The Future Is Now!
Building Information Modeling (BIM)

Academy of Electrical Contracting Annual Meeting
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- Associate Professor, Construction Management at Cal Poly State University in San Luis Obispo, CA
- Graduate research in MEP Coordination from Stanford University
- Current research focus is Specialty Contracting Industry
Trends 2000 to 2010

- Poor Economy
  - Slow down of work, layoff of productive employees, etc.
- Change in Delivery Methods
  - CM at risk, Design/Build, Integrated Project Delivery (IDP), etc.
- Additions to the Marketing Teams
  - Estimators and Superintendents, etc.
- Green Building
  - Green building techniques, Sustainable construction, LEED, etc.
- Continued integration of information technology technologies
  - Laser screed, total stations, document control software, electronic specification and plans, etc.
- Building Information Modeling (BIM)
  - 3D Modeling, Clash detection, Cost and Scheduling Model Attributes, etc.
Trends

- Poor Economy
  - Slow down of work, layoff of productive employees, etc.

- Change in Delivery Methods
  - CM at risk, Design/Build, Integrated Project Delivery (IDP), etc.

Has your company successfully used these alternate delivery methods when they had the chance?

Has your company aggressively pursued or asked to participate in these types of project?
**Trends**

- **Additions to the Marketing Teams**
  - Estimators and Superintendents, etc.

Clients want to know costs earlier and earlier.

Clients want to know who will be on the project team.
*(Companies can no longer use the bait and switch on Project personnel.)*

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**Trends**

- **Green Building**
  - Green building techniques, Sustainable construction, LEED, etc.

You have to talk the talk and walk the walk when it come to GREEN

Have you trained your personnel, top to bottom in this area?

Do you practice “Green” throughout your company?
Trends

- Continued integration of information technology
  - Laser screed, total stations, document control software, electronic specification and plans, etc.

Trends

- Building Information Modeling – BIM
  - 3D Modeling, Clash detection, Cost and Scheduling Model Attributes, etc.
BIM Training and Implementation Course for Electrical Contractors

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California Polytechnic State University
San Luis Obispo, CA

Introduction, Background, and Justification

- Building Information Modeling (BIM) is the process of generating and managing building data over the entire lifecycle of a building
- BIM process and software technology has become a widely used tool in the construction industry, particularly in the use of Design-Build project delivery methods
- Survey results show that there is cost and time savings attributable to the use of BIM technology
- Additional benefits are still to be realized through the increased ability to prefabricate electrical component assemblies
Goals and Objectives

Develop a six-module BIM training course tailored specifically for Electrical Contractors:

- Familiarization with the software platforms and their capabilities
- Criteria for choosing and implementing BIM solutions
- How to determine the appropriate level of representation in a BIM model for design, estimation, coordination, scheduling, and fabrication
- Awareness of contractual implications of using a shared model
- How BIM can facilitate sustainable practices and provide opportunities for new services
- Strategies for developing and implementing BIM

Module 1 – Introduction to BIM

- Recognize differences between 2D CAD and 3D BIM
- Describe the evolution of BIM (past, present, and future)
- Discuss the importance and benefits of BIM to all parties involved
- Explain the overall BIM process, and how it is relevant to the work of Electrical Contractors
- Demonstrate how BIM is a communication and collaboration tool
- Present practical aspects of using building information models, specifically from an Electrical Contractor’s perspective
Module 2 – BIM Technology Software Applications

- Understanding the uses of BIM for Electrical Contractors and demonstrate the basic application of BIM tools
- Evaluation of available software to include: cost, capabilities, ease of use, etc.
- Understand the different types of software programs needed to support the transition to, and implementation of, BIM
- Discuss the need for planning and organizing to use BIM tools, and the requirement to embed tools into project development processes
- Present processes for selecting relevant BIM tools

Module 3 – BIM Process – Modeling, Coordination, Scheduling, Estimating, and Life-cycle Assessment

- Demonstrate how Electrical Contractors can use and leverage BIM software tools for construction
- Understand the basics of collaborative modeling with design teams and coordination
- Recognize BIM uses in visualization, value analysis, and scope clarification
- Show how material quantities can be extracted and costs estimated from the 3D model
- Recognize how companies are using BIM to assist in performing building maintenance and operations and to conduct life-cycle assessments
Module 4 – Case Studies and Lessons Learned

Focus on lessons learned, best practices, and case studies of actual projects in which the BIM process was used

- Highlight the differences between using BIM and not using BIM on similar construction projects
- Demonstrate the ROI realized and the kinds of decisions and dilemmas managers confront on a daily basis
- Illustrate examples of how companies use BIM and demonstrate the tools, techniques, and concepts that are necessary for a complete understanding of BIM

Module 5 – Legal Issues and Risk Management

Legal and risk management issues associated with using the BIM process

- Legal cases using BIM and a shared model for design and construction
- Overview of the legal and insurance issues that are important to consider when utilizing BIM on a project
Module 6 – Developing an Implementation Plan

- Options to begin incorporating BIM into its business practice
- Understand the reformation of the traditional workflow processes (including the closer collaboration between GC, Architect, designer, and how to work with all project stakeholders in order to achieve better and more efficient projects)
- Discuss the typical challenges, pitfalls, and hurdles associated when transitioning to BIM
- How to develop an implementation plan specific to a company’s unique situation
- Understand the importance of identifying and empowering BIM champions

Work Plan

<table>
<thead>
<tr>
<th>Task Name</th>
<th>Date</th>
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<tbody>
<tr>
<td>Begin Study</td>
<td>Mar</td>
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<tr>
<td>Data Gathering</td>
<td>Apr</td>
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<tr>
<td>Foundation Task Force Meeting</td>
<td>May</td>
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<tr>
<td>Analyze</td>
<td>Jun</td>
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<tr>
<td>Draft Report Outline</td>
<td>Jul</td>
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<td>Review and Comment</td>
<td>Aug</td>
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<td>Telecom Meeting</td>
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<td>Final Report Outline</td>
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<td>Review and Comment</td>
<td>Dec</td>
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<tr>
<td>Telecom Meeting</td>
<td>Jan</td>
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<tr>
<td>Final Report, Project Summary, and Leadership Guide</td>
<td>Feb</td>
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<tr>
<td>Final Review</td>
<td>Mar</td>
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<tr>
<td>Incorporate Final Comments</td>
<td>Apr</td>
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<td>Insert Final Report, Project Summary, and Leadership Guide</td>
<td>May</td>
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<tr>
<td>NECA Convention</td>
<td>Sep 2010</td>
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<td>Cal Poly</td>
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<td>EL Meeting</td>
<td>Jul 2010</td>
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NECA Convention

September 2010

Cal Poly

Electri International
The Foundation for Electrical Construction Inc.
Product Information Dissemination

- Final product would be introduced as a seminar at the NECA national convention
- Course should be further disseminated via the NECA Management Education Institute (MEI) as a stand-alone MEI course, offered throughout the United States
- Proposed structure of the course will allow for flexibility so that courses and modules can be taught in several different formats to meet the needs of today's working professionals (including on-line)

Benefits to the Industry

- BIM enables collaboration between all participants in a project, saving money and producing better projects.
- Building Information Modeling has become standard practice for large-scale projects and consistently provides more efficient
  - Coordination
  - Scheduling
  - Cost estimating
  - Fabrication and Installation
- Increases Business Development opportunities with BIM services
- Attracts tech savvy entry level talent to the Electrical Constructing Industry
Module 1
Introduction to BIM

Building Information Modeling

- BIM is generally described as "an object-oriented building development tool that utilizes 5-D modeling concepts, information technology and software interoperability to design, construct and operate a building project, as well as communicate its details."
- Although the concept of BIM and relevant processes are being explored by contractors, architects and developers alike, the term itself is under debate, and it is yet to be seen whether it will win over alternatives, which include:
  - Virtual Building Environment (VBE)
  - Virtual Building
  - Integrated Practice
  - Virtual Design and Construction (VDC)
### Building Information Modeling

- Allows for the creation of intelligent contextual semantic digital models in terms of building elements and systems, such as spaces, walls, beams, columns and MEP systems.
- BIM technology allows for a creation of a model that contains information related to the building physical, functional and procurement information.
- The BIM model is able to contain data about the geometry, location, its supplier, operation and maintenance schedule, flow rates, and clearance requirements for an air-handling unit.

### Definition of BIM

**Building Information Modeling (BIM)** is 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.
Components of the BIM Model

Three Dimensional (3-D) Model
Shared Intelligent Knowledge and Data
- Quantities & Cost
- Schedule & Sequencing

Goal - Reduce Project Cost and Enhance Constructability by finding conflicts on paper before finding them in the field

BUILD IT VIRTUALLY BEFORE BUILDING IN THE FIELD

Why BIM?

- Today, Nobody is on the same page
- With BIM everyone is looking at the same conditions, issues, and problems.
- BIM is the state-of-the-art of collaboration

Risk!

- We have it. (We always have.)
- But we are only getting more.

The $64,000 Question: Can you afford not to try BIM?
Possible Uses of the BIM Model

- **Design**
  - Plans & Specifications
  - Material or product data
  - Engineers Estimate
  - Building Performance - Energy use, Comfort, Lighting, etc.

- **Construction**
  - Construction Schedule and Sequence (4th dimension)
  - Construction Cost (5th dimension)
  - Planning - Resource Use, Management, Quality, Safety, etc.

- **Operation**
  - Facilities Management
  - Energy Use
  - Maintenance

Proponents claim that BIM offers:

- Improved visualization
- Improved design and construction productivity due to easy retrieval of information
- Increased coordination of construction documents
- Embedding and linking of vital information such as vendors for specific materials, location of details and quantities required for estimation and tendering
- Increased speed of delivery
- Reduced project delivery costs
BIM Technology and Current Applications

- **Visualization:** ability to create a 3D presentation of building modules geometry, location, space, contained systems in relation to each other
- **Modeling:** ability to generate a 3D rendering tool to present the final product and finishes to owners, designers and constructors
- **Code reviews:** allows for building officials and fire officials could use the 3D models with related data for code compliance reviews

**Visualization**

From Static Drawing to Walk or Flying Thru the Project

*Light Tables & AutoCAD Overlays*

*NavisWorks Collaboration & Clash Detection*
Visualization

2D Drawings

Plan View  Section View

X  Hand Drawn Multiple Views

3D Drawings

✓ Any view with mouse click
✓ Conflicts found & fixed fast
Code Review

Structural Beams not tied to a column

All doors in bunker don’t fit with the beams. Bunker head height is less than code min.
BIM Technology and Current Applications

- **Fabrication/shop drawings**: facilitates for the generation of detailed shop drawings could be easily produced once the BIM model is completed.
- **Communication**: facilitates simultaneously creation of construction documents, product imagery, rapid prototypes, exterior envelope, interior finishing, and MEP fixtures of building modules. Through this single information platform, BIM promote collaborations among the design team, consultant, constructors and the clients.

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**Fabrication/Shop Drawings**

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Communication

BIM Technology and Current Applications

- **Cost estimating**: provides for cost estimating, material quantifications, and pricing to be automatically generated and modified while changes are applied for each building module.
- **Construction sequences**: provides a complete construction schedule for material ordering, fabrication, delivery and onsite installation of each building systems. With the integration of 3D rendering, 4D (3D model + scheduling information) could be easily generated during the project design and construction phase.
- **Conflict, interference and collision detection**: ability to determine building system interferences which can be visually presented. For instance, an air distribution duct for the HVAC system physically interfering with a concrete beam.
Cost Estimating

Construction Sequence
Conflict, interference and collision detection
From BIM to Actual

From BIM to Actual
BIM Model Progression – Level of Detail 100

- Essentially the equivalent of conceptual design, the model would consist of overall building massing and the downstream users are authorized to perform whole building types of analysis (volume, building orientation, cost per square foot, etc.)
BIM Model Progression – Level of Detail 200

- Similar to schematic design or design development, the model would consist of "generalized systems or assemblies with approximate quantities, size, shape, location and orientation." Authorized uses would include "analysis of selected systems by application of generalized performance criteria."

BIM Model Progression – Level of Detail 300

- Model elements are suitable for the generation of traditional construction documents and shop drawings. As such, analysis and simulation is authorized for detailed elements and systems.
BIM Model Progression – Level of Detail 400

- This level of development is considered to be suitable for fabrication and assembly. The responsibility for this LOD is most likely to be the trade contractor or fabricator as it is usually outside the scope of the architect's or engineer's services or would constitute severe risk exposure if such parties are not adequately insured.

BIM Model Progression – Level of Detail 500

- The final level of development represents the project as it has been constructed - the as-built conditions. The model is suitable for maintenance and operations of the facility.
Working Group Exercise
Module 2
BIM Software Technology Applications

BIM Software Technology
- AutoCAD MEP & AutoDESK Revit
- ArchiCAD
- Navisworks
- Solibri
AutoCAD MEP

- Computer Aided Design or Computer Aided Drafting (CAD) software application for 2D and 3D design and drafting.
- discipline-specific version of AutoCAD® software for mechanical, electrical, and plumbing ( MEP) designers and drafters that offers greater drafting productivity.

AutoDESK Revit MEP

- BIM software developed by Autodesk, which allows the user to design with both parametric 3D modeling and 2D drafting elements.
- employs intelligent 3D objects to represent real physical building components.
- BIM solution for mechanical, electrical, and plumbing engineers, providing purpose-built tools for building systems design and analysis.
- Revit’s database for a project can contain information about a project at various stages in the building’s lifecycle, from concept to construction to decommissioning (4D CAD)
ArchiCAD

- An architectural BIM CAD software developed by the Hungarian company Graphisoft
- Development started in 1982 for the original Apple Macintosh.
- ArchiCAD is recognized as the first CAD product on a personal computer able to create both 2D and 3D drawings.
- In its debut in 1987 ArchiCAD also became the first implementation of BIM under Graphisoft's Virtual Building concept.
- Today more than 100,000 architects are using it in the building design industry.

ArchiCAD

- ArchiCAD allows the user to work with data-enhanced parametric objects, often called "smart objects" by users.
- This differs from the operational style of other CAD programs created in the 1980s.
- The product allows the user to create a "virtual building" with virtual structural elements like walls, slabs, roofs, doors, windows and furniture.
**ArchiCAD**

- Allows users to work with either a 2D or 3D representation.
- 2-D drawings can be exported at any time, even though the model in the program's database always stores data in 3-D.
- Plans, elevations, and sections are generated from the 3D virtual building model and are constantly updated.
- Detail drawings are based on enlarged portions of the model, with 2D detail added in.
- ArchiCAD can import and export DWG, DXF IFC and SketchUp files among others. Graphisoft is an active member of the International Alliance for Interoperability (IA), an industry organization that publishes standards for file and data interoperability for architectural CAD.
- The newest version (2010) is ArchiCAD 14.

**NavisWorks**

- Autodesk® Navisworks® products deliver project review software for 3D coordination, 4D planning, photorealistic visualization, dynamic simulation, and accurate analysis.
- Create a whole-project model by integrating design and construction information, including complex building information modeling (BIM), Digital Prototyping (DP), and process plant data.
- With Autodesk Navisworks project review software, users are able to collaborate, coordinate, and communicate more effectively to reduce problems during design and construction.
Solibri

- Tool for finding mistakes and dealing with problems before they transform into costly delays.
- Analyzes BIM for collision detection, design quality and physical safety in a clear and practical way by offering visualization along with walk-through navigation.

Solibri Model Checker™ “X-rays” the building model and automatically reveals potential flaws and weaknesses in the design, it then highlights any clashing components and checks that the model complies with building codes as well as your firm’s best design practices.
Module 5
Case Studies and Lessons Learned
Case Study
Superior Group – Bluegrass Project

Project Bluegrass Computer Room
Case Study
Superior Group – Battelle Project
Case Study
Superior Group – CEP Project
Case Study No. 1
Healthcare Expansion, Charlotte, North Carolina

- Constructed improvements were valued at $44 Million
- 110,000 SF of healthcare space
- Modular construction project - concrete panels were prefabricated for the floor slab.
- Project delivery method was CM @ Risk with a cost plus and GMP
- No design involvement on the part of the GC
- BIM implementation cost totaled $44,000
- Estimated savings from the use of BIM totaled $220,000
Case Study No. 1
Healthcare Expansion, Charlotte, North Carolina

(a) Structural Steel BIM Model
(b) Automatic Quantity Takeoff from BIM Model

(a) Structural BIM Model
(b) Architecture BIM Model
(c) MEP BIM Model
Case Study No. 1  
Healthcare Expansion, Charlotte, North Carolina

The specific benefits have been identified by using BIM model in this project includes:

- Clearly defined subcontractor's work scope
- Automatic quantity extraction of structural steel and major MEP systems
- Facilitate shop drawing of structural steel and MEP systems
- 560 clash conflicts between MEP systems and the structural systems were identified prior to the fabrication of the MEP and structural systems
Case Study No. 2
Gastonia High School - Gastonia, North Carolina

- The project scope included $38 Million of constructed improvements which totaled 220,000 SF High School Project.
- Modular construction project - classrooms were prefabricated and included rough-in MEP installations.
- Project delivery methods was Design-Build.
- Contract type was cost plus with a GMP
- GC was extensively involved with the design development stage
- BIM implementation cost totaled $38,000; savings were not calculated.

1st Floor BIM Model
Case Study No. 2
Gastonia High School - Gastonia, North Carolina

2nd Floor BIM Model

(a) Ductwork Conflicts Structural Steels
(b) Ductwork conflicts with Bar Joists
Case Study No. 2
Gastonia High School - Gastonia, North Carolina

- MEP coordination was conducted through the BIM platform.
- Using the BIM model for this project, 258 conflicts were identified and eliminated during the design phase.
- Each classroom module was accurately manufactured offsite with rough-in plumbing pipes and electrical conduits installed.
- The finishing MEP and furnishing process began after the installation of each classroom module.

Findings and Conclusions

- Most effective use of BIM models was for
  - design coordination
  - walk-through animation
  - clash detections
- This was more so for modular construction project which requires extensive design coordination especially for MEP systems.
- Greatest challenge of using BIM in construction project is the implementation process itself, regardless of the software capabilities.
- Development of accurate BIM model requires extensive resources and in-depth knowledge of construction methods and process.
Findings and Conclusions

While BIM can unlock process efficiencies on any project, its benefits are most pronounced in large projects. The $339-million, 695,000-sf Maricopa County Court Tower in Phoenix is a perfect example.

Findings and Conclusions

THE BUSINESS VALUE OF BIM
Getting Building Information Modeling to the Bottom Line

Importance of BIM in 5 Years

<table>
<thead>
<tr>
<th>Importance of BIM</th>
<th>Percentage</th>
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<tr>
<td>Very high importance</td>
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<tr>
<td>High importance</td>
<td>31%</td>
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<tr>
<td>Moderate importance</td>
<td>39%</td>
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<tr>
<td>Low importance</td>
<td>16%</td>
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<tr>
<td>No importance</td>
<td>3%</td>
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Autodesk

ELECTRI INTERNATIONAL
THE FOUNDATION FOR ELECTRICAL CONSTRUCTION INC.
Findings and Conclusions

**Perceived ROI on Overall Investment in BIM**

- **Architect**
  - Positive: 14%
  - Neutral: 23%
  - Negative: 63%
- **Engineer**
  - Positive: 6%
  - Neutral: 28%
  - Negative: 66%
- **Contractor**
  - Positive: 11%
  - Neutral: 17%
  - Negative: 72%
- **Owner**
  - Positive: 7%
  - Neutral: 18%
  - Negative: 75%

**Effect of BIM Use on Project Profitability**

- Increase: 49.5%
- Don't know: 27.7%
- No change: 18.5%
- Decrease: 11.5%

*Source: Building Information Modeling (BIM) in Construction - 2009*