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RiskTopics

Building Information Modeling (BIM)

As the construction industry continues to recognize new benefits and increase the use of BIM and supporting technology tools, prudent steps must be taken to evaluate and manage the use of these aids in project execution. Risks in the performance of professional services on projects (e.g. engineering design, procurement, project scheduling, cost control, etc.) must be effectively managed during the adoption and utilization of these complex and ever-changing tools. In order to maximize the benefits of BIM and simultaneously reduce these utilization risks, it is crucial for the owner, designer(s) and contractor to understand and manage the process from pre-design through operations and maintenance.

Introduction

Building Information Modeling (BIM) has progressed significantly beyond the isolated and often incohesive use of three-dimensional (3D) design software. BIM is now a collaborative technology-driven process of managing tremendous amounts of data (including but not limited to multiple 3D analysis and design models) to plan, design, procure, install, commission and manage a facility throughout its lifecycle. As with any process, it needs to be managed and controlled. 3D models (and ideally one ultimately federated model) enable the architect, engineer and contractor to simulate construction of the building in a virtual reality before actually commencing work. Conflicts, issues, clashes, etc., can be resolved prior to starting construction, which can save time and money, while also potentially improving overall project performance and quality. However, as this "cradle to grave" technology process continues to develop, project execution risks can escalate if the process isn't managed effectively.

Discussion

An enhanced value of BIM is generated from a well-defined and (ideally) owner-led process, collaboratively implemented by a team with common goals. The primary results of a well-executed BIM and technology deployment process can be:

- More efficient design process

- Simulation and optimization of the construction process
- Automated quantity take offs and estimating
- Improved precision, speed, and quality of construction
- Enhanced collaboration and coordination leading to more informed and timely decision making
- Well-coordinated designs = less risk of project conflict and claims
- Optimal construction sequencing
- Highly accurate project records
- Valuable digital assets for the building owner after construction
- Greater accuracy of future project pricing
- More profit and less risk for all stakeholders.

Guidance

BIM provides less value when the owner is not integral to project execution:

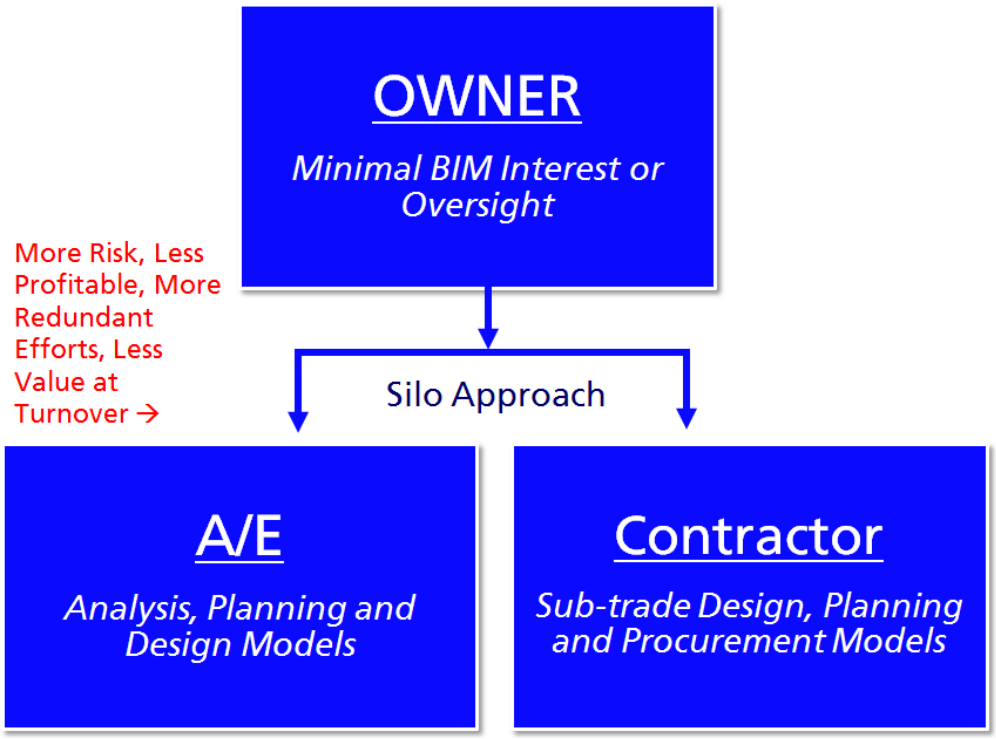


Figure 1 – BIM Usage in this Type of Project / Collaboration Scenario is of Less Value

BIM provides much greater value on a project when the owner is integral to the collaboration:

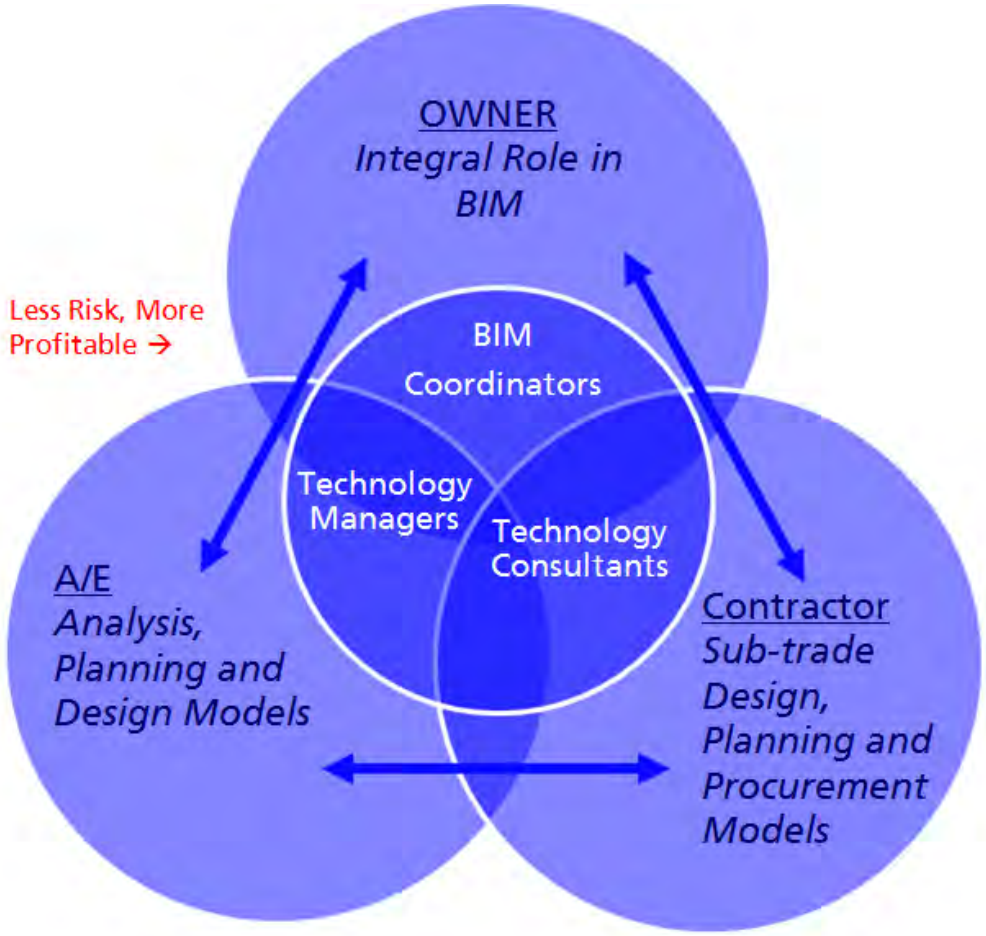


Figure 2 – BIM Usage in this Type of Project / Collaboration Scenario is of Greater Value

BIM in Pre-Design/Planning

- Consider making your firm's BIM standards high-level enough to apply to all projects, but detailed enough to ensure beneficial outcomes. Standards should also be updated regularly, as BIM and supporting technology tools are rapidly evolving and increasingly complex. BIM software and supporting technology deployments are advancing much more frequently than traditional construction industry standards.
- The owner should be an integral part of the process.
- BIM standards should address, among other things, the following:
    - Execution Plan
    - Modeling protocols and tolerances
    - Requisite Level of Development (LOD) for common / primary model elements
    - Communication protocols

    - Coordination (e.g. delegated design and design-assist roles, model acceptance, etc.)
    - Technical infrastructure and software updating protocols
    - BIM facility maintenance (BIM FM) requirements (Asset / Construction operations building information exchange COBie data formatting)
    - Model ownership and liability
    - As-built data requirements and model format at project turnover
- BIM standards should be outlined in all RFP's (request for proposals) and included in contracts.
- Contemplate / incorporate owner BIM standards in development of a specific BIM Project Execution Plan.
- BIM execution planning components are applicable to all project delivery methods at varying levels of effectiveness. Collaboration is improved in more integrated forms of project delivery.
- A project specific BIM Execution Plan should include the following:
    - Introduction section of content / project information
    - Key milestones
    - Project contacts
    - Project coordinate systems clearly defined
    - Delineated project zones and sequences to aid in procurement / erection
    - BIM LOD specification
    - BIM technical infrastructure (hosting, software, updating protocols)
    - Coordination hierarchies to aid decisions in clash situations
    - Clear and specific collaboration procedures / BIM roles and responsibilities
    - Intended utilization of reality capture tools
    - Project BIM deliverables (e.g. model files, documents required, etc.)
    - BIM manager / coordinator and modeler skillset requirements
    - Open standards / interoperability planning
    - References to contractual provisions on model ownership / risk allocation at specific design and construction intervals
    - Intellectual property rights
- For information, preplanning checklists and suggested execution plan templates, please visit:

www.bimforum.org
www.dbia.org/wp-content/uploads/2018/06/BIMChecklist.pdf
www.pankowfoundation.org/our-work
www.bim.psu.edu

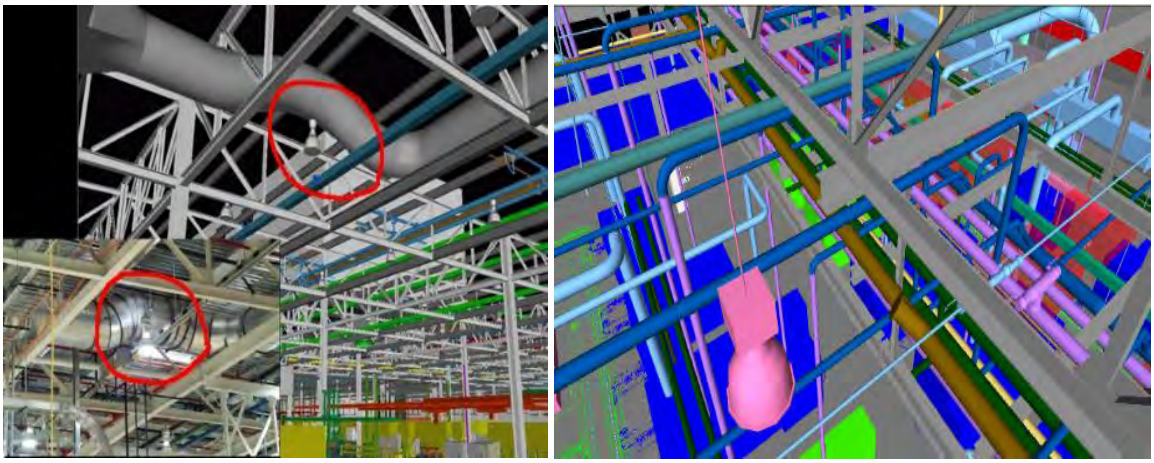
BIM in Design and Pre-Construction

- Exercising care in the proper use of BIM is critical.
- Many architects and engineers use BIM simply because it is more efficient than CAD for producing 2D drawings.
- Designers may take short cuts with BIM, simply copying and pasting 2D drawings for construction documents while utilizing models that are incomplete. This can lead to the following issues:
    - Significant 3D coordination challenges for eventual federated model/s
    - Inability for construction planning entities to create 4D schedules
    - Inaccurate quantities for generating 5D estimates
    - Lack of sufficient data for facilities management and maintenance, including the inability to utilize the model for future space planning, renovation and expansion considerations
- 3D systems design (e.g. mechanical, electrical, plumbing, etc.) requires the design professional to do the following:
    - For each element - size it and locate / route it, ensuring no clashes with other work
    - "Field route to suit by contractor" or "verify in field" is no longer a design option.
    - Execute a coordinated design – this drives the need for collaboration between designers, fabricators, contractors, and trade partners (typically mechanical, electrical and plumbing (MEP) trades) with design input and responsibility for installation and integration.
    - Ensure proper model coordination budgets exist. (Some trade contractors now insist that a minimum of 30% of their total labor efforts are necessary for such coordination to achieve substantial field benefit)
    - Develop and execute a robust 3D model coordination process well in advance of work proceeding in the field.
- Consider material / scope tolerances in modeling and overlaying building elements (e.g. cast-in-place concrete, structural steel, exterior façade elements, interior finishes, etc.) to facilitate component installations with minimal fit-up issues.
- 4D scheduling can reduce risk through better planning. This process allows the contractor to visualize installation of each item of work in a virtual model. It also ensures sequencing of work is understood, and facilitates subcontractor prefabrication to further reduce risk and cost.

BIM in Construction

- 3D Construction Coordination
    - Clash detection for spatial coordination of various building elements continues to offer a significant return on investment (ROI). (e.g. a 3D model allows the contractor to verify if plumbing is incorrectly routed through heating, ventilation and air conditioning (HVAC) ductwork)
    - Utilize a clash matrix with coordination hierarchies to identify which disciplines take precedence in element location and define which trades need to adjust.
    - Clash detection should be viewed as part of an overall formally defined interference management process, whereby care should be taken to ensure that efforts are not wasted in coordination meetings that may have little to no field benefit:
        - Include regular reporting intervals of clash tracking logs to all relevant parties.
        - Understand the design intent and recognize that certain "clashes" as defined by BIM software may not actually be clashes.
        - Avoid too high a focus on perfection of a model (e.g. checking off a worksheet with thousands of clashes resolved) when in reality this may be wasted effort.

        Case in Point: It is unnecessary to model every penetration in every stud wall when the walls are not prefabricated assemblies in the first place. The conduit penetrating the stud is NOT a clash when planned operations are to field drill holes. Such excess efforts can bring coordination meetings to grinding halts.
    - The BIM coordinators / technology managers should:
        - Hold or be well versed in an AGC Certificate of Management in BIM (CM-BIM) credential
        - Ensure design team participates in the construction coordination process
        - Ensure the owner's FM and engineering team participate to verify end use requirements
- A quality BIM coordination process can lead to a high level of installation accuracy and downstream benefit.



Photos / Illustrations from CII Research Team #324 final presentation with team member Zurich risk engineer Craig Durgarian

Figure 3 – Example of constructability and maintainability benefits from a Federated Building Information Model

- 4D Scheduling is integral to construction management / risk reduction:
    - Simulates the construction activities by applying time and sequencing (schedule) to the design model/s
    - Indicates when trades are in too many (or too few) areas concurrently
    - Identifies out of sequence work
    - Depicts interference between trades crew clash detection
- BIM promotes prefabrication and virtual erection planning of modularized units which subsequently can:
    - Increase productivity and safety – work performed in a factory environment reduces typical construction site hazards and obstacles
    - Minimize waste through lean processes
    - Improve precision, quality and accuracy
    - Save time and labor – more efficient procurement, assembly and installation of systems
    - Reduce construction defect and designer / contractor performance risk
- Strong backlogs, labor shortages and increased fast track scheduling requirements have forced contractors to evaluate utilization of recent / ongoing technology advances to compress schedules, enhance quality management practices and preserve profit. Exercise caution in deploying some of these tools without proper training and cost-benefit analyses:
    - Drone use has increased for progress tracking of façade element installations, roofing component checks, verifications of work complete on large project footprint sites
    - Construction robotics for labor assistance (e.g. brick laying, repetitive overhead work, etc.)

- Computer numerical controlled (CNC) machinery programming advancements to build custom project components
- Fully autonomous equipment for earthwork operations
- New technology for documentation / photographic inspection of work in place and to complete
- Virtual reality (e.g. use of goggles to view mock-ups and project conditions to plan work execution)
- Robotic total station and laser scanning technology to verify installation accuracy of project components (e.g. concrete slab embedded items for façade elements)

Benefits of BIM in Operations and Maintenance

- Accurate as-built and record models for reference and future use
- Crucial asset data
- Efficient data integration with FM software (COBie Standard)
- More efficient operation and maintenance (O&M) support – A single repository for all asset data and maintenance requirements, warranty information

Common pitfalls in BIM Utilization for New Users

- Pursuant to any developing technology, there are a host of issues unique to BIM utilization and management that may not be readily apparent to newer users. A few of the most common problems identified by early adopters of BIM technology include:
    - Omission or ambiguous responsibility for model management and provision of design and reporting deliverables at each step of the BIM process (e.g. who provides what, when?). BIM Execution Plans are critical to success.
    - Failure to formalize / adjust LOD requirements in workflows, leading to errant application to entire model, as opposed to only specific building components requiring higher level of detail.
    - Failure to sufficiently compensate designers who are likely to incur more labor intensive design processes and front end coordination costs, as compared to traditional design methods. Typically, the contractor is the beneficiary of the ROI generated from these processes (such as clash detection and elimination), whereas designers are often asked to perform more BIM related services for the same traditional fee.
    - Project inefficiencies stemming from a lack of process in effectively extracting and utilizing the available digital model content for downstream construction use.
    - Organizational constraints that do not support the mass file transfer and storage requirements for successful BIM implementation.

- Ambiguous requirements for final BIM deliverables (e.g. what did the owner actually buy?)

Zurich Assessments of BIM / Technology Programs

- Zurich risk engineers evaluate responses to the following BIM / technology practice inquiries as part of our procedures in developing an overall risk profile of our architect, engineer and contractor (AEC) customers. These discussions can also provide meaningful insight on key decision makers, technology rates and levels of adoption, as well as cost-benefit studies executed by our customers:

    - Utilization of available technology for virtual reality checks of the model (e.g. use of augmented reality goggles for constructability verifications and prevention of design mistakes)

    - Utilization of reality data capture (e.g. photographic documentation, robotic total station and laser scanning, etc.) for field verifications of installed project components and back-checked to the 3D model

    - Are designers leveraging technology to facilitate construction efforts? (e.g. developing construction documents in a progression compatible with steel fabrication and erection sequence zones)

    - What plans are in place to achieve consistent team collaboration? (e.g. co-location work sites, BIM execution plans updated regularly, meeting frequency, budgets for technology / innovation deployments, etc.)

    - Are key subcontractors (e.g. MEP) adequately budgeting for model coordination?

    - What are model sharing, handoff and reliability procedures? There are several available model contract forms (e.g. American Institute of Architects (AIA), Design-build institute of America (DBIA) and ConsensusDocs, etc.) that provide templates for terms specific to BIM and data sharing. For further guidance, please visit:

      https://bimforum.org/legal/

    - Are dedicated BIM Coordinators / Managers employed on projects, and are they provided periodic training to stay current with trends, software developments and emerging technologies? For training guidance and assistance, please visit:

      https://www.agc.org/learn/education-training/building-information-modeling-education-program

      https://www.construction-institute.org/resources/knowledgebase/knowledge-areas/construction-technology

    - Are Technology Consultants being employed on projects? Please refer to the following "BIM Tools / Matrix" for a recent excerpt of the vast array of available tools for analysis, design, fabrication, construction management, estimating, scheduling and file sharing / collaboration:

https://bimforum.org/wp-content/uploads/2017/06/Copy-of-BIM_Tools_Matrix_june-12-2017.pdf

Conclusion

BIM continues to rapidly change the construction industry landscape. Today's architects, engineers, and contractors have a seemingly endless menu of choices when it comes to the utilization of BIM and related technology. The expanse of analysis, design, procurement assistance and construction management software tools available on the market can be overwhelming. Integration of the people, organization, processes and technology is vital to the success of not only the design and construction process, but for the full lifecycle of the completed facility.

Zurich is now partnering with our customers and prospective insureds to:

i) impart knowledge on current and upcoming technology advances,

ii) suggest tools and procedures to manage / navigate the project execution process

iii) reduce overall risk in the performance of professional services on projects.

Resources

- BIM Forum website: The US chapter of building SMART International
  www.bimforum.org
- Design Build Institute of America (DBIA) BIM Checklist:
  www.dbia.org/wp-content/uploads/2018/06/BIMChecklist.pdf
- Charles Pankow Foundation website: BIM Project Execution Plan Guide under "Highlighted Projects"
  www.pankowfoundation.org/our-work
- Penn State College of Engineering website: BIM Planning
  www.bim.psu.edu
- Associated General Contractors (AGC) of America website: Building Information Modeling Education Program
  https://www.agc.org/learn/education-training/building-information-modeling-education-program
- Construction Industry Institute (CII) website: Construction Technology Knowledge Base
  https://www.construction-institute.org/resources/knowledgebase/knowledge-areas/construction-technology
- BIM Forum website: BIM Tools Matrix June 2017
  https://bimforum.org/wp-content/uploads/2017/06/Copy-of-BIM_Tools_Matrix_june-12-2017.pdf

September 2019

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