Autodesk Revit MEP in the Process World

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MP1304

When Autodesk Revit software first hit the market, users thought the best place for it would be in the architect world, doing simple, cookie-cutter buildings. Who would have thought that it could turn out to be a powerful modeler for non-traditional buildings, such as process plants, water treatment plants, or wastewater treatment plants? In this class, we discuss how the MEP tools in Revit benefit these types of jobs; how to work with your content providers to get the best representation possible; how to get more value from BIM models in other products, such as Autodesk® Simulation-based software; and how to position the BIM model to your client and their contractor. Learn what it takes to be competitive in this market with Revit as your primary modeling tool, and do it efficiently.

Learning Objectives

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

- Describe how Revit MEP tools are used in process and water resource projects
- Define and edit manufacturer-based content for efficiency and accuracy for a design project
- Make full use of BIM models with external analysis and simulation software
- Define BIM projects to maximize owner and contractor benefits

About the Speaker

David Butts is a BIM Specialist for Gannett Fleming, a multi-discipline engineering firm based in Camp Hill, PA, with 60 offices in the US and overseas. Based in the Raleigh, NC office, he provides BIM Implementation and training for the firm's engineering design software, including Revit, Navisworks, AutoCAD MEP/P&ID and more. He has 28 years of experience in both the design and Autodesk VAR channel, spending 13 years working as an instructor and consultant for the Autodesk building design product line. David also worked as a training manager while in the channel, and was a member of the Autodesk ATC Advisory Board for 2009-10. He is a Revit Architecture Certified Professional, and also earned the MEP Implementation Certified Expert title. David has spoken at AU for several years, and was named the Top Speaker for both labs and lectures at AU 2011. As an author, he also contributes to 4D Technology's CADLearning training programs and has written several training manuals for Revit MEP.

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Armundo Darling is the senior technical marketing manager for MEP engineering solutions at Autodesk. He has extensive knowledge of both Autodesk® Revit® MEP and AutoCAD® MEP, and is responsible for the production of all global MEP marketing deliverables and technical training of global technical specialists. Armundo was previously the CAD manager for Flack + Kurtz Inc., where he managed the firm's San Francisco and Seattle offices. He was responsible for the training of all staff in AutoCAD MEP,

and the configuration, customization, and implementation of AutoCAD MEP and related software. Armundo has over 29 years' experience in the architectural engineering field as a drafter, designer, and CAD manager. He started drafting for the U.S. Air Force in 1984 as an engineering assistant specialist. His professional background includes working in the aeronautical engineering industry for several years.

Using Revit Tools in Process and Water Resource Projects

Three years ago, I made the jump from the Autodesk Reseller channel to return to the engineering world. At that point in my career, I really wanted to put what I had been preaching and selling for the previous couple of decades to the test. At Gannett Fleming, the firm's visionary leadership is what impressed me the most. The willingness to take hard looks at how they design, and to make changes to improve the client experience, were all it took for me to make the switch.

After the first three years of the rollout, we've made substantial progress in several areas, but we're still just scratching the surface of the potential and promise of BIM. And we took on one of the more challenging tasks right out of the gate – implementing BIM for our water resource and process projects.

Leveraging 3D modeling and data sharing isn't a new concept in these worlds. Applications such as PDS have been around for many years, but the cost of playing in that arena is very high, and very proprietary. In order to be successful, we had to establish some early goals. These goals included:

- Start with 3D modeling basics and foundation training for the engineering side of our business. While we already had modeling experience on the architectural side, and some with the civil and structural side, very little of our MEP and process engineering work was completed with anything more than 2D documentation and spreadsheets.
- Begin to address and understand the data associated with design elements, such as equipment, piping and more, and learn how the information is managed or shared throughout a project. One of our big roadblocks was effectively communicating design criteria to all disciplines, such as the electrical data associated with water treatment or process equipment.
- Implement the System approach to design. This included building the entire system as a series of associated parts, from the process and instrumentation design to the connected piping, electrical and HVAC systems used in these types of projects.
- Establish a fixed standard and method for sharing the end result – the design model – with the end users, including the client, contractor and facility manager.

The decision to leverage Revit as the primary design tool was made prior to my arrival, as our corporate leadership recognized the inherit capabilities of the model. While the earlier releases did not provide the results we were looking for, Revit has continued to develop, and we've learned how to manipulate the projects, families and data in such a way to help us improve accuracy, reduce errors, and manage costs.

Implementing the software also exposed several areas we needed to improve in our work process, including where we made decisions about items such as equipment selection, and how to assign tasks to occur at more efficient points in the project schedule for the design team. As

we like to refer to it in the South, we didn't know we had fire ants until we turned over some rocks…

So, in this first segment, let's review these key items and learn how to make Revit fit into these projects.

Leveraging Revit – It Starts on Day One

When we first started implementing Revit, several of our engineers believed the best thing to do was finish the job in plain AutoCAD until 30%, or even 60%, and then model it. Part of this premise was based on the current design workflow of waiting until the last minute to actually select equipment that was going to be used in a project. Because CAD allowed us to make changes at the last minute, such as changing a dimension to make a pipe size larger or smaller, or overriding a dimension, decisions that should be made in the schematic phase were getting kicked down the road.

We started to correct this by working with a team in one of our offices that was more than eager to embrace changes and new technology. By keeping an open mind, and leaving their own conceived notions about design, and where traditional tasks should be completed, they adopted BIM technology faster than other groups.

Pleasant Hills Authority – SSO Elimination Project　　　　　*© Copyright Gannett Fleming - 2013*

One of our first projects with this group entailed a renovation of a water treatment plant, with 13 structures to be updated, and 3 new structures added to support a new headworks, screening,

and administrative offices. The decision to start BIM early was based on several positive factors, including:

- We had completed the original design in CAD, including detailed structural drawings showing the shapes of concrete basins and tanks that were drawn "actual size"
- We already had a civil site file showing the existing side, which was at the correct elevation and coordinates.
- Several of the staff engineers and project manager were already familiar with the client and facility.

On this project, we made several key decisions early on that helped keep the project on track:

- The existing structures to remain were modeled using the existing documentation and field verification. This work was completed over a 4 week period at the very start of the project. Architectural and structure components that were to be demolished were also modeled, and assigned the correct phase. The as-built model for architectural and structure was created in one file, and was used for demolition plans as well as the base for the renovation model. All existing components were modeled to LOD 200, since the lack of changes did not warrant the same level of detail as a new project.
- New facilities were added at the correct coordinates and relevant location adjacent to the existing facility. By keeping this in a separate file, it automatically gave us a separate file set to track changes between the existing and new facility. This also will provide more clarity between new and existing conditions for the contractor.
- Existing MEP items to remain, such as piping and equipment, were modeled as it was relevant to the new design. Only items that were necessary for connections and coordination were modeled to LOD 200. Where an existing 2D footprint was adequate to communicate conditions, the original CAD files were used.
- Scope boxes were provided to limit levels to their relevant building. Where a common datum level that intersected several buildings was needed, this was not limited by a scope box, but was instead named in such a way the designers would understand how it was common for these structures. Rotated views were utilized to provide plan documentation that could be easily displayed for sheet orientation.
- Communication with potential equipment providers began at the project launch, right after the project kickoff meeting. We made them aware of our requirement that 3D models be provided in order to be listed as a preferred vendor. Most vendors were already using 3D modeling software, and were willing to provide models with limited editing capabilities. Vendors that already had standing relationships with our firm and clients have continued to work in tandem with the design team, providing updates and modifications as the design progressed.
- Our BIM team worked on initial equipment model conversion, but technicians in the office have learned how to do the conversions themselves. A standard family file was

provided to ease the use of corporate standard shared parameters, so items could be properly scheduled.

- Training for the staff occurred on the start of the project. At key submittals, and during internal QA checks, a full review of the model and key parameters was completed by our internal BIM team, to make sure the finished product was easy to use by the owner and contractor. Just in time training and content creation was also provided by the BIM team throughout the project, allowing the design team to focus on the overall design.

The lessons learned on this project had a positive impact on the engineering and project management teams in that location, which now correctly plan for BIM based projects.
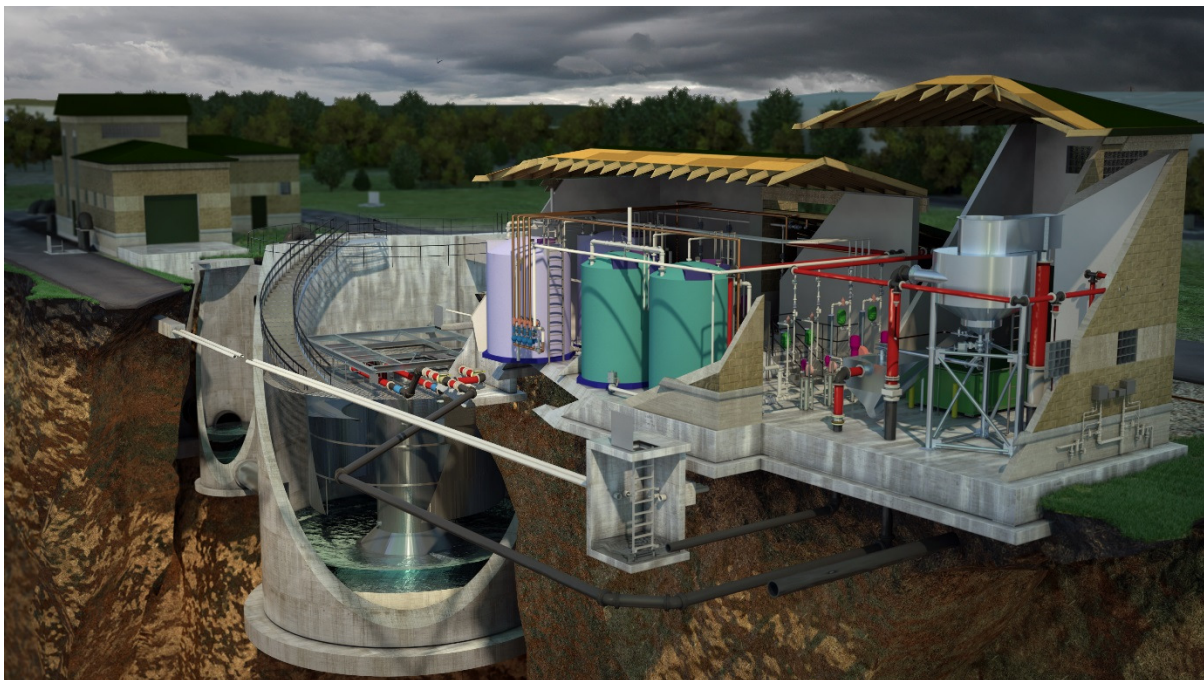
Mon Valley CSO Treatment Facility   *© Copyright Gannett Fleming - 2013*

Another project example was a combined sewer overflow facility for an existing system that was constantly exceeding the plant's ability to process raw materials at higher flow levels. This bypass facility was slated to be placed in a riverfront location that was deemed vital to the town's future growth, so the facility not only had to meet its purpose, but be aesthetic as well.

In this project, Revit was also used from the launch. Since it was a new facility, basic structures and reference lines were used to layout building and treatment structures. During the course of the project, several changes were made based on owner and local authority requests. During this period, the primary equipment vendors worked closely in conjunction with the design team to make changes quickly, so they could be adopted into the design. Lessons learned on this

project (which is shown as a video during the presentation in this class - http://www.youtube.com/watch?v=P-mqwBgeLCQ) include the following:

- The creation of the schematic design and hydraulic profile are critical, and should be well defined prior to starting model based design. This does not exclude a user from using Revit to initiate the project. The existing site can be imported, and detail lines and reference lines can be utilized in the early stages to locate new buildings, structures, and pipe routing.
- Getting the hydraulic profile defined earlier meant fewer vertical changes, which can have a negative impact on BIM projects. For example, moving a lower level above a higher level can break several constrained objects such as walls. This results in wall and other element replacement, instead of revision.
- The critical importance of the civil/site file cannot be overlooked. We found it was easier to make sure the site was restricted to only include adjacent areas as needed to complete the design. The site was linked using center to center options, pinned in place, and a common location for the new/modified structures defined at the start of the job. The site file was also linked into the architectural file only, with structural and MEP files only displaying the linked site as needed in relevant views. Structural and MEP models were linked origin to origin to the architectural model instead, and rotated views/scope boxes were also utilized for consistent document creation.
- This project was also instrumental in helping to implement new data standards for the company. Project and shared parameter usage was more clearly defined, and project managers were able to learn what information other disciplines required in order to start their designs earlier.

The importance of establishing clear standards, a training and implementation plan, and project follow up procedures for lessons learned is key to successful usage of Revit on a project. These projects helped us gain valuable knowledge for future projects, and helped us win more work with our clients.

Editing Manufacturer Based Content for Efficiency and Accuracy

In order to create a more refined and accurate model, we decided that we would start requiring vendors to provide 3D content, in order to remain as a preferred supplier for basis of design. Since we already had strong relationships with most of our vendors, it was important to clearly state these goals and expectations early in the implementation process.

During the past three years, we have used a variety of methods for getting vendor content into our projects. Initially, we began by asking for 3D **DWG** or **SAT** files, since they were already compatible with the Revit families. Over time, we discovered in some cases, the models would

be extremely large, with more detail than was required. We also discovered that some 3D components didn't translate very well, such as weldments and 3D meshes in the SAT files.

Over the past two years, two Autodesk products have emerged as our primary conversion tools. We began by using **Autodesk Fusion 2012/2013**, which is now the cloud based **Fusion 360** tool. This gave us the ability to take any of the common model formats, such as STL, SAT and more, and use them to save them into a friendlier format, such as 3D DWG. Since our staff was already proficient at using AutoCAD, making 3D edits to eliminate unneeded detail, such as the guts of a pump, made the models smaller and more efficient.

One year ago, we started using **Autodesk Inventor** to edit and import models. Since the product was already part of our ultimate Building Design Licenses, it made more sense to use this tool. With **Autodesk Inventor 2014**, the ability to directly export an RFA file is now what we are looking to use the most. In this section, we'll examine how we used Fusion 2013 as compared with Fusion 360, and then examine how Inventor is used to make Revit content. We'll wrap up with a quick look at the full version of Inventor 2014.

Inventor Fusion 2013

When Autodesk released **Inventor Fusion** a couple of years ago, we began using it immediately. This tool allows users to take nearly ever modeling format, including .IPT, .SAT, .IGES, .STEP and more, and make minor edits. The main reason we use it is for converting these formats to 3D **DWG** or **SAT** so we can use the parts to create our own intelligent content. In this lesson, we're going to learn how to use this software package to save a pump model from *Flygt*, a major pump manufacturer, and create the DWG file we need to use this in a project.

1. From Inventor Fusion, use the *application menu* to open the model file:
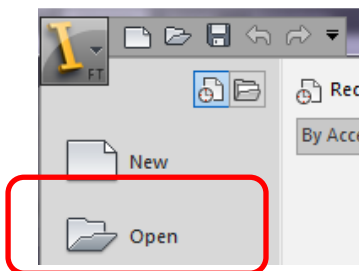
2. When the **Open** dialog appears, check out the file types you can use:

3. You can see how this program becomes the "jack of all trades" when it comes to file conversion. Select the **Pump NP 3085 3hp.ipt** file. Select *Open* to continue.

4. When the file opens, you'll see a 3D model of the part:
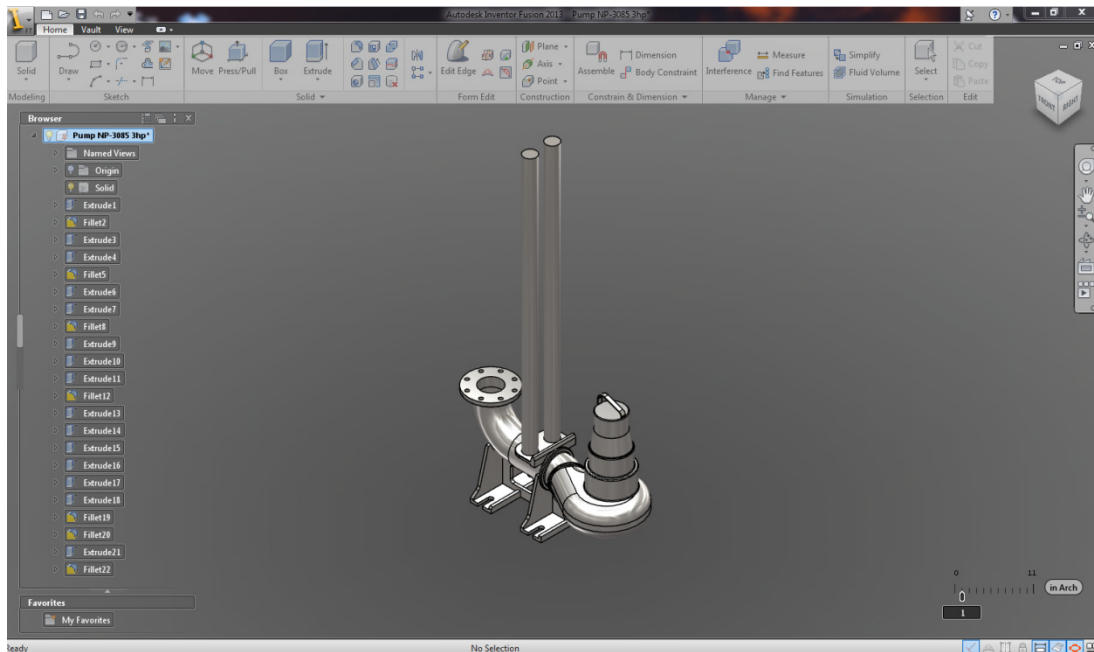
5. Fusion includes a browser that lets you select and review items in the screen area. If you select a component in the list, it is highlighted in the view. If you right click on the component, you can *copy, cut, edit material, dissolve features, delete* and *validate*.
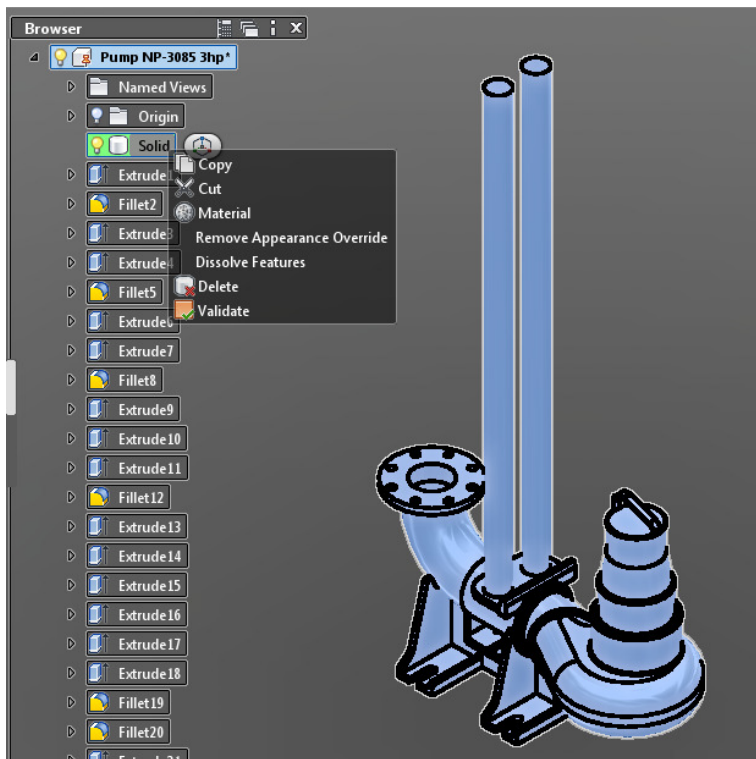
6. The tool features depend on the type of component you select, so an "extrude" will list different tools than a solid, for example. While this class does not go into editing in Fusion, be aware that you can make some changes to file before you convert it.

7. To convert a file, this is really tough – go to the *Save As* command on the application menu. When the dialog opens, you can save to DWG, DWF, STL, SAT, DXF, IGES, STEP and other modeling formats. When you select *Save*, you've created the DWG you need to make the part.

And that's all there is to it – you can save the file to any location you want.

Fusion 360

This year, Autodesk migrated **Fusion** to the **Autodesk 360** site – and a whole new world opened up.

1. To access **Fusion 360**, you must have an Autodesk product on subscription that supports the use of the software – to find out what you need, check it out at http://www.autodesk.com/products/fusion-360/overview

2. Once you're logged in, you're placed into a **hub**, which includes pages for defining work groups, adding designs, and importing files. In this example, you can see that I've already created a **group** for my models that I'm going to convert.
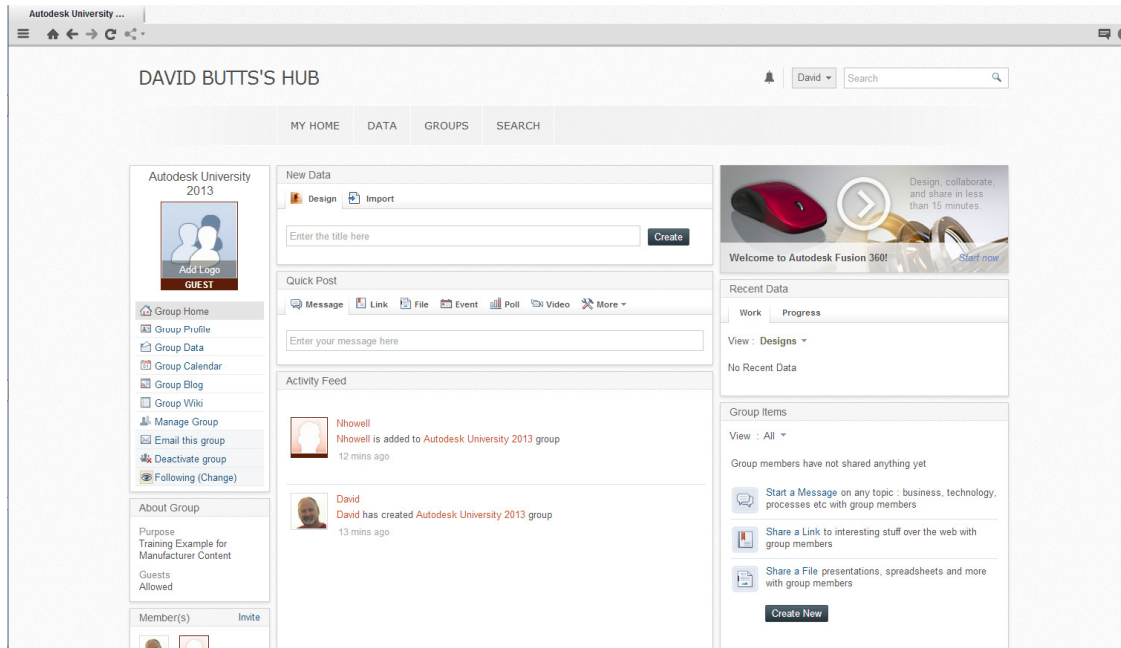
3. The group is where you *add members, define profiles, setup blogs* and more to share models and information. **Group settings** give you several options:
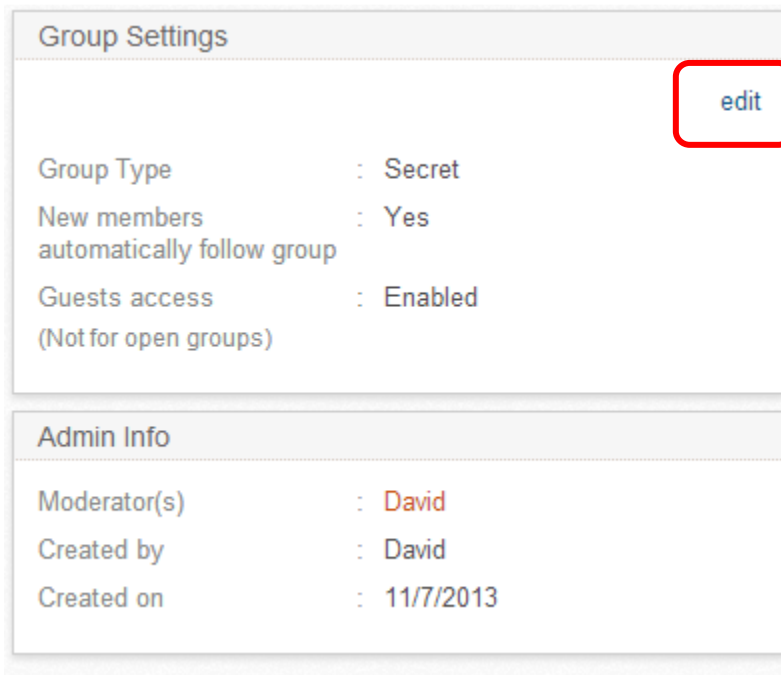
- **Group type:** Can be set to secret or public when defined

- **New members:** can utilize default options to set if they automatically follow posts, or they can start following the group
- **Guest access:** controls whether or not someone else can join the group by invitation – helpful for project teams where a specific group is creating content for the job.

4. Once the group is defined, you can **import** files to edit. You can select as many files as needed for a project.

5. You'll get an **alert** letting you know when a file is updated. After getting the notification, check out the **My Home** tab.
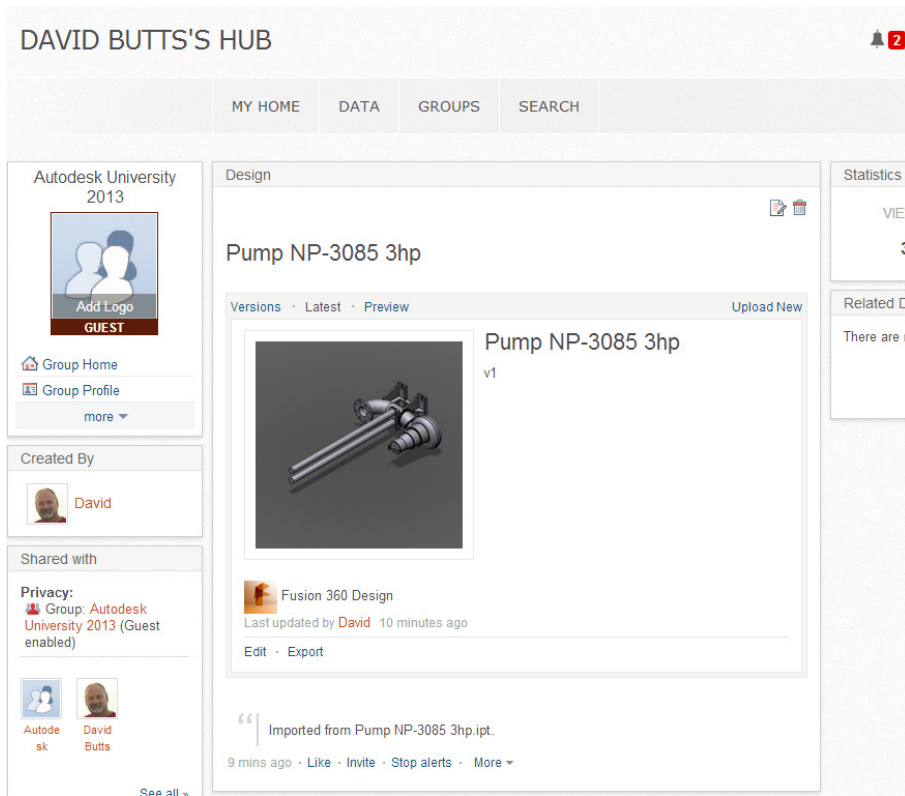
6. You can select the **Edit** button to make changes. The part will appear on a new tab in the window.
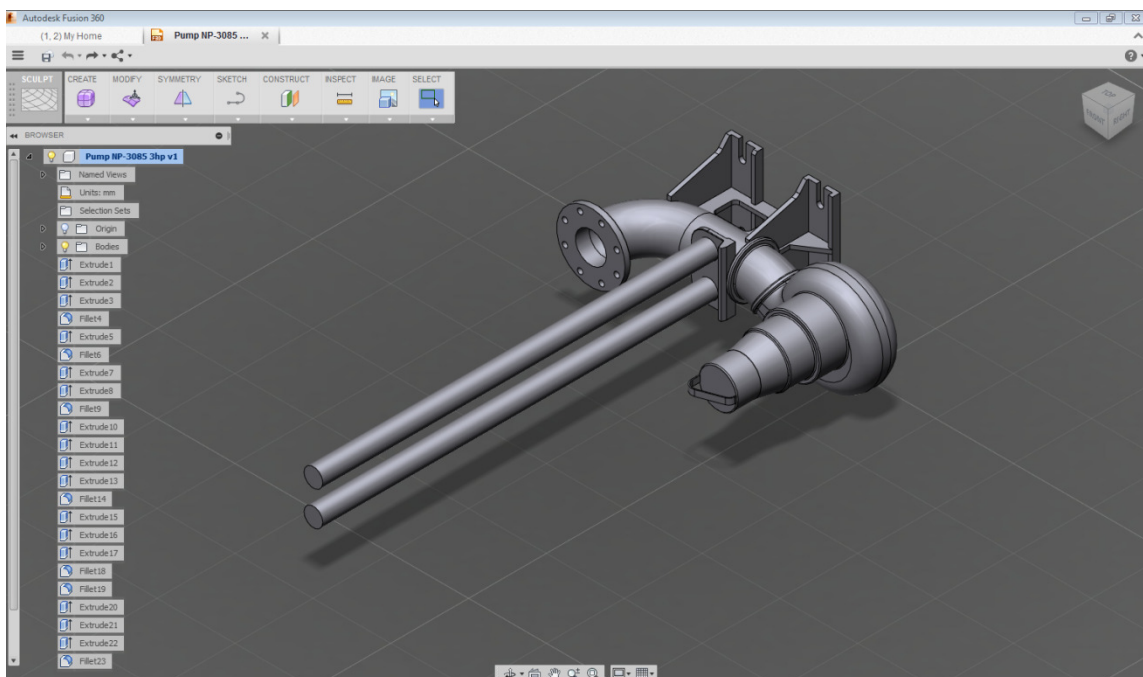
7. While this isn't a class about using Fusion, it's interesting to see all of the different options you have for editing the parts. Both Fusion 2013 and Fusion 360 include tools for editing the solids in a model. In our case, we're more likely to be removing objects to reduce complexity. For this model example, we wanted the rails to be parametric in Revit, so we removed these solids, and then added them back when the remainder of the pump body was imported into a family.

   To remove the rails, use the **Select** tool to pick them.
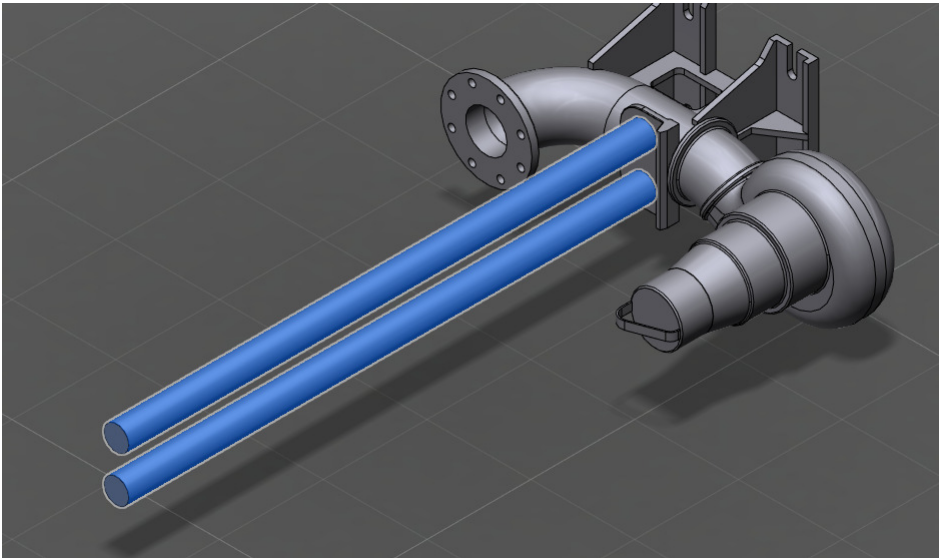
8. Select **Modify** from any of the workspaces, and then click **Delete**. The parts are removed:
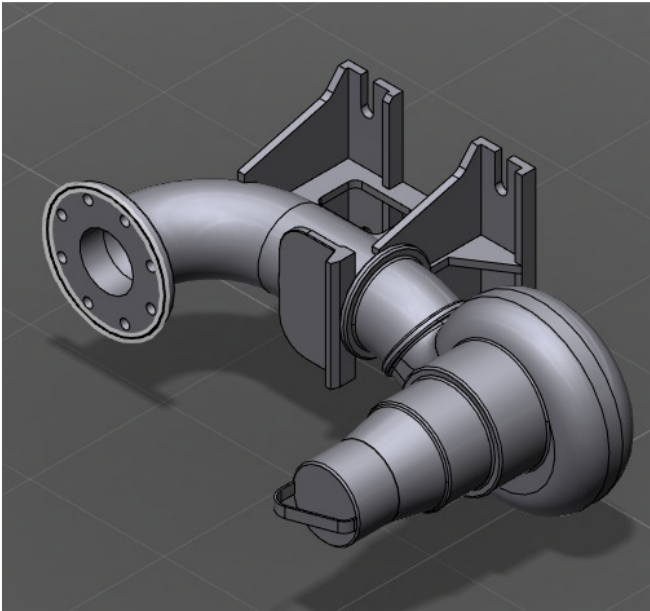
9. Next, you can create a **new version** from this model:
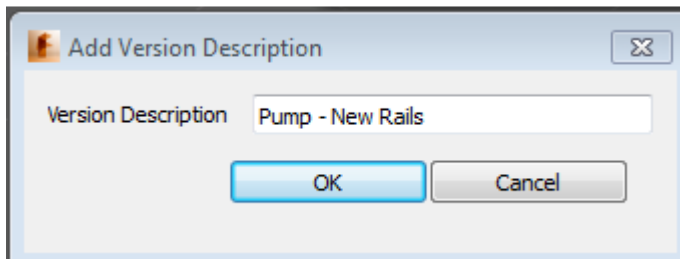
10. You can also export to various formats, including *IGES, SAT, SMT, TPF* and *STP* files (note that 360 includes *fewer* format options that 2013):
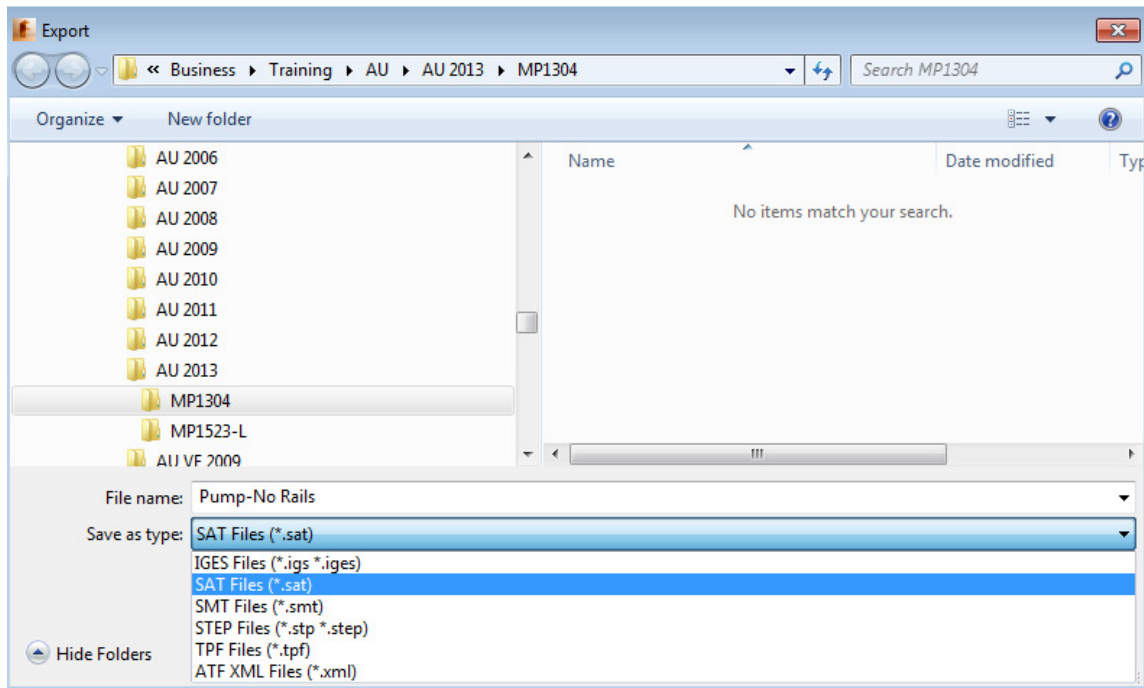
11. Since SAT is supported as an import file format for Revit, you can save in that format for a direct import into a family.

There are some basic differences for working with content through the 2013 and 360 versions. While the 2013 version gives you **more export options**, 360 has better **sharing capabilities**, **versioning** and **modeling** performance. Choose which version works best for you.

Inventor 2014

To close out this section, we'll take a look at how the full version of Inventor 2014 can help you with content. When you are installing the program, an option appears for Revit compatibility – make sure you include this when loading the program onto your system. Inventor can open nearly any type of modeling file, but only specific Inventor file types can be written directly to an RFA file.

1. In the program, start by opening an **IPT** file. This example includes a UV treatment unit.
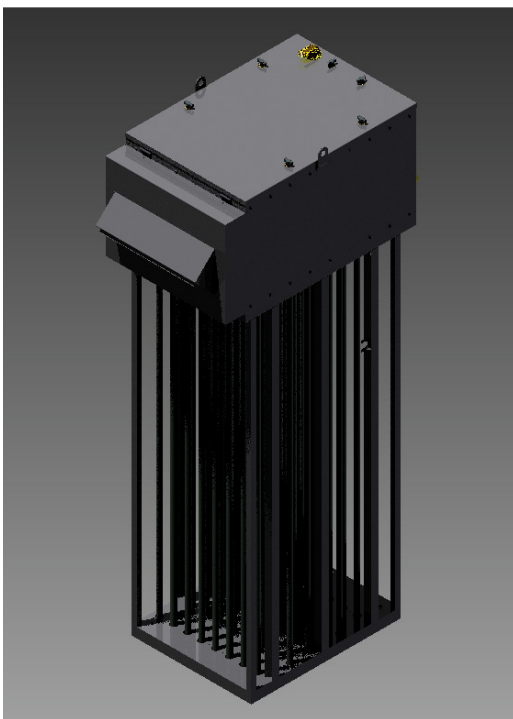
2. **IPT** files include a BIM option for conversion. Select the **BIM** tab.
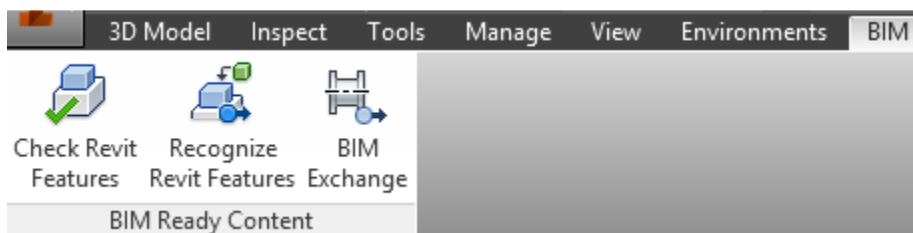
3. **Check** and **Recognize Revit features** help you determine if any features can be used to reduce file complexity.

4. Select **BIM Exchange**. From this tab, you can add connectors for cable tray, conduit, duct pipe and electrical circuiting The UCS tool also helps you to correctly orient an object.
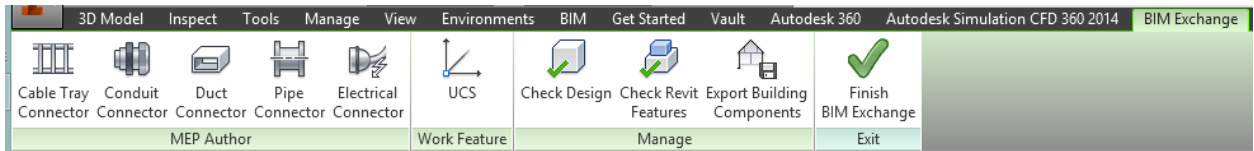
5. **Check Design** lets you know what, if any issues will occur during export, and displays information such as dimensions, component properties, model complexity and connections.
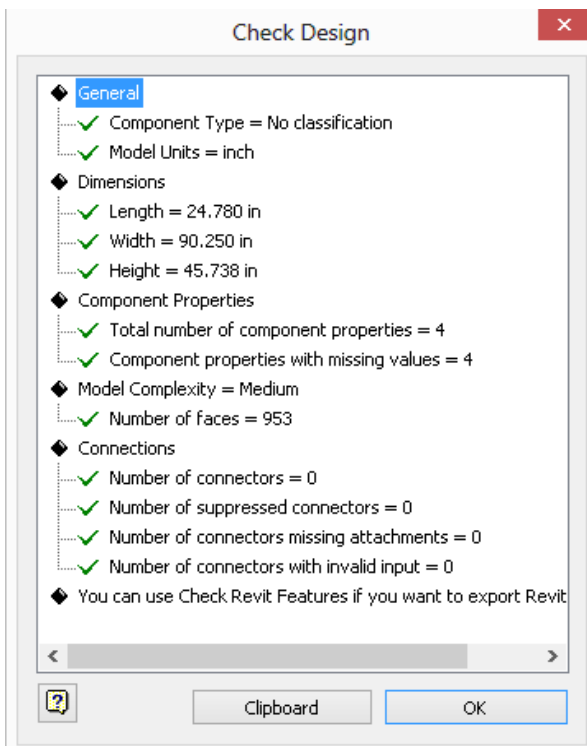

6. Select **Export Building Components**. This dialog lets you pick between **RFA** or **ADSK** file formats.
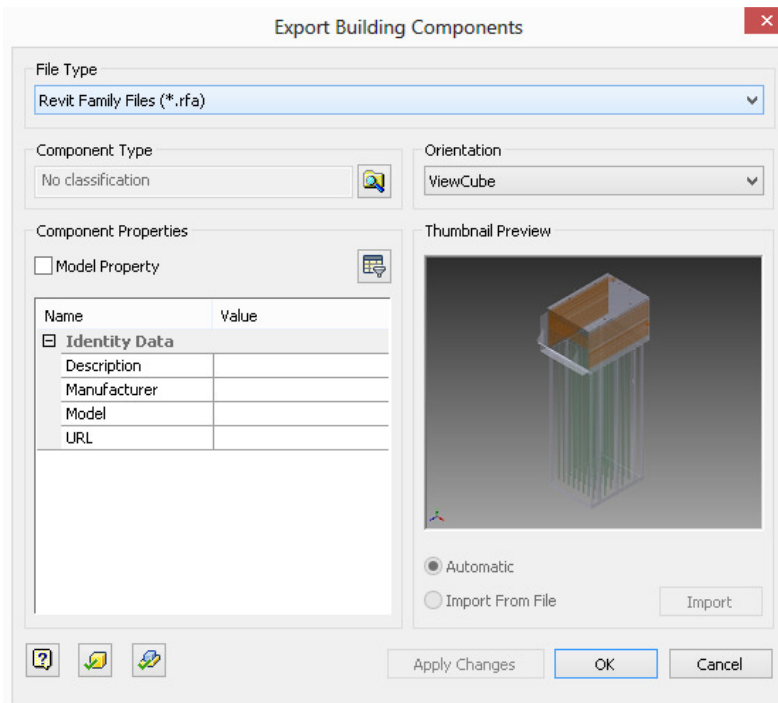
7. **Component Type** lets you set the **Revit Category** for the object. Set it to **Mechanical Equipment**, by expanding **Supply and Distribution of Liquids and Gases** to the **Water Filters** section.
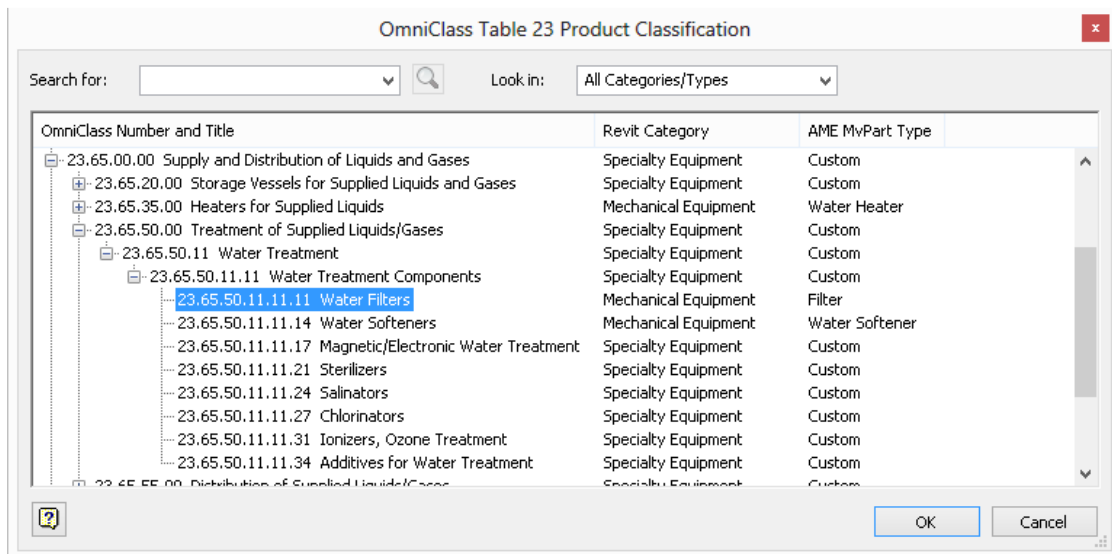

8. **Model Property filter** allows to select any values you want to include in the exported file.
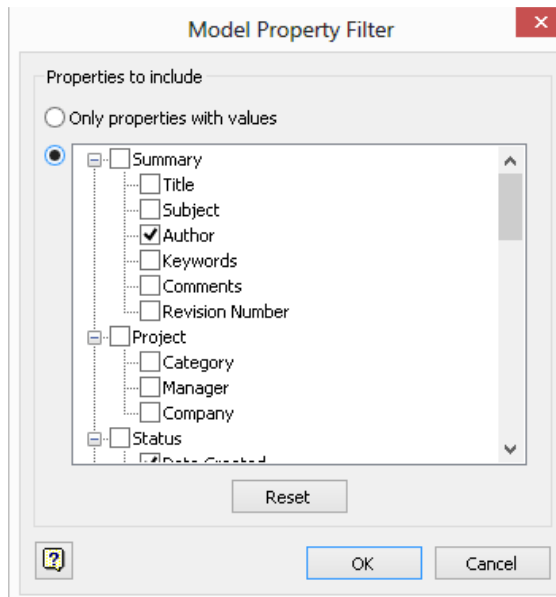
9. Select **OK**, and save the file. **Finish BIM Exchange** will close the tool.
10. Let's look at another example. This file was created by opening an SAT model, and saving it as an Inventor assembly. The BIM tool is not available as a separate tab, but click **Environments**.
11. Select **BIM Exchange**. When the tab opens you now have a **Shrinkwrap Substitute** command, which allows you to simplify and reduce the complexity of model. This also results in a smaller file size. When you run this tool you can create a new component, set the template and specify the file location.
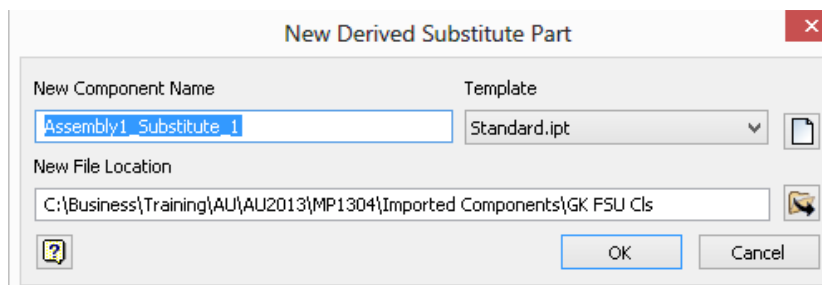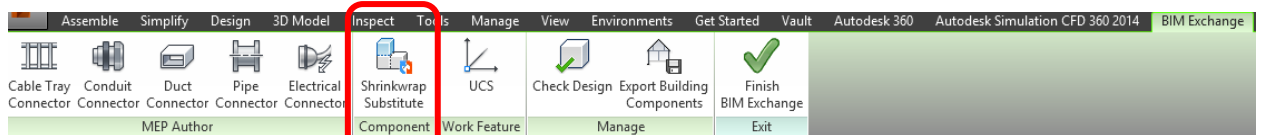
12. The Shrinkwrap options dialog appears. In most cases, you want to remove geometry by visibility, and only include what you can see. You can pick between whole parts, or parts and faces. You can also remove parts by size, and patch holes. Click **OK**, and you'll see the results.
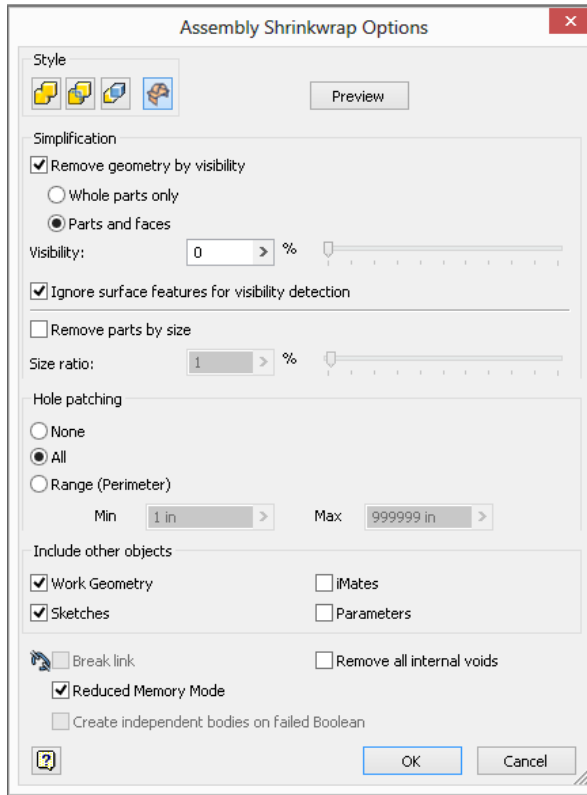
13. Once you've simplified the model, you can **export** it. The only format for export is **ADSK**, but you can open this file directly in Revit and save it as an **RFA**.

These packages give you a variety of options, from *RFA* and *ADSK* files to *SAT* and 3D *DWG* models. The advantage of RFA and DASK over SAT and DWG is the **native file format**, but SAT and DWG can always be imported as CAD files in an RFA, and connectors or other Revit-based solids can be added to the models. Whatever you choose, these tools help you create the level of detail you need in your design.

Using BIM Models with External Analysis and Simulation Software

One of the ways you can gain value from a BIM model such as the ones we create in Revit, is to use the geometry and data in the model to improve productivity from an analysis perspective. There are several tasks during a project that can really take advantage of this, and in this section, we'll take a look at these.

Preparing the Model

In Revit, there are a few things you need to make sure you have completed prior to using a model for analysis. Depending on the tasks, the level of detail needed can vary, but here are the basics:

- Bounding Elements need to be properly defined. Architectural models should contain floor levels that define boundaries, and include walls, openings, floors and roofs where possible. Having the specific wall type isn't necessary for preliminary analysis for items such as heating and cooling loads. Most external applications include templates based on constructions, so different iterations can be defined. But as you get further into the project, and want to check these items, you can leverage the properties of materials to provide more detailed and just-in-time data that's relevant to the analysis.
- Rooms, spaces and zones should be defined for heating and cooling load analysis. Void areas such as chases don't need a room defined, since a space, when automatically placed, will recognized this as an unoccupied area and treat it as such. But all occupied areas should be defined as rooms, so spaces can use that base data for names, numbers and geometry.
- For other types of analysis, such simulations for airflow, the model needs to be site oriented and as well defined as possible. This helps make identification of wind sources, as well as topography that can affect airflow, provide more detailed results. Additional detail in the model, such as raised edges for standing seam metal roofs, helps to produce more accurate results. More detail inside the building, such as the location of equipment and furnishings, can also affect the results.
- For early conceptual studies, you can define mass models with assigned mass levels, and use these for conceptual energy, solar and cost analysis. While an

architect would be more likely to use these tools, it's still a viable way to review how the project will perform in the earliest stages of design.

Once you've maneuvered through these steps, you're ready to start using the model.

Starting with in-model Energy Analysis

In our world, our most common use for Revit in performing analysis relates to the heating and cooling loads tools that we use daily. Anything that can save time in one area is put to use in other areas of the application. In this example, let's review a couple of items. The current plan shows a plan view in our diversion structure. Only the conditioned areas have spaces and zones defined.

1. Start by activating the **Enable Energy model** tool, which is a toggle that allows Revit to use energy modeling tools. Once these are set active, you can perform an internal heating and cooling load analysis as needed.
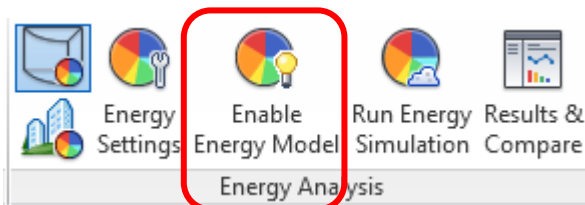
2. There are two modes you can use to perform an internal analysis. **Conceptual Mass Models** ( ) are defined using an architectural mass model with mass floor levels added. This level does not require bounding elements to be defined. **Energy analysis using Building elements** ( ) enables the energy settings features, and uses bounding elements in conjunction with spaces and zones to perform an energy analysis.
3. Click **Energy Settings** to define parameters used for the analytical energy model.

| Parameter	Value
Identity Data	⌃
Workset	Project Info
Edited by	
Common	⌃
Building Type	Office
Location	Monessen, PA, USA
Ground Plane	LEVEL ZERO
Detailed Model	⌃
Export Category	Spaces
Export Complexity	Simple with Shading Surfaces
Project Phase	New Construction
Sliver Space Tolerance	1' 0"
Building Service	VAV - Single Duct
Building Construction	<Building>
Building Infiltration Class	None
Export Default Values	✔
Report Type	Standard
Energy Model	⌃
Analytical Space Resolution	1' 6"
Analytical Surface Resolution	1' 0"
Core Offset	12' 0"
Divide Perimeter Zones	✔
Conceptual Constructions	Edit...
Target Percentage Glazing	40%
Target Sill Height	2' 6"
Glazing is Shaded	☐
Shade Depth	2' 0"
Target Percentage Skylights	0%
Skylight Width & Depth	3' 0"
Energy Model - Building Services	⌃
Building Operating Schedule	Default
HVAC System	Central VAV, HW Heat, Chiller 5.96
Outdoor Air Information	Edit...

4. This dialog allows you to set the default energy settings, including:
   a. Common – building type, location and ground plane level;
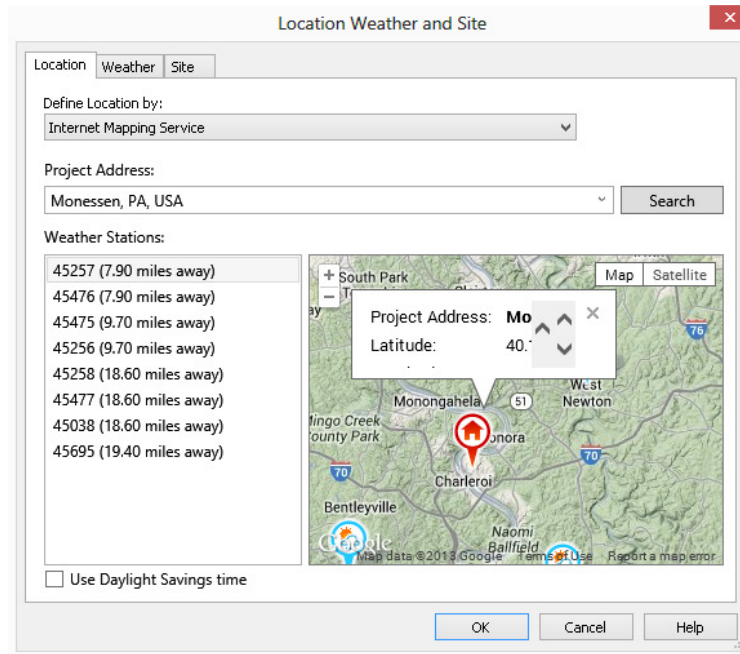
b. Detailed model information – export settings, phase, building information, and report types;
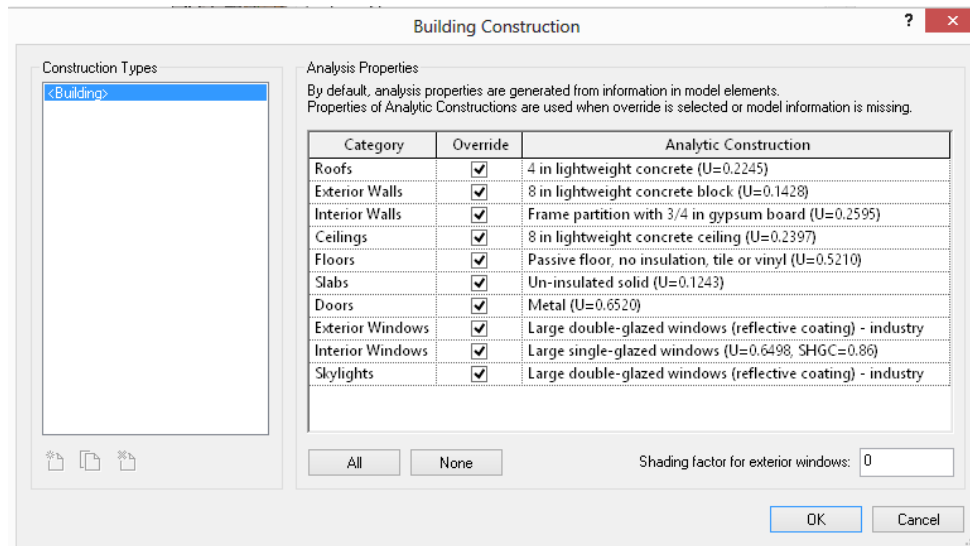
c. Energy model – space and surface resolution dimensions for gaps, core offset, perimeter zones, settings for glazing, shading and skylights, and conceptual construction types for bounding elements;
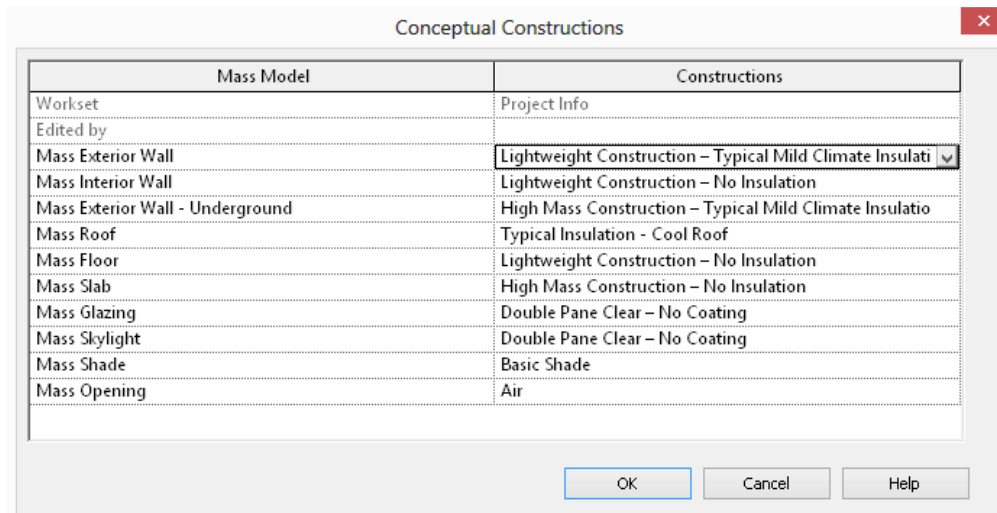
d. Energy model for building services – include operating schedule, HVAC system and outside air information:
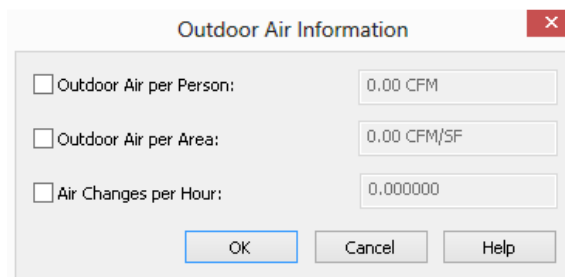
All of this data is included in an exported gbXML file.

5. Once the settings are edited, the program will create a default energy model, which can take a few minutes to create, based on the size of the project.
6. One the model is defined, you can immediately start a Green Building Studio project by selecting the **Run Energy Simulation**.
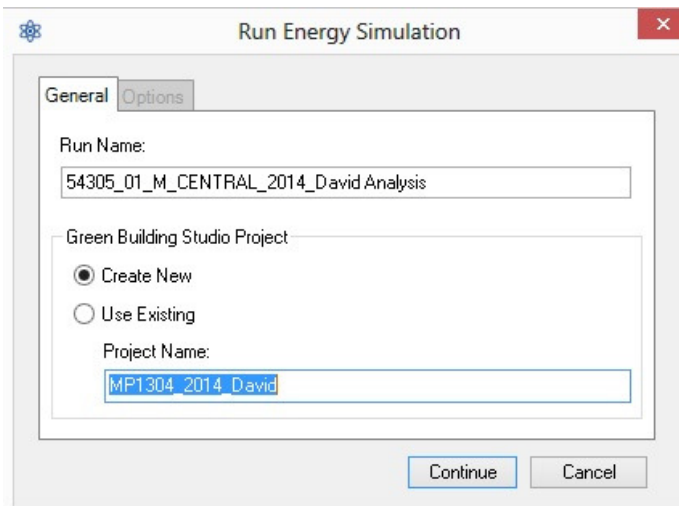
7. Use the **Results and compare** tool to review the summary of the energy analysis, and to compare results based on changes in the energy settings.
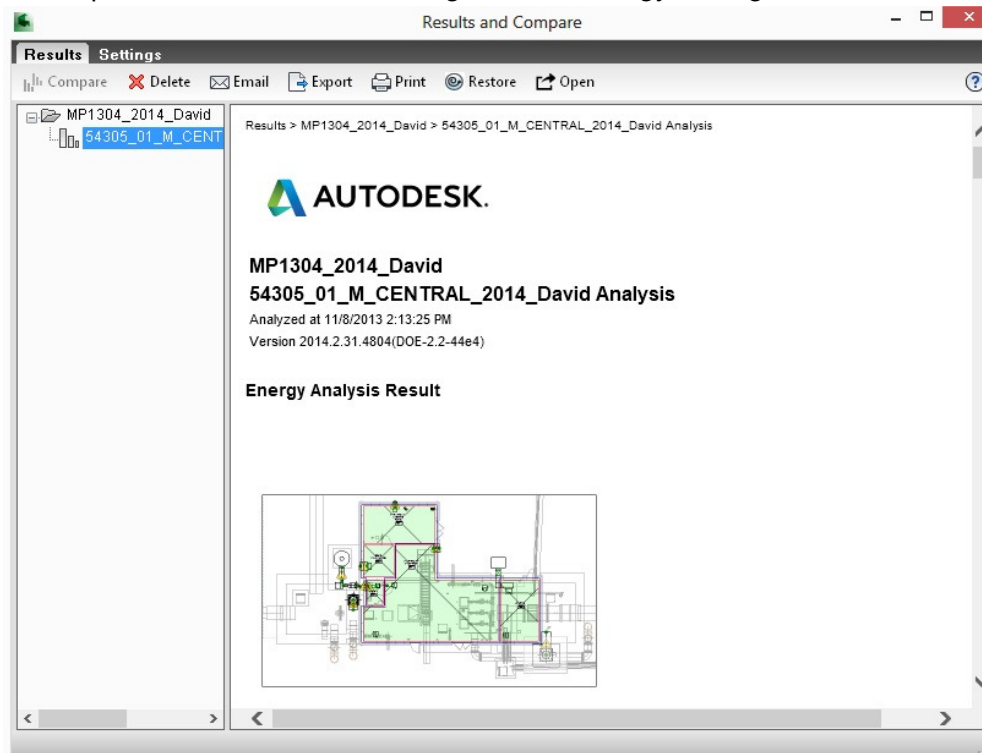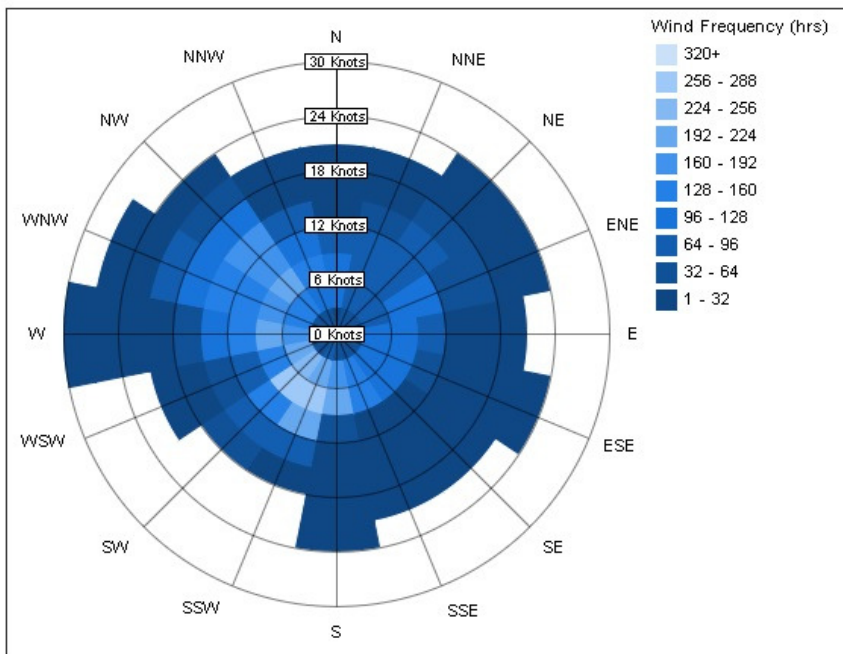

The results can include detail on the site and local energy costs. Other types of information, such as the Wind Rose chart showing annual wind direction and speed, can be helpful when working with other forms of simulation, such as in odor control studies:

Annual Wind Rose (Speed Distribution)
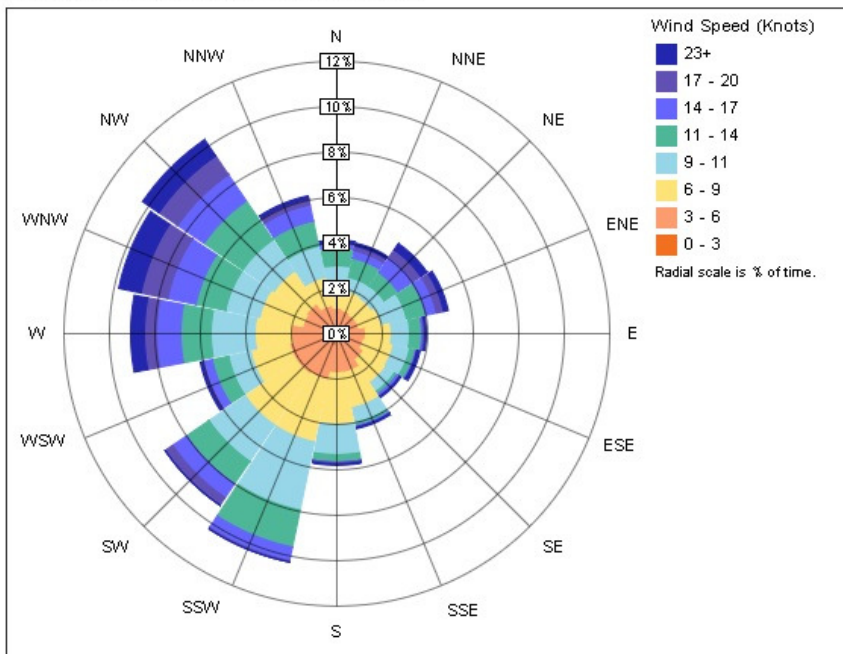
Annual Wind Rose (Frequency Distribution)

8. Once all of these settings have been made, you can also export to a gbXML file for other applications that support this format, including Trane Trace and IES Virtual Environment.

*Leveraging Revit Models in Autodesk Simulation Tools*

One new addition to the family are the **Autodesk Sim 360** tools, which are available to **Autodesk 360** users. This suite includes several programs for running simulation models for air and fluid flow, stress analysis, and more. The **Simulation 360 CFD** relates most closely to what we need in the building design arena.

So how is this applicable? In various stages of design, you might need to get an idea of what happens when a chemical leak occurs, or high water levels within a structure. Simulation gives you the ability to study results without having a Ph. D. sitting in the chair next to you. The visualization also helps to explain design decisions to laymen, who may gain a better understanding from a visual tool. In this lesson, we'll take a quick look at using a Revit model in this situation.

For this example, when you have Simulation CFD 2014 installed on your system, an add-in for Revit is installed. You can also import DWG and other model formats directly. Keep in mind that more complex models may result in extensive load times, so follow the KISS axiom and keep it simple. Key tips for using Revit models in this application include:

- Work from smaller portions of a building or structure, rather than trying to export an entire structure.
- The more edges and surfaces in a model, the more setup and editing you may need to do in the CFD application.
- Leave out model-line and generic model components that don't impact the analytical part of the model. Avoid creating a design study from a model that is not well defined.
- Tools like CFD are better suited to less detailed models, so using it earlier in the project (such as during the schematic phases) is more appropriate use.

The program installs a plug in that allows you to launch an active model into a design study directly from Revit.
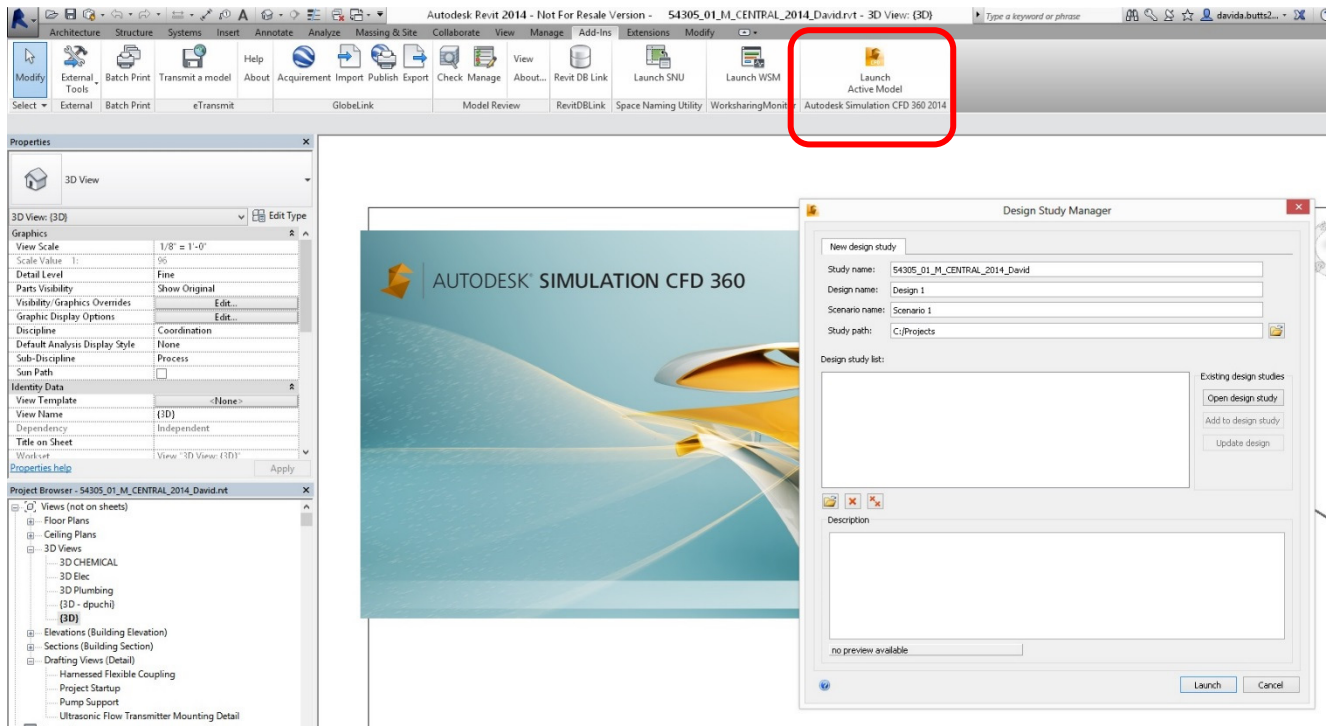
Once the model is imported, the program will perform checks on the model, including an edge merge tool that helps correct surface and edge errors that can affect a simulation:
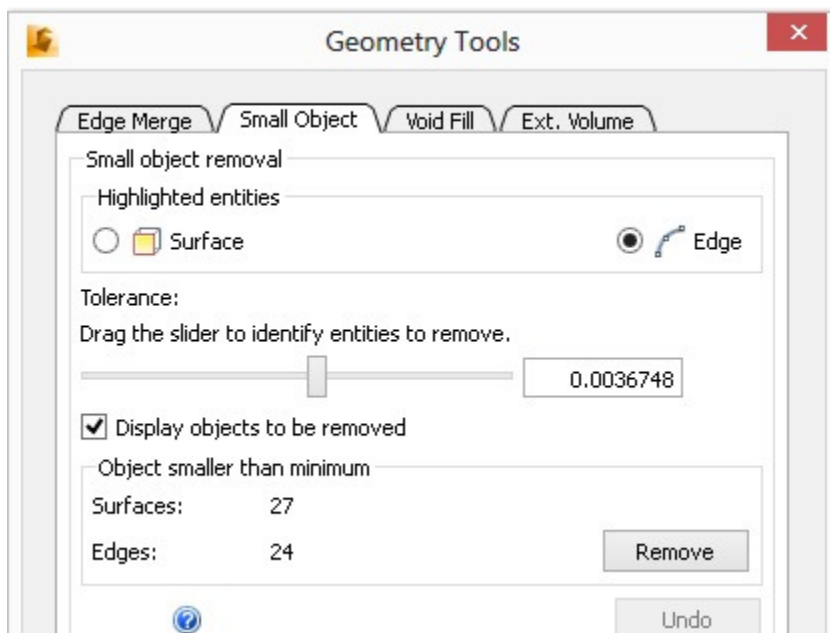
Also included is a small object tool that searches for items that may not be relevant to the simulation:

While this class does not go into detail about performing an analysis, this demonstrates another way that you can leverage your Revit model for more than just a set of construction documents.

Defining BIM Projects to Maximize Owner/Contractor Benefits

For our last segment, let's talk about the **data**. In most firms, the focus for BIM is on the construction documents. Heavy emphasis is placed on project productivity, and using tools such as Revit for coordination and automatic view creation are typically the main tools we work to integrate. On our first projects, that's exactly what we focused on. During the first year, our construction management group became more interested in tools such as Navisworks Manage, and how to leverage the models

As we started to look at scheduling tools, we took a deeper look into the data that's associated with a BIM model. Unfortunately, the "I" in BIM gets overlooked, since so much of the information associated with a project is held in outside files, such as specifications or spreadsheets. So, our goal was to learn more than just how to take care of schedules, but learn how data gets used beyond the construction documents.

In this lesson, we'll take a look at ways we leverage our model for construction management, and then how we export data for use with operations and maintenance applications for owners and end users.

Working with Navisworks

Creating an exported Navisworks file isn't a new feature for Revit, but making sure that you do things correctly on the front end makes the exported file work better for your construction managers. Here's a list of key tips:

1. When exporting a model, always check the Navisworks settings first. One of the options I check is for the file readers. I like to make sure that I don't include links – unless I'm the owner of all the files. Including the data associated with a part is also important – even in a coordinate model, it helps to know what information is associated with a part.
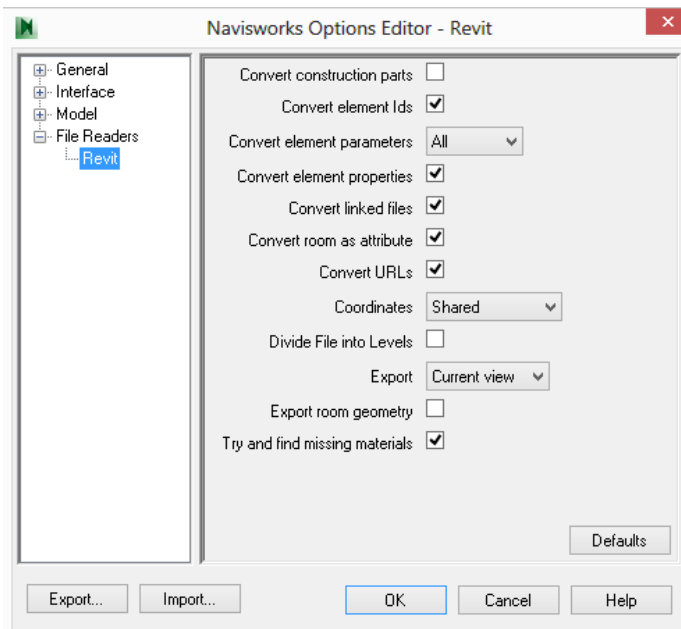
2. Name your styles correctly! Too often – and especially with the out of the box Autodesk parts – the type name doesn't describe what the part it. Name both the family and the type, and be descriptive.
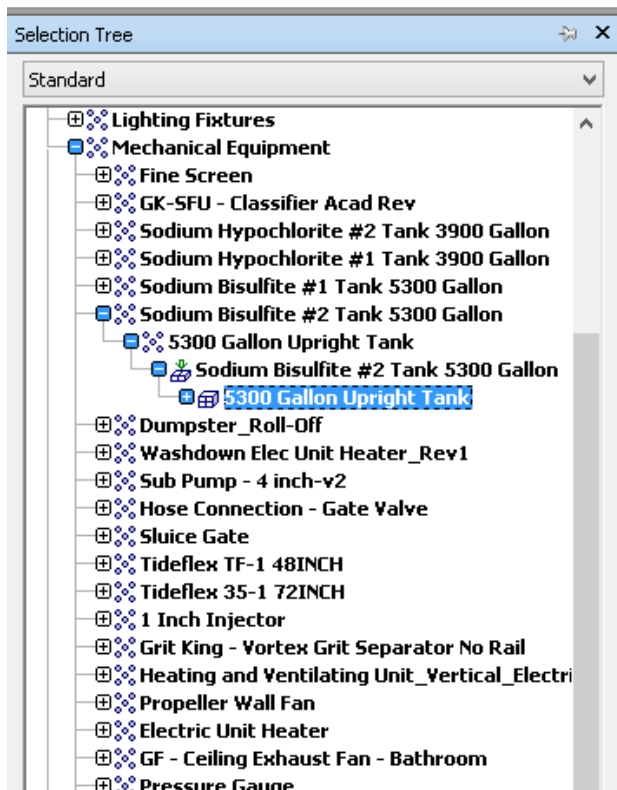
3. Whenever possible, don't over detail the model. We use as many placeholders as possible. But when detail is demanded, make sure you define the family correctly. Imported solid models, such as DWG and SAT files come in fine, as long as you defined them as an external family – we don't use any in-place families for any equipment in a project. Keep in mind you'll only be able to select the entire family – nested items can't be selected.
4. Make sure that you've lined up your models correctly, so when they export, everything lines up. Early we discussed using site-oriented models. When working with Navisworks, having everything come in at real world elevations and common coordinates make coordination and timeline simulation a snap.
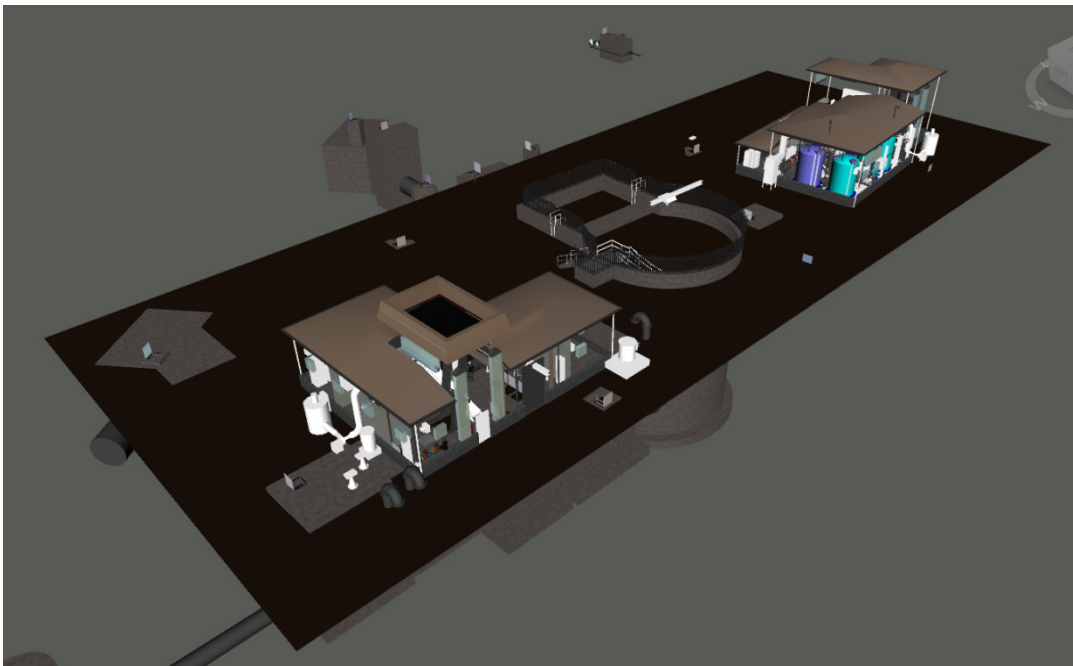

Mon Valley CSO Treatment Facility   *© Copyright Gannett Fleming 2013*

5. Check your materials. So far, we hadn't really paid attention to these, since most users think of materials only within the context of a rendering. But now, with data such a physical and thermal properties associated with a material type, you'll want to make sure you pick the right ones. Where this can mess with Navisworks is when you don't select the right one – for example, this basic shows glass back for the bottom of the grit separator chamber – it's just wrong!
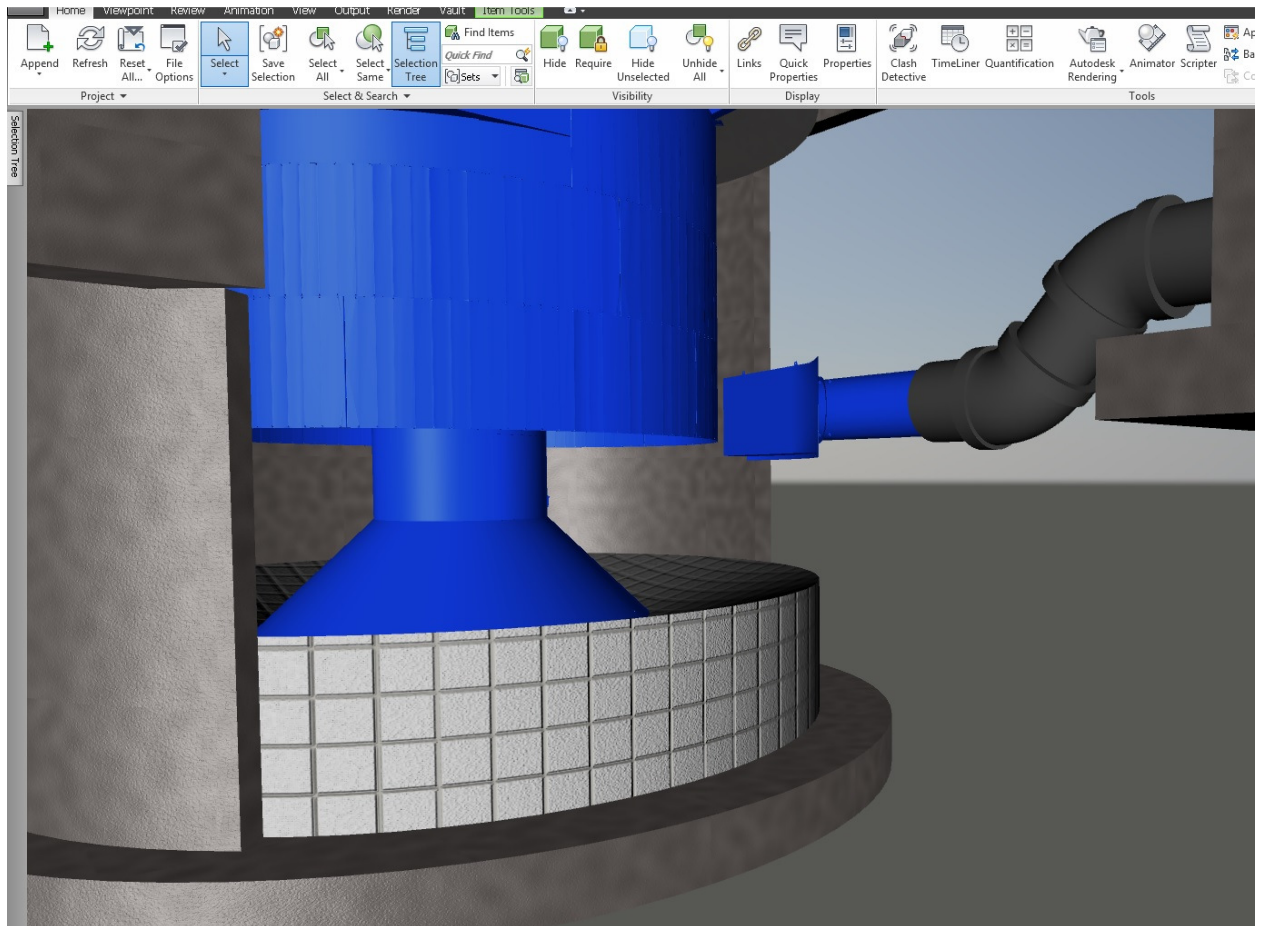
6. If you're working with other consultants and not using the same version of Revit, or sing other applications such as AutoCAD MEP (we eschew both ideas, and work hard to make sure everyone is not only on Revit where possible, but on the same release), you can use Navisworks for the interference detection. One of the features in 2014 I really like is the ability to save predefined tests using the Clash Detective. Just make sure you approve any items that aren't really clashes.
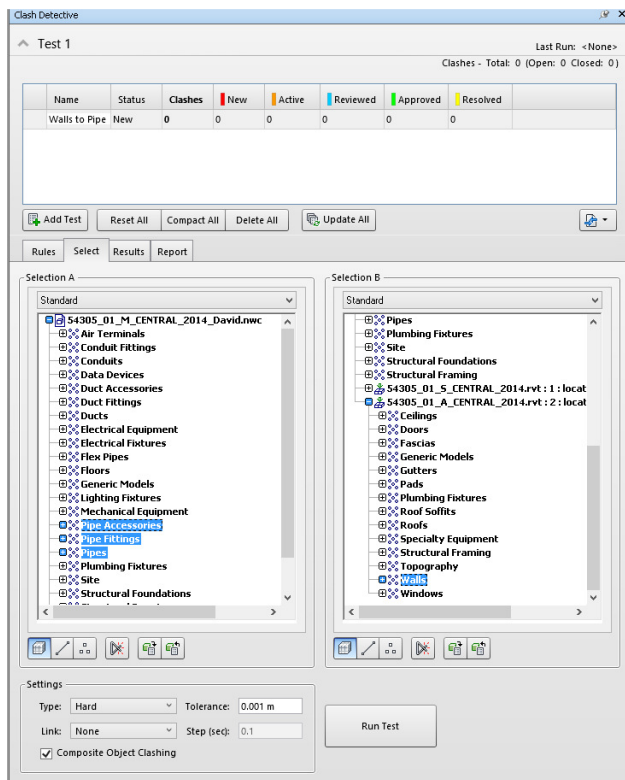
One feature I've really gotten a kick out of the Navisworks Switchback Feature. When this tool is enabled in Revit, you can select a part in a Navisworks model. It's so easy to use, there's just a couple of steps:
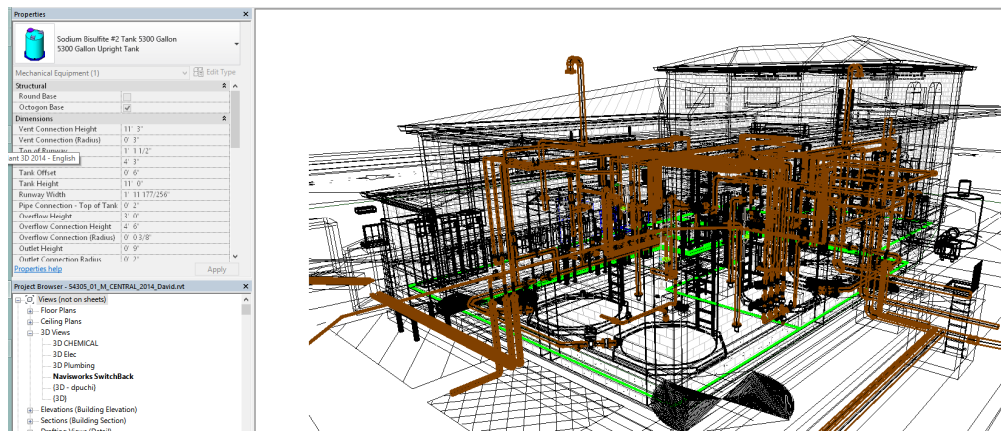
1. From **Revit**, go to the **Add-in's** tab (note: you need to have these tools installed first – they are automatically installed with Navisworks when it's installed). Select the **Navisworks Switchback** command.
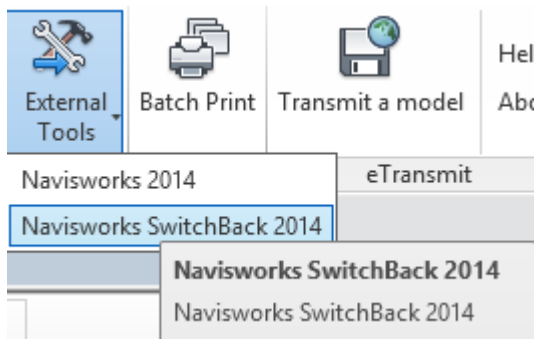
2. From **Navisworks Manage**, select a part. Right click and select **Switchback**. In Revit, the part will be selected and highlighted in a view.
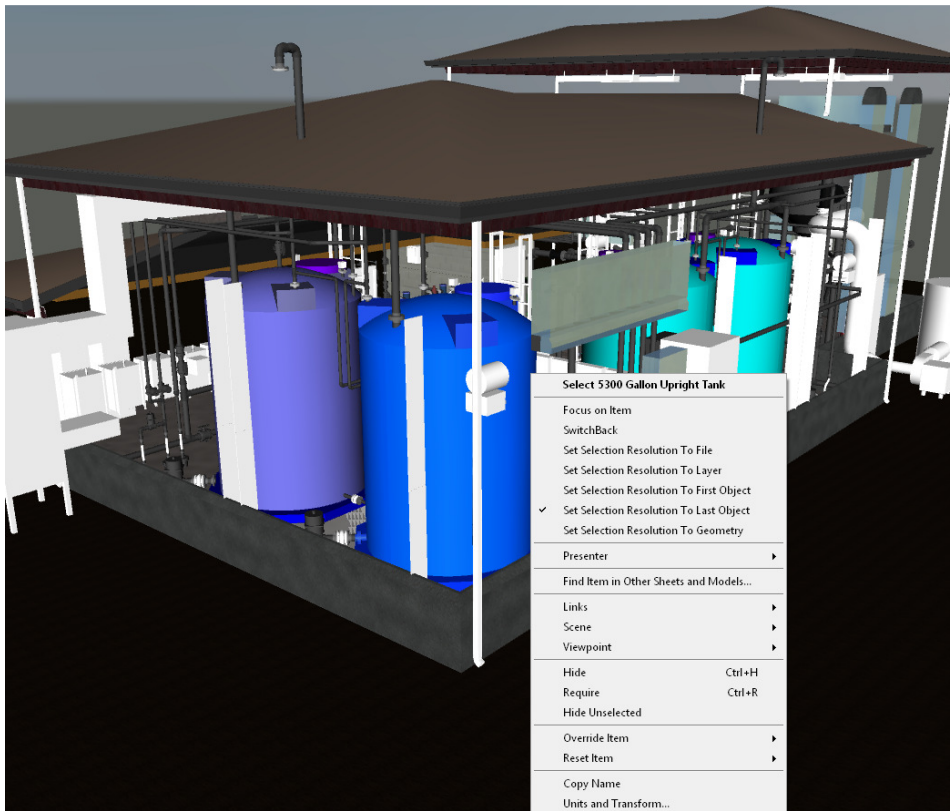
Selected object in Navisworks

The Switchback View in Revit with properties displayed form selected tank

This great for going back and making revisions, if you didn't follow the first few steps in this exercise.

Navisworks is great tool for our construction management team, but you want to make sure they can use your files and not get lost in all the geometry. Take the time to follow these guides, and use this tool frequently.

Leveraging the Data in your Model

One of the first things I started to study at Gannett Fleming was how we could share data between a Revit MEP model and an AutoCAD P&ID diagram. In this case, we didn't want to share everything. We primarily wanted to share a few fields, such as the equipment tag, manufacturer, model number, and specific electrical data. Since I first presented this at AU 2012 last year, we have made several updates to our internal data synchronization tools, but it bears repeating. Sharing data is becoming more relevant when it comes to working with clients that understand the value in BIM. In this section, we'll look at a few of the key features that make this work.

Define the Data!

The first step is getting the templates in Revit and the default project in AutoCAD P&ID to have the same fields. For most users, the common identity data is already embedded in a Revit model, and is based on a type property:
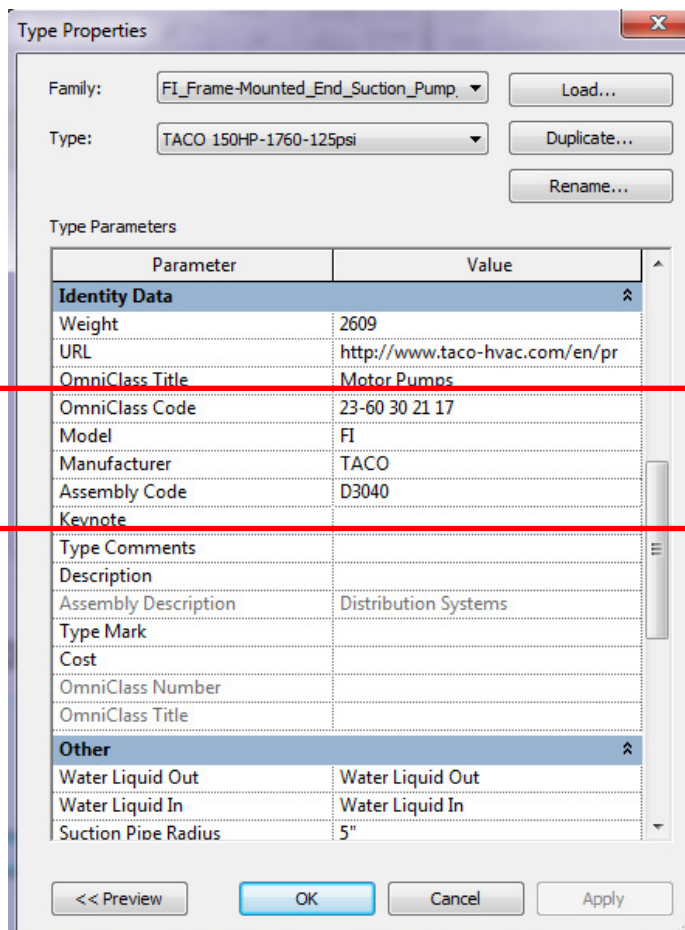
Since this is type based, we had to make sure that any exported data would be locked and editable only at a single location. Other information, such as the equipment tag, utilizes an instance mark value, so it can be unique to each piece of equipment. Potential data that is subject to change in either the Revit model or the P&ID diagram would be instance based.
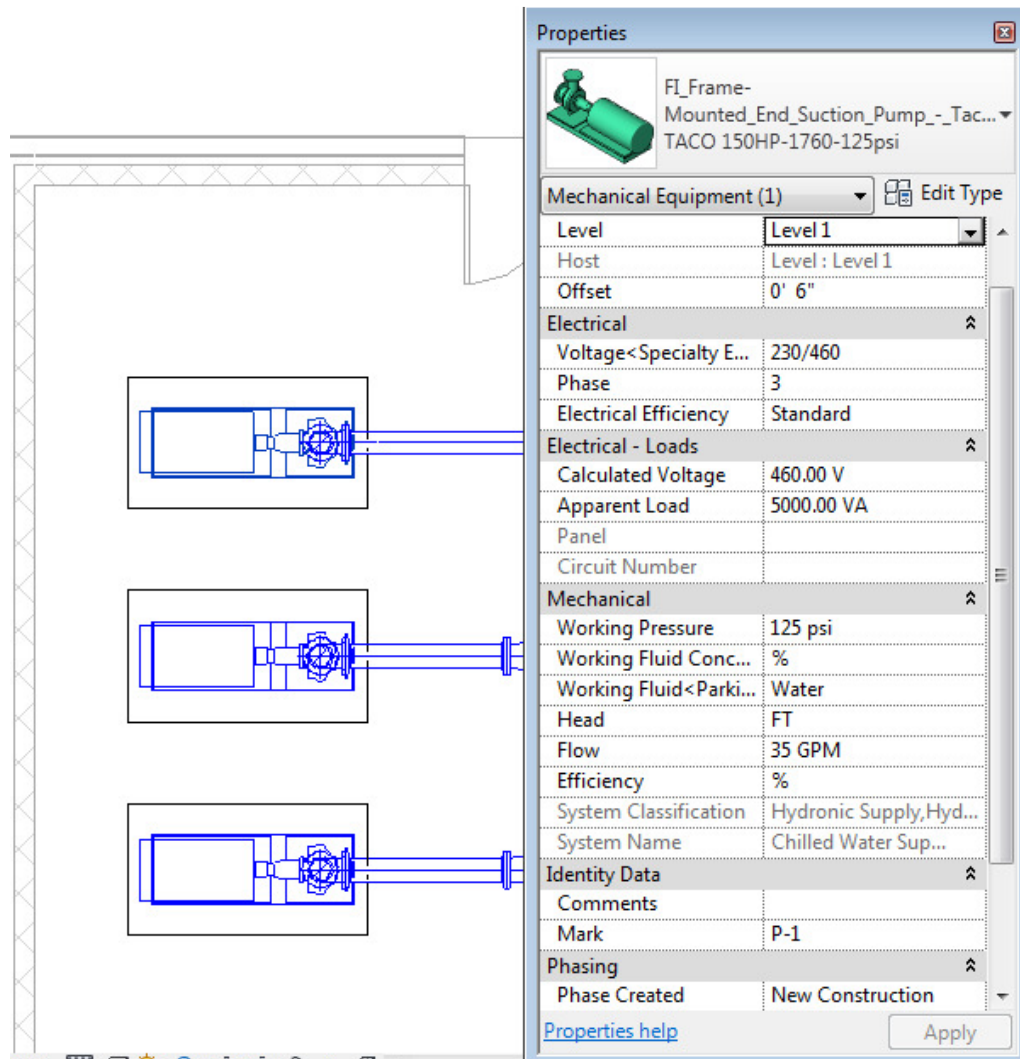

Additional data was added as a shared parameter to families, so that it would be available when needed for export.

Here's a tip – use the shared parameter exporter add-in that is available as a subscription tool. This lets you add the parameters to several families at once, assuring that they are all using the same GUID identifier.

Once the parameters were defined in Revit, the default project in AutoCAD P&ID should also bear the same properties. Naming convention for these items is critical – it's a good idea that the name of the parameter matches the properties and location for AutoCAD P&ID objects,

For example, an instance mark is defined at a class definition level, which is a top level in the data hierarchy of an AutoCAD P&ID project (similar to the instance mark in Revit). Since all equipment must have a mark, the property is defined at the engineering item category:
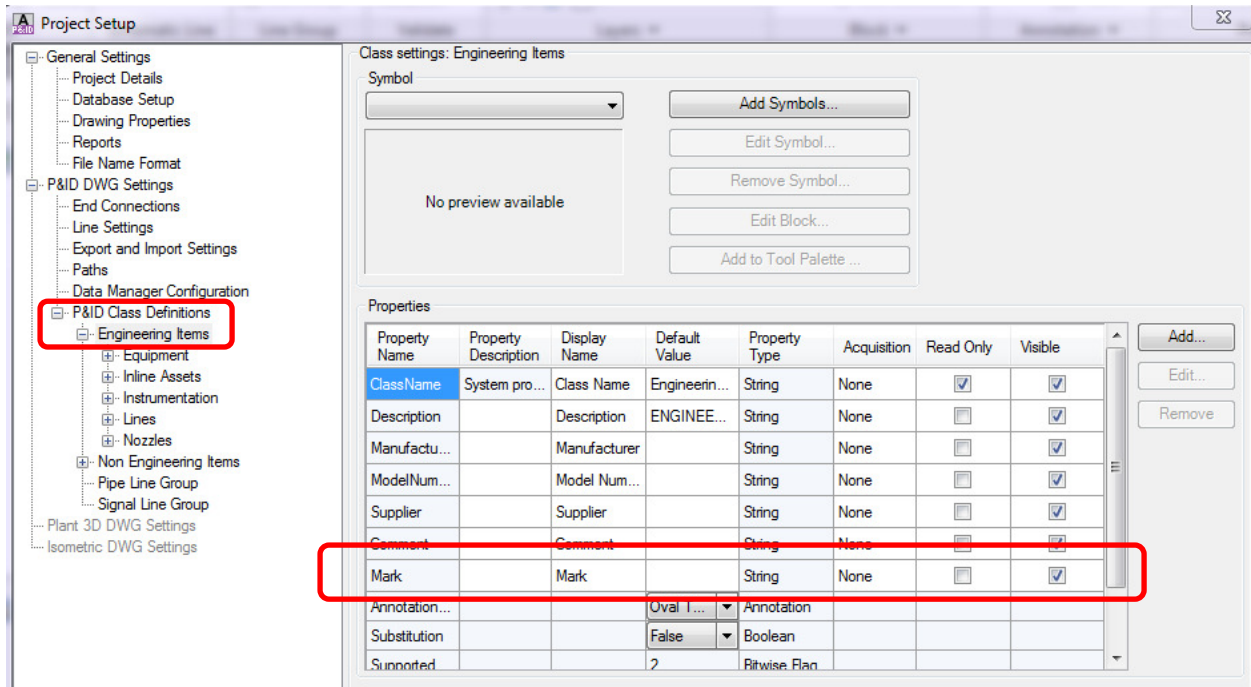

The property is then pushed to all sub-classes, but it still a unique property, all the way down to pump symbols in a project:
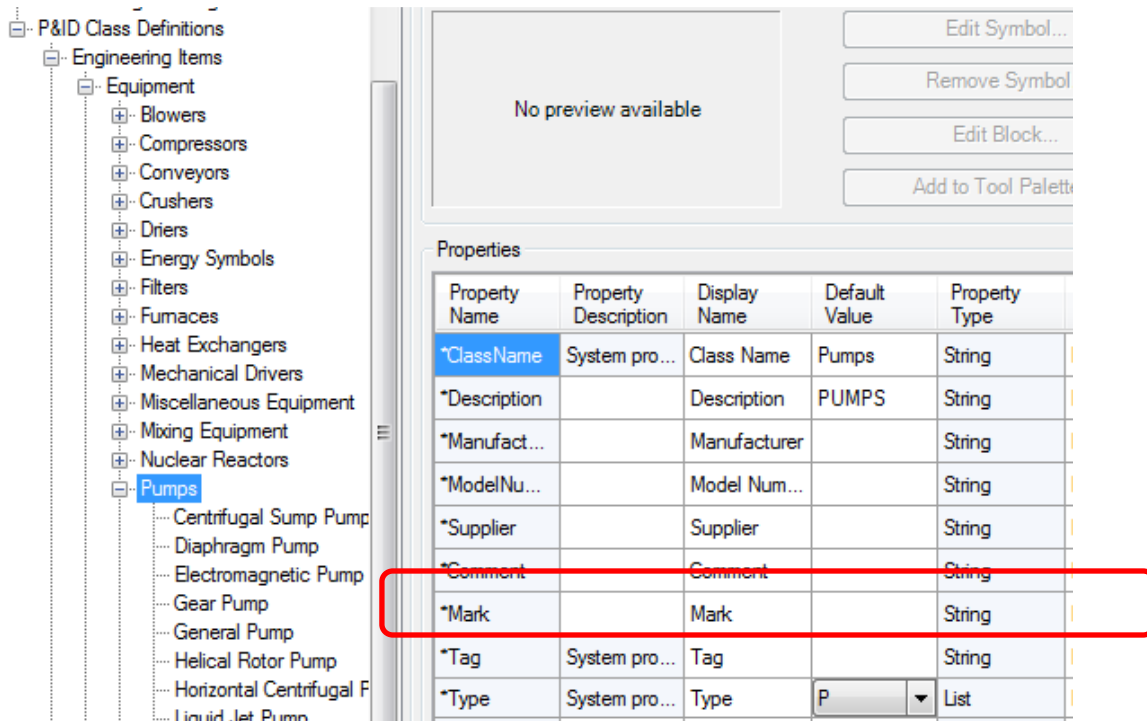
In order for the data sync to work correctly in this case, it's a best practice to make sure this exists in both areas before starting a project.

Understand the Shared Database

One big advantage to using both AutoCAD P&ID and Revit is their ability to communication with SQL databases, which is the primary database type we decided to use. AutoCAD P&ID is designed to work within a project environment. Each project has a link defined to one of two type types of databases:
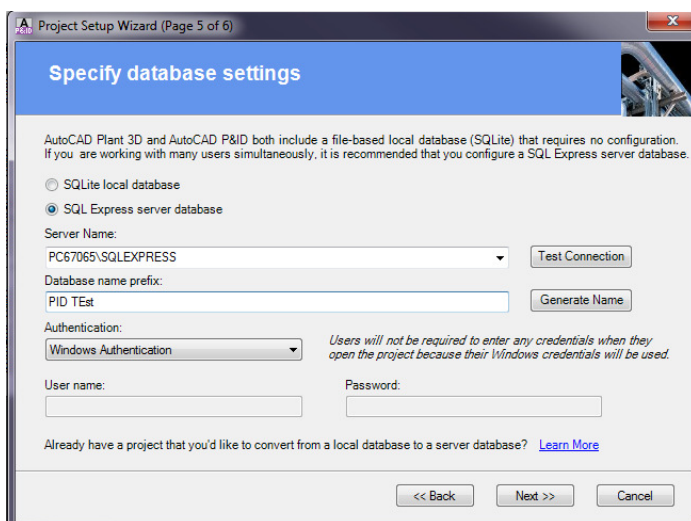
AutoCAD P&ID creates an automatic association to a SQL Database, in both the form of a local, "lite" database, which gets its data strictly from what you add to the project class properties. You can also set up to use SQL Express, which is required when more than one user is assigned to work on a project. The full SQL server or express server resides at the server level in a network, but access is limited. Users can only access the database via their Windows Authentication, or via the SQL authentication. As with Revit, the SQL Express software has to be installed prior to using this option.

The other side of the data coin is the Revit database. Autodesk release the Revit DB Link utility a few releases ago, and at first blush, it takes a little bit to get going. In our initial tests, this utility allows a user to create a connection to a SQL database directly, and create a bi-directional link. At first blush, it's seems pretty simple, but then there's the rub – it's not. The db Link represents a static point in time for a project. If you are continuing to work on the job, the database has to be exported again, which means the work process is inefficient. And with multiple users on a project, you can't use a local project database unless you're willing to let everyone in the company have access to your workstation.

While you can create links to more types of databases, these still have to be defined before you can create the link. From a layman's standpoint, you'd better have a couple of things straight.

1. Microsoft has three primary versions of SQL Express you can work with – 2005, 2008 and now, 2012. There are older versions, but the 2008 R2 release is the most common. The 2008 R2 release is the latest currently supported by Revit, as of this current date.
2. As with any other software package, SQL Express and the SQL Management Studio must be installed, in order for this to be used with Revit or AutoCAD P&ID. You have the option to install the database locally or on a network. After Express is installed, the management studio is used to create the local or server database:
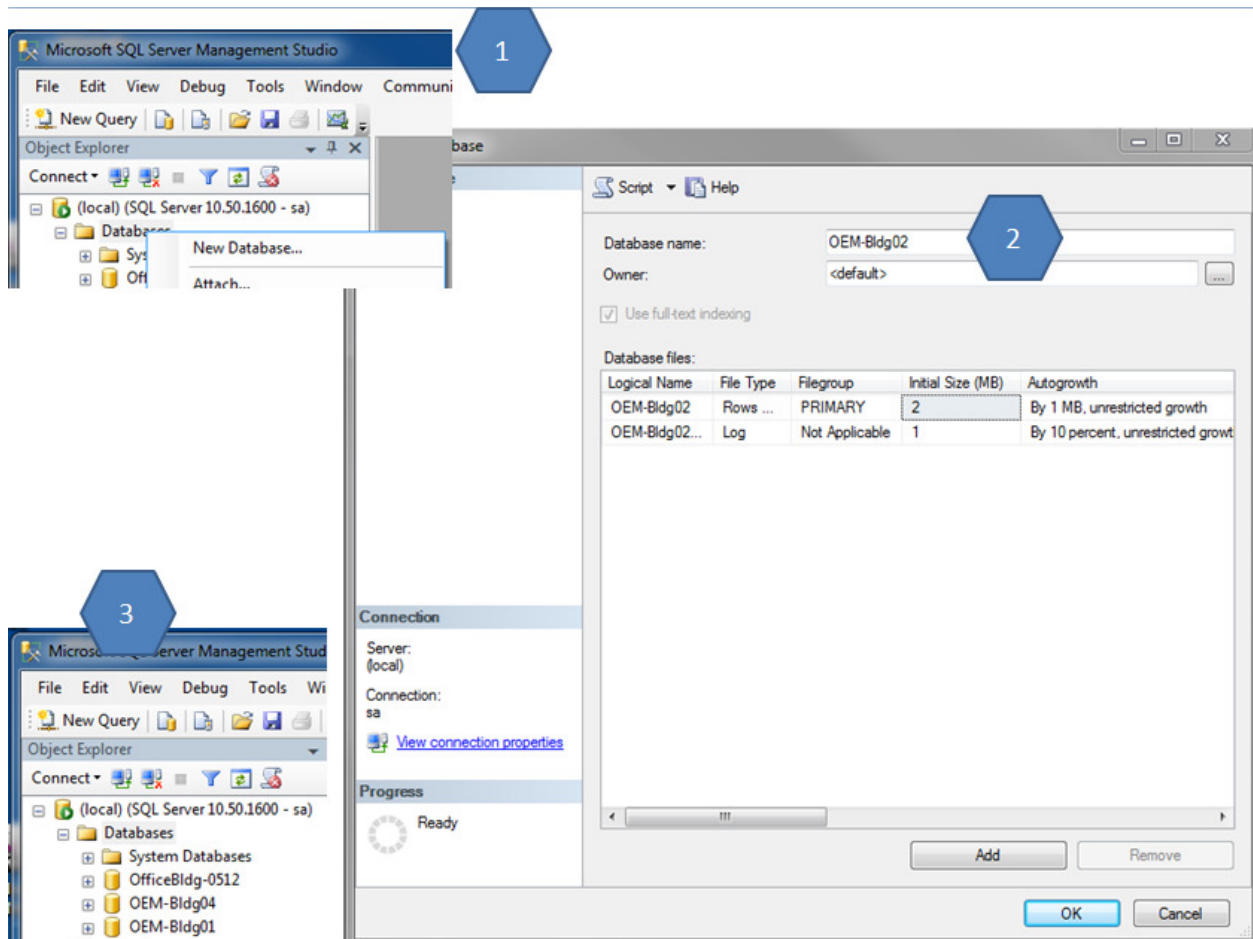
Note: Be aware that you must have full administrative rights to the computer where the database will be stored. I would recommend using Windows Authentication, since this use's a person's Windows login credentials to provide the shortest access.

3. Once the server database is defined as a named instance on your local hard drive, you can start Revit DB Link. In the application, you establish a link to your SQL database.

   For new projects, do this at the beginning of the project. Existing projects that have large amounts of data can take a long time to export.

4. You can create database links to Access or an ODBC database such as SQL. From the ODBC tab, start by selecting a new connection, and then choosing Export:
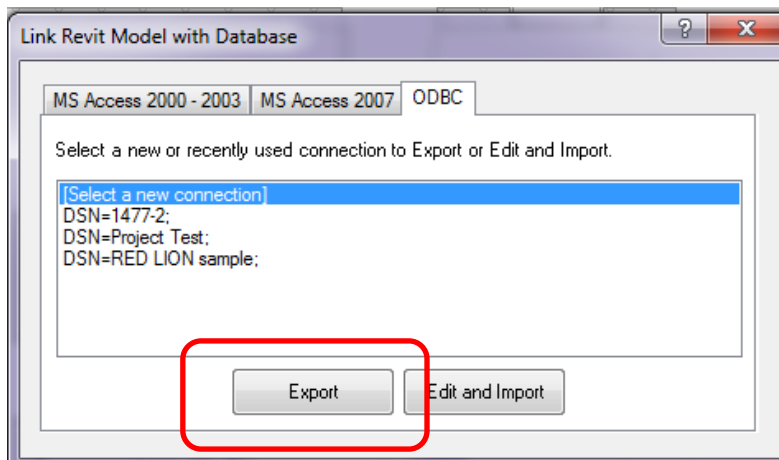
5. Once the export is started, there are two options – file data source, and machine data source. Since Machine data sources are specific to a machine, access is limited by the system or user. Servers are an example of a system wide machine, so if you are sharing data, this is the best option. You can select existing data sources such as the ones I have below, or create a new data source. For example, I would use existing data sources for multiple RVT files on one project. For a new project, select New:
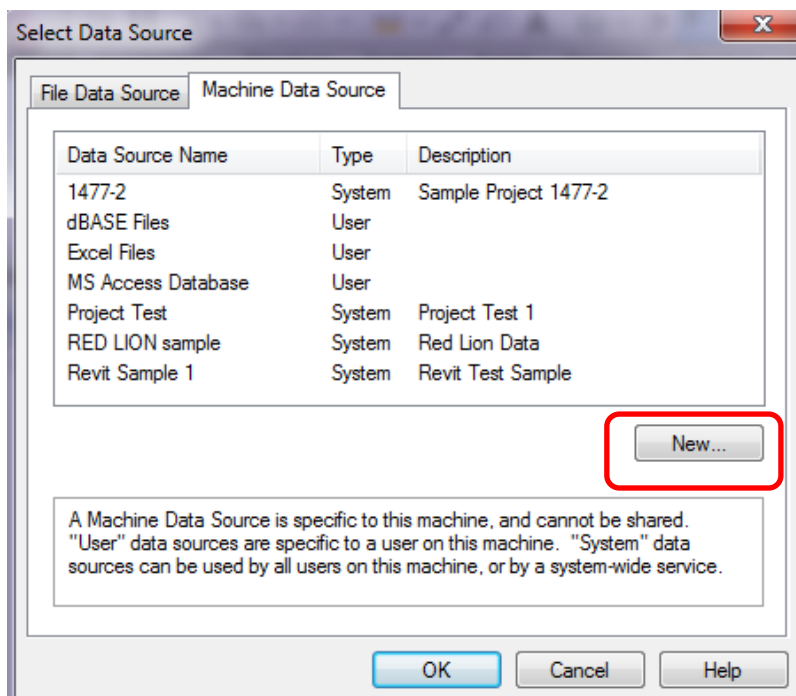
6. The sequence is a little backwards here, but the next dialog allows you to choose between the user and system data source. If the data is to be accessed by multiple users, pick the System option.
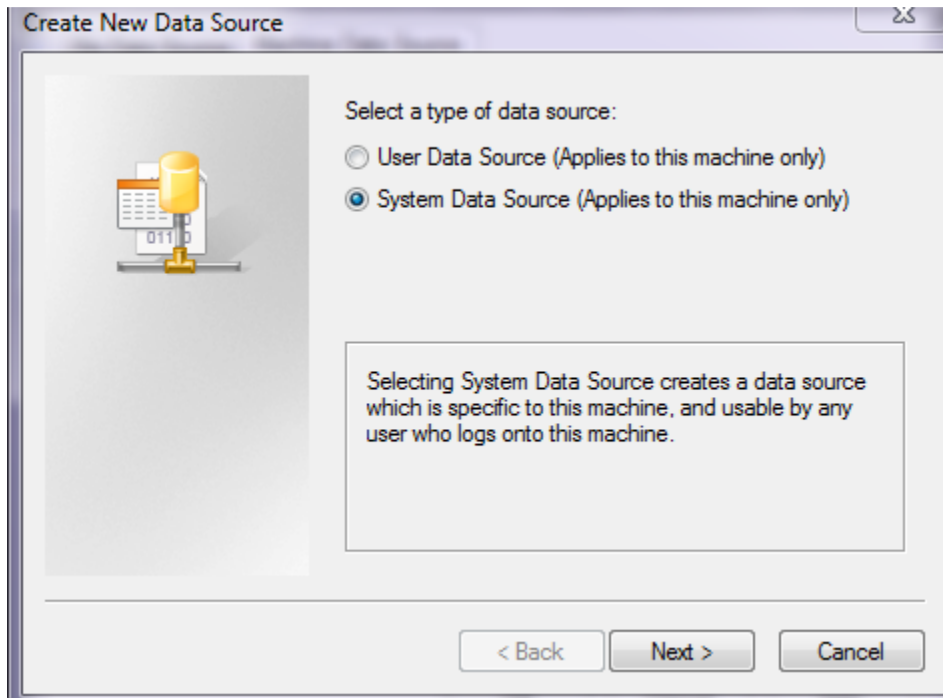
7. After selecting the source, select the database type – in our case, SQL Server:
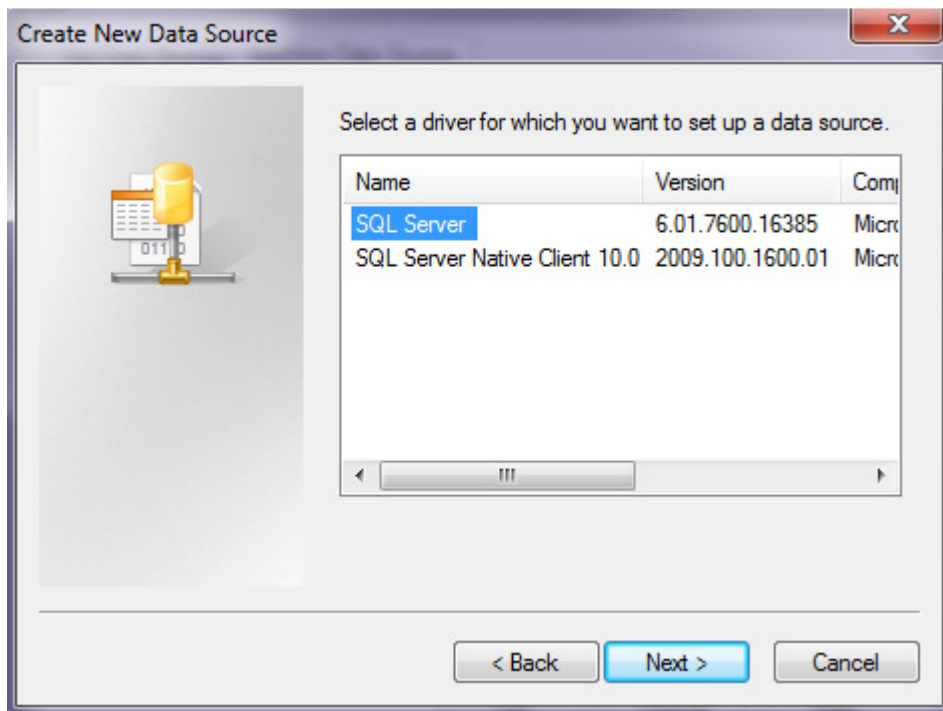
8. The last dialog in this step reviews the configuration – you can go back if needed to make changes. Otherwise, select Finish:
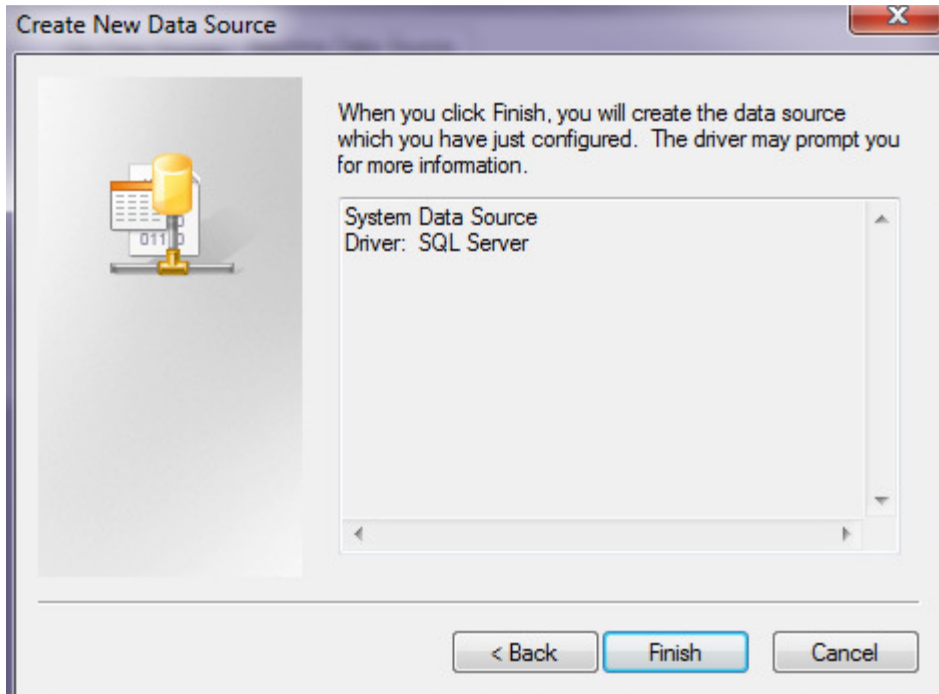
9. Next up is the data source wizard, which first lets you add a name and description to the specific database you are creating. You can also select the location of the SQL server. In this case, I defined the SQL database to reside on my computer:
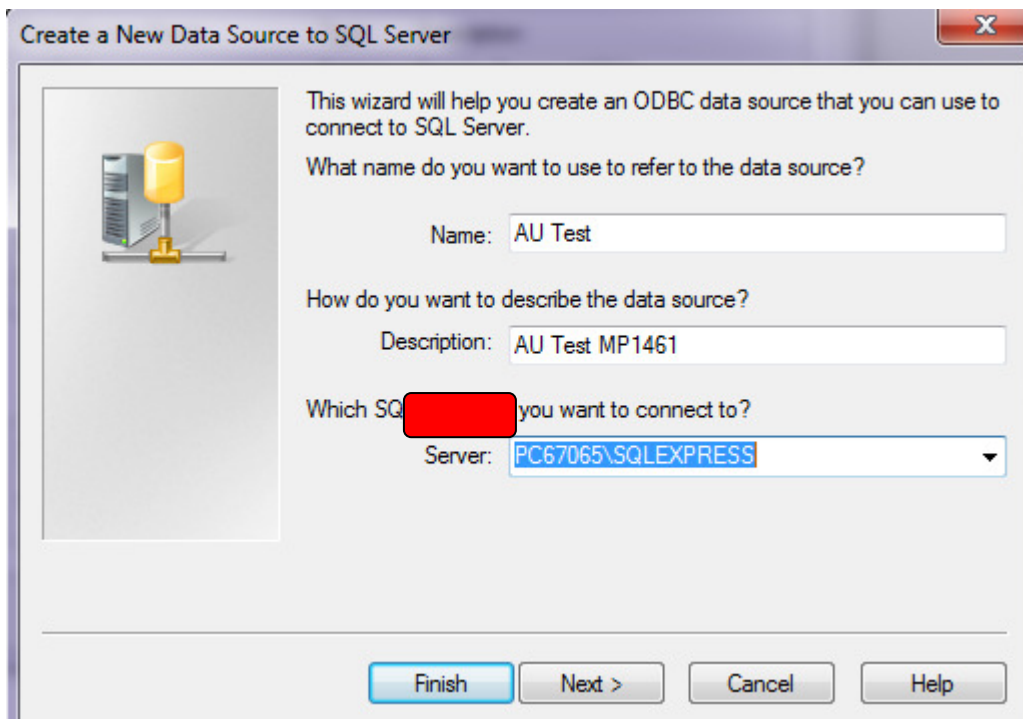
10. The following step lets you set up the login:
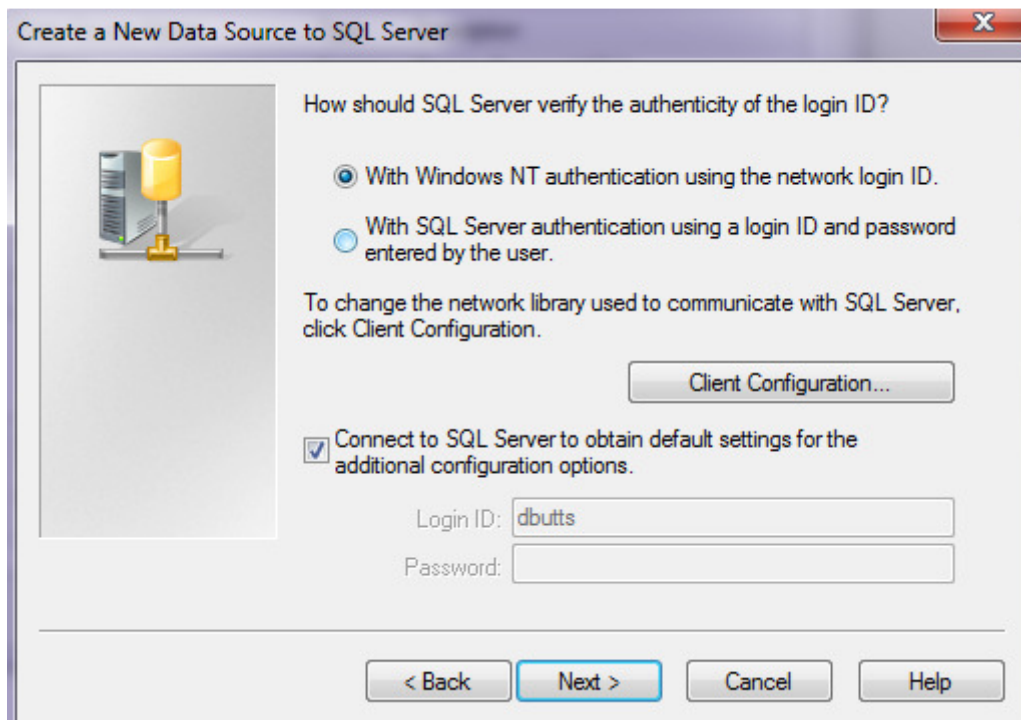
11. The third step lets you change the default database, attach a database filename, and define how identifiers, nulls, paddings and warnings are used:
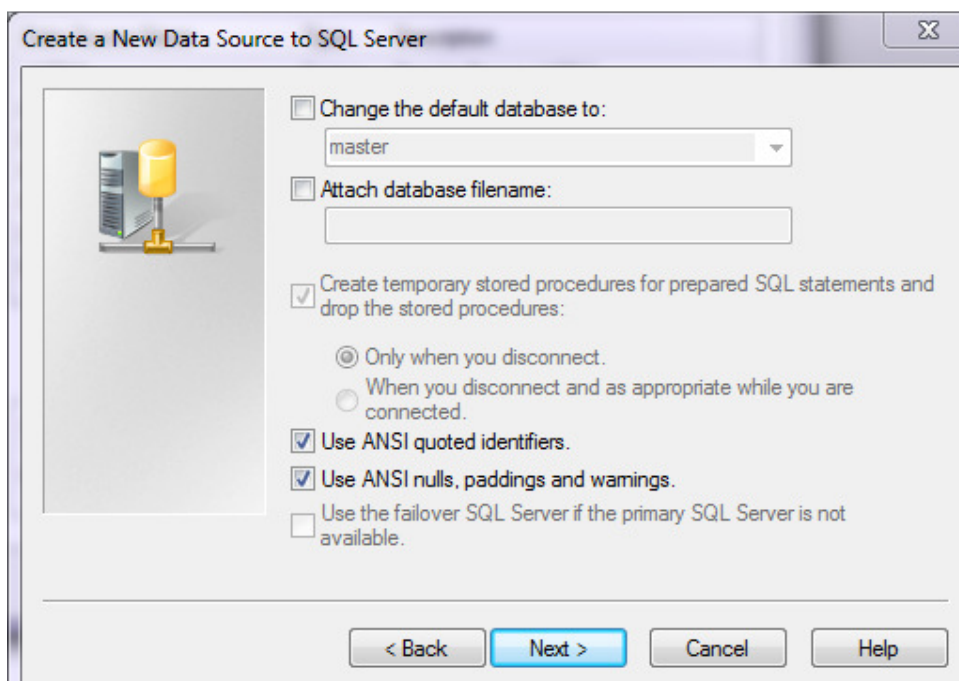
12. And the last step lets you set the language, encryption strength, character translations, regional settings and log files:
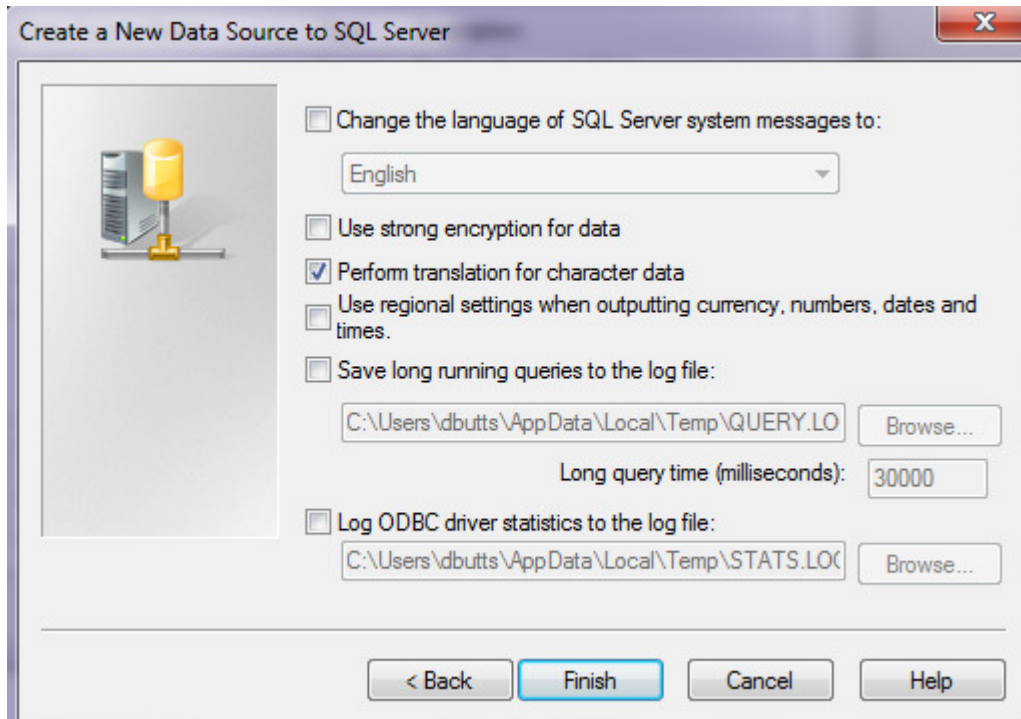
13. Once you've finish, you'll get a review dialog:
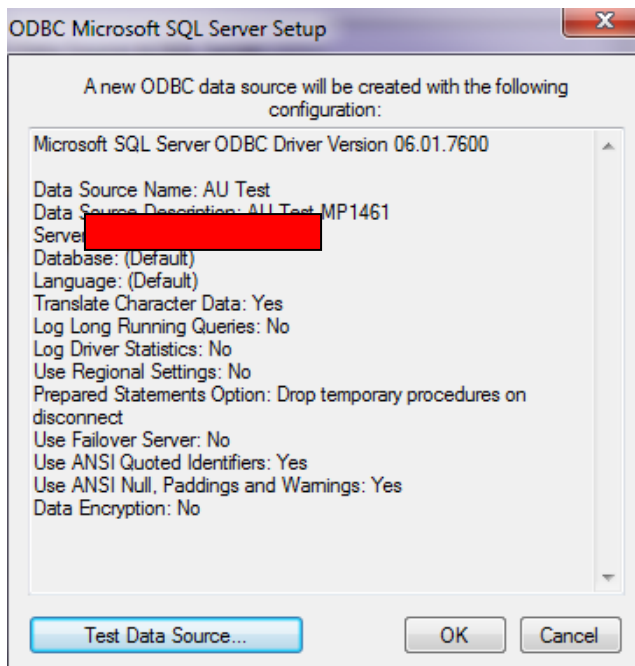
14. After selecting OK, the new database will appear in the machine data source list:
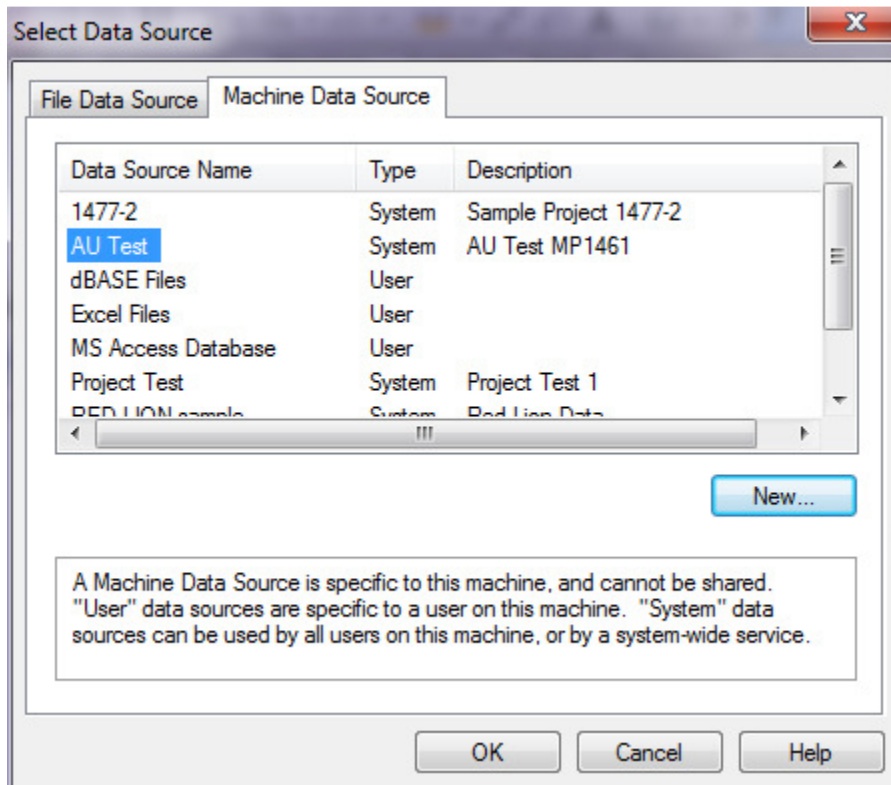
15. Select OK, and you've created your link. Revit will export ALL data from the model – architectural, structural and MEP object data, for instance and types.
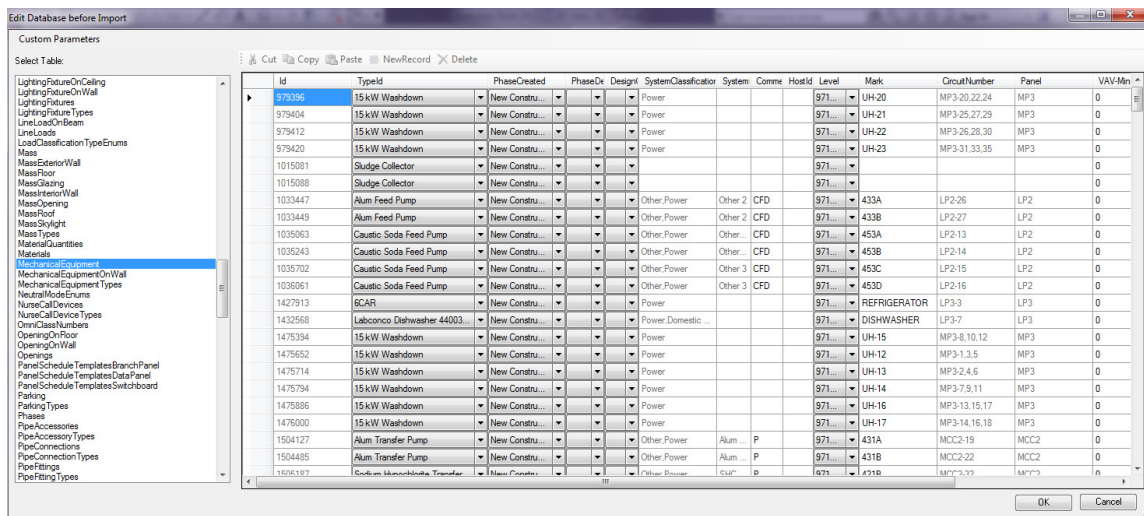
Revit runs through an initial export – once this is complete, you can use the edit and import features to review the data. One item I noticed right out of the box is that all data doesn't automatically flow from the project to the database, such as custom shared parameters

In order to share the data, it's not required to have the same names, but it is preferred. At certain points, we were looking at linking data by Revit element ID to AutoCAD handle, but found it wasn't necessary.

You can now go into the back of the house and do your programming to link the P&ID database to the Revit database.
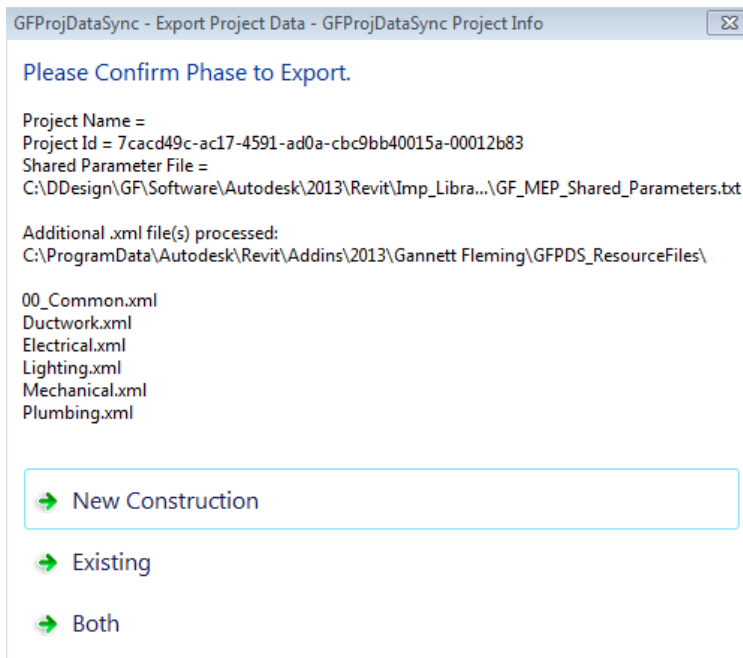
The GF Project Data Sync Application – Importing and Exporting Information

We had a few primary goals when we started developing our own in-house application. First we wanted to be able to export in some form of an Excel or CSV format, since it was something our engineers were familiar with. We also wanted the user having control over the specific data that needed to be exported and linked. In the first stages, we had reviewed other applications, but decided to do our own in house for several reasons:

- Intellectual property control – by owning the application, we could modify and expand based on our needs and the client's needs

- Cost control – by using in house resources, we can develop parts of code that could be used in other applications, reducing their future development costs

- Portability – while developing the programming for Revit, the common code items could also be structured for other BIM applications we might be required to use, such as Bentley BIM applications.

- Keeping it simple – for the Excel portions, we could alter the interface and other user features without having to depend on external developers to do the work.

So we developed the application that allows us to generate linked Excel files, which could also be used with old-fashioned OLE links to share the data. The data can also be locked, so that items in the Excel file could not be changed, if they needed to be only changed in the Revit model. An example of this would be an electrical connector's values, or circuiting information.
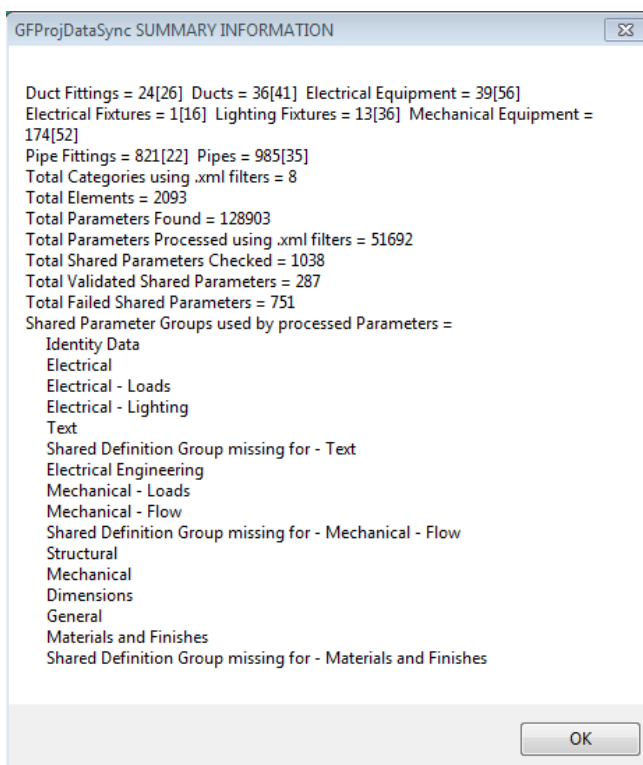
The application starts by showing critical information about the project, and allowing the user to select the phase. The application also looks at predefined XML databases of shared parameters, to make sure the project is compliant with corporate data formatting and standards:

GFProjDataSync - Export Project Data - GFProjDataSync Project Info

Please Confirm Phase to Export.

Project Name =
Project Id = 7cacd49c-ac17-4591-ad0a-cbc9bb40015a-00012b83
Shared Parameter File =
C:\DDesign\GF\Software\Autodesk\2013\Revit\Imp_Libra...\GF_MEP_Shared_Parameters.txt

Additional .xml file(s) processed:
C:\ProgramData\Autodesk\Revit\Addins\2013\Gannett Fleming\GFPDS_ResourceFiles\

00_Common.xml
Ductwork.xml
Electrical.xml
Lighting.xml
Mechanical.xml
Plumbing.xml

→ New Construction

→ Existing

→ Both

Gannett Fleming Project Data Sync Tool   *© Copyright Gannett Fleming 2013*

The tool also provides a summary of all the elements and parameters, as well as compares the parameters to a standards file for compliance:

GFProjDataSync SUMMARY INFORMATION

Duct Fittings = 24[26] Ducts = 36[41] Electrical Equipment = 39[56]
Electrical Fixtures = 1[16] Lighting Fixtures = 13[36] Mechanical Equipment = 174[52]
Pipe Fittings = 821[22] Pipes = 985[35]
Total Categories using .xml filters = 8
Total Elements = 2093
Total Parameters Found = 128903
Total Parameters Processed using .xml filters = 51692
Total Shared Parameters Checked = 1038
Total Validated Shared Parameters = 287
Total Failed Shared Parameters = 751
Shared Parameter Groups used by processed Parameters =
    Identity Data
    Electrical
    Electrical - Loads
    Electrical - Lighting
    Text
    Shared Definition Group missing for - Text
    Electrical Engineering
    Mechanical - Loads
    Mechanical - Flow
    Shared Definition Group missing for - Mechanical - Flow
    Structural
    Mechanical
    Dimensions
    General
    Materials and Finishes
    Shared Definition Group missing for - Materials and Finishes

OK

We didn't stop with a summary report, but also provided a log with information about the failure, and why it fails. Novel concept….

Once the review is complete, the user can choose what information they want to export. In this case, the XML databases list all default, project and shared parameters that allowed to be exported and sync's with our P&ID database. The user can also run the report again, selecting an existing spreadsheet, and updating the file:

We made sure that several key features were included:

- The Ability to lock cells and the entire sheet

- Workset Export for sorting

- Saved settings so that the same group of parameters could be reused, and expedite updates to existing spreadsheets

- Warnings for excessive missing parameters, along with email notifications to BIM leads and project managers

- Verification for import/export data that can be easily documented

The add-in for importing and exporting to Excel is current deployed and being used on variety of projects.

We're also currently working on two new applications that coincide with our data sync utility. The first is a common web portal that is used to input project equipment information for process and

water resource projects. The equipment for the job is added, along with specific parameter data that is used in Revit, AutoCAD P&ID or both applications.

BIM Validation Project Input

Project Name	GFPDS Test 1		Revit Project Location	\\gfcph03s\share\DIV-18\3D Information Modeling	...
Project Type			P&ID Project Folder	\\gfcph03s\share\DIV-18\3D Information Modeling	...
Project Number			Revit Project Data Source	GFPDS Test 1_$$$_7cacd49c-ac17-4591-ad0a-...	
Project Manager			P&ID Project Data Source	GFPDS-01Pnld	
Owner					
Project Address					

Name	Practice
Doe, John	Water Management
Smith, Jane	

Employee / Practice — Add User to Project

New Group Name — Add New Root Group / Add Sub-group to Selected Group

Site 1: Blowers, Pumps, Tanks
Site 2: Blowers

Rotary Blower - Enclosed
Base Mounted Pump #1 - 6x4 - 600 GPM
Base Mounted Pump #2 - 6x4 - 600 GPM
6000 Gallon Bulk Storage Tank

Primary Category	Mechanical Equipment
Sub Category	Blowers
Equipment Description	Rotary Blower - Enclosed

Add to Project

Mark/Tag	Manufacturer	Model	Voltage	Apparent Load	Hertz	Number of Poles
B-100	Cyclo	11391	480	0.00	0.00	3
P-100	Flygt	BR-549	480	37285	60.00	3
P-101	Flygt	BR-549	480	37285.00	0.00	3
TK-100			N/A			

The second part of the application is data verification, where we compare both databases. This information is useful to the BIM lead and project team in the sense that doesn't just look for conflicts between physical objects, but conflicts with associated parts.

GFPDS Test 1

Equipment Item	Parameter Name	Parameter Value	Override
Rotary Blower - Enclosed B-200	[GFBVS].[Mark]	B-200	
	[REVIT].[Mark]	B-200	
	[P&ID].[Tag]	B-200	
Rotary Blower - Enclosed B-200	[GFBVS].[Model]	undefined	
	[REVIT].[Model]	undefined	
	[P&ID].[ModelNumber]		
Rotary Blower - Enclosed B-200	[GFBVS].[Number of Poles]	3	Override
	[REVIT].[Number of Poles]	2	
	[P&ID].[NumberofPoles]	NULL	
Rotary Blower - Enclosed B-200	[GFBVS].[Voltage]	480.00	
	[REVIT].[Voltage]	480.00	
	[P&ID].[Voltage]	480	
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Apparent Load]	37285.00	Override
	[REVIT].[Apparent Load]	30000.00	
	[P&ID].[ApparentLoad]		
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Hertz]	60.00	Override
	[REVIT].[Hertz]	120	
	[P&ID].[Hertz]		
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Manufacturer]	Flygt	
	[REVIT].[Manufacturer]	Flygt	
	[P&ID].[Manufacturer]	Flygt	
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Mark]	P-100	
	[REVIT].[Mark]	P-100	
	[P&ID].[Tag]	P-100	
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Model]	BR-549	
	[REVIT].[Model]	BR-549	
	[P&ID].[ModelNumber]	BR-549	
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Number of Poles]	3	Override
	[REVIT].[Number of Poles]	2	
	[P&ID].[NumberofPoles]	NULL	
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Voltage]	480.00	
	[REVIT].[Voltage]	480.00	
	[P&ID].[Voltage]	480	
Base Mounted Pump - 6x4 - 600 GPM P-101	[GFBVS].[Apparent Load]	37285.00	Override
	[REVIT].[Apparent Load]	37285.00	
	[P&ID].[ApparentLoad]		
Base Mounted Pump - 6x4 - 600	[GFBVS].[Hertz]	60.00	

Once the data analysis is complete, the corrections are verified by the application. This tool helps us track where conflicts occur between data in a model, and data in a diagram.

GFPDS Test 1

Equipment Item	Parameter Name	Parameter Value	Override
Rotary Blower - Enclosed B-200	[GFBVS].[Mark]	B-200	
	[REVIT].[Mark]	B-200	
	[P&ID].[Tag]	B-200	
Rotary Blower - Enclosed B-200	[GFBVS].[Model]	undefined	
	[REVIT].[Model]	undefined	
	[P&ID].[ModelNumber]		
Rotary Blower - Enclosed B-200	[GFBVS].[Number of Poles]	3	
	[REVIT].[Number of Poles]	3	
	[P&ID].[NumberofPoles]	3	
Rotary Blower - Enclosed B-200	[GFBVS].[Voltage]	480.00	
	[REVIT].[Voltage]	480.00	
	[P&ID].[Voltage]	480	
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Apparent Load]	37285.00	
	[REVIT].[Apparent Load]	37285.00	
	[P&ID].[ApparentLoad]	37285	
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Hertz]	60.00	
	[REVIT].[Hertz]	60.00	
	[P&ID].[Hertz]	60	
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Manufacturer]	Flygt	
	[REVIT].[Manufacturer]	Flygt	
	[P&ID].[Manufacturer]	Flygt	
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Mark]	P-100	
	[REVIT].[Mark]	P-100	
	[P&ID].[Tag]	P-100	
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Model]	BR-549	
	[REVIT].[Model]	BR-549	
	[P&ID].[ModelNumber]	BR-549	
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Number of Poles]	3	Override
	[REVIT].[Number of Poles]	3	
	[P&ID].[NumberofPoles]	NULL	
Base Mounted Pump - 6x4 - 600 GPM P-100	[GFBVS].[Voltage]	480.00	
	[REVIT].[Voltage]	480.00	
	[P&ID].[Voltage]	480	
Base Mounted Pump - 6x4 - 600 GPM P-101	[GFBVS].[Apparent Load]	37285.00	Override
	[REVIT].[Apparent Load]	37285.00	
	[P&ID].[ApparentLoad]		
Base Mounted Pump - 6x4 - 600	[GFBVS].[Hertz]	60.00	

All of these tools are geared towards helping our offices in different regions create a more comprehensive and coordinate set of documents, beyond just the sheets. It looks at all forms of critical data, and helps us make sure that we're consistent in our approach.

Conclusion

So you've had a chance to learn how we approached using Revit for our process and water resource projects, to share information in a more consistent manner, cut down on errors and omissions, creating a higher quality set of construction documents. You've also gotten a glimpse of how we're trying to stay outside of the box to help us meet our goals. For more tips and trick, refer to my blog, The MEP CAD Engineer, at http://mep-cad.blogspot.com.

Thanks for attending!