Cross-Discipline Coordination in Autodesk's Revit Platform

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AB214-4 The Revit platform offers many opportunities and tools for coordination that have not been possible in the past. This class will explore the various methodologies for sharing and coordinating data among architects, MEP professionals, and structural and civil engineers using product mixes from both the Revit and AutoCAD-based platforms.

About the Speaker:

A registered architect with over 20 years of experience in Autodesk architectural applications, Matt has worked with AutoCAD Architecture (formerly Autodesk Architectural Desktop) since its initial release and is an Autodesk Certified Instructor at an Autodesk Authorized Training Center. In addition to providing end-user technical support and assisting customers in implementing AutoCAD Architecture and Revit Architecture (formerly Autodesk Revit Building), he consults with Autodesk development staff in product design and usability for AutoCAD Architecture and is the coauthor of "Autodesk Architectural Desktop 2007 -- An Advanced Implementation Guide." Matt has been a highly rated instructor at AU since 2000.

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Cross-Discipline Collaboration Workflow Scenarios

Working in a model-based design platform such as Revit Architecture provides several benefits internally, including more coordinated construction documents, fewer errors and omissions and others. However when it comes to working with consulting engineers and other collaborating partners, the benefits to be gained from the Building Information Model will vary according to the technology used by the various collaborators involved, as will the ways in which you share data with them.

Currently there are three primary disciplines that are addressed, at least to some level by the Revit Platform:

- **Revit Architecture** is a mature product for the architectural community and has been in use for several years. Now in it's 10th major release it is "ready for prime time" and can be used by any firm that is looking to move to Building Information Modeling and that is ready for the changes that the new workflow will bring to their business.

- **Revit Structure** is in its 5th release and provides a much more streamlined workflow for those structural engineers who choose to use it. The Revit Structure model manages the physical model of a building's structure as well as its analytical model and its major drafting views. The analytical model can be exported to many popular third-party structural analysis applications. After the analysis has been completed, the modified structural model can be imported back into Revit Structure, modifying the Revit model and updating the drafting views.

- **Revit MEP**, while the least mature of the three Revit products, provides clear benefits for MEP engineers who use an analysis-based design process, although it is only beneficial on specific project types and only in an environment where the architect is using Revit as well.

Chances are, however, that the majority of consultants that the architect using Revit will be working with today are still using AutoCAD (or possibly AutoCAD MEP) or even AutoCAD LT. There is also the possibility that they may be using MicroStation as well. Fortunately, Revit is very good at importing and exporting both AutoCAD and Microstation files. While the intelligence of a Revit model is not present in the CADD geometry, the graphics can at least be shared between the disciplines.

- Civil Engineering and Survey drawings can be imported into Revit and used to create toposurfaces.

- MEP and Structural plans, sections and elevations (as well as details) can be imported into Drafting Views and be plotted alongside the views from the architectural building model.

- Architectural backgrounds can be exported from Revit to AutoCAD or MicroStation from floor plan or ceiling plan views. The resulting DWG or DGN file will be 2D and will be comprised of lines, hatch patterns and blocks.

Working with Collaborators and Consultants using AutoCAD

Translating Lineweights and Layers/Levels

When importing DWG or DGN files, if you intend to plot them with your Revit project, you need to account for lineweights. In AutoCAD and MicroStation, lineweights are controlled either directly or indirectly through layers (in AutoCAD) and levels (in MicroStation). Revit doesn't use either, since it is a fully object-oriented database. Simply put, a Wall is a Wall – it doesn't need to be on a layer to organize it or control its plotting parameters. Revit allows you to map object colors from either AutoCAD or MicroStation to Revit lineweights using the Import/Export settings found under the File pull-down menu (see Figure 1).

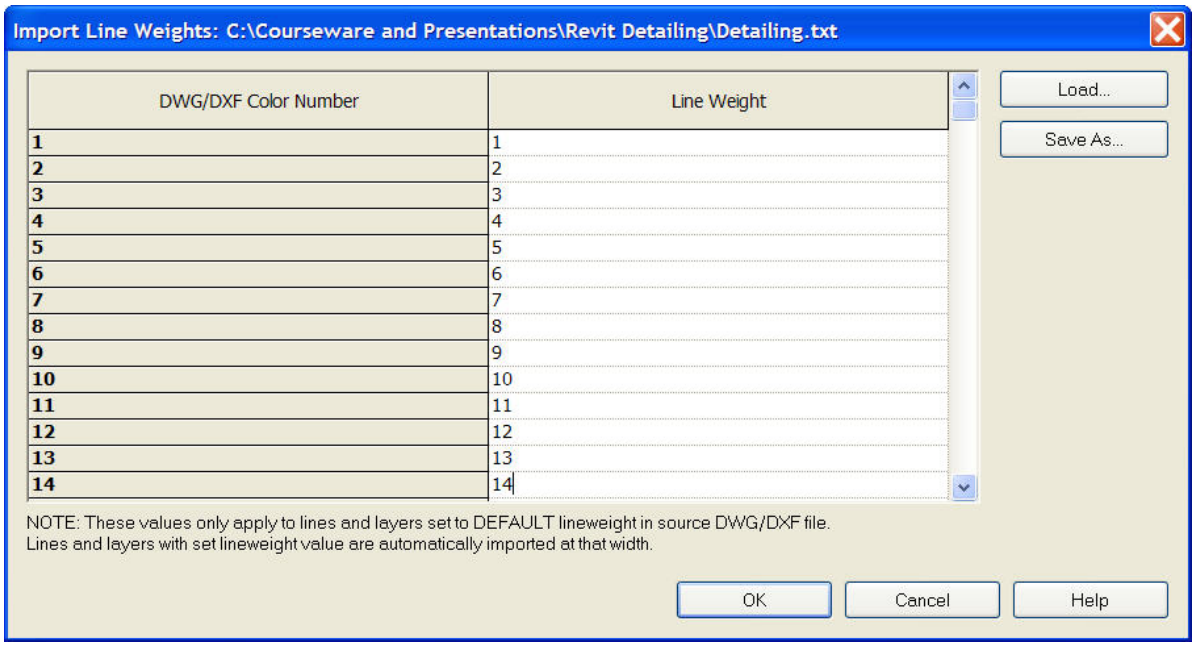
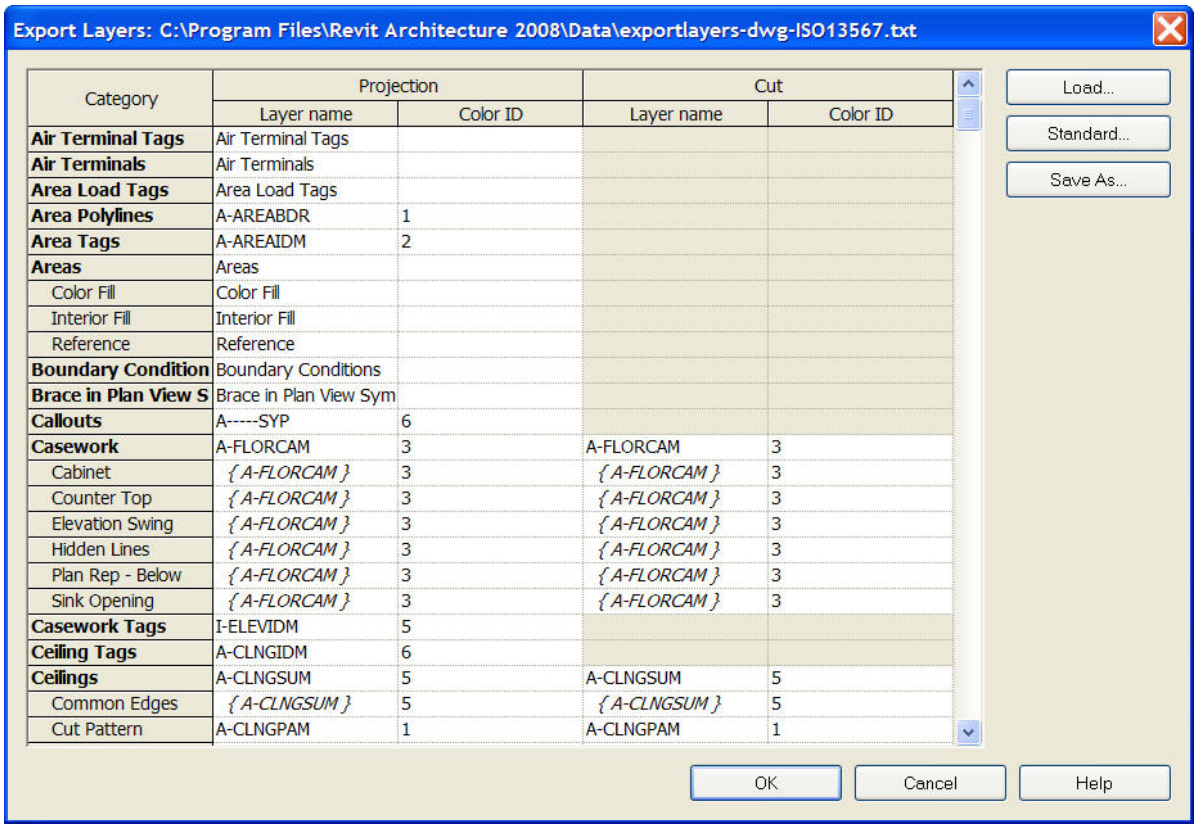


Figure 1. The Import/Export settings allow you to map colors from AutoCAD and MicroStation to any of 16 lineweights available in Revit.

When exporting a Revit view to a DWG or DGN file, you can map object categories and sub-categories to specific layers and levels, as well as colors using the Import/Export settings (see Figure 2).



Category	Projection		Cut	
	Layer name	Color ID	Layer name	Color ID
Air Terminal Tags	Air Terminal Tags			
Air Terminals	Air Terminals			
Area Load Tags	Area Load Tags			
Area Polylines	A-AREABDR	1		
Area Tags	A-AREAIDM	2		
Areas	Areas			
Color Fill	Color Fill			
Interior Fill	Interior Fill			
Reference	Reference			
Boundary Condition	Boundary Conditions			
Brace in Plan View S	Brace in Plan View Sym			
Callouts	A-----SYP	6		
Casework	A-FLORCAM	3	A-FLORCAM	3
Cabinet	*{A-FLORCAM}*	3	*{A-FLORCAM}*	3
Counter Top	*{A-FLORCAM}*	3	*{A-FLORCAM}*	3
Elevation Swing	*{A-FLORCAM}*	3	*{A-FLORCAM}*	3
Hidden Lines	*{A-FLORCAM}*	3	*{A-FLORCAM}*	3
Plan Rep - Below	*{A-FLORCAM}*	3	*{A-FLORCAM}*	3
Sink Opening	*{A-FLORCAM}*	3	*{A-FLORCAM}*	3
Casework Tags	I-ELEVIDM	5		
Ceiling Tags	A-CLNGIDM	6		
Ceilings	A-CLNGSUM	5	A-CLNGSUM	5
Common Edges	*{A-CLNGSUM}*	5	*{A-CLNGSUM}*	5
Cut Pattern	A-CLNGPAM	1	A-CLNGPAM	1

Figure 2. Layer Export settings for exporting Revit views to AutoCAD. A similar dialog is available for mapping Revit objects to MicroStation Levels.

Both the import and export settings can be saved to a text file, allowing you to save multiple layer/level/color mappings to accommodate the standards of any number of consultants.

Discipline-Specific Revit/CADD Workflows

Revit/AutoCAD workflows will vary depending upon the discipline with which you are collaborating.

Civil Engineers and Surveyors

There is no Revit product for Civil Engineering or Surveying. Chances are the engineer you are working with will be using AutoCAD, Civil 3D and/or Land Desktop or MicroStation. Revit can read these files however, and use the 3D geometric data in them to generate a toposurface. Typically when you get a file from a Civil Engineer using AutoCAD for example, it will contain polylines that have a Z value (elevation) that is equal to the elevation that they actually represent. Revit can use the X,Y and Z coordinates of each vertex of those polylines to generate the points needed to create the Revit toposurfrace (see Figure 3).

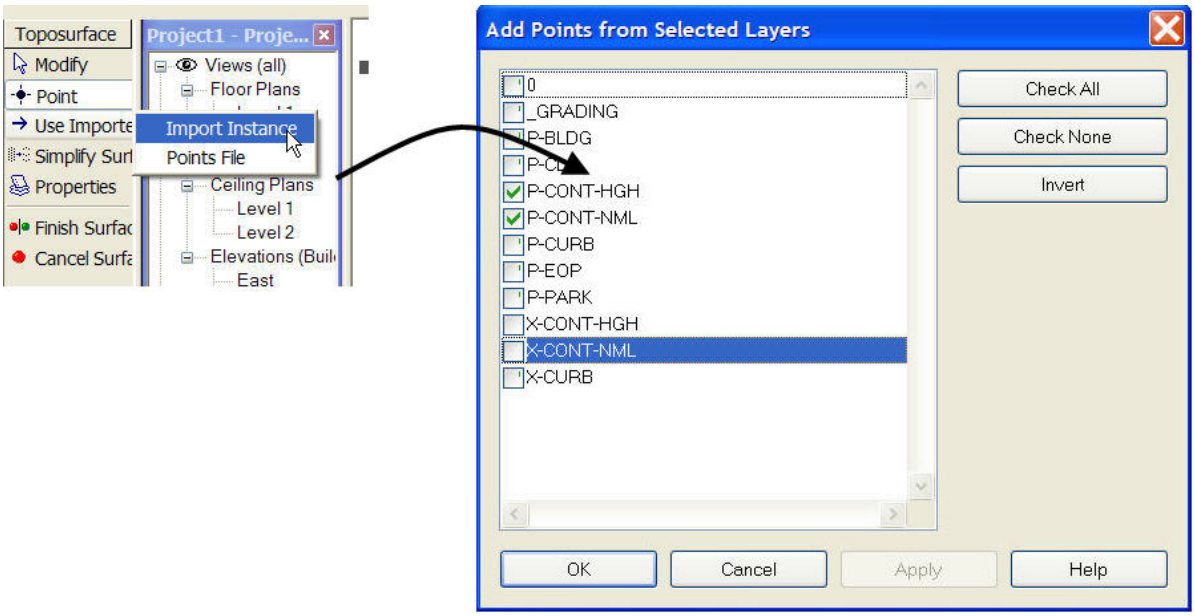


Figure 3. AutoCAD files can be used to generate toposurfaces in Revit.

A couple of items should be noted when importing Civil Engineering drawings for use in creating toposurfaces:

- Do not use the "Current View Only" setting. Doing so will prevent the DWG or DGN file from being able to be used to create a toposurface.
- Use the "Center to Center" placement method. Civil Engineers typically work in large coordinate systems to locate their geometry. If the coordinates for the site plan are too large, Revit will force the insertion to "Center to Center" regardless.

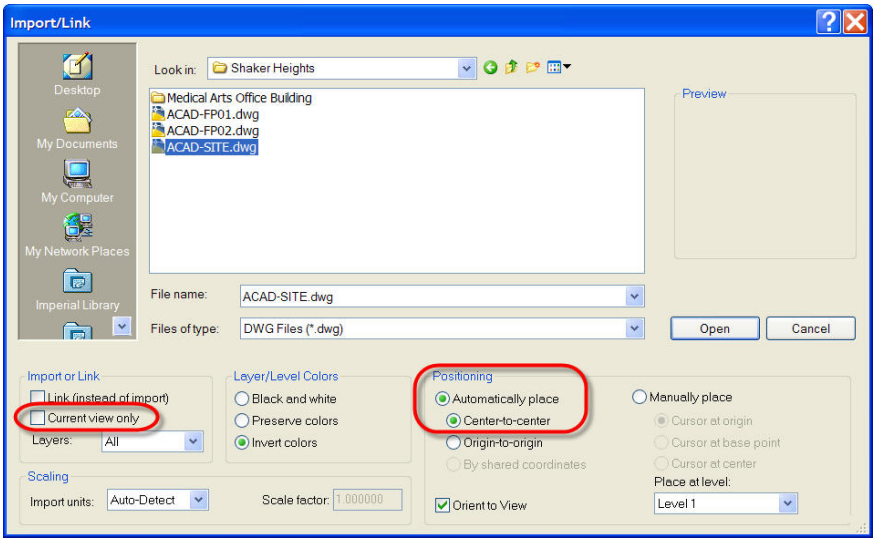


Figure 4. Recommended insertion options when importing a DWG or DGN file to be used to generate a toposurface.

Structural and MEP Engineers

Working with Structural and MEP Engineers in an AutoCAD / Revit workflow is essentially the same process. They require 2D background drawings that they can open in AutoCAD, which can be easily exported from Revit Architecture. Using the Import/Export settings explained previously, you can set up an export file according to your consultant's standards to simplify the sometimes tedious task of preparing an architectural plan as a background drawing.

If you need to import their drawings back into your Revit project for plotting purposes, simply create a drafting view for each plan that you need to import (see Figure 5). The benefit of a Drafting View in this scenario is that while it is as valid a view as any other Revit view, it is not connected to the model in any way whatsoever. Callouts can reference a drafting view just as they can reference a model-based section or detail. Additionally, when you import geometry into a drafting view it is automatically set to import into that view only, since it cannot be model-based.

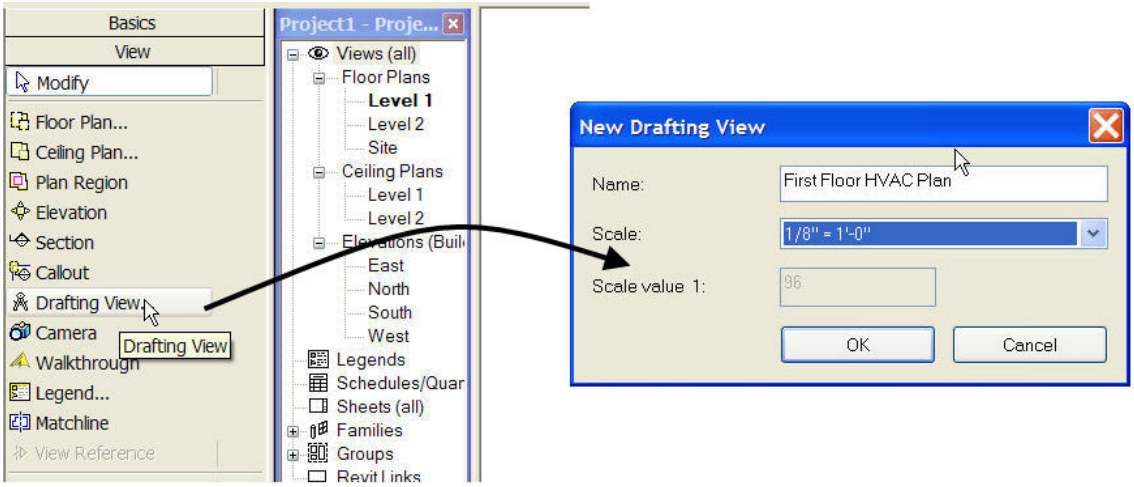


Figure 5. Import consultants' drawings into Drafting Views in order to plot them with your Revit project.

Working in Revit Collaboration Workflows

Without a doubt, the largest gains to be seen from model-based design and Building Information Modeling come when the architect and as many collaborators and consultants as possible are working in the Revit platform. Models can be shared seamlessly and without any translations necessary between all disciplines with little or no data loss.

If you are working in a multi-disciplinary office the most effective workflow is to have all disciplines collaborating on the same building model, using worksets to separate data and improve performance. More likely however, you are working with consultants in other offices. In this scenario file linking is the best way to work, with regular updates of the Architectural, MEP and Structural models on a project hosting website such as Buzzsaw or some other central location.

Understanding File Linking and the Copy/Monitor Tools

Revit file linking is in many ways very similar to the AutoCAD XREF functionality. When you link a Revit file into your project you have the choice of linking as an attachment or as an overlay (see Figure 6). As with AutoCAD, if you link with an overlay, the linked file is not "nested" – if the parent file is then linked into another file, the overlay will not "follow" it. With an attachment, the linked file will follow the parent into any other files that it is linked into. Also as with AutoCAD, linked files can be unloaded to remove them from memory when not needed (without actually detaching them completely) or bound to make them an integral part of the current project.

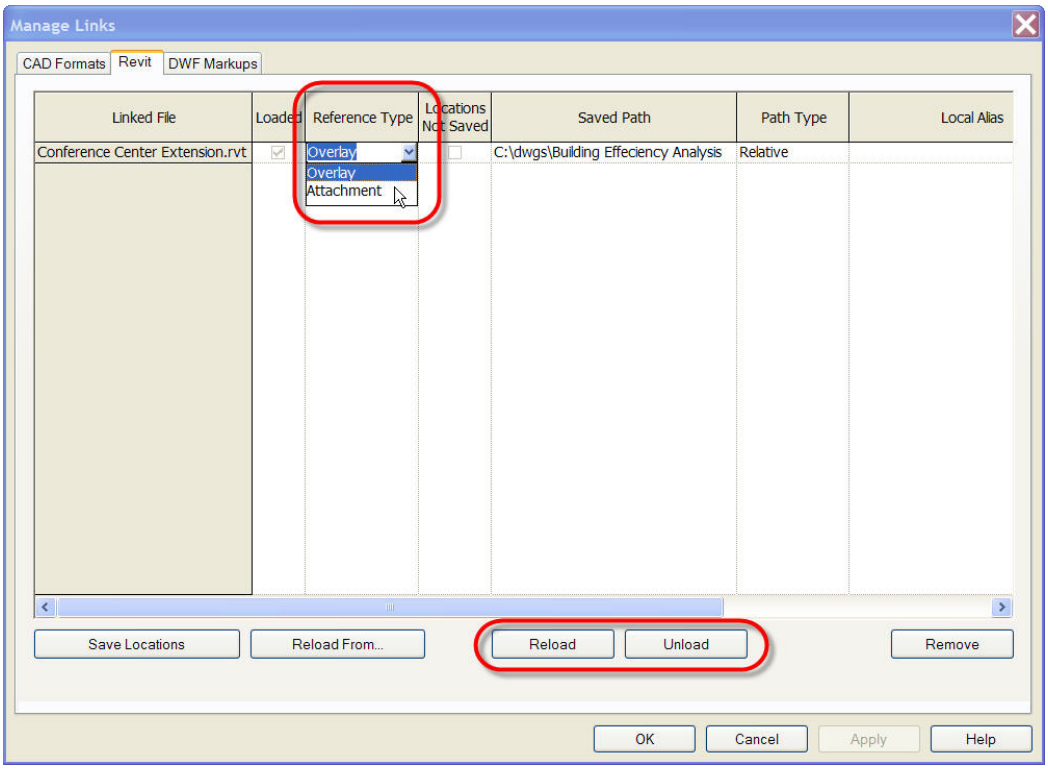


Figure 6. Revit file linking has many similarities to AutoCAD external reference files.

Copy/Monitor

Revit's Copy/Monitor tools provide a unique capability for different disciplines to maintain a higher level of coordination between their linked models, allowing elements in linked models to be linked (or "monitored") with elements in the parent model, and providing notifications when monitored model elements have changed in the linked file.

To begin the Copy/Monitor process, click the Copy/Monitor button on the toolbar and choose to select a link (see Figure 7).

Figure 7. The Copy Monitor button.

Next, select any element in the link that you wish to copy objects from. At this point, you will be in the Copy/Monitor "mode", which is similar to Sketch mode in that you must Finish or Cancel the Copy/Monitor session before working on any other aspects of your model (you can switch between different views during the Copy/Monitor session however).

The first thing you need to do once the Copy/Monitor session has begun is set the Options. This is where you establish what actually gets created when you "copy" an object in the linked file. For example if you are a structural engineer you probably don't simply want to copy an architectural column, as it won't have any structural information with it. Instead you can choose to create an instance of a true structural column instead (see Figure 8).

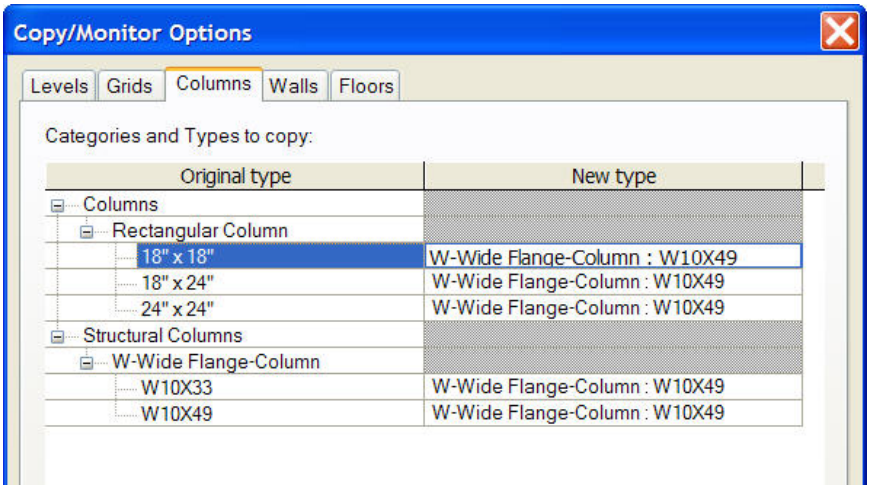


Figure 8. Revit's Copy/Monitor tools allow you to "swap" different component types for objects that you copy from the linked model.

Note that currently the only object categories that you can copy and monitor are Levels, Grids, Columns, Walls, Floors. If you are using Revit MEP you can also copy Rooms from which you can extract vital information for heating and cooling load calculations.

Once you have established the settings for how to copy the elements, you can begin the copy process. Each object that you copy will have an icon displayed next to it that looks like an eyeball when it is selected indicating that it is being monitored against a corresponding object in the linked file. When you open your project and the linked files are updated you will be notified if any changes to monitored objects are found. Using the Coordination Review tool from the Tools pull-down menu you can quickly identify those items that changed and determine what, if anything, to do in your own file to address the changes (see Figure 9).

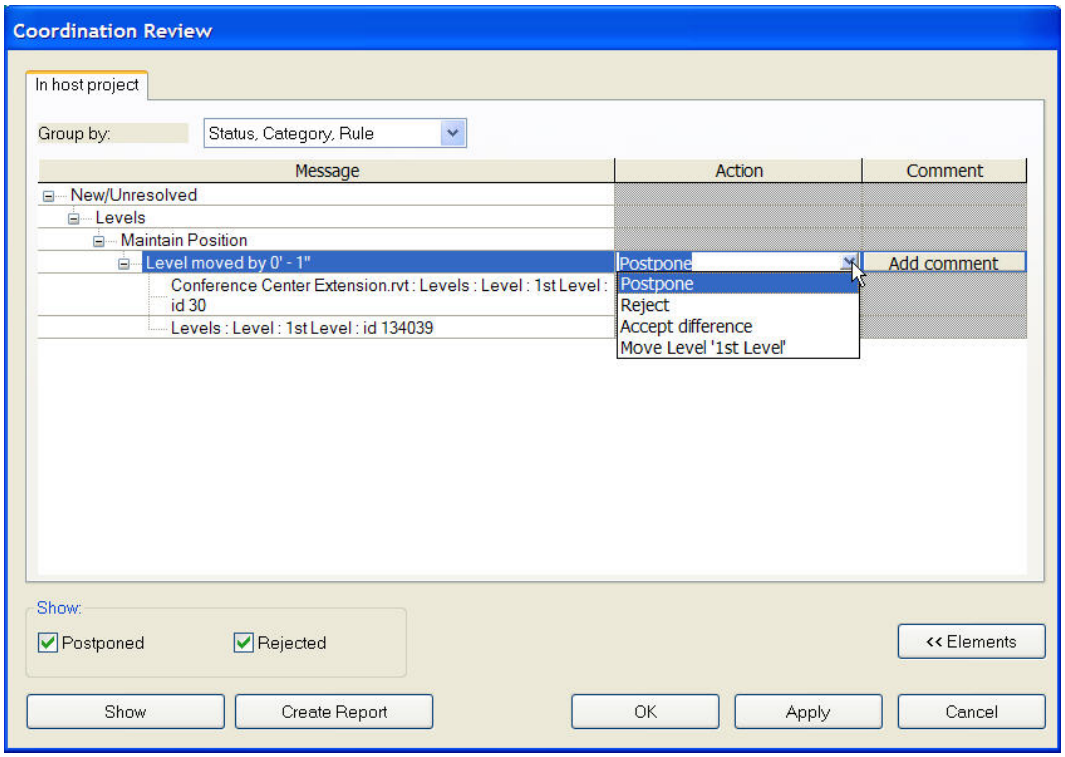


Figure 9. Coordination Review allows you identify and address changed elements in the linked file that are being monitored.

How Architectural Model Data is Used by Collaborators

Structural Engineers and MEP Engineers will have different needs when using your Architectural model:

- Structural Engineers will need to copy and monitor column grid lines, levels, walls, columns and floors. You should take care in particular to specify which walls are load bearing or shear walls before sending your model to your Structural Engineer (this is an element property of the wall). If a wall is not classified as load bearing or shear, it will not be visible in a view that is assigned to the structural discipline.

- MEP Engineers will need to copy levels, possibly column grid lines, and rooms. The rooms can be used in heat and cooling load calculations. In the Architectural model you should make sure that the room volumes are calculated properly. This can be easily done by first setting the *Upper Limit* property of the room to a value that meets or exceeds the highest elevation of the room volume itself. The default Upper Limit for a room is usually to the next level above that from which it is placed on. If you have a room whose volume extends above the next level, you should adjust it in the element properties dialog (see Figure 10). In general, the *Limit Offset* should extend up to or beyond any geometry that contains it (volume calculations in Revit MEP will stop when they reach a room bounding object even if the Limit Offset extends above the object, but they cannot continue past the Limit Offset). In addition to making sure that the room's

Upper Limit is adequate to cover the tallest extent of the rooms, you should also make sure that any roofs are room bounding as well. This is an element property and is checked on by default, but if your project originated in an earlier version of Revit it will be checked off and needs to be changed.

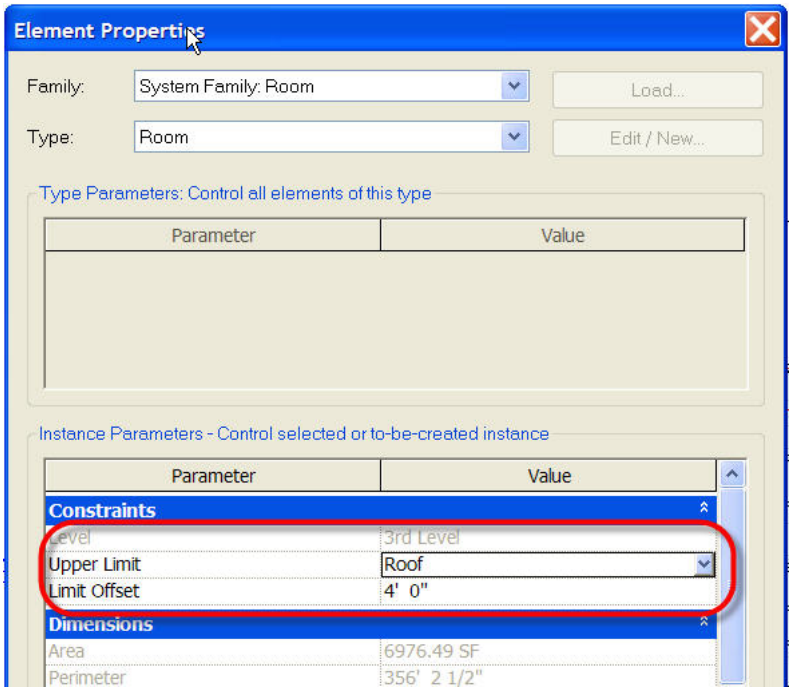


Figure 10. The Upper Limit and Limit Offset values determine the extents of room volume calculations. In this example, the Limit Offset is set to 4' to accommodate a sloping ceiling.

Interference Detection

In addition to providing a mechanism for copying elements and monitoring changes in Revit models, the Revit platform includes a tool for checking for interferences between objects. You can check for clashes within your own project, or between your project and any objects in a linked project (see Figure 11).

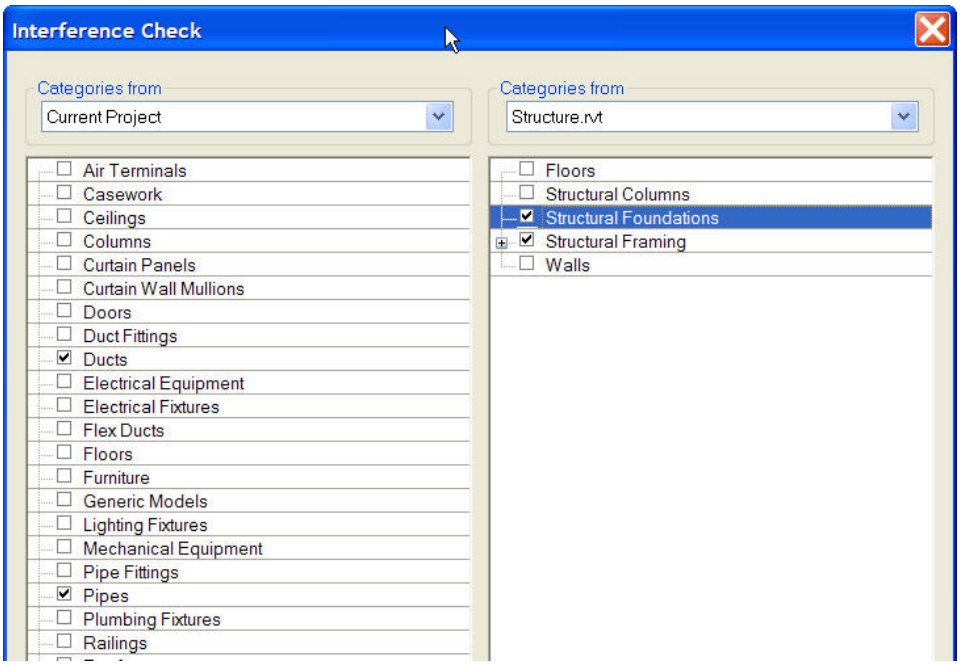


Figure 11. Revit allows you to check for interferences between linked projects.

If interferences are found, a dialog will appear that will provide details as to what the interfering objects are. This dialog can be left open while the condition is examined and dealt with, then refreshed to update it to any changes made in the model (see Figure 12).

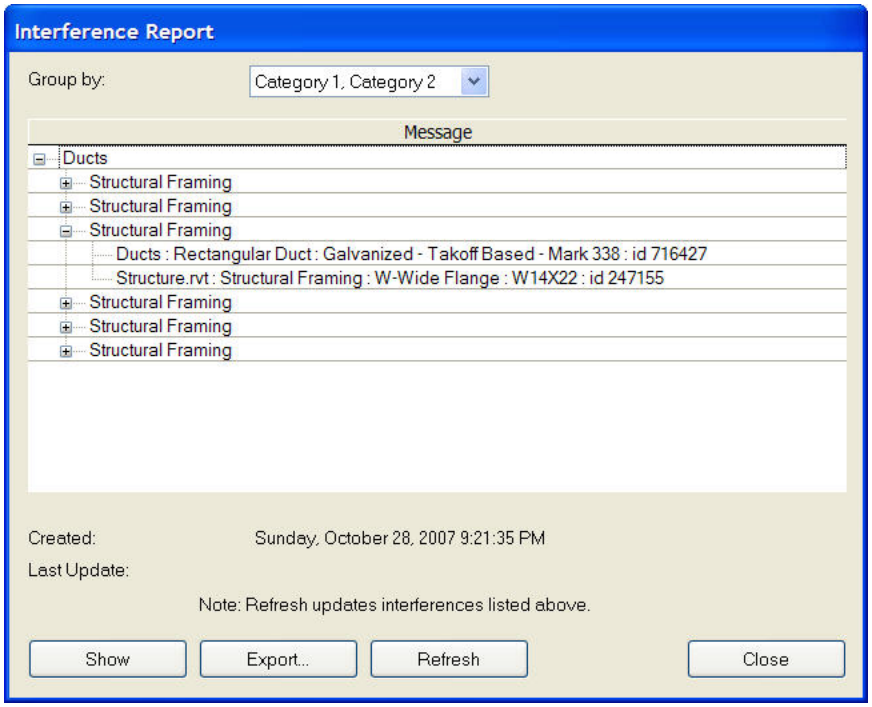


Figure 12. The Revit Interference Report

Summary

In general communication is the key to effective collaboration with consultants using Revit. In addition to communicating changes in the model you should also strive to make sure that all design partners are using the same version and build of Revit to minimize data integrity issues.

It is important to not only understand what your collaborators are using, but what they need from you and taking that one step further, what you can do in your model to facilitate the delivery of information that they can use to maximum effectiveness given what they are using, whether it is AutoCAD, MicroStation or Revit.

In a Revit workflow in particular understanding file linking workflows and capabilities, Copy/Monitor and interference detection are invaluable in establishing a process that benefits the entire design team, as well as ultimately the owner of the project.