BES469281

Revit to Fusion to Autodesk CFD

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Learning Objectives

- **Discover good practices for Autodesk CFD geometry preparation**
- **Learn about the workflow from Revit to Inventor to Fusion 360**
- **Learn how to optimize Revit geometry for simulation using the Fusion 360 Simplify tool**
- **Learn how AnyCAD, Revit, Inventor, and Fusion 360 work together**

Description

Best practices to leverage Fusion 360 Simulation workspace with Revit Models. CFD often requires geometry optimization that is better suited for Fusion 360. Inventor and AnyCAD bridge the gap between Revit and Fusion.

Speaker: Dave Graves

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Good Practices for Autodesk CFD geometry preparation

Having geometry optimized for CFD is a paramount to being successful. The Autodesk CFD tool will try to mesh the 'true' geometry. Geometry that is too detailed can increase simulation run times significantly without dramatically changing the results.

Tools like Revit are great for designing buildings, however quite often the resulting geometry is not appropriate for use in a CFD program. Some examples include:

Small Gaps

In the model below the Curtain Wall and the rest of the geometry appear to be modeled very well, however if you look a little closer, you can see the model has a small gap in it.

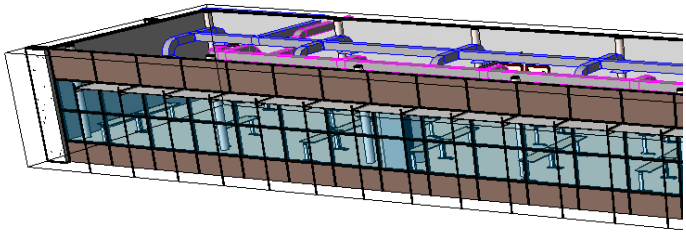


Figure 1 Standard Revit Model

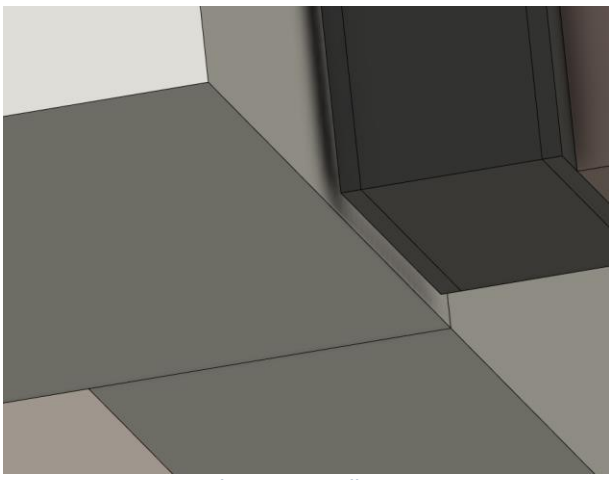


Figure 2 Small Gap

Small Gaps are not desired for a couple of reasons.

Autofill:

One of the more challenging things for new users is actually creating or modeling the internal air volume for simulation. Revit and other tools are not built to generate this. Most designers and engineering don't design this, they design the product or in this case the room. If the geometry is 'air' tight, CFD can automatically generate the internal volume saving you time. In the example above, Autodesk CFD could not generate the internal air volume due to the gap in the model.

Require significant amount of mesh and will increase run time.

If we take a look at the desk that is in the model, you will notice a few things. The first is that due to the feet, this creates a gap between the floor and the bottom of the desk. Additionally because the feet are modeled with a smaller cylinder it creates additional geometry that must be considered when generating the CFD mesh.

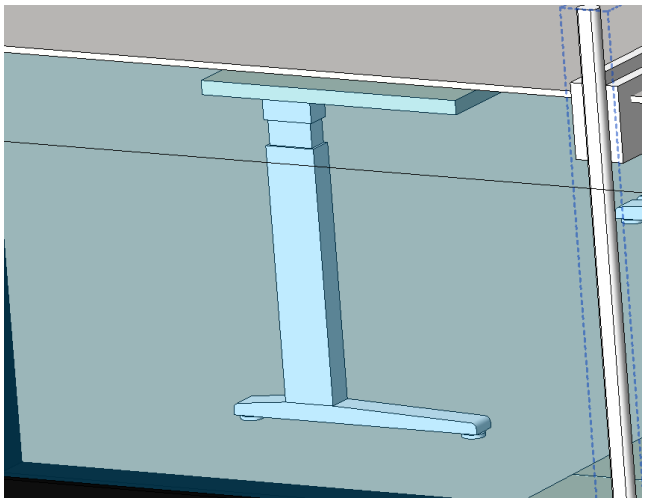


Figure 3 Desk Detail

In this example we can see the additional mesh required to account for the gap between the bottom of the floor and bottom of the desk leg. We can also see the extra mesh required to take the foot into account.

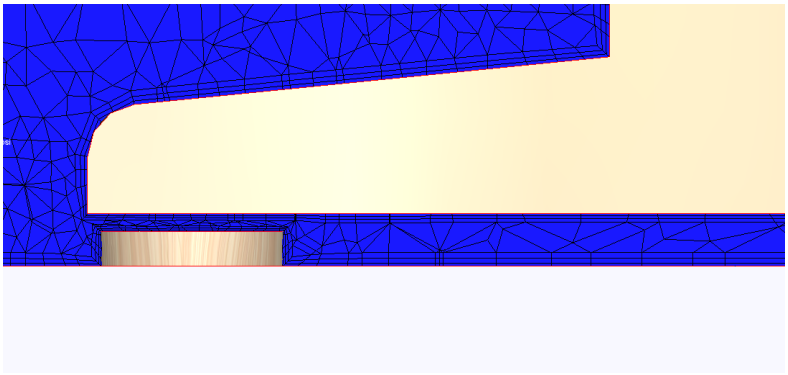


Figure 4 Mesh of Gap and Foot (25732 Nodes)

As you can see the there is significant mesh under the leg of the desk. In reality there is typically very little air flow in that region. A better approach would look something like this:

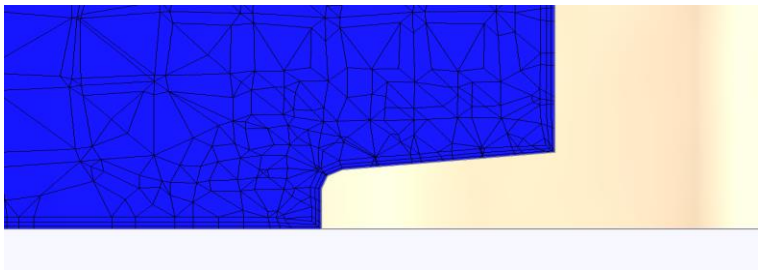


Figure 5 Mesh with Gap and Detail removed (14591 Nodes)

In this case the mesh was reduced by over 10,0000 nodes per desk. Considering there are 20+ desks in this room, that is over 200,000 nodes which will significantly reduce the solve time.

Extra Detail

While Gaps can contribute to meshing challenges and longer run times, so can unnecessary detail. From furniture to lighting and everything in between can contribute to this. One example is

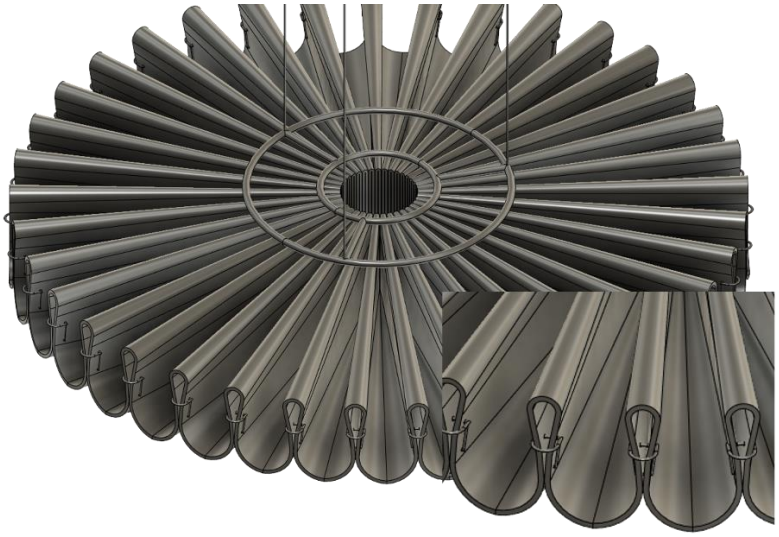


Figure 6 Detailed Example

In the model above you can see a lot of detail for this lighting fixure. If you look closely you can see how there are rings/clips that help keep the shape. There is probably not much flow going through that portion of the light.

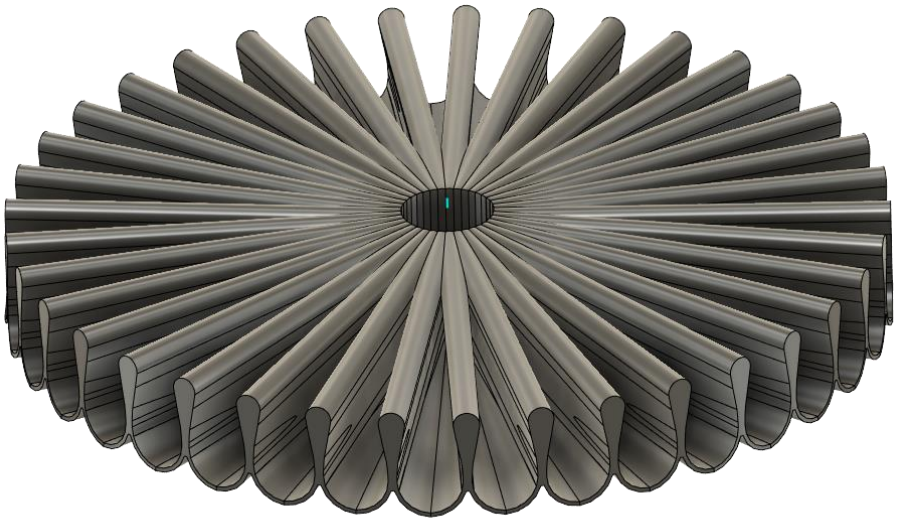


Figure 7 Optimized Lighting Fixture

This simple change again, reduces the amount of mesh required to run simulation.

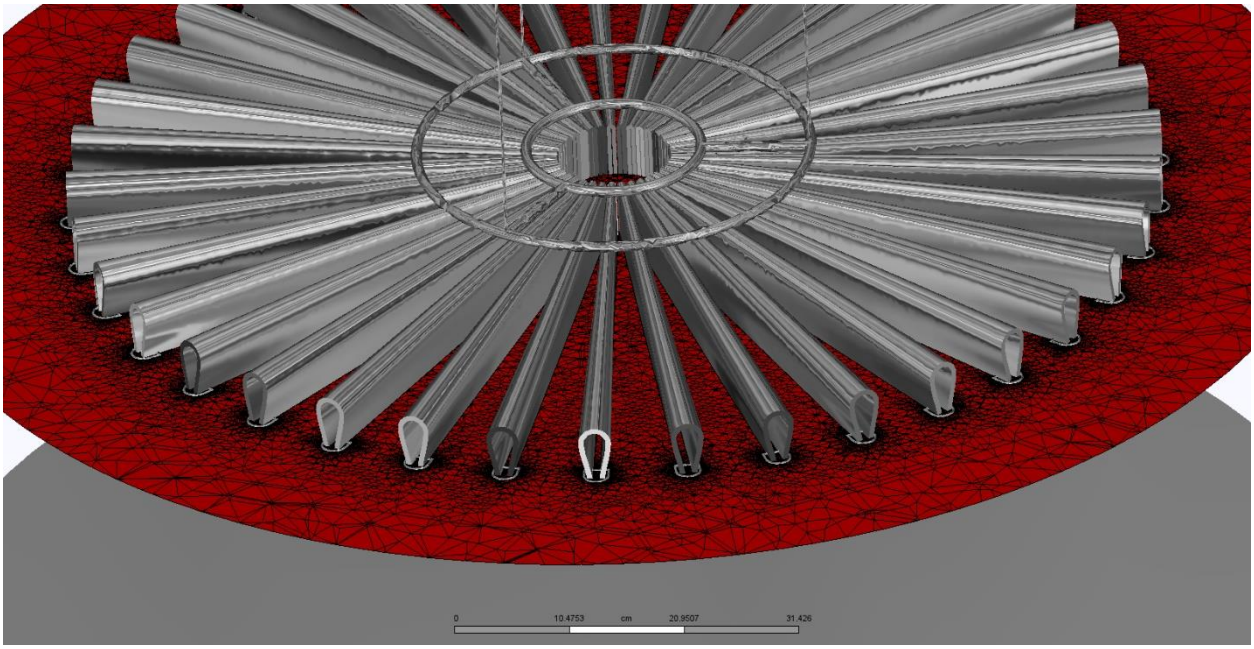


Figure 8 Mesh 'As is'

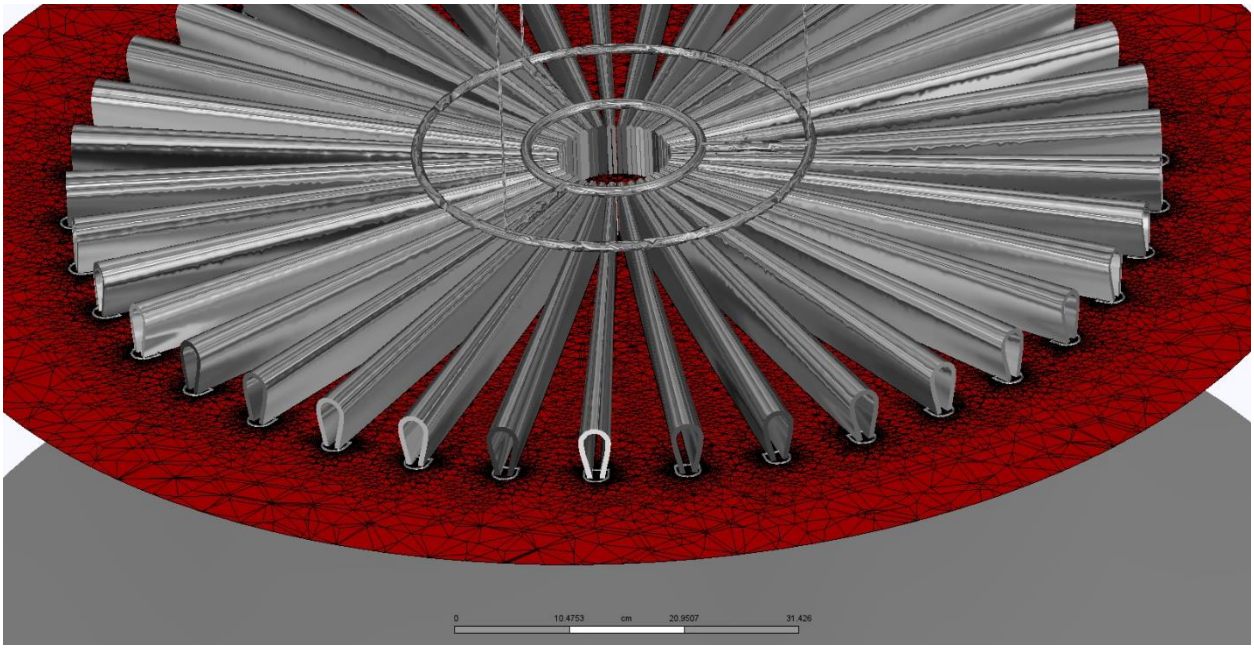


Figure 9 Optimized Mesh

The model was reduced from 2.1M nodes to ~850K, again this will signifantly help run times.

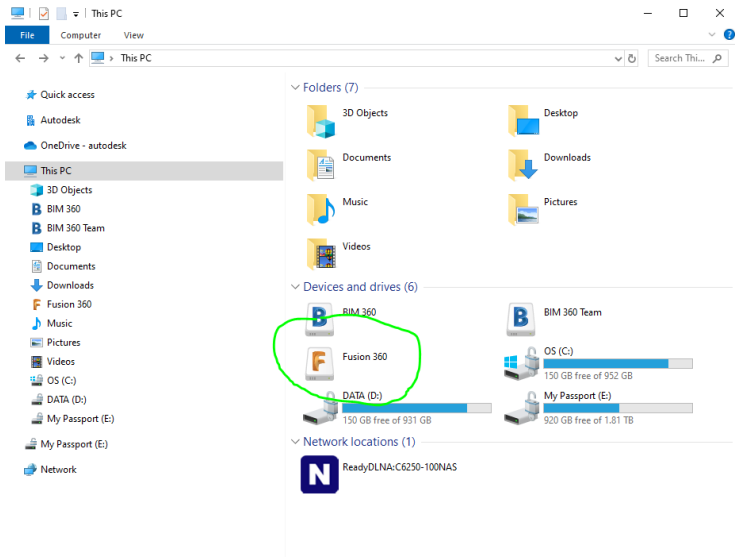
Work from Revit to Inventor to Fusion 360

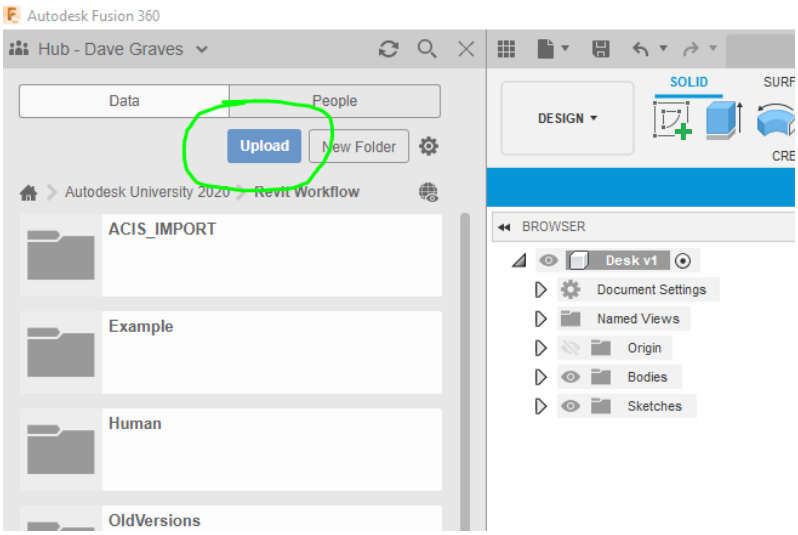
Fusion 360 does not read native Revit files, however Inventor does. Fusion 360 can read native Inventor files so that is the proposed workflow

Revit to Inventor to Fusion

Step 1: Upload Revit file to Fusion Team Hub

While you could possibly keep the Revit file on your desktop, it will work best in Fusion Team. Additionally it's possible to have your Revit file in BIM 360 and leverage Vault to sync between the two hubs. This can be done by either copying the Revit file to the desired location with the Desktop Connector or Uploading directly in Fusion





Step 2: Open the Revit file in Inventor

Consider creating a project file whose path is set the Fusion Team Hub

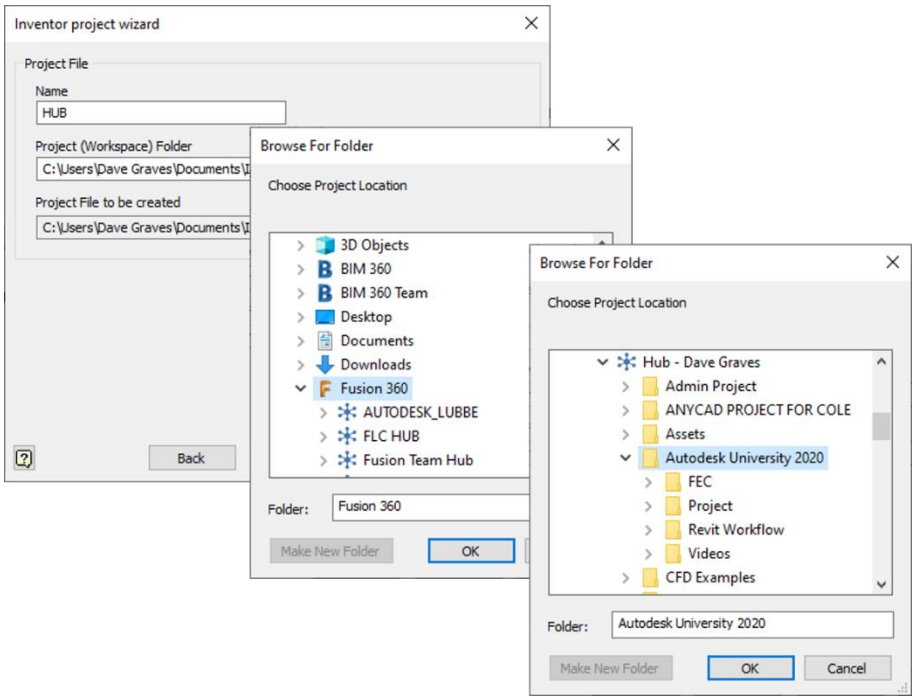


Figure 10 Make sure Model is in Fusion Team

You can then open the Revit File Directly in Inventor. When the files opens there are some options. Be sure to make sure the 'Reference Model' option is checked. This will allow for associativity If the Revit Model changes.

Additionally you can chose specific 3D views that were created in Revit. You can also chose certain elemetns to include/exclude.

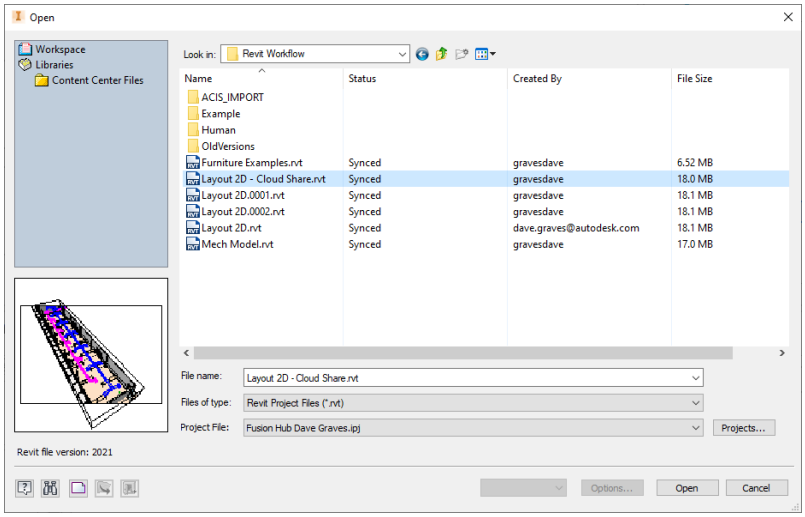


Figure 11 Open Native Revit File

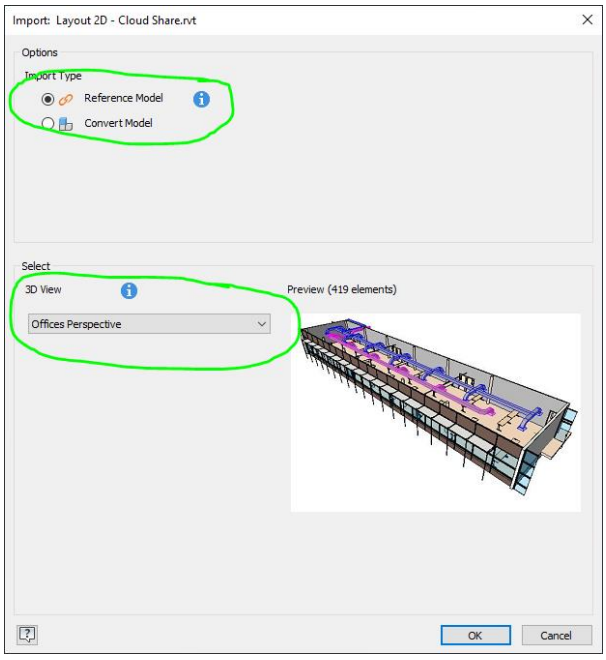
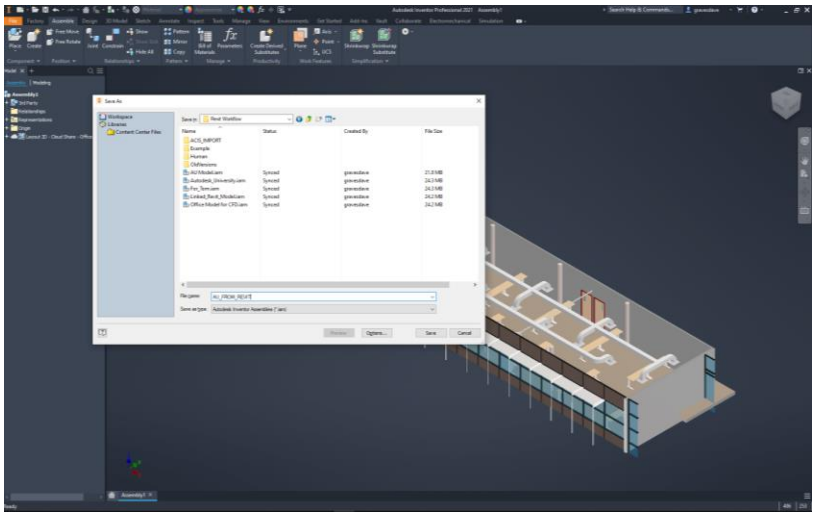


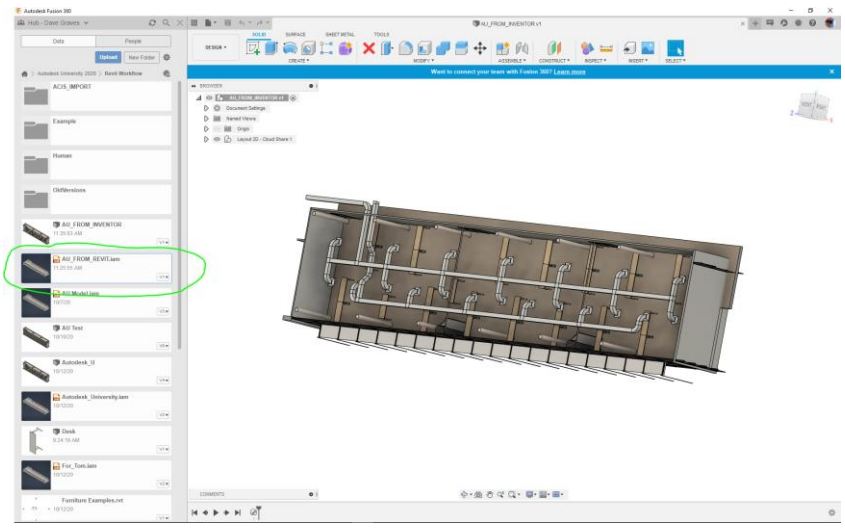
Figure 12 Chose Reference Model and Desired View

Step 3: Save the Inventor File to your hub

Once the model is open in Inventor you simply need to save it. Be sure that the file is saving to your Fusion Team Hub. Once the file has been uploaded you can open it directly in Fusion.



Step 4: Open the Inventor assembly in Fusion



When you open the Inventor model in Fusion, it will create a new Fusion file that is associated to the Inventor file.

Optimize geometry for simulation using the Fusion 360 Simplify tool

Fusion 360 has purpose built tools in the Simulation work space that can help with the geometry optimization. These include the ablity to remove features, surfaces, as well as push, pull, and snap surfaces to help with gap removal.

Enter the Simulation Workspace

From Fusion you can chose the Simulation Workpace. Rather than chose a simulation type you can chose the ‘Simplify’ options. This creates a derived version of the model from the Model Workspace.

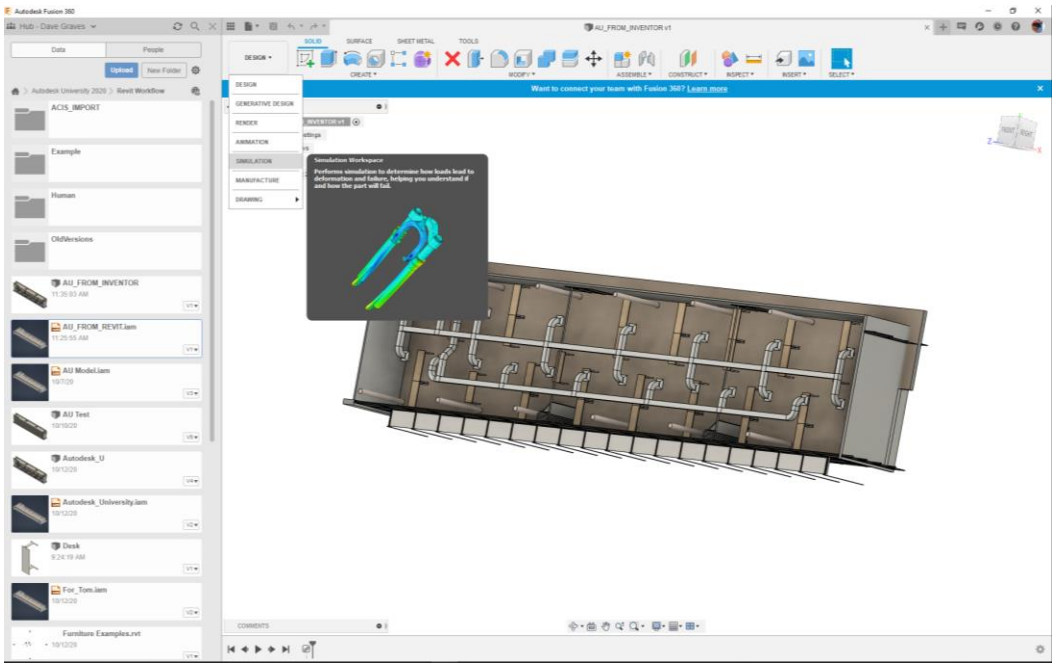


Figure 13 Enter the Simulation Workspace

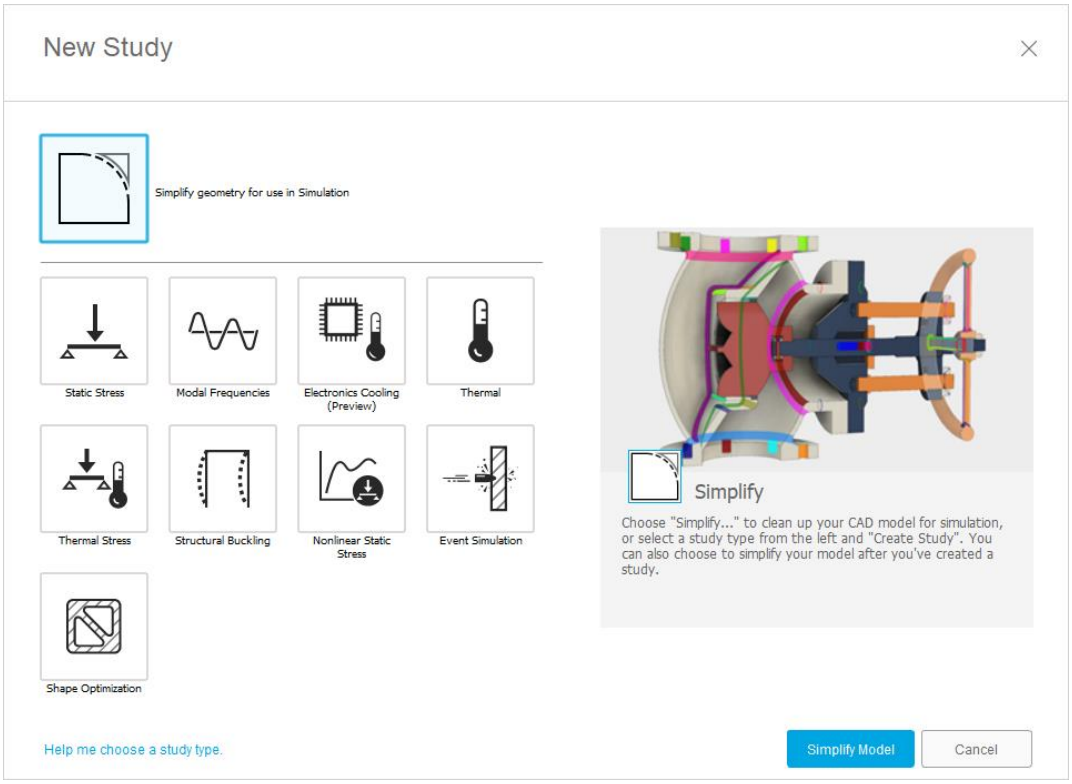


Figure 14 Chose Simplify Geometry Option

Edit the Desk Geometry

The desk geometry is not optimized for simulation. As discussed earlier there are feet at the bottom of the legs that create a gap between the floor and the bottom of the desk legs. The feet also add extra detail that does not effect the air flow in the room.

The first thing I can do is isolate the desk so it is easier to work with, rather than have the entire room.

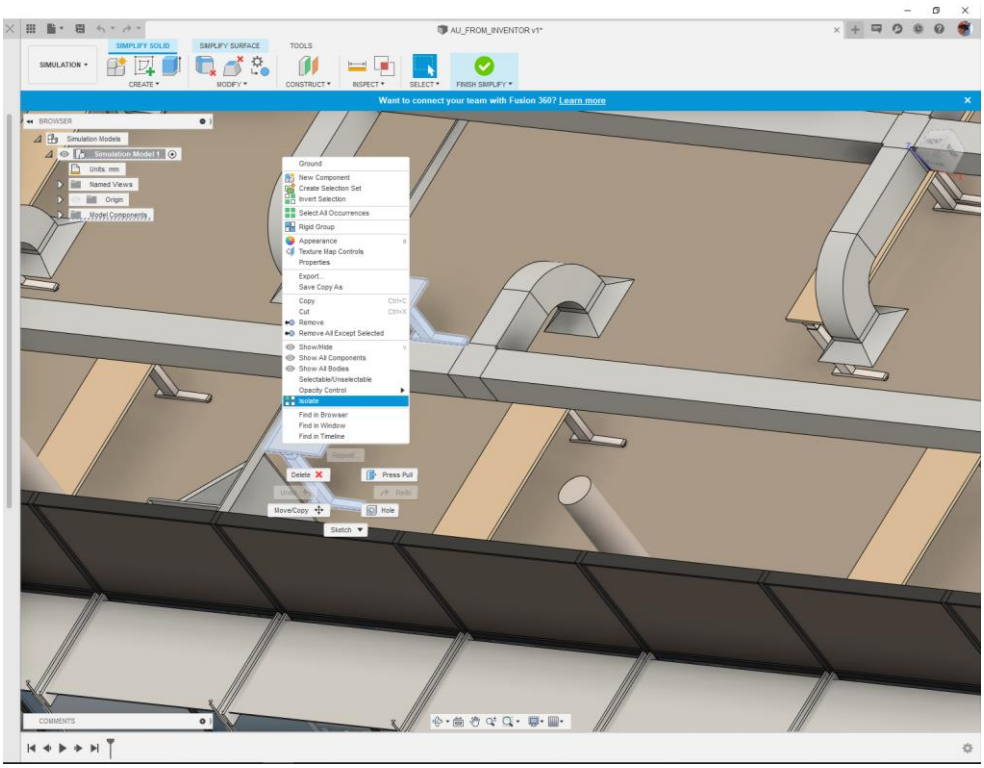


Figure 15 Isolate the Desk

Once isolated, I can select one of the feet. After a foot is selected, I can ask fusion to select all of the similar occurances. As you can see Fusion finds the other 3 feet and I can simply remove all of them in one feature.

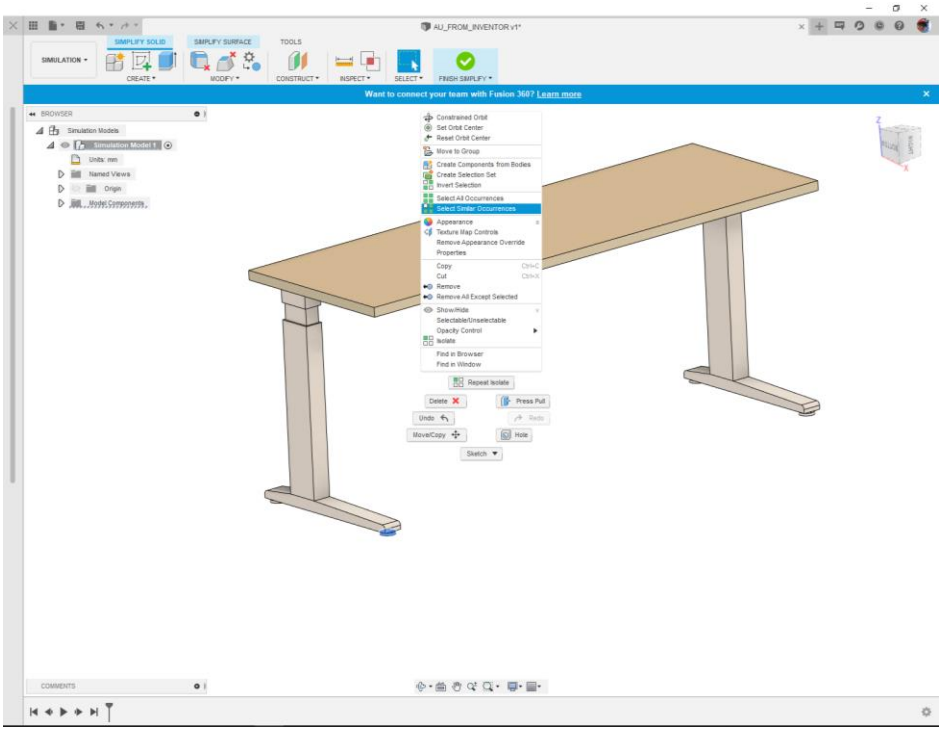


Figure 16 Select the Foot

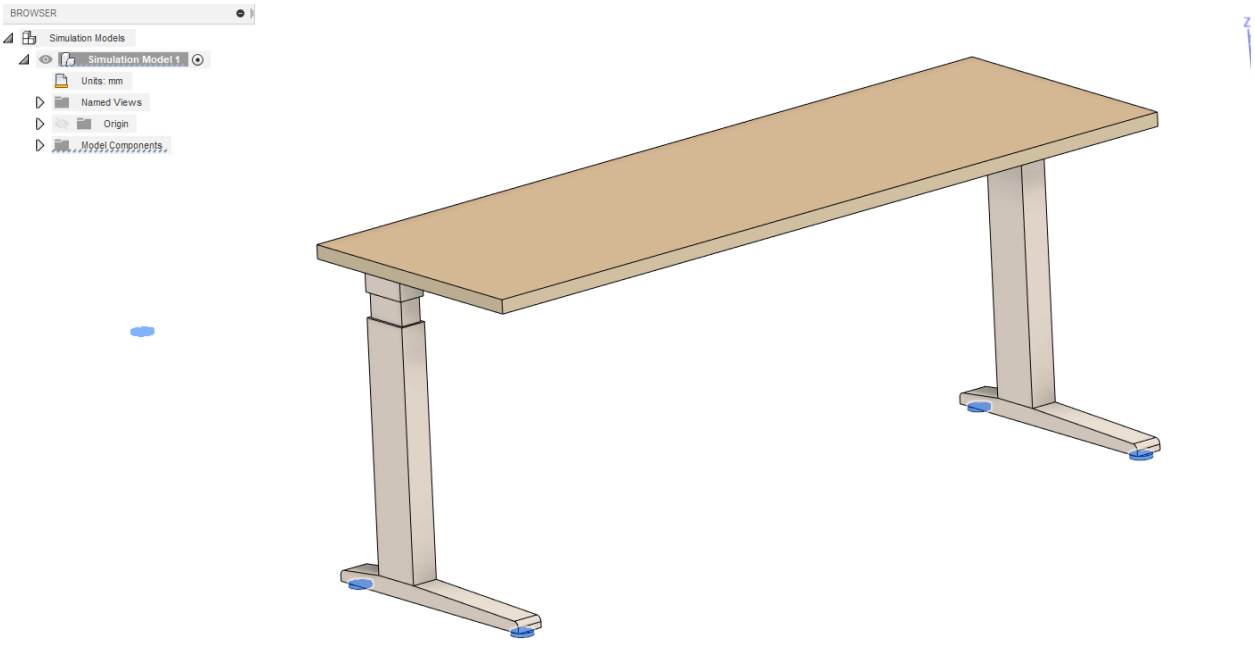


Figure 17 Choose all Occurances

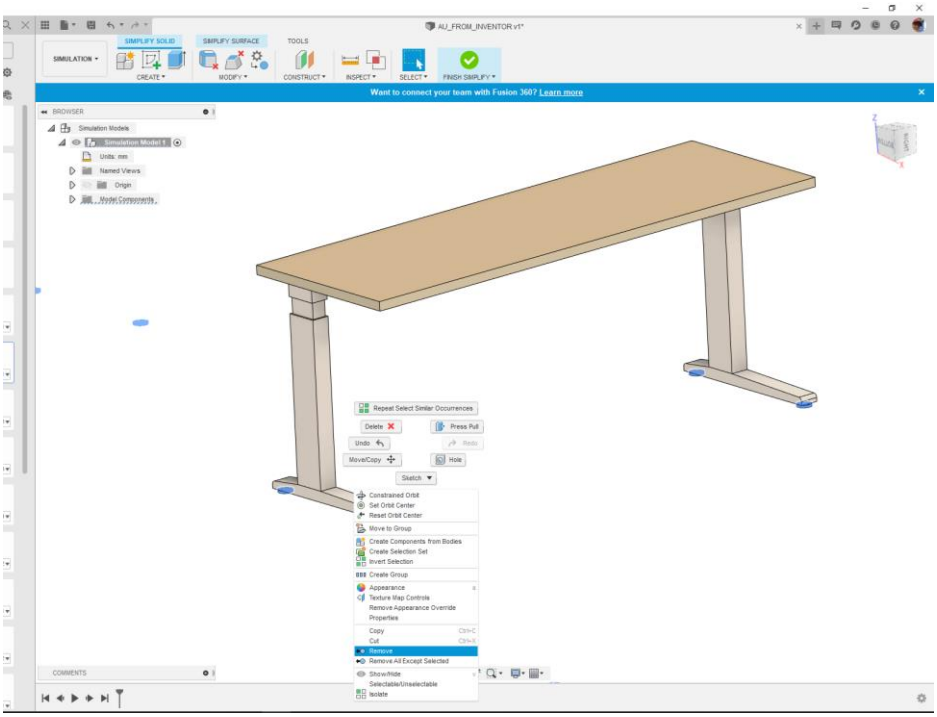


Figure 18 Select Remove

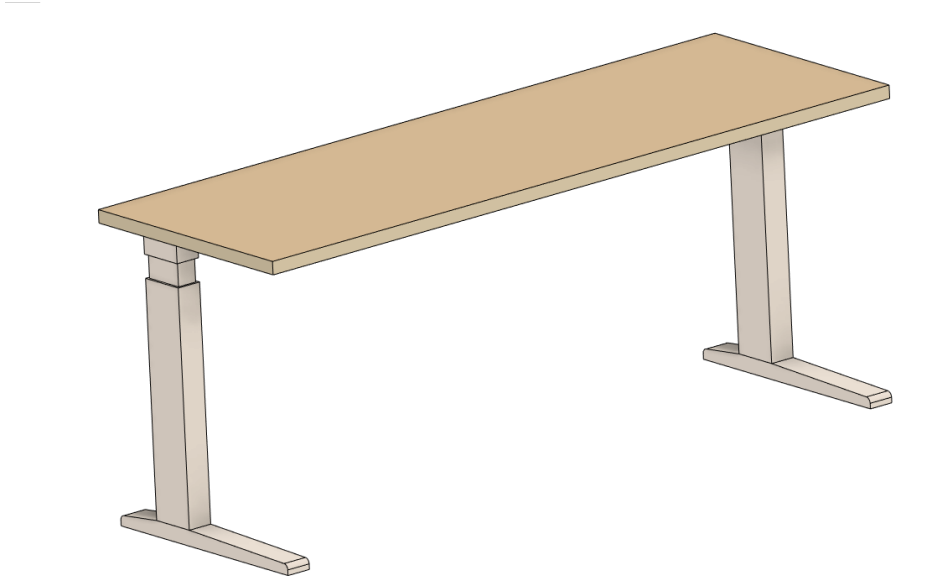


Figure 19 'Feet' have been removed

Often in simulation it is advantageous to combine bodies into a single part. This can make meshing easier as the software does not need to mesh each individual part and calculate the surface relationships between them. In Fusion this can be easily with the combine command. (Hint: Do not Keep the Tool Bodies)

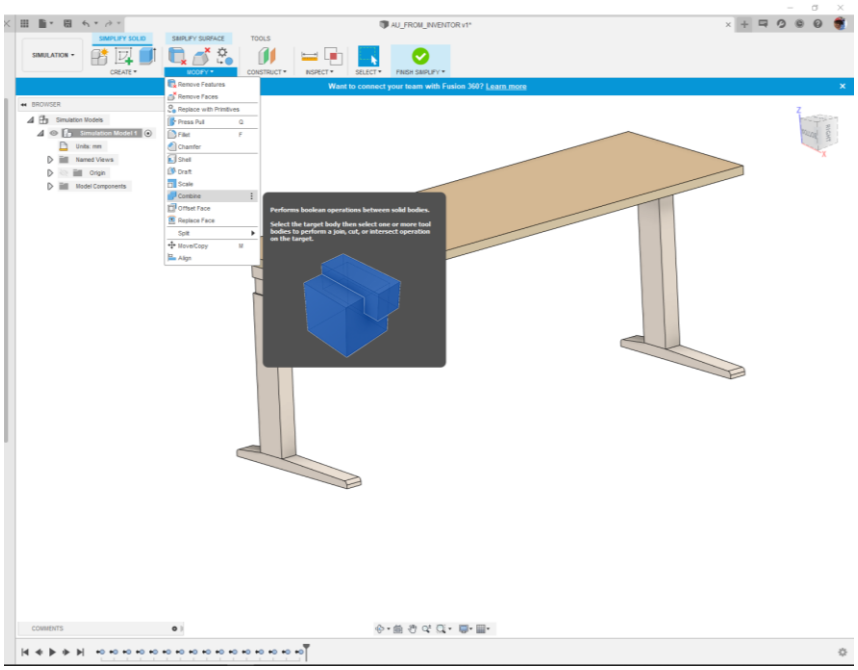


Figure 20 Combine Command

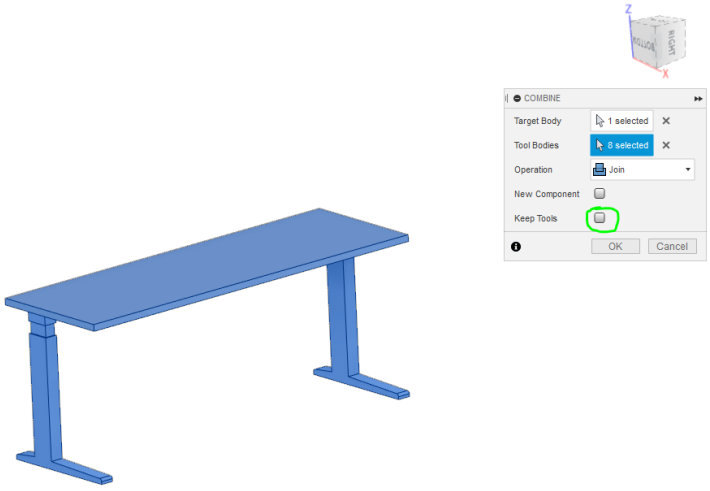


Figure 21 - Do not Keep Tools

Additionally small features like fillets and radius can also increase run time. In the case of the desk, the bottoms of the feet have curves on the. While this is a small change it is very easy to remove these in Fusion. There is the ability to chose 'Remove Features' command. After doing this you can select the geometry in chose what type of features you would like to remove. With a button click, all fo the fillets are removed.

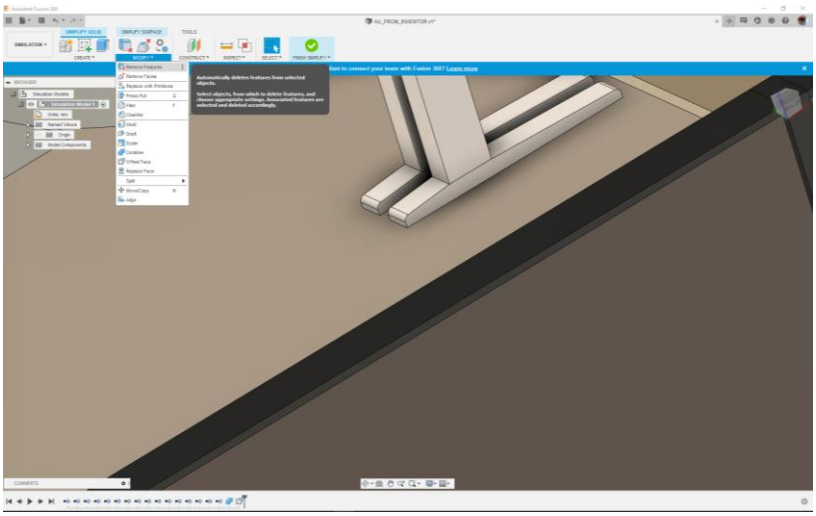


Figure 22 Remove Features Tool

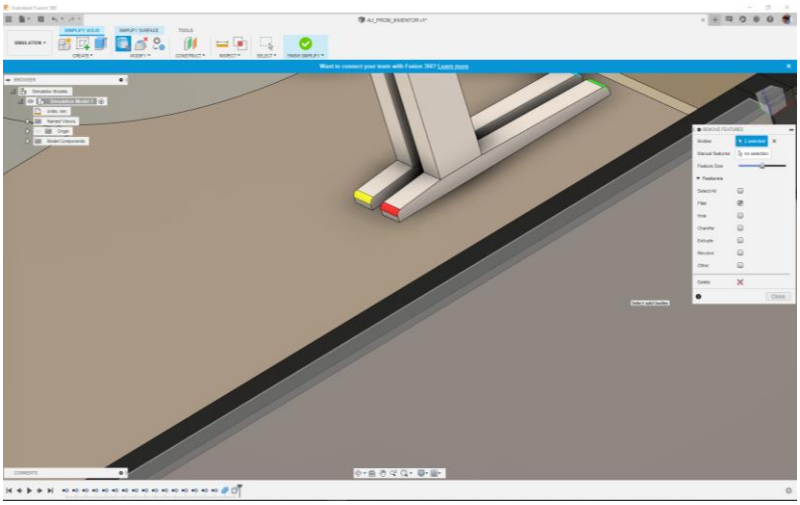


Figure 23 Fillets Chosen as option

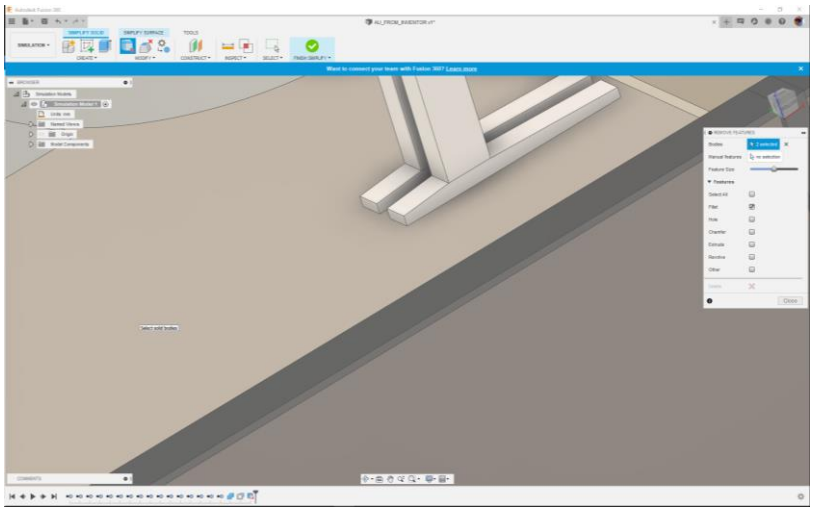


Figure 24 Fillets have been removed

Additional gaps in the model can create excess mesh and cause Autodesk CFD not to be able to create the internal air volume. With Fusion's direct editing technology closing some of these gaps is easy. A user can select on a surface and then push/pull it until it snaps to the other side of the gap.

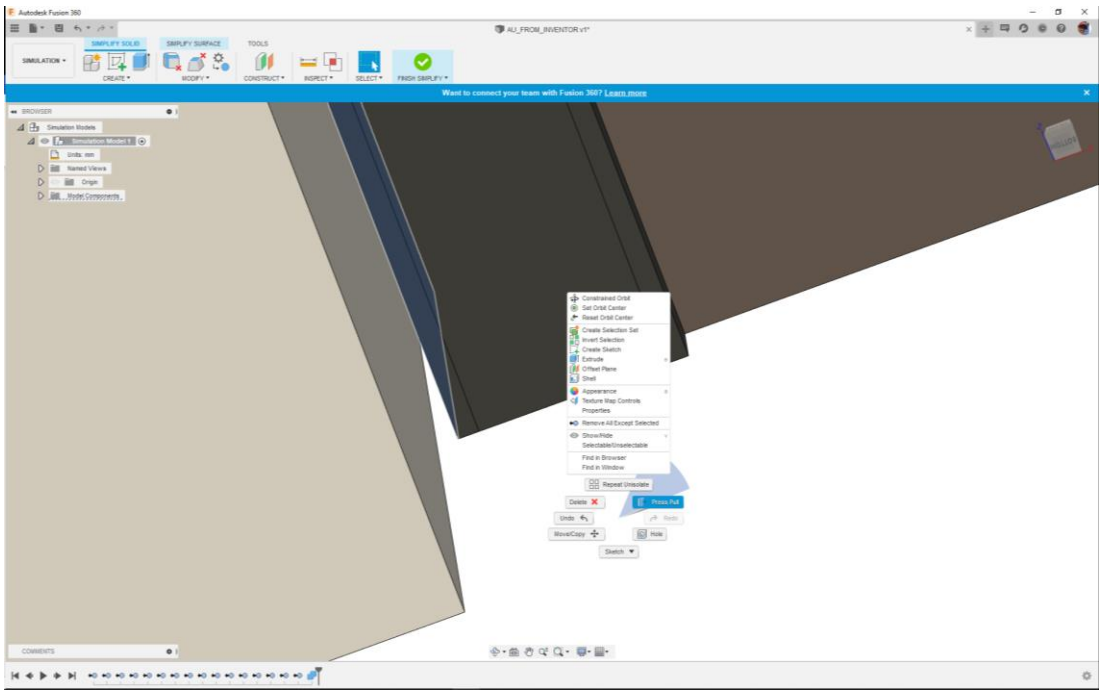


Figure 25 Chose a surface in Fusion, then Push/Pull

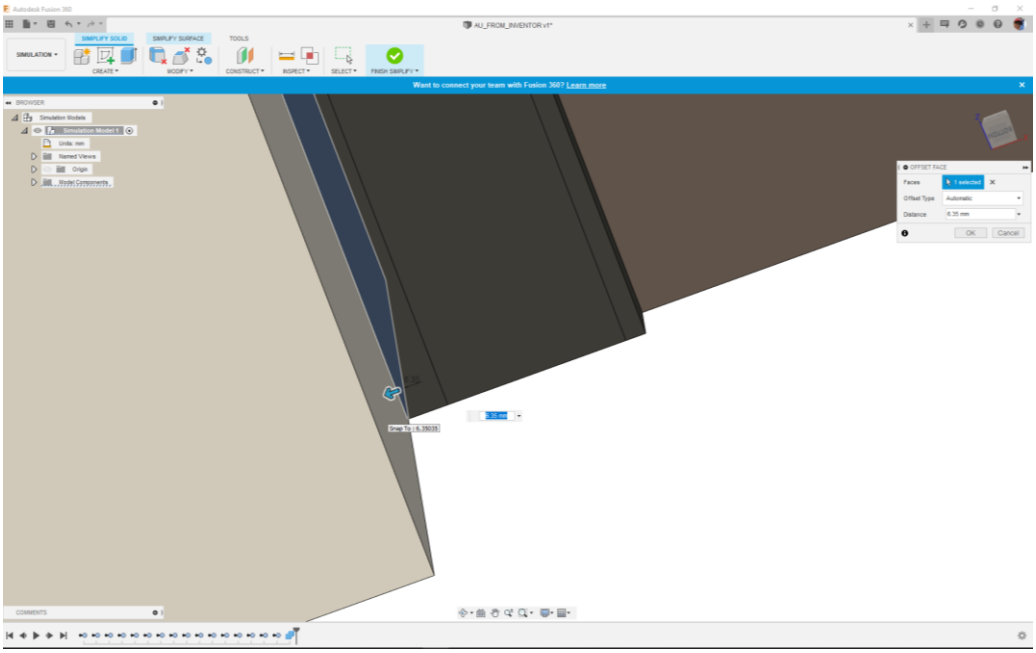


Figure 26 Drag and Snap to close the Gap

Ductwork from Revit typically is represented by solid bodies. In some cases this is fine to use if CFD, however to make a simulation more realistic, it can be advantages to have it actually represent actual duct work. This only requires a few steps in Fusion. You need to combine all of the ductwork into a single body. Once this is complete you can use the shell command by chosing all of the opening and Fusion will do the rest.

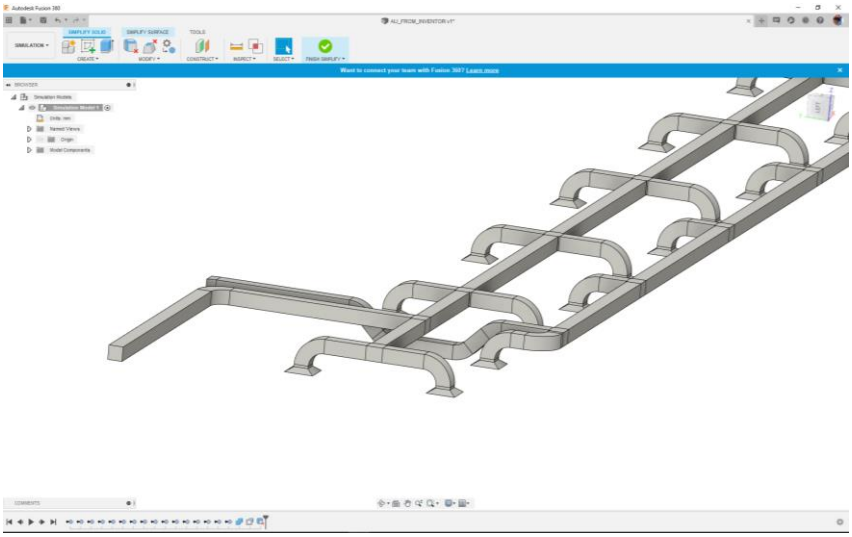


Figure 27 Ductwork from Revit

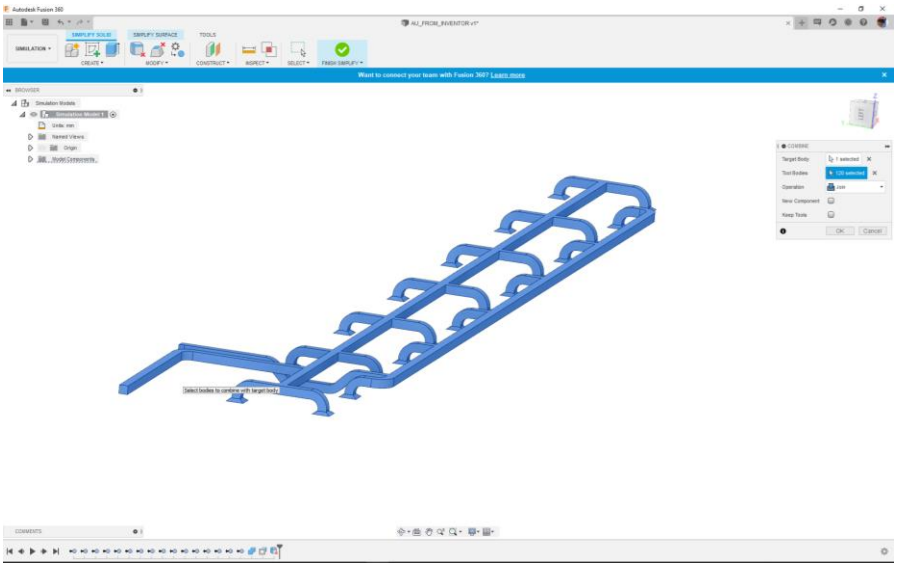


Figure 28 Merge into Single Body

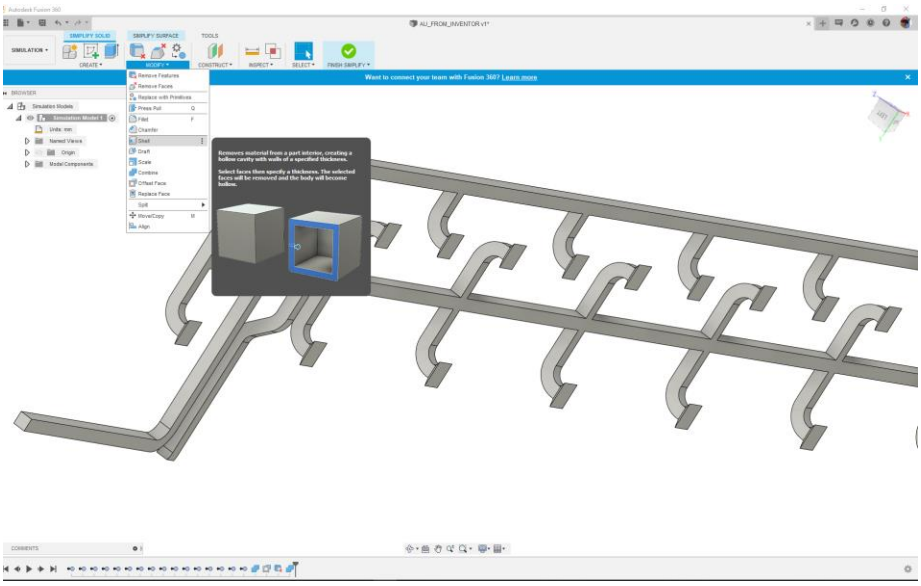


Figure 29 Chose the Shell Command

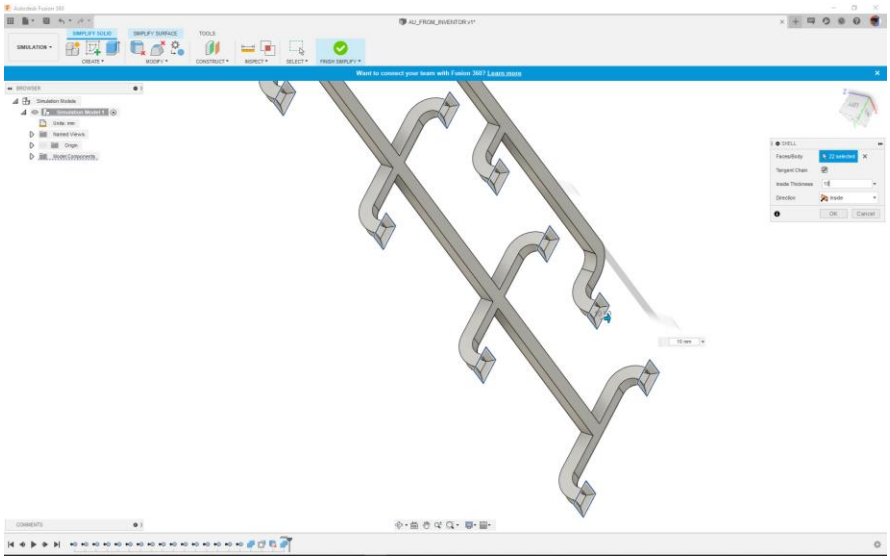


Figure 30 Choose the Openings and Thickness

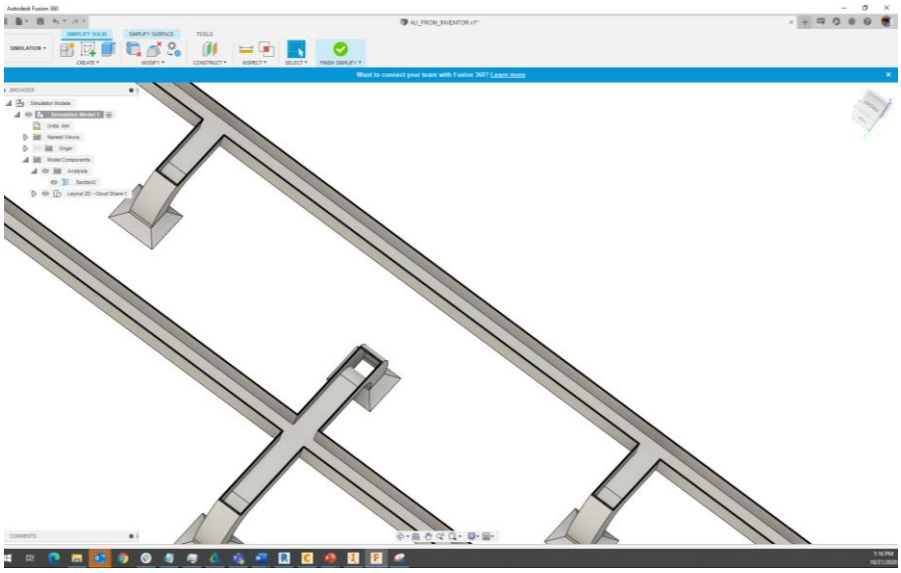


Figure 31 HVAC Ductwork

How AnyCAD, Revit, Inventor, and Fusion 360 work together

Using AnyCAD technology we have built associativity between the Revit file and Fusion 360. This will allow a Revit user to update a model and have the changes propogate through to the Fusion/Simulation Model

Update and Save the Revit file

In the example below, I have a moved a desk closer to the wall. Remember this is saved in my Fusion Team Hub.

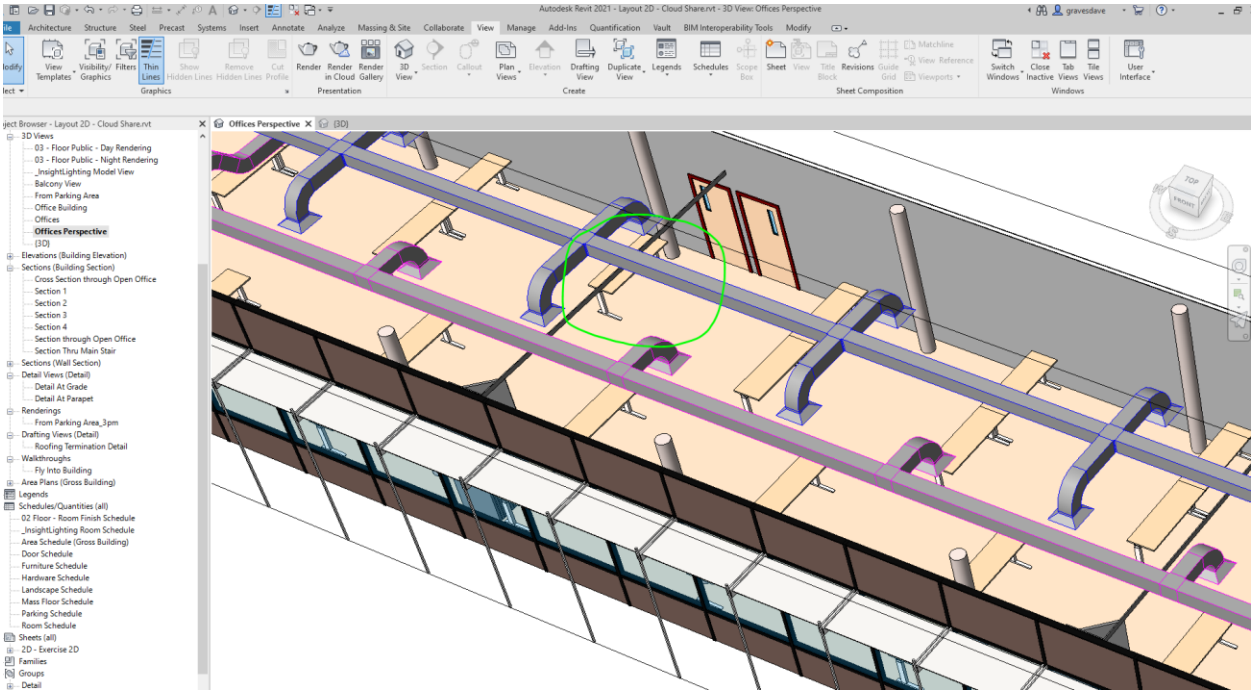


Figure 32 The Desk has been moved and saved

Open the Inventor file we created earlier

When you open the Inventor file, due to AnyCAD, it will recognize the change. You will see the icon changes that let you know the model has been updated. If you chose the global changes options, the Inventor Model will update with the changes. You simply need to save the Inventor model (In the Team Hub)

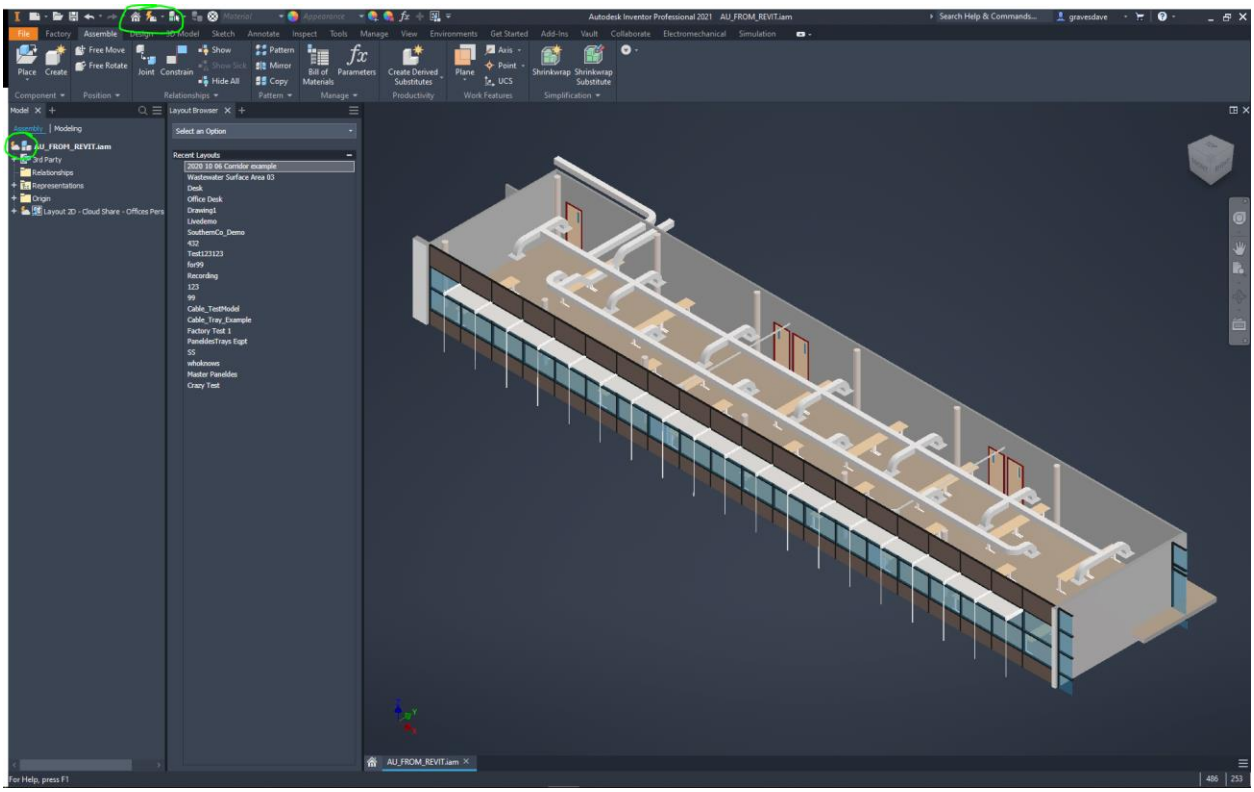


Figure 33 Notification

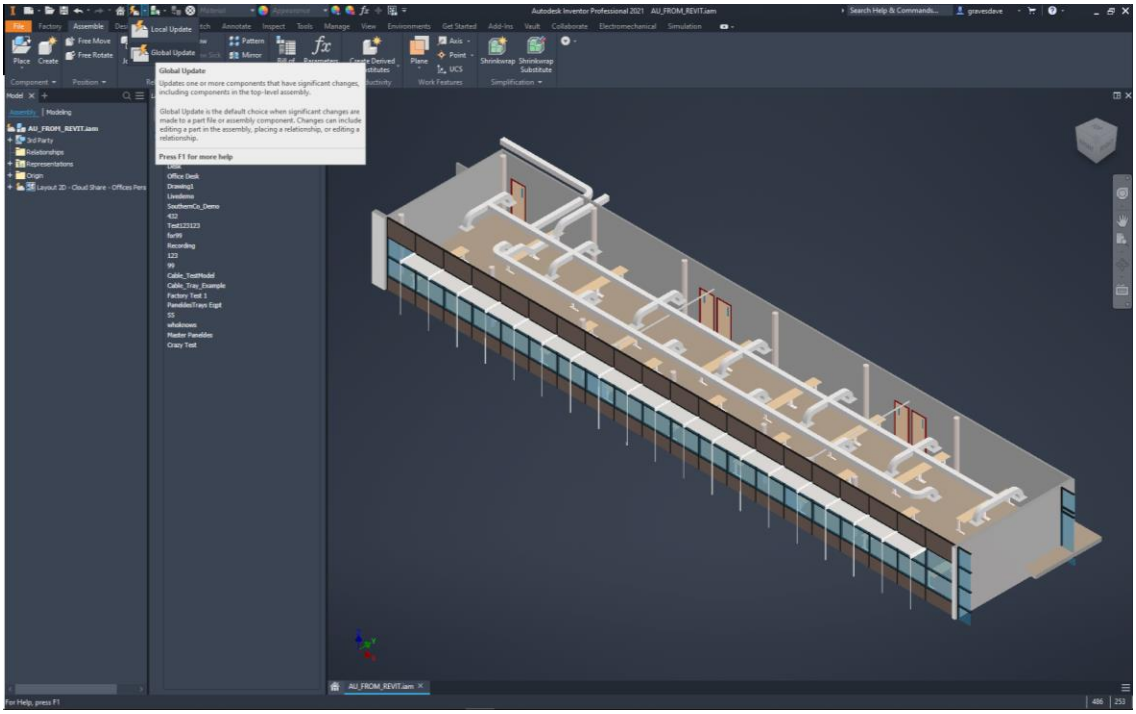


Figure 34 Global Update

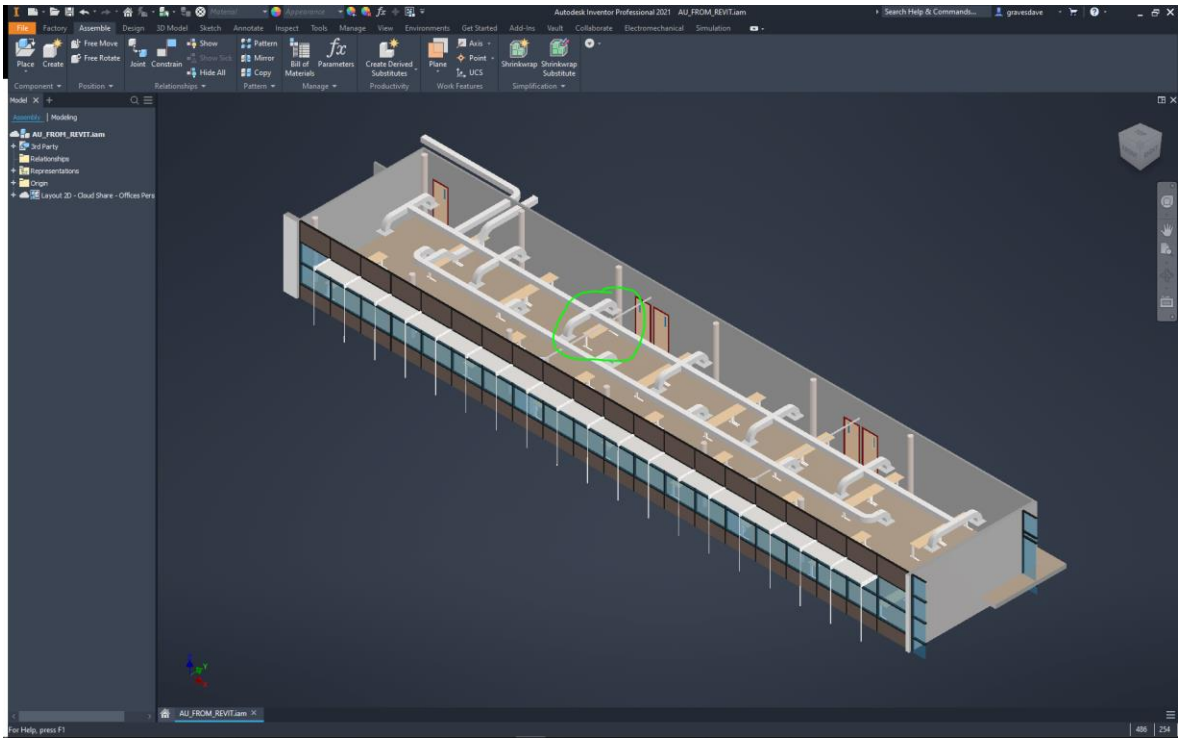


Figure 35 Desk Location Updated

Wait for the Change to be recognized in Fusion

Since the Fusion model is synced to the Inventor model, it will recognize the change. You will have the option to update to the latest or chose a specific version. These changes should propogate to the Simulation workspace so additional geometry optimization may not be required.

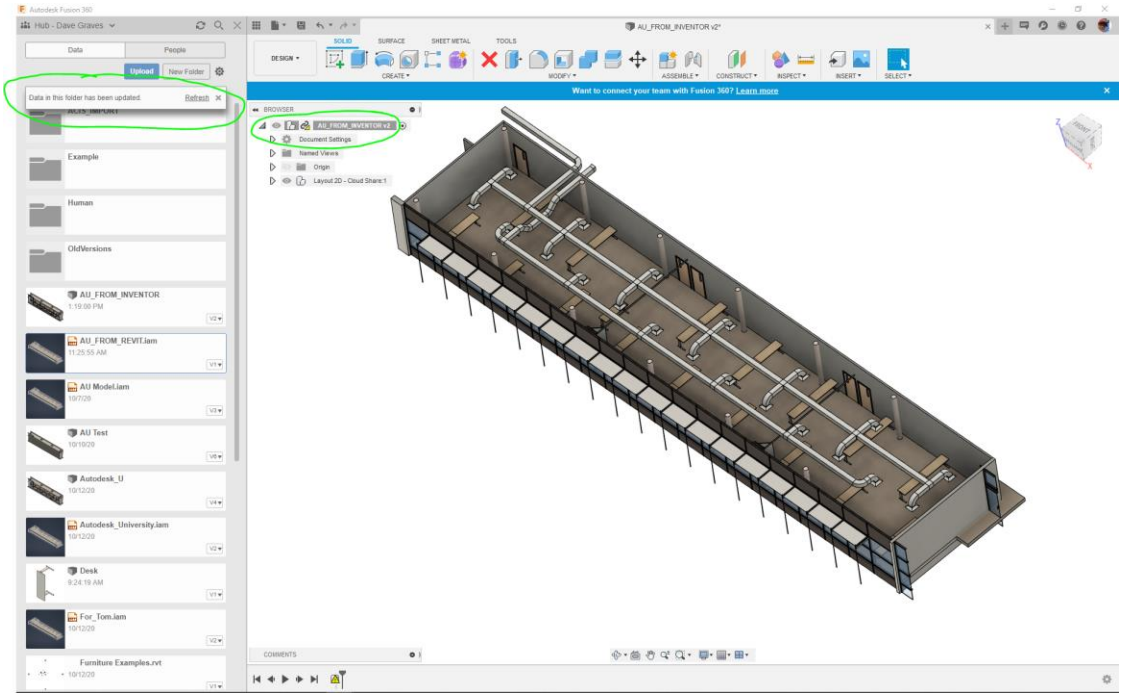


Figure 36 Model Change Notification

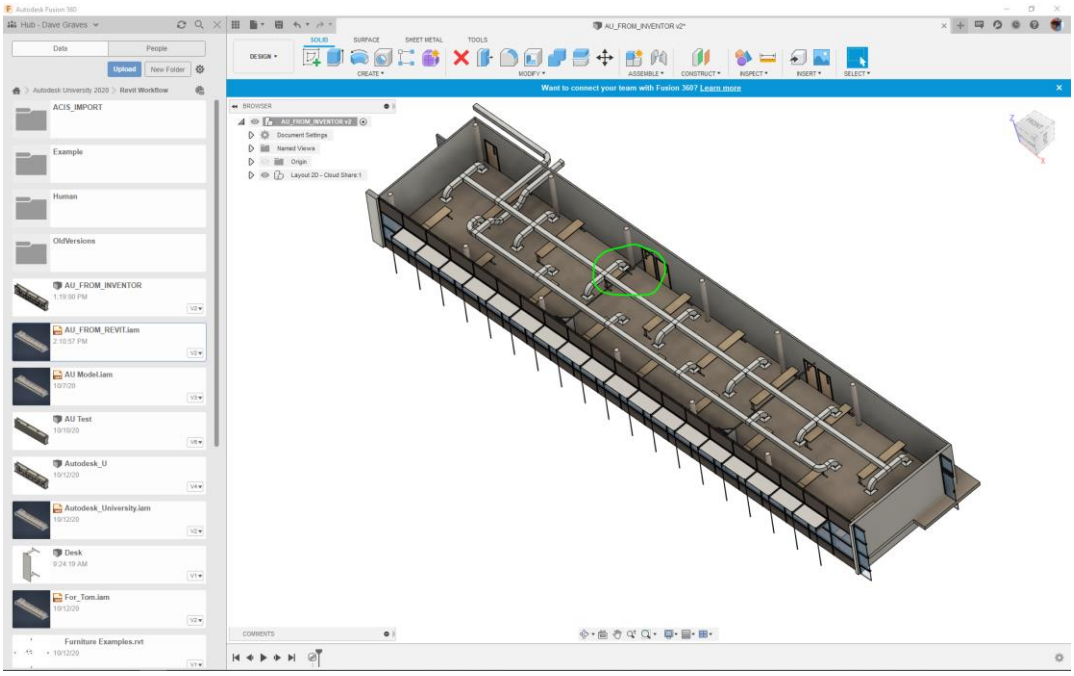


Figure 37 Desk Location Updated