

Integration of BIM and Business Strategy

Joe Harris

Masters of Project Management Program
Department of Civil and Environmental Engineering
McCormick School of Engineering and Applied Science
Northwestern University
Evanston, IL

Table of Contents

List of Tables	iii
Abstract	iv
Executive Summary	v
Preface.....	vi
1.0 Introduction to Building Information Modeling	1
1.1 History of BIM.....	3
2.0 Planning	4
2.1 Design	5
2.2 Sustainable Construction	6
3.0 Construction.....	7
3.1 Location Based Management.....	8
3.2 Collision Detection	9
3.3 Cost Estimating.....	10
3.4 BIM in the field.....	11
4.0 Operations and Maintenance.....	13
4.1 Facilities Maintenance	14
4.1 Financial Asset Management.....	15
4.2 Property Valuation	17
5.0 Moving forward with BIM.....	17
5.1 Communication.....	18
5.2 Integrated Program Controls.....	19
5.3 Industry Standards	21
5.4 Work Flow	22
6.0 Conclusion	24
6.1 Integration of BIM and Business Strategy.....	25
References.....	27

List of Figures

Figure 1. Tekla Structure	5
Figure 2. AutoDesk’s NavisWorks	5
Figure 3. VICO Software.....	8
Figure 4. Collision detection.....	9
Figure 5. BIG ROOM	9
Figure 6. Field layout with BIM technologies	11
Figure 7. Laser scanning	11
Figure 8. Machine guided technologies	12
Figure 9. U.S Coast Guard BIM applications	14
Figure 10. Facilities Maintenance.....	14
Figure 11. Net Operating Income shown with BIM technologies	16

Abstract

BIM is the newest technological innovation in the construction industry, and companies are trying to adopt the best practices of this new technology. The industry is moving towards better implementation of BIM technologies. Best Practice for the implementation of Building Information Modeling include: the integration of the project team, leveraging the current capabilities of BIM, and moving forward with an open mind.

Key Words

Building Information Modeling

Integrated Project Delivery

Integrated Program Controls

Communication with BIM

Location Based Management

Executive Summary

Building Information Modeling, BIM, and Integrated Project Delivery, IPD, are two of the fastest growing trends in the construction market. They are quickly replacing the older systems of computer aided design, or CAD, and other delivery methods such as lump sum.

Building Information Modeling is the future of the industry and staying ahead of the curve takes time, effort, and innovation. However, because the technologies are still in the early development stages they are not being utilized to their full potential. That being said, BIM technologies need to broaden the horizons of the current applications and be simplified for the everyday user. Current BIM examples tend to be virtual models of buildings for the purpose of supporting the design, and construction phases of the built environment. The future of BIM modeling is to expand the information model to include more of the life cycle phases (property valuation, operations and maintenance, sustainability), to integrate the program controls, and to standardize information management so that meanings are clear and consistent.

While all answers regarding Building Information Modeling are still up for debate, there is no argument that the BIM process is gaining momentum, and to stay ahead of the curve research and development are necessary. Investments need to be thoroughly researched on a case by case basis, but the return on quality, time, cost, and marketability are becoming evident. One answer is clear; BIM is becoming the new standard and will result in tremendous change for everyone involved in the construction industry.

Preface

Born to build, I am proud to be part family immersed in the construction industry. My father and I hold the same undergraduate degree from Michigan State: B.S. in Construction Management. He has been a life-long mentor of mine and has guided me throughout my career in the construction industry.

I am currently finishing my M.S. in Project Management at Northwestern, and am working on capstone report to conclude my time at Northwestern. I would like to use my capstone to prove that the next generation can build smarter, and take this opportunity to **build** on the lessons that I have encountered in my career and my education.

Before studying at Northwestern, my first career out of college was a project management position with First Hospitality Group. The firm specialized in the management of hotels and restaurants, but had internal development and construction capabilities. It was here that I first learned what it meant to be an owner's representative, and turned my view from a general contractor to an owner's perspective.

During my time at FHG I learned valuable management skills and an industry outside of construction. I was fortunate enough to work on the project of a lifetime in the WIT hotel, a boutique hotel in the Chicago loop. This mega project further developed my skills as a project manager. I was also fortunate to meet another mentor of mine, John Jurewicz.

When my time at FHG was abruptly ended due to the state of the economy, I was left at a crossroad and turned to several of my mentors; John Jurewicz, an architect, and also an adjunct

professor at Northwestern's M.S. in Project Management Program. Curiosity led me to the program at Northwestern, and opened my eyes to a whole other level of education.

While at Northwestern I was exposed to several industry leaders in Construction and Project Management. Dr. Krizek and Dr. Hadavi have created a unique, niche program in construction that has equipped me with the necessary skill to be successful in my career. Thank you for your dedication to excellence and pride in the construction industry.

I am nearing the end of my degree and my capstone report will showcase how my career as an Owners Representative and education in project management can be applied in the construction industry with Building Information Modeling. Thanks to all of those who have supported me in my pursuit of excellence.

Introduction

My objective in this capstone report is to examine the current uses of Building Information Modeling technologies, and then showcase the industry's shortsightedness in applying BIM. I will show how communication is the most effective tool within BIM, and propose strategies to better implement the current technologies.

Building Information Modeling is defined as:

. . .the process of generating and managing building data during its life cycle. Typically it uses three-dimensional, real-time, dynamic building modeling software to increase productivity in building design and construction. The process produces the Building Information Model (also abbreviated BIM), which encompasses building geometry, spatial relationships, geographic information, and quantities and properties of building components. ¹

BIM is a new communication tool, process, and technology in project delivery and is also known as computer-integrated project delivery because computers have helped drive the integrated project delivery methods. However, I feel that using integrated project delivery is shortsighted because the construction industry as a whole should take a more comprehensive look at how BIM can contribute through the "whole life-cycle" of the program to communicate the design, construction, operations and maintenance of the facilities, as well as financial information during the life cycle of the facility.

Some types of buildings, such as hospitals are considered to make good case studies in showing how BIM strategies can be implemented due to their complexity of systems. In a recent case study of Sutter Medical Center in Castro Valley, California the project team used an Integrated Project Delivery method, which it defined as:

. . . a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all

participants to reduce waste and optimize efficiency through all phases of design, fabrication and construction. IPD principles can be applied to a variety of contractual arrangements and IPD teams will usually include members well beyond the basic triad of owner, designer and contractor. At a minimum, though, an integrated project includes tight collaboration between the owner, architect/engineers, and builders ultimately responsible for construction of the project, from early design through project handover.²

BIM and IPD are currently being used in a shortsighted way because they could support a better method of controls and communication that is Integrated Program Controls (IPC). Integrated Project Delivery stops once the building is turned over to the owner, but Integrated Program Controls would last throughout the life cycle. Currently, most owners and project teams use a number of different applications to communicate data, financial information, project information and all internal communication that needs to occur during typical business functions. BIM should be the central application.

Current BIM examples tend to be virtual models of buildings for the purpose of supporting the design, and construction phases of the built environment. Used within this scope, BIM speaks primarily to architects, engineers, estimators, constructors, and owners as they participate in the new-building development process. The future of BIM modeling is to expand the information model to include more of the life cycle phases (property valuation, maintenance and operations, sustainability), to integrate the program controls, and to standardize information management so that meanings are clear and consistent. This expanded scope definition will make BIM useful to a wider community and prove that the construction industry can make progress in regards to its' shortsighted implementation of BIM.

To show how BIM can be used in this expanded scope, this paper first will look at the history of BIM and then explain the planning, construction and operation phases of Building

Information Modeling. Next, the paper will demonstrate how businesses can communicate more efficiently through the use of BIM. After that, the paper will focus on how and where to move forward with Building Information Modeling. Finally, the paper will conclude by explaining how all of these elements can come together with BIM to help develop and manage a company's strategic plan. The final objective of this research is to show the need for a platform that combines all business sectors into one source including all business function and levels (business, functional, and corporate). By integrating marketing, engineering, operations, finance and information technology, companies can operate more efficiently, reduce rework and improve interoperability, or ability of one system to work with another.

Research shows that interoperability at this time is in great need of improvement. In August 2004, the U.S. National Institute of Standards and Technology published a report entitled *Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry*, which concluded that, in a conservative estimate, the U.S. capital facilities industry loses \$15.8 billion annually as a result of inadequate interoperability due to “the highly fragmented nature of the industry, the industry's continued paper based business practices, a lack of standardization, and inconsistent technology adoption among stakeholders.” The report also said this about BIM: “Recent exponential growth in computer, network, and wireless capabilities, coupled with more powerful software applications, has made it possible to apply information technologies in all phases of the building/facility life cycle, creating the potential for streamlining historically fragmented operations.”³ By creating a central platform and Integrating Program Controls problems with interoperability should be reduced and the industry will become more efficient.

History of BIM

Since the inception of Computer Aided Design (CAD), computers have played a vital role in the construction industry. Recently, computers have been the main platform that allows all parties to communicate design with along with a Building Information Model. BIM and computers help provide essentials of a good design, as well as allowing an integrated process for delivery.

The theory of Building Information Modeling was developed by scholars at Georgia Institute of Technology in the late 1970s. It progressed quickly. Construction teams have found value in using BIM to integrate the process of the construction industry. The term Building Information Modeling, first used in 2002 to describe virtual design, construction and facilities management, and gained traction with the release of several BIM authoring tools this decade. Today BIM is a moving target that is making progress daily and as users become more sophisticated in its applications; BIM has shown the ability to improve the planning, execution and close-out phases of the construction process, and it here to stay.

Planning

Once shareholders decide that something needs to be constructed, the planning phase begins. Its objective is to identify the owner's project requirements. The project team needs to be able to uncover the needs and constraints of the client. By integrating BIM, project teams can present client with accurate plans that match their specific business strategies and project requirements. Nailing down an owner's project requirements is one of the most important aspects of a project. BIM allows project teams to determine an owner's project requirements with greater accuracy than ever before. Owner's Project Requirements (OPR) are:

typically developed in the pre-design phase of a project to assist the team with understanding the owner's objectives and criteria for the project. Information about the project is gathered from the users and supplements the designers programming efforts. The OPR forms the basis from which all design, construction, acceptance, and operation decisions are made. The OPR is often modified during the design process as the owner's objectives and criteria are refined. 4

Design

Architects were the first members of the Architect, Engineer, Owner, Contractor (AEOC) team to embrace BIM. By using BIM technologies, the project team has the ability to quickly alter previous designs and provide the client with multiple iterations of the planned building to fit the owner's development needs. BIM technologies are currently used by

architects to help owners visualize space. Owners have used these models to "virtually" walk through their planned building and confirm that the design is satisfying the project requirements. BIM is being used efficiently on a growing number of projects to communicate design in the planning phase.

BIM provides the structure to capture all this important project data and retain it for the life cycle of the building. BIM differs from the previously used CAD models in that it builds with objects, instead of the previous methods, in which lines represent objects. Within BIM, these objects can carry product data such as thermal resistance, or something as simple as color, manufacturer and when the specific object was installed. Traditionally, important project data typically is lost somewhere in the building engineering department and more often than

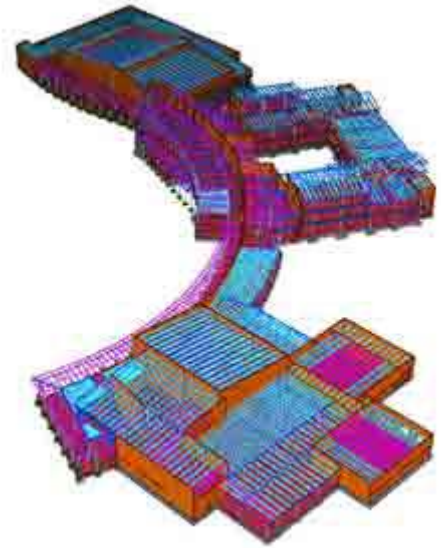


Figure 1. Tekla Structure

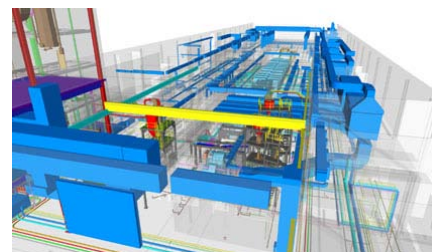


Figure 2. BIM mechanical systems

not, never used in business decisions or capital improvement programs.

Architects use BIM to define the initial space requirement and basic building massing. They can use programs such as Google Sketch-Up to provide a schematic design of what the building program entails, and BIM authoring programs such as Autodesk's Revit, Tekla Structure (Figure 2), or Graphisoft's ArchiCad some of the leading software's used to create the initial BIM model. BIM authoring tools allow you to create Construction Drawings and can be viewed in 3d. Figure 3 shows the mechanical systems of a BIM model. Early adopters and project teams are finding clear benefits, such as reduced time and drawing with fewer errors. Empirical data has been captured from these cutting-edge projects to help sell the industry and bring the movement mainstream.

Sustainable Construction

One emerging market that supports the use of BIM is sustainable construction. Since the inception of Leadership in Energy and Environmental Design (LEED) in 2001, sustainable practices have been at the forefront of clients' needs. Architects however, will say that the only new things about sustainable construction are the buzzwords "Green" and "LEED." Designers and architects, such as Frank Lloyd Wright, have used sustainable elements in their designs for decades.

BIM acts as a tool for verifying the performance of high-efficiency buildings. Information models can be tested and verified using emerging technologies that link directly to the BIM models. Project teams can use a "whole building" design approach to test various iterations of design within the safe confines of BIM. LEED specifies that buildings need to optimize energy, and the most cost effective way to produce these outcomes is to build a BIM

model and then test the design criteria with various “plug and play” applications, such as energy modeling. BIM and LEED will be forever linked, not only because of their relatively close time of inception, but because they are interdependent tools for the future of our industry.

Construction

After the initial design phases have been completed, contractors get involved in executing and using BIM technologies. They use several areas of BIM implementation during the pre-construction and construction phases including location based management, collision detection and detailed quantity surveying. These processes, which previously were manually computed, are now taking on a whole new meaning in the BIM arena. They are providing essential information at a fraction of the time, allowing the project team to focus its efforts in different directions.

This section will discuss a growing development in the construction delivery process--the five dimensions of BIM and how they benefit project teams. The first three dimensions (xyz) are defined by the model or the three-dimensional space of the building, and can be tied to geospatial information systems (GIS) to show where the building is located in 3d space. The next dimension of BIM is 4D, which adds the element of time to the BIM model. Project teams use this component to help with construction logistics and planning. They can visually show where and when work is to be completed. The fifth dimension involves tying the model object to cost data, or cost-loading the model. This allows the team to show where significant costs are occurring and to perform detailed cost estimates. In the future, project teams need to look at project life cycle and sustainability; this emerging sixth dimension known as, lifecycle, focuses on facilities management and sustainability.

Location Base Management

Location-based management is a clear early benefit of the BIM process because it shows where materials were stored and work is to be completed. Location-based management is the fourth dimension of BIM; a building information model provides the xyz data of the construction project and can easily be tied to the time, or t. Figure 5 shows a BIM model and a flow line schedule (Location Based Management).

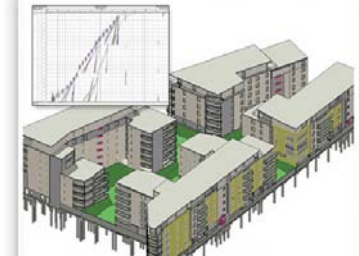


Figure 3. VICO Software

Early *construction* adopters of the BIM movement have begun using VICO software to perform detailed project management functions. VICO is one of the leading *construction* software suites that uses BIM. Dr. Olli Seppanen of VICO software pioneered location-based management. VICO, combined with an information model, provides contractors with the tools they need to compete in the future.⁵

VICO specific function of Location Base Management has allow users the ability to visualize a project schedule .Project scheduling has long been a phase of the preconstruction process. In this planning phase of preconstruction, the project team develops a schedule for constructing the building, including how the bricks and sticks will come to the site, and be stored, transported and installed in their permanent positions. With the creation of the location-based management systems as used with VICO, the schedule is tied to a direct location within the BIM model. In the pre-BIM era, the scheduler used critical path methods to plan and schedule construction, but failed to state *where* the work would be completed. Schedules tied directly to the construction documents paint a clear picture.

Collision Detection

Collision detection coordinates the mechanical systems and piping of a facility, and is not a new skill to most Mechanical, Electrical, Plumbing (MEP) Contractors, who have been communicating design requirements for decades. However, methods have evolved because of BIM. In the pre-BIM construction era, these collision detections were performed over the infamous light table. Contractors would lay their drawings on top of each other and try to minimize coordination issues in the field. Figure 6 is Autodesk's collision detection software.

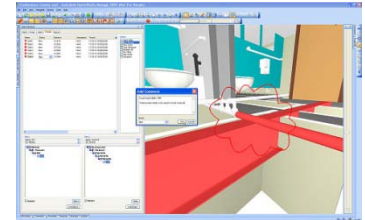


Figure 4. Collision Detection

Collision detection, which is quite beneficial to contractors, has taken on an automated life; it is now performed in a group setting in which all the subcontractors are present, and the coordination can take place in real time. Architect John Jurewicz has been directly involved in these coordination meetings that are becoming a slowly growing trend. He describes the process thusly: “As building information modeling continues to gain traction, many contractors who have become familiar with managing a project with BIM recognize the need for meeting rooms where three-dimensional visuals are analyzed. These meeting rooms are being called Big Rooms.”⁶

With the inception of the Big Room (shown in Figure 7), contractors can now come together and *compute* the changes in coordination and design in real time. The previous manual method showed changes using colored pencils and various markups. Now the coordination problems can be fixed on the drawings as



Figure 5. BIG ROOM

they arise. Software programs such as Autodesk's Navisworks are leading the industry in collision detection. In a Big Room session, MEP contactors bring their designs and run a "Clash" on Navisworks to see the coordination issues. The various parties then work collaboratively to resolve all issues and update their iterations of the design. Collision detection is becoming a selling point to contractors for the BIM software vendors.

Cost Estimating

Cost estimating is another aspect of the building process that benefits from information provided in the BIM models. Building design is the responsibility of architects and engineers, whereas construction is handled by contractors. The first step in a project with detailed drawings is to perform a quantity takeoff of materials (also called bill of materials) to estimate the cost of a construction project. In the past, estimators manually measured and added quantities to gain a detailed quantity takeoff, and recently they have found methods to use computer to aid in the process.

The quantities that contractors use for detailed cost estimating come directly from the objects of the model, there is no data lost in the estimating process. This function is known as the *5th dimension* of Building Information Modeling. The estimators are able to gain the required information at a fraction of the time, which cuts cost and improves overall production. A variety of methods and programs are available to obtain the numerical data from BIM models, but the key is integration; integration with the model that can quantify or count the bill of materials and export the data into a cost estimating software. After the model is built with objects in one of the BIM authoring tools, contractors can export specific quantities for pricing. Automating this process with BIM provides fast and accurate information.

Regardless of what method is used for project delivery, BIM benefits architects, quantity surveyors, estimators, and contractors and their clients. Some of the early benefits of BIM during the construction process have been highlighted; general contractors, though slow to jump on the BIM bandwagon, but are realizing the direct benefits of BIM and are exploring other areas of its implementation. Some of the areas contractors are exploring in the field include laser technologies, machine-guidance technologies and radio frequency identification tags (or the equivalent of a bar code). These technologies are in the beginning stages of development, and innovation of further applications is inevitable.

BIM in the field

BIM is progressing from the office environment into the field. Contractors are starting to use various applications to automate and use computers to control process, mitigate risk and human error. An example of this is the Trimble companies, a group of software companies who lead the industry in construction GPS technologies in the field. They have developed solutions to various applications of BIM in the field. Figure 8 shows an application of BIM in the field using BIM to lay out the site. GPS technologies allow the BIM model to communicate with equipment in the field and provide a high level of support to the contracting team. A few of Trimble's' technologies applications are laser scanning, machine guided technologies and radio frequency identification tags.

Laser scanning technologies (as shown in figure 9) can help capture as-built construction and assist the project

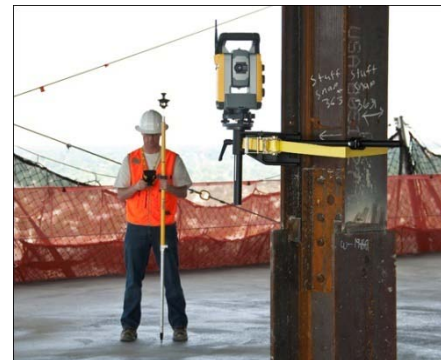


Figure 6. Field Layout

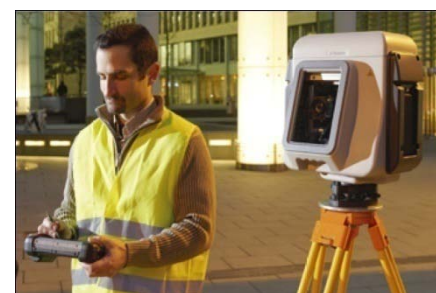


Figure 7. Laser Scanning

teams and renovation project. Laser scanning has a direct benefit of reducing time and providing more accurate information. After the initial scan, architects can use the three-dimension information to create designs and concepts. Without the use of this new technology, architects are forced to take tedious measurements and re-create as-built-drawings. Laser scanning is an obvious benefit of BIM and will become more readily applied in years to come.



Figure 8. Machine -
guided Technologies

These measurements then can communicate with a three-dimensional BIM model, which can automate the adjustments needed to control the work being done by that machine. Although machine operators will never be out of a job, machine guidance is valuable in helping them to be accurate in their work and increase their productivity.

Another future BIM application is bar coding, or Radio Frequency Identification Tags. RFID can help with the tracking, procurement and asset management of construction materials. RFID tags can communicate into a main system and help track verify materials onsite. These technologies are being used on large materials and equipment, such as steel and HVAC equipment.

Trimble also has a product line that deals with machine-guided technologies. (These technologies provide civil engineers and machine operators with invaluable tools for the future.) As shown in figure 10, Trimble GPS units can be installed on the blade of earth-moving equipment, and linked to the satellite to convey its geospatial position., including the unit's coordinates, blade pitch and angle.

Bar coding is not a new technology, but it is new to the construction industry. Using logistics, purchasing and supply chain management, to code and scan helps suppliers, vendors and purchasing agents track the constant flow of materials in the construction process. This technology will no doubt help the construction industry be more efficient.

RFID tags are being used only to track materials at this point, but could be used to convey the product data of materials. This product data then could be used in facilities' maintenance programs and asset management; however, keeping BIM and IPC in mind, having these systems communicate with RFID on a central platform would be the most advantageous.

Operations and Maintenance

Limited BIM modeling is being used in Operations and Maintenance (O&M). Public entities such as the General Services Administration and the U.S Coast Guard, however, are leading the industry in further implementation of BIM.

In the National Institute of Building Sciences spring 2009 edition of *The Journal of Building Information Modeling*, the General Services Administration is quoted as saying, "Most important to GSA in these studies was the realization that BIM could be a real benefit for many building types, both new and renovations, and across the entire life cycle of planning, design, construction, and facility management and operations."⁷

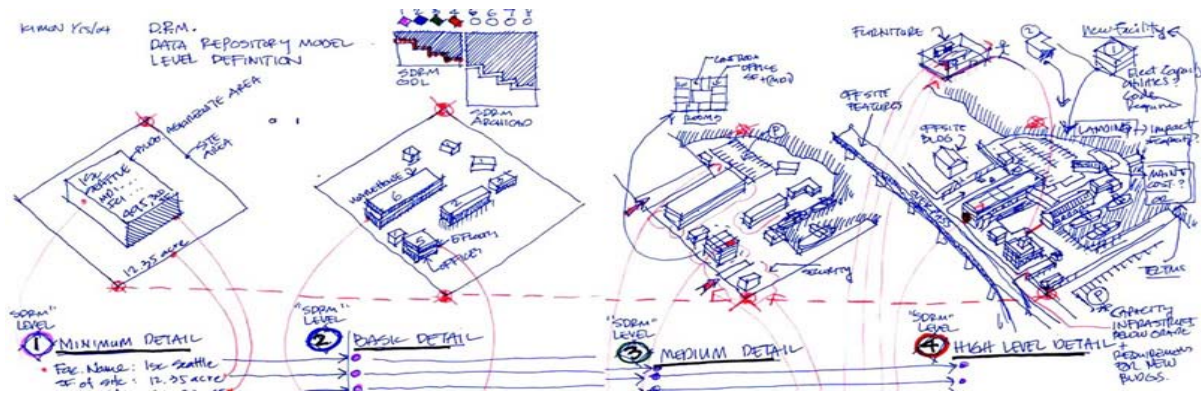


Figure 9. U.S. Coast Guard BIM applications

Figure 11 shows a schematic design developed for the O&M BIM platform created by Kimon Onuma and team to manage the U.S Coast Guard’s 33-million-square-foot facility portfolio. On the left is the lowest level of detail and only one facility; as the sketches progress they incorporate a higher level of detail and show the interrelationships between the various functions. Although this is only an initial sketch of Onuma’s award-winning work, it shows how various functions of an organization can be linked by using BIM. It is essential to the backbone of the operation to have a program such as BIM to develop the level of detail necessary to manage information.

U.S. Coast Guard Chief David Hammond stated that “The integration of BIM, geospatial data, real property data and mission requirements supports the need of a common operational picture for the USCG. This common operational picture can be real time tactical information as well as longer term strategic information, which is enabled by the Onuma Planning System.”⁸

Facilities Maintenance

BIM is helping Facilities Maintenance (FM) programs progress by controlling information with BIM. As discussed, owners such as the U.S. Coast Guard and the General Services Administration are beginning to integrate BIM models into software programs to allow FM managers to

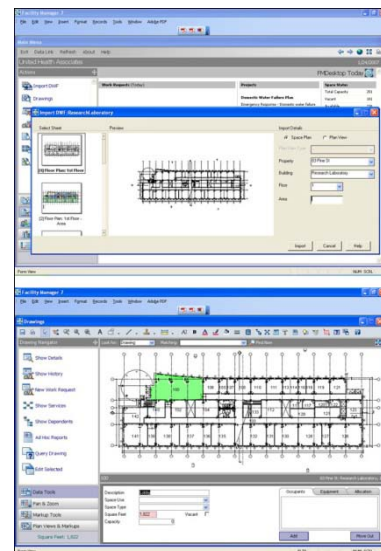


Figure 10. Facilities Maintenance

work on a collaborative platform. Building engineers have begun to implement computer-aided facilities management with construction drawings (as shown in figure 12), and now are looking to use more BIM applications. BIM can provide the highest level of detailed information that is more comprehensive than any other source, supplying the FM manager the best information to make decisions. Implementation has been slow, but progress is being made.

In a recent article by Harry Singh, project director of facilities management and assessments for Woolpert, Inc he stated:

A properly implemented Computer Aided Facilities Maintenance or Computerized Maintenance management system for facilities management will help facility managers, planners, and owners better manage facility life cycles, Information for a CAFM or CMMS can be used to inform the design process and result in better designs. This technology can serve as the integrating platform that captures information from the beginning to the end of a facility's lifecycle, including that critical transition from sustainment to recapitalization planning. 9

Facilities Maintenance is the 6th dimension of the BIM process, and represents life cycle management for owners. Adding this dimension has been a challenge of interoperability between programs and integration of all valid data; once an integrated approach becomes mainstreamed, this dimension will have the greatest value and return for its owners, because they will see the greatest return in facilities management.

Financial Asset Management

The last function of Building Information Modeling is managing real estate assets and providing information to corporate leaders. After project delivery, the owner needs a tool to manage the asset; BIM would be the most logical tool to integrate this aspect of business. Once the facilities are properly managed at a micro level, entities will have the ability to analyze decisions and impacts from a macro level. BIM could provide lending intuitions with direct

communication about a company’s business strategy and allow these institutions to analyze their core business; it also could work to automate lenders’ approvals and provide a high level of information to the appropriate parties.

Although real estate may not be a company’s core business, it certainly is a primary concern. Real estate helps companies define their identity and business, because most companies need a space—whether leased or owned-- from which to operate. And they need to be financially responsible in managing these assets. Companies need to turn a profit in their core business to keep the doors open, and to service their debt to provide ongoing operations.

Senior commercial lending analyst Marcus Harris stated: “Banks are most concerned with debt service and how an entity is going to be fiscally responsible for these debts. Companies need to report their revenues and expenses to show to the lending institution they can service these debts. It’s all about the money.”¹⁰ To manage real estate and



Figure 11. Net operating income shown with BIM technologies

other assets, you first need to manage your core business; BIM needs to penetrate this unexplored market. Creating business Pro forma’s could become (Property valuation) a new dimension of BIM and the unexplored market. All of these dimensions should be computed using a BIM application that would model the business’ operating income.

By linking financial information directly to the BIM model, the owner can now start to see a system of integrated program controls in which all parties are working for the same

information and providing the best tools for management. Creating an Integrated Program Controls system is the next step in information modeling and will take significant research and development. BIM will be the backbone of this platform and provide the optimal structure to start the building.

Once companies start to analyze more than one building on an integrated platform over the life cycle of a building, the benefits of IPC will be realized because managing business assets is the final goal in using BIM as a management tool.

Property Valuation

One approach to property valuation in the real estate industry is the income method. Building Information Modeling could be deployed in using this approach. Using location-based management techniques, such as those using *VICO* software, and linking revenues and expenses to a location asset management could take on a whole new approach. BIM is the platform for integrating communication and could link financial information from operations to the financial departments; BIM technologies could then be developed to compute the value of the property in real time using information from BIM models. This is an area of BIM technologies that should see rapid development. Property valuation is a necessary function in real estate that BIM will eventually expand to accommodate.

Moving Forward with BIM

Moving forward with BIM, there are several areas that need development and other areas that could benefit from further integration Building Information Modeling. Communication is one clear area, but other areas, such as program controls, industry standards and the workflow through BIM need to be further explored and integrated. Once these areas are further developed,

it will become possible to fully integrate project teams and finally use BIM to develop business strategies and integrate multiple business sectors.

Communication

BIM provides the project team the ability to communicate information essential for making business decisions. Communication is the function of project delivery with the largest impediment to success and the area that needs the most improvement. The I in BIM -- *Information*-- is the most important part of communication. Information is the key to BIM and its use as a management tool. The more information communicated from one single channel, the more accurately the information can be controlled and communicated. With BIM, the information can be visually displayed for greater understanding of the system as a whole; this allows owners to reach a better understanding of the final product.

That being said, the current BIM technologies do not address all the issues of information communication of which they are capable. BIM is still in the early stages of inception and will inevitably progress with technology, money and time.

“BIG BIM little bim” is a term coined by architect and author Finith Jernigan. In his book, *Big BIM little bim*, he describes the difference in theories in the applications of BIM. Jernigan speaks to the issue that many BIM users are using only a “little” of the BIM authoring tools. In his book example, he defines BIG BIM as “ the management of information and the complex relationships between the social and technical resources that represent the complexity, collaboration and interrelations of today’s organizations and environment.”¹¹ The focus of his definition is to look at the big picture of the project’s life cycle, and not focus solely on the

technologies, but rather the process that is BIM. Both BIM technologies and the process need to be improved.

BIM technologies need to be created to host all building information from the project conception through the life cycle of building so that owners can clearly communicate and adapt to internal and external market conditions. The best decisions come from the most current information; that information should be hosted by a central platform. While BIM is not that platform yet, it will be. With rapid improvements in the technology industries and the BIM movement, communication will be highlighted as the most prominent tool.

Building Information Modeling is only the first step in future delivery methods in the construction industry. The newly developing delivery method, Integrated Project Delivery, is the next step in the industry. IPD seeks to form a partnership between the owner, architect and contractor for responsible delivery of a construction project. The partnership also should use cooperation and mutually beneficial rewards to keep all parties working toward the end goal, a completed construction project.

Integrated Program Controls

Integrating multiple projects throughout a building's life cycle using the same control system is the focus of Integrating Program Controls. Integrated Project Delivery is only the beginning. A building starts its life upon construction delivery. So why stop with project delivery? Why not search for solutions to integrate the building from conception through delivery and into the operations process? The industry is shortsighted in that it is developing terms to define the IPD process, while failing to see the need for discussions regarding Integrated Program Controls. When the project delivery is complete, another project -- the building life

cycle -- starts. The information from the first project needs to flow into the next set of projects. If the industry fails to identify the direct link necessary for information workflow, they have overlooked the true control that the BIG BIM can command; but luckily for the construction industry, there are individuals working to develop BIM so that the applications can work in any phase of the program or project life cycle. Integration problems will need to be resolved to allow BIM to flow seamlessly through functions and end up in a state where end users and stakeholders can learn to use BIM to continue the communicate back to the shareholders.

The key difference between a program and a project is that a project is temporary and comes to a finish, whereas a program will span multiple projects and extend the life cycle of the program. The Project Management Institute defines a project as “a temporary endeavor undertaken to create a unique project, service, or result.”¹² RISE, a Chicago-based program management firm, defines a program as “multiple projects linked by a single common business plan.”¹³

The project team will inevitably change during from the planning, construction and the operations phases but the information database could remain relatively unchanged. BIM should integrate all project information into a central program controls system throughout the life cycle of the endeavor, which is precisely the goal of IPC vs. IPD, integrating throughout the lifecycle.

The various parties in the Design, Building, Operations and Maintenance (DBOM) phases of the build environment need to communicate vital information to the project team. BIM should be the platform for this information using Integrating Program Controls. In having a central platform, you can be certain that no information is lost and that all the information is given to the correct parties.

The key team will change as the project progresses. In the inception phase, it may be critical for the owner to communicate about the design with the architect, as well as checking design against financial constraints. As the project progresses to the planning and execution phases, the key parties shift, and as the project comes to a finish at the substantial completion milestone, a whole new program emerges that is the building life cycle. Integration during the lifecycle is the goal of Integrated Program Controls.

In a recent interview, Paul Teicholz, founding director of Stanford University's Center for Integrated Facilities Engineering, founding director, stated: "Integration is the key to effective use of BIM; this is similar to communication. The tools for integration are still very basic... it would still be necessary to develop trust to permit effective working relationships." ¹⁴

Industry Standards

A main problem with the current state of BIM in the market is that there are no standards or specifications in information modeling. Several industry organizations are spearheading efforts to standardize the workflow of the information modeling process, such as: Construction Users Round Table (CURT), Technology in Architectural Practice (TAP), buildigSmart alliance, and Construction Operations Building information exchange (COBie).

Dana Smith, FAIA, executive director of the buildingSMART Alliance, is a key figure in the adoption of standards and specifications. The Alliance is a council of the National Institute of Building Sciences and is known as the father of the U.S. CAD Standard. The buildingSMART alliance was established to coordinate the profound constructive changes coming to the fragmented built environment in North America. The alliance's goal is the adoption of open interoperability and life cycle implementation of building information models.

Smith stated: “BIM is certainly one of those issues where you find out that the more you learn the less you really know. Every step opens up new opportunities as well as creates new challenges. I am concerned that we are not taking on some of the bigger issues related to how to get information to flow through the lifecycle.”¹⁵

Work Flow

The building industries' current problem integrating BIM into its operations has to do with the workflow of projects through BIM. The workflow of projects starts with a project inception in which the stakeholder states a business purpose to construct or renovate. They the project team then move into the planning phase, which is where BIM enters the picture.

Planning starts with programming the owner's project requirements. Google Earth is typically one of the first tools a manager can use to communicate and help determine site selection. Another function of the planning phase is programming an owner's needs and developing schematic designs. Several BIM applications offer an architect's drafting tool or BIM authoring tool, which aids in drafting preliminary designs.

A couple of new software tools have emerged as leaders in the planning phase: Google SketchUp and the Onuma Planning System. Google SketchUp is a likely BIM tool to create a massing of a building. If the project deal with an existing building, a likely starting point would be laser scanning. Laser scanning technologies help to capture as-built architectural information to re-create plans. From the massing or scan, a BIM model would then flow into one of two places: The Onuma Planning System (OPS), or one of the authoring tools discussed above. OPS provides one of the leading software functions of the front end of project delivery and has the ability to link multiple locations to one planning system. OPS implements time, space,

programming, demographics and the multiple layers of information that Google provides into a central location.

After the model flows from programming and into a BIM authoring program, designers develop the various construction documents from 3D BIM tools. At this point in the project, the construction team has to take the lead for project execution so the BIM life cycle will continue. As discussed, contractors sell the direct benefits of collision detection and integration of the element of time to the BIM model. With BIM in the field, contractors leverage the power of BIM and use it to help coordinate layout, logistics and relaying communication. The project management information systems provided by some BIM contractors tools, such as VICO, help manage communications; they include: submittals, requests for information, and correspondence.

The last phase of a project is closeout; it is an essential part. However, most teams deliver the project and fail to realize that although the project has been delivered, a new project starts, the lifecycle, which is where owners will ultimately reap the most benefit of using BIM as a tool for project communication and management. Management of a project lifecycle is the goal of integrating program controls.

During project close-out, Construction Operations Building information exchange organization (COBie) focuses on the delivery methods of product data to close a project and deliver information to the facilities management team. Owners have begun using information provided from BIM models and are populating COBie templates to communicate specification information to the individual project team responsible of maintaining the facilities. COBies' focus is to standardize the process in which in project information is exchanged during project

closeout. By creating standards for each phase, teams have improved the interoperability of projects, workflow, and communication.

To successfully use BIM in future projects, project teams need to resolve these interoperability problems. It is impossible to expect all these workflow problems to be eliminated overnight, but they do need to be worked out day by day in the trenches of BIM. Most pioneers of BIM had to develop their own project workflows, which led to problems with interoperability and proprietary software. Moving forward, information needs to be shared and lessons learned need to be talked about at industry forums. Using BIG BIM and the integration of BIM to develop business strategies are the next steps once these integration problems have been resolved.

Conclusion

Charles Eastman, author of *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors*, stated:

When revolutions occur, traditional means of operation are no longer effective. Traditional cultures become unstable and new practices are explored to address the instability. Some social units will succeed and become successful, while others will not adapt and fade away. ¹⁶

The revolution is here, and that revolution is BIM. The future of the construction industry depends on BIM and integration of fragmented sectors. The design and construction phases are the most developed, and provide the most obvious payoff of BIM, but there are several areas where BIM has not been effectively implemented and where new innovations within information modeling are being developed and explored, such as property valuation. There is an obvious gap between what is currently being implemented and where BIM could go, but to be truthful, there is no end to the journey. Jerry Laiserin, Professor and industry analyst at Georgia Tech

University, sums it up nicely by saying, “100% BIM... we don’t know what 100% BIM is.”¹⁷ In conclusion, we have looked at the current state of the marketplace and where the construction industry is headed. While we may never be 100% BIM, the industry is making progress.

Building Information Modeling is a very new technology that is not being used to its full potential. Our industry needs to explore the capabilities of this powerful tool and seek to work them into everyday practice. Providing managers with the best information and integrating project teams will have a direct benefit on communication and decisions for shareholders. BIM should not be viewed as one tool, but as a centralized platform for multiple disciplines to integrate and communicate.

Most owners and project teams use a number of different applications to communicate data, financial information, project information and all internal communications that occur during typical business functions. BIM could be the platform to host these communications and link essential business functions in a central location.

Integration of BIM and Business Strategy

A successful implementation plan will integrate all functional levels. BIM is the platform to implement integration and provide a structure to communicate information. By integrating *program controls, communication, and information*, teams will be able to make business decisions with the correct information and manage assets from a central location. BIM is a tool for project management, but, management functions do not need to be limited to the construction industry. Rather, they could encompass *any* company’s strategy and be used as a strategic management tool.

Integrating Building Information Modeling and business strategy is the future of Building Information Technologies. BIM is the umbrella under which the network of information can be communicated. BIM can capture multiple dimensions of projects and programs, and integrate the information for all stakeholders. BIM is the future, and the starting place of integrating information is now.

References

Citations:

- ¹ Holness, Gordon V.R. (June 2008) "Building Information Modeling Gaining Momentum." ASHRAE Journal. Pp 28-40.
- ² Khemlani, Lachmi. "Sutter Medical Center Castro Valley: A Case study of an IDP project," *AEC Bytes*. (http://www.aecbytes.com/buildingthefuture/2009/Sutter_IPDCaseStudy.html) Accessed March 16th, 2010.
- ³ National Institute of Standards and Technology. "Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry," *U.S Department of Commerce Technology Administration*. (<http://www.bfrl.nist.gov/oae/publications/gcrs/04867.pdf>). Accessed March 16th, 2010.
- ⁴ Commissioning & Green Building Solutions, Inc. "Owner's Project Requirements," ASHRAE. Buford, Georgia. (<http://images.ashrae.biz/renovation/documents/opr61507final.pdf>). Accessed on March 16th 2010.
- ⁵ Seppanen, Olli Ph.D. (2010), Personal Communication.⁷ Jurewicz, John. "The Growth of 'Big Rooms'," *Project Controls*. (<http://www.projectcontrols.com/articles/20091221>). Accessed on March 16th, 2010.
- ⁶ Jurewicz, John (2010), Personal Communication.
- ⁷ National Institute of Building Sciences Journal of Building Information Modeling (Spring 2009). "BIM: The GSA Story." Washington, D.C.
- ⁸ Eastman, Chuck- Teicholz, Paul (2008) "BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Engineers, and Contractors." Hoboken, New Jersey
- ⁹ National Institute of Building Sciences Journal of Building Information Modeling (Spring 2009). "*Reducing Facility Management Cost through Integration of COBIE and LEED-EB.*" Washington, D.C.
- ¹⁰ Harris, Marcus (2010), Personal Communication.
- ¹¹ Jernigan, Finith. (2007) "BIG BIM little bim." 4Site press. Salibury, MD.
- ¹² Project Management Institute. (2008), *A Guide to the Project Management Body of Knowledge*, Fourth Edition, Project Management Institute, Inc. Newton Square, Pennsylvania.
- ¹³ Crowell, David- Hartman, Jack. "Program Management." *Northwestern*. Presentation given April 7th, 2009.

¹⁴ Teicholz, Paul Ph.D. (2010), Personal Communication.

¹⁵ National Institute of Building Sciences Journal of Building Information Modeling (Spring 2009). "Message from the Executive Director of the buildingSMART Alliance." Washington, D.C.

¹⁶ Eastman, Chuck. "An Assessment of Technologies in Design and Construction and University Research Opportunities," Georgia Institute of Technology. (http://www.coa.gatech.edu/news/symposiaarchives/CIB06_Eastman.php). Accessed March 16, 2010.

¹⁷ Laiserin, Jerry. "BIM Past, BIM Future," *Georgia Institute of Technology*. (<http://smartech.gatech.edu/handle/1853/22439>). Accessed March 16th 2010.