Sharing CAD and Building Information Modeling (BIM) data with project team members who are outside of your organization has its challenges. If outside team members are using software packages that are different than yours, the challenges are multiplied.

This session will discuss methods and best practices that you can put in place to help make the data-sharing process go a bit smoother. We will also discuss best practices and lessons learned when working on a project that uses integrated project delivery (IPD) and only Autodesk® Revit® software among multi-discipline team members, including taking full advantage of the live model for coordination. This session will discuss the initial project team kickoff meeting, "in-progress" coordination meetings, and finally - project delivery.

Learning Objectives

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

- Discuss some of the basic goals, expectations and challenges of working in an IPD environment
- Develop “best practices” for multi-discipline/multi-firm/multi-software coordination
- Determine the best methods for sharing data (formats, naming, sharing schedule, importing and exporting methods) throughout the project team
- Identify potential issues that may occur when different members of the same project team are working with different software packages
- Put together a dynamic “changes on the fly” coordination session on Revit-Only multi-discipline IPD projects

About the Speaker

With over two decades using and supporting a wide range of CAD software packages and with duties and responsibilities that have included training, managing and organizing teams, Brett brings a real-life understanding of what works and what does not work with today’s CAD and BIM technologies. Actively bringing together diverse teams to work as cohesive teams to both improve discipline coordination and also to build in the long term value associated with intelligent building models is a challenge that is constantly evolving. Brett stays on the leading edge of this technology by contributing to/participating in many online CAD user support groups and industry focus groups. Brett is a two time speaker at Autodesk University, a speaker at the Revit Technology Conference North America and is an AutoCAD 2012 Certified Professional and a Revit Architecture 2012 Certified Professional. - bgatti@hedev.com
Expanded Session Description

*Quote from the AIA document* "Integrated Project Delivery: A Guide.pdf“

"Integrated Project Delivery (IPD) is a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction.

IPD principles can be applied to a variety of contractual arrangements and IPD teams can include members well beyond the basic triad of owner, architect, and contractor. In all cases, integrated projects are uniquely distinguished by highly effective collaboration among the owner, the prime designer, and the prime constructor, commencing at early design and continuing through to project handover."

*General thoughts on IPD*

The marriage of BIM and IPD is a classic example of the sum being greater than its parts, at least a perfect world. Historically the construction industry processes are wrought with built-in waste (duplication of efforts) and burdened by adversarial relationships. Alternative delivery processes such as design/build, CM at Risk and lean construction (amongst others) have sought to improve the building process and product. IPD which brings together the owner, contractor and architect/engineer in a single, trust based contract provides a formal structure for sharing risk and reward, with a focus on the successful delivery of the constructed building.

The sharing of design technology helps reduce process waste. For example, with careful planning information generated by the structural engineer in the building model can be directly used by the structural steel contractor to further develop connection details and fabrication data. Being able to use a common platform can eliminate significant time and effort for both the engineer and the contractor, which can ultimately provide a lower cost for the owner.

Bringing together all team members in a unified BIM environment is a challenge. In this session we'll look at some real life examples of how integrated teams have been structured and the different levels of IPD that has been realized/utilized and what the workflow can look like for each of the different levels. This session will take a look at some of the technology challenges encountered on an IPD project – from software selection to hardware requirements.

During this session best practices and technology options will be discussed as they relate to sharing data between project partners. We will also spend a bit of time discussing lessons learned.
Additional Topics of Discussion

In addition to the items that were outlined under “Learning Objectives”, during this session we will also spend some time talking about:

- Different levels of IPD
- Identifying some potential issues that may occur when different members of the same project team are working with different software packages
- Creating and sharing a project specific Coordination Document that outlines each team member’s responsibilities in regard to project setup and data exchange
- Determining who owns what / who is hosting the data
- Exporting for other team members (Navisworks, AutoCAD, file naming, options, etc…)
- Dealing with “out of the ordinary” warning messages (missing links that are actually there, etc…)
- Dynamic Room by Room coordination (multiple users, multiple models)
- Potential issues with changing software versions midstream (Revit and AutoCAD)
- Recognizing and addressing the importance of consistent coordination methods throughout the lifecycle of a BIM/IPD project

Items that are NOT part of this session

- IPD Partner Agreements
- Contract language
- Contract Documents
- Any financial implications of IPD or BIM
A little bit about Different Types/Levels of Integrated Project Delivery (IPD)

Regardless of what contract language may say, from a coordination standpoint there can be multiple levels of IPD:

**Full “co-located” IPD**

One organization hosts the data set and all other modeling related team members temporarily move to the office of the hosting organization to work and collaborate “live”.

**IPD with direct network connection (multi-firm sharing one data set)**

One organization hosts the data set and shares the location on their network with the rest of the project team. All other team members connect to this shared location in order to work and collaborate “live”.

**IPD with data set shared in a “BIM Cloud”**

One organization hosts or contracts with an organization to host the project data in a virtualized “BIM Cloud” environment or implements their own virtualized environment. All team members connect to and work within the shared project.

**IPD with an aggressive posting schedule**

Each organization works independently but post their models/data set at multiple times throughout each day to create an “almost live” collaborative environment.

**IPD-Lite / IPD’ish**

Each organization works independently and posts their models/data set based upon a predetermined schedule. This could be once a day, once a week or whatever interval has been determined as a “good fit” for the development of the project.
Basic Goals, Expectations and Challenges (some Solutions too) when working in an IPD Environment

Some possible goals when entering into an IPD Partnership

**Increased profitability for all project team members:**
- This is as a result of Shared Risk, improved communication and team wide collaboration.
- Everyone is part of the same Team.
- Everyone shares the same Risk/Reward – there is not an “us vs. them” type of relationship.

**Relationship building:**
- Attempt to better involve all team members in the design/decision making process – everyone has a voice.
- All partners are on board early.

**Team Members identified early:**
- You know who you are working with early on in the project. This leads to improved communication and helps to facilitate collaboration amongst the entire project team.

**Improved Coordination and Review:**
- Real-time 3D coordination. The use of live models results in a designed and built project that will have less interferences and problems during construction.
- All team members being fully involved in the ongoing design and collaboration effort will result in a decreased number of RFI’s and should also help to minimize the number of Change Orders.
- A faster and more efficient review process that takes advantage of the 3-D model information.
- The ability to leverage the 3D data to help minimize “hard copy” reviews. This results in less printing and plotting – equaling less waste and less cost.

**Some anticipated benefits when entering into an IPD Partnership**

**Bringing together the project team:**
- Assembling the project team at a very early stage helps to improve the accuracy of each decision and can lead to a more successful project.
- Having all stakeholders involved helps to make the process more fluid and interactive, thereby helping to avoid many instances of redesign
- Constant / real-time collaboration between the entire project Team can facilitate better decisions throughout the life of the project
  - Helps to improve project quality and to mitigate risk.
- Leveraging precise 3D virtual models equals enhanced coordination reviews
  - Clarifies data that is being presented and leads to reduced interferences during design and construction.
  - Involving all stakeholders in the review process can also help to reduce uncertainty/murkiness in the documentation.
Best Practices for Multi-discipline / Multi-software Coordination on BIM & IPD Projects

Decision Making:
- Improved accuracy and a collaborative effort leads to better documentation
- All stakeholders having a voice and being involved via ongoing/constant collaboration leads to better project decisions
  - Resulting in a finished project with improved quality and mitigated risk for all participants

Leveraging precise 3D virtual data (the BIM):
- Leads to enhanced coordination reviews (3D clash detection and review).
- Helps to clarify design decisions. This is especially for team members who have trouble visualizing flat 2D data in 3 Dimensions.
- Reduces uncertainty and potential murkiness in the documentation.

Lower number of Change Order and RFI’s:
- Change Orders and RFI’s are minimized due to full team collaboration and 3D model coordination from the earliest stages of the project.
- This contributes to projects that are completed on schedule and on budget.

Constant collaboration means a change in the project timeline:
- Early and ongoing collaboration leads to a coordination responsibility shift.
- Less coordination is needed at the end of the project and in build – it has been spread out over the entire project timeline. Once again, this will lead to fewer RFI’s.

IPD leads to constructability improvements:
- Teams are able to take advantage of different viewpoints (Reality vs. Design) when putting together project documentation.
- Leads to better, more detailed documentation and more complete and accurate bid sets.

A full Team effort:
- Owners will end up with a project that was completed by a “Team” that was comprised of members who all shared the same risk and all had the same ultimate goal.

Data for the Lifecycle of the building:
- As a result of BIM, the owner can also be provided with a 3D virtually constructed building that has the potential of being utilized for Building Operations/FM.

Technology Challenges when working in a BIM – IPD environment

Not all software is created equal:
- For a variety of reasons different disciplines and/or project partners may be using different software packages.
- How to bring disparate data together for collaboration?
- Different Software packages recognize/utilize different coordinate systems.
Sharing Project Data/Revit Models with geographically dispersed teams:
- Where does the data “live”? In other words, who is hosting the project data?
- What is the most appropriate/best method for sharing data between team members?
  - How often to exchange data?
  - What formats are needed by the different Team members (DWG, DGN, NWC, etc…)?
  - What Data Exchange method should be utilized (Autodesk 360, Buzzsaw, PIM, FTP, Data Management System, etc…)?

What if the best method to share is to grant access to YOUR network to external team members?
- Security concerns when letting others into your network:
  - Who needs access?
  - How long do they need to have access to the data?
  - What specific files / folders do they require?
- Data Access control:
  - Which team members have access to what data?
- Last minute team additions:
  - How to deal with randomly added team members?

Some possible Technology Solutions when working in a BIM – IPD environment

WAN Accelerators:
- Riverbed Devices – internal team members
- Riverbed Devices – external team members
- VPN Access to a shared location on one network

Revit Server – (internal or via VPN):
- Share Revit project data within one organization with multiple offices
- Co-located team members using your Revit Server
- Sharing data with outside partners (security concerns)

BIM Cloud
- Virtualized collaboration space.

Collaboration Software (pulling it all together):
- Navisworks Manage

Co-Location:
- If possible (and practical) temporarily Co-locate external team members to the appropriate team member office

Enhanced Coordination Meetings:
- Designate and setup a “BIM Theater” at a team member’s office for use throughout the project
Setting the stage for a successful BIM / IPD project

Making it work – the Project Kick-Off Meeting

An effective IPD Project Kick Off meeting helps to set the stage for your project’s success. Encourage all project participants to attend. Exhibiting that everyone has a voice early on in the process can help plant the seeds for a more successful collaboration effort.

There are a number of different items that will need to be addressed during the BIM / IPD Kick-Off meeting. Some of the collaboration items that will need to be discussed are:

- Defining who owns what… (grids, levels, walls, floor slabs, etc…)
- What software packages will each partner be using?
  - What version(s) are acceptable?
- How will everyone share data (assuming that co-location is not possible)? PIM, FTP, etc…
- Setup a schedule for file sharing - if files need to be posted/transmitted.
  - Are special exports needed for different disciplines/partners that are not using Revit?
  - Does anyone need 2D CAD backgrounds?
- Define the project deliverable (AutoCAD, Revit Model, PDF, etc…) and final version.
- How will models be collaborated / clashed?
  - What software will be used?
    - Revit?
    - Navisworks?
    - Some other collaboration package?
- Which Team Member’s Firm is leading the model collaboration effort?
- Is there an overall BIM Coordinator within one of the organizations who will be performing clash detection?

It is important that all Team Members understand that free, open and honest communication is encouraged. This open exchange of ideas is one of the keys to a successful IPD effort.

Some comments about the Revit yearly release cycle and long term IPD projects

A couple of the items mentioned as possible discussion points for the Project Kick-Off Meeting are “What software packages will each partner be using?” and “What version(s) are acceptable?” These can be very important questions on a long term Revit project.

At this point Revit (and most of the Autodesk lineup of software) has a new release every year. Note: Opinions on the yearly release cycle vary but that is a topic for a whole different conversation.

One important impact of the yearly release cycle is that Revit does not have the capability to “save back” to a prior version. For that reason, all project team members MUST work in the same release of Revit. It is also highly recommended that all team members stay on the same Service Pack/Web Update of Revit.
To move or not to move (to the most current version of Revit)

Some organizations upgrade all users and all projects to the “latest and greatest” release of Revit every year as soon as it is available. If you are part of an IPD team and this is your normal operating procedure, you will have to rethink this methodology. The possible side effects of one team member upgrading their model (thereby forcing others to upgrade as well) without discussing it with the rest of the project team can have very negative results. Remember, sometimes something as “innocent” as a User Interface revamp can result in an unacceptable learning curve for some members of the project team (remember Revit 2010 and the introduction of “The Ribbon”) – especially on short delivery projects.

Another thing to consider is that there are times that Revit has trouble upgrading models. This can result in a situation where one of the project team members is unable to upgrade their model without losing a large quantity of data – or requiring a large amount of rework. That is why; during the project kickoff meeting, the project team needs to address what version of the software is going to be used.

In the example below, Revit does not like a “circular chain of references” that it has identified during the model upgrade. According to this dialog box, it seems that the only option is to select the “offending items” and choose “Delete Checked…” Doing this step results in the error “Delete is not allowed”. Closing that message and pressing “Cancel” on the original dialog brings up a warning that the data “is corrupt”.

Note: the file used in this example opens without any errors in its original Revit version.

Autodesk was able to upgrade this particular Revit file for us but the upgrade destroyed Visibility Graphics settings in almost every view that was used for documentation - this rendered the upgraded file unusable. Therefore, this project will remain in its original version until the “as-built” updates are complete.

The team can also leave open the possibility of investigating the move to a newer version if it is deemed appropriate. There are times that software enhancements and improvements make an upgrade almost a necessity for some team members. I.e. the added functionality (or stability improvements) will allow them to better deliver their project requirements. In this type of situation, the overall pros and cons of moving to the new version will have to be weighed against each other by the project team.
The risks of moving project AutoCAD files to a more current version (than that of Revit)

Upgrading project AutoCAD files to the most current version (and saving in that new version format) can cause issues on the project if the Revit version has not changed as well.

The images shown in the example below are a result of opening a Revit 2012 model that contains a series of AutoCAD files that have been saved in 2013 format. Revit 2012 does not recognize the format of the 2013 AutoCAD data so it cannot be properly loaded and displayed.

If this situation comes up on your project, the members of the Project Team that are working with AutoCAD (or an AutoCAD Vertical application) will have to save “back to an earlier format”. We currently have AutoCAD 2007 format set as our default save format to help eliminate any potential compatibility issues.

Note: The messages shown above are typically displayed if Revit does not find any elements in the expected “Space” within a linked AutoCAD file. When linking an AutoCAD file into a Revit View, Revit looks for entities in the DWG’s Modelspace first. When linking an AutoCAD file into a Revit Sheet, Revit looks for entities in the DWG’s Paperspace first.

In the example shown, saving the problem files back to AutoCAD 2010 format (an earlier release than the 2012 Revit format) eliminated the error messages.
Developing Best Practices for multi-discipline / multi-firm BIM Coordination

(AKA – creating a BIM/IPD Coordination Checklist)

The entire project team should meet early in the project cycle to establish project goals and address collaboration/coordination questions.

Having a BIM Coordination document can go a long way towards making sure that everyone on the project team is on the same page regarding collaboration expectations. The BIM Coordination document can help to outline specific information about the project files.

These images show a portion of a BIM Coordination Checklist that can be completed on each project (internal only and/or multi-firm).

This file would be filled out and shared with all project team members during the project kick off meeting. Its use helps to establish data related expectations and responsibilities.
Some of the questions that can be addressed in the BIM Coordination document could be:

Software Questions

- Which disciplines/project partners will be using Revit?
- What Version of Revit will be used?
  - Is there a specific Revit “build” (Service Pack / Web Update) that should be used by the project team?
  - Is a specific version noted as the Project Deliverable?
- What other software packages will be used on the project?
- What software will be utilized for Clash Detection/Interference Checking (Navisworks)?

Overall Project Coordination questions

- How often will coordination meetings take place?
  - Who is hosting the coordination meetings?
- Determine who “owns” the coordinate system and where the origins are.
  - Where is the Project Origin?
  - Where is the Survey Point Information coming from?
- Is there a mandatory/preferred naming convention for exports?

File transfer method - How to share project data

- How will data be shared/distributed?
  - FTP, Network Share utilizing WAN accelerators, PIM System (ex: Newforma, Buzzsaw), email, etc…

Working with Navisworks

- What version of Navisworks will be utilized?
- Does the project require a single export or floor-by-floor?
- How often do the Navisworks files need to be exported (export schedule)?
  - When do they need to be posted for use in the Coordination Meetings? (ex: Tuesday coordination meeting - post by noon Monday)
- Will the Navisworks exports utilize Internal or Shared Coordinates?
- How often will the models be “Clashed”? 
Best Practices for Multi-discipline / Multi-software Coordination on BIM & IPD Projects

- Which discipline models (or portions of discipline models) will be clashed against each other?
  - How will the Clash Tests be divided (which disciplines or sub-disciplines will be clashed against each other)?

- Who is performing the “Clashing”?
  - What type of Clash Report will be generated?
  - How will the Clash Report information be shared?
  - How will the Navisworks “clash” file be shared?
  - How long after each Coordination Meeting will the “clashed” model be posted for use by the rest of the team?

Working with other Export formats

- What export formats will be utilized/created (besides Navisworks)? DWG, IFC, etc…
  - What version of these software packages will be used?
- What is the Coordinate System basis of the export files?
  - Shared Coordinates or Project Internal?
- What needs to be shown in the exports for each discipline?
- How often will the exported DWG files be shared with the rest of the team (export schedule)?

Consistent Export information is crucial to the project coordination effort

Consistency is important when exporting data from Revit. This is true whether you are sharing this data with others or if you are performing all coordination “in-house”. For more accurate and track-able coordination efforts, the same data must be presented in the same way each time that it is shared.

It is extremely important that the same export views are used for every coordination meeting and every scheduled export of data for others to use as CAD backgrounds – regardless of the chosen export formats (dwg, nwc, etc…). If you will be exporting AutoCAD and/or Navisworks files for use by your
organization and/or others on the project team, you should create “Export Sets” within the Revit model. The use of export sets ensures that you can easily export the same group of files each time.

**Hint:** for the initial setup of your Export View set in Revit, you may find that the Print interface allows an easier way to create your Export Sets (compared to the Export dialog). See images below:

You can “multi-select” in the View/Sheet menu that is available through the Print command

You can only “single-select” views and/or sheets in the menu that is available via the Export command

**CAD / DWG Exports**

When creating CAD files for use by others, you should utilize the same Export Setup within Revit for each scheduled export set. This ensures that the recipients will receive files with consistent Layers, Line Types, Coordinate System, etc…

![Modify DWG/CIF Export Setup](image)

**Note:** Whichever settings you choose to use should be saved and then reused each time you export to DWG format for this project.

**Note regarding Navisworks exports**

When creating Navisworks Exports, keep track of the export options that are used (at minimum the Coordinates setting) on each of the projects for which you are responsible.
Possible issues when Team Members are using “other” software packages

In a perfect collaborative environment, all project team members would be working with the same software and on the same network. However, due to various reasons (software limitations, ability to fabricate from the geometry, etc…) this is not always possible.

Revit does have the ability to read-in/link-in multiple non-Revit file formats (DWG, DGN, etc…). But, keep in mind that issues can occur with any of the different file types.

Working with DWG files

Different Coordinate Systems (Origins)

Revit has Graphic related “rules” regarding how far building elements can be from Revit’s internal origin. If items are too far away from the internal Revit Origin, you will experience display problems.

In AutoCAD, the origin (0,0,0) can be “anywhere” in relation to the file geometry without causing any obvious issues. On the other hand, Revit has a 20 mile limit for its file elements. The location of the origin in an AutoCAD file can cause issues when a DWG survey file is linked into a Revit model.

Below is a possible workaround that can be utilized when you receive this error message:

- Link the “problem” AutoCAD file into a blank/empty Revit project file. Ignore the message “…dwg has extents greater than 20 miles…”.
- Acquire Coordinates from the linked AutoCAD file.
- Save this Revit “container” file into your project folder structure.
- Link the “container” file into the “real” project (Origin to Origin).
- Select the linked Revit file and move it so that the actual location of the building is near the center of your default Revit drawing area. Hint: you can use the default Elevation Markers or make the Project Base Point (Revit 0,0,0) visible to find the approximate center of the Revit Drawing Area.
  - You can also align a “known” location in the linked file (a “monument” on the site) to the Revit Project Base Point.
- Acquire Coordinates from the linked “container file”.
  - By using this method, you are utilizing the coordinate system from the linked AutoCAD file without having it physically linked into your “real” Revit model.
A few comments about Object Enablers

When linking a DWG file into Revit, you may see this error message.

If you do see this message, it typically means that the file(s) in question have come from an AutoCAD “vertical” application such as CADDuct, Civil 3D, AutoCAD Architecture, etc…

Proxy graphics are AutoCAD’s visual representations of AutoCAD Architecture, AutoCAD MEP, Civil 3D, MAP/CADDuct (now “Autodesk Fabrication CADmep”), etc… objects. Unlike the native elements within the authoring software package(s), proxy graphics have no intelligence.

One thing to note is that Revit does not treat data from all AutoCAD Verticals the same. Sometimes changing the PROXYGRAPHICS setting to 1 in AutoCAD as noted in the message is sufficient. But, in many cases it is not.

As an example, we have run across a very specific issue when linking in some Civil 3D files. These files have been opened in AutoCAD (with the Civil 3d Enabler loaded) and saved with the PROXYGRAPHICS setting at 1. When these AutoCAD files are linked into Revit, the Proxy data is “split” from the actual AutoCAD line data. The Proxy data (the Civil Points) is approximately 100 miles from the line data (this matches the distance that the AutoCAD origin is from the line data within the Civil 3D file).

If I open these files in AutoCAD and use the command “-exporttoautocad”, the files link in at the proper location but I do continue to receive the “Elements Lost on Import” message.

You can deal with this message in a few different ways.

- Request “Vanilla” AutoCAD exports from your project partners.
- Install the appropriate Object Enablers and export the file to Vanilla AutoCAD yourself using the command “-exporttoautocad” (yes, you do need to include the dash “-“ at the beginning).

This is not a “perfect” method but it will usually allow you to view the necessary data. Warning - you still might see the “Elements Lost on Import” message after performing this step. In other words, no matter what you try the message still may appear. If this is the case, your users will have to respond to and dismiss the dialog each time that it appears.
A couple more possible errors when working with linked AutoCAD data

“Lost” AutoCAD Links

There are times when Revit “loses” AutoCAD links. It will say that the linked file cannot be located. Even browsing to and selecting the file in question leads to the same error message. If this occurs, you have two choices:

- Remove and reattach the “missing link”. This is the most reliable option. It ensures that any changes to the linked DWG are reflected within the Revit model. The one drawback to this option is that you will have to verify visibility for this item in each view.
- Live with the error dialog and the link not being refreshed. You can do this if the data in the “missing” file will never change. Revit remembers the way that the file appeared the last time that it was able to load it.

According to my last Autodesk Support case update on this topic (Dec 2011), it is a repeatable error and it has been forwarded to development for their review.

Rounding and/or truncating of angles

We have run into a situation in which Revit 2012 “rounded” the angle of data in a linked DWG file.

In this instance, the survey origin point was very far from the model data in the Revit file and Project North was slightly skewed (0.082 degrees) relative True North. When the survey file was linked into the project model, Revit decided that this angle should be Zero. This caused the location of the project to be off by approximately 6” (on the 0.082 degree angle) in the “real world”. The position of this project on the site was critical as we had an extremely tight Property Line condition (almost zero) relative to the building location.

We also experienced problems when trying to export DWG backgrounds from this Revit file. The data in the exported file was off by almost 500’.

To work around these problems, we ended up having to remove the “real” survey file from the Revit file. We then utilized localized 2D backgrounds to locate the building on the site.

Update: this issue has been addressed in Revit 2013 with the addition of the option to “Correct lines that are slightly off axis” check box on the Link CAD Formats dialog.
Working with 3D AutoCAD data

Use care when working with AutoCAD 3D data. The visibility of these items within your Revit views could change on you.

On multiple projects, we have encountered very inconsistent visibility when using imported AutoCAD 3D data (DWG and SAT/ACIS). Visibility would be good one day and the next it would be completely different.

The main issue that we encountered was that 3D AutoCAD data (originated in CADduct – exported to AutoCAD format) would not “remember” the boundaries of Section Boxes. When a section was originally cut, the visibility would be correct. The next time the file was opened (or a random subsequent open), you could see “everything” in the AutoCAD file in the Section View (forward and behind the original Section) – even though the section box was still intact and cutting through the 3D AutoCAD data. This issue occurred when linking the AutoCAD files directly into Revit views and it also occurred when we tried linking the AutoCAD data into “in-place”, Generic Families.

With this visibility issue occurring, we could not trust any of the views that needed to display this AutoCAD data. We ended up requesting 2D exports for Plan View and RCP visibility and developed our own “traced” partial views (Detail Lines) to display the items necessary for Section or Elevation coordination. The 3D files did remain linked into the Revit model to ensure continuous 3D coordination during project development.

Clash detection and full project coordination were performed in Navisworks Manage utilizing the 3D data from the CADduct files.

Note: We also experienced the same visibility issues when we tried exporting to .sat (ACIS) format and then importing that format into Revit.
Putting together a “Changes on the Fly” coordination session

A simplistic view of the generic concept behind a Room-by-Room review

In a typical Room-by-Room review a copy of a coordination model is opened (typically in Navisworks), problems/concerns are pointed out, notes are taken (or drawings are redlined). Then the items that need to be modified are communicated to the “hands on” person or team who is responsible for the modeling on the project (if they were not a Coordination Meeting attendee). This results in a bit of wasted time and effort and leaves some markups subject to individual interpretation.

The “aha” moment

On one of our earlier in-house, multi-discipline Revit/BIM projects we realized that there is a “better way” to perform Room-by-Room coordination reviews. It dawned on us that it would be a more efficient process if we brought together the “hands on” project personnel to perform “live” model modifications as a result of the items that were pointed out in the Room-by-Room review.

The result - A new, streamlined, more interactive process

For the purpose of the Room-by-Room we physically moved enough computers for each discipline into one of our larger conference rooms (in this instance 4 plus the computer that “lives” in the conference room). We then invited one user from each Revit discipline to the meeting (Arch, Elec, Mech and Stru). Once in the meeting room, they each opened their discipline specific Revit models so that they could make changes “on the fly” as coordination concerns were identified during the review (if necessary).

We loaded the “pre-clashed” Navisworks model on the main screen in the conference room. We used the identified “clashes” to help determine what changes would need to be made and in which discipline model these changes needed to occur.

Once it was determined “whose” model(s) needed to change, the appropriate Revit model(s) would be modified prior to moving on to the next “clash”. The modifications to the Revit model(s) occurred “live” – during the meeting.

We found that performing the changes during the Coordination Review meeting helped with the accuracy of the changes and the speed in which they were made. Markups did not need to be explained or clarified and cryptic notes did not need to be interpreted. This method also forced all recommended changes to be proven out while the review group was still together.
The next step - “on the fly” coordination across offices

Our next step will be to perform a similar exercise on projects that we share across our different offices. Note: we share data across a Wide Area Network (WAN) with Riverbed WAN Accelerators being utilized for optimization.

In this scenario, a conference call and/or video conference can be held that includes all participants, each of whom can have a copy of the “pre-clashed” Navisworks model open on their computer, in addition to their discipline specific Revit model. The Clash Results can be reviewed by all users - each of whom will have to open each specific “clash” in their session of Navisworks.

Once it is determined which discipline(s) need(s) to modify their model(s), the user representing that discipline can use the Switchback function from within Navisworks to instantly “jump” to the clash in their Revit model. They can then make the necessary change(s).
Random Lessons Learned on a full scale, co-located BIM / IPD Project

Communication

Changes to Linked files:

- Even when working in a co-located IPD environment that is utilizing “live” model linking, team members need to communicate with the rest of the Project Team (at least the affected disciplines) when major changes have been made. This is very important when multiple software platforms are being utilized.
- When team members are used to working and collaborating within a single software package (Revit to Revit), changes made to imported/linked data from other software packages are not always readily apparent. This is especially true if you are working with 2D CAD backgrounds that are linked into Revit models.

React cautiously to “questionable” changes:

- Use caution and verify intent when reacting to changes.
  - Just because a change (that may not make sense) has appeared in a linked file, it does not mean that it was intentional. Sometimes data gets changed by accident and is not noticed right away. If you come across a change to a linked model that doesn’t seem right, contact the appropriate team member to verify that the changes that you are seeing are valid. This simple step of communication can save many hours over the lifecycle of a project.
- Due to the “on the fly” nature of 3D collaboration on IPD projects, users want to react instantly when they see a change in data from a team member. If in doubt, question it.

The BIM Coordinator

A BIM Coordinator / Manager / Administrator is a necessity when working in an IPD environment:

- This person is the bridge/support mechanism between all of the different team members.
- Should be available “on call” or “as needed” to support each IPD project.
  - Does not have to be 100% assigned to each project but must be available as a support mechanism.
- Responsible for preparing and exporting your files for sharing with other team members.
- Also responsible for verifying the integrity and accuracy of data that you receive from others before making it available to the Project Team.
- Should be able to perform coordination/clash reviews for the team and assist/troubleshoot should issues arise.
Best Practices for Multi-discipline / Multi-software Coordination on BIM & IPD Projects

Working with the Unknown/Unfamiliar

Take the time to investigate unfamiliar or unclear processes – especially when working within a team that is using multiple software packages.

- Identify how will you link in/utilize the data from other team members – regardless of their software platform. I.e. aligning coordinate systems.
  - Remember that the first method that seems to work may not be the one that you end up using.
- Your BIM Coordinator/Administrator should investigate and prove out this interaction.

Staffing and the Project Team

Verify that all project team members are adequately planning for project peaks and lulls.

- In an IPD environment, manpower shortages from one team member can affect the flow of the project for the entire team.

The “go-to” people

Identify your Project “go to” people to the rest of the Team. Each organization should identify one person as their main point of contact.

- Plan ahead so that you don’t have multiple people giving different direction for the same tasks.

Meshing Personalities

Identify and address any “personality conflicts” between project team members.

- Adversarial relationships and attitudes amongst the team can doom your IPD partnership
- If certain individuals who have been assigned to the project from different organizations have “bumped heads” in the past, odds are they will do it again.

The long term Project Team

If possible keep the project team intact for the duration of the IPD venture.

- Team chemistry, trust and familiarity can go a long way towards project success.
- Changing out key team members late in a project can cause a serious disruption in work flow.
Some unexpected benefits of Co-Location

**Improved Construction Documents**

From a design standpoint we have found that:

Having external members of the team “co-located” within our office helped to improve our understanding of what the contractor really needs to see in the Construction Documents.

- With this input, we are able to generate a greater level of detail on the final deliverables. I.e. Installation drawings were created by (or with direct input from) a team member from the appropriate project partner.

The ability to directly interact with others on the project team, whenever necessary saves many hours of back and forth emails and / or phone calls and ensures that all personnel involved in the discussions were on the same page. This helps to resolve murkiness and/or gray areas.