# Autodesk University 2015

## CS1082 – How to Manage Design Validation Priorities

Preconstruction support for sharing in the development of construction documents on a “Design Build” Hospital project. The support includes project set up, a strategy for BIM, aligning the processes with the resources and the methods of communication. Teams manage the priorities so the schedule can be maintained while building high quality contract documents.

## Class Objectives:

**At the end of this class, you will be able to:**

- **Learn how to define BIM in the contract**
- **Learn how to time priorities**
- **Discover the balance between priorities and schedule**
- **Learn how to manage BIMs in terms of priorities**

## About the Speaker:

I am a Director of VDC at McCarthy Building Companies; with over 20 years’ experience bringing electronic file management and 3D comprehensive construction pre-planning to benefit construction projects. I am a current holder of a Class B OSHPD inspector’s license and have worked on a variety of different construction projects in a variety of industries, including healthcare, corrections and cleanroom lab environments. My work focus has been strategic as well as tactical, with emphasis on preconstruction, through project delivery methods. My work has been used for project coordination, virtual mock ups, engineering, composite plan submittals, collaboration with design teams, company promotions, new project planning and pursuits, design management, partner marketing, website development.

**Introduction:**

In this course; the needs for balancing traditional design development with the requirements of means and methods (trade contractor coordination) consideration will be described as an avenue to reduce risk for all parties. I will approach the subject of prioritizing design constructability subjects, the conditions required to prioritize the cycles of re-design, and some of the challenges. Although the presentation is taken from the General Contractors point of view, the involvement of all parties will hopefully become more clear. The project example from which this course was developed is a healthcare project contracted during Design Development and situated in California, which is subjected to OSHPD review and approval. This course and project were selected partially because of the nature of the project, the delivery method, and the fact that there is a current and growing interest in collaboration that benefits all stakeholders.

Trends in software development have become increasingly focusted on collaboration, merging file contents and exporting the information to cloud based platforms to a more distributed and global community. Tools have improved exponentially over the last several years. This has slowly given way to an audience of participants both more experienced using the tools and a group of contractors who more uniformly understand challenges where the benefits are more clearly understood.

The design build delivery method and process blends traditionally separate worlds. The designer of record and the General contractors' obligations to maintain the construction schedule will be described in a progressive migration from DD through CD. The examples and the descriptions discussed will explore a shift away from the clash detection model; and move more in the direction of maintained design evolution with a Hybrid of BIMs.

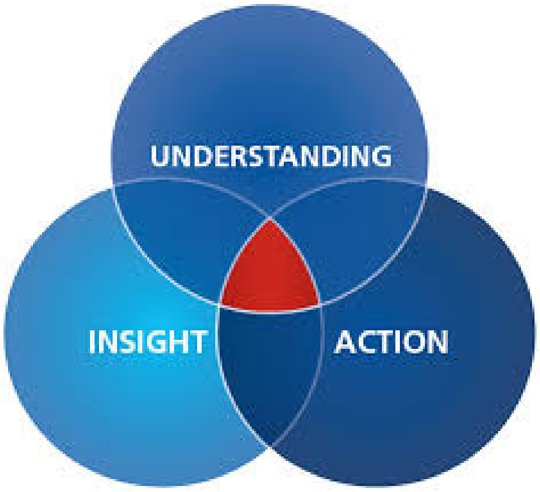
The tools used to facilitate this process Included:

- Revit
- Cad programs
- Assemble Systems
- Navisworks
- BIM 360 Glue
- BlueBeam

The Alignment of Process with Tools:

- Organization of Information
- File Exchange Sites
- Sequence of Coordination Prioritization
- Effectiveness of Quality Control measures
- Refinements

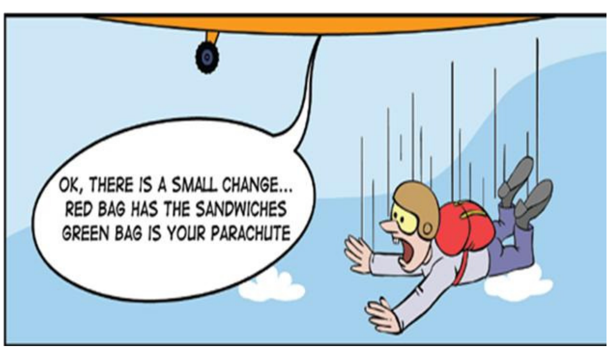
As you can imagine, the complexity in constructing a hospital project with OSHPD oversight inclusive of designers, contractors, engineers and sub-consultants can become a very complex mix of risks and information overload. The big picture can only be realized when each of the pieces of the puzzle are organized, timed, and put into place.




**Project Goals:**

1. “No Material Changes after Agency Review”
2. “Target Value Design” – Target Budgets
3. “Confirm the design before agency review” – Reduce the risk.

The overarching goal for everyone was to reduce their risk on the project. In order to reduce risk the designer, contractor, owner, and sub-consultants were required to come together and agree on next steps and action items of the projects budget, constructability, and schedule. The goals of the project were required to blend design intent represented on the 2D documents with means and methods engineering from each trade contractor. When and how this occurs means that there is an emphasis placed on the analysis of the information, and the necessary action items for resolution. The design community worked almost exclusively using Revit, in project example provided; they also agreed to regularly publish (bi-weekly) updated files through a series of regular file exchanges. These file exchanges required each contractor to refresh their sense of direction and maintain the necessary focus on completing the validation goals. While this at times caused problems and occasional information overload, the partnership of the revision cycles helped with the overall communication of expectations in-between revisions.




Over the past few years “Clash Detection” as a term has probably been overused. It became a standard for the industry and was used to judge how good a design was developed or not. The same was true of trade coordination; regularly the subject of constructability was described in terms of “how many clashes”. More recently this concept is more thoroughly understood and where we are today is a hybrid of intelligent engineering and coordination means and methods, and less emphasis placed on the clash counts. The model systems are valuable resources (at least in California) with high price tags, and the questions related to their involvement are more specific to **when** they should begin to use the analysis of visualization and clash detection. Since the reduction of risk funnels engineering through the BIM models reducing the risk comes with a cost. A way to reduce this cost is to include a BIM management plan to sequence the schedule in a way that more closely organizes how many resources are used to do what.

Clash detection is one part of the equation, engineering and construction experience is another. Overall, it is the construction schedule that must align the organized 3D content with the correct design validation goals. This schedule starts with the end game in mind and includes consideration of incremental submittals and the timing of agency review.

| | 10/9/2014 | 10/16/2014 | 10/23/20015 | 10/30/2014 | 11/6/2014 | 11/13/2014 | 11/20/2014 | 11/27/2014 | 12/4/2014 | 12/11/2014 | 12/18/2014 | 12/25/2014 | 1/1/2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OSHPD SUBMISSION | | | | | | | | | | | | | |
| INCREMENT 4- RECOVERY SCHEDULE | | | SEOR to print QA/QC | PEA to send final BG to SEORCivil to provide final dwgs SEORStructural | SEOR to print QA/QC | SEOR to coordinate with team | (PRINT AND SIGN) **OSHPD SUBMISSION** | | | | | | |
| INCREMENT 5 | | | | | | | | | | | **90% CD** (PEA to provide BGs) | Consultants/DBs to verify coordination with PEA BGs | |
| INCREMENT 6 | | | | | | | | | **PEA QA/QC** | **AOR/EOR Stamp** | **Print for OSHPD** | **OSHPD SUBMISSION** | |
| INCREMENT 7 | | | | | | | | | | | | | |

Trade contractor involvement in document participation means that their BIMs relate to each sequence of the risk reduction as well as the document production for agency review. Therefore an alignment strategy is required to keep both in sync as constructability subjects are brought to light. It is through the BIM Model that means and methods engineering can be scrutinized alongside of design intent. The information necessary to affect the change on the contract documents includes constructability subjects which in resolving means that the designer must also consider the contractor’s position, and the contractor must consider the designer’s intent. As evidenced in the schedule listed below; the constructability (means and methods) engineering are synched with the overall submittal schedule. The two worlds invariably run into each other as the deadlines approach.

| | 10/9/2014 | 10/16/2014 | 10/23/20015 | 10/30/2014 | 11/6/2014 | 11/13/2014 | 11/20/2014 | 11/27/2014 | 12/4/2014 | 12/11/2014 | 12/18/2014 | 12/25/2014 | 1/1/2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **VAL PHASE** | | | | | | | | | | | | MEOR DWGS | |
| **Seismic Engineer AND KPFF** | | | | | | | | | | | | | SEOR Incorporation |
| **VAL PHASE-Detailed** | | | | | | | | | | | | | |
| Shafts | | MEOR DWGS | TARGET SIGN OFF | PEA EDGE OF SLAB REVS | | | | | | | | | |
| Mechanical Room | | MEOR DWGS | TARGET SIGN OFF | SEORSTRUC FRAME DWGS | | | | | | | | | |
| OVERHEAD | | | | | | | | | | | | | |
| Level 4 | | | MEOR DWGS | | | | | TARGET SIGN OFF | Seismic Engineer Point Loads | SEOR Incorporation | | | |
| Level 3 | | | | MEOR DWGS | | | | | TARGET SIGN OFF | Seismic Engineer Point Loads | SEOR Incorporation | | |
| Level 2 | | | | MEOR DWGS | | | | | TARGET SIGN OFF | Seismic Engineer Point Loads | SEOR Incorporation | | |
| Level 1 | | SITE SPECIFIC **LITES+BOOMS** | AEOR DWG UPDATE | | MEOR DWGS | | | | | TARGET SIGN OFF | Seismic Engineer Point Loads | SEOR Incorporation | |
| Level G | | SITE SPECIFIC **PHILLIPS** | AEOR DWG UPDATE | | MEOR DWGS | | | | | TARGET SIGN OFF | Seismic Engineer Point Loads | SEOR Incorporation | |
| Level B | | SITE SPECIFIC **BELIMED** | AEOR DWG UPDATE | | | | MEOR DWGS | | | | | Seismic Engineer Point Loads | SEOR Incorporation |

**Team Alignment:**

The Team alignment needs a common strategy. The strategy for this project was one overarching goal, “No Material Changes after OSHPD review”. With this goal in mind the CAN 10 document (an OSHPD agency review description listing what constitutes a material change and what is a non material change) describes how to avoid material changes. Since material changes can take a long time be be approved the strategy for the project was to reduce them.

> “The 2010 California Administrative Code (CAC) and the 2010 California Building Code (CBC) state that all construction work must be executed in substantial conformance with The construction documents approved by the Office of Statewide Health Planning and Development (OSHPD). The CAC requires changes that materially alter the work must be made by addenda, change orders, or instruction bulletins approved by OSHPD. Materially alter is defined in the CAC as any change, alteration, or modification, as determined by the Office, which does any of the following:
>
> - Alters the scope of a project
> - Causes the project to be in noncompliance with the California Building Standards Code (CBSC)
> - Causes an unreasonable risk to the health and safety of patients, staff, or the public
>
> The CBC requires any changes made during construction that are not in compliance with the approved construction documents shall be resubmitted to OSHPD for approval as an amended set of construction documents.”

With this goal in mind, prioritization should be easy, yes? No... As described earlier, the complicated mix of project participants means that the navigating the strict interaction of systems requires some more clarification. The goals must also be listed as they relate to design development, not only from a design intent, but also to enable the trade contractors to engineer the means and methods understanding of the project.

Early BIM involvement included rudemental communication tools geared to communicate risk at a glance. Priority 1 items were high risk construcability issues and required immediate attention and were listed in Red. This was done in an effort to focus a large community of participants on highlighted areas of risk. These priorities relate directly to the construction schedule milestones, and are either listed as priority 1, 2, or 3, or Red, Yellow, Green, depending on the risk accessment.

# Autodesk University 2015

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R | Multiple Open issues which would cause significant material changes after OSHPD | | | | | | | | | | | | | | | | | |
| Y | Simple Material Change concerns with clear and actionable resolution steps but need approval/execution | | | | | | | | | | | | | | | | | |
| G | Coordination can proceed | | | | | | | | | | | | | | | | | |
| **Model Combinations = Yes or No** | | | | | | | | | | | **Models = Design Validation Goals** | | | | | | | **Open Issue View** |
| **Str** | **Arc** | **MS** | **Mec** | **PT** | **Plu** | **FP** | **MP** | **Ele** | **JC** | **SteF** | **Modeled Areas** | **Inc 3** | **Inc #4 risk** | | | **Inc 5** | **Inc 6** | |
| | | | | | | | | | | | **Status Indication** | | R | Y | G | **%** | | Mark Up Views |
| | | | | | | | | | | | **Shaft Coordination** | | | | | **80%** | | |
| Yes | Yes | Yes | Y/N | N/A | Yes | N/A | Yes | N/A | N/A | Yes | Shaft #1 - In progress - Peterson working at roof level | | | | | **90%** | | Coordination in Progress -Edge of slab/ attachment |
| Yes | Yes | Yes | Yes | N/A | N/A | N/A | Yes | N/A | N/A | Yes | Shaft #2 - In progress - Peterson working at roof level | | | | | **90%** | | Coordination in Progress -Edge of slab/ attachment |
| Yes | Yes | Yes | Yes | N/A | Yes | N/A | Yes | N/A | N/A | Yes | Shaft #3 - Mechanical Piping Shaft | | | | | **80%** | | Coordination in Progress -Edge of slab/ attachment |
| Yes | Yes | Yes | Yes | N/A | N/A | N/A | Yes | N/A | N/A | Yes | Shaft #4 -In progress - Peterson working at roof level | | | | | **80%** | | Coordination in Progress -Edge of slab/ attachment |
| Yes | Yes | Yes | Yes | N/A | N/A | N/A | Yes | N/A | N/A | Yes | Shaft #5 - In progress - Peterson working at roof level | | | | | **80%** | | Isolation duct resizing in progress |
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | Yes | N/A | N/A | Fire Protection Risers | | | | | **80%** | | Coordination in Progress |
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | Yes | N/A | N/A | New Pathway #G -New Risers from Ele Generators | | | | | **75%** | | Alternative locations in Review Morrow Mead. |
| | | | | | | | | | | | **Mechanical Rooms** | | | | | **65%** | | |
| Yes | Yes | Yes | N/A | N/A | No | N/A | Yes | Yes | No | Yes | Roof Chiller Room - Base Isolation | | | | | **85%** | | SEOR to floating slab vs. Base isolation |
| Yes | Yes | N/A | No | N/A | No | N/A | No | N/A | No | Yes | Roof AHU final positioning and Duct/Piping Coordination | | | | | **75%** | | Final Placement and Q/C in Progress |
| Yes | Yes | N/A | N/A | N/A | No | N/A | Yes | N/A | No | Yes | Roof Cooling Towers - rotating cooling towers | | | | | **85%** | | Acoustical report and spring isolation base? |
| Yes | Yes | Yes | N/A | N/A | N/A | N/A | N/A | Yes | No | Yes | Roof Electrical Room - size and equipment in space | | | | | **30%** | | Still in Design |
| Yes | Yes | Yes | Yes | N/A | No | N/A | Yes | Yes | No | Yes | Basement Boiler Room Redesign in progress | | | | | **45%** | | Awaiting Combusion Air Shaft location |
| Yes | Yes | Yes | No | Yes | N/A | Yes | N/A | N/A | No | Yes | Basement P-Tube Room - | | | | | **85%** | | P Tube Room final combustion air duct coord. |
| Yes | Yes | Yes | N/A | N/A | N/A | N/A | N/A | Yes | No | Yes | All other Electrical Rooms - In progress | | | | | **75%** | | Soiled Elevator guide rail conflict |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | **Overhead** | | | | | **22%** | | |
| Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Overhead Tower #1 AHU #4 Level 4 and 2S | | | | | **25%** | | MEOR Model in use for coordination |
| Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Overhead Tower #1 AHU #5 Level 1 | | | | | **25%** | | MEOR Model in use for coordination |
| Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Overhead Tower #1 AHU #6 Level G and B | | | | | **25%** | | MEOR Model in use for coordination |
| Yes | Yes | No | Yes | Yes | No | No | No | No | Yes | Yes | Overhead Tower #2 L 4 and 2S | | | | | **25%** | | MEOR Model in use for coordination |
| Yes | Yes | No | Yes | Yes | No | No | No | No | No | Yes | Overhead Tower #2 L1 | | | | | **25%** | | MEOR Model in use for coordination |
| Yes | Yes | No | Yes | Yes | No | No | No | No | No | Yes | Overhead Tower #2 LG and B | | | | | **25%** | | MEOR Model in use for coordination |
| YN | N/A | N/A | N/A | N/A | No | No | N/A | Yes | N/A | N/A | Underground Coordination | | | | | **10%** | | Pending MEOR Underground design |

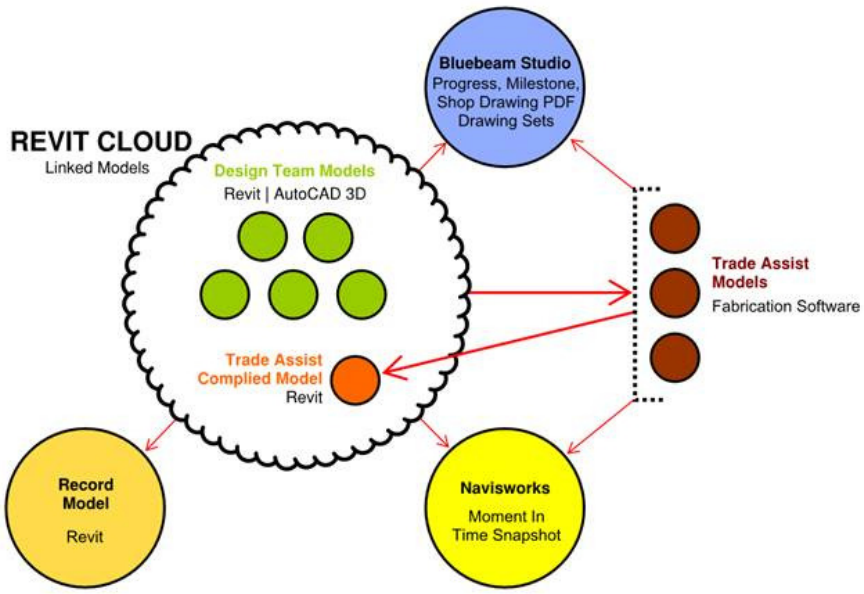
Design and constructability reviewed under a new light – " The Goals" (remember no redesign or rework that constitutes a material change after OSHPD) include:

- Structural validation with MEP Equipment loading
- Main systems routing, analysis of deck to deck heights,
- penetration criteria,
- deck loading in congested areas,
- Slope piping pathways to their POCs,
- the need for structural
- beam penetrations,
- Edge of slab clearances

The approach used in the project example emphasized that the early participation meant that the design team could still consider design refinements necessary to progress from DDs to CDs while the trade contractors could focus on engineering and means and methods (constructability).

The contractors would regularly bring to light subjects which included, among other things, key constructability issues which required immediate attention.  The approach selected defined that the validation analysis would only utilize a filtered set of criteria to accomplish these goals. This filtered criteria included only the "Mains" in the anaylsis during the Pre-Permit coordinatiom. The mains only coordination during early development phases was done in an effort to collaborate as many trade contractors as possible in an environment of multiple systems, using as few of their BIM resources as possible to achieve the before mentioned goals.

The next step in the process is to prioritize the constructability subjects so that the revision cycles could be better managed.

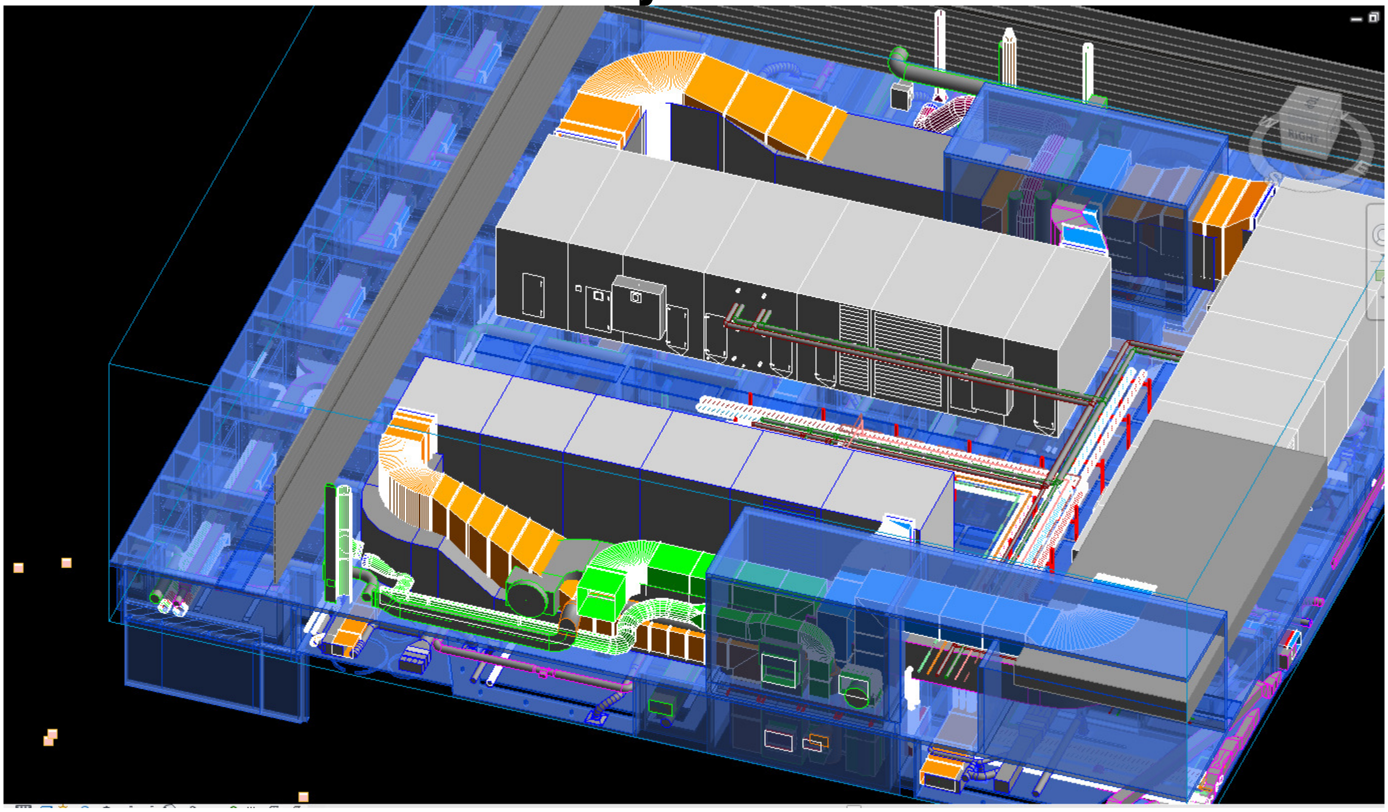



The software tools, with their emphasis on information sharing and analysis, accomplish this feat. The benefits and complications of using BIMs, and the resources required to maintain them, are becoming more widely understood. Projects are exploring BIM at a level which creates a "Hybrid" approach to technology and the contractors' means and methods engineering. The benefits arise as a result of interactions that are not specific to clash detection, but are more specific to mutually understood risks and rewards. This results in direct impact to the construction schedule and effectiveness of site-specific logistics necessary to put material in place.

**The trick becomes:**

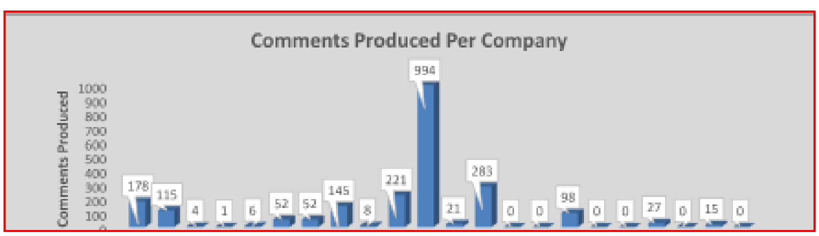
How do you transfer this knowledge back and forth between the 3D models and the 2D plans in an organized and efficient method? Some of the tools available assist in relating the engineering to the location as detailed. Funneling the engineering analysis through the BIM models highlighted the challenges. Recognizing the challenges enables the appropriate priority and allocation of resources.

The image below reflects the 3D file sharing in a hybrid model.  The trade contractors revised the routing and coordinated more finite applications of trade interaction and routing, then communicated these refinements back to the MEOR through .ifc file transfers. The image below indicates the trade contractor models in orange, and blue and the MEOR model in grey.

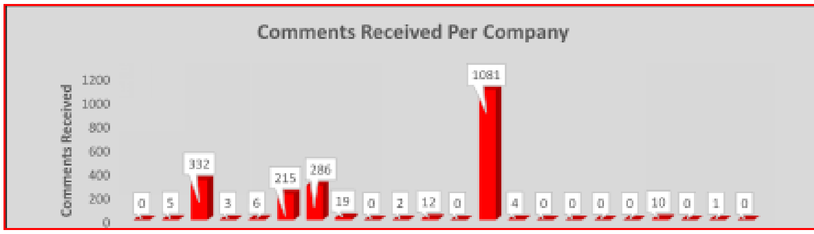


The final step in the process was to document the necessary constructability and resolution through marked up .pdf exports of the contract documents. This was accomplished using Bluebeam studio session and produced reports which were reviewed on a weekly basis.

The marked up constructability issues were used to bring the matter to closure and ensure that the proper Q/C was applied to the project's documentation. This was accomplished through both 3D as well as 2D document Q/C. Trade contractors used the MEOR model as the basis of coordination initially. Through a 360 analaysis of trade coordination in the light of the project goals and objectives file exchanges were used to synchronize the hybrid model into the contract documents.



# Autodesk University 2015




**Comment Responses**

| | |
|---|---|
| *Total comments to date:* | *2220* |
| ***Status*** | ***Status Count*** |
| Not responded to | 1240 |
| Accepted | 974 |
| Rejected | 6 |
| Completed | 0 |
| Cancelled | 0 |
| **Total Initial Response** | 980 |
| **Total Final Response** | 0 |

**What we learned:**

- Inter-team group clusters
  - The functional teams each have their own integration challenges with workflow
  - Inter-team process expectations
- Organize early around a process
  - Set expectations – and follow up
  - Engineering and constructability challenges can be very disruptive
    - Initiate engineering analysis and BIM after CDs.
- Training necessary for global application tools
  - Overarching project applications
    - BlueBeam mark ups
    - BIM 360 Glue
    - Follow up methods
- Make adjustments for more effective process where ever possible