Autodesk University 2012

# Coordinate and Dominate BIM Project Success

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**AB2965** Coordination techniques using Autodesk® Revit® 2013 software as the Building Information Modeling (BIM) authoring platform truly enable a changing of the game. Modeling and project execution capabilities are becoming so comprehensive that we need equally comprehensive processes for collaboration and coordination. Hardware, software, processes, paperwork… What is most important?

**Interaction** **Communication** **Collaboration** **Completion**

Every BIM project and frankly, every architectural project, have multidiscipline teams, the question is: Are those teams working together? The best projects have the most coordinated teams, greatest dynamic information flow, and most efficient communication and interaction strategies employed.

Use the lessons learned to develop your own coordination techniques and expertise to even greater levels.

## Learning Objectives

At the end of this class, you will have learned methods and ideals on how to coordinate BIM projects with proven techniques and technologies through combined Architectural, Structural, Mechanical/Electrical/Plumbing and General Contractor's points of view.

AB2965 **Coordinate and Dominate for BIM Project Success |** Presented by BIM Directors from each discipline.

- **Develop better strategies for collaboration, communication and project delivery**
- **Develop coordination process management for internal and external team benefit**
- **Determine how and what to "round-trip" to and from the BIM project data, for use upstream and downstream; through the project lifecycle**
- **Learn keys to process refinement and documentation to make future work even better and more efficient**

## About the Speakers:

**Jay B Zallan |** Perkowitz+Ruth Architects **| BIM Director**

*Art | Architecture | Technology | Ideas. These are Jay B. Zallan's professional passions. He is a Designer, an Artist and an AEC technologist. Currently the VDC Director of BIM at Perkowitz+Ruth Architects & Studio-111, Jay brings unique & qualified insights into the business & creative processes of Architecture with proven strategies for production & growth. Mr. Zallan has over 20 years of Architectural experience and enjoys a varied & diverse portfolio of Architecture and Art. He is currently the President of the Los Angeles Revit Users Group, AUGIworld magazine Revit Architecture Content Manager, BIM Advisory Board member for Graphic Standards and he is a frequent lecturer on Creativity, BIM and Virtual Design & Construction. He can also be found presenting at Autodesk University, Revit Technology Conference and as a guest lecturer at the University of Southern California, LACMA, as well as AECO & AIA events.*

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**Marcello Sgambelluri |** John A Martin Structural Engineers **| BIM Director**

*Marcello is the BIM Director at John A. Martin & Associates Structural Engineers in Los Angeles, CA. He has been using Autodesk products for over 15 years including AutoCAD, 3ds Max, and Revit. He is a member of the ASCE-SEI BIM committee and continually speaks at structural professional conferences across the country. Marcello teaches classes regularly at Autodesk University and the Revit Technology conference that focuses on free form modeling in Revit and he beta tests the yearly releases of Revit. He has worked on many projects that incorporated complex geometry including the Walt Disney Concert Hall in Los Angeles, CA, the Stata Center at MIT, and the Tom Bradley International Terminal Expansion at the LAX. Marcello received B.S. and M.S. degrees in Civil Engineering and is a licensed Civil and Structural Engineer.*

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**Troy Gates |** Mazzetti Nash Lipsey Burch **| Design Technologies Manager**

*Troy worked for some time in the civil/infrastructure industry before joining the AEC industry in 2000, where he immediately became an early adopter, user, and implementer of the Autodesk Revit platform while serving in CAD/BIM technology management roles. In addition to his direct experience using BIM design technology tools, 3D modeling platforms, and software programming, he is an Autodesk Revit certified professional and an Autodesk Revit implementation Certified Expert. Troy graduated with degrees in both design and operations management. Troy currently holds the position of Design Technologies Manager with Mazzetti Nash Lipsey Burch. Troy is currently part of the Los Angeles Revit User Group (LARUG) leadership that hosts Autodesk Revit users from around southern California for monthly advanced Autodesk Revit demonstrations and topics. Troy also actively participates in Autodesk Revit and BIM discussions on Twitter and Revitforum.org.*

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**Darren Roos |** Bernards **| Corporate BIM / VDC Director**

*Darren has enjoyed 15 years of experience in the manufacturing, design, engineering, and construction industries. During his career he has tested, tweaked, and leveraged technology to implement lean production practices and improve processes. Using BIM a decade ago Darren was able to efficiently design, model, and coordinate custom steel structures for projects such as the Dubai Convention Center in the United Arab Emirates and the Hong Kong Convention Center in Wanchai Hong Kong. In 2009 Darren and his team received the CMAA National Project Achievement Award and an International BIM award from BIMFusion for General Contracting work and Virtual Design and Construction on the LA Dodgers and Chicago White Sox spring training facility. Today Darren is a proud member of the Bernards team as their BIM/VDC Director and enjoys finding new ways with his BIM team to keep Bernards at the front of Building Information Modeling, Virtual Design and Construction, and Augmented Reality technology. Darren has presented BIM/VDC topics for ACE, CMAA, USGBC, USC, and the Revit Technology Conference and is excited this year to be part of a talented group at AU co-presenting this class ☺AB2965 - Coordinate and Dominate BIM Project Success.*

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## Introduction

A successful Revit project goes beyond simply knowing and excelling at the technical side of the BIM software. There are important topics that need to be considered at the beginning of each project, long before the first element is even modeled in the BIM software.

The difficult parts of coordination and collaboration are not always the technical parts, rather linking a file, building models, etc. are comparatively easy in the context of the entire project... There are always people who can handle the technical button pushing… The most important and oft difficult main point in coordination is **Interaction**.

Revit models contain extensive amounts of rich and intelligent data and the use and application of these Revit models are virtually endless. Therefore, it is extremely important to establish boundaries for the Revit models with the Architect, Engineers Owner and Contractor. This means that you will need to come to some understanding and agreement on the expectations of the team members for what the Revit model(s) contain and what the uses are and how to 'get there'.

**S** Structural Viewpoints for entire team consideration

**M** MEP Viewpoints for entire team consideration

**G** General Contractor Viewpoints, for entire team consideration

**A** BIM Execution Plan component headings

Keep in mind that in the construction industry, every project is made of "ad hoc" team members and every building is a "prototype". This means that the situation is different from project to project and one method of doing something in a past project does not mean that it will work for another project. Therefore, it is important to make sure that the right questions are asked on each project. This class and handout is formatted to provide this guidance.

Think of coordination between the disciplines, for any given project, as being made of up of one part technology and five parts human interaction. This means that the essential ingredients for successful coordination are the personal interactions and the communication paths. Think of it this way: if you as a Structural Engineer do not get the information you need from the Architect, how could you proceed? vice versa…

As we have seen, the process of effective project collaboration takes communication, but not like meeting or talking, more like the communication of artists or musicians. The Producer/Musician relationship is a good model to consider.

Using the BIM Execution Plan as the basis of your BIM orchestral score, the integral teams and players must be united in a single vision: To create as efficient a project that can be had.

Given the dynamic and fluid state that AEC projects can be, it is also requisite to remember what the main goal is: **The Built Project**. Hint: *Flow with unforseen obstacles.*

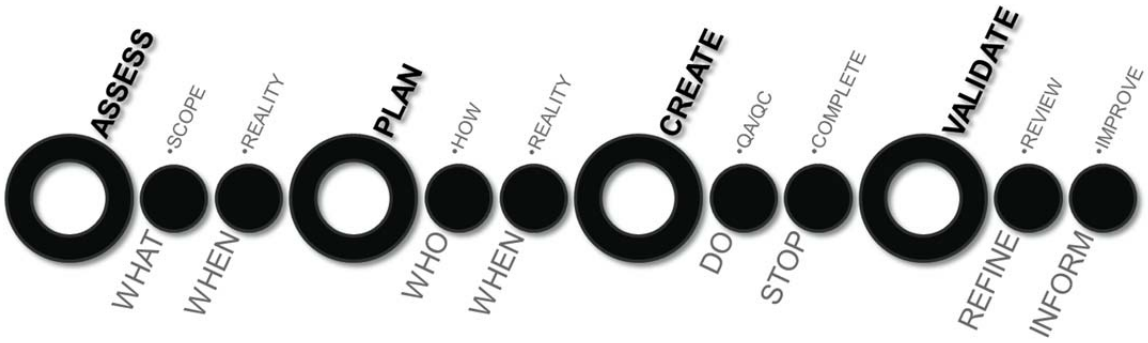
Develop your orchestra, have experts in every chair. Not just decision makers but also thinkers, creative and technical players as well...

When all players are smoothly adept at their instrument (or discipline); then and only then can quality music possibly be created. So to in BIM.

**The BIM Orchestra**
If the extended team is an orchestra working in concert with one another, then the project can reach levels where the disparate parts blend with and balance one another out, working with one another's distinct offerings with harmony and productive counterpoint. Do not take this lightly, managing the human interaction on a project is probably the most difficult, yet potentially most rewarding aspect to managing BIM from concept through operations.

**The BIM Director**
Combining the separate pieces into a whole Building Information Model takes hard work and the hardest work is the creation and guidance of these **Interaction-Integration Processes**. Successfully build a BIM framework, like any good record producer does in the studio, where the players are expert, in an environment where they can create in an uninhibited manner, at their highest and most inspired levels. This is the job of a great BIM Director. If you do not have a great BIM Director, then get one… NOW

### Assess | Plan | Create | Validate
A straightforward way to plan and complete any project in BIM or Life for that matter!




# Assess
## Pre-Schematic Phase (BIM Project design)

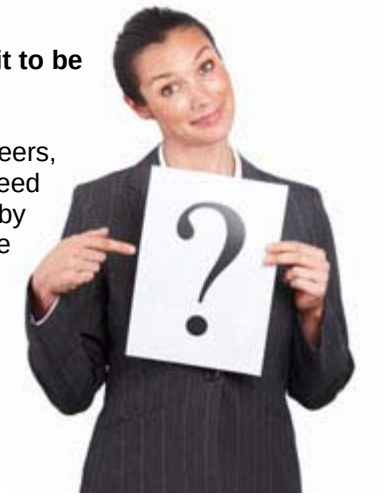
**Know What you are Modeling, When and Why!**
Once the BIM Teams or BIM Orchestra are chosen and the contracts are being finalized and signed, a BIM Execution Plan should already be in place and part of the agreed upon contracts, since they define much of the scope. This early phase communication and collaboration comes at a crucial time where the prospective players begin to formulate an alliance and open working channels.

Define and articulate all knowable tasks, methods, workflows and schedules at the Pre-Schematic or Project design phase. This is the time to come to an agreed upon understanding of what is expected and what is ultimately going to be delivered, when; in effort of getting the project built and operating.

# Plan
## Strategic BIM Project Planning
The Architect, Structural, MEP Engineers and Contratcors plus all other design team members will need to come to an understanding on who is modeling what elements in each of their respective models and phases. Do this by using a checklist like the AIA-E202 that lists the elements on the project and then assign an element author and Level of Development (LOD) for each, at each phase. Bear in mind that some element ownerships may overlap and more than one design team member may want to model these elements; such as floor slabs, lighting, etc. *Do not do this in a vaccuum!*

The question: “Who Owns What and for How Long” is paramount to decifer. Once decided, further plans on how to transfer these from one ‘Author’ to another become necessary. Try to keep it easy, but provide the appropriate levels of complexity.

## Project Planning Questions | A Partial List



First off, preface every project-planning question with: **"Whatever we do; is it to be individually, together, collaboratively and/or jointly?"**

Coming to an agreement on the use of the models with the Architect, Engineers, Owner and Contractor will establish how much modeling efforts there will need to be on the project and will set expectations accordingly. Furthermore, by planning the entire process and illustrating those plans, you will provide opportunities to stay on track and not waste valuable time and money. Another good device, in addition to the AIA-E202 is the Project Execution Plan (PXP) or BIM Execution Plan (BEP), explained later in this document.

- Who will do what?
- When will we do what?
- How will we do it?
- Where will we coordinate with one another?
    - Whose hardware is to be used?
- Do we need a VR cave or Virtual Prototypes?
- What will we need from one another?
- When will we revise?
- How long will we change what we do?
    - Pencils-Down" needs to be real
        - per each model distribution?
- How will we integrate what we each do, how often?
- Where are the models housed while working
- Where are the aggregated models housed
- How we will deliver and submit what we do, how often?
- What are all of the intended uses of the BIMs?
- Is the model (or models) to be simply used for Architectural and Structural coordination only
- Will other disciplines be involved in the 3D coordination effort?
    - MEP
    - Contractor
    - Sub-Contractors
    - Fabricators
    - Fire Sprinkler (if not MEP)
    - Owners (FM)…
- Will the Revit model be part of the deliverable as a contract document
- Will the Contractor use it to estimate or build from?
- Will the Contractor use it at all or re-build anew?
- Are there other platform models?
- What are all (YES ALL) of the softwares and versions used?
- Are there other deliverables beyond CD's and Models?
- What is required to be submitted and approved at each phase & milestone of the project?
- Is the Revit model expected to be delivered with 2D drawings and digital prints at Schematic Design, Design Development, CD, etc.?
- What is the plan to organize the models themselves
    - Views, Sheets, Components, Parameters, discrete zones/buildings, etc.
- Project Phase, defined model and submission protocols
- Revit Specific "Phasing" usage protocols
- What is the change management process?
- What are the cutoff dates (Model Freeze, Designer Freeze, etc.)
- What is the strategy to get Construction changes into The As-Built BIM?

As you can see there are a lot of issues to deal with and these along with the BEP and PXP, etc. will get you right on your way to addressing the issues at hand: A Coordinated BIM.

### A Few Notes on Sheet Coordination

Coordination of the sheet set is nothing new to BIM projects. By coordinating through sheet parameters, disciplines can designate their sheets that should be included in the sheet index as well as which are included in each release. These parameters can then be scheduled, including those in linked models, to create and sort the master index.

> *Remember, these solutions are scalable for projects of differing sizes and complexities, so don't get overwhelmed if you have smaller or only moderately complex projects… these same concepts will help every project type and size.*

### Level of Development (LOD) -Component and Systems Coordination

Prior to modeling define the progression of not only ownership/authorship of components and models, but also define the transferrance processes. The AIA-E202 is a great start for this type of planning.

**§ 4.3 Model Element Table**

*Identify (1) the LOD required for each Model Element at the end of each phase, and (2) the Model Element Author (MEA) responsible for developing the Model Element to the LOD identified.*

*Insert abbreviations for each MEA identified in the table below, such as "A – Architect," or "C – Contractor."*

*NOTE: LODs must be adapted for the unique characteristics of each Project.*

| Model Elements Utilizing CSI UniFormat™ | | | | | LOD | MEA | LOD | MEA | LOD | MEA | LOD | MEA | LOD | MEA | LOD | MEA | Note Number (See 4.4) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A SUBSTRUCTURE | A10 | Foundations | A1010 | Standard Foundations | | | | | | | | | | | | | |
| | | | A1020 | Special Foundations | | | | | | | | | | | | | |
| | | | A1030 | Slab on Grade | | | | | | | | | | | | | |
| | A20 | Basement Construction | A2010 | Basement Excavation | | | | | | | | | | | | | |
| | | | A2020 | Basement Walls | | | | | | | | | | | | | |
| B SHELL | B10 | Superstructure | B1010 | Floor Construction | | | | | | | | | | | | | |
| | | | B1020 | Roof Construction | | | | | | | | | | | | | |
| | B20 | Exterior Enclosure | B2010 | Exterior Walls | | | | | | | | | | | | | |
| | | | B2020 | Exterior Windows | | | | | | | | | | | | | |
| | | | B2030 | Exterior Doors | | | | | | | | | | | | | |
| | B30 | Roofing | B3010 | Roof Coverings | | | | | | | | | | | | | |
| | | | B3020 | Roof Openings | | | | | | | | | | | | | |
| C INTERIORS | C10 | Interior Construction | C1010 | Partitions | | | | | | | | | | | | | |
| | | | C1020 | Interior Doors | | | | | | | | | | | | | |
| | | | C1030 | Fittings | | | | | | | | | | | | | |
| | C20 | Stairs | C2010 | Stair Construction | | | | | | | | | | | | | |
| | | | C2020 | Stair Finishes | | | | | | | | | | | | | |
| | C30 | Interior Finishes | C3010 | Wall Finishes | | | | | | | | | | | | | |
| | | | C3020 | Floor Finishes | | | | | | | | | | | | | |
| | | | C3030 | Ceiling Finishes | | | | | | | | | | | | | |
| D SERVICES | D10 | Conveying | D1010 | Elevators & Lifts | | | | | | | | | | | | | |
| | | | D1020 | Escalators & Moving Walks | | | | | | | | | | | | | |
| | | | D1030 | Other Conveying Systems | | | | | | | | | | | | | |
| | D20 | Plumbing | D2010 | Plumbing Fixtures | | | | | | | | | | | | | |
| | | | D2020 | Domestic Water Distribution | | | | | | | | | | | | | |
| | | | D2030 | Sanitary Waste | | | | | | | | | | | | | |
| | | | D2040 | Rain Water Drainage | | | | | | | | | | | | | |
| | | | D2090 | Other Plumbing Systems | | | | | | | | | | | | | |
| | D30 | HVAC | D3010 | Energy Supply | | | | | | | | | | | | | |
| | | | D3020 | Heat Generating Systems | | | | | | | | | | | | | |
| | | | D3030 | Cooling Generating Systems | | | | | | | | | | | | | |

*Partial AIA-E202 BIM Planning Document*

## BIM Execution Planning

A well planned program between the all of the AECO design professionals is fundemental to coordinated BIM. The BIM Execution Plan is a basis that establishes many things, such as how each model is organized and how each model, drawing, document, spec. etc. is to be exchanged, developed and formatted. This all helps the coordination process and eventually creates a smooth road.

In our minds, we do not want you to create the oft-typical Single Author Document (SAD) BIM Execution Plan (SAD BEP), otherwise referred to as a BIM Fascist Plan; where one player exhorts their will on the other players. That's not very team oriented, but rather we profess that a Coordinated BIM Execution Plan be created and authored by all players: A, E, C and O. In other words a true BIM Interaction Plan.

The BIM Execution Plan is the essential lifeblood of any well-coordinated Revit/BIM Project. The BEP is the guide to which all team members will adhere. That is all great in theory, however with all great "plans" they are only effective if everyone follows them. The best way to get everyone to follow a BIM execution plan is to have everyone contribute to its creation. Yes, this is not that common, especially for Engineering Consultants, there are countless times when a BIM execution plan is created and it has absolutely no input from any team members outside of the Architect, the Contractor, or the Owner.

When this happens the BIM execution plan becomes lopsided and does not "address" every design teams members discipline specific issues. So, once again, make sure to help author the BIM execution Plan. Consider that it is much harder to additions to a completed BIM execution Plan be followed, than it is to help write it. If forced to though do get your considerations included and manage the implementation.

The easiest way to achieve efficient coordination is to get all of the design team to agree on a logical structure for the Revit model. This is achieved via a BIM Standards project. Creating project standards for items such as the software in use, file and object naming, view naming, sheet naming etc. can all go a long way in creating a more efficient environment for the coordination efforts on a large job.

Establishing ownership of items such as gridlines or levels for example can really help, as responsibility is maintained by one member. To extend this level of accuracy, using Revit's tools for copy/monitor or clash detection, the other design team members can maintain the same geometry without any errors…Given they use the tools as prescribed.

While BIM technology will continue to mature, new big picture items and issues are appearing on the landscape that must be addressed:

- Who owns the final Building Information Model?
- *What is* the final Building Information Model?
- What is the final BIM to be used for?
- Is the final Building Information Model simply the 3D Model(s)

The BIM, as is contended herein is; "**All of the Developed Information and Graphics from the Idea to the Handoff to Operations**"

### Collaboration with the Design Team

G

By participating in the BIM Execution Plan with the design team, a General Contractor can help establish clear levels of development (LOD) of the model components. as well as helping define the GC and the Design team's responsibilities within the models later on, into and during construction. With a live, accurate building information model during the pre-construction and construction phases, this model becomes the central reference tool for constructability review and collaboration with the design team. For many scopes of the project LOD 300 models will be transformed into LOD 400 fabrication models. The BEP will help define where to draw the line between the design and fabrication model as well as how to federate them as one LOD 500 deliverable after construction.

**Who Owns What?**
Deciding who will be ultimately responsible for the completed model at the conclusion of a project, or who will be maintaining as-built models for the project is very important, so as to avoid repeat work or unnecessary future survey work. *Plan with Construction, Construction Administration and Closeout in mind.*

Other decisions that are critical to efficiency are items such as whether the fabricators or detailers will be working from the models? The consequences of sharing the digital model with the contractor could have a very positive influence on the communication of the design and execution on site; plan this interaction early, so all team players can Model into Success, **Providing What is Needed, When it's Needed**.

These ownership and responsibility issues should be covered in the BEP and contracts for BIM projects so that communication lines can be setup for each member of the design-construction team. Set all this language up in the terms and conditions of each contract and is also referenced in the general notes of the contract documents.

**Structural | MEP | Architect | Interface at a Glance**
Coordinate what is to be submitted at the end of each phase. Then verify with the following questions.

- Are plans only required or do you want the 3D model?
- Will anyone ever look at the schematic Structural or MEP Models?
- Will the Architect ever use the Structural or MEP Models in their schematic submittals
    - Coordination
    - Printing
- Shampoo, Rinse, Repeat for DD, CD, CA, etc.

If the answer is no to these questions, then perhaps there is no need to send the model to anyone at the schematic phase of the project (good luck with that). If this is the case then save time and simplify your modeling efforts as much as possible. This is specifically important for Engineering Consultants: Structural may want to model such that everything looks correct on plans only (as one example): *See Images on Page 17 herein.*

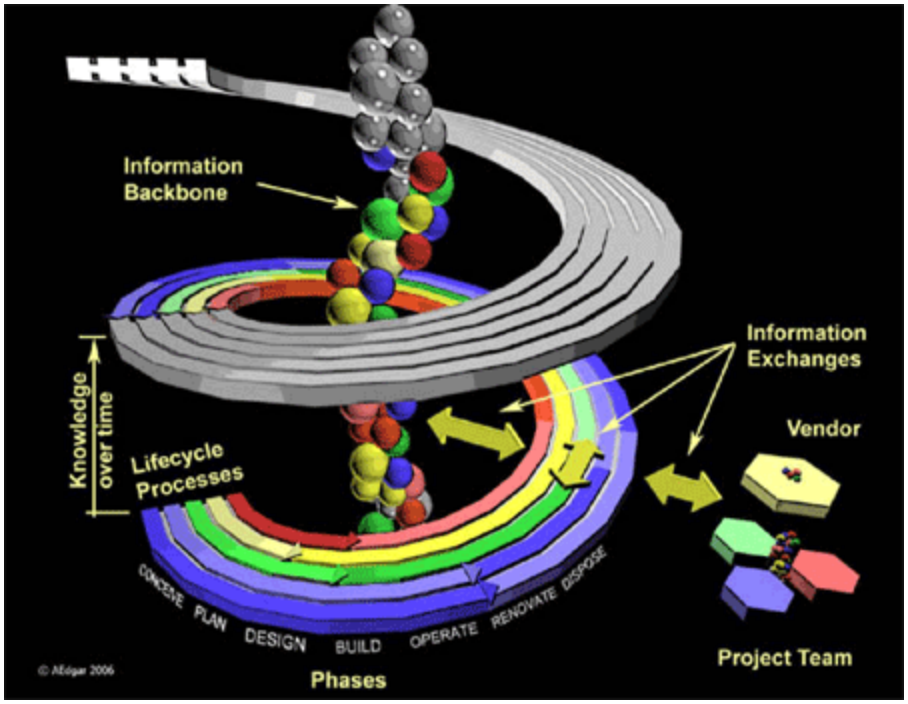



*Image from: Whole Building Design Guide http://www.wbdg.org/bim/nibs_bim.php*
*Oh Yes, we suggest you go there too!!!*

# BIM Execution Plan

X **Index** *Reference NBIMS BIM PXP Template*




A **Project Execution Plan Overview**
"The BIM Project Execution Plan defines uses for BIM on the project (e.g. design authoring, cost estimating, and design coordination), along with a detailed design of the process for executing BIM throughout the project lifecycle." Add to that BIM Mission statements and other detailed information pertinant to the specific project.

B **Project Information + Schedule and Milestones**
"Basic project reference information + Include BIM milestones, pre-design activities, major design reviews, stakeholder reviews, and any other major events which occur during the project lifecycle."

C **Schedule and Milestones**
"List of lead BIM contacts for each organization on the project. Additional contacts can be included later in the document."

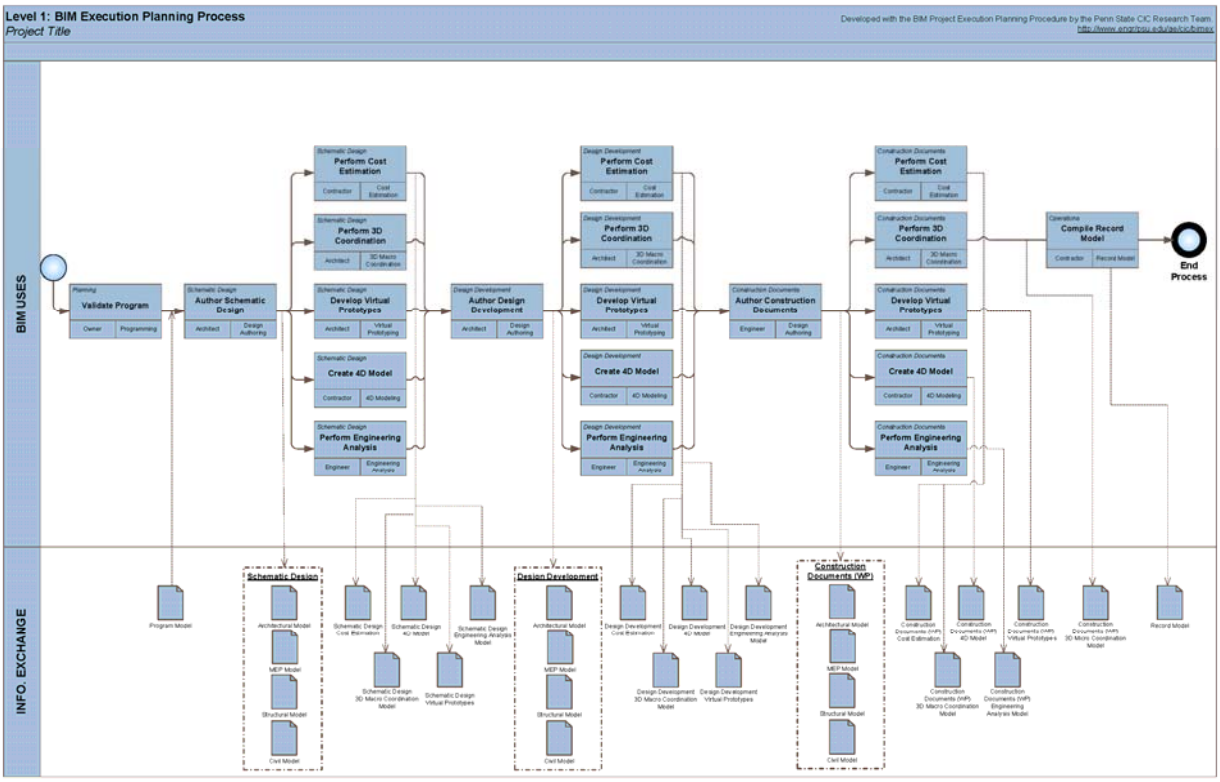
D **Project Goals and BIM Uses**
This endeavor has three main component data sheets:

- Major BIM Goals and Objectives
- BIM Use Analysis Worksheet
- BIM Uses

"Describe how the BIM Model and Facility Data are leveraged to maximize project value (e.g. design alternatives, life-cycle analysis, scheduling, estimating, material selection, pre-fabrication opportunities, site placement, etc.) Reference www.engr.psu.edu/bim/download for BIM Goal & Use Analysis Worksheet."

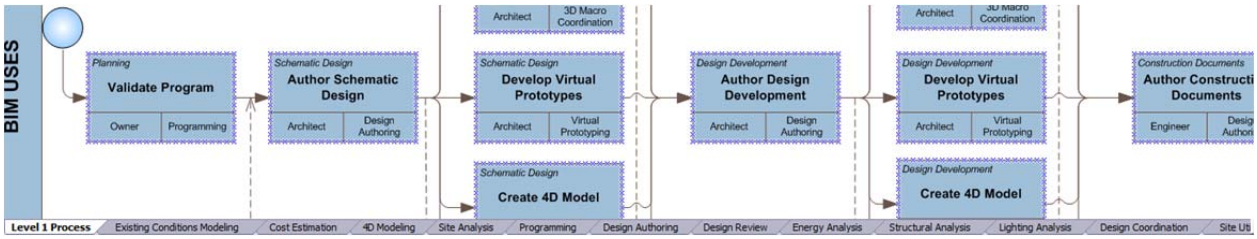
E **Organizational Roles and Staffing**
"For each BIM Use selected, identify the team within the organization (or organizations) who will staff and perform that Use and estimate the personal time required."

F **BIM Process Design**
"Provide process maps for each BIM Use selected in section D: Project Goals/BIM Objectives. These process maps provide a detailed plan for execution of each BIM Use. They also define the specific Information Exchanges for each activity, building the foundation for the entire execution plan. The plan includes the Overview Map (Level 1) of the BIM Uses, a Detailed Map of each BIM Use (Level 2), and a description of elements on each map, as appropriate. Level 1 and 2 sample maps are available for download at www.engr.psu.edu/BIM/download. (Please note that these are sample maps and should be modified based on project specific information and requirements). Please reference Chapter Three: Designing BIM Project Execution Process in the BIM Project Execution Planning Guide found at www.engr.psu.edu/BIM/PxP"




*BIM Project Execution Process Map (PXP) sample. Source: buildingSMART alliance™*

The Process Execution Plan is part of the set of documents available for use in the planning and organization of BIM projects and teams, etc. (Verify all documents for usage legalities).




*BIM Project Execution Process Map (PXP) sample.-Notice the additional page tabs at the bottom!!! There's a whole world of help out there!!!*

**List of Detailed BIM Use Process Maps**

The following are examples of Process Maps that may be needed, as part of your BIM Execution Plans.
*-Your list may very well be longer or shorter, again; depending on project specifics.*

a. Existing Conditions Modeling
b. Cost Estimation
c. 4D Modeling
d. Programming
e. Site Analysis
f. Design Reviews
g. Design Authoring
h. Energy Analysis
i. Structural Analysis
j. Lighting Analysis
k. 3D Coordination

l. Site Utilization Planning
m. 3D Control and Planning
n. Record Modeling
o. Maintenance Scheduling
p. Building System Analysis

G **BIM Information Exchanges**
"Model elements by discipline, level of detail, and any specific attributes important to the project are documented using information exchange worksheet." To understand more fully the needs in defining the requirements for Information Exchanges reference once again, the NBIMS BIM Project Execution Planning Guide to understand more of the necessary details involved. This is a good time to visit with I.T. as well.

H **BIM and Facility Data Requirements**
"The section should include the owners BIM requirements. It is important that the owner's requirements for BIM be considered so that they can be incorporated into the project's BIM process."

I **Collaboration Procedures**

- **Collaboration Strategy**
  "Describe how the project team will collaborate. Include items such as communication methods, document management and transfer, and record storage, etc."
- **Meeting Procedures**
  Including but not limited to: Meeting Type, Project Stage, Meeting Frequency, Participants, Location…

- **Model Delivery Schedule of Information Exchange for Submissions and Approvals**
  "Document the information exchanges and file transfers that will occur on the project."

- **Interactive Workspace**
  "The project team should consider the physical environment it will need throughout the lifecycle of the project to accommodate the necessary collaboration, communication, and reviews that will improve the BIM Plan decision making process. Describe how the project team will be located. Consider questions like "will the team be collocated?" If so, where is the location and what will be in that space? Will there be a BIM Trailer? If yes, where will it be located and what will be in the space such as computers, projectors, tables, table configuration? Include any additional information necessary information about workspaces on the project."
- **Electronic Communication Procedures:**
  (Note: File Naming and Folder Structure will be discussed in Section L: Model Structure).The following document management issues should be resolved and a procedure should be defined for each:" Permissions, access, File Locations, FTP Site Location(s), File Transfer Protocol, File, Folder Maintenance, File Types, File Maintainer, Update Schedule and Status etc.

J **Quality Control**

- **Overall Strategy for Quality Control**
  **"**Describe the strategy to control the quality of the model."

- **Quality Control Checks:**
  When, Who and what time is needed to make necessary changes and round-trip with entire BIM team for full coordination.

  Consider:
  **Quality Assurance** (QA) To happen by users and management throughout modeling and coordinating phases.

  **Quality Control** (QC) To happen by experienced technical staff toward end of SD, again in the middle of DD and finally at about 80% CD phases. These are much like comprehensive peer-reviews, only internal… or external??? Hmmm…

The following audits must be performed to assure quality and coordinated efforts and output (The Virtual Project), you may have more audits as well:
**Visual Audits**
**Interference Audits**
**Standards Audits**
**Model Integrity Audits**

Remember this is all distinct from the Architectural and Engineering technical checks that need to happen…

Pencils-Down is no joke when considering getting projects coordinated properly!

- **Model Accuracy and Tolerances:**
  "Models should include all appropriate dimensioning as needed for design intent, analysis, and construction."

  Level of detail and the included model elements are to be provided in the Information Exchange Worksheet and AIA E-202, or similar.

K **Technological Infrastructure Needs**

- **Software**
  List all BIM software and any ancilary programs to be used.
  **BIM Use**
  **Discipline**
  **Software**
  **Version**

- **Hardware**
  "Understand hardware specification becomes valuable once information begins to be shared between several disciplines or organizations. It also becomes valuable to ensure that the downstream hardware is not less powerful than the hardware used to create the information. In order to ensure that this does not happen, choose the hardware that is in the highest demand and most appropriate for the majority of BIM Uses."
  **BIM Use**
  **Computer System Type and Name**
  **Hardware Specifications** (Detailed)
  **Owner**

- **Modeling Content and Reference Information**
  "Identify items such as families, workspaces, and databases." Provide lists, cutsheets and website links that will be used to populate BIM objects.
  **BIM Use**
  **Discipline**
  **Reference Information**
  **Version**

L **Model Structure**

- **File Naming Structure:**
  "Determine and list the structure for model file names."
  Determine and list the structure and conventions for model View Names
  Determine and list the structure and conventions for model Sheet Names
  Example Model Name Convention Example:
  Discipline_Project Number_Name.File Type Suffix **A_00000_Project 1.xxx**

  Prefix Examples (Why use extra, unnecessary letters??? Option 1 should suffice but it's your call)

| Discipline | Option 1 | Option 2 (NBIMS) |
|---|---|---|
| Architecture | A | ARCH |
| Civil | C | CIVIL |

| | | |
|---|---|---|
| Structural | S | STRUCT |
| Mechanical | M | MECH |
| Electrical | E | PLUMB |
| Plumbing | P | ELEC |
| Energy | G | ENERGY |
| Construction | GC | CONST |
| Coordination | CO | COORD |
| Facilities Management | FM | - |

- **Model Structure:**
  "Describe and diagram how the Model is separated, e.g., by building, by floors, by zone, by areas, and/or discipline."
  Determine and list the structure and conventions for model Component Names.
  Determine and list the structure and conventions for model Component Parameters.

- **Measurement and Coordinate Systems:**
  "Describe the measurement system (Imperial or Metric) and coordinate system (geo-referenced) used."
- **BIM and CAD Standards:**
  "Identify items such as the BIM and CAD standards, content reference information, and the version of IFC, etc."

**M** **Deliverables**
"In this section, list the BIM deliverables for the project and the format in which the information will be delivered."

**Bim Submittal Items | Stage | Due Date | Format | Notes**

**N** **Delivery Strategy and ContractAttachments**

- **Delivery and Contracting Strategy for the project:**
  "What additional measures need to be taken to successfully use BIM with the selected delivery method and contract type?"
- **Team Selection Procedure:**
  "How will you select future team members in regards to the above delivery strategy and contract type?"
- **BIM Contracting Procedure:**
  How should BIM be included in this project's contracts?
  "How should BIM be written into the future contracts?"


**O** **Attachments**

- **BIM Use Selection Worksheet** [From Section D]
- **Level 1 Process Overview Map** [From Section F]
- **Level 2 Detailed BIM Use Process Map(s)** [From Section F]
- **Information Exchange Requirements Worksheet(s)** [From Section G]
- **Model Definitions Worksheet** [From Section G]
- **Developed Documents and Contracts** [From Section H]

## BIM Resources

The available documents that can be used as references and/or starting points for BIM Execution Plans, etc. come from many sources and the list is growing nearly every day. Below is a list we suggest you start with. They will prove invaluable in planning any scale BIM process. The sources include, yet are not limited to the following:

***NBIMS***

- National BIM Standard
- Interactive BIM Capability Maturity Model (BIM CMM)

***buildingSMART alliance*™ and Penn State** (Used herein)

- BIM Project Execution Planning Guide
- BIM Project Execution Process Map Template
- BIM Project Execution Plan (PXP) Template
- BIM Goal Use Analysis Worksheet
- Information Exchange Worksheet

**AIA**

- AIA E202
- AIA B 080344 On Compensation
- AIA IPD Guide
- Model Progression Specification

**US Army Core of Engineers (USACE)**

- Building Information Modeling (BIM) Roadmap
- USACE BIM PXP Template

**Autodesk**

- BIM Deployment Plan
- AEC BIM Communication Specification
- LOD Exhibit CSI95

**Other sources of documentation for project planning, BIM and process resources, etc.**

- COBIE
- IDM (Information Delivery Methods (via buildingSMART alliance™)
- Vico (Model Progression Specification, etc.)

## Kick Off Meetings

In addition to all that should be included in the BEP, here are some other Revit Specific, Proactive Plans to consider including and discussing and finalizing at the Kickoff Meeting.

- Warnings (Zero is the best number to work with!!!)
- Timelining Expectations
- Modeling Procedures
- Copy-Monitor
- Design Options
- Phasing
- Worksets
- Pencils-Down strategy at each phase
- Visual Model Coordination items
- Model Clean up

**Kick off meetings are essential** and may be a series of meetings that include the creation or completion of the BIM execution plan.
The project starts at these meetings, not when something is first modeled. Therefore, assign the right people now.

Getting the right people in the meeting and not just principals is paramount. Get people with technical knowledge and understanding of not only BIM, but the Project Type and Construction Methodology and Design, Owner and Budgetary needs, so that unrealistic promises are not made. As stated previously: "…Not just decision makers but also thinkers, creative and technical players as well..."

The more that is nailed down early the more coordinated the project will be. Make sure to strategize every system, major and minor so there are as few unknowns as possible.

M

**Hosted Components**
Discuss positives/negatives for using hosted & non-hosted objects. In particular, the results for deletion of host objects in relation to their hosted objects. **This is mandatory for every object**, just like Copy/Monitor protocols are necessary!

**Copy/Monitor**
Copy/Monitor should be avoided for plumbing fixtures and lights, according to some MEP philosophies; it is a better workflow to have these objects in both models and coordinate views showing either the architect's or the engineer's version via view templates and/or worksets. This requires coordination from both sides to ensure both are on the same page with changes. There are other philosophies where this duplication is not desired…work it out early, so everyone knows what is expected.

Another approach is to transfer the "ownership" of these components, based on the BEP and AIA-E202, but whatever the case get this down in the BEP.

**File Linking**
Upon successful linking, MEP should set the linked architecture model(s) to room bounding so that spaces can be created, based on the Architect's room objects. Correctly label the spaces with the same name as the architect's rooms. MEP can either create a space tag that uses the room name/number from the architect's model or use the subscription add-in called 'Space Naming Utility' to transfer the names from the architect's model into the spaces in the MEP model.

**Linked views**
Linked views are very powerful when used to match views from other models. Structural and MEP should coordinate with the Architect and each will create dedicated views that can be used for backgrounds in one another's discipline specific models.

**Annotation Import**
Having a set of documents look the same across multiple disciplines is a desired touch. The architect should create an example project that has their annotation families displayed and explained for use by the other disciplines. These annotations should include grids, levels, tags, view markers, view titles, titleblocks, etc. *See pages 23-24 for more info and examples.*

**Who "Owns" What**
Owning an element just does not mean who "models" the elements. Owning an element means that the "Owning" team is ultimately responsible for the elements placement, size and location. Its ok if the Architect and the Structural Engineer model the same elements, such as slabs but only one team should own them. Make a checklist, the AIA E 202 is a good start but expand it since only the very basic of structural elements are listed in that document. Pay close attention to who owns columns, beams, curbs, slabs, and non-load bearing masonry walls, lights, receptacles, plumbing fixtures...

**Model Exchange & Setups**
Several steps are involved when exchanging models between disciplines. Setup includes linking, model cleanup, shared coordinates, etc. Have everything possibly known about project needs addressed and discussed at these meetings. Define cleanup procedures, so those can be added to the BEP as well, as no-one needs extraneous things in models that are linked back and forth…Do you "Need" those sheets, schedules, legends, details, renderings, elevations and sections in the other discipline's models, etc. for each model transfer? (See: http://cad-vs-bim.blogspot.com/2010/04/revit-to-revit-file-linking.html for considerations to consider in cleaning files for transfer ;-) Don't forget to Purge Unused too!!!

# Create

## Schematic Design

**Refining the BIM | Modeling *for* Coordination**
If the BEP is followed and teams are conscious of and modeling into coordination, employing good QA processes; this along with Project and BIM management oversight and input then there will be less QC and ultimately better projects.

**Pencils-Down**
Make sure all the teams understand the importance of Pencils-Down being well before the actual submittal dates. Designers need the earliest Pencils-Down at each stage, since so much depends on the model not shifting under Documentation and Details, etc. Also the "Production" and Coordination and Consultant teams will need time to integrate changes, round-trip that all back at least once and then submit: once the coordination and corrections are completed. Staying ahead of the schedule and budget is Coordination Job One!

> **Example of Pencils-Down Planning:**
> If the work to coordinate prior to a submittal generates one week of work for each discipline, that means Pencils-Down for Design is three weeks... Now, the production teams can add information such as Tags and Dimensions, etc. but no Design changes to the Virtual Building itself…or else SNAFU.
>
> This example considers: One week to do the individual work, One week to integrate each other's work back in and do QC of that work, then the third week for slight touch ups, printing and delivery.
>
> Be very clear, the third week in that scenario is going to be used, no matter the schedule or plan, sometimes due to unforeseen issues, missing work, mistakes, etc. or will be a more rare occurance where time can be actually captured back on the project timeline, allowing us to do more of the big picture work...
>
> **Plan a Pencils-Down Strategy** for each project stage and phase; for each necessary team component: Design, Detailing, etc.

**Staying ahead of the schedule and budget is Coordination Job One!** Keep teaching/reinforcing that.

Working "with" others can bring up very interesting scenarios, one that Architecture finds with Civil seems a relic from the past that may want to be re-thought (read as 'must be re-thought')! Properly modeled BIM require that Civil is best to call out and model to Top Of Dirt, not Top Of Surface. The Architects and Structural teams will model the actual finish surfaces and we do not want to have those objects taking up the same space and time!

To coordinate curbs and surfaces with design teams and models in a BIM World, the dirt is what is important from the Civil Engineers, if the other Hard-Surfaces are to be modeled by others, that is. Get these and other items strategized in the BEP and Kickoff Meetings and you will have a much better BIM. In addition, if or as issues come up during the project that speak to missing parts of a plan, etc. then add those to your documentation for next time… The "Refine" part of "Validate" from the **Assess | Plan | Create | Validate** concept shown earlier.

**Coordinated Model | Modification Reactions**

Teams are likened to an artist learning eye to hand coordination, via Blind Contour drawing techniques... Drawing by looking at onlt the subject, not the paper… Doing that there are those times when the eye to hand is working great there are bits of clarity… likewise, the BIM Execution Plan and preliminary coordination meetings can be the catalyst that binds the teams into one greater organism.

If we can work in a less linear fashion, more dynamically, interactively; the team or Building Artist Team can make more beautiful pictures... AKA: Better BIM and ultimately Better Projects!

**M**

During the SD phase if the architect is able to produce a model that contains rooms, then MEP should create a spaces model for analysis and pre-design. Space models allow for HVAC calculations based on room volumes as well as potential day lighting calculations and other calculations. If the architectural model does not have rooms then the typical MEP SD deliverable would be a narrative based on calculations performed in other software.

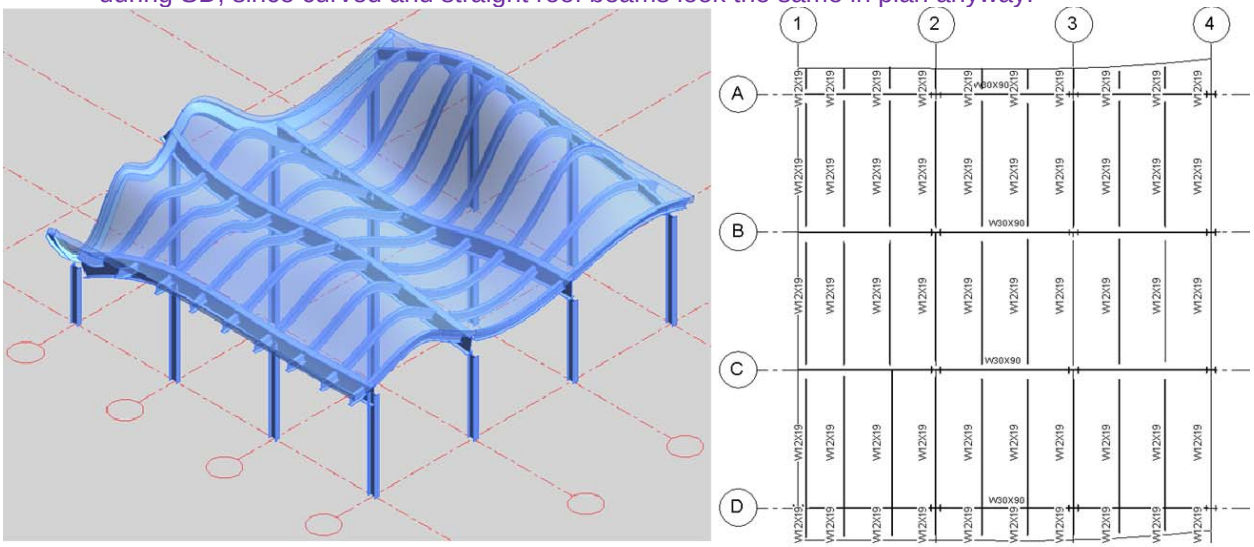
**S**

**Considerations for All to Use, though Structural in Nature**

BIM has changed the traditional Schematic Design phase of a project because so much information is now required to be placed into the 3D models early on. This is good in that there is a lot of information that is decided early on which helps with design, however this also means that much more information is expected from the Architect.

This is where a lot of time and money could be wasted, if we are not careful. So do not do more than what is required, no more than the BEP stipulates. It's possible that very little coordination needs to happen at the SD phase, other than showing the Architect the nominal beam depths for instance.

Consider the following roof surface and framing and ask if this would need to be modeled with curving roof members at this time, or if modeling straight, flat roof members is good enough during SD; since curved and straight roof beams look the same in plan anyway!

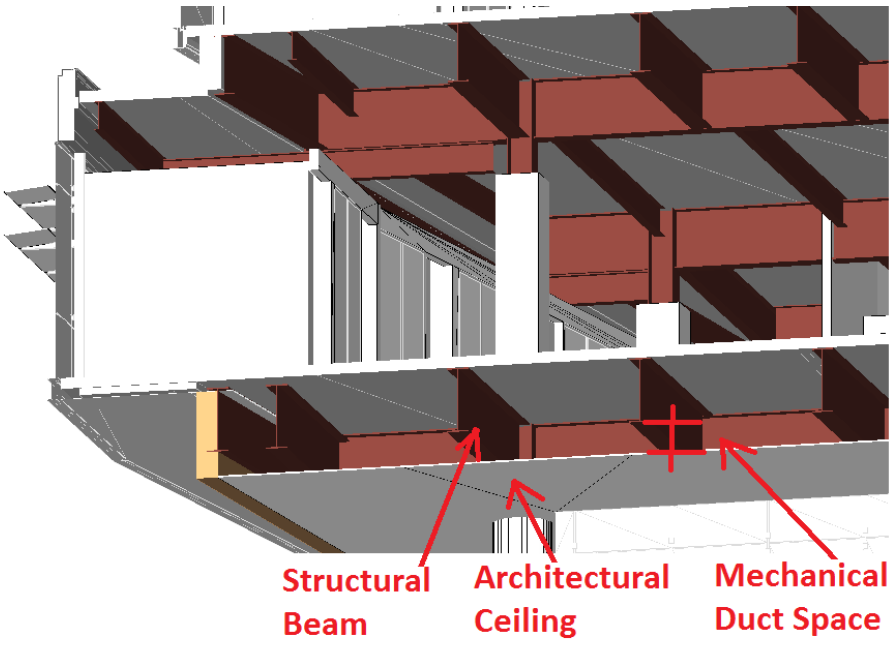



**3D View of Roof Framing** **Plan View of Roof Framing**

*Schematic Framing: Plan looks flat, no matter the nature of modeling: Is this modeling needed at SD???*

The SD phase of the project is less about coordination and more about setting up the correct parameters of the project so coordination can go smoothly later on. If you spend a lot of time on coordination at this phase, in fine detail, the chances are that things will change and you will have to coordinate those items again. Be patient and let columns, and grids, and walls settle down in their locations first, then coordinate the structure with them, unless the BEP stipulates otherwise.

Ask what the nominal ceiling depths and wall widths are and make sure there is enough room left for mechanical systems. If the ceiling depths are too shallow, make sure to point out that the beam designs could be non-efficient and may need to get deeper. Make sure to be very clear what Nominal vs. actual Beam depths mean.



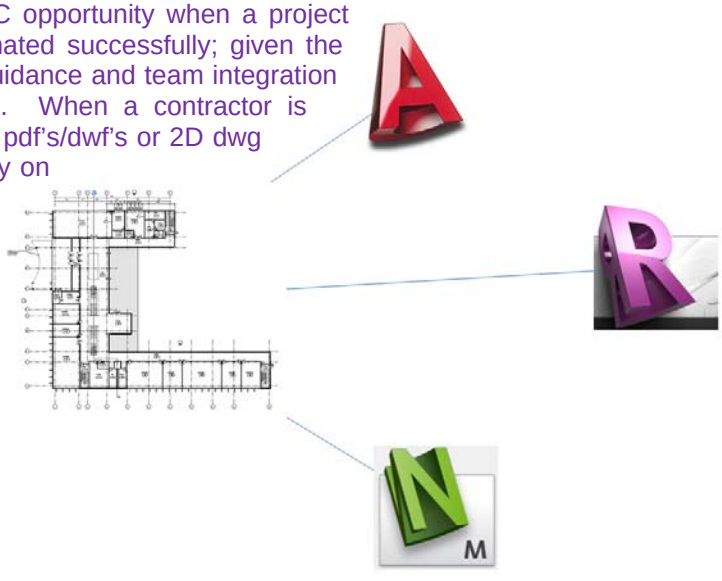

*Coordinating Ceiling Depths (3D Cut away View)*

Make sure to get the Geographical Coordinates and shared coordinates set up was well and ask the Architect if they plan to move the building or if the Architect has accounted for that to potentially happen. Finally, determine whether it is worth the effort to Copy/Monitor all or any elements in Revit. Copy/Monitor will work great and help coordinate elements between the Architectural and the Structural models seamlessly… *if it is planned for, used and managed correctly that is.*

There are major limitations to Copy/Monitor since only grids, levels, columns, walls, and slabs could be Copy/Monitored and it's ok to just use it in the early phases. Be cautious if elements are too complicated. In the end, I would recommend that you use Copy/Monitor in the early stages of the project then once everything is settled down and the architect "promises" not to move anything then stop doing it.

**G**

A General Contractor has windows of VDC opportunity when a project plan and design are executed and coordinated successfully; given the opportunity to provide early input, design guidance and team integration greatly impacts the projects success rate. When a contractor is brought to the table later, only given prints, pdf's/dwf's or 2D dwg files for a project, or not given a right to rely on the model(s) from the design team, during the construction phase most of the General Contractor's time must then be spent in model creation and coordination. This is an endeavor that can be abated by fully leveraging the Contractors expertise throughout the project's design lifecycle.



# Design Development

**Coordinating Changes**
The process and players are now known elements. The space to perform the coordination sessions have been setup and perhaps even used for SD phase coordination, if the plan specified as much. What is the best setup? That answer comes down to budget and project type. For a 5,000 SF pad building, not much more than a conference room with a large monitor and a computer to view the aggregated model from may suffice. For larger more complex projects, we could use a 'Cave' where there is a computer and large monitor for each discipline, plus another with the aggregated model, so as items are discussed each player can control their needed changes, while the CM, etc. can manage the overall process.

Is there a need for or a case to make that Virtual Reality is to be used (BTW: this would have been brought to light in the planning stages and included in the BEP)… If so, does there need to be space provided for that? Do prospective tenant/users need to have other sessions where they can virtually test the pending Design, to ensure proper clearances, etc. such as in the case of Surgical Theaters, etc.?

**Model Auditing**
Remember this from earlier? DD and CD are the phases where these audits will happen multiple times.

> The following audits must be performed to assure quality and coordinated efforts and output (The Virtual Project), you may have more audits as well:
> **Visual Audits** (Human Clash Detection)
> **Interference Audits** (Clash Detection Reports)
> **Standards Audits**
> **Model Integrity Audits**
>
> This is all distinct from the Architectural and Engineering technical audits and reviews that need to happen…
>
> **Pencils-Down is no joke when considering getting projects coordinated properly!**

In every case, these live coordination sessions should use models from each discipline, individually color-coded for ease of visibility. Cut the model using a live 3D view and keep moving the 'cut line' through the building a foot or so at a time. When completed from the first direction, un-cut the view and repeat the process in a perpendicular direction.

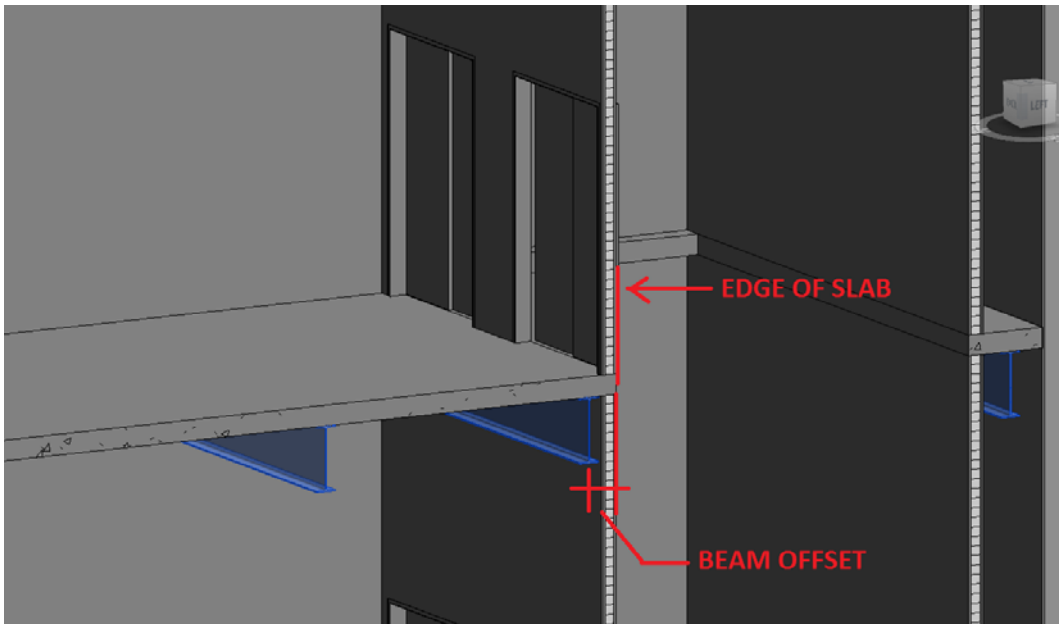
These Visual Audits are the same as for internal coordination but can highlight many potential issues well before they are built or planned on being built.

**Other items to Verify During DD & CD Audits**
- Critical path for contractor being addressed
  - Material Ordering Needs
  - Foundation Permits, etc.
  - Detailing
  - SOP
- Mitigating Rework, Copy/Monitor management.
- Getting the models back and reacting
- Coordinated 100% DD Model Submittal Strategy
- Engineering Development
  - Nominal to Specific Structure & MEP
- Is the envelope virginal and intact, or is it now violated? *AKA: Get that Column out of the Toilet!!!*

DD is the phase where most coordination needs to occur, typically. At the end of this phase all the major structural elements will need to be "sized" and placed. Therefore, its important get the coordination correct so that the major structural elements will not need to be changed in the CD phase.

All the 3D models need to be refined in this phase so make sure that you are finalizing and accounting for all the correct ceiling heights, wall assemblies, and interior opening locations so that the MEP and Structural members fit with the Architectural envelopes, etc.

Verify that everything is becoming properly placed, for instance Structure at the edge of openings or at the edge or slabs, per the desired detailing and design needs. If the team does not know this information, ask for details of these systems. The image below that shows a sample of beam offset.




*Coordinating Beam offsets with slab openings (3D Cut away View)*

**S** Verify that the Architect has shown any Structural elements in the architectural Revit/BIM. It is better to ask early so that any structural elements that are not showing up correctly could be fixed so you could avoid it in the 11th hour in the CD phase when everyone is in panic mode to make a submittal. A common problem is that family settings, for structural framing of braces for example, work for the structural Revit model but do not show correctly for the architectural Revit model.

**No Blind Changes in a Vaccuum Any Longer**

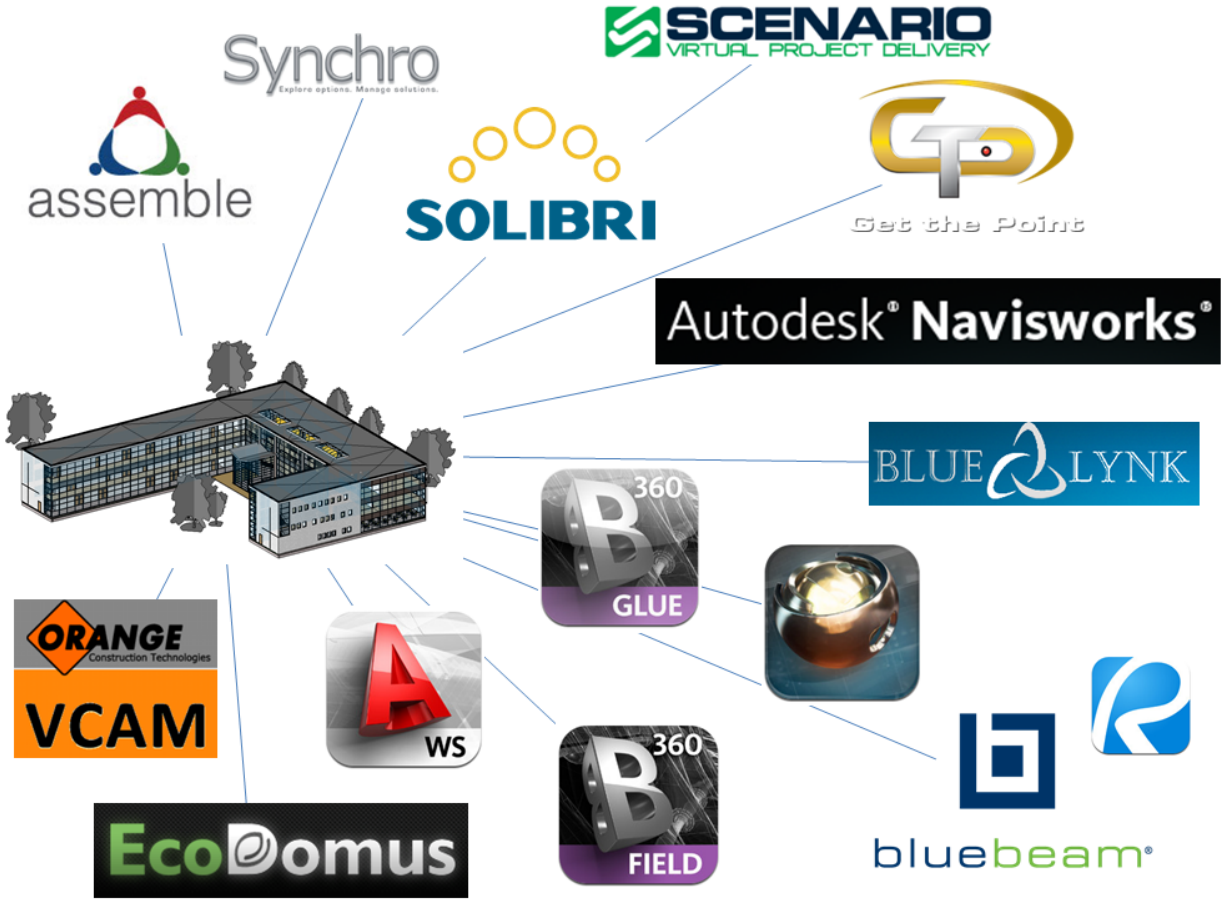
It's in DD and CD where we must not blindly change settings or components in any of the models without first considering the down-stream ramifications. Such as to change settings in the Structural Revit model and risk it not looking correct in the Structural plans just because it is not showing as desired in the Architectural model. Help each other and suggest a solution such as, that the Architect may need to make their own Structural Revit families to show their own graphic settings, or help them realize that BIM graphics can look different than CADD graphics and that is usually the best solution as those purely graphical issues arise.

Set up and or attend live coordination sessions with the architect and other design professionals and at these meetings and establish how often model are exchanged and models are to be shagged back and forth.

What about the MEP design engineers and what about their models? As the structural engineer the coordination should primarily occur between the architectural model and the structural model. This is because the architectural model should be constantly updated to account for MEP changes that would affect structural. Again there are exceptions, but as a structural engineer you do not want to get involved with having to coordinate between the MEP and architecture. Consider interior slab edges as an example, if the architect is responsible for the structural slab edges then its best to wait for the architect to coordinate those openings with the MEP engineer and then coordinate those openings with the architect. With all this said, its best to open and link in the MEP 3d model into the structural 3d model to find major items that would need coordination.

If all of this coordination and collaboration is done successfully and the contractor is happy with the design team's well-coordinated models and well "formatted" models, then the owner will find out and everybody wins…plus the models may actually not require rebuilding for CA and FM…just ammended.

**G** When a contractor is given well-coordinated Revit models from the design teams during pre-construction, there are a number of Autodesk and Autodesk compatible tools that they can now use to improve the project quality and workflow.




These tools

- enhance coordination and collaboration with the design team during pre-construction and construction, reducing RFIs and change orders
- allow the General Contractor to mine the model for construction phase information
- give the construction team leverage to use other tools like augmented reality and the growing list of mobile apps to improve BIM in the field
- and help the entire team to provide a data rich deliverable to the owner for facility maintenance and operation

**M** During DD, the MEP consultant should coordinate with the architect and structural engineer for the location and size of the mechanical room as well as utility risers, shafts, and chases. Major equipment location should be coordinated, such as boilers, cooling towers, air handlers, heat pumps, exhaust fans, electrical panels, generators, etc. Additionally, ADA requirements for plumbing fixtures should be addressed.

Planning and interaction-modeling by the entire Design-Construction team throughout each phase will help the overall streamlining of processes and raise the abilities of all to deliver more predictable, effective projects, whether micro (Discipline specific) or macro (whole Project specific). **Know What you are Modeling, When and Why!**

## Construction Documentation

- All consultants get deep into it with Contractor coordination
- Sequencing for Construction
- Production does documentation & detailing while BIM teams coordinate away final clashes
- All efforts toward BIM Handover to GC

At this phase, in theory, the architects should not be "designing" anything any longer, if it impacts the coordinated nature of the project, unless full cost/benefit analysis is completed to justify the changes…no matter where the idea to change comes from (read as Client). The Design should have all been completed in the DD phase (That's why it is called that afterall) so that it allows the documentation & detailing teams, the engineers and other consultants the ability to finish all the final work to get the model and documents buildable, submitted approved and priced out.

Keep in mind that some Structural drawings are submitted to Municipalities in DD all the time, for reasons such as to secure mill orders for rough steel framing lengths or for a foundation permits to the building department, etc.

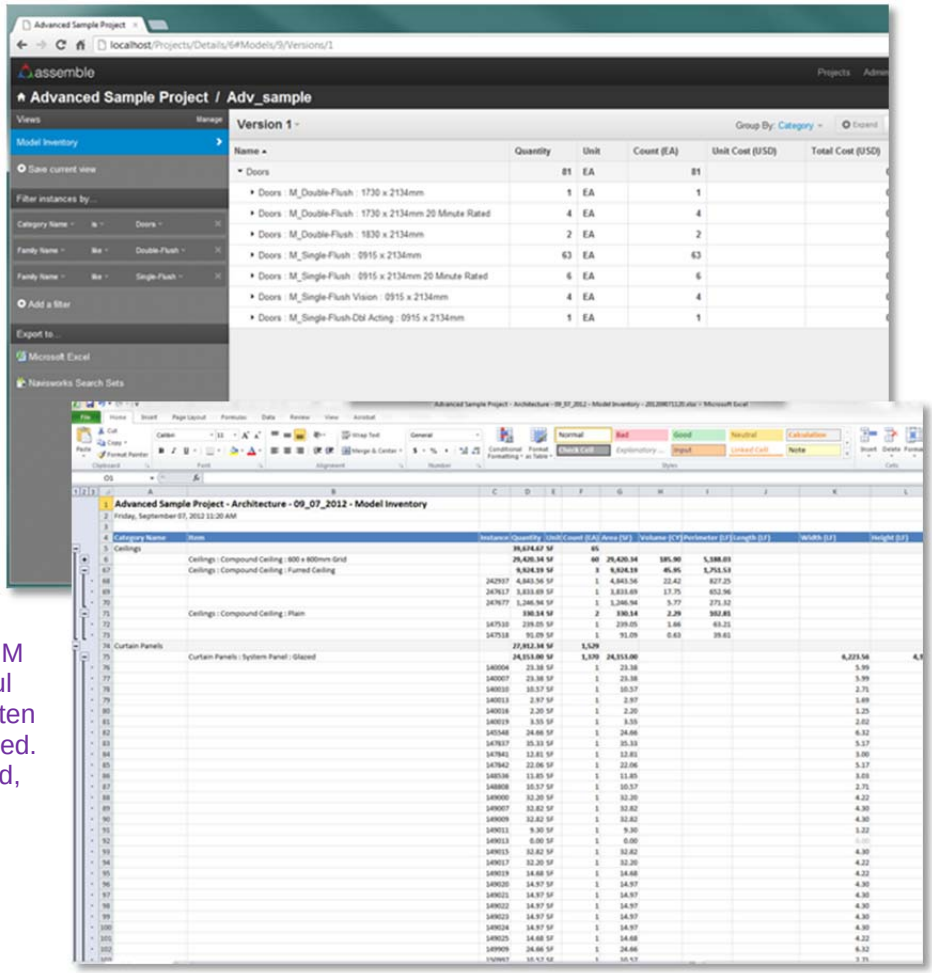
**CD Phase Design Changes Cost a S#@*Load**

What is important to remind the team well before a submittal is due, is that the design should be complete at this point and if any of the early documents have been submitted and approved (thus legal contracts) for material purchase, etc. then any Design changes will be costly.

S

Architectural drawings and Structural drawings and other design drawings all work, each as a symbiont being, where one cannot survive without the other. Therefore, it is important to make sure that the architectural and structural 3d models are well coordinated before the early structural submittal and that the architect has planned to create a set of early submittal drawings as well. This is not as easy as it sounds for the architect because usually when the structural engineer needs to submittal drawings early the last thing on all the other design team's minds is to also create a set of drawings to accompany the structural.

Coordination meetings between all the design teams should work out the connections and detailing of the primary structure. If may be necessary to model large connections of the structural elements such as gusset plates, that may interfere with architectural elements. Also, make sure to ask and coordinate where all the non-load bearing masonry walls in the project.




**Mining the Model**

G

BIM has always been defined as "Building Information Modeling." Even though the "I" in BIM can be the most powerful part of the model, it is often overlooked and underused. Well organized, designed, and developed Revit

models contain valuable information for the construction team. By mining this information from the model the construction team can get organized lists of quantities; assign costs, and instantly track changes between different iterations of the models. Quantities drive the schedule, fabrication, delivery, and manpower. Cost drives the budget which can impact the design. Using BIM to store, organize, extract, and manage this information puts a project team on the right path for a quality project, on-time and on-budget.

**How do we deal with changes?**

As discussed previously, Using Copy Monitor can make it extremely efficient to modify the design to match new geometry or design options. Setting up the Revit model to look for the latest linked models can make reloading the latest version of consultant's models very simple and efficient. This can be done very simply in the Revit software and basically involves using the "Manage Links" tool to point the linked model at the latest version of a consultant's model. If these automated systems are not used, or for other items that Copy/Monitor does not handle we must perform all of the types of coordination mentioned in the BEP: Visual Audits, Interference Audits, Standards Audits, Model Integrity Audits and any others you deem necessary.

Remember that Copy Monitor only works on 5 elements: Beams, Walls, Slabs, Grids, and Levels, at this time.

S When working with a new model from a consultant it is definitely a best practice to utilize whatever new grids or levels that have been created or modified in their model. These items are the cornerstones of the BIM and should be maintained very accurately which is very easy to do if using Copy Monitor on them.

**Coordinating with Non-Revit Design Team Members**

For very large Revit models the combination of all discipline's models will, at this time, require Navisworks be used. The use of such software can make it easier to clash check and visualize very large or complex models, especially if some of the design team members are not using the Revit platform.

One of the many useful tools that Revit has for coordination in conditions where a multi-platform BIM is in effect is the use of the 3d Dwf file which is a very lightweight file that can be emailed if necessary.

Revit is able to batch export 2d or 3d cad files from the model, this can make it very easy to work with non-Revit consultants that require dwg or dgn files for coordination. The export of such files is very streamlined and should be tailored to suit the standard layer and linetype setup for the company cadd standards.

**Partial Summary of Methods to achieve well-coordinated *Documents* in Revit**

- Set up linked views that show only specific elements and control this with view templates in each design teams Revit model so that when the models are linked there no extra elements showing.
- Clean up models before linking/importing
- Consider project size before linking/importing
- The modeler should be aware of the frequency of revisions (weekly, bi-weekly?) of the other models
- Origin (0 North/South, 0 East/West, 0 True Elevation) should be maintained throughout all design team member's drawings. This is much more crucial than in 2D drawings.
- The standard organization can work for smaller projects, but custom organization may be necessary for larger, more complex projects.
- Customize for intuitive understanding for others that may work on the model.
- Use "Project Parameters" and apply to Views for custom organization. (i.e. "For Reference Only" or a separation of "Perspective" and "Orthographic" for 3D views may be necessary)
- Keep in mind that copy/monitoring elements depends on the project and that there is no absolute standard.
- Consider the fact that the party responsible for the geometry (i.e. slab outline - architect) may be different than the party responsible for its properties (slab thickness and reinforcement – engineer).

- Coordination Review can be used only after copy/monitoring is set up and there will even be an automatic notification.
- Create/save HTML Coordination Review Report once Coordination Review is completed then export to Excel format – since the Excel format allows better organization and manipulation of data.
- Identify person responsible for the "actions" (manager or modeler). Do not ignore the "add comments" option for record keeping purposes.
- Exporting to AutoCAD is useful for design team member that does not use Revit
- 2D DWF may work better than 2D PDF for simpler viewing and printing


*Example structural and architectural coordinated sheets*

## Construction Administration

Construction, Construction Administration | Updates, Closeout, Completion, FM.

**Do Not Trust Your Beliefs**

Impirical data can be helpful but can also be hurtful if held as 'absolutes' in many cases… keeping an open mind is paramount in coordinated interactive projects such as AECO endeavors!

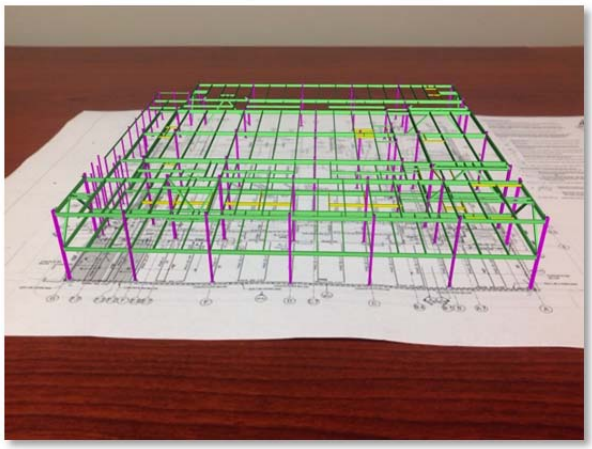
Teams may believe that there is not much coordination that needs to occur in this phase… unless the project has a large amount of addendums and supplemental submittals -*which they all pretty much do!!!* What is more in focus are getting all of the Contractor's changes and additions/subtractions included into the As-Built BIM. Who is to do this? Who is to Pay for this? **What does the BEP say** about this?

Consider this to be an extension of the CD phase of sorts. This section refers to those areas of the project that correspond to when shop drawings are being created and eventually under "construction".
Make sure to update the structural model and ask if the architect is doing the same with their models.
Consider the following when updating the model in the CA phase and use a separate model if updates get in the way of submittals.

- Model updates may be required after BID Phase
- Update Model per RFI Responses
- Update Model per Shop Drawing Reviews
- Update Model per Site "fixes"
- Pro-actively document the model

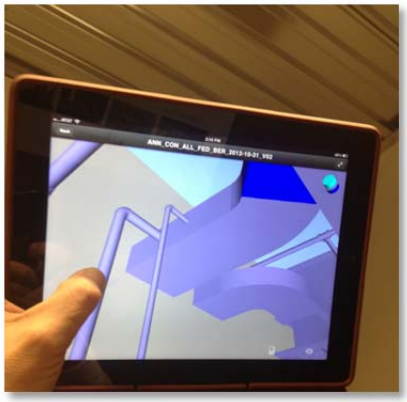
## Virtually Augmented Reality and BIM in the Field

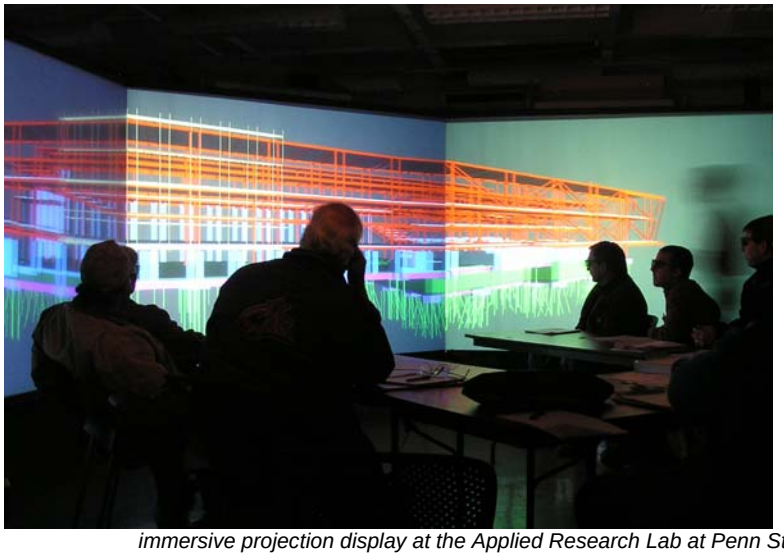
More than a decade ago BIM gave us the ability to create a virtual world to design, analyze, and simulate our construction projects. One challenge has always been finding ways to transfer the information in the virtual world into the real construction world environment.



Mobile devices and apps now allow contractors to overlay the virtual world with the real world with augmented reality model visualization. 3D information can be pulled directly from 2D pages:

With global positioning systems and gyroscopes, mobile devices can now determine location and detect movement. This technology coupled with BIM now gives us a tool to view and interact with our virtual world in actual corresponding real world locations:



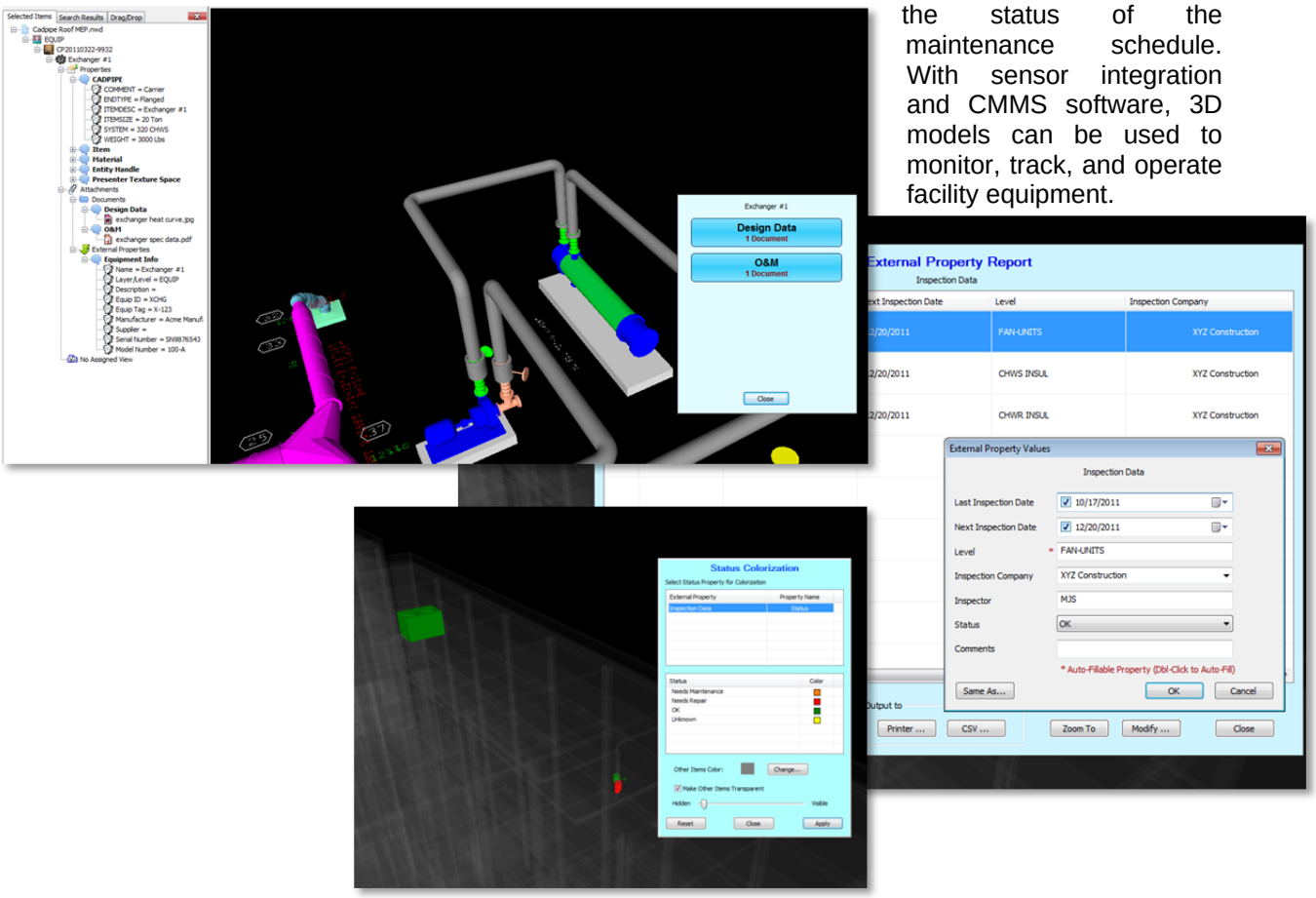


*immersive projection display at the Applied Research Lab at Penn State*

Onto Facilities Management and Operations…

### BIM Deliverable for FM

During construction, design information from the original design model can be combined with specific information from the equipment suppliers. This information in the model provides facility owners with a tool for accessing facility maintenance information, scheduling future maintenance tasks, and monitoring the status of the maintenance schedule. With sensor integration and CMMS software, 3D models can be used to monitor, track, and operate facility equipment.




## Coordinate and Dominate | BIM Project Success

**E**very building is constructed and maintained differently, due to particular needs and constraints. Plan and Create accordingly.

**B**eginning with the end in mind is critical to ensure that the BIM project is successful throughout.

**B**uilding **I**nformation **M**odels and the interactive AECO teams themselves must be created, coordinated, managed, and finally the virtual project delivered and constructed in a way that will best help the end user achieve the goal: **The Built Environment**.

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