Making the BIM Paradigm Shift:
What to Expect Along the Road to BIM Adoption

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Jim Upton thanks all contributors to this white paper for their generous time and interest in helping construction executives understand BIM's value.

Introduction

Building Information Modeling (BIM) is the revolutionary buzz in the AEC industries. Once facility owners experience BIM's benefits, they want it, and top-level construction executives know they must adopt it. But BIM adoption lags modeling system enhancements. Somewhere among the technology's bells and whistle stand decision makers with looks of consternation, wondering how BIM truly enables better business processes and well-run, profitable facilities.

BIM removes the barriers to project-wide collaboration. The industry must now overcome its own culture to fully adopt the technology and capture BIM's full value.
~ Jay Irwin, Industry Principal—Real Estate, Construction and Homebuilding, SAP America

BIM is likely the single biggest enabler of change in the AEC industry that will occur in the span of one's career. BIM is market tested and stable—and comes packaged with a paradigm shift: seamless and transparent collaboration by all project stakeholders in a virtual environment.

Once implemented and embraced by an organization's internal and external parties, BIM fosters *a culture of freely exchanged* ideas and information. This high-level collaborative approach enables all project stakeholders to easily access and update project information, helping to unify all phases of the project and asset's lifecycle—from concept to salvage.

But technology developers still have their work cut out in making BIM interoperable across a variety of IT platforms, as well as making it compatible with software used by the industry's practitioners. And some potential BIM adopters are daunted by the complexity of BIM's capabilities, the lack of complete interoperability, perceived loss of control in a free data-exchange environment, and the willingness required to allow each stakeholder exert a greater degree of influence during decision making processes.

Based on our interviews with the industry's top 20 contractors and facility owners, BIM adoption appears to be gaining momentum—to be reaching the tipping point: "the levels at which the momentum for change becomes unstoppable," as stated by Malcolm Gladwell in his book *The Tipping Point: How Little Things Can Make a Big Difference.* This paper guides you, the executive of a construction company or facility owner, to embark on the BIM adoption journey with a new paradigm—a new set of mechanisms by which facilities are designed, procured, constructed, and maintained. Our goal is to give you fuel for your journey so, in an industry undergoing dramatic change, you can create exceptional customer service and predictable value: high performing facilities, constructed faster and within budget.

The BIM Journey—What You Should Expect

Let's first take a look at what the industry's dramatic change is all about. There are many elements, one of them being a $15.8 billion[1] external force driving asset owners and contractors to better define their building requirements in BIM. Trying to achieve an efficient level of interoperability among building stakeholders currently operating in silos costs too much, and it leaves too much value out of the project's and facility's lifecycle. Add to that the construction industry's challenges cited in FMI's *CMAA Eighth Annual Survey of Owners*[2], the urgency to collaborate seamlessly with all project stakeholders heightens.

So, what should you expect on your journey to adopt BIM?

[1] Gallaher, M.P., O'Connor, A.C., Dettbarn, Jr., J.L., & Gilday, L.T. (August, 2004). *Cost analysis of inadequate interoperability in the U.S. capital facilities industry* (NIST GCR 04-867). U.S. Department of Commerce, National Institute of Standards and Technology.

[2] FMI's *CMAA Eighth Annual Survey of Owners* cites these seven challenges to the future of the construction industry: aging infrastructure, an aging workforce, attracting Generation Y (born between 1983 and 2000) and retaining Generation X (born between 1966 and 1982), managing owner's accelerated schedules, learning alternative financing and project delivery systems, meeting increased global competition for resources, investing in purposeful training. To get the full report, visit wwwfminet.com.

As an industry executive, you should expect to champion the adoption process and the culture of free information exchange. During the adoption process, you will need to allocate funds to develop BIM experts who can evangelize the business value of this new technology—its features and benefits—among your staff members, and who can also train them on how to use the software in a BIM-centric work environment.

BIM allows us to 'build it twice'. Once virtually to optimize design & constructability, then physically to create the high performing asset.
~ Ed Hoagland, Construction Modeling Manager, PCL Construction Services.

As virtual collaboration evolves among all stakeholders, you begin creating a single pool of knowledge and a unified view of the building—its design and cost and how it operates—all before ground is broken. This is BIM's greatest offering. And in the end, you create a new value proposition for facility owners, new performance criteria for your vendors, and new opportunities for your employees to acquire valuable talent. BIM doesn't force you to drop existing processes and adopt new ones, it helps you identify which existing processes you should change or improve. And, it doesn't subdue the creativity of design teams—it enhances them by letting designers leverage their talents and explore numerous design options without incurring hard costs. But BIM does make you refine established business practices, which could make it be viewed as disruptive technology. You will most likely find that you need to:

- Adjust your workflow and decision-making time scale for condensed construction phases.
- Reassign each project role's level of authority and escalation process.
- Redefine how tasks are executed within an expanded team (e.g., Move away from endless paper revisions to collaborating in a virtual environment).

In exchange for making these changes, though, you will begin to experience greater productivity and a new-found horsepower that adds strength to your business development efforts and project delivery success. Not only will you be able to differentiate yourself among potential customers, but among potential employees as well in your pursuit to become the employer of choice.

Speed Bumps on the Road to BIM Adoption

One should not be deceived by the coolness of the technology, but rather understand what process changes must be implemented to enhance customer value, for it is the latter which is the most critical.
~ Brad Phillips, Managing Director, Beck

We see making the BIM paradigm shift as the greatest challenge, for it is truly a journey along multiple paths of change with facility owners, employees, and internal and external stakeholders. The level at which you embrace and commit to a multidisciplinary building process based on free data exchange enhances the value of BIM's benefits.

Shaun Yancy, VP of Construction and Director of Corporate Development Team at PCL Construction Services, said some people in his company "initially saw BIM as a marketing and business development tool. With BIM now embraced from the top down, its greatest value is in the construction process. BIM helps us align all team members to deliver the most value to our clients."

We see the ability of BIM developers to create a truly interoperative environment as a significant challenge and a possible deterrent to adoption. But industry executives, vendors, and support organizations are working to overcome interoperability issues. Just as the recent "war" that raged between HDTV and Blue Ray on who had the preferred format, market forces will drive BIM technology vendors toward a particular platform. Additionally, The International Alliance for Interoperability (IAI), the U.S. BuildingSmart Alliance, OSCRE, the National Institute of Building Sciences (NIBS), the Facility Information Council (FIC), and other organizations are working to "create common ground to bring unity to the growing trend"[3] of BIM adoption. The National Building Information Model Standard (NBIMS) project, a committee of the NIBS Facility Information Council, is working to improve the ease at which project information is shared by

[3] Buckley, Bruce. (April, 2007). *Building groups seek unity on interoperability and BIM. ENR.com.*

establishing a national BIM standard—a set of rules for "typical processes and computer-based exchanges of information employed during the conception, creation, and operation of facilities."[4]

In addition to BIM's cultural and interoperability issues, you will also need to give these following issues your attention:

Issue	Suggested Remedy
Adopting the BIM Standard	Run an analysis on the cost of migrating away from your in-house IT operating standard(s) toward a BIM-centric standard, such as the National BIM Standard (NBIMS).
Acquiring Design Tools	Build robust object libraries so you can repurpose existing data into new knowledge that is accessible to all stakeholders across various IT platforms.
Assigning Project Roles and Levels of Authority	Describe how each project member will interact with all stakeholders throughout the life of the project. Then, assign each member's authority for data collection, building design, costing, scheduling, procurement, commissioning, construction, and operating and maintaining the facility. Based on Shaun Yancy's perspective, from pre-BIM to post-BIM, project roles do not change, only in how project members execute their tasks.
Assigning Project, Design, and Risk Ownership	Update or create new standard contract forms that embrace Virtual Design & Construction (VDC) and the value BIM tools create. Move away from contracts focused primarily on assigning risk. Select team members based on BIM strengths and their ability to drive value in the total project. Regardless of which party facilitates the final design, each party remains accountable for their respective contractual obligations.
Re-establishing Work Flow	Adjust workflows to operate in a condensed design and documentation phase so you can move away from endless paper revisions to online collaborative design meetings. Though often in an accelerated timeline, plan on a greater degree of participation in the design and preconstruction phase to yield greater benefits in project delivery and through the asset's performance.
Providing Training and Education and Attracting Top Talent	Allocate funds to develop BIM experts who can collaborate with stakeholders from all project disciplines, and who can also train staff members on how BIM changes workflow, collaboration, and execution of tasks. This is an opportunity to address the AEC industry's talent shortage—BIM experts will help you position your firm to become the "destination employer."
Overcoming Project Procurement Criteria	Collaborate with city officials on shifting bid requirements away from low-cost bids to ones based on facility and asset lifecycle values.
Managing and Mitigating Risk	Come to understand how BIM's collaborative features can help reduce errors in the design phase because each stakeholder has "collective and enlightened" input." After the design phase, though, understand that stakeholders remain responsible for managing and mitigating risk associated with each of their specific project roles.

[4] National BIM Standard Initiative FAQ, retrieved from the Internet on January 28, 2008, at www.facilityinformationcouncil.org/.

Destination—Exceptional Client Value: The well-run, profitable facility

Envision architects, engineers, and contractors murmuring a "Build as One"[5] mantra during their mission to stay aligned with a construction process that delivers exceptional value to asset owners.

Crate & Barrel Reduces Time-to-Market by 67%

Because of BIM's integrated design, build, and construct capabilities, Crate & Barrel has migrated to a BIM-centric approach on all phases of its construction processes. Even though no two stores have the same floor plan, Crate & Barrel, from day one of a project, can count on predictable design time frames, documentation content, constructability, hard costs, and building schedules. John Moebes, Director of Construction for Crate & Barrel, states, "In the last several years, we have driven down our design and documentation phase from 24 weeks to just eight weeks. While our staff remains the same, we can deliver eight projects in a year compared to the two projects per year we delivered before adopting BIM and VDC."

The construction industry is the only industry that builds all of it's prototypes in full scale and at full price. With BIM, we are able to make virtual prototypes, and in terms of functional and physical characteristics, provide higher quality facilities for our customers. BIM allows you to design in optimal lifespan and lowest O&M costs.

~ Derek Cunz, Director of Project Development, Mortenson Construction

SDCWA Awards Contract to Provider with BIM Strengths

San Diego County Water Authority (SDCWA) needed a water treatment plant built for the long haul. After a competitive selection process, SDCWA entered into a Design-Build-Operate contract with CH2MHill. Using BIM technology, CH2M Hill beat its competitors' by using an advanced process design with lower capital construction costs and lower operating costs over the 20-year lifespan of the contract.

"BIM enabled performance-based design," stated Tim Suydam, Senior Engineer at SDCWA. "Using detailed process modeling capabilities, the designers used a submerged membrane design. The plant will use less chemicals and less electricity than a conventional plant. The economic value and reduced environmental impact are both enhanced by BIM."

The Well-Run Facility and BIM's Role

Unified Building Phases

BIM enables the "Build as One" philosophical approach to building design and construction. Before breaking ground, all project stakeholders create information that is stored in a single repository, then repurpose the information to create numerous simulations of:

- Planning and design
- Raw material selections
- Procurement and building schedules
- Means and methods of construction
- Real-life facility operation and maintenance scenarios

Compliance with Green Buildings (LEED)

Because BIM allows you to simulate facility performance under a variety of energy-use assumptions, it enables validation of green designs and ultimately, compliance with green standards. Mechanical, Electrical, and Plumbing (MEP) designs; thermal mapping; and light penetration modeling are examples of ways to (1) validate compliance with green design and building standards and (2) ensure that high performance buildings can actually "live up to their calling."

[5] Mohammed Luqman, Director Business Development at Lydig Construction, sites the "Build as One" philosophy as significant advantage stakeholders acquire through BIM adoption.

The Well-Run Facility and BIM's Role

Lean and JIT (Just In Time) Construction

BIM allows you to tie manufacturers and suppliers to performance-based design, including the quality and reliability of materials delivered to the site. BIM is the enabler that helps educate the AEC industry on standards that manufacturers have used for years. BIM allows for increased use of prefabrication by avoiding the uncertainties and delays of waiting for field verified dimensions. Also, the Lean Construction Institute (www.leanconstruction.org) is driving reform of management practices across the spectrum of AEC providers.

A key value will come from managing the supply chain of materials during construction, which will dramatically drive out waste in the construction process, very much as the implementation of lean processes revolutionized the manufacturing industry. Just-in-time materials management has forever changed the manufacturing and distribution industries and BIM has the promise to do the same for the construction industry.

~ Sandra Benson, Global Industry Director of Engineering & Construction, Oracle

Operation & Maintenance O&M) Practices

When designing a facility for optimal lifespan and lowest O&M costs, BIM allows designers to evaluate each system component as it relates to the entire facility's operational requirements and reliability. This is especially applicable to complex Engineering, Procurement, and Construction (EPC) projects. Information from similarly built facilities or plants can be used to forecast preventive maintenance schedules, work-order requirements, labor costs, replacement parts, and causes of failure. On a broader basis, BIM can help with shutdown planning and execution, down to the details of isolating individual systems.

Global Economic & Market Forces.

Facility owners face the reality of rising core material (steel, cement, aluminum, glass) costs when currencies become devalued, possibly making a project's economic feasibility not to make sense. By offering BIM-centric processes to your customers, you provide them with tools that can help drive down project costs and increase productivity while staying within budgetary constraints. As the demands of international markets for materials continues to grow, BIM can help you win the battle for cost competitiveness by keeping your market cost structures competitive with global market demands.

Swinerton Keeps its Eyes on the Big Picture

The Swinerton Virtual Design & Construction (VDC) initiative, "Build a Better Builder," focuses on leveraging BIM tools to improve business processes. When Swinerton used BIM to modify its plan for placing concrete floors, it discovered that breaking the floors into three pours actually compressed the construction schedule, leveled out the demand on resources, and reduced costs.

We drive a performance-based design that results in better customer service, less risk, open team collaboration and built in sustainability. Our VDC teams tackle potential constructability and cost issues during both the pre-con and construction phases that allow Swinerton to streamline project delivery and create value for our customers.

~ Daniel M. Gonzales, Corp. Mgr. Virtual Design & Construction, Swinerton Inc.

BIM City—Getting There

The vehicle that will help you adopt BIM the fastest is that of a mindset—a willingness to allow professionals from all disciplines to influence building design, construction and O&M decisions. At a minimum, BIM requires all participants to rise above their knowledge domains to a thirty thousand foot view of a building process that is dynamic, symbiotic, and complete. With that view in focus, stakeholders acquire a heightened awareness of how their actions affect the entire building process, thereby reducing the risks of poor communication and "siloed" information. As a result, during each building phase, stakeholders can seize opportunities to better serve their clients.

To begin the adoption process, Sabine Hoover, Consultant at FMI, suggests overcoming uncertainties about BIM by starting where you get the most bang for your buck. An FMI client "started implementing BIM in its self-performed concrete division where BIM provided the greatest immediate return on investment. The success achieved within this division served as a great way to showcase the value of BIM and build awareness across the firm."

Dean Reed, Lean Construction Leader, DPR Construction Inc., said his company embraced BIM and VDC from the top and fostered a "collaborative approach by creating 'The Big Room,' where design professionals, builders, and representatives of all disciplines come together to plan, explore solutions, and develop and coordinate 3D models for a truly unified execution of the project." Dean continues, "Our preconstruction and project managers are now being asked to explain and justify why BIM will not be used on their project, as opposed to the other way around."

How to Assess Your Needs and Readiness for the Journey

Before you consider adopting BIM, assess your confidence level in your current project management systems. Do they allow you to manage to the level of detail you need? Once you are satisfied with your internal systems, asses your willingness make a paradigm shift—to adopt a free-data-exchange culture, then make it the cornerstone of your corporate policy. And finally, are you prepared to evangelize the benefits of BIM? In a BIM-centric environment, where project stakeholders collaborate project-wide and throughout its lifecycle, builders become guidance counselor, coach, and trainer during BIM adoption.

If you understand the importance of how a fact-based view of the asset will perform over its lifespan, and you're prepared to change the culture of how facilities are designed and delivered, then you are probably ready to adopt BIM.

With BIM, builders become true asset managers; it's just that some of their assets haven't been built yet!
~ Richard Cork, Business Consultant—Construction, IFS UK, Ltd.

BIM City—What You Will Find

BIM is the tool that will help you position your firm to be globally competitive, attract top talent, and maintain a bird's eye view of your project's events. It may be the closest thing to a crystal ball as you'll ever get. Although BIM's benefits have been well-documented, we summarize them here.

Strategic Advantages—BIM allows you to…
Build for ROI: Faster to Market—Faster to Revenue Maintain a high degree of certainty that you will spend within project budgets, stay on condensed building schedules, not exceed facility O&M costs, and minimize time-to-revenue. In short, count on the asset's operating costs to be consistent with the financial model it was built against, regardless of the asset's intended use.
Attain Project Certainty from the Get-Go Optimize assets during the design process and retire tactical, value-engineering approaches that exist only to cut costs once the design is complete. Even though no two buildings have the same floor plan, BIM-adopter Crate & Barrel can go to the bank, certain of its project's feasibility and profits.
Mitigate and Reduce Risk Reduce risk through improved design quality and project execution and by collectively signing off on project goals. All stakeholders identify and drive out potential problems. In complex projects, BIM makes visible "the devil that is in the details" so you can root it out of the building process.

Tactical Advantages—BIM allows you to…

Make Fewer Design Errors and RFIs (Requests For Information), al in a Compressed Timeline

Accommodate asset owners' requirements for compressed building schedules while maintaining ease of construction:

- Work out design glitches prior to project execution
- Eliminate delays due to design inconsistencies
- Avoid "defensive detailing," a no-value-add level of detail that simply exists to avoid liability (e.g., showing pores in a brick or bolt patterns on a column base plate)

Re-use and Repurpose Information

Ease day-to-day project execution by mitigating costly and time consuming issues such as beam and duct clashes and dimensional inconsistencies. Though it is difficult to measure the impact these disruptions *would have* created, their cost avoidance can become well known. EPC and O&M contractors can make better tactical decisions on basic issues such as how high off the floor a valve should be installed. By tapping into the maintenance history, condition-based maintenance records, man-hours, parts consumption, and failure history of one system, contractors can forecast how well system components will operate in a new but similar system, balancing an asset's capital costs, lifespan, and reliability. For example, Beck recently had the opportunity to build a second project very similar to another project previously delivered. Beck delivered the second building by re-using information available through BIM to cut costs and reduce delivery time by amounts not thought to be attainable prior to this new technology.

Select Suppliers Who Perform

Select suppliers based on end results rather than purchase price and standard, system-driven procurement. Convert supplier performance data from your ERP system into an intelligent decision-making tool by seeking answers to these questions:

- What is the supplier's history of providing a key component from its preferred vendor?
- Was the quality of the suppliers' components compliant with performance specs and industry standards?
- Can we tie this supplier to the contractual obligations of the prime contract?
- Is the quality of the supplier's engineering adequate?
- Did the supplier deliver on time and within budget?
- Was it able to commission the equipment and validate its performance requirements?
- Does the supplier promptly address warranty issues?

As interoperability matures, you will be able to tap the power of ERP systems to address these sourcing and performance issues across portfolio projects. For EPC firms, BIM can automate the "P" and be the glue that binds the "E" to the "C," uniting the power of corporate buying processes to demands of project delivery people.

Maintain Fixed Assets and Depreciation Schedules

Identify facility components and systems for different depreciation schedules, SOX compliance, and financial audits plans. Operating components (electrical and mechanical; pumps, valves, compressors, air conditioners, etc.) depreciate on shorter schedule (say, 10 years). Structural components (steel, concrete) depreciate over a longer period.

Accurately Forecast Skills Required for Construction and Operations & Maintenance

Define each project's labor requirements for welders, electricians, and truck drivers by assigning certification and skill requirements to objects. Create realistic parts lists and instruction manuals for maintenance practices using BIM's robust project documentation capabilities. As BIM adoption matures, connectivity to other enterprise systems will start to drive further value from all departments.

Accurately Forecast Energy and Utility Costs

Confidently depend on the long-term view of your asset's performance and verify LEED certifications and long-term views of high performing green buildings and LEED certifications.

Conclusion—The Vision and Reality of BIM Adoption

After hearing many favorable reviews of BIM and its ability to add customer value, its adoption is clearly gaining momentum and may reach a tipping point before the end of 2008. And going beyond the abundant quantitative ROI stories, BIM's real value is derived at a more qualitative level across all aspects of a firm's operation and an asset's lifecycle: the customer's long-term relationship with construction services providers.

As we discussed in this paper, making a paradigm shift to a culture of free information exchange prior to adoption makes for a smooth journey to BIM's benefits. Even then, Sandra Benson, Global Industry Director of Engineering & Construction at Oracle, says BIM adoption comes down to people. While much is discussed about methodologies and technology needed to build profitable facilities, the human nature of resisting change will be the most challenging aspect of adopting BIM. She says, "Large firms are dictating adoption in a top-down manner, while in smaller firms, the newly graduated engineers are driving the change. This generation,' the iPod generation', embraces technology and assumes its use in every aspect of their life."

Moving forward with BIM, architects and solution providers can focus more on their core strengths and shift into a progress-monitoring role. Concerns about beam and duct collisions or bolt patterns can be left to the builders. Again, Jeff Weiss: "Architects will have to deal with their loss of complete control by exchanging it for enhanced quality and timeliness." And throughout their oversight of the project's completion, architects and designers can remain confident of successful project delivery. David Morris, Director of Virtual Construction for EMCOR, says that design teams crave the installer's input: "As an installer and subcontractor, we are being brought in earlier in the process to assist with spatial coordination and budgeting. Whenever this occurs, our goal is to add value to the total project, not just 'value engineer out' budget problems."

And if decision makers acknowledge that BIM may be a disruptive technology, providing an incentive to adopt it, doing so can be complicated. Applying Clayton M. Christensen's discussion of disruptive technology in his book *The Innovator's Dilemma: The Revolutionary Book that Will Change the Way You Do Business*, adopting BIM could involve competing with your existing and more profitable technological approaches. But as muskets replaced the crossbow and emails replaced faxes, BIM will continue to revolutionize the AEC industry. John Moebes, Director of Construction, Crate & Barrel sums it up with this: "The market has evolved from 'Should we take the leap of faith that the value can be realized?' to 'How did we do without this?'"

BIM tools and related processes are the center piece of an integrated project delivery system. Once adopted by all stakeholders, the entire project becomes transparent, from tactical design and constructability issues to strategic goals, such as auditability and return on assets. When supported and championed by executives, BIM tools and processes foster an ecosystem that adds value to all project stakeholders and optimizes a built asset's performance during its lifespan.
~ Jim Upton, Consultant to the Built Environment, JCU Services, LLC

Jim Upton, President of JCU Services, LLC, provides consulting services to Engineering & Construction and Facilities Services providers. His mission is two-fold: (1) Help contractors and facility owners select solutions for the greatest business benefit and to lay a foundation that connects contractors and asset owners to new opportunities for profit, productivity, and revenue growth, and (2) help software providers prepare to serve the AEC and related markets.

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