states has been driven by federal work that requires BIM.

By comparison, Barrett says it is a challenge to find other build team members using BIM on jobs in the Northeast. "It's unusual to get even a 2D electronic drawing in New York," he says. "On the West Coast, it's standard that everything is digital. It's a cultural issue where people [in the Northeast] are more resistant to change, and on the West Coast they have a more open-minded attitude about experimenting with new methods."

BIM Use In North America



Source: McGraw-Hill Construction, 2009

Client Demand for BIM

Lack of client demand is the top rated reason AEC companies do not adopt BIM. But increasingly, contractors are mandating BIM from key trades and owners are demanding it from entire teams.

ENR Top 100 contractor Layton Construction of Sandy, Utah, mandates BIM from key subs, especially for health care work. BIM Manager Damon Socha says BIM willingness is now a prequalification and even first-time users cooperate. Most owners will pay extra to have subs model their work, he says. A sub's decision about how much to model follows a simple rule, he says. "If it's not in your model, then you're responsible for coordinating it and any cost of moving it, which gets us pretty complete models" he explains.

On the federal level, the U.S. General Services Administration mandates BIM for spatial validation on all projects. The GSA goal is that teams will continue using it through construction, which about half currently do. The U.S. Army Corps of Engineers mandates complete BIM for many of its standard building types. Both agencies provide BIM guides detailing its requirements, but no financial support.

Wisconsin and Texas mandate BIM for most new projects. Texas plans to host a master version of the project model on its servers during design and construction, so that at completion it's ready for energy and facility management.

Many private owners are also mandating BIM. John Moebes, director of construction for Crate and Barrel of Northbrook, Illinois, runs an all-BIM nationwide program and is constantly pushing his teams to "deliver BIM value the board of directors will care about."

Non-Users Remain Open-Minded

Although nearly half of building team members aren't using BIM today, **most non-users are open to evaluating its potential benefits.** These team members see numerous possible opportunities for BIM to pay off, but challenges lie on their path to adoption, primarily a lack of demand from clients and peers. **With use of BIM expected to expand significantly in the coming years, demand will rise and push more team members to put BIM to the test.**

Key Findings About Non-users

- Nearly half of non-users are open to exploring BIM's potential value.
- Almost a quarter are already convinced it will be valuable.
- Almost a quarter are currently evaluating it, but haven't tried it yet.
- Few non-users have no interest in using it (11%) or have tried it and decided not to use it (2%).
- Engineers who have not used BIM are the least likely to be actively evaluating it, but one-half are open to exploring its potential value.
- Architectural non-users have both the highest number not interested in BIM, and the most number actively evaluating it, a sign of this segment approaching a mature state of adoption.

Client Demand and Competition Drive Adoption

Savvy design and construction firms understand the need to **keep pace with their competition and fulfill the needs of clients.** Current BIM users recognize the impact these factors have on the value of BIM to their businesses, listing marketing BIM services and satisfying client demand among their top ways value can be improved.

Non-users are influenced by these same issues when considering adopting BIM. Many say they don't see enough client demand and believe their competition isn't using it very much or at all. This perception doesn't match industry trends. Non-users hold these views despite the fact that half of the industry is currently using BIM and that 70% of owners recognize that BIM brings positive return on investment.

Perceived Lack of Demand

Two-thirds of non-users say they haven't seen enough demand from **owners** or other project team members to prompt them to try BIM.

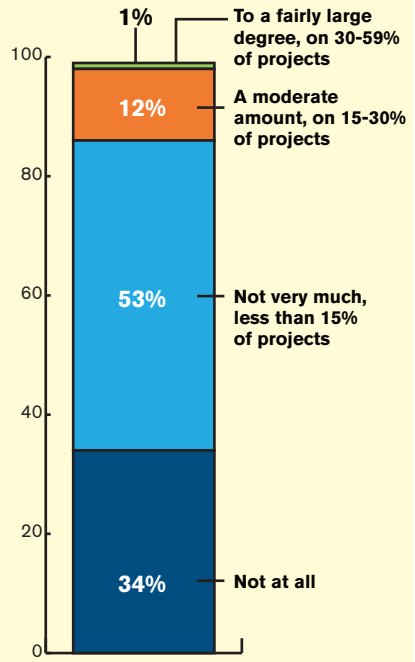
- Four in five non-users (86%) believe current or prospective clients are either not using BIM very much or not using it at all. Half of architects believe clients aren't using it at all.
- One-third (35%) of **owners** who do not use BIM believe the design and construction firms working for them are using BIM on a moderate number of other projects. Another third (36%) believe they are not using BIM very much.

Little Pressure From Competition

The vast majority of team members not using BIM do not see their competition adopting it either.

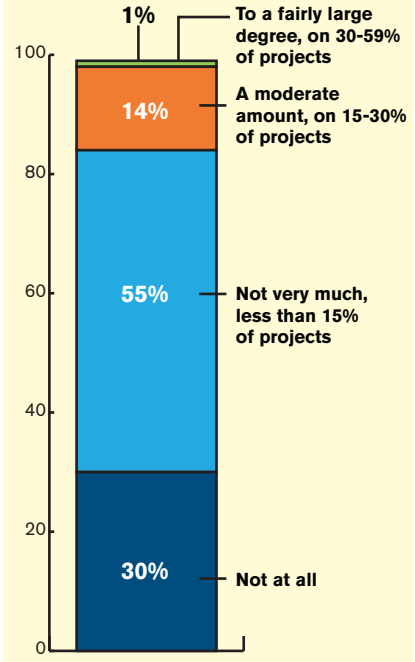
- More than four in five non-users (89%) believe their competition is either not using BIM very much or not using it at all. A third of engineers and contractors believe their competition isn't using it at all.
- Three-quarters (77%) of **owners** who do not use BIM believe that other owners similar to them are either not using BIM very much or not using it at all.

Perceived Frequency of Clients Using BIM



Source: McGraw-Hill Construction, 2009

Perceived Frequency of Competition Using BIM



Source: McGraw-Hill Construction, 2009

Challenges to Adoption

Beyond client demand, non-users see challenges that are of moderate to lesser concern when considering whether to adopt BIM. **As a new technology, dealing with costs and training issues have been the greatest hurdles on the path to adoption.**

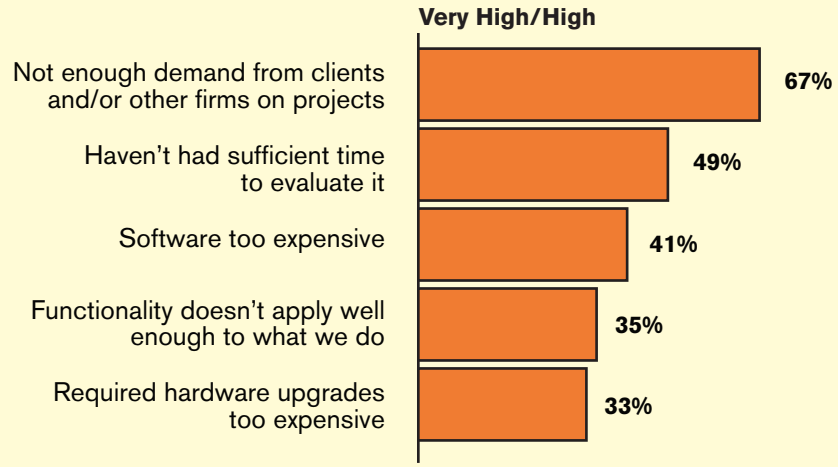
- **Haven't had sufficient time to evaluate BIM:** With construction running at record highs in recent years, many firms had been too focused on their existing projects to consider testing new methods. In light of the recent slowdown in new construction, firms may find this is not a significant issue moving forward.
- **Software/hardware upgrades too expensive.** Architects and engineers are most likely to believe this, which could reflect the fact that they generally bring in lower revenues than contractors.
- **Functionality doesn't apply well enough to what we do.** Engineers are most likely to believe this, which illustrates a belief that BIM is not addressing their practice-related needs.
- **Insufficient BIM-compatible content available for my needs.** Owners rank this among their top reasons for not implementing BIM, which could indicate that they see BIM as more relevant to the work of other team members.

Issues With Little Impact on Adoption

Some issues that have been identified by users as challenging are not seen as significant barriers to adoption by non-users. At least half of non-users say these factors have **little to no influence** on their decision not to adopt BIM:

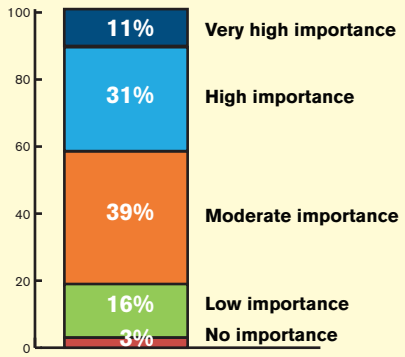
- **Concerns about insurance/liability: 64%**
- **Current methods we use are better: 62%**
- **Poor interoperability with CAD applications: 54%**
- **Software too difficult to use: 51%**
- **Insufficient training available: 50%**

Most Important Obstacles to BIM Adoption



Source: McGraw-Hill Construction, 2009

Importance of BIM in 5 Years



Source: McGraw-Hill Construction, 2009

Upbeat Future Outlook

About two in five non-users (42%) believe that BIM will be highly or very highly important to the industry in five years. Only a small group of them (13%) say they either have no interest in using it, or have tried it and decided not to use it again. The vast majority are open to exploring it.

Evaluating factors that would prompt non-users to adopt, client requirement ranks as the most important. Two-thirds say they don't see enough demand from clients yet. However, 55% of owners say that BIM will be highly or very highly important to the industry in five years – more than any of the other team members surveyed. If owners see BIM as important and can push it as a requirement, more adoption will follow. (See Client Demand for BIM on page 39).

Believing in the cost effectiveness of BIM ranked as the second most important factor that would encourage adoption. And when asked about reasons for delaying adoption, concerns about BIM's cost and it's effectiveness on smaller projects are the top two reasons given. Six in ten (59%) non-users believe that BIM seems less efficient for smaller projects, while 54% list cost required as a limiting factor. Firms that focus on smaller jobs need to understand BIM's value in that context in order to make the investment.

Influential Benefits

Just like those who have already championed BIM, **non-users want to see it improve efficiency, eliminate errors and reduce costs**.

Accuracy

Improved accuracy is a big potential draw for non-users. Seven in ten are enticed first and foremost by the potential for BIM to provide **more accurate construction documents**. Every team player ranks this among their top benefits. **Reduced number of field coordination problems** is also seen as a critical benefit by all non-users.

Productivity

Productivity issues are also driving factors. All non-users list **improved communication between all parties in the design and construction process** among their top benefits, especially owners. Naturally, architects welcome the prospect of **less time drafting; more time designing.** Owners and contractors highly rank **reduced number of and need for information requests**.

Schedule and Budget

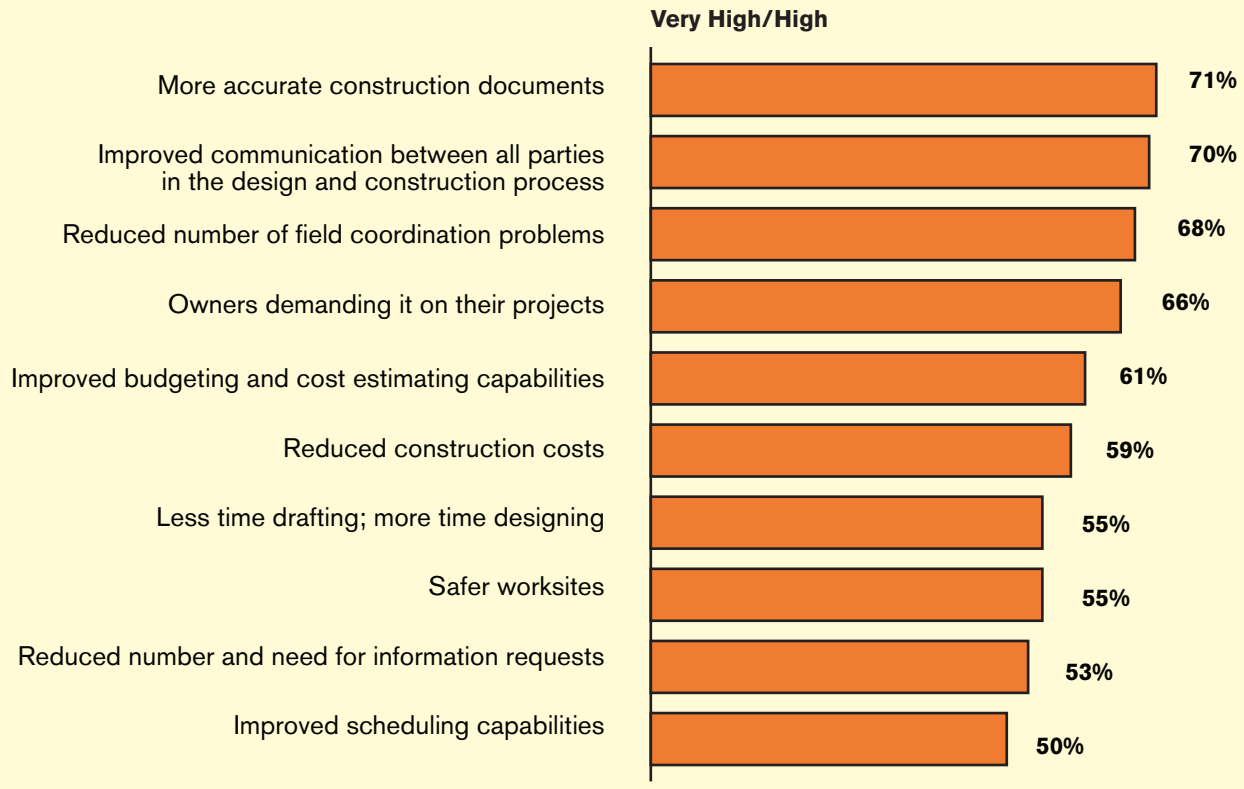
Saving time and money is a core goal of any building team, especially owners. Contractors and owners would like to see BIM lead to **reduced construction costs**. Both rank it among the benefits that would most influence their decision to adopt BIM. All users except engineers say **improved scheduling capabilities** as well as **improved budgeting and cost estimating capabilities** would be influential factors.

Less Influential Factors

Less than half of non-users said these potential benefits would highly or very highly influence in their decision to adopt BIM.

- **Reduced construction schedule**
- **Increased ability to use lean construction techniques**
- **Improved code checking, compliance**
- **Reducing litigation, insurance claims**
- **Improved ability to do sustainable design and construction**
- **Parametric modification of designs**
- **Improved operations, maintenance and facility management**
- **Improved ability to do digital fabrication**

Factors Influencing Decision to Adopt BIM in the Future



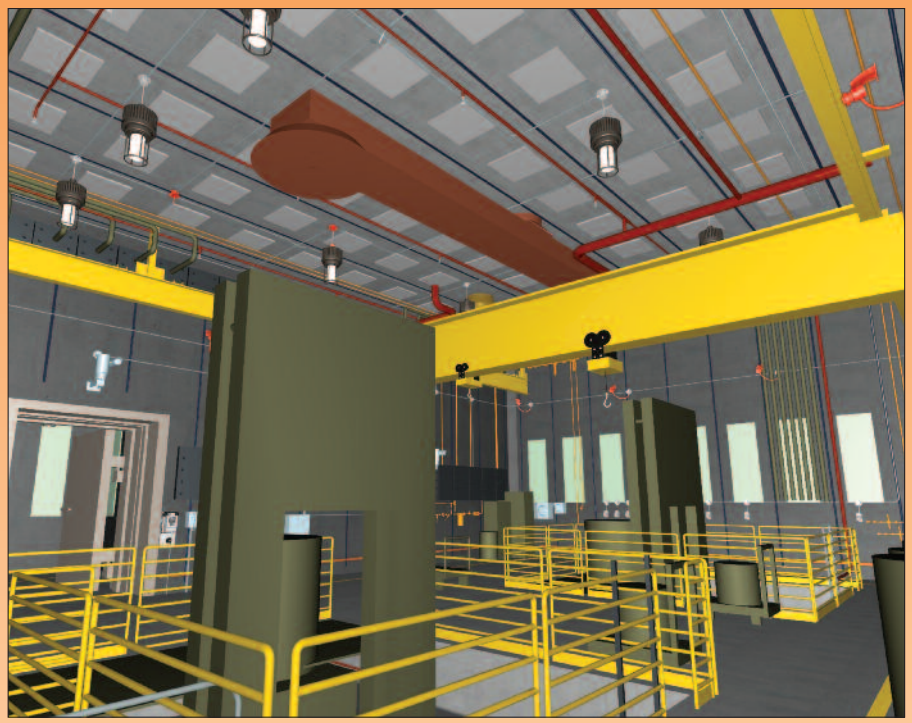
Source: McGraw-Hill Construction, 2009

Case Study:
Department of Energy

The U.S. Department of Energy's National Nuclear Security Administration processes nuclear and high-explosive materials at its Pantex complex in Amarillo, Texas. CH2M-Hill is providing full design services for a new $100 million, 45,000 square-foot high-explosives pressing facility there. Unique project features include multi-layered blast-resistant concrete architecture, extensive process piping, sophisticated operating equipment, and eight separate electrical and control systems.

When conventional CAD construction documents were 95 percent complete, the project went on hold for funding and scope review. Although DOE had little experience with BIM, Pantex project engineer Stephen Forman was inspired by lessons learned from other DOE projects where problems could have been prevented using BIM. Taking advantage of this hiatus, Forman modified CH2M-Hill's contract, giving them four months to convert the CAD design into BIM. David Fouché, senior technologist for CH2M-Hill, was eager for this opportunity. "This is a great case for 'It's never too late'" he says.

To optimize spatial coordination in this systems-intensive facility the team decided to model everything down to ¾-inch conduits. They also modeled every piece of equipment, including cranes and robotics that could be animated to demonstrate their operation. Forman wanted to be able to "see everything" so his team could understand critical interfaces between structure, systems and operating equipment.

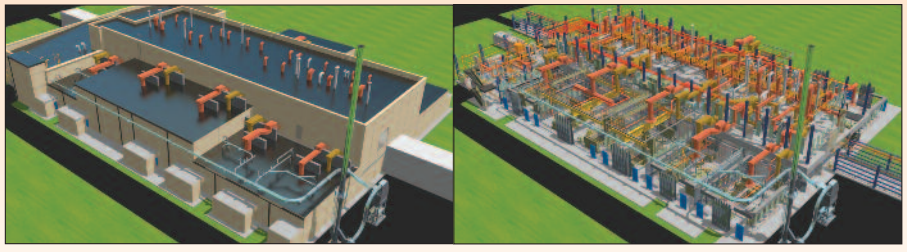


Images courtesy of B&W Pantex, CH2M Hill, DOE NNSA

Interior bay with animated equipment models that simulate operation

The modeling proved highly valuable. Clash detection software identified thousands of collisions but more importantly, virtually "walking through" every room with the operations staff uncovered over 500 serious problems. In one case, "the user wouldn't be able to function because the crane would get in the way," Forman recalls. As a result, the cranes were redesigned to work properly.

Independent cost estimators calculated a $10 million savings generated by the modeling effort. "You're building a V-8 engine inside a building, so it's worth it to get it right," Fouché says.



Complex systems are modeled down to ¾" conduit for precise coordination

Forman is particularly enthusiastic about BIM enabling better constructibility. "All the wiring is in conduit," he explains. "It's easy just to say 'field route that,' but how do you know it's even possible? With BIM we know. In fact we developed new pipe supports for the conduit to ensure it." And quantities extracted from the model are "almost exactly" what the independent estimators found doing traditional takeoffs.

DOE expects the project will take three to four years to construct. Forman is exploring ways to use the model to reduce construction time and is also planning to use it to train employees at the facility virtually before occupancy, taking months out of the traditional startup phase.

Fouché has high praise overall for DOE's use of BIM on this project, saying the agency "really knows why they want to use it, in the places it makes an impact. It's all about knowing your building better."

Industry Issue:

Opportunities and Obstacles for Engineers

In the expanding world of BIM, many engineers find themselves stuck in the middle. On one side, most architects are transitioning to BIM, and those who have made the move often expect their subconsultants at engineering firms to do the same. On the other side, contractors are rapidly adopting BIM, driven in large part by the tangible savings in cost and time that are possible during the construction phase. Above it all, more owners are pushing for BIM use in project teams.

Meanwhile, engineers see mixed results. Adoption is slow in some disciplines as firms struggle to fit BIM into their practices and gain value. Results from this SmartMarket Report show that 42% of engineers use BIM or BIM-related tools, compared to 58% of architects and 49% of contractors. Most engineers who use BIM perceive that they break even (22%) or lose money (32%) on BIM, while most architects and contractors see positive returns.

Solving the value proposition in the engineering world can be tricky, as a firm's discipline, size and ability to rethink its internal processes all factor into the equation.

While engineers as a whole lag behind other team members, many structural engineers are champions of BIM. The large elements designed by structural engineers—such as steel columns, beams, trusses and concrete—are easier to model than smaller elements needed by disciplines such as mechanical, engineering and plumbing, says Erleen Hatfield, principal at Thornton Thomasetti in New York.

"It fits well with what we already do, and using BIM has increased our productivity as a result," she says, noting that the firm uses it on all projects.

On the new $1 billion Meadowlands Stadium project being built in East Rutherford, New Jersey, Hatfield estimates that using BIM enabled Thornton Tomasetti to save at least three months in the schedule.

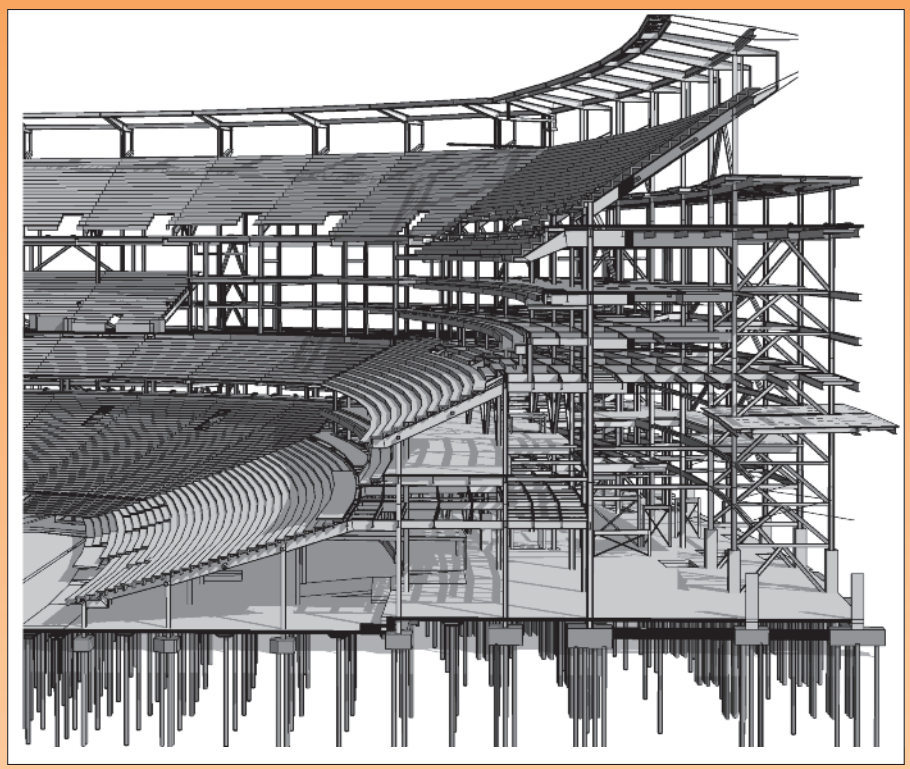


Image courtesy of Thornton Thomasetti

Structural model of Meadowlands Stadium, East Rutherford, N.J.

The firm shared its models with the steel fabricator, who pulled an advanced bill of materials from the data and saved nearly four weeks in the schedule.

The structure's most complicated connections were also detailed in models that were passed on for use by the contractor, Skanska USA Building of New York. The project, which broke ground in 2007, was five months ahead of schedule when steel erection was finished. The project is on track for completion in 2010.

Even smaller firms see BIM playing a major role on structural engineering jobs. EMC Structural Engineers in Nashville, Tenn., which has eight engineers on staff, has followed client demand and moved into using BIM. Ben Buergler, senior engineer at EMC, says most elements are easy for his firm to model in BIM, with some exceptions, such as wood trusses.

However, Buergler says, the firm has yet to explore the technology as a true engineering tool. Although it drafts in BIM, it is unable to do analysis. The firm is currently committed to a structural analysis program that isn't interoperable with its BIM software.

"As a small firm, we can only take on one transition at a time," he says. "We've made the move to BIM for drafting, but trying to switch both drafting and analysis is too great of a task right now."

As a result, Buergler says the firm doesn't see any productivity gains from BIM today, but he is hopeful that will change.

"Once we can link drafting and analysis, we'll see some real benefits," he says.

"We know it's coming. We know we have to invest. For now, the benefit is that architects are demanding it and we can provide that service."

Many MEP engineering firms see similar issues, but some concerns are magnified. McGraw-Hill Construction's 2008 SmartMarket Report on Building Information Modeling showed that large mechanical elements such as ductwork and air handlers were frequently modeled by MEP engineers who use BIM. However, few MEP users reported modeling electrical elements, which are much smaller by comparison.

WSP Flack & Kurtz began 3D modeling five years ago and within a few years started building a library of smart content, says John Bredehorst, executive vice president and managing director of the firm's New York office. Because there is little existing content on the market, Flack & Kurtz has developed most of its libraries in-house, creating content for multiple software platforms.

As projects increasingly move toward BIM and models get more complex, Bredehorst says the company is also investing heavily in hardware upgrades to handle storage capacity demands and computing power needs.

Years into the process, he says, the company is "close to breaking even" on its investment in BIM. Like many early adopters, Bredehorst takes the long view of BIM.

"We know this will be important in the future and we want to be out front and shaping it, rather than come in at the tail end and be a follower," he adds. "We jumped in with both feet and knew some would be written off as training and development, but that's the cost of doing business."

Many early adopters are banking on benefits that could result from that same pioneering spirit. As some of their peers have yet to invest in BIM, those firms with existing BIM expertise see significant marketing opportunities. MEP firms are most likely to see marketing new business to new clients as the top business benefit of BIM, according to results from this SmartMarket Report.

Matt Jensen, project manager at Dunham Engineering in Minneapolis, says his 85-person firm made the move into BIM two years ago to give it a competitive advantage, as more architects demanded it and few competitors were able to comply. The move has paid off for business development, as two of the company's largest clients have committed to working 100% in BIM by the end of 2009.

While the firm may not see benefits in the form of improved productivity yet, Jensen says the marketing gains are clear.

"We wanted to be out front," he adds. "Not a lot of firms have made this jump. In an environment like we're in today, a lot of people don't want to make the investment, so we see ourselves as ahead of the game."

Mark Brumfield, senior principal at Heapy Engineering in Dayton, Ohio, agrees that process change is critical in BIM adoption for engineers.

"I've heard engineers say, 'Aren't we doing the contractor's job for them?'" he says. "My question back is, 'Does your design work?' If you're depending on a contractor in the field to determine if it works, you're not doing your job well enough."

Heapy Engineering adopted 3D modeling six years ago and over time it has modified its practices to leverage the benefits of the software.

"You have to be smart and understand what the software does," he says. "You shift time and effort to where it's needed. If you fight the software, it will win every time and it will be painful."

That shift also means rethinking the idea of value, Brumfield says. Although he can't say if the firm has improved its profitability by using BIM, using it has led to a 75% decrease in changes—a fact that doesn't go unnoticed by clients.

"Project productivity is a benefit," he says. "There's value in that."

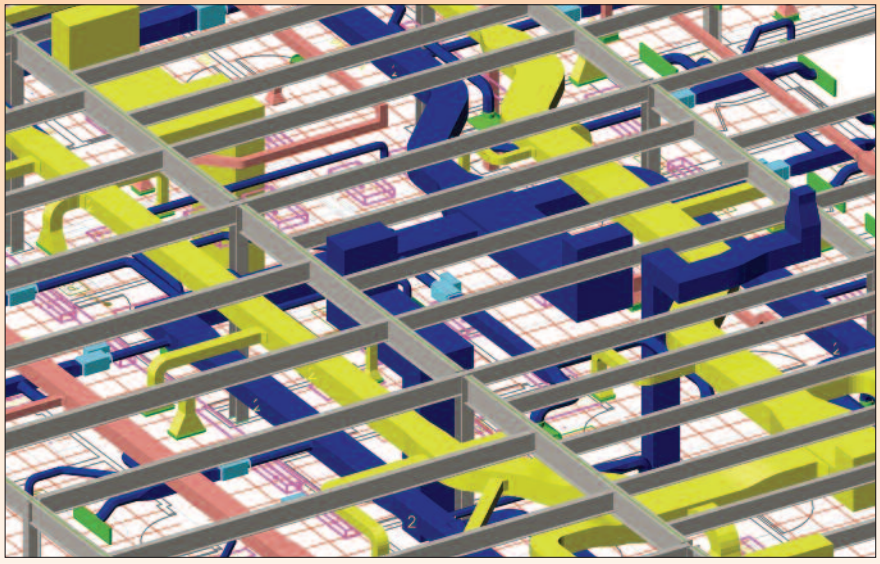


Image courtesy of Heapy Engineering

Heapy Engineering, which created this model for its Adams County Hospital project, has modified its internal processes to better leverage the benefits of BIM.

Case Study:
BIM on Heavy Civil Projects

Among many in the design and construction industry, building information modeling is trapped in a vertical world. Its initial development as a design tool aimed primarily at architects helped lay a path that has led to widespread use of the technology in the building sectors. But an emerging group of users in the heavy civil disciplines see valuable applications for BIM on horizontal projects, paving the way toward a range of new opportunities.

"People shouldn't look at the word 'building' in BIM as an actual building, but as the verb 'to build,'" says Jay Mezher, design visualization manager for Parsons Brinckerhoff in Seattle. "It's not limited to vertical structures. You can model and analyze as many issues in horizontal projects as you can in buildings."

The civil world is starting to get the message. Research for this SmartMarket Report shows that civil engineers lag behind others in their adoption of BIM. More than four in five civil engineers are not using BIM today. However, its use in the civil engineering community is gaining traction. Among BIM users, one in ten civil engineers utilize it on more than 60% of their projects, but that level of involvement is expected to quadruple in two years.

In the transportation sectors, owners are beginning to take notice. Cosima Crawford, chief engineer for the New York City Transit Authority, predicted in an August 2, 2009, article in *Engineering News-Record* that, "in 10 years, we will be living in a BIM world. It's our new reality."

In New York, that reality is becoming clear. The New York City Metropolitan Transportation Authority used virtual design and construction on the $1 billion Fulton Street Transit Center and the $4.5 billion Phase One Second Avenue Subway project, particularly for visualizations and time sequencing.

Image courtesy of Parsons Brinckerhoff

Deep-bore tunnel model of the Alaskan Way Viaduct, Seattle, Washington.

Simulated in Seattle

PB began using VDC at the Alaskan Way Viaduct and Seawall Replacement project in Seattle in 2004 and has seen its application evolve over time. The project aims to replace the existing Alaskan Way Viaduct, a critical elevated highway that was damaged by an earthquake in 2001.

Initially, PB's efforts were focused on project visualization for public outreach. The team modeled two options—an elevated structure and a tunnel—creating a five-minute video that would allow the public to visualize driving through the proposed alignments. In addition to modeling the structures themselves, the surrounding existing buildings were created in 3D. To improve the sense of virtual reality, cars, trees and people were added to the animations.

In addition to traffic simulations, the models also played a critical role in supporting environmental impact studies, showing pedestrian views of the project. The team blended actual photos with the 3D model to create a more realistic sense of place.

"We were beginning to build the entire city in 3D," Mezher says. "Since it's an urban-scale project, we had GIS data that we could use; we had the footprints of the buildings; and we had the building heights. It was all a very accurate representation."

As the database of project-related information began to grow, other tasks emerged. To help show the potential impact on the local community, PB created visual simulations of construction phasing. Data from multiple traffic studies was added to the model so viewers could accurately visualize the impact that construction might have on traffic. An interactive web tool was created to help show traffic during each construction phase and at different times of the day.

Although the two original alignments were rejected, the database was available for use on ten new options that were created. Among the alternatives was a deep-bore tunnel that required modelers to add in all of the basements of surrounding buildings as well as existing railroad, sewer and utility tunnels. At this point, the team's modeling tasks began to transition from a tool to help with public presentations to one that could guide design decisions.

"We already had this database and these models to pick and choose from," Mezher adds. "We could not only to show what

the options were, but during the design process they started asking us to model every single option and compare them from different camera angles. Ultimately, we helped the design team make more informed decisions about where the best potential alignments would be."

In April 2009, the deep-bore tunnel option was approved, and PB has continued to leverage its models for design purposes. Accurate daylighting studies have been drawn from the models, combining the geo-referenced coordinates with exact daylighting at different times of the day or year.

At the south end of the tunnel, the model was linked with a 100-activity schedule to generate a 4D model that simulates construction sequencing.

"We've been able to move into a very integrated approach," Mezher says. "We call it a CAVE—computer analysis visual environment. We bring in key stakeholders to one joint meeting, open up the 3D model and work through any issues. We've been able to answer 85 percent of all questions on the spot."

As the ten-year construction project moves ahead, Mezher expects the model to continue to bring value.

"The idea is to pass this on for construction purposes and even operations and maintenance," he adds. "Once you have these built, if you keep them updated the uses could carry on well past design."

Overcoming Conflicts

Some in the heavy civil construction world are already seeing the potential for BIM to bring value. The Walsh Group of Chicago is banking on BIM for its wastewater treatment plant projects, especially for conflict resolution.

"Just like in vertical buildings, we see it as a way to reduce errors," says Dan Klancnik, VDC manager at the Walsh Group in Chicago. "Conflicts tend to be much more expensive in treatment plants and heavy construction than in commercial work, so the benefits are easily realized."

Given that commitment, the company is using BIM even when others on a project are not. Archer Western of Atlanta, a subsidiary of Walsh, used BIM on the $76 million Central Arizona Project water treatment plant expansion, building models from 2D drawings created by the project engineers.

Klancnik says the company spent $40,000 to create the models, but identified more than $150,000 in system clashes. Requests for information were also reduced by an estimated 75%, with zero change orders. Klancnik says that the 12 people who worked on the model during preconstruction saved the work of dozens in the field later, helping shave the 28-month schedule by five weeks.

Field Experience

Sundt Construction of Phoenix has also taken a horizontal view of BIM. Dan Russell, simulated construction manager at Sundt, says the company has seen success in wastewater treatment plants and now is exploring it on highway and transit projects.

Russell says Sundt is approaching underground utility modeling the same way it would approach building systems, using it to identify potentially costly clashes.

"The idea came from a light rail job we worked on," he explains. "The as-built information said certain utilities were in certain locations, but we hit a gas line. We went back to the design team and told them the as-builts weren't right and we stopped working. They came back with new information and the first time we stuck a bucket in the dirt, we hit a line again. That's when we realized we needed to be modeling this just like in the building world. If we can use it to avoid issues in buildings, we can use it to help avoid hitting things like gas lines and fiber-optic cables that cost a lot of time and money."

Russell says the next goal is getting the models tied into the company's survey equipment and GPS-guided heavy equipment to help with tasks such as layout.

"At first the uses of BIM in civil aren't obvious, but once you see them, you can get just as much benefit in the heavy civil world as in the building world," he says.

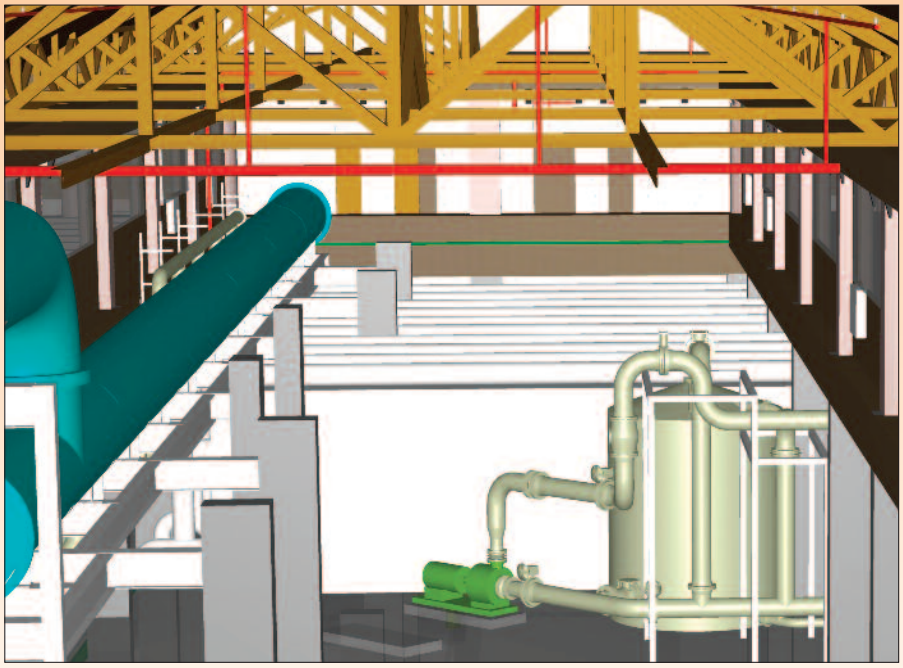


Image courtesy of The Walsh Group

The Walsh Group identified $150,000 in system clashes at Central Arizona Project water treatment plant expansion project near Phoenix, Arizona.

Conclusions

Getting BIM to the Bottom Line

The business case for BIM is rapidly taking shape around the themes of productivity and profitability.

When asked to identify the most important way BIM is saving time and/or money for their company, 77% of BIM experts cited "increased productivity/efficiency" and other productivity-related benefits. And all of the productivity-enhancing benefits noted as highly valuable by BIM users show a significant increase in impact as experience and skill level advance, promising a steady path to increasing productivity gains for BIM implementers.

Although the direct impact of BIM on profitability currently scores somewhat lower than other productivity benefits, the cumulative effect of all these benefits will most certainly help BIM find its way to the bottom line.

Impact of skill level on internal benefits (rated High or Very High value)	**Beginner**	**Expert**
Increasing profits	7%	43%
Reducing cycle time of specific workflows	14%	58%
Reducing rework	23%	77%
Maintaining repeat business with past clients	19%	61%
Offering new services	28%	72%
Marketing new business to new clients	28%	71%
Improving productivity of personnel	46%	71%

Responsibility + Control = Lower Risk

Shifting detailed design and modeling to trade contractors is an increasing trend on BIM projects. This may be one of the reasons the data shows MEP engineers trailing all other design professionals, while MEP contractors boast a significantly higher percentage of expert and advanced users than construction management, general contracting and other contractor types.

The business benefit of this trend derives from aligning responsibility with control, encouraging trade contractors to become more engaged in problem solving and optimization. As a result, these contractors would be more willing to accept responsibility for the outcome because they have greater ownership of it and control over it.

Going forward, the practical question of "who ought to do what" on projects will increasingly challenge traditional roles, scope definitions, and contracting and compensation arrangements, as well as liability issues. BIM is a game changer.

BIM Experience Highly Valued

BIM users would rather work with strangers who know BIM than with friends who don't. A majority of users (between 55% and 74%, depending on the discipline) gave high value to other team members on a project having BIM experience. This displaces the traditional favorite of "previous experience working together," which only scored 42%. Additionally, when asked to rate factors that would most enable improved ROI, 66% of BIM users gave a high score to "more external firms with BIM skills." This shows that adoption needs to accelerate to meet demand.

"In 10 years, we will be living in a BIM world. It's our new reality."

Cosima Crawford
Chief Engineer
New York City Transit Authority

Winning Business and Growing the Company

AEC BIM users cite its positive impact on marketing and providing new services. Reflecting their recent surge of adoption, nearly 25% of contractors picked this over all other internal BIM benefits not related to time or money. And looking to the future, the top BIM investment 5 years out will be "Marketing your firm's BIM capability."

But as BIM becomes mainstream how will users convey the unique value of their particular approach to BIM-savvy clients? Industry leaders will need to keep innovating to stay ahead of fast followers.

Future Business Value

Business benefits related to visualization and spatial coordination (clash detection) dominate the current perception of BIM value. But significant new benefits are emerging, such as model-driven prefabrication, which 77% of contractors predict will be the dominant value five years from now. And 80% of all expert users share that view. Growing those skill sets now will certainly pay off.

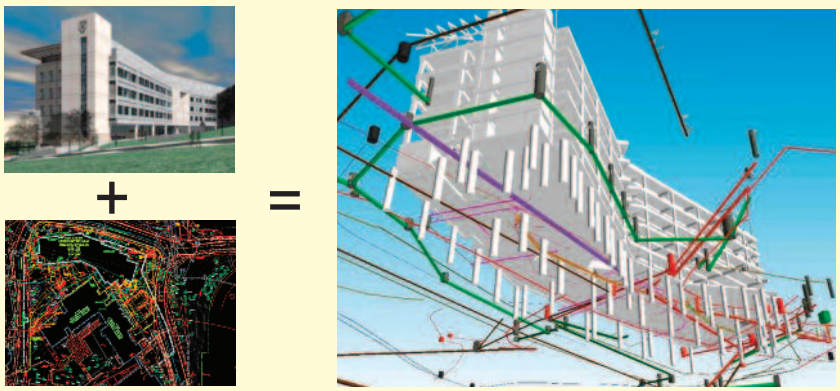
"I don't know how you'd design and build a medical facility today without BIM."

Douglas Fitzpatrick, P.E.
Fitzpatrick Engineering Group

A Model is Worth a Thousand Drawings

The business value of visualization is a strong theme running throughout the research results. When asked about the single most important way (other than saving time or money) BIM is improving their company, 40% identified benefits directly related to visualization. And 93% of expert BIM users designated "Better multi-party communication and understanding from 3D visualization" as providing high or very high value.

But visualization is not about making a pretty picture. Its real power derives from linking project information—the "I" in BIM—with graphics, giving everyone the ability to "see the data". As rendering, simulation and animation technologies continue to advance, visualization will increase the value of modeled information for everyone.



HOK and Holder Construction modeled a maze of below-grade utilities so foundation contractors could "see" where to delicately weave new foundation members among them.

Images courtesy of HOK (top left), Emory University (bottom left) and Holder Construction (top right)

Convergence of BIM, Lean and Green

Another emerging trend to watch is the convergence of three previously separate but related streams of innovation: BIM, lean and green.

In research for this SmartMarket Report, only 3% scored "positive impact on sustainability" as a top-rated business benefit of BIM, with 12 other benefits ranking higher. For some, the functionality of the software needs to catch up to the sophistication of the users.

"BIM is effective for the people who are new to LEED, but less effective for the people who are already masters of it," says Scott Kelly of Seattle-based KPG, Inc, who recently completed a U.S. Green Building Council LEED Platinum-certified project.

But an increasing number of practitioners are seeing the opportunities to jointly leverage these three initiatives. "BIM is the tool; lean is the process," says James Barrett, regional manager of Construction Technologies at Turner Construction in New York. Barrett says the combination will prove to be the "killer app" for virtual design and construction, helping create high-performance buildings in the most efficient way.

Flowing as-built models into operations and maintenance offers another opportunity to connect sustainable design objectives to real-world performance. Seema Pandya, senior consultant with New York-based YRG Sustainability, says that, "while BIM aids in the design process and recording the predicted energy usage of a building, BIM should help integrate ongoing measurement and verification of actual building energy use and compare it to the predicted model to inform owners how their building is performing against the designed energy standard."

"BIM is the tool. Lean is the process."

Jim Barrett
National BIM Manager
Turner Construction

BIM Adoption: West Leads East 56 to 38

Author William Gibson's line, "The future is already here, it's just not evenly distributed," applies perfectly to the current state of BIM adoption.

With a 56% adoption rate, the West Coast of the United States outpaces the Northeast (38%) by a factor of almost 1.5, while other regions fall between these extremes.

This is significant to owners looking to roll out national BIM programs and for BIM-oriented contractors looking for model-capable subs and suppliers to help them expand geographically.

Industry organizations should increase efforts to inform their members in all parts of North America about BIM.

Additionally, institutions of higher learning should produce graduates who are ready to work in this new environment. In fact, 54% of BIM users highly rated "more incoming entry-level staff with BIM skills" as a way to help them increase the ability to experience business benefits of BIM.

"BIM is the greatest thing for a young architect that ever existed. There's more opportunity here for the single practitioner and the small firm than ever before."

Paul Seletsky
Director of Digital Design
SOM

Resources and Methodology

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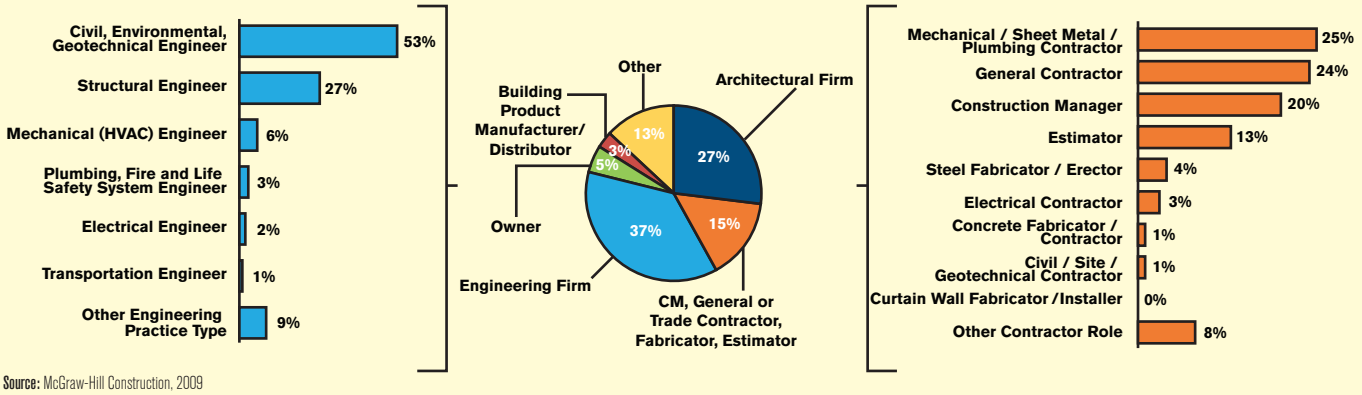
BIM Survey Methodology

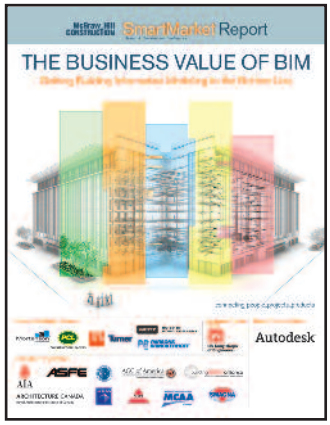
McGraw-Hill Construction conducted the 2009 Building Information Modeling Study to assess adoption of BIM across the construction industry and to gauge the perception of value that firms are receiving by implementing BIM. The research in this report was conducted through an Internet survey of industry professionals between May 28 and July 2, 2009. The survey had 2,228 complete responses. The "total" category displayed throughout the report includes 598 architects (27%), 326 engineers (15%), 817 contractors (37%), 118 owners (5%), 73 building product manufacturers (3%) and 296 other industry respondents. In addition, MHC further segmented the engineers and contractors categories.

The use of a sample to represent a true population is based on the firm foundation of statistics. The sampling size and technique used in this study conform to accepted industry research standards expected to produce results with a high degree of confidence and low margin of error. The total sample size (2,228) used in this survey benchmarks at a 95% confidence interval with a margin of error of less than 5%. For each of the architect and contractor respondent groups, the confidence interval is also 95% with a margin of error of 5%. The engineers respondent group had a confidence interval of 95% with a margin of error of 5.4%; while the owners group had a confidence interval of 95% with a margin of error of 9%. For the top three engineers subcategories (structural, civil and MEP) and top four contractor subcategories (mechanical/sheet metal/plumbing subcontractors, general contractors, construction managers and estimators) the confidence interval ranges from 90% to 95% with a margin of error ranging from 7% to 14%.

BIM Survey Methodology Respondent Profile



Source: McGraw-Hill Construction, 2009



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