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AN INTEGRATED PRACTICE

W205 BIM Best Practices
December 9, 2008

Kurt D. Maldovan
kurt.maldovan@jacobs.com

ecobuild america

buildingSMARTalliance

AEC–ST Science & Technology

AIA

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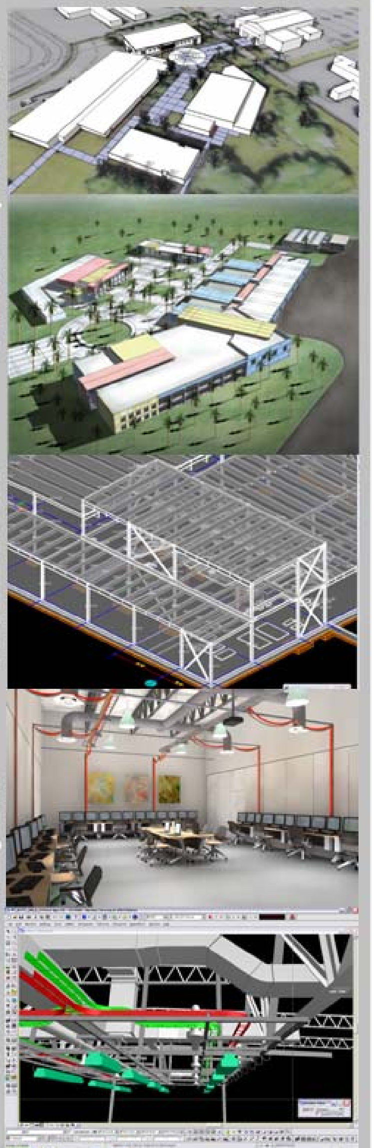
Full BIM Projects



BIM in Planning:

- Early Design Tool
- Links to Cost Model/ Program

BIM in Design:

- 35 Active Full BIM Designs
- All Disciplines, All Phases
- Coordinated Designs

BIM in Construction:

- 7 Full BIM Designs in Construction
- 12 VDC Projects

The 6D BIM Approach

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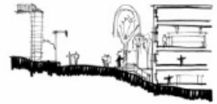
- 2000-2005 – **Pockets on BIM/4D**
- November 2005 – **Internal BIM an**
- January 2006 – **Commissioned A**
- March 2006 – **Best BIM Path Forv Project**
- April 2006 – **First Full BIM Projec Phases)**
- July 2006 – **Committed to doing**
- May 2007 – **First three BIM Projects into Construction**
- August 2007 – **Developed Integrated VDC Scope and Approach – Began VDC Dialog with Clients**
- October 2007 – **Began aggressively proposing Integrated VDC Delivery – 12 Active Projects with varying levels of VDC Application**
- November 2007 – **22 BIM Projects/ Today 35 Projects**

AIA

BIM: Transforming a Traditional Practice Model into a Technology-Enabled Integrated Practice Model

By H. Thomas McDuffie, AIA, RIBA

Like most design firms, we are continually driven by our clients' need for faster delivery and lower cost. And like most design firms, we continually strive for design excellence, increased production efficiencies and opportunities to provide added value for our clients. However, unlike most design firms, our business model includes not only architectural and engineering services, but also design-build, construction management, and facility O&M services. And it is these additional services that prompted us to look for ways to leverage BIM not just as a tool for design, but as an integral part of the entire project development life-cycle.



As we looked at our use of the traditional linear design process, two opportunities for improvement became evident. First is accelerated decision-making. Early decisions based on good data save time and money. Second, is to create a more collaborative concurrent process. Removing the stops and starts inherent in the linear model results in improved coordination. Individual phase activities are pulled forward into the "big picture" context. This not only increases interaction between disciplines, but importantly provides added opportunities for front-end involvement by stakeholders. Increased stakeholder involvement, particularly during early project activities, significantly enhances the ability to fully identify and address owner objectives and expectations, benefiting quality and functionality.

We were an early user of BIM tools and frequently applied BIM during the initial project phase efforts. However, while BIM was adding a visual dimension to our early architectural phases, it was not providing schedule compression nor was it significantly improving overall work efficiencies. We needed a solution that supported an integrated big picture...a solution that optimizes the use of BIM across all disciplines and activities from planning through design, construction, and occupancy.

Initial Actions

With this challenge in mind, we took three key actions.

1. Got informed. We asked hard questions of staff, vendors, and industry. How was BIM affecting quality control activities? How was it impacting schedule? What cost benefits were gained? What added value was provided to clients? While pockets of innovation and success were found, we concluded that the full value of BIM was not being realized. What was needed were new work processes that engaged BIM not only in visualization of design interferences, but also in understanding impacts of design decisions on construction, commissioning, close-out, and operation and maintenance activities.

2. Commissioned a task force. This group was given a mandate to identify procedural changes needed to maximize the value of BIM within and across each phase of work. To facilitate this analysis, the task force identified a key project to serve as a case study and catalyst for change.

3. Set an internal expectation. A goal was set. All new projects will be executed through BIM by the end of 2007. By setting this expectation, we made BIM an operational requirement. We removed discretion for its use from that of project management and from client requirements.

Management by Outcome

We understood that BIM should be leveraged not just for design-related quality, schedule, and team coordination, but also for its potential to integrate post-design quality, schedule, cost, and coordination issues. With our stake planted firmly in the ground, it was critical to identify a means with which to measure results. Considering our two initial objectives (i.e., faster projects; increased project efficiencies), we identified two key metrics:

- **Schedule compression.** A goal was set to accomplish twice as much work within the same time frame and with the same number of staff. Our range of project size and complexity limited our ability to do this on all projects, but this provided an ambitious goal across all projects. Further, we expected BIM to assist in understanding impacts not only on design schedule, but also on subsequent project schedule for activities such as construction and commissioning. Success would be visible in our Rolling Workload Forecasts. If we met this objective, we would soon be in a position to tell our sales staff they needed to double their results in order to support current staff levels.

- **Team coordination.** This metric evolved over time. It began first with an objective to eliminate all construction-related change orders due to design-related coordination issues. Responding to our client focus, the metric quickly grew into the elimination of all client-generated review comments related to design coordination issues. It next progressed to the elimination of all internal quality control review comments related to design coordination issues. Ultimately, our goal is the real location of time budgeted for rework to investment in value adding design efforts.

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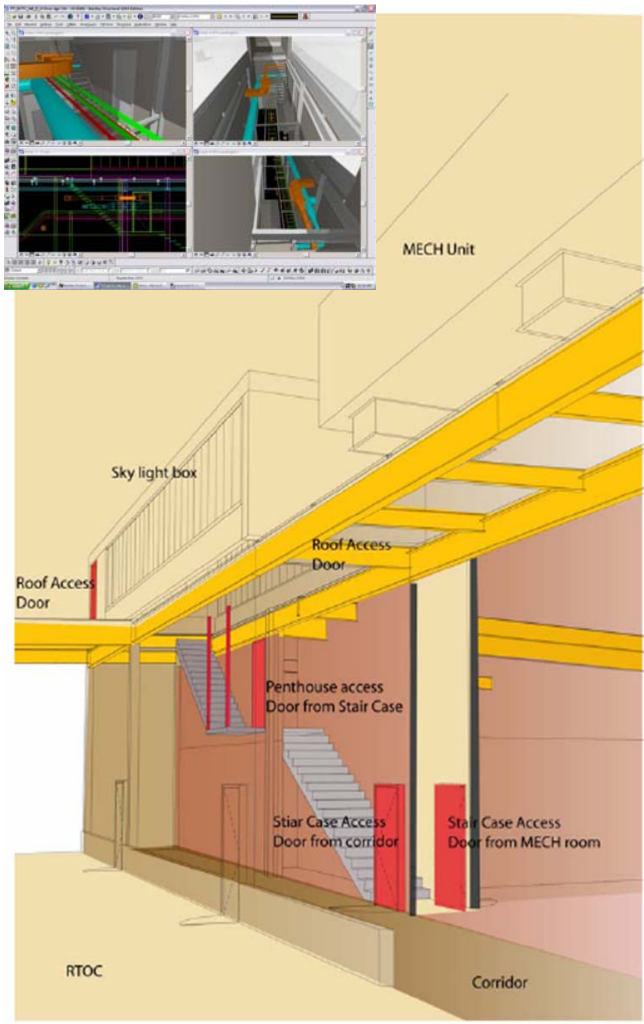

Typical Scope Of BIM On 1st Projects

- All Disciplines Involved in BIM
- BIM Used In All Phases Of Project
- Majority Of Drawings Will Come From The Model
- Use Interference Detection/Management
- Model Will Be Used To Develop Quantities
- Use 4D Scheduling to Evaluate Constructability
- Design Reviews Done In The Model
- Design Model Used In Construction

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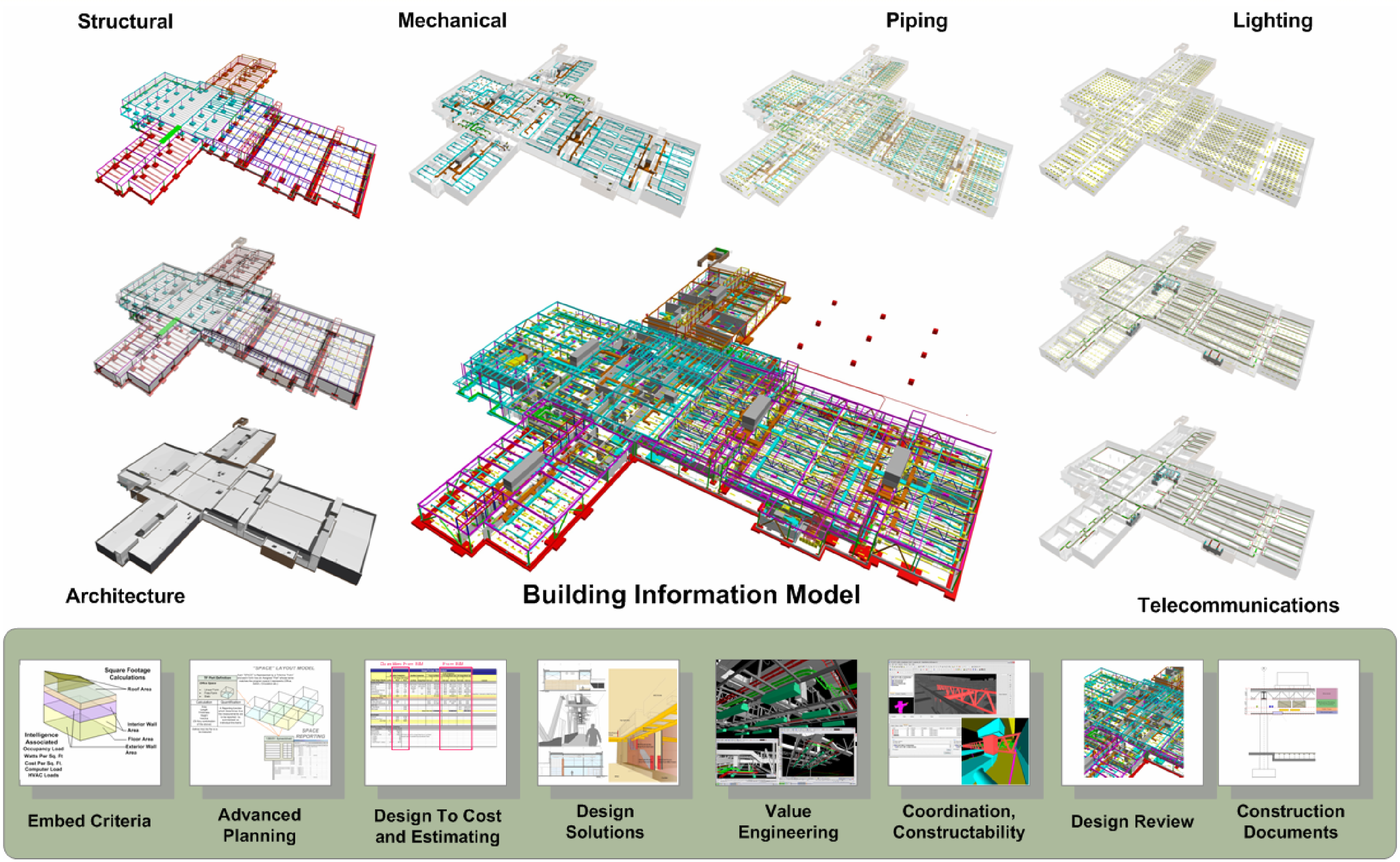


Key Metrics For BIM/VDC:

1.) Schedule Compression and Utilization:

- **Accomplish more work in shorter time-frame**
- **Focus more time on Design problem solving and project solutions**

2.) Design Quality and Constructability:

- **Eliminate design related change orders in construction**
- **Eliminate client review comments related to coordination**

3.) Deliver Solutions for the Lifecycle:

- **Apply 6D delivery across all projects linking 3D visualization with cost, schedule, commissioning, and O&M**
- **Exceed client expectations with an integrated practice model**

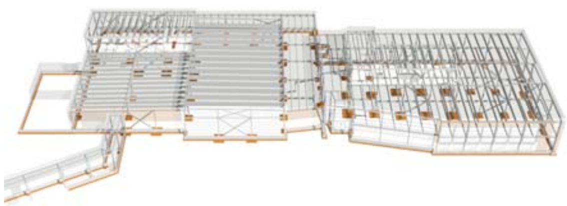
What Works Well:

- **Drawings From Models**
- **Coordination From Models**
- **Quantities From Models**
- **BIM as a Design/Engineering Tool**
- **The BIM-Based Work Process**
- **Team- Can Do Attitude**

Challenges:

- **The tools are perfect until you start to use them**
- **Models need to be accurate and up-to-date**
- **Model File Sizes and Tool Performance**
- **The Details – Standard Details in CAD, Model Detail required to create Drawing Details.**
- **Interoperability/ Multi Office/ Large Project Collab.**
- **Work Process Change is uncomfortable**

Typical Scope Of BIM On 2nd Projects



- Imbed Manufacturers Data
  - Schedules
  - Procurement
  - O&M Baseline
- Design Automation
  - Routing
  - Layouts
  - Connections
- BIM Integration with Analysis
  - Structural
  - Sustainability
  - Lighting
  - Power
  - Code Analysis

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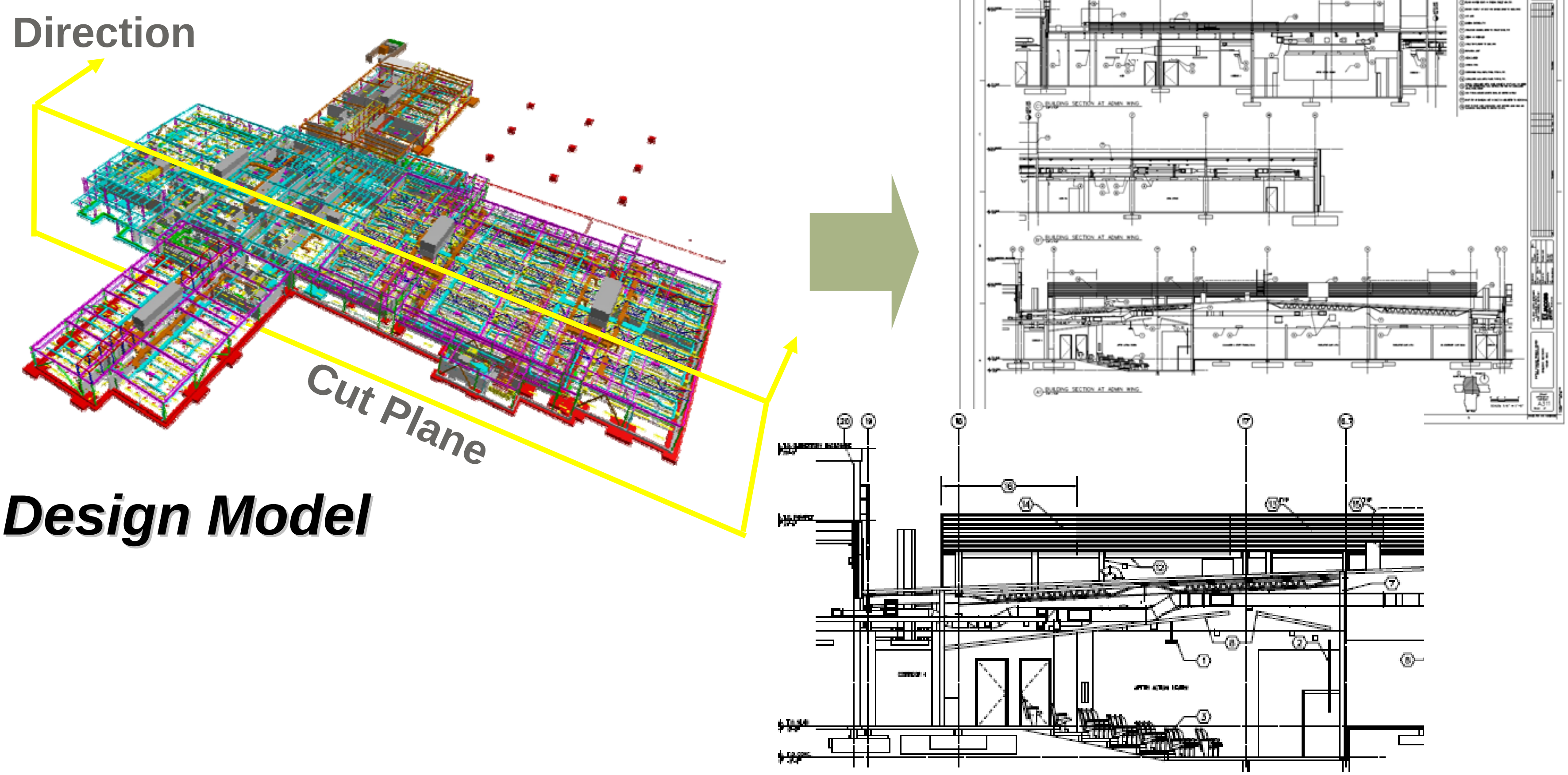
What About My Drawings?

Drawings



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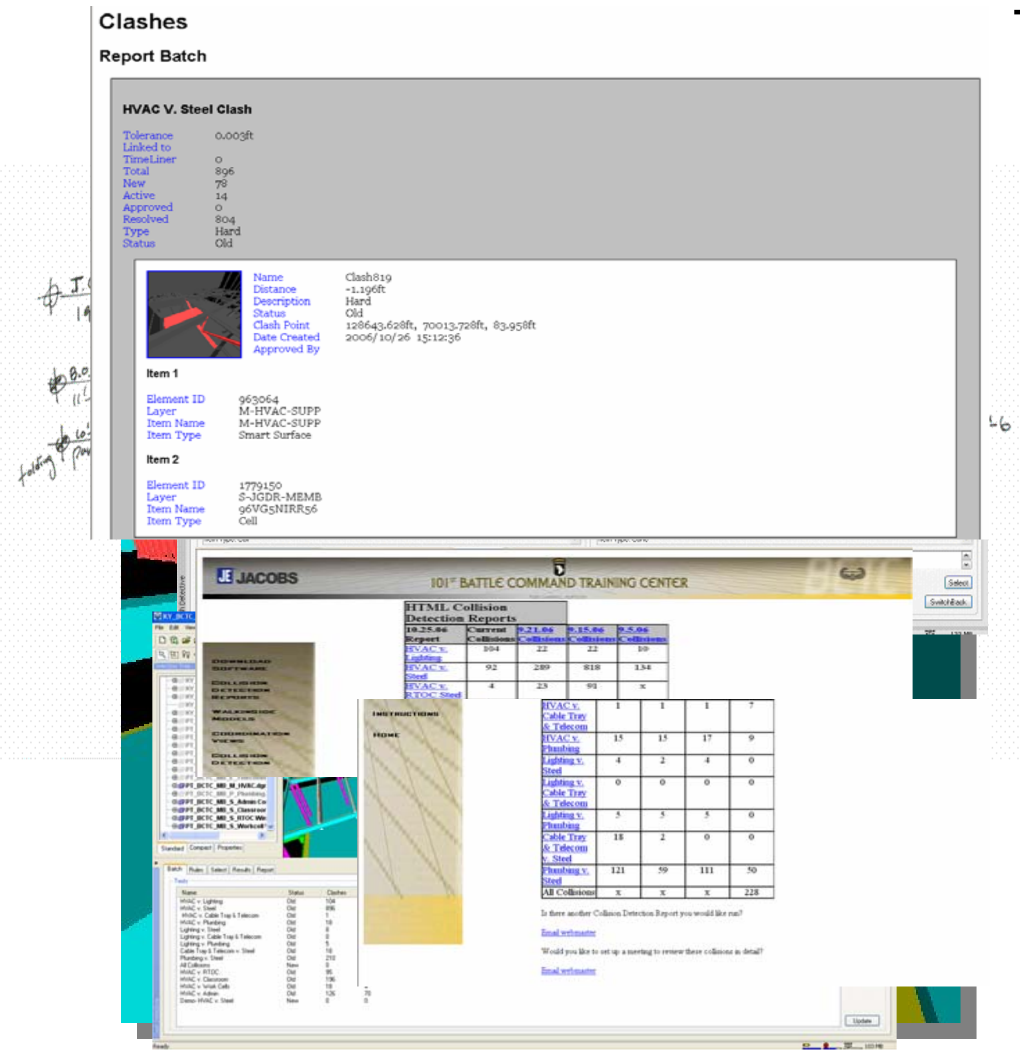


1.) Started Day One With Design Planning and Integrated Decision Making

2.) As Design Modeling Commenced, Visual Coordination Took Place

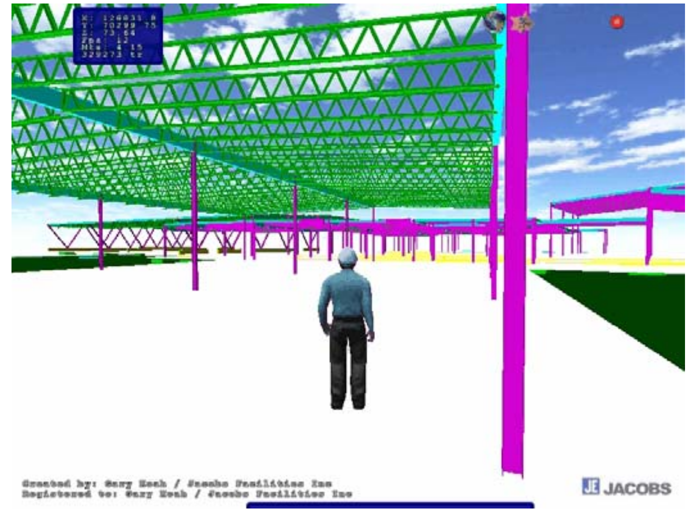
3.) Daily, Automated Interference Detections Were Run/Reported

4.) Design Team Collaborated to Resolve the Interferences and Optimize The Design

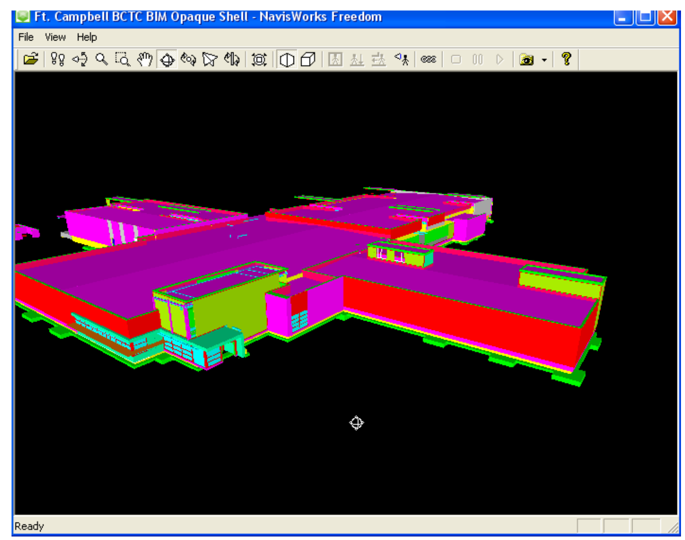
Design Reviews in BIM

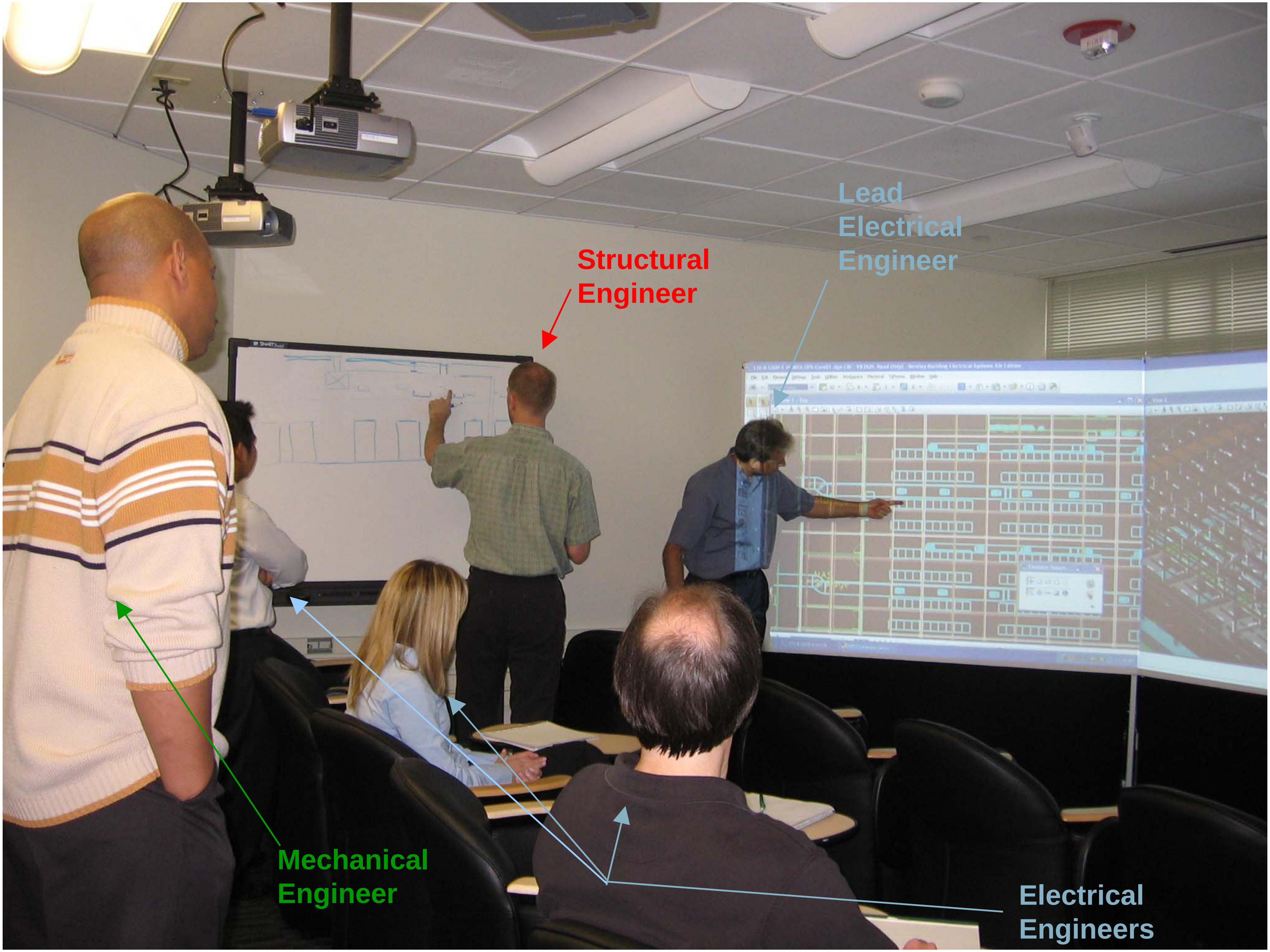
- Utilized Model Review Technologies to provide design team the ability to Collaborate within the model
    - Walkinside – Virtual Hardhat reviews
    - Navisworks virtual Navigation and analysis environment

Walkinside



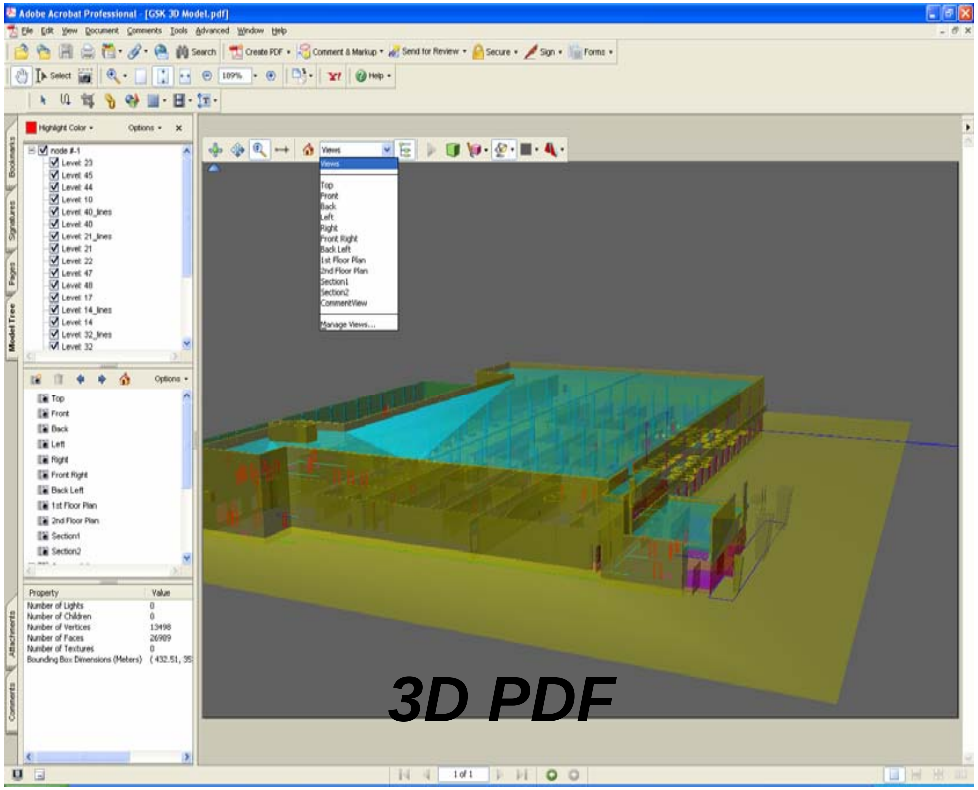
Navisworks




Structural Engineer
Lead Electrical Engineer
Mechanical Engineer
Electrical Engineers

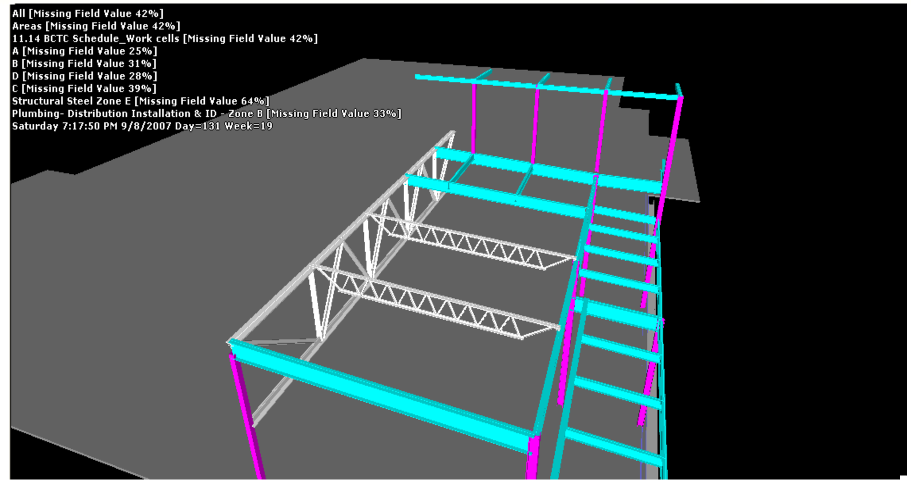
Quality Control of BIM

1.) Check- Model & Extracted Drawings
2.) Coordinate- Resolve System Interferences Prior to QC
3.) Develop QC-Specific Extractions to aide Review Teams
4.) Focus on Evaluating the Design Model's Constructability & Operational aspects of each System



BIM + Schedule

- Use Model to Establish Schedule (in Design)
- Iterative Process to Optimize Approach
- Simulate Site Logistics, Evaluate ***Safety (Safe-D)***
- Develop Detailed Short-term Look-ahead's
- Design for Construction



5D - BIM and Cost:

Utilizing Building Information Modeling in Design to Support Cost Estimating

Lingyun Wang [1], **Kurt Maldovan** [2], **and John Messner** [3]

[1] Design & Construction Visualization Coordinator, Jacobs Engineering Group, 1100 N. Glebe Rd, Suit 500, Arlington, Virginia, VA, USA, Phone 571/218-1223, FAX 571/218-1400, grace.wang@jacobs.com
[2] Design & Construction Visualization Coordinator, Jacobs Engineering Group, 1100 N. Glebe Rd, Suit 500, Arlington, Virginia, VA, USA, Phone 571/218-1439, FAX 571/218-1300, kurt.maldovan@jacobs.com
[3] Associate Professor, Dept. of Architectural Engineering, Penn State, 104 Engineering Unit C, University Park, USA, Phone 814/865-4578, FAX 814/863-4789, jmessner@engr.psu.edu

Abstract: Building Information Modeling (BIM) can provide innovative approaches to building design, construction, and management. One area in which BIM provides improvements over traditional methods is in quantification and estimating. BIM includes information of building element types such as walls, doors, and windows, as well as information of element properties including length, width, and volume, which can all be used for estimating. This information contained in the BIM makes it possible to extract parametrically intelligent building quantities.

Though BIM does not generate automatic cost estimates, one of its significant advantages over traditional 2D drawing based cost estimating is that it saves time by reducing manual takeoffs. Since the information in BIM is always consistent with the design, any changes in the design can automatically ripple to the takeoffs and counts used by the estimator. This can reduce potential human errors and result in more accurate quantities and cost estimates. Traditional industry databases are still used to determine the estimated costs. By using BIM and accurately generated quantities, estimators are given more time to practice the "art of estimating". Estimators can now help design teams think more about the constructability of their projects rather than spending the majority of their time counting objects.

In this paper, two case studies are used to illustrate how BIM can be used to support cost estimating in an architectural and engineering design firm. Challenges encountered regarding the practical implementation of semi-automated estimating given the current data representation in the models are explored. The benefits of using BIM in design to support quantification and estimating along with lessons learned are provided.

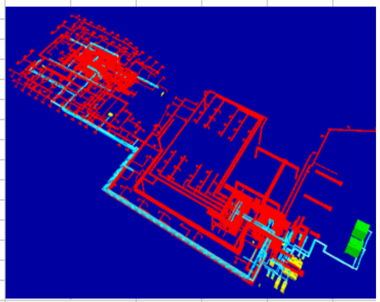
Keywords: Building Information Modeling, Quantification, Cost Estimating

'S

Quantities From BIM

Air Flow	W1(")	D1(")	Length(")	SurfaceArea (Sqft)	Pressure Class
Supply	34	18	870	628	Low
Supply	36	16	159	115	Low
Supply	36	16	212	153	Low
Supply	38	32	115	112	Low
Supply	38	32	108	105	Low
Supply	38	32	230	224	Low
Supply	40	18	761	613	Low
Supply	40	18	41	33	Low
Supply	40	18	18	15	Low
Supply	40	24	484	430	Low
Supply	44	20	115	102	Low
Supply	44	20	241	214	Low
Supply	48	32	28	31	Low
Supply	48	32	77	85	Low
Supply	50	20	141	137	Low
Supply	50	20	95	93	Low
Supply	52	30	47	54	Low
Supply	60	24	72	84	Low
Supply	60	24	22	25	Low
Supply	60	24	30	35	Low
Supply	60	24	99	116	Low
Rectangular Duct Total				28524	

From BIM



HVAC - Ductwork

Air Flow	W1(")	D1(")	Length(")	SurfaceArea (Sqft)	Pressure Class
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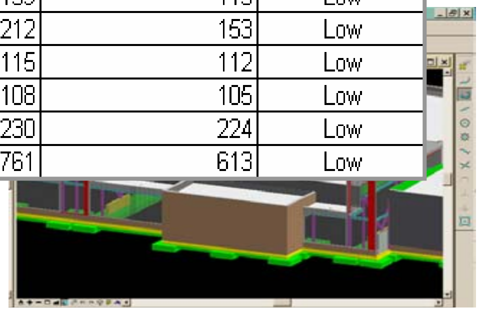
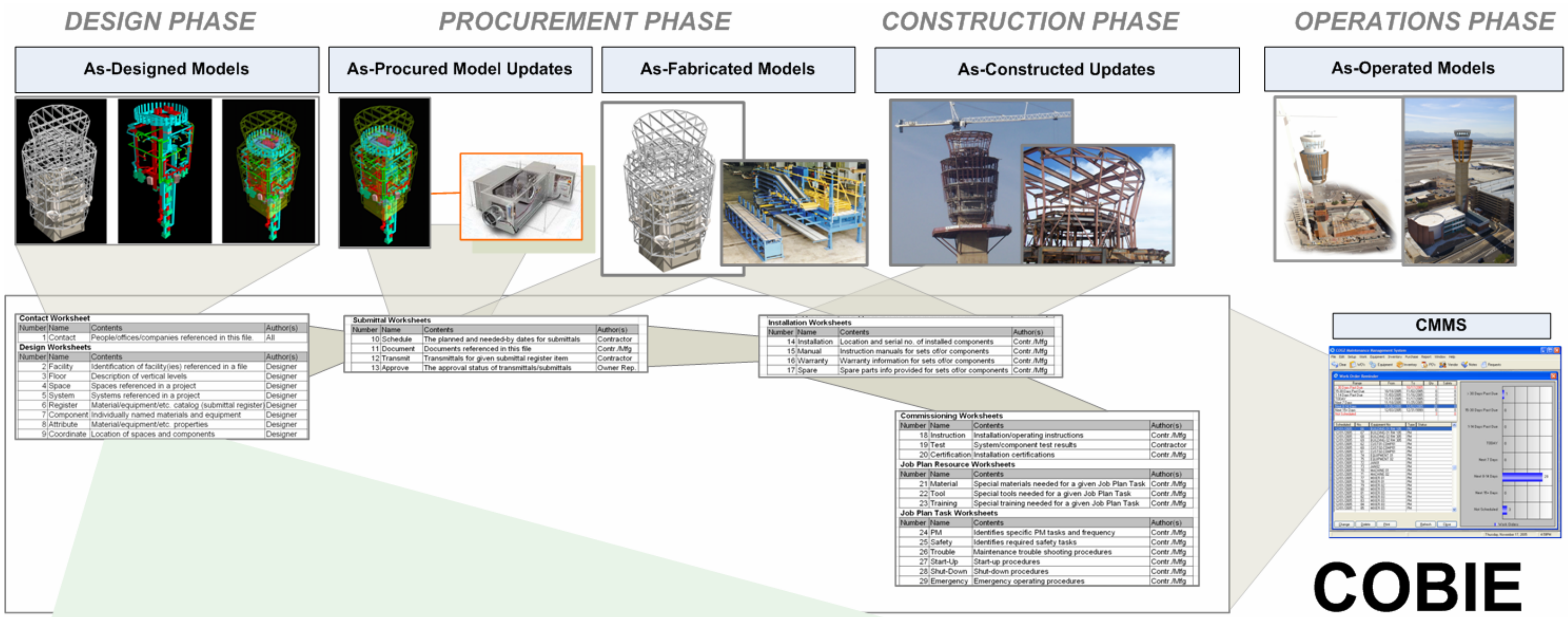




Contact Worksheet			
Number	**Name**	**Contents**	**Author(s)**
1	Contact	People/offices/companies referenced in this file.	All
Design Worksheets			
Number	**Name**	**Contents**	**Author(s)**
2	Facility	Identification of facility(ies) referenced in a file	Designer
3	Floor	Description of vertical levels	Designer
4	Space	Spaces referenced in a project	Designer
5	System	Systems referenced in a project	Designer
6	Register	Material/equipment/etc. catalog (submittal register)	Designer
7	Component	Individually named materials and equipment	Designer
8	Attribute	Material/equipment/etc. properties	Designer
9	Coordinate	Location of spaces and components	Designer

COBIE

BIM and Facilities Management

The objective of the Construction-Operations Building Information Exchange (COBIE) project is to create an open-standard through which information created during design and construction can be transferred directly to facility operators, maintainers, and managers in useable electronic format.

Lesson Learned:
Transitioning Model to Construction

- Owner Should be Conduit to Share the Model
- Model Should be Shared with Bidders
- Review Model at Pre-bid Conference
- Provide Model to Awarded GC
- Metrics- RFIs/ Change Orders/ CCGs

Raises Understanding and trust level
Reduces Contractors' level of perceived risk

Job Site Viz Lab

Bridging A/E BIM Design into Construction

The Line Between BIM Design and BIM Construction

- BIM-Based Design Models have **80%** Of the Data that the Contractor needs for construction.
- Contractors need to add the Remaining **20%** of Data
  - Primarily Comes From *Sub-Contractors*
  - Sub-Contractor Models are Merged Into Design Models
- Design Model Data Changes
  - Based on Specific Sub-Contractor and Manufactures Submittals
  - Sub-Contractor Models Replace/Update Data In The Design Model
- Design/Construction Changes during actual assembly of building
  - Contractor Updates Design/Construction Data Based on Assembly

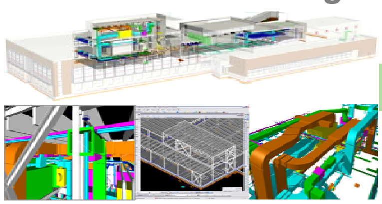
The BIM Integrator- A New Business Line

BIM Integration - Approach

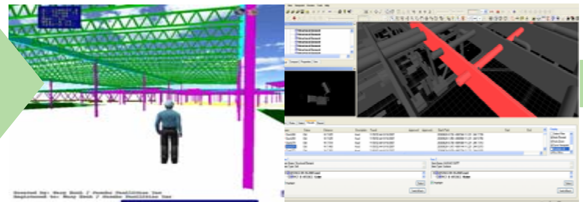
Team Phases Delivery

Integrated BIM

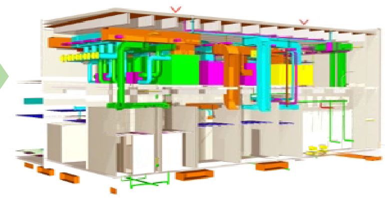
A/E Models Design



Contractor Builds From The Model



Owner Operates From Model



Design Phase

Construction Phase

Operations Phase

Keys to Success

- BIM Execution Plan
- Controlling BIM Model Performance
- Fully Coordinated CD's in BIM
- Visualization

Resources

- www.bimwiki.com
- USACE BIM Roadmap
- NBIMS V2.0
- WBDG
- Autodesk Communication Spec
- Consensus Docs
- AIA IPD Guide and Contract Language

BIM {{wiki}}

WBDG
WHOLE BUILDING DESIGN GUIDE

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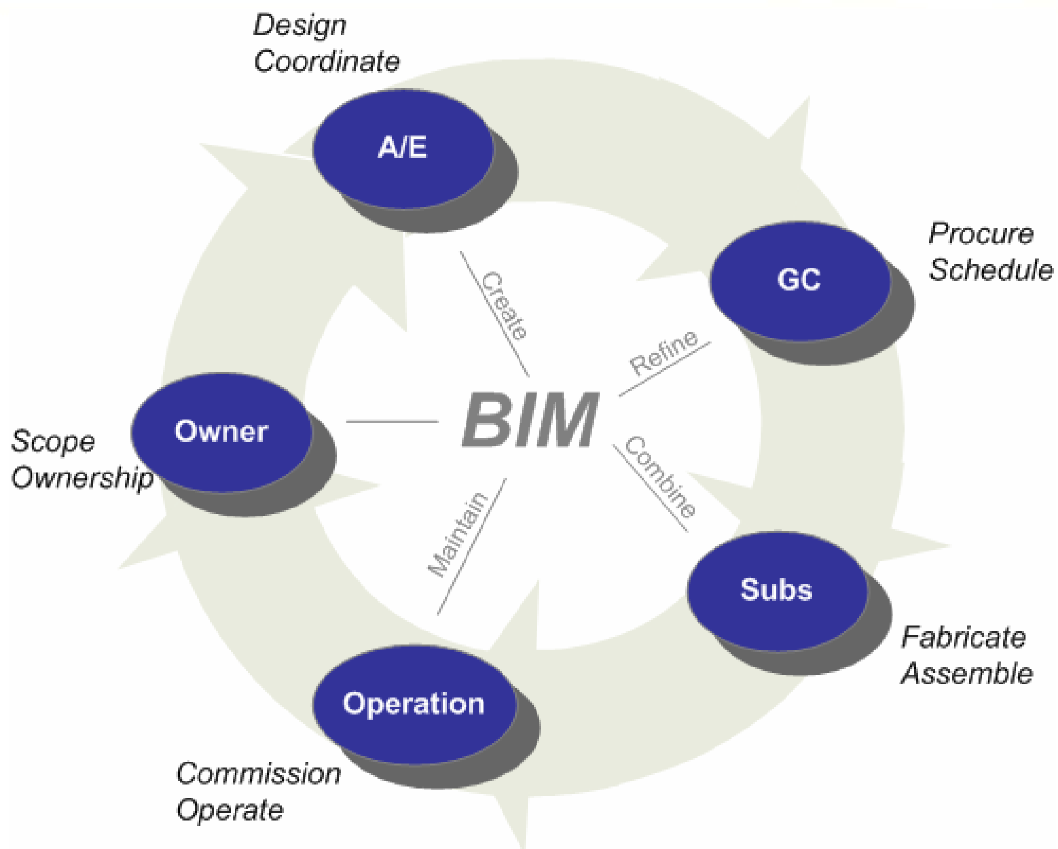
Discussion



Contact:

Kurt Maldovan

BIM Integrator

571-218-1439

kurt.maldovan@jacobs.com