BES323259

Engineering with a Fabrication Database in a Revit Case Study

Craig Chappell
VDC Technology Specialist
TDIndustries, Inc.

Lyle Janda
VDC Technology Manager
TDIndustries, Inc.

Jacob Featherston
Mechanical Designer I
TDIndustries, Inc.

Learning Objectives

- Discover how to use Fabrication Parts during the design scope
- Explore best practices to add value for engineering, estimating, and VDC
- Discover tips for converting Revit Families to Fabrication Items
- Learn how to solve methods that create hurdles for estimating and VDC partners

Description

This talk will focus on a case study using a common Fabrication database in Revit software for engineering through a Design Build project. With an effort to vertically align Engineering, Estimating, Virtual Design and Construction (VDC), and Manufacturing on a common platform, it was important to use the same common database. It was also necessary to determine the hurdles involved in adapting engineering workflows to use Fabrication ITMs and how we were able to resolve them. To learn to determine when it's best to use Revit Families, and when it's best to convert Families to ITMs. This class is not meant to be a definitive explanation of the right methods, but a look at the methods "we" used to accomplish the task. There may be terms and/or phrases that are not recognized early in this document. However, they will be defined as you move though the text.

Speakers

Craig Chappell is the VDC Technology Specialist for TDIndustries in Dallas, Texas. His role at TD includes working with Partners to advance the Engineering and VDC teams and help them learn how to work more intelligently and efficiently. He is currently an associate faculty member at Collin College in the Computer-Aided Drafting and Design Department and serves on their Faculty Advisory Board.

Lyle Janda is the VDC Technology Manager at TDIndustries. He has extensive experiencing in implementing, installing, training and supporting Autodesk Fabrication products. Lyle previously worked as a Technical Adviser for an Autodesk Platinum Partner.

Jacob Featherston started in the field as a pipefitter/welder for 6 years and since starting at TD 15 years ago has moved into the engineering department as a mechanical designer. Along with design responsibilities, he assists with Autodesk/Revit training and maintaining Autodesk/Revit standards and templates within the engineering group.

Table of Contents

What is the why?

TDIndustries was awarded a large Design-Build project that provided many opportunities to explore new ideas and workflows. A major challenge from our leadership was to develop and produce one Revit model facilitating Engineering and VDC scopes. This model would also be used by our Estimating group to establish cost using ESTmep. The product was to consist of shop drawings and spools sent to our Manufacturing shop for Pre-fabrication that will then be sent to the jobsite.

The goal of this challenge was to gain knowledge while working jointly with Engineering and our VDC Partners, moving through our workflows and to get a better understanding on how our Fabrication Database would perform in Revit.

The Ask

Can we develop an efficient workflow for a Design-Build project using one Revit model that will facilitate Engineering design workflows and VDC Coordination while supporting Estimating and Shop Fabrication scope?

What are some of the potential impacts?

There were numerous discussions held to discover potential hurdles and solutions to the project workflow before they even happened.

TDEngineering does not design every project that our Construction teams work on. There are still projects that utilize an external Engineer of Record where we only bid on the construction scope. This means we must consider both Design-Build and Plan & Spec concepts in our discussions. For the purpose of this one project, we were able to use the of Design-Build model which allowed our Coordinators and Construction Partners to be involved in some of the important design decisions very early on.

With the current technology abilities, a major focus in our discussions surrounded around, when we would convert from Revit Families to Fabrication ITMs, if at all. We even discussed remaining with Families or beginning with ITMs.

There were still some project milestones that needed to be met, even though we were attempting to provide a quality product to our client using new workflows. The Engineering Team still had to produce progress models throughout the design phase and submit Construction Documents (CD), sometimes called the “Permit Set” issued to the city for approval. Project Coordination would be ramping up at this point, so we had to develop a process to accommodate the needs of each group.

Utilizing one model also allowed us to be much tighter on model standards that had previously been more relaxed between groups working in separate models or platforms.

Discover how to use Fabrication Parts during the design scope

Definitions

For the purpose of our conversation, we will try to define certain words that may have different use or function at various companies.

Families – Revit Families are modeled content that is native to Revit and developed to support basic geometry and facilitate system performance.

ITMs – Fabrication ITMs are modeled content that is native to Fabrication and developed to represent true construction properties. ITMs may also be referred to as Fabrication Parts.

VDC Coordinator – Trade specialist focused on producing clash free shop drawings for construction. May also be referred to as a Detailer.

Partners – All Employees at TDIndustries are called Partners. As an Employee owned company with an ESOP program, we are accountable to each other for the success of the company.

Design Build

The nature of this project being a Design Build gave us the ability to work together across departments from Engineering, VDC as well as Estimating. Engineering was able to leverage the expertise of our Partners in Estimating and VDC to provide feedback on construction layout and cost.

When to Convert?

The final goal is to provide to our shop, coordinated spool drawings in Revit using ITMs. Through that process we still needed to develop Engineering Construction Document drawings for Permit Set. This meant that we were going to either start initially in ITMs or convert to them at some point.

Starting in ITMs was not ideal because our Engineering Partners did not have strong expertise with fabrication ITMs overall. ITMs also do not carry flow information that is used in our design workflows with Families. This made it undesirable to use ITMs initially. There are then 3 points in the design process in which the conversion can take place, as follows

Schematic Design (SD) phase: There is not much “known” information in the project regarding which systems the client wants to use or major system layout information. Many systems and specifications are still being discussed. Not much is modeled to this point, so a conversion would not be ideal. At this point it’s too early.

Construction Document (CD), a.k.a. Permit Set phase: When preparing the documents, a lot of work goes into creating final drawings with regards to annotations and documentation. Converting

after the issued Permit Set would cause all the annotation work using Revit Family Tags to be lost. At this point, it's too late.

Design Development (DD) phase: Most information is now known about the types of systems to be created along with major routing. The modeling is in the early stages with most of the systems roughed in and with little annotations created. This is the SWEET SPOT.

After much discussion, it was decided that we'd model with Revit Families through the DD phase and then begin to convert to Fabrication ITMs any Sheetmetal, Piping or Plumbing components that could be converted. Due to limitations using Fabrication in Revit, any purchased components would not be converted. This included Flex Duct, Flex Pipe, Mechanical Equipment and Plumbing Fixtures.

After the DD set was issued, VDC Coordinators began supporting the Engineering teams and provided guidance on conversion and basic coordination and constructability. It was not necessary to fully coordinate the systems yet, which was a little out of character for our VDC Partners.

THE ENGINEERING TEAM WAS DIVIDED INTO FOUR GROUPS TO REPRESENT SHEET METAL, MECHANICAL PIPING, PLUMBING AND MODEL MANAGEMENT. THIS ALIGNED WITH OUR VDC PARTNERS, SO THAT EACH TRADE COULD BE ASSIGNED TO A SPECIFIC VDC COORDINATOR

As Design layouts began to be more formalized, the routing was also being coordinated with other trades as best as possible. Design decisions were still evolving, so there was little value to focusing strictly on coordination.

In the final days before issuing Construction Documents, there was a command for "Pencils Down!" with our VDC Coordinators to stop converting Families to ITMs. This allowed the Engineering team time to finalize the Sheets and any required annotations to complete the drawings. Coordinators did assist but were instructed not to convert any Families or worry about coordination edits.

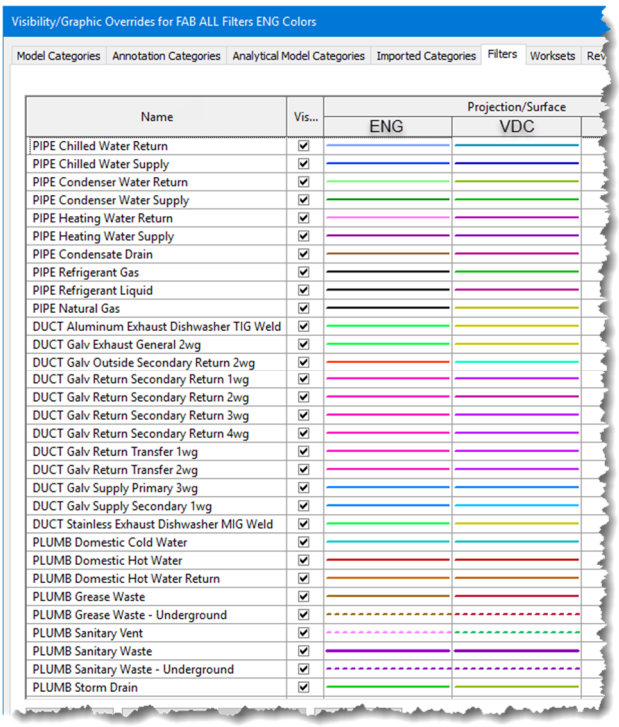
Most Engineering Partners were comfortable working in Revit, but new to Fabrication. The VDC Partners were comfortable utilizing a Fabrication database from CADmep, but new to the canvas of Revit. The teams worked jointly to mentor each other. We were able to support each other and keep a productive pace in the project.

The Engineering team was divided into four groups to represent Sheet metal, Mechanical Piping, Plumbing and Model Management. This aligned with our VDC Partners, so that each trade could be assigned to a specific VDC Coordinator for the remainder of the Design phase and then continue through the Coordination phase.

A company-wide database is managed by a team and its use was introduced into the Revit model. This common platform is working towards developing modeled content that can be used by Engineering, Estimating, VDC and ultimately Manufacturing.

Best practices to add value for Engineering, Estimating, and VDC

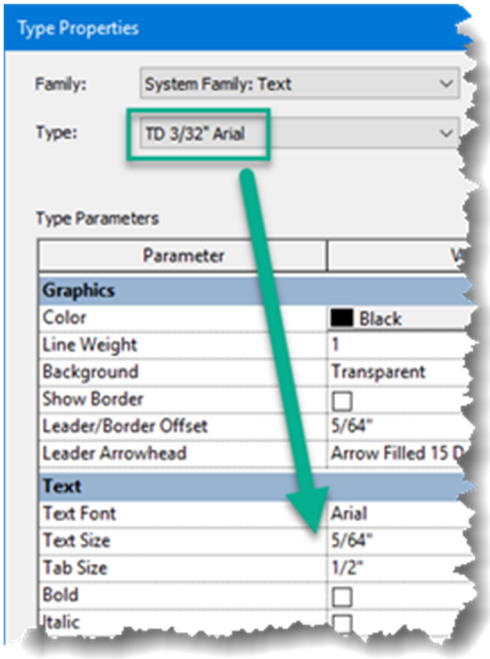
CAD Standards



It may or may not be a shock that different units within the same company were using slightly different color standards to represent systems. That is in large part because each separate team had not been sharing modeled content before now. Engineering had been modeling in Revit and producing PDFs for Estimating to take off manually. Our Estimators have upgraded to using ESTmep and now develop cost from models. The VDC group had been working in AutoCAD CADmep with the Fabrication Database. Any Revit content was simply exported for use as backgrounds.

The various teams had been working in silos with no overlap of work. With the teams working in new platforms that allowed for sharing modeled content, there was now the possibility to support each other. This Design Build project was incentive to find common ground and work even closer together.

With the push to develop one model for all groups, there were discussions on how to accommodate each other's needs. Representatives of each group met together to discover and discuss what CAD standards deviated and how we would develop one common standard.

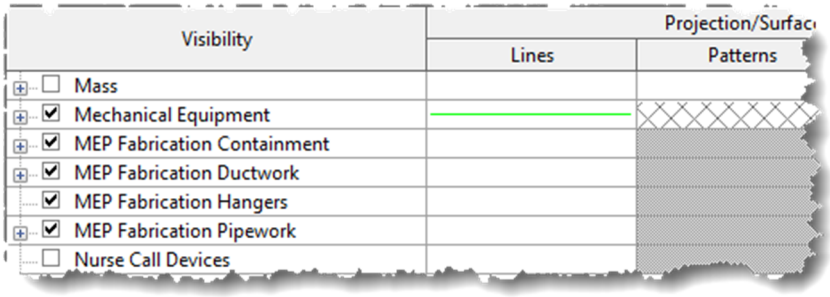


System colors were close, but there were numerous settings that deviated and would cause confusion when Partners from different units were involved. Engineering decided to simply adopt the VDC color systems. We developed View Templates for both standards of system coloring, but the VDC colors would be the dominate setting for views. The primary reason for this adoption was to assist the VDC coordinators who would be working in the Design phases of the project assisting the Engineering scope.

Another easy compromise was our common text font and size. Engineering was using Arial at 3/32" and VDC was using RomanS at 5/64" in CADmep. VDC understood the importance of Arial when working in Revit. Engineering could see that a slightly smaller font size provided more room in the plans. So, the compromise was for the project to utilize Arial at 5/64" across the model. In order to update all the Engineering View Templates in use, we simply changed the Arial 3/32" properties down to 5/64". It also tricked our designers into thinking that nothing changed in our Engineering setup.

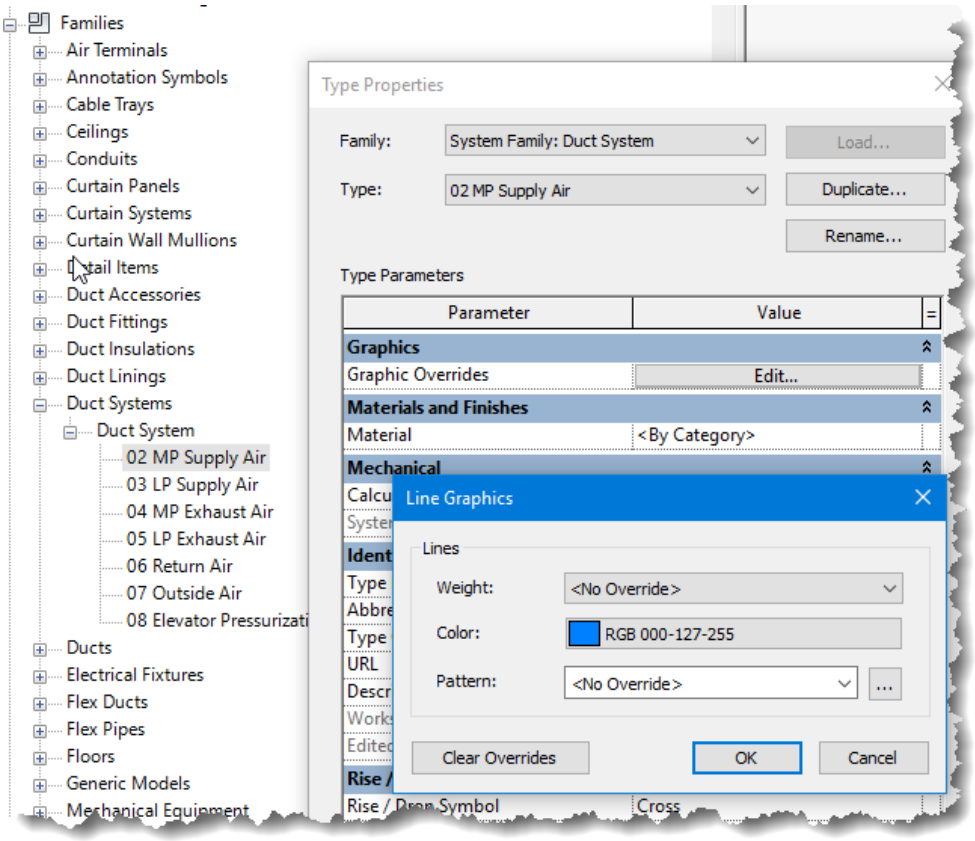
Visibility Graphics

Some standards were not going to be as easy to adjust and would require updates to the Visibility Graphics settings. This was mostly a result of mixed use of Revit Families and Fabrication ITMs throughout the model. Families and ITMs are controlled by different categories.



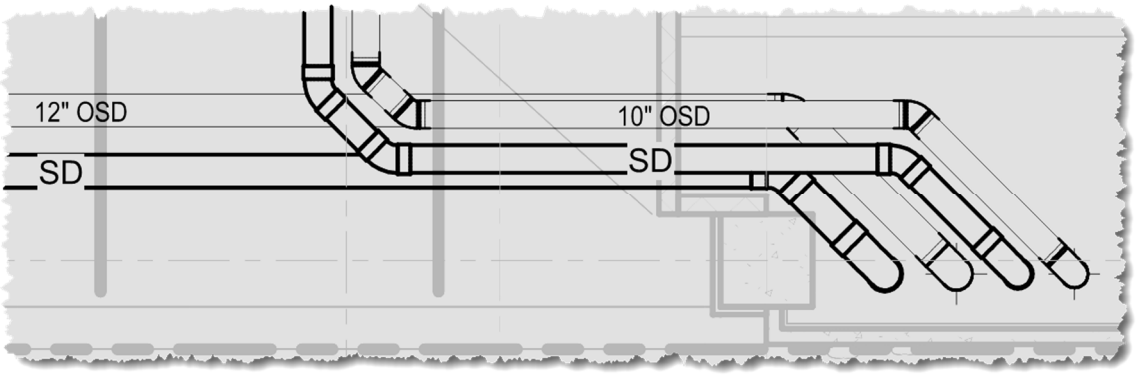
Revit Families are governed by different Model Categories than Fabrication ITMs. All View Templates had to be updated to accommodate the use of both in any view.

Revit Families colored by system can be manipulated using the Graphic Overrides of Duct and Piping System properties globally in the model. Fabrication ITMs are not governed by this same system property. ITMs can only be recolored using Filters in Visibility Graphics. View Templates were developed to provide standard system colors for ITMs based on Database Services that matched the system colors of the Families by their System assignment.

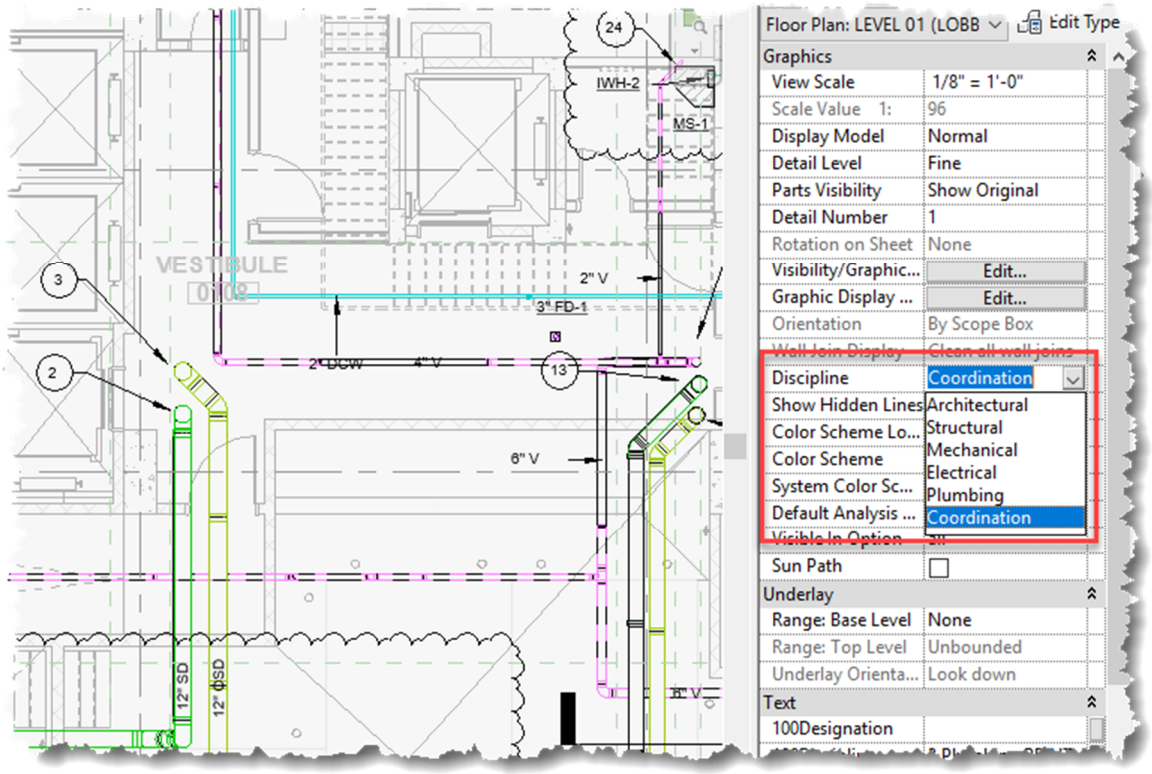


Visual Style is impacted simply because ITMs are not able to show as single line in Coarse mode. Depending on the complexity of the drawing, the Plumbing may have been shown in Coarse mode. With ITMs and Families viewed together, the decision was made to have all views set to Fine for Visual Style.

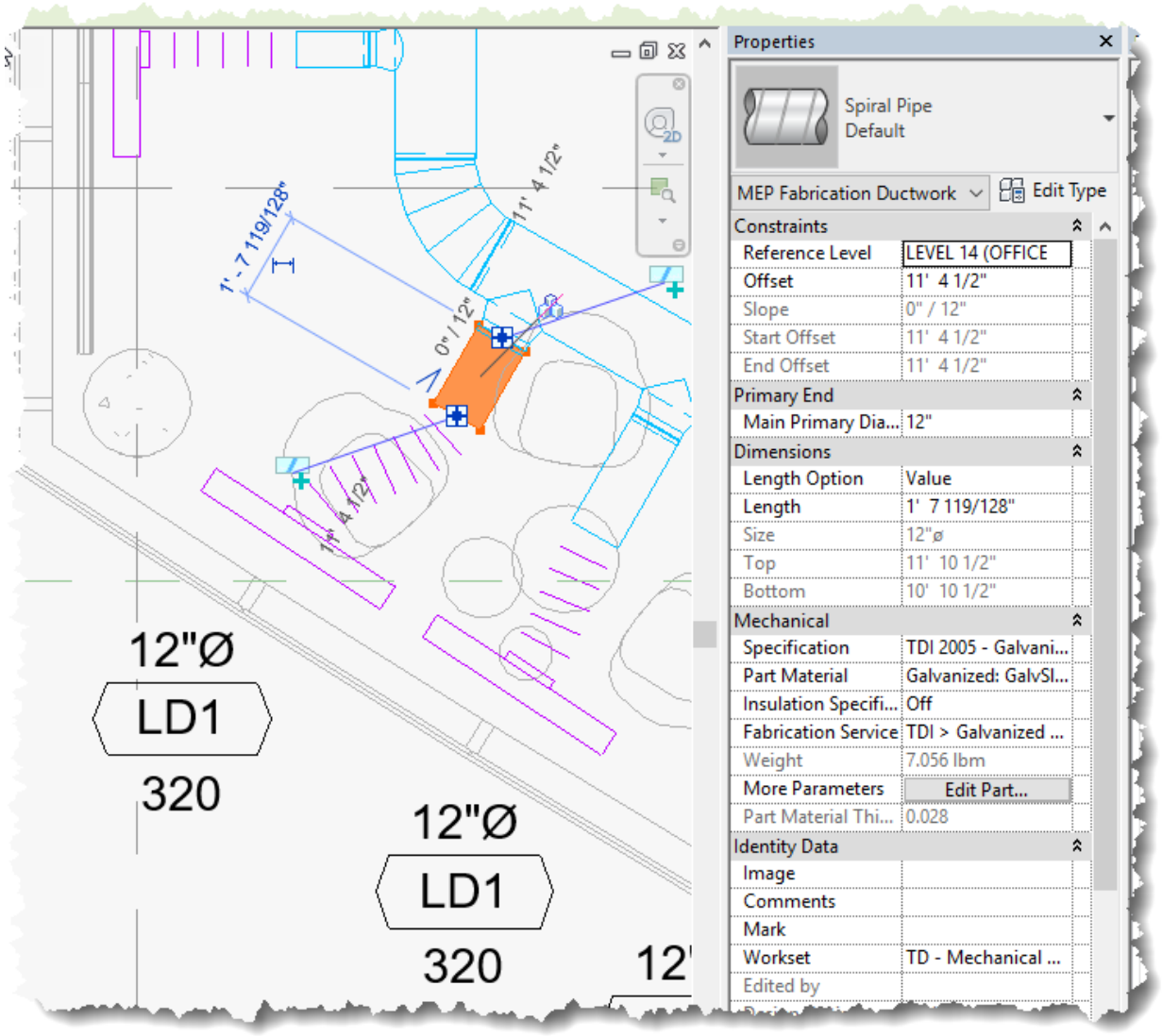
Line Weights are also governed separately between Families and ITMs. One discovery was the affect the View Discipline Setting had on these Line Weights.



With Revit Families, the Plumbing drawings preferred to use the Coordination Discipline setting. This caused Line Weight issues among other factors and Plumbing became the standard setting for our view Discipline setting.

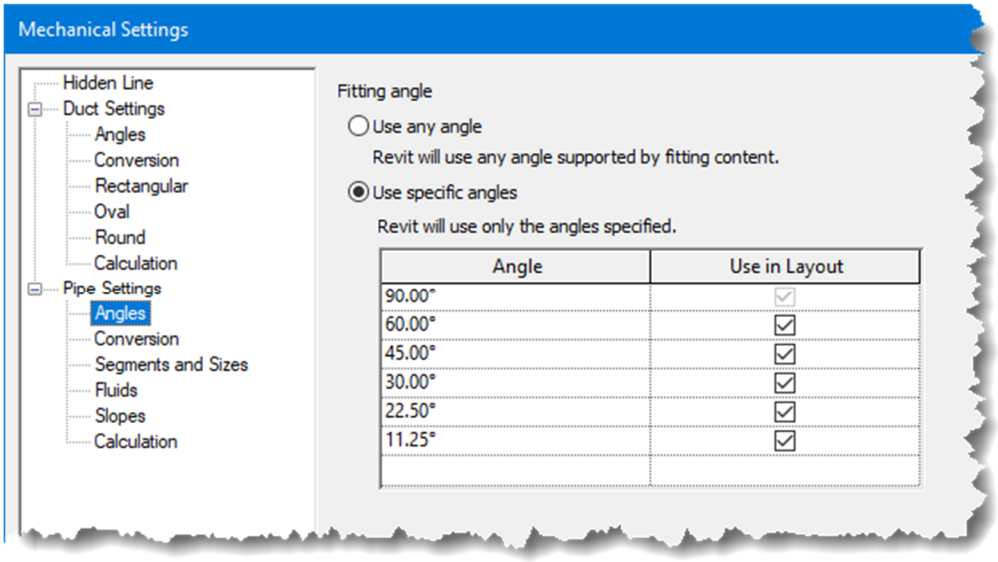


One of the largest impacts from converting to ITMs is the loss of Flow information that Revit Families were able to maintain. Fabrication ITMs do connect to Families and are working better with the flexibility that Revit provides with moving components and maintaining that connection. From an Engineering Design standpoint, you are going dark with any information that was being used to help size the system. Unfortunately for Engineering, the project has more important gains using the ITMs than the pains of losing Flow information. Hopefully, this will be resolved in future releases of the software.



ITMs do not carry flow information like Revit Families are able to maintain.

Some design teams like to allow fittings to be created using any angle. It keeps the modeling process easier by providing almost any position to be connected. This will work fine for schematic efforts but will wreak havoc for coordination efforts and the conversion process. Any modeled content that cannot be constructed will have to be redesigned. It was necessary to lock the fittings down to only use specific angles in Mechanical Settings for Angles of Duct and Pipe.



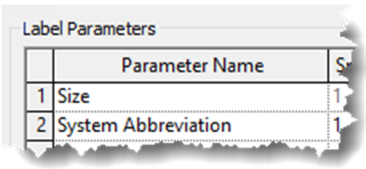
Modeling Standards

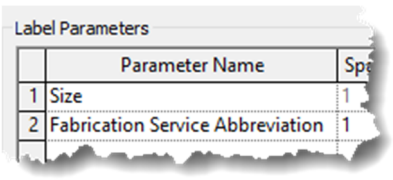
The direction that a Revit Family of Duct or Pipe is modeled determines the orientation for an ITM when converted. Slope does not affect this issue. The Family can be flipped, but the converted ITM will revert to the original modeled orientation. There is no known method to prevent the ITM from flipping back when converting.

When initially modeling the early design layout, concentric fittings were used to connect system components. This prevented any issues with lost pieces during the conversion. The VDC Coordinators were going to insure the proper fittings were modeled in the end, so there was little value in the early design representing anything beyond routing.

Annotations

Families and ITMs are different model categories and Tags will remain when the associated Family is converted. The Labels for the Tags had to be recreated, since the Tag cannot simply change category assignment.





Tips for converting Revit Families to Fabrication Items

General Tips

This section is a compilation of lessons learned either through experimentation or from online help forums. As software updates occur, some of these tips may no longer be valid.

All conversion from Revit Families to Fabrication ITMs were done using the Design to Fabrication command in Revit. Individual components or entire systems can be converted. The result of the conversion is based on the Button Mapping in the Fabrication Database of the selected Service settings as well as the Design Line information of the components being converted.

The more components selected when attempting to convert content may increase difficulties during the process. When selecting multiple components, be sure they are well connected for better results in all the components getting converted together. The larger the initial selection, the more likely errors will occur.

The Fabrication Service settings must contain all sizes related to the Families selected for the conversion process.

Keep the initial drafting of Revit Families simple. Leave detailing for after the conversion process of any Families.

Families of a specific orientation will convert to the original position regardless of whether the Family was flipped before the conversion. Directional pipe fittings, such as combination, wye or sanitary tee, will be converted based on the originally model direction of flow. This direction of flow is established by the direction the original Revit pipe is create, regardless of the systems flow direction.

Any Family Tags will be removed from the model when the corresponding Family is converted to an ITM.

Even if ITMs in the Fabrication Database are present, some Model Categories in Revit do not support conversion or use of those ITMs. This includes Mechanical Equipment, Plumbing Fixtures, Air Terminals, Duct and Pipe Accessories, Flex Duct and Flex Pipe.

Conversions of multiple elements will not be supported for fittings that are back to back or directly connected to each other. Transitions that are not centered in justification or eccentric will not convert with the same properties.

Incomplete modeled components with fittings containing open ends may develop issues in conversion and need to be capped.

Taps that are not center justified or connections to equipment utilizing a transition may not convert correctly. Families joined by analytical connections are not supported in the conversion.

Families that are modeled at random angles will not convert if they are outside the acceptable ranges of the angles represented by ITMs in the database.

Utilize a Schedules & Quantities schedule for Fittings to select specific types of a fitting in a group that will allow conversion together regardless of locations in the model.

Air Terminals that are directly connected to sheet metal will lose that connection when the sheet metal Family is converted to an ITM. Those Air Terminals will have to be rehosted.

If there is not enough space in the connected components for an ITM to be placed, then that component will be left blank and not converted. It is important to model Families to utilize as much of the same space as the ITM will require.

The Route & Fill and Multi-Point Routing commands work well created ITMs in Revit using services to connect major ITMs together into a system.

The Database for this specific project was originally developed for CAMduct and had to be updated for the current use. Data was added in order to facilitate the needs of this project.

Button Mapping must be developed for components such as bends and tees using standard button codes. Ancillaries must be included in the Button Mapping.

Converting elbows requires a selection of one specific elbow ITM for the conversion. It is not possible to have a large selection and convert short and long radius elbows in the same selection. ITMs can be changed after the conversion.

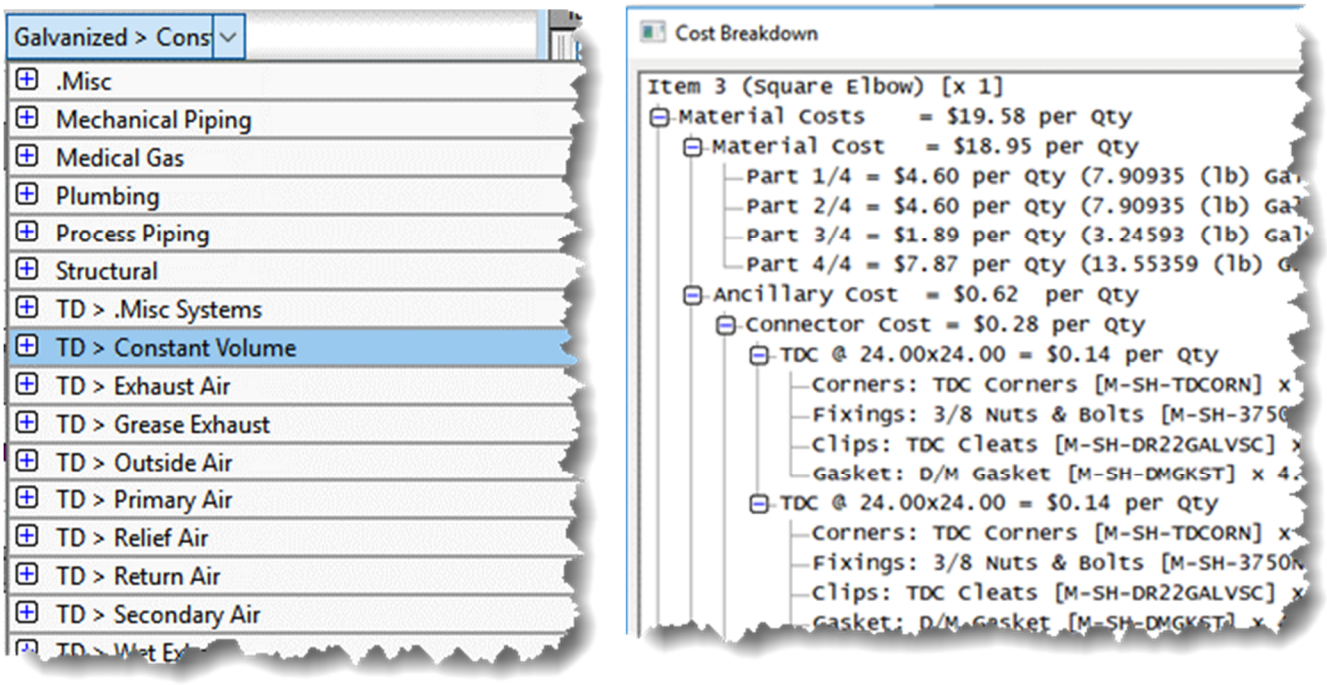
Button mapping for Family fittings to ITMs only works with inline equipment like valves or dampers.

Some ITMs were working well in CADmep, but had issues functioning in Revit that had to be addressed.

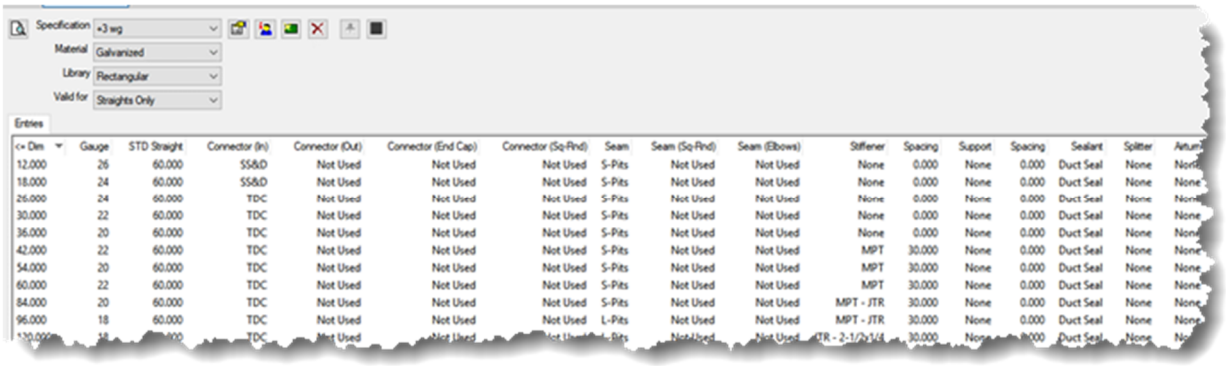
Fabrication Database Tips

Only one Database can be loaded into one Revit model, so a common Database is needed for Pipe, Plumbing and Sheet Metal in order to model ITMs in Revit for all trades.

All costing data for estimating was added and can be extracted at any time during the project. Ancillary data and be reported out such as Solder, Cleats, Corners, Nuts and Bolts, etc. Costing data from Revit modeled ITMs is available when utilizing ESTmep.

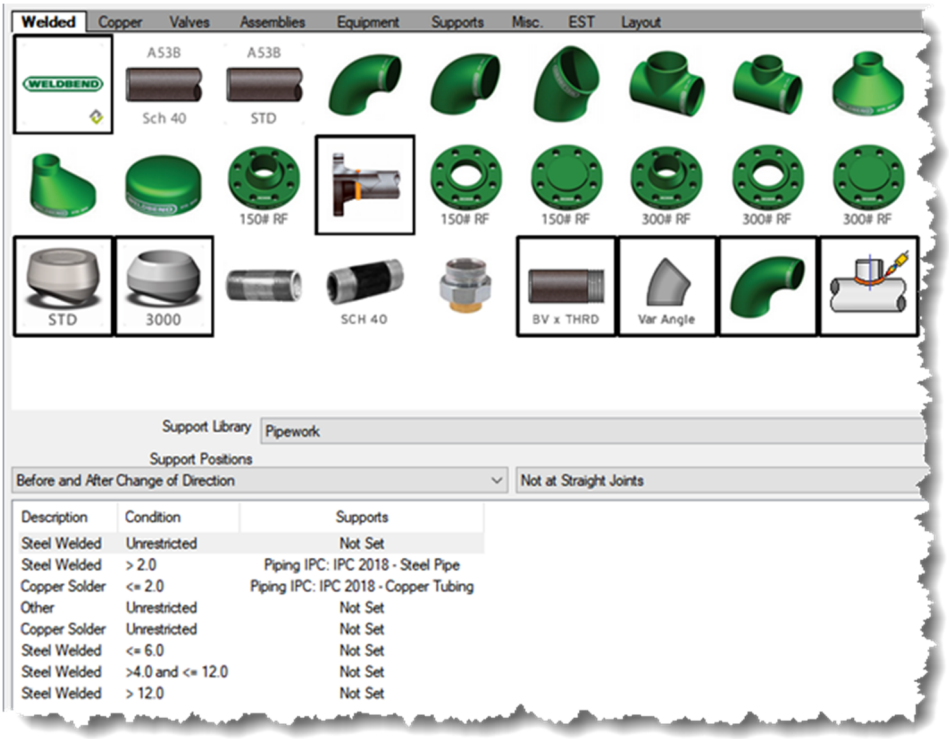


Product information was added for ease of reporting and assigning supplier cost codes to each line item.

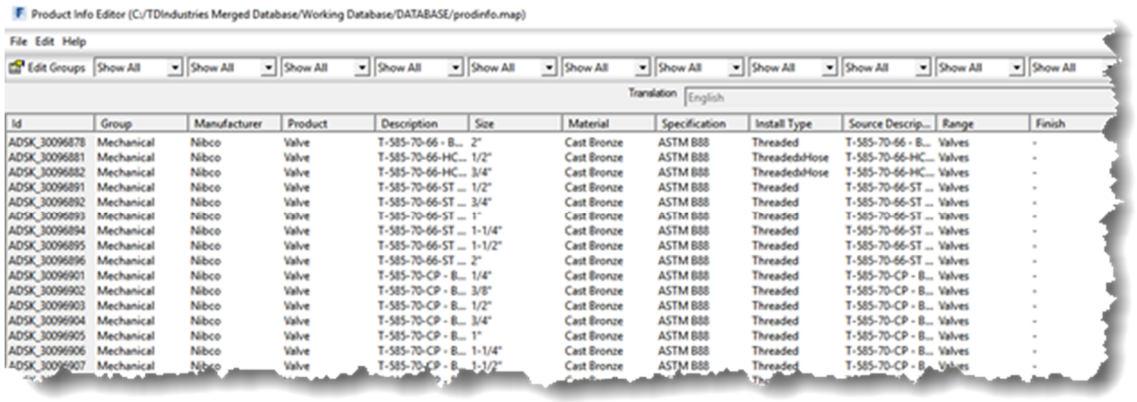


ITMs used in Revit are built off the standards set in the Fabrication Database and can be accessed through CADmep, ESTmep or CAMduct.

Button Mapping standards were created across all services in order to accommodate converting Revit Families to ITMs. Items for each service were set up for the proper size conditions. Pipe ITMs are specific to each Service for what will be used in the Pre-fabrication Shop.



Profiles are developed for each project to allow for services, sections, and insulation specifications to be specific to its own specifications. All team members of a project have access to the same profile.



Specifications for Pressure Class are assigned to each Duct Service for Round, Rectangular and Oval.

Solve methods that create hurdles for Estimating and VDC Partners

Peer to Peer Mentoring

One of the best results from this project and testing was the natural support we provided internally to each other. As a company, we see the value in providing our scope of a project to the team using Revit. We also know the value from using the Fabrication Database to drive our construction efficiencies to create a better product to the whole team.

With the silos falling, we naturally found a support occurring across teams that typically were not involved jointly in a project. There was a good spirit within the teams that we were embarking on new territory that will show the rest of the company how successful this effort can be.

Engineering was able to utilize a VDC Coordinator during the final design scope to assist with modeling in Revit using the Fabrication Services. The VDC Coordinators were able to quickly get support on setting up views and sheets as well as questions getting familiar with the landscape of Revit. This allowed everyone to maintain good production speed without getting slowed down by inexperience.

With our Estimating group now working with ESTmep, and beginning to look at Revit, we were able to share modeled content using the common database. Estimators were able to run reports and get actual job cost analysis much faster than doing traditional takeoffs. This also gave them the opportunity to give feedback on our modeling efforts and understand how we could all help each other develop our needs faster.

Key Takeaways

Engineering is adapting design workflows to better assist our Estimating and VDC Partners. There may be some added scope, but overall the joint efforts are easily reducing the time needed for job cost analysis and model coordination. This is reducing the overall man hours needed to successfully develop projects for our clients.

The effort to work together has created opportunities to develop common standards across the company that improve our efficiencies.

Testing and producing a design model through the use of Fabrication ITMs in Revit has pushed us to develop solutions to hurdles regarding the use of the two merging technologies.

Looking to the Future

The goal is to win more opportunities to do Design Build projects in the future. This case study proved that we can develop a project model within our scope used across multiple teams.

A common Master Database in use across the entire company allows us to share modeled content, supporting each other and reducing rework.

We are also looking to the future of where technology is taking construction and working to be prepared for the coming tools and new abilities. BIM360 projects are becoming more frequent and soon may be incorporated into Forge.

TDIndustries is currently developing a replacement for our Enterprise Resource Planning. Part of that initiative is to have an interface with Revit models to provide valuable project information to our project managers through the Design Automation API of Revit.

All of this is possible, because we are focused on developing projects using the best platforms to work better together.