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DAVE MCCOOL
BIM
AND
Construction
Management
PROVEN TOOLS,
METHODS,
AND WORKFLOWS
SECOND EDITION
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BIM and Construction Management

BIM and Construction Management

Proven Tools, Methods, and Workflows

Second Edition

Brad Hardin

Dave McCool

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For my parents, who let me draw on the walls. For my great kids who are loved by their geek dad and for my beautiful wife who is beyond supportive.

– B.H.

For Paul Vance, my high school technical drawing teacher at Vestavia Hills, who found and fostered a passion that has shaped my career.

– D.M.

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– Brad Hardin

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– Dave McCool

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Brad Hardin is the Chief Technology Officer for Black & Veatch, a global engineering and construction firm. He is a LEED-accredited architect, an ENR 20 under 40 recipient and is an advisory board member of the New School of Architecture. He has written numerous articles, given numerous presentations, and enjoys participating in industry events to further the cause of BIM, technology, and AEC startups in the design and construction market. He is a co-founder of Virtual Builders (`www.virtualbuilders.com`) the world's first nonprofit software- and association-agnostic certification and open source BIM intelligence development community for the design construction and operations industry. He lives in Kansas City with his wife, Iris; his two children, Wes and Lulu; and a dog named Shiloh.

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Contents

Introduction

This book shares a rounded perspective of how BIM and enabling technologies are changing the way we collaborate and distribute information. As an industry, we are constantly facing new challenges in the field of construction. This book will show how many of these challenges are being addressed with cutting-edge tools, leveraged with experience, and a practical application of the "right tools for the right job." There is a shift happening in the construction management market in the context of technology, and this book serves as a catalyst for more fundamental changes that create positive outcomes.

The first version of *BIM and Construction Management: Proven Tools, Methods, and Workflows* (Sybex, 2009) by Brad Hardin was written just as the construction industry had largely begun to pay attention to this exciting new tool and process: building information modeling. Since then, the pace and transformational changes that have cascaded through the industry have been remarkable. Now clash detection, 4D sequencing, model estimates, and walk-throughs have become table stakes. Customers are now asking about Big Data, model to prefabrication, life-cycle energy modeling, project partnering approaches, and how BIM can mitigate other risk factors during construction. And still the pace of technology continues to move at an incredible rate.

The focus has now broadened from beyond BIM and the question is being asked, "If BIM can change the construction management business so significantly, what else can BIM do and what possibilities do other technologies hold?"

This broader questioning of the tools, teamed with economic challenges, has given rise to a technological renaissance in the construction community. Because of the recession, many firms were forced to refocus and question the best way to deliver construction product to customers under new margin and overhead constraints. The early successes of BIM gave many organizations a starting point to focus on. Some firms didn't stop at BIM and began taking a deeper look at not only the technology, but the underlying processes that were built around these tools. In this broader examination, there has been a significant push for innovation in construction technology and processes as well as enabling behaviors.

So What's Changed?

To begin, innovations in technology such as wearable tech, cloud-based collaboration, and the continued removal of hardware constraints have opened many doors for

continued impact. Additionally, process innovations such as lean planning and an overall challenging of many of the traditional constructs of the construction industry, such as CPM scheduling, documentation strategies, contract arrangements, and the roles of design and construction teams at large have brought about a refreshing analytical perspective to the way we deliver work. The result has been an exciting view "into the looking glass" of what the future of our industry holds. We may very well be at the point of another paradigm shift in which the analysis of industry norms combined with more informed construction consumers could bring about the next revolution in the construction industry. These customers continue to be less willing to pay for our inefficiencies as an industry. Because of these factors, this movement will focus on *results-based deliverables*, with technology acting as a baseline expectation instead of an innovation to deliver on the "best value" promise.

Arguably, all industries are becoming increasingly reliant on technology to uncover previously unexplored value potential. The construction industry is no different. Almost daily, it seems that companies and individuals are coming up with an array of potential opportunities for improvement that will surely shape the way we do work for years to come. On average, there are 20,000 applications a month being uploaded to Apple's iOS store. Technologies like Google Glass, tablets, photogrammetry, mobile applications and a host of other potential hardware and software improvements are beginning to migrate into the way we do business; see the article at `http://readwrite.com/2013/01/07/apple-app-store-growing-by#awesm=~oDoS5C7qwveOnJ`. What impact will these tools have? How much safer will they make our jobsites? How do we quickly analyze the value of these tools at a pace that keeps up with the market? Questions like these led us to believe that the construction industry needed a more rounded take on not just BIM and how it relates to construction management, but an overall perspective of what these tools are and the enabling ecosystem that shows a more holistic approach to the way we can improve the design and construction industry.

> *You can't connect the dots looking forward; you can only connect them looking backwards. So you have to trust that the dots will somehow connect in your future….*
>
> – Steve Jobs

Because of this broadened focus, this new edition will look at the results desired and show the process of selecting tools to get there. This book will also look at some of the cutting-edge applications that either work in tandem with BIM or operate outside of it, and provide significant value to users during the construction process. Some of these tools may relate to each other, whereas some may not. However, it is important to highlight where information links to other tools and where the gaps are because they show the opportunities for improvement within our workflows as an industry.

An additional benefit of broadening the scope and context of this work is to better understand best practices on how construction management companies quickly analyze

tools as they become available and how to implement the tools that create significant value and identify disruptive ones.

Trust is everything. And this book delves deeper into the enabling behaviors and mind-sets that make the use of BIM and technology successful. Significant research has been done on this topic and the better outcomes as a result of teams having the right behaviors as well as better understanding people's personalities and working dynamics. According to *Profitable Partnering for Lean Construction* (Wiley-Blackwell, 2004) by Clive Thomas Cain, "Strategic partnering can deliver significant savings, of up to 30% in the cost of construction." One of the major benefits in BIM is the unlocked potential that comes from having trusted information available early that make for better informed decisions. Similarly, understanding your project partner's abilities and the ways they work can make for a more meaningful dialogue and ultimately better workflows.

Lastly, this book will introduce the concept of information flow in construction management. While relatively new to the construction management space, flow is something that is critical in the performance of construction projects. If you have a project with good flow, teams distribute and receive information on time, in the desired format, and with clear expectations of the desired outcomes. Without good flow, projects jerk and start like a car without a consistent fuel supply, constantly grabbing at the next bit of information that will allow them to proceed with their tasks, all at the expense of the overall project as someone is consistently waiting on someone else. The goal of the Japanese term *Genjitsu* is the passing of reliable and accurate data to your fellow team members. The goal of BIM is to ultimately drive waste from the way we deliver construction projects to construction consumers. This book will show the value in information flow planning and how it is accomplished by focusing on passing the right information to project stakeholders rather than volumes of disconnected data.

Who Should Read This Book?

This book was written for those who wish to learn more about better ways to holistically leverage BIM and technology in the construction process. Those who will find this book useful may be:

- Designers wanting to better understand construction managers' tools and processes
- Construction managers looking to better understand the ways BIM and technology can be used to create better outcomes
- Subcontractors and project stakeholders looking to find ways to become a more valued player
- Owners and construction consumers who want to be more informed and who wish to create a more successful project and project team
- Students who want to grow their knowledge of BIM and technology in construction and learn how they should challenge the constructs of the industry where there are better ways of working

In particular, this book is for those who are interested in creating a better paradigm of delivering the built environment. It is not intended to be the sole definition of how to use BIM on a construction project, nor is it intended to be the definitive "how-to" guide. Rather this book is meant to delineate a way of looking for and delivering value in using BIM and technology. Readers will be shown how to challenge traditional deliverables and thinking, and how best to combine available project information and technology and pull these toward a desired end state.

How to Use This Book

This book is structured, in a linear fashion, similar to how a construction project would progress throughout the various stages until completion. The contents will walk users through tools that may be applied at various points along a project timeline and what the anticipated outcomes and results should be. The tools and processes highlighted are meant to be contextual and the concepts shown are for reference. To be sure, just as this book is printed, new tools are being introduced into the market that may very well improve on some of those mentioned. By reading the chapters in sequence, you should gain an understanding of how the tools can work through a construction project, what information is required, what the outputs are, and where that information may or may not connect to other systems.

This book will show how to establish agreed-upon metrics in the beginning of a project to gauge project success from which the team as a whole will be measured. We will show screenshots of various workflows and how some processes work to illustrate interfaces, information required, and level of effort. Lastly, case studies will be used on relevant topics to show real-world examples of the tools and processes in action to further explore the use case and context of the topics within the book.

The chapters in this book are as follows:

Chapter 1: Why Is Technology So Important to Construction Management Chapter 1 has two purposes; the first is to act as a preview of the more detailed contents within the later chapters, as well as exploring where BIM and technology is being applied in construction management. This chapter will show ways BIM is used in construction as we collaborate together to virtually build structures and what impacts the various tools have in the BIM process. This chapter will cover at a high level the places where BIM and technology can provide additional value. These areas of focus include a linear approach to the project cycle. We will walk through topics such as team engagement, pursuit and marketing, preconstruction, construction, and closeout with many other detailed subpoints such as contracts, scheduling, logistics, and estimating to give further perspective.

Finally, this chapter will discuss industry trends relating to where technology and BIM is headed and show you how to get ahead of the technology curve. The chapter concludes with how to achieve leadership buy-in, strategies to attract and engage the right talent to drive the use of the tools, and the results the industry has seen.

Chapter 2: Project Planning Chapter 2 includes a detailed overview and results-driven approach to how to set up your project to succeed. As it relates to BIM and technology, project planning is of critical importance to a construction project and is often a driver for a successful project. This chapter will walk you through standard contract delivery vehicles and the pros and cons of using technology in each. This chapter will also focus on defining the various uses of BIM and the resources required to execute them successfully. Lastly, it will focus on information flow, where project participants have a clear understanding of their role and responsibility in a project and aligned expectations throughout the entire project team. The chapter will identify current BIM contract language from industry organizations and explain how to create meaningful language derived from the BIM execution plans and checklists available in the market.

Chapter 3: How to Market BIM and Win the Project How do you market your BIM and technology capabilities to customers and the industry? This chapter will walk readers through the process of how to show your capabilities, share results, and deliver focused solutions that are customized for each customer without having to constantly invest in new tools and technology. This chapter will explore with readers the dangers in overpromising on new technologies that haven't been proven and what impacts that can have downstream. Most important, it shows how to establish a trust-based technology delivery platform that will not only satisfy customers' needs but also drive future business opportunities as a mutual partnership.

Chapter 4: BIM and Preconstruction Since the introduction of BIM into the construction management marketplace, preconstruction has been a key focus area for the use of the tools. Partly due to the nature of BIM and the ability to create and use information early as well as a means for better collaboration and exchange between project teams, BIM has grown in use and possibilities in the area of preconstruction. Chapter 4 explores how BIM and technology is being integrated throughout preconstruction activities such as scheduling, logistics, estimating, constructability analysis, visualization, and prefabrication planning.

Chapter 5: BIM and Construction Chapter 5 is dedicated to BIM during construction. This chapter focuses on the nuts and bolts of using BIM and technology during the construction process. The topics covered include strategies for translating BIM to the field, integrating accountability, and how mobile technology is changing the game during the construction phase of a project. This chapter covers processes for quality control, installation validation, change management, equipment tracking, and inventory management. Lastly, this chapter covers how to create a real-time digital jobsite that is constantly connected with information being shared almost instantly.

Chapter 6: BIM and Construction Administration BIM and construction administration is where information created and analyzed during preconstruction is put into use in the field. The combination of virtual environments with mobile-enabled site information has shortened the

gap between information availability and response times. This chapter explores how to go from a BIM department to a BIM company. Additionally, this chapter looks at the various processes required of project teams in the field, document control, information clarification, sequencing, and project team training, and looks at the ways BIM and technology can reduce information processing times during the construction administration phase of a job. Lastly, it shows how to integrate best practices and capture knowledge sharing from one project to the next to improve the way an organization delivers a technology-enabled construction product.

Chapter 7: BIM and Close Out Project closeout is often the last touch point with a construction consumer and is becoming increasingly important to deliver effectively. Many customers are becoming more informed on the value of as-built BIM and information for the life cycle of their project and are requesting new deliverables. While there may be projects that require a hardcopy set of as-built information and digital PDF sets, other customers have begun shifting to digital deliverables only. This chapter explores the artifact and constant deliverable strategy that better prepares a maintenance and operations team to update facility information.

This chapter also explores how to successfully deliver on promises made during the project planning stage and includes information on how to use technology to better perform project closeout, punch list issue resolution, and as-built capturing. Lastly, this chapter includes an overview of mobile applications and tools that make the job of closing out work easier and shows how to complete information migration requests into facility management or CMMS tools.

Chapter 8: The Future of BIM Chapter 8 shares insights into what is in store for construction management. By looking at industry trends and new connected tools, enabled by new teams and collaborative processes, this chapter proposes an exciting and bright new future for the construction management industry. This chapter also shares information from other industries that have established knowledge management platforms with a focus on improvement and better quality, and it shows where many of these discoveries can be directly applied in the construction management space.

Addressing Change

So much has changed since the first version of the book that it only made sense to reinvent the focus of this version by taking into account the entire ecosystem of information management during construction. With information as the constant thread and enabling technologies such as BIM and mobile applications serving as the vehicle to provide a better way of collaborating around and distributing information, our goal for this book is to show the new "rounded out picture" of what BIM during construction management is being defined as.

While we know this book will cover specific technologies and tools, it is not intended to be exhaustive. By showing the bright spots as well as the challenges to using

technology in construction management, we wish to add fuel to the fire of innovation that is happening within the construction industry. Just as BIM significantly impacted the industry, who is to say that there aren't innovative colleagues working together in a garage right now on the next application that will disrupt the existing toolsets and fundamentally change construction again? This is an exciting proposition, particularly for an industry that has not kept up with other major industry innovations over the last 40 years.

Lastly, we want to emphasize that change which creates successful outcomes requires better tools, different processes, and enabling behaviors. Construction management has indeed changed over the last five years, and it is our hope that it continues to change for the better over the years to come with a renewed focus on results and better information flow.

BIM and Construction Management

1 Why Is Technology So Important to Construction Management?

The construction industry is in the midst of a technology renaissance. BIM served as the initial catalyst for this period of innovation, but has now grown beyond "just BIM" to include innovations in many other areas such as mobility, laser scanning, and Big Data analytics among others. Supporting processes are changing as well. The construction industry is realizing that these new technologies don't fit into previous processes.

In this chapter:

The promise of BIM
The value of BIM in construction
Where the industry is headed

The Promise of BIM

Before the advent of BIM, the construction industry generally worked in silos, where each member of a project team looked out solely for his or her own best interests and the project took a backseat (or was in the trunk) to other priorities. Further compounding the isolation issue was the prevalence of the hard bid delivery method, which contractually and financially isolated team members from one another. Both the culture and this standoffish delivery method made for a litigious environment that was plagued with waste and cost overruns. According to the book *The Commercial Real Estate Revolution: Nine Transforming Keys to Lowering Costs, Cutting Waste, and Driving Change in a Broken Industry* (Wiley, 2009), by Rex Miller, Dean Strombom, Mark Iammarino, and Bill Black, the waste created by "simple efficiency and not-so-simple bad behavior" in the United States alone in 2007 was an estimated $500 billion. If we are to continue to function as a profession, we must ask ourselves, "Why should we ask construction consumers to pay for our mistakes?"

The promise of BIM is to build a structure *virtually* prior to physically constructing it. This allows project participants to design, analyze, sequence, and explore a project through a digital environment where it is far less expensive to make changes than in the field during construction, where changes are exponentially more costly. Today, this promise is becoming reality. An array of BIM software and mobile applications are delivering results that mitigate construction risk. Although some tools are more advanced than others, we are rarely at an impasse where some function is simply "impossible" and not able to be achieved through technology.

Where we find the majority of challenges nowadays in virtual building is that many teams fail to realize that the integration of team members creates significantly better outcomes. For example, subcontractors who are allowed to participate early in the scheduling process are able to leverage their expertise and share valuable information such as material lead times, crew sizes and installation methods that can create a more meaningful model simulation. Additionally, when a construction management team is allowed to participate in an architect's design review meeting, they are able to see what factors are important to the client and design team and use that knowledge going forward as they prepare to build. In this book, I acknowledge these best practices and propose a new way of evaluating technology and teams holistically by using *integrated teams* that are capable of keeping pace with the rapid introduction of available technologies to deliver better construction outcomes. As George Elvin states in *Integrated Practice in Architecture: Mastering Design-Build, Fast-Track, and Building Information Modeling* (Wiley, 2007): "Integration enables a team of designers and constructors to work together toward a common goal, allowing design and construction activities to unfold in the best way for the project, rather than locking them into separate phases required in over-the-wall delivery." It is this collaborative,

project-focused approach that allows teams to function more efficiently and use BIM to get to better answers faster. Team integration moves the focus beyond individual needs and shifts it to how information-rich models can be used to explore options and scenarios that create better projects and remove risk.

BIM has evolved. The construction community is seeing a shift from the 3D or visualization aspect of BIM to workflow-specific tools that are being directly applied to solve real-world problems, such as installation verification, sequencing, and estimating. The industry dialogue is now moving to a general questioning of how we optimize the effective capture, analysis, and dissemination of information in real time to make projects more successful.

As a result of this shift in focus, existing tools are adapting and new ones are being created to address these challenges. The adoption of BIM into mainstream construction management practice has taken the typical constructs of what it meant to be a construction manager and transformed them into a new way of looking at how we work. We are now asking new questions such as:

- What else can we do with all this information?
- Who else can benefit from this data?
- How can we use models to enable better decision making?
- What is the right level of virtual augmentation on a project site to make our teams more productive?

It's an exciting time in the AEC industry because just as applications are improving, so are many of the technologies that support its use. Technologies such as cloud computing, which gives you the ability to use remote servers to process data from any web-connected device, and the accelerated growth of mobile and wearable hardware continue to shift the paradigm of practice in construction management for designers and builders alike.

Other changes are more incremental in nature. These improvements come in the form of better software features based on user feedback as well as enhanced stability of these tools, which increases productivity and reliability.

Finally, the constant stream of new ideas and improvements in the form of innovative tools and processes entering the marketplace continues to challenge the way in which teams work and build structures at a variety of levels. In the midst of all of this change is the promise of a better way of working collaboratively with more useful information to create value in the built environment.

Since BIM's introduction, BIM software has progressed with new features and applications. Likewise, BIM has forced many in the construction industry to evolve as well and challenge the way they previously thought about designing and building projects. As a result, the construction industry began investing in new and better technology. The rapid growth of new technology for the construction market is no coincidence. Construction hasn't kept pace with other industries in regard to automation and technological improvements over the last forty years, which has created fertile ground for new tools and products that offer better ways

of working. Although innovation is encouraged, new tools require fast analysis and project testing before widespread adoption.

In the first version of *BIM and Construction Management*, I stated that BIM is not just software—rather, it is a process *and* software. Taking that one step further, we now see that successful BIM use requires **three** key factors:

- Processes
- Technologies
- Behaviors

These three components can make or break a project using BIM and technology. Think of these as the three-legged stool to the successful integration and use of BIM (Figure 1.1). Take one leg away and you are left with a pretty useless object that isn't good for much. So why are these three pieces so important?

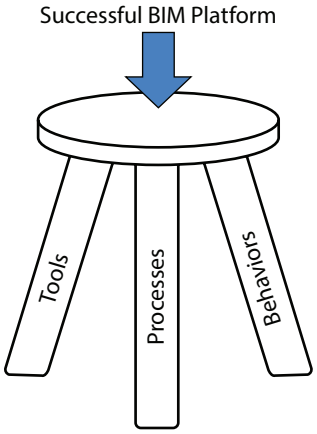

Figure 1.1 Three-legged stool of BIM

Processes

Construction management and many other engineering-focused firms tend to take new technologies and try to make them work in old processes. This approach creates waste by not taking into account the implications of the new tool and what existing processes and workflows should change that would make an outcome more efficient. A good example was the evolution of clash detection and resolution. As clash detection started to gain traction, many teams would host a number of meetings each week that involved the entire project team to coordinate among themselves using this new 3D environment. Although the technology was better, the process used was similar to what had been done before in a 2D coordination review. As a result, many users found the new process was not only inefficient but actually detrimental to a project's efficiency. Because team members were tied up in clash detection review meetings, response times for project-related issues increased. They were also burning through valuable time and found that

their production declined steeply because of the lack of available hours. Nowadays, these meetings typically focus on two or three particular trades or scopes at a defined 2-to-3-hour timeframe to best use each team member's resources. Additionally, teams are now looking at ways of eliminating the clash detection process altogether by modeling in cloud-based tools that notify users in real-time when they create clashes.

These process shifts are critical to improvement, because they allow users to continually think of ways to improve and deliver work. In his book *The Spirit of Kaizen: Creating Lasting Excellence One Small Step at a Time* (McGraw-Hill, 2012), Robert Maurer states that "When you need to make a change, there are two basic strategies you can use: innovation and kaizen. Innovation calls for a radical, immediate rethink of the status quo. Kaizen, on the other hand, asks for . . . small, doable steps toward improvement." Successful BIM integrators realize that both large innovation and smaller process step changes are needed when using technology. Innovative change is driven by the speed at which technologies are deployed, and in order to stay relevant, you need to find ways to be nimble and look at these tools as fast as they come. Kaizen change calls for patient, iterative improvements to current tools and processes used and, at its core, require a cultural mind-set in order to work.

Keep in mind that, like a hammer or a saw, BIM is just a tool. Used with the right processes in place, BIM systems can create tremendous value for an organization. When new tools are combined with old processes, they can inhibit success as well as frustrate users. This is why it is so important to look at new tools as they become available for what they are and treat the investigation of the processes required to enable a new tool with the same rigor as that of the technology itself.

Technologies

The successful integration of BIM involves using BIM tools that work. Though this sounds simple enough, tools need to be explored further "post sales pitch." This means after the software or application salespeople have left the room, we need to ask, "Does this product improve our organization or way of working?" The strategy for how a team analyzes new technologies and selects them is important because it determines how nimble and responsive a team will be. The method for selecting tools in the construction industry typically falls into three approaches, each with different results.

The first strategy for selection and integration is the "pile on" method. In this approach, a company or organization looks at tools consistently as an *addition* to their current systems. The main hypothesis in this method is that the firm will begin by piloting the new tool and then look at how it interfaces with the company's other systems to see whether the product can meet its demands. If the tool looks like it is valuable and can be used, then the company begins a broader series of pilots that

explore it further. The intention is that the new tool will "weave" its way into the fabric of the tools used within the company and ultimately the best tools will be used, while the others will fade away.

This method is the least painful of the three strategies, mainly because it is easy and requires the least rigor and thought. However, the constant addition of new tools creates confusion as to which tools are foundational and which are being tested. The pile on method rarely evaluates new tools against the current tools a firm is using. This type of diligence usually results in tools that overlap in functionality without a decision to remove one or another, until absolutely necessary. The pile-on method does allow for iterative or Kaizen-like changes to be made with little pain; however, a firm must be diligent about not selecting too many tools that inhibit the company's ability to perform.

The second strategy is a "swap out," or a direct replacement strategy. In this method, a company examines a new tool and its features and then looks internally to see which current tool or tools could be replaced. This one-to-one analysis allows for systems to be upgraded and consolidated. Direction on which tools are to be used and which aren't are usually clearer than with the pile-on method. This method also creates the ability to continually optimize the "toolbox" of a firm to stay relevant and competitive.

One of the shortcomings of the swap-out method is that the related processes and in-depth discovery of how a team works together takes a backseat to the feature comparison of each piece of software. Additionally, this method of selection is weaker against disruptive technologies that change the fundamentals in the way a company works, because behind the tools there is usually an established way of working. The improvement cycle in this methodology often follows industry trends, though this method does allow tool selection to be consolidated and the toolbox of an organization to be focused.

The third strategy is less well known but is now growing in popularity due to the rise of lean concepts and outcome-focused thinking. Using this method, known as the "process first" strategy, a team begins by looking at their current processes and then asks "How do we want to work?" This question requires "blue sky" thinking and assumes that the technologies needed to enable this new way of working will be there when they determine their optimal working conditions. This method of selection is more tedious and time-consuming than the two previous strategies and requires a significant investment of time and research to work. The outcomes from this effort vary, but many firms come away with a plan that includes input from a broad cross-section of their stakeholders. The difference is that the team understands the desired outcomes, and the selection of one tool versus another requires considerably less effort.

In this method, the litmus test of value is whether or not the tool aligns with the firm's vision. In some cases, no tools exist that support how a team wants to work. This situation is a risk of the process-first strategy; however, it is also fertile ground

for customized solution development that meets the needs of the team. These custom solutions can be developed internally or with a third-party developer, or information can be provided to software vendors to develop and integrate into future releases of existing tools. This method of technology selection provides a framework for identifying tools that help a team reach its desired end state, because it allows the most flexibility in a rapidly changing environment and limits the "analysis paralysis" stage that many organizations face when analyzing tools from too many perspectives.

Unless a firm truly hasn't changed tools in some time, it will typically use one of these three methods or some combination. Whether the methodology of selection was purposeful or less rigid, a firm that wants to continue to adapt and improve should look at the way it analyzes and selects tools. Doing so determines the speed and efficacy of that company to stay at the forefront of technology and market trends.

Overall, BIM in construction is seeing a trend of consolidation in quantity and a focus on cross-platform integration. Some vendors are rising to the call of interoperability, application programming interfaces (APIs), and open source information sharing that limits redundancy and starts to create interesting new ways of using BIM information. This continued improvement in BIM software can largely be attributed to user communities and feedback. Whether that feedback comes from online forums, consumer councils, or involvement in industry organizations and committees, the lifeblood of improvement in BIM relies on users in our industry to take an engaged stance in the future iterations of existing tools in these venues. Just as important is the willingness to be "sold to" by new companies with new ideas to support a dialogue and cultivate a culture of innovation and advancement within the construction community.

Behaviors

Of the three key components to successfully integrating BIM, behaviors are the most difficult to change. As Scott Simpson of design firm Kling Stubbins says, "BIM is 10 percent technology and 90 percent sociology." The core of BIM is far more than updating software—it is a cultural shift in the mind-set in the way construction management teams collaborate. So, what do we mean when we say "behaviors"? When we consider what makes BIM work within a construction project, the core component becomes *enabling behaviors*. Think about it. Would you rather work with a team that is excited to work in a cutting-edge environment—or a team that is overly skeptical and limits further progress by being closed-minded?

Not a tough decision to make.

Teams need to fully realize that a future forward mind-set is just as important as the technologies and processes behind it. Those who misunderstand this principle will quickly find themselves irrelevant in the design and construction market. As the philosopher Eric Hoffer says, "In times of change, learners inherit the Earth, while the learned find themselves beautifully equipped to deal with a world that no longer exists."

Although we have discussed the importance of personal behaviors, it is also important to note that organizational behaviors can impact the successful integration of technology as well. A company that has a culture of innovation and a nimble attitude to begin with will create a persisting dynamic where change is a constant and improvement and analysis are to be expected. Conversely, an environment that is resistant to change and that stifles innovation will become exponentially more difficult to create that enabling dynamic that supports the successful analysis selection and use of the right tools that may translate to process changes.

Behaviors Matter

Construction management firms are facing an increasingly competitive environment all over the world. This is particularly true for large projects, where significant effort is required and large amounts of revenue can be made or lost. In many of these projects, joint ventures (JVs) are used to take the best of what both teams have to offer as well as spread out the risk, bonding, and insurance requirements. It is important to note that when JVs are being created, individual teams are selected based on various factors, including their experience, portfolio, client relationship, technological capability, availability, and behaviors. Why behaviors? Well, these projects often carry a significant amount of risk, not only as it pertains to the construction project but also as two or more companies with different cultures begin working together. For this reason, teams with the right enabling behaviors often find themselves as a desired partner, whereas teams resistant to change often find themselves left on the sidelines.

One of the main themes in Finith Jernigan's *Big BIM, little bim* (4Site Press, 2008) is the concept that truly successful BIM is much more than just BIM software (little bim); rather, it is the assemblage of the tools, processes, and behaviors (BIG BIM) required to make BIM truly effective. Just as BIM tools are becoming more collaborative, so must our behaviors and mind-sets. We as an industry have a significant opportunity to capitalize on what has the potential to revolutionize the way construction is delivered going forward by shifting our attitudes and mind-sets to more enabling behaviors.

The Value of BIM in Construction

The value of BIM in construction comes in many shapes and sizes. Whether it's the ability to save time through automated functions, eliminate the need to travel to a meeting, or save money because better information is available earlier to make cost-effective decisions, they all have the same focus: results.

It's hard to imagine an area of our daily lives in which technology doesn't affect us, particularly in the workplace. The same is true within the construction industry. The advent of BIM and the rise of application-based technologies have opened doors

and arguably created one of the most exciting new dynamics since Microsoft Excel. Over the last 50 years, the construction industry has had just a handful of notable technological innovations compared to other industries. Granted, there were many innovations in material research, installation methodologies, and energy efficiency, such as prefabrication, eco-friendly materials, and green building design. However, the technologies used by project teams for construction management remained largely the same. Now, innovation is becoming a part of the way contractors deliver their work and differentiate themselves from their competitors. As a result, we are starting to see a healthy ecosystem of supply and demand for ever better tools between technology vendors and construction management firms willing to invest to drive efficiencies, as is evident in the rise of contractors adopting BIM technologies (Figure 1.2).

Contractors' Current and Future Expected BIM Implementation Levels

Source: McGraw-Hill Construction 2013

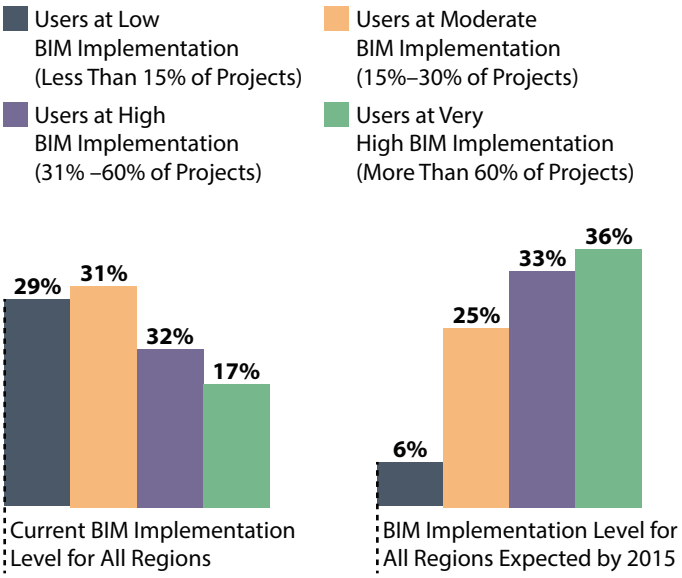

Figure 1.2 Expected growth trends of BIM

BIM in construction management has a unique history. It is important to understand this unique evolution in order to best understand its value and trajectory (Figure 1.3).

BIM as we have come to know it is largely based on object-based parametric modeling technologies that were developed by the Parametric Technologies Corporation in the 1980s (source: *BIM Handbook*, p. 29). BIM for the construction industry was commercially available as a tool in the early 1990s with the ability for computers to handle the size and processing requirements of 3D CAD models. The