BRAD HARDIN
DAVE MCCOOL

BIM AND Construction Management

PROVEN TOOLS, METHODS, AND WORKFLOWS

SECOND EDITION

WILEY

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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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,