Autodesk University 2012

A Round-Trip Through a Real-Life Autodesk Workflow

Scott Moyse - SMI Group
John Evans - John Evans Design

MA2340

Autodesk® PLM 360 to Autodesk® Inventor® to Autodesk® Simulation software with data managed by Autodesk® Vault then closing the loop back to PLM 360. Have you ever wondered if people actually employ a full workflow from concept to completion using several Autodesk tools, software and solutions along the way? Come and learn how it's done with Scott Moyse and John Evans from the Design & Motion blog.

LEARNING OBJECTIVES

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

1. Create a digital prototype in Autodesk Inventor considering CAE requirements
2. Learn how to use some of Autodesk's CAE tools to improve & validate your designs
3. Manage the entire project from concept to completion with offsite collaboration using Autodesk PLM 360
4. Store & manage versions of the design, simulation & visualization data using Autodesk Vault Professional

ABOUT THE SPEAKER

Scott Moyse is a proud Cornish man & the Design Manager at Specialist Marine Interiors in New Zealand. He's worked at the company for over 8 years after moving over from the UK while studying Motorsport Engineering.

He started out as design support & quickly moved into programming their new CNC machine. Over the next 4 years he worked closely with both manufacturing & design to create & implement automated processes. This provided him with an invaluable insight into both departments operations. 4 years ago he moved back into design full-time, resulting in him taking up his current position 2 years ago.

Over the last 18 months he's implemented Autodesk Vault Professional, improving communication, work allocation, organization & increased control over the design review process. Although he has no prior 'PLM' experience he has been deeply involved in process formation, implementation & development in an ever changing environment. Since January this year he has been implementing PLM 360.

scott@smigroup.co.nz

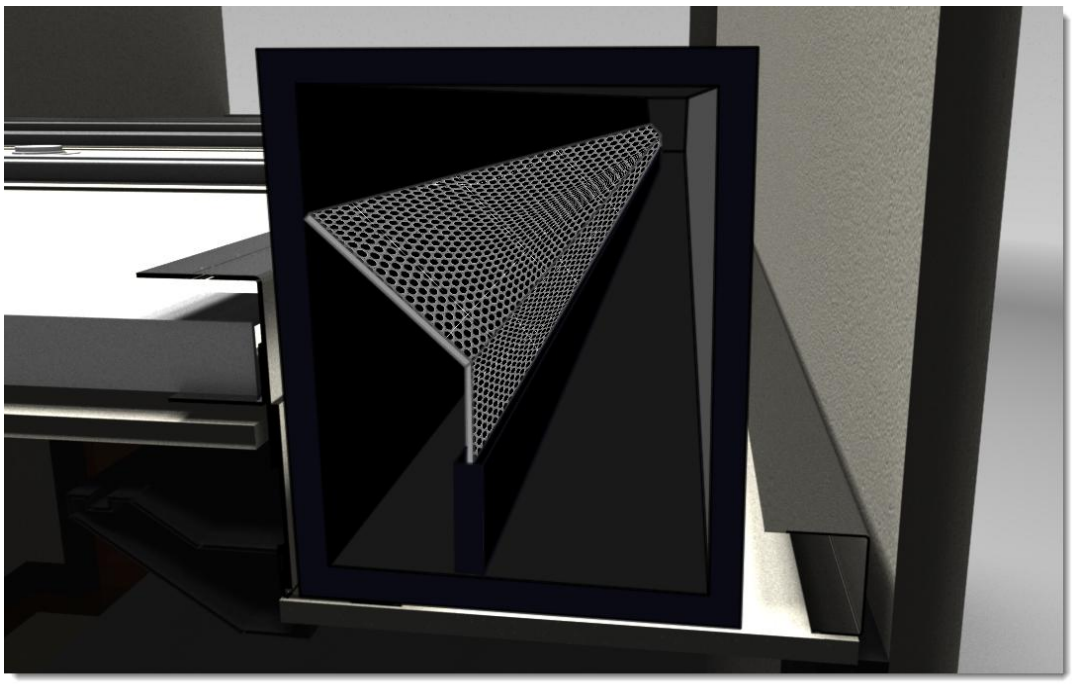
INTRODUCTION

Earlier this year I worked on a 120m Giga yacht project. Part of our company's scope was to design the fire rated ceiling system. The ceilings on super yachts are hung from the deck structure above in an isolated manner and generally have to incorporate air conditioning supply via a plenum. Space is extremely limited in the overhead space, so not only do the plenums have to be compact and light, they also have to offer enough volume for the air to expand into, slow down & quietly exit into the room. In addition the air needs to be well balanced upon delivery for even distribution throughout the room.

Since the vessel is so large, we had to come up with an effective way to manufacture a lot of custom plenums following a constant geometric cross section which performed in a desirable and consistent manner. As a team we didn't agree with the plenums internal design which had been submitted by our client. So I contacted John knowing he was expanding his simulation knowledge and asked if he was keen to perform some CFD on some of our design variations.

It seemed natural to present how we achieved this; including a number of retrospective adjustments which would stand us in good stead should either of us require this kind of workflow again in the future.

The last 2 learning objectives will be covered throughout the presentation since they are by their nature interwoven within the entire process we are about to show you.



HANDOUT ICONS

Throughout this document you will notice a few different icons, we wanted to make more of the document visually instructional instead purely texted based. The 1st time a repeated process is used you will be introduced to a new icon. Thereafter it will just appear within the documentation whenever that process should be used.

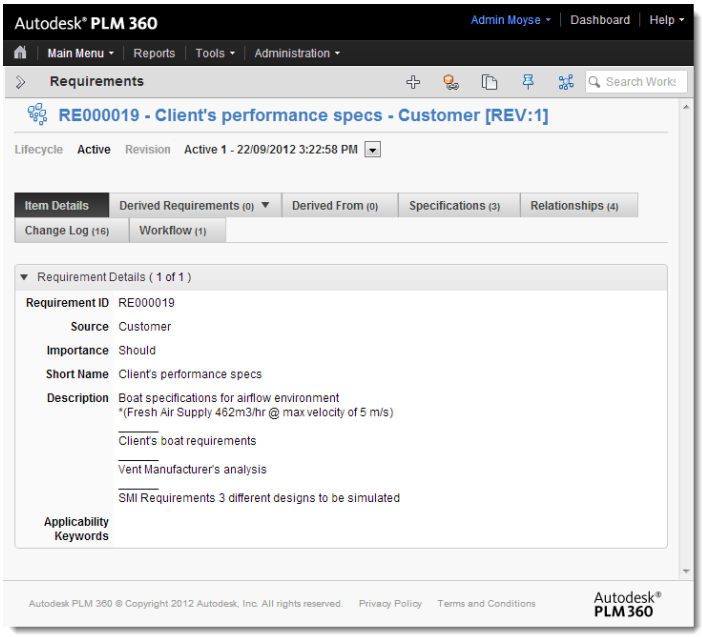
DESIGN BRIEF

Establish the effectiveness of using baffles & air straighteners to reduce turbulence and therefore sound in a super yacht air conditioning supply plenum. This needs to be achieved across two time zones 17 hours apart.

IDEATION & CONCEPTS

INITIAL REQUIREMENTS

The Initial Requirements come from a couple of specification documents provided by our client. These types of documents are always stored within Vault along with all the design files. However for collaboration outside of the design office it may be necessary to store them within the requirements workspace of PLM 360. As a result we are duplicating the data between Vault & PLM 360. You just have to make the call on whether it's worth duplicating the data in these cases.

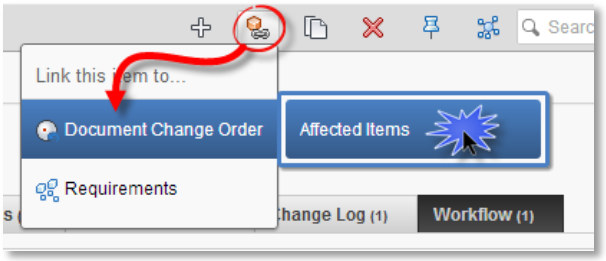


In this situation, since we are engaging a sub contractor to do some work for us, PLM 360 is the ideal platform to manage the collaboration with.

To begin, I create a Requirements Item, and then attach it to the Projects' Simulation CFD study task we assign to the sub contractor.

Creating the Requirements Item is fairly straight forward:

1. Fill out the Item Details
2. Attach the specification documents. It is very easy to attach Vaulted files to a PLM Item since you can drag & drop directly from Vault Explorer into the attachments tab in PLM 360, you don't even have to have the file checked out in Vault.
3. Click on the Create Relationship button & create a new Document Change Order:
4. Make sure you only add yourself to the 'Approvals Required' field.
5. Click on the Workflow tab then select the change order you just created.
6. Cycle through the workflow states until you reach Closed.



7. Now the Requirements Item you created has been locked & versioned.

Refer to the video in my presentation for steps on how I used this workflow

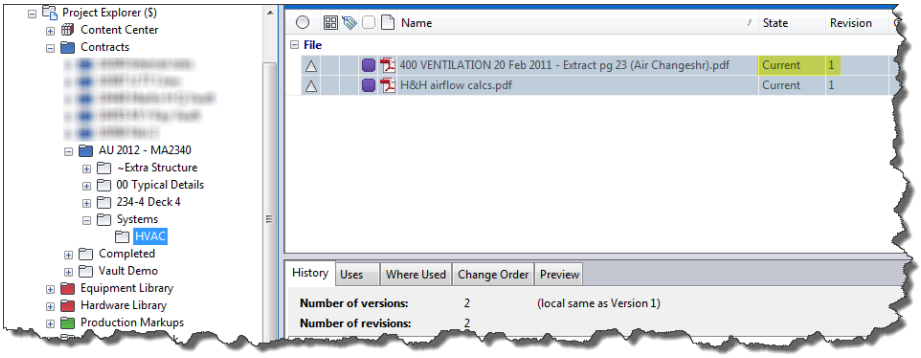
Targets & Boundaries Summary:

1. 462 m3/hour
2. Max Supply Velocity of 5m/s into the Plenum
3. Max Exhaust air velocity of 4m/s
4. Max Velocity outside of Air ducts is 3.5m/s

To summarize; the minimum TARGET supply must be met in the quietest way possible. Generally the faster the supply from the plenum exhaust the noisier it gets.

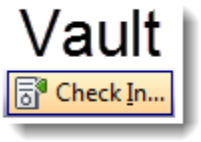
Autodesk Vault

All systems specification documents received from the Client are stored in Vault within the respective contract folder under the systems folder.

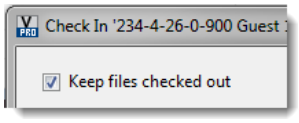


Add the files to the Vault either by checking them in from an application add-in or dragging & dropping them from Windows Explorer to Vault Explorer.

If it's not possible to setup a rule to automatically categorize the files, change the category if suitable. We change files received from the client over to a category called Customer files, which assigns a basic lifecycle & revisioning scheme to them.



From now on whenever you see this icon you need to check in the file(s) you are working with. If the files belong to an application which has a Vault client add-in, it's highly recommended you use that method. Otherwise once the files are in Vault you can check them in & out from within Vault Explorer. Often you may opt to 'Check In' but keep the files Checked Out, this will skip the need to check it out again later if you know you'll need to overwrite a version soon.



SKETCH PLENUM CONCEPT

At this stage of the project a number of things have already been designed or defined:

1. The room layout and ships structure are known.
2. Ceiling construction details are set
3. Ceiling Coffer layouts and Styling have been defined by the Interior Designer
4. The guts of the HVAC system have been routed, so we know how many ducts are supplying each coffer.

As a result we are able to define the structural space & the maximum available dimensions for the supply HVAC plenum. From this we are able to take some sections screenshots which will allow us to brain storm ideas by sketching out concepts over the top of it using Sketchbook Pro.

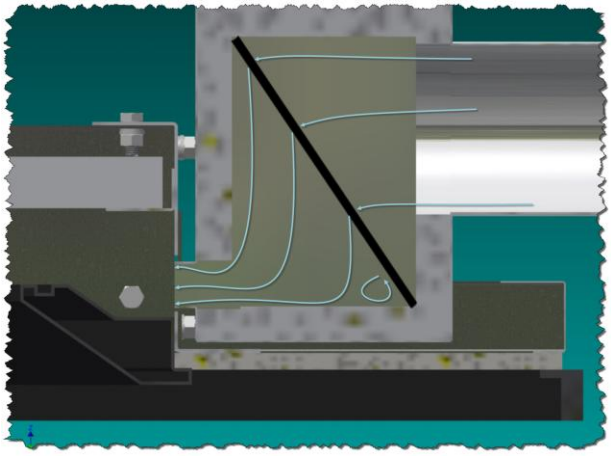
I chose to use Sketchbook Pro on my iPad to take advantage of the touch screen since I don't have access to a tablet for my PC if I were to use Sketchbook Designer. The downside to this choice is I won't be able to reuse the geometries I draw since there isn't support for Vector layers within the mobile version of the application.

I used Layers to separate my concepts, it was quite a handy approach, since I was able to quickly switch between ideas or borrow objects I had already drawn across multiple design ideas.

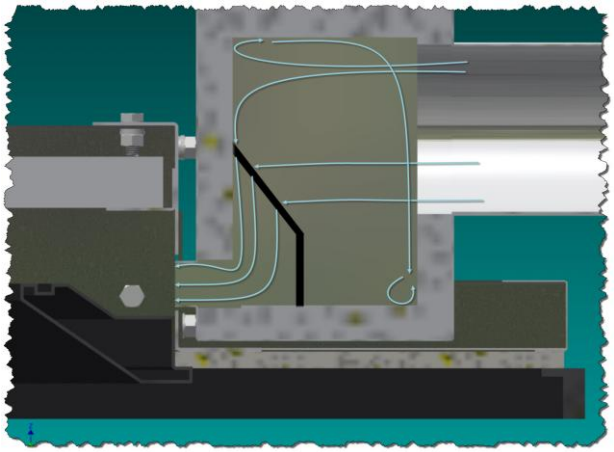
Ideation

As part of my ideation process I decided to import the images into Snagit & apply some vector arrows predicting what I think may happen to the airflow within the different design configurations. It will be interesting to compare these later on in the process.

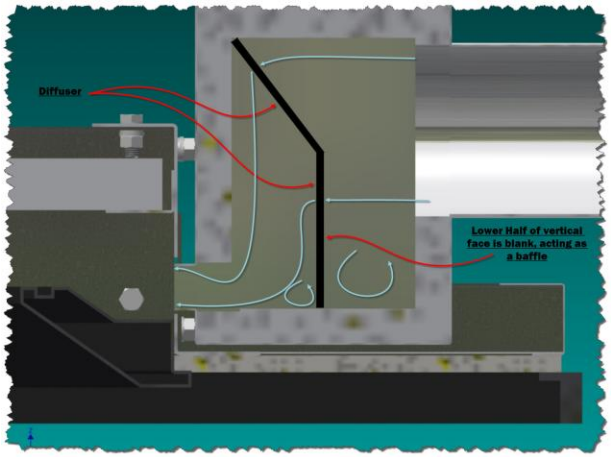
Concept 1:



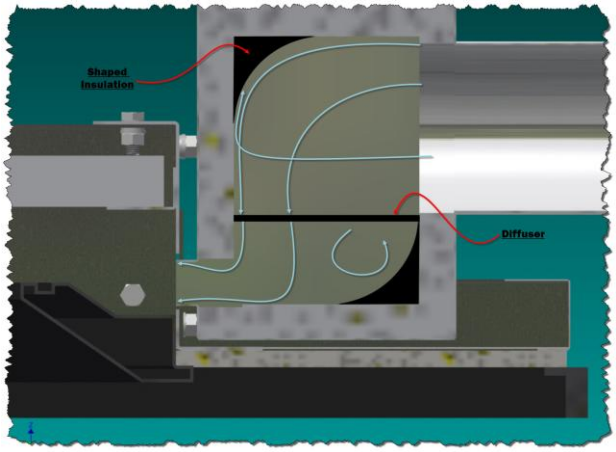
Concept 2:



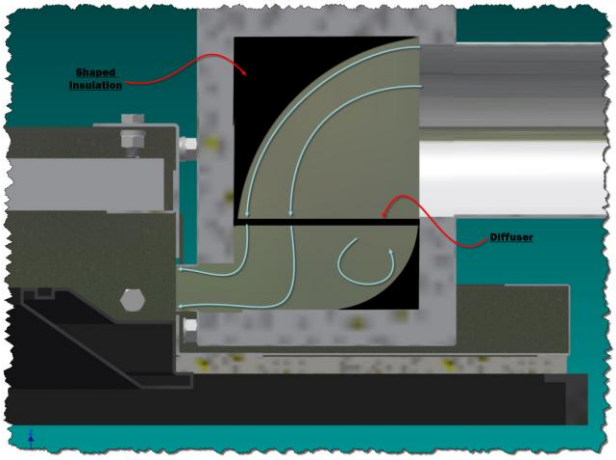
Concept 3:



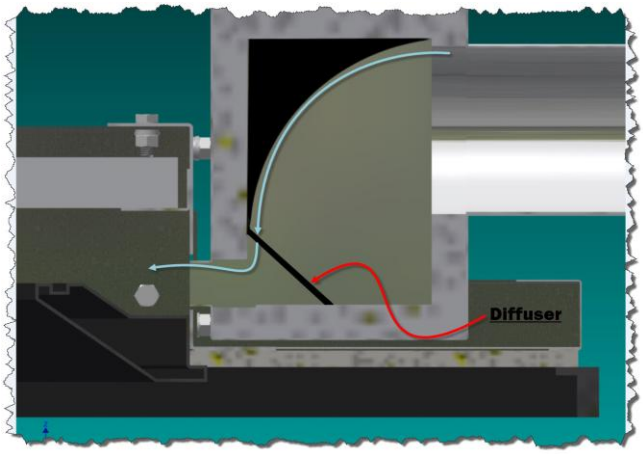
Concept 4:



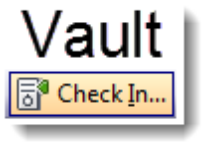
Concept 5:



Concept 6:



Autodesk Vault:



- Email Sketchbook Pro Mobile files to myself
- Save them into the 'Plenum' directory in my Vault Workspace
- Drag & drop those files into the equivalent folder in Vault Explorer.

Note: *If I was using Sketchbook Pro the story would be much the same, albeit without the need for emailing the files, as a result you would be able to 'version' the concept images by checking the Sketchbook Pro files in and out of Vault.*

As part of the Product Design Suite you are more likely to be using Sketchbook Designer, so if you have the Vault administrative option for 'Disabling Check In of Design Files' enabled (If you don't you should have!), then you are out of luck. You won't be able to check in your Sketchbook Designer DWG files, since Vault treats them as AutoCAD or Inventor DWG files. Alas, without Sketchbook Designer Vault integration ***you can't version your 'Designer' and therefore Vector Layer based concept files.***

PLM 360 CONCEPT COLLABORATION

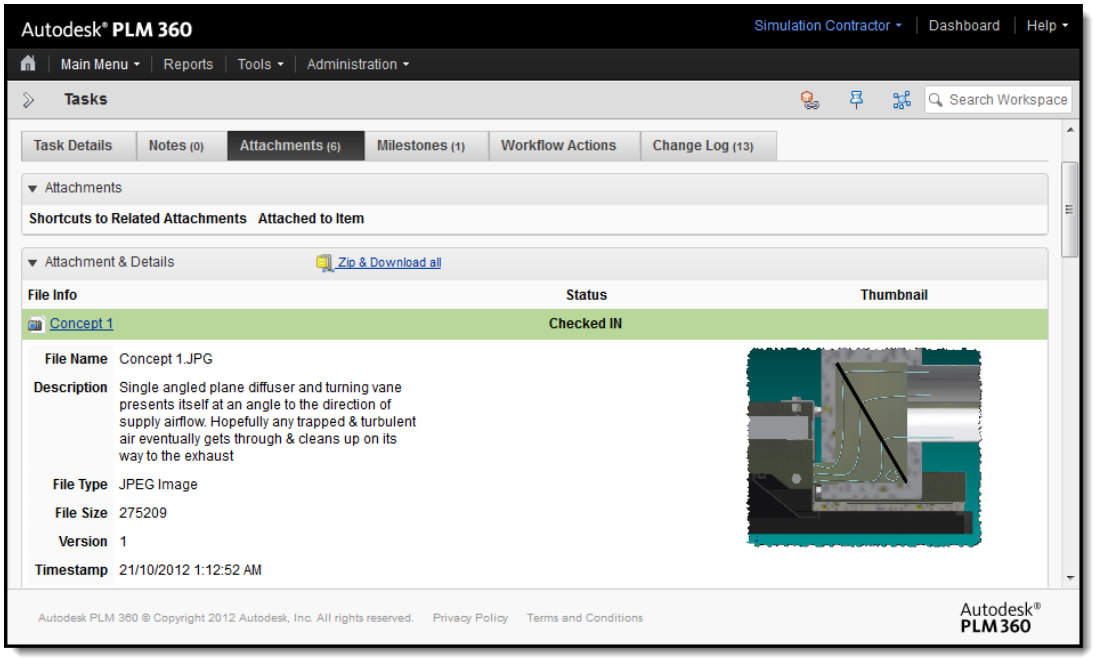
Since we only currently have the budget approved to run 3 different designs through CFD, we have to pick which designs we should spend the time modelling & subsequently simulating. Therefore, it's logical we engage the CFD simulation contractor at this point via PLM 360.

To open up collaboration on these ideas with the simulation sub-contractor, we create a new task from the Projects' Project Management tab. Fill out the prerequisites then edit the new task item to add the additional information & change ownership over to the subcontractors user account:

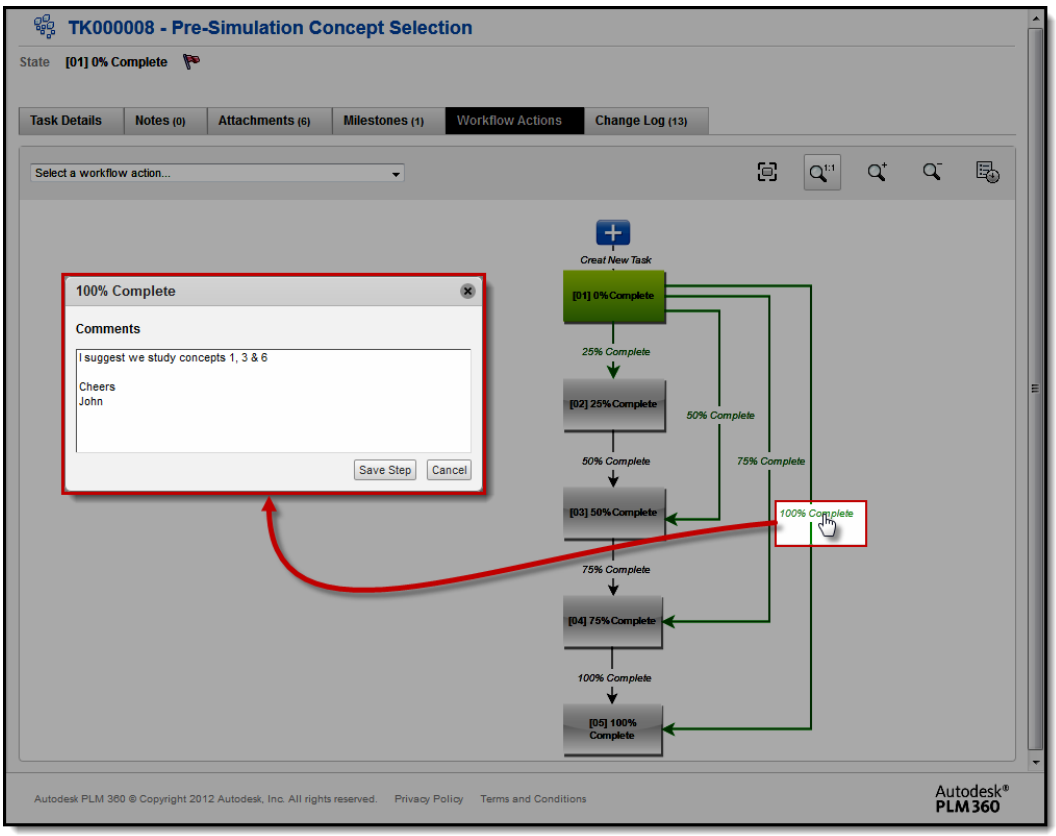
Refer to the video in the presentation to see how I completed this workflow

Simulation Contractors Workflow:

1. Browse to the Concept review Task
2. Download & Review the Concept Images

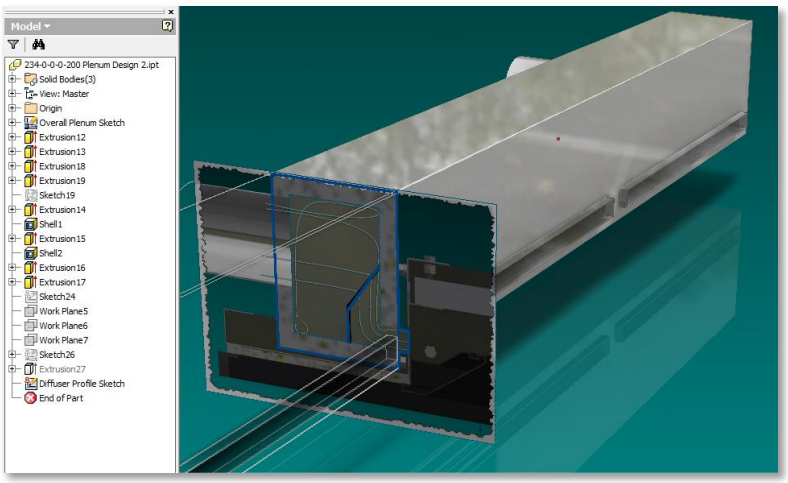


3. Switch over to the Workflow Actions Tab to change the state of the Task over to 100%. As per the instructions in the Item Details description make sure the comment section contains the Concept choices the Simulation Contractor is suggesting.



AUTODESK INVENTOR

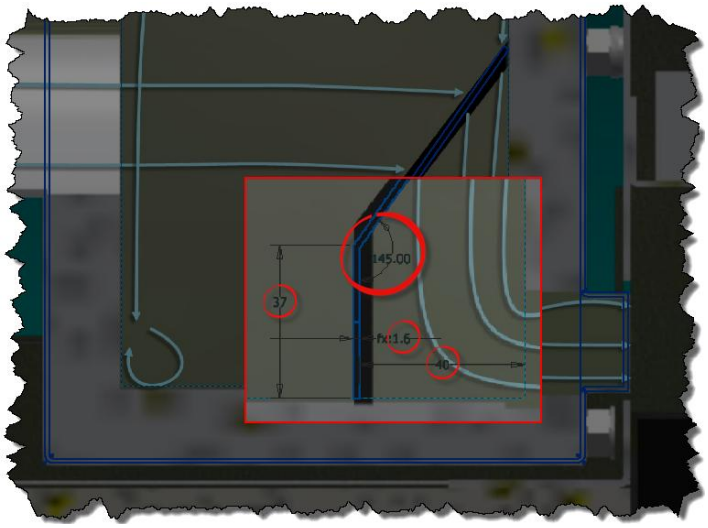
MODEL PLENUM CONCEPT



We chose to decline the simulation contractor's choice including concept 6. We're going with concepts 1,2 & 3 on the basis that they are simpler to manufacture.

I modeled the plenum to known dimensions including everything I know I'm going to need across all the chosen variations. At that point I save off a copy to use as a template then place and constrain it into the ceiling assembly.

Tip: *Using this approach has the added benefit of maintaining the unique face ID's across all the design versions, which means replacing the versions within the assembly won't result in failed constraints.*



At this stage I don't need to model it with sheet metal manufacture in mind, which can be done once the chosen design has been finalized.

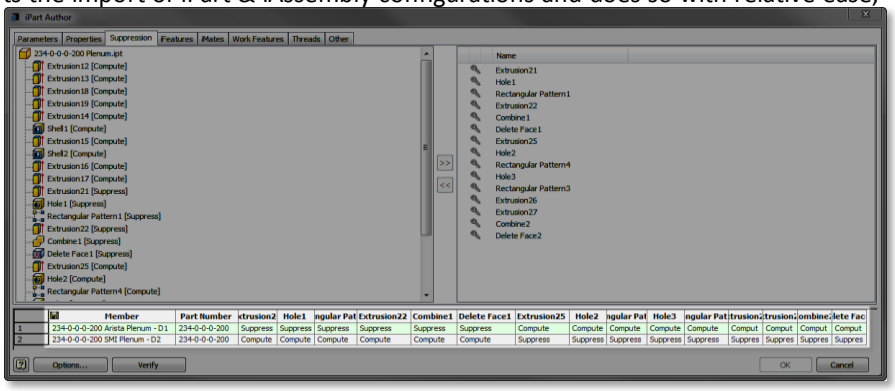
Having saved off my template, I can copy it then customize each one to create the individual concepts. I start with importing the image created in Sketchbook into the Overall Plenum sketch. As you can see my 'hand' drawn lines are far from perfect, whereas you would obviously want to apply angular & linear dimensions which make sense.

Create all the bodies you require for each concept, creating the bodies is important since Simulation CFD picks up on those and differentiates them allowing materials to be applied to them individually.

iParts:

Because we are effectively creating configurations, you might wonder why we aren't suggesting the use of iParts. The answer is simple; there are too many features to suppress from one iPart table row to the next.

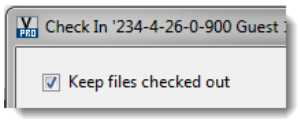
The Simulation CFD add-in supports the import of iPart & iAssembly configurations and does so with relative ease, but I believe it's mainly intended to support optimization type workflows.



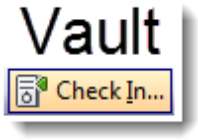
In this particular case we don't think it provides any real benefit. Each time a new concept/configuration row is added to the table, another 3-4 columns need to be added for feature suppression.

If your workflow was naturally iParts then by all means the Simulation iPart export tool is magnificent, however, there is no need to create an iPart specifically for the transfer to SIM CFD.

Autodesk Vault:



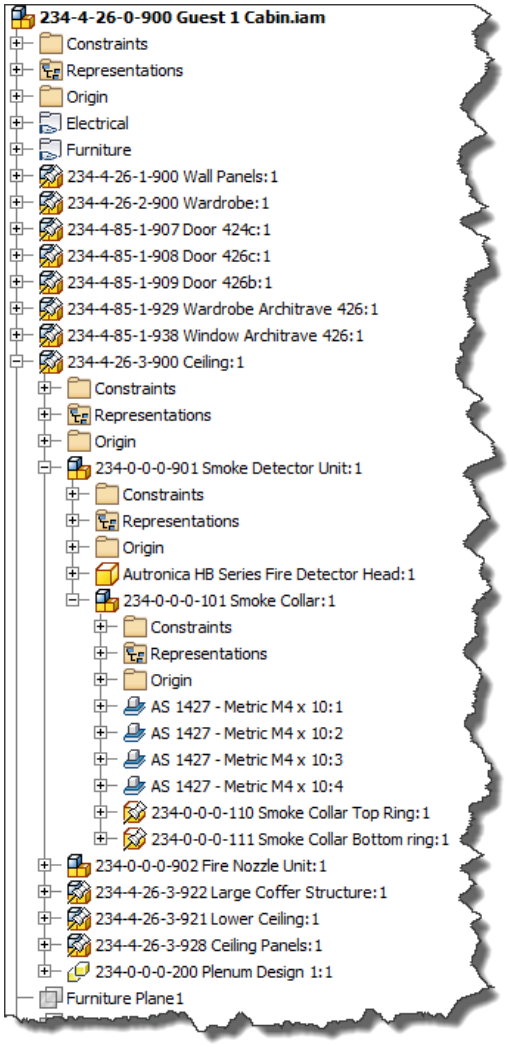
Each concept design part file is checked into Vault so versioning can be maintained. Since the final design of the plenum will be used across a number of areas on this project it's saved into a folder named 'Local Library' in the project workspace.



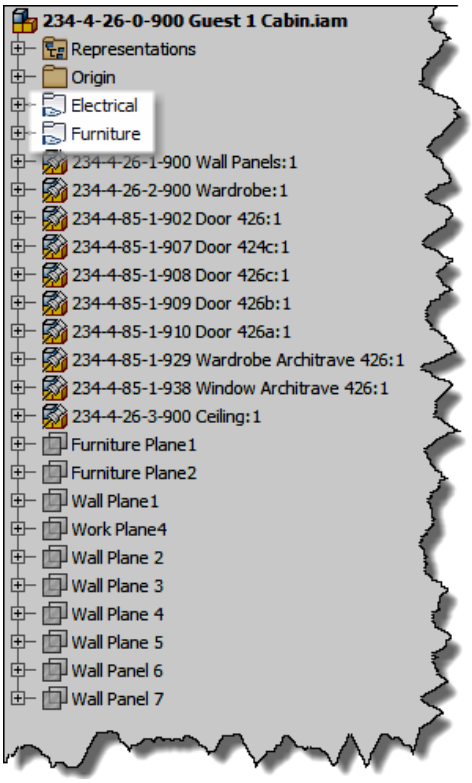
FULL DATA SET SIMPLIFICATION

Once we have ascertained which Plenum design achieves the required specifications & fulfills our manufacturing requirements, we will take the output data & run a simulation on how the air is distributed throughout the room. So I have included the Plenum into a ceiling assembly & subsequently an entire room assembly. This will mean a large amount of simplification needs to be done so we can pass the design into Simulation CFD 360.

Since the entire room is going to be passed into simulation, we have to find a way to balance the needs of the digital prototype and the simplistic 'watertight' geometry called for by CFD simulation. Therefore the room is broken up into logical sub assemblies:

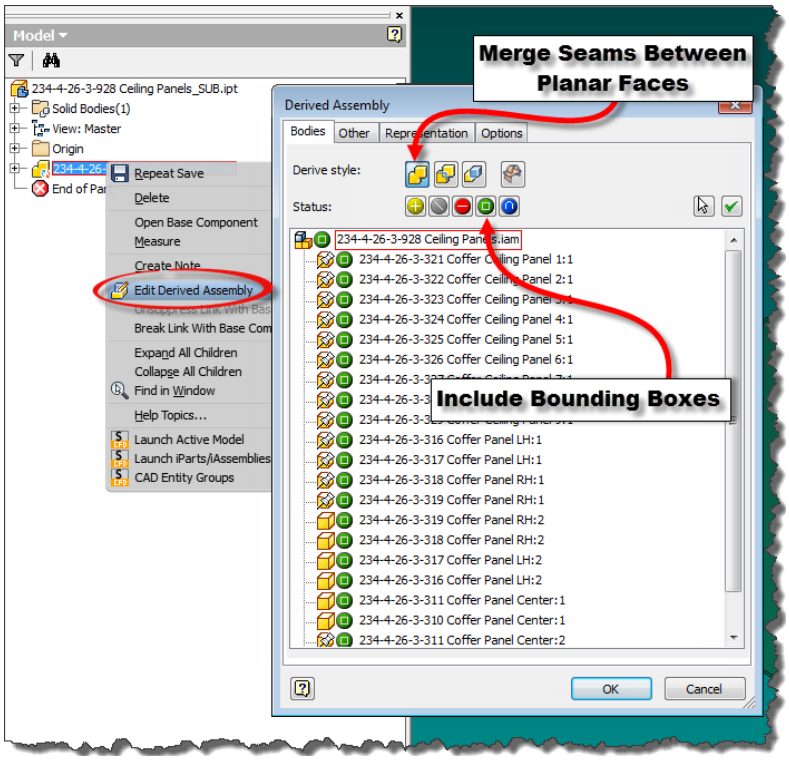


In addition I've made use of Assembly browser folders here to organize parts placed in the main assembly into logical groups.



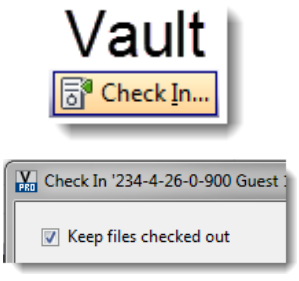
I've then gone through the sub assemblies systematically using the following simplification techniques:

Create Substitutes



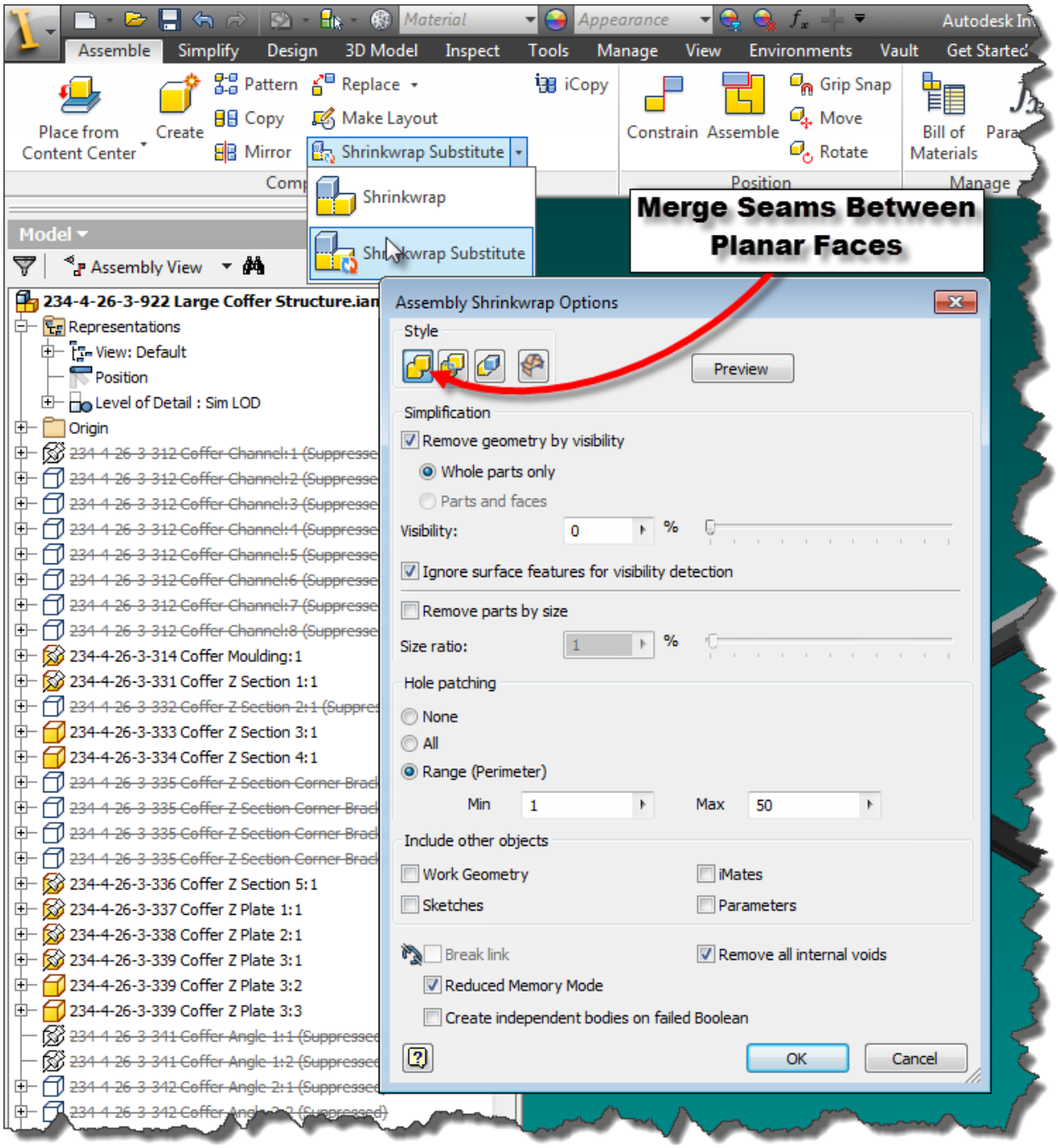
If you need to blend a number of parts with gaps between them into a single body you can use the Bonus Tools 'Create Substitutes' command.

Then edit the newly created part, edit the derived node then change the derive status over to bounding boxes instead of 'Includes'. Remember to switch the Derive Style over in order to merge out seems between planar faces.



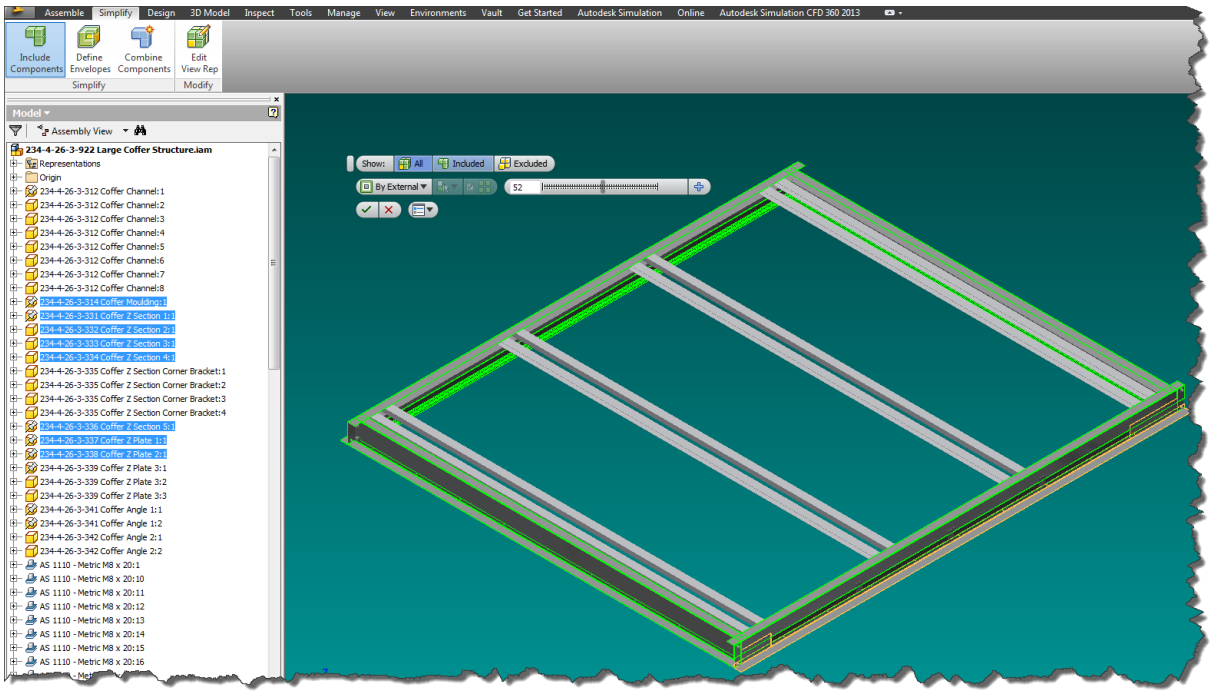
Shrinkwrap Substitute

If you need to blank off a bunch of features but maintain more of the geometry, then using the shrinkwrap subsitute tool is very appropriate. You can consider basing the substitute on a Level of Detail to decrease the number of parts before you even start simplifying with the Substitute tool.



Tip: *Often the Shrinkwrap tool doesn't give you the flexibility to remove some of the larger unnecessary components. So you can suppress the components (using a Level of Detail) you don't want to have included prior to launching the Shrinkwrap command. I have had to use this technique on the Ceiling structure assembly to remove the components I didn't want included in the simulation above the ceiling panels.*

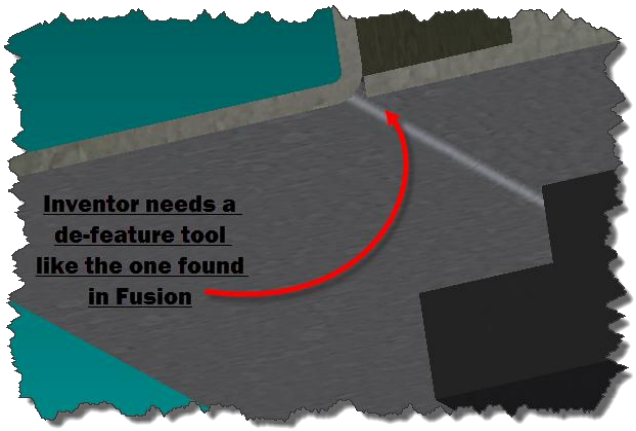
Labs Inventor Simplification Technology Preview Tool



Then there is the Simplification tool from Autodesk Labs. It's a nice expansion/compliment to the Substitute tools which ship with Inventor. It does a great job of dealing with the issue I highlighted in the tip above and it also allows you to cap any shape penetration in the part environment (not just holes).

The various selection filters are phenomenal, but there are some workflow issues:

1. Once you use the Combine Components tool, there doesn't appear to be a way to use the resulting part file as a substitute in the assembly without placing it in the assembly as a reference component and controlling it all via an LOD.
2. If you have voids to fill then you have to edit the derived assembly from within the part file, jump to the options tab then turn on 'Remove all internal voids'. This is an acceptable workflow; however, it fails if you do this after having capped any holes.
3. Often there are 'open' pockets or slots between components which need to be filled, but there's no option to do this with any of the simplification tools in Inventor to date, it would be nice if this tool addressed that in the future by 'welding' faces together within a certain tolerance of each other, but also with a manual override if needed.

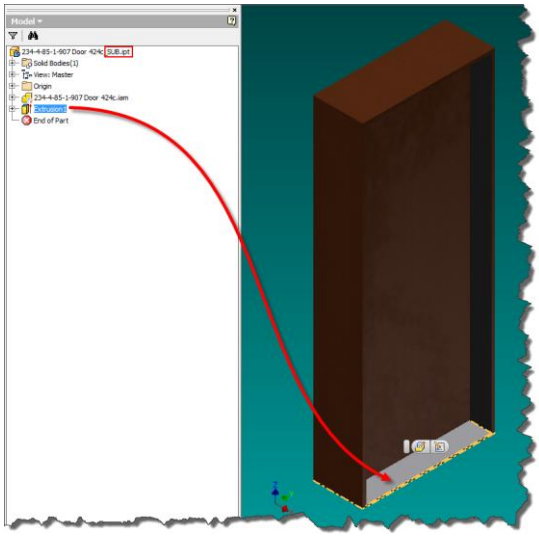


In the real world, the 3rd limitation throws up a problem, since there are often situations where there are open 'slots' or gaps between components which will need to be closed up for the benefit of CFD. In this case the faces between the sheet metal parts are adding unnecessary complexity, but also with the ceiling panels in the coffer, there's a 5mm gap running around its perimeter. It would be nice if these types of gaps could be filled easily within Inventor.

The 1st workflow issue is why I used a combination of an LOD and the Shrinkwrap Substitute commands. I just wish I'd had the selection tools available in the Labs simplification tool.

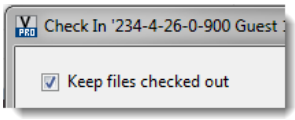
Modifying the substitute part

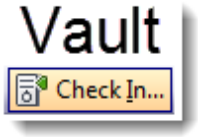
To overcome some of the simplification issues surrounding the 'open' penetrations none of the intended tools can deal with, I have opened up the substitute part file created by the above methods, then just added features to fill in cavities or simplify otherwise complicated geometry.



For this door I added a false floor which will then allow the Sim contractor to define the gaps around the door leaf as additional routes for the air to exit from the room.

The convenient thing about this technique is you aren't modifying the original part to create the geometry which is only needed for simulation.

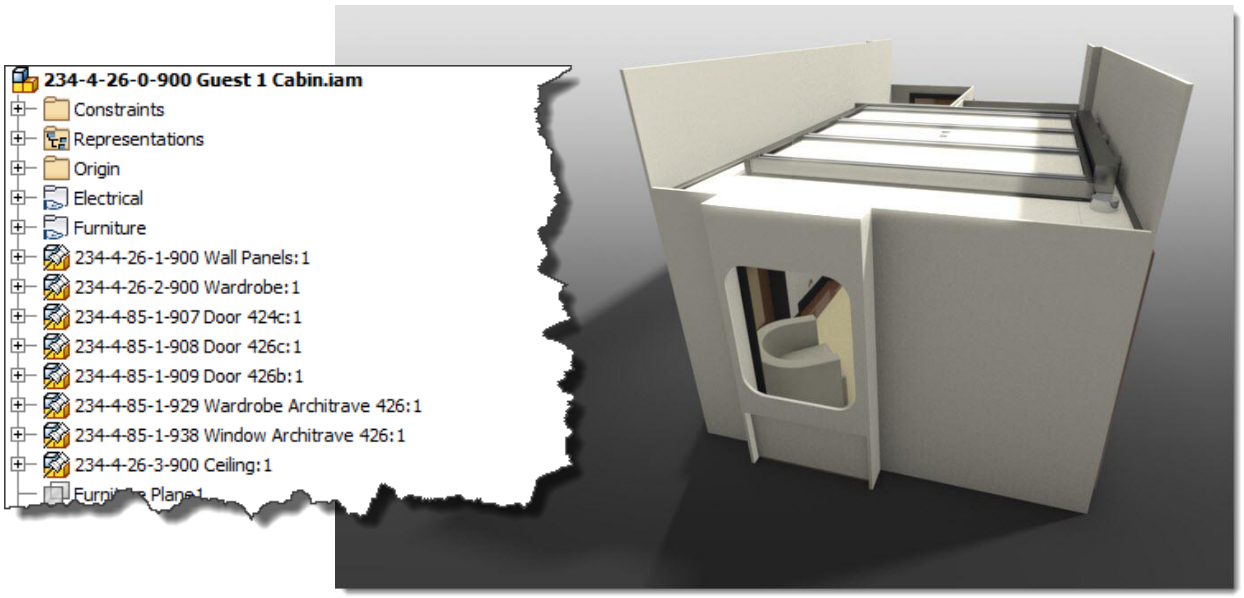




I have noticed an annoying issue though, it appears that each time you update the substitute Inventor completely refreshes the bodies. Essentially this means any features you add aren't associative because the faces the sketches or workplanes are applied to end up with a different internal ID, creating a series of errors. So its best to use this technique only if absolutely necessary & once you know the referenced files aren't going to change thereby pushing an update.

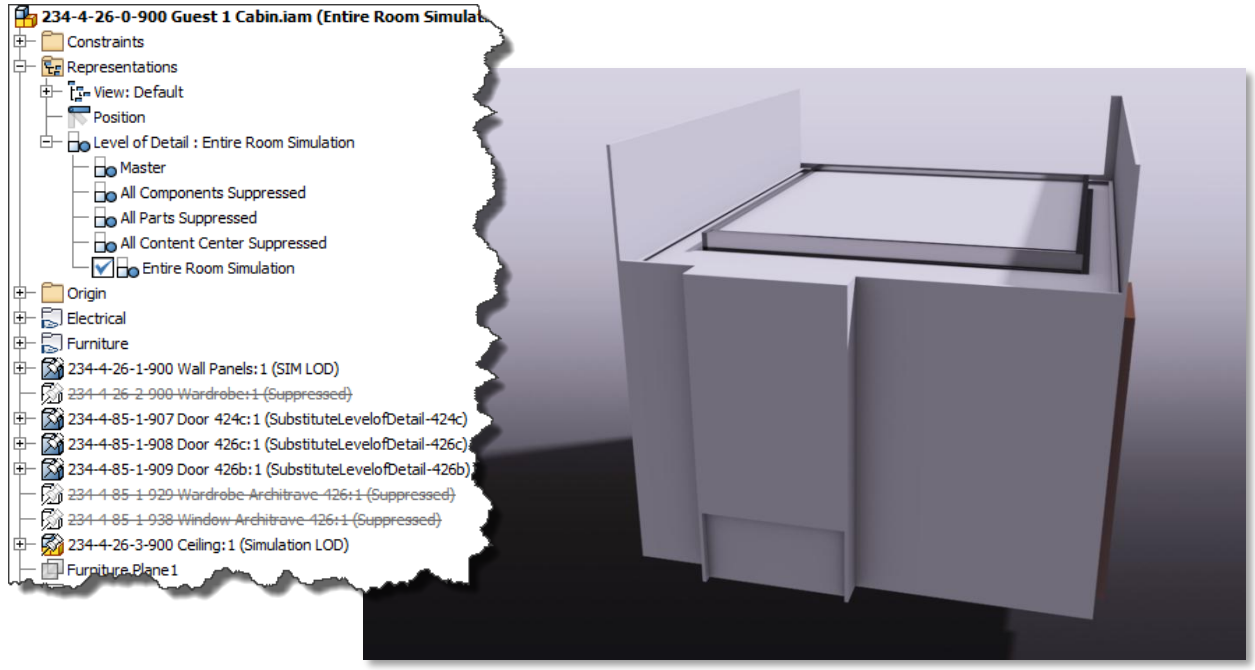
INVENTOR SIMPLIFICATION RESULTS

Before



All components are active & there are gaps everywhere between components (ceiling panels, sheet metal, door frames etc). Inventor's model brower above shows all the components appearing as normal with zero suppressions.

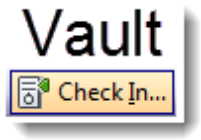
After

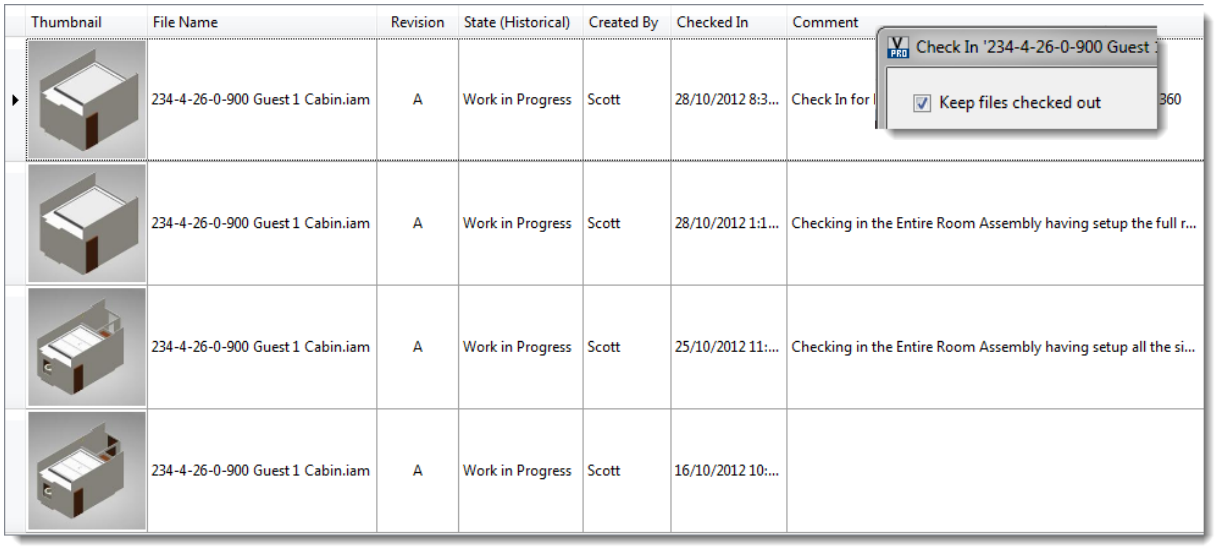


Now you can see the model has been hugely simplified, in addition the Inventor Feature Tree now shows substitutes and suppressed components all controlled via the LOD's.

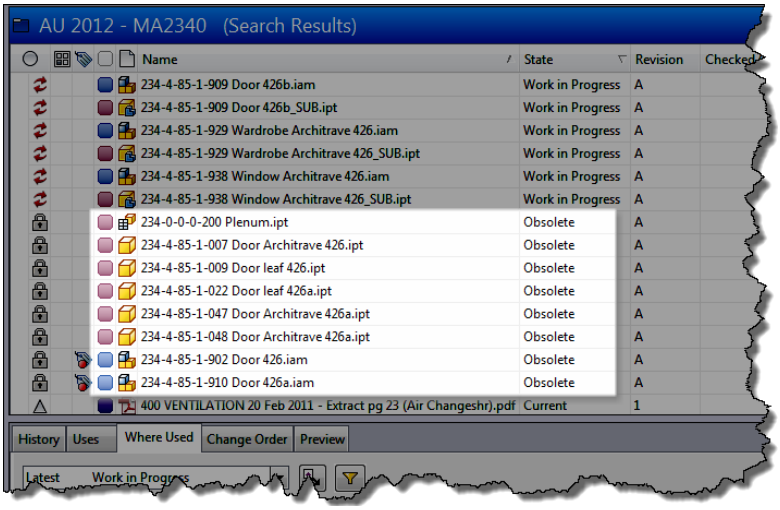
Autodesk Vault

At each significant stage during the models creation I save the dataset & check it into Vault, with comments detailing which changes have been made and/or what the intended next step is. We will then be able to view this information within each files History tab within Vault Explorer, additionally we will be able to search on the content of these comments.



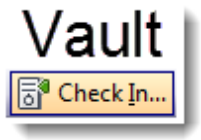


Lifecycle state change



Inevitably as part of the design process some components or designs may become obsolete, using Vaults lifecycle workflow I make sure that instead of deleting them forever they are just switched over into an obsolete lifecycle state.

This maintains an accurate history for assemblies which have used them. It also gets around any Vault errors relating to the file being used by a previous version of another file in the system, when you try to delete them from the Vault.

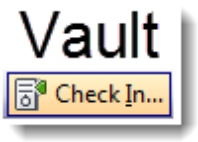


Discussion Point

It's debatable whether or not the obsolete files should be visible to the designers or not. If they are visible then they can see if a part number has already been used or if an obsolete design fulfills their needs & it needs to be resurrected from the dead.

PDM & COLLABORATION

CREATE PRE-RELEASE VAULT BOM

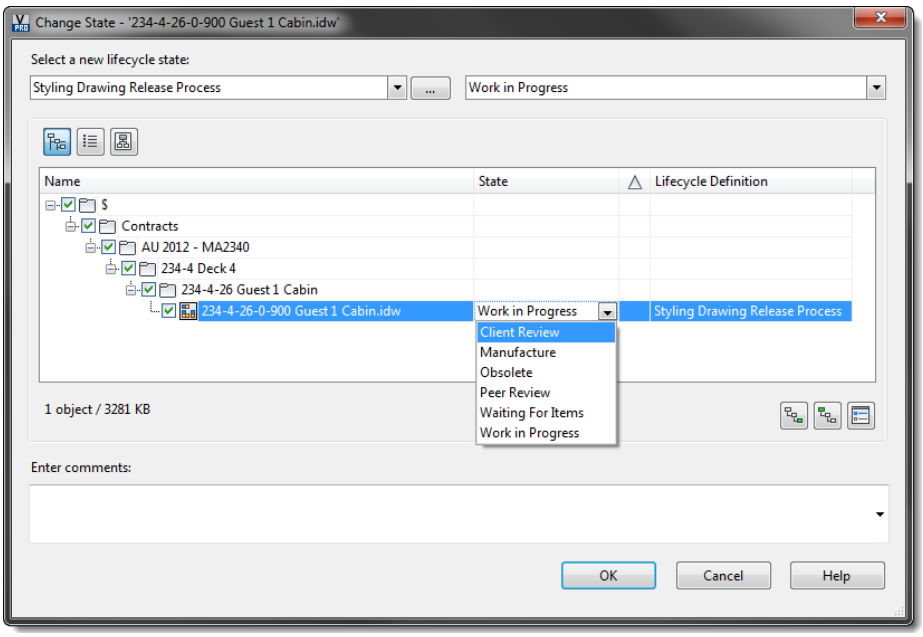


The entire room assembly is ready in principle. We want to upload the pre-release BOM to PLM 360 so stakeholders can start to leverage the information, therefore compressing the lead time between design & manufacture. In this specific case we would like the ability to share BOM Item data with the Simulation contractor if we need to.

Once you have your BOM released with no revision bump, export it from Vault using the Parent method. You will then be able to use PLM 360's import tools to get this data uploaded. For an explanation on how to do this check out Michelle Stone's blog post over at Under the Hood.

MANAGE DESIGN LIFECYCLE IN VAULT

I also use Autodesk Vault throughout the design process to manage the lifecycle of my drawings.



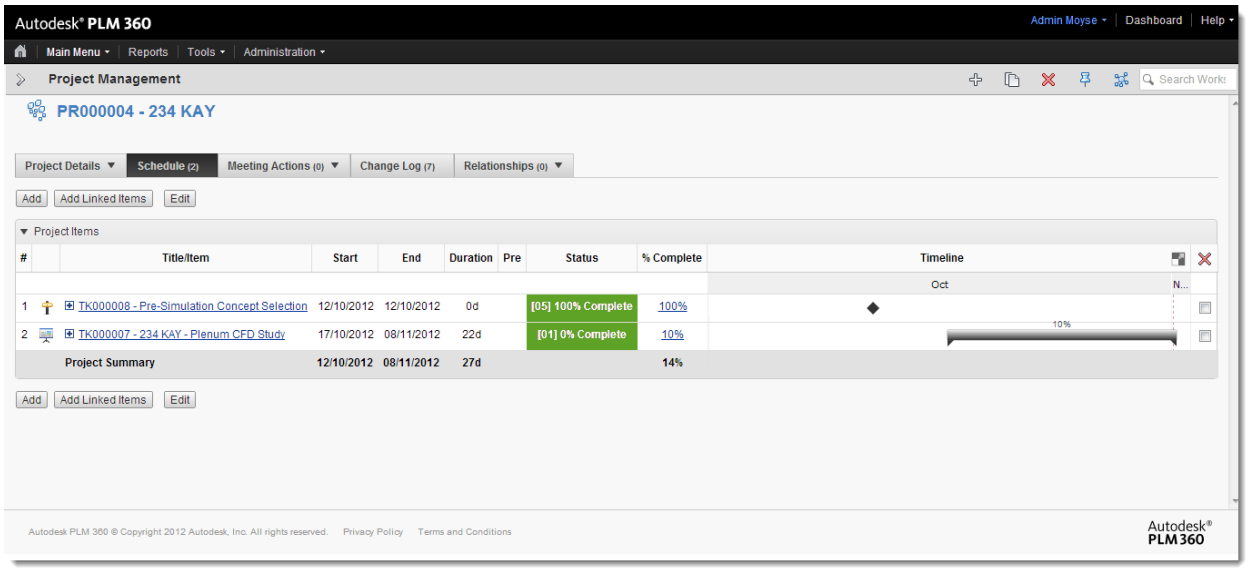
The lifecycle's for the components are fairly basic, but for drawings I want to control the revisions more carefully during the pre-release phase to maintain clarity while reviewing drawings internally & externally with clients & suppliers.

The added benefit of using file state changes is the ability to purge out file versions between state changes from the ADMS console at an administrative level. This is ideal if you need to manage the size of your Database & Filestore.

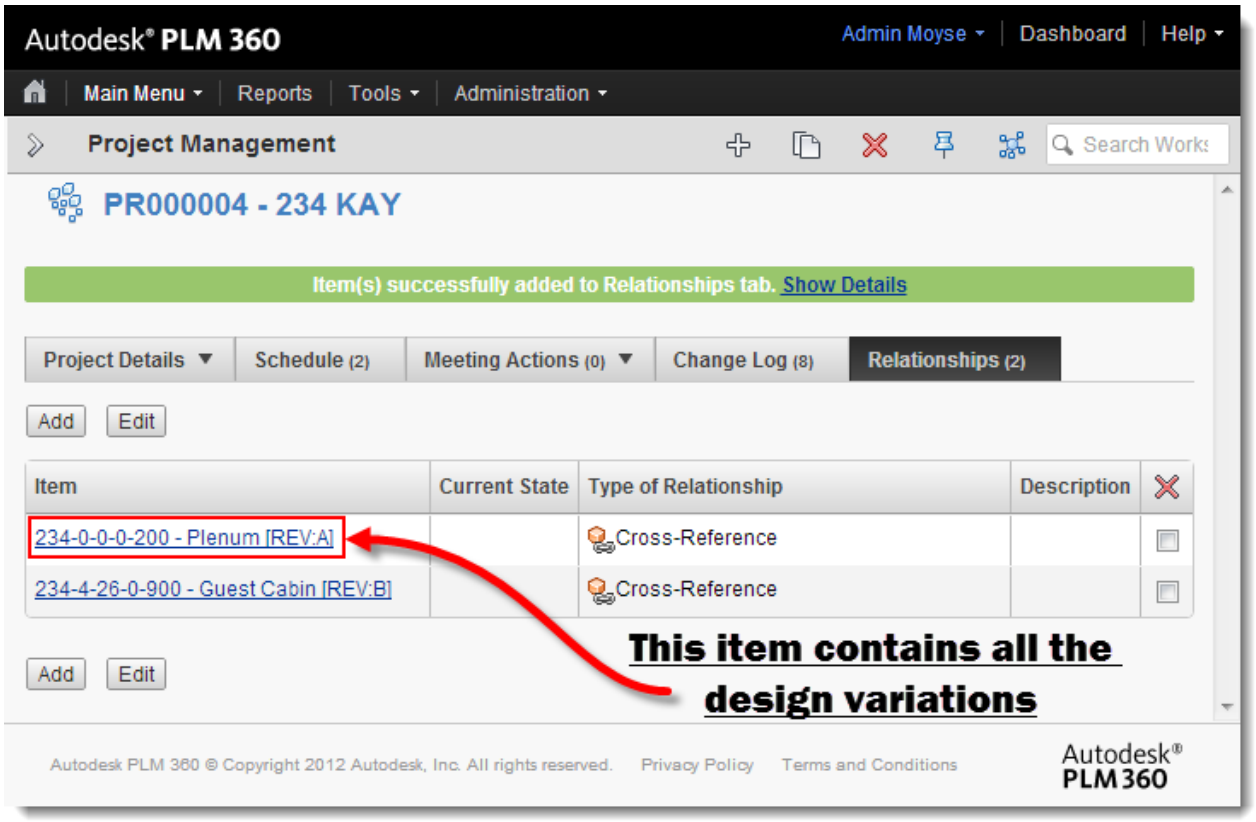
PLM PROJECT

The sole purpose for the project Item in PLM 360 is to tie together all aspects of the project across all processes & departments.

All the Tasks associated with it are nested under the Project Management (Schedule) tab:

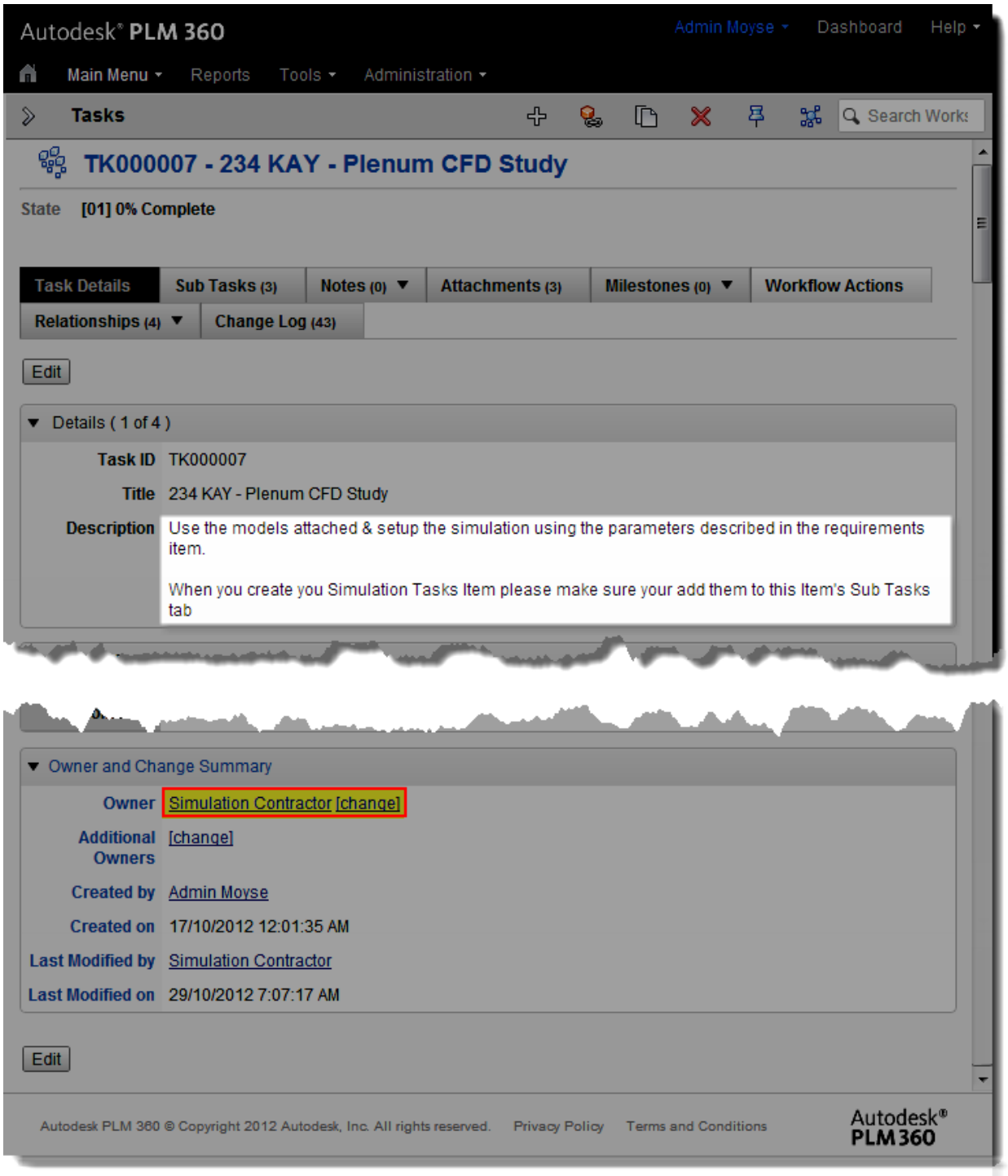


All relevant BOM items imported from Vault are added to the Relationships tab:



PLM TASK ASSIGNMENT

Now comes the time to assign the simulation task to the sub-contractor. I use the same steps to assign this task as I did for assigning the concept collaboration task, along the way I make sure to include clear instructions for the sub contractor explaining I would like him to create his own Simulation Task Items & add them to the Sub Tasks tab on this Item.

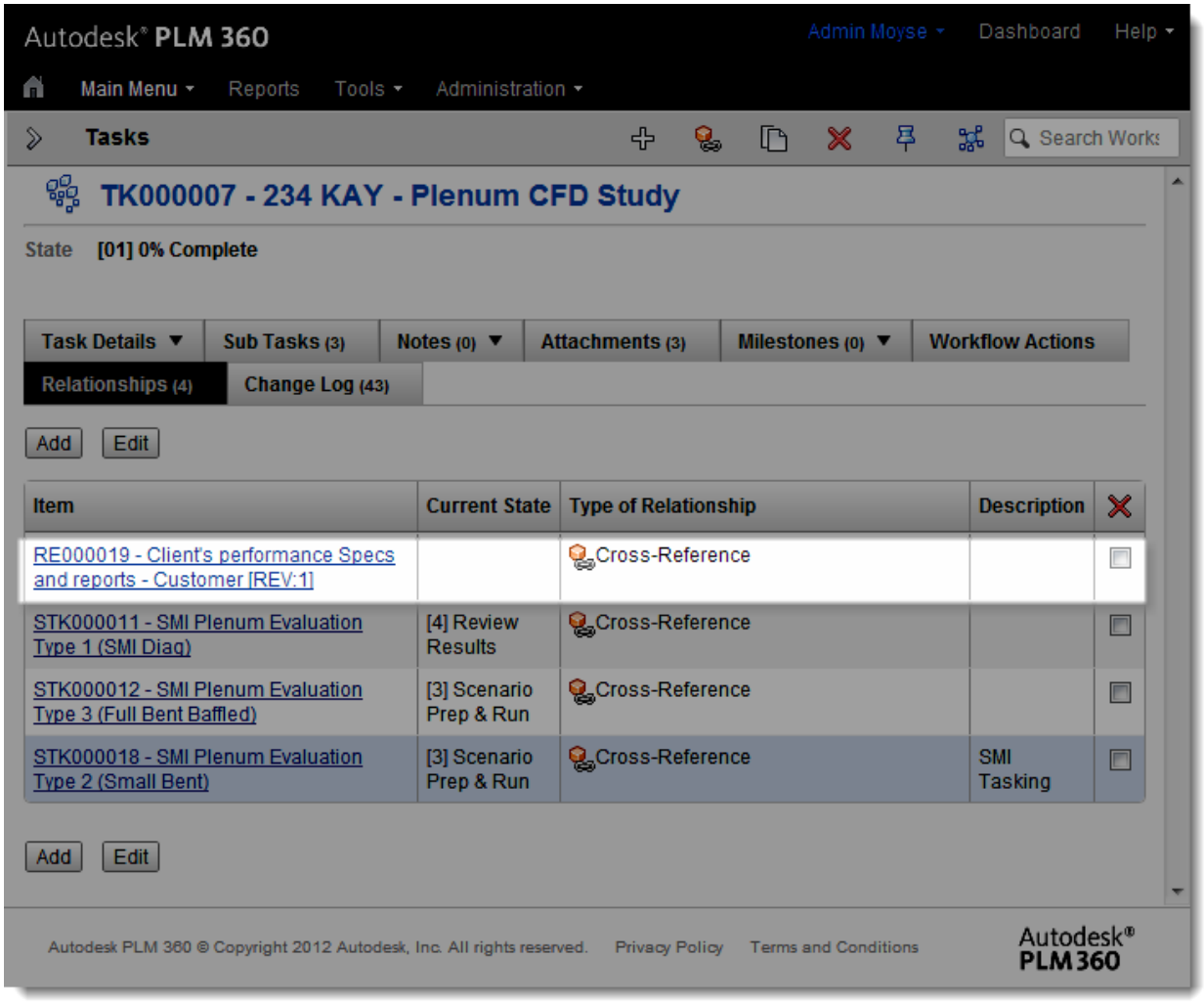


I made sure to add them as the owner of this Item, otherwise due to their user permissions they wouldn't be able to see it. The idea behind this method is to restrict their view of your tenant only to the items they own.

Tip: *Make sure you select to notify the user about making them the owner of this item. Then not only will this Item appear in their Outstanding Tasks section of their homepage but they will receive an email notifying them they have a job to do.*

The next steps are:

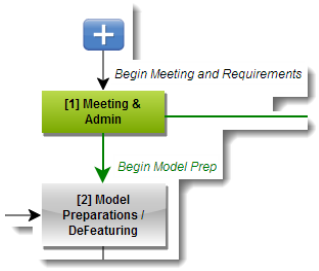
1. Attach the Inventor part files directly to the Item
2. Add the Requirements Item to the Relationships tab.



AUTODESK SIMULATION CFD 2013

The PLM 360 task was issued from SMI, which contained all the relevant information required to perform the task, including:

- Related Requirements item containing the specifications
- Previous Environment analyses
- The Plenum Model Inventor Files

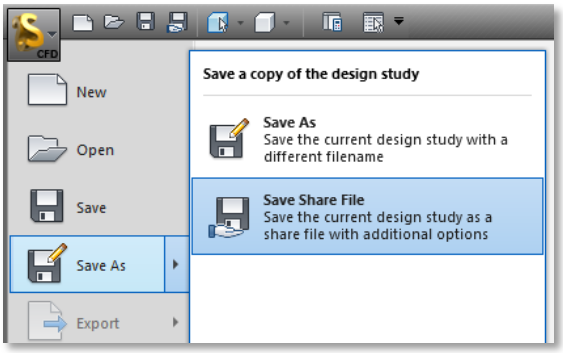


Note: *Keep track of the Workflow Actions Icon that I have at relevant locations during my workflow in our discussion. Rather than stop and say that I need to update my Workflow Actions, I have simply shown the icon at that point.*

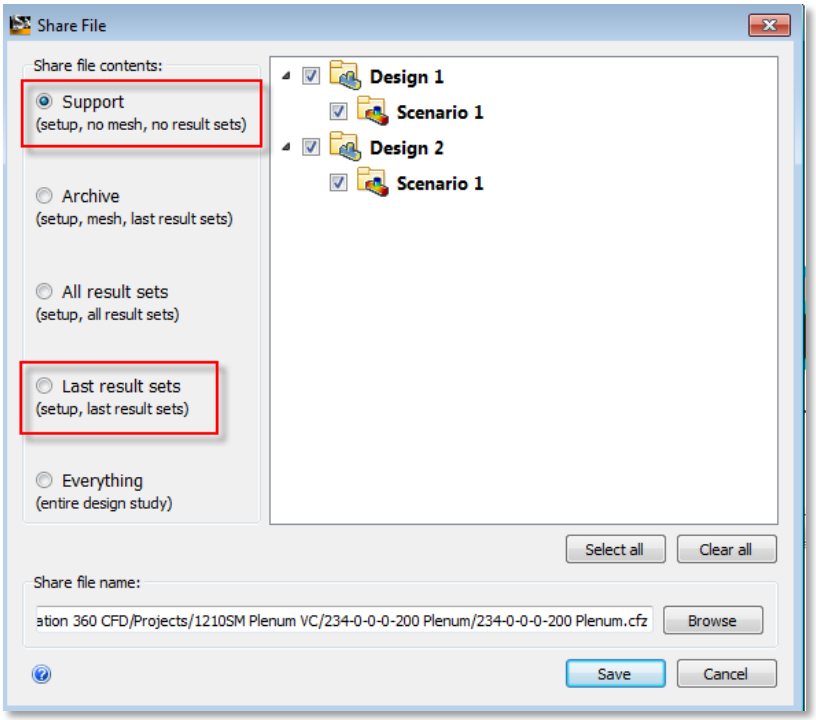
A NOTE ABOUT CFD AND VAULT

We use the Vault Add-ins in Inventor and Fusion where possible to keep the model connectivity intact. CFD however does not offer Vault integration and as such we use the CFD Share File option to incrementally archive the setup and analysis.

Note: *There are plans to develop a Vault client for CFD in 2014.*

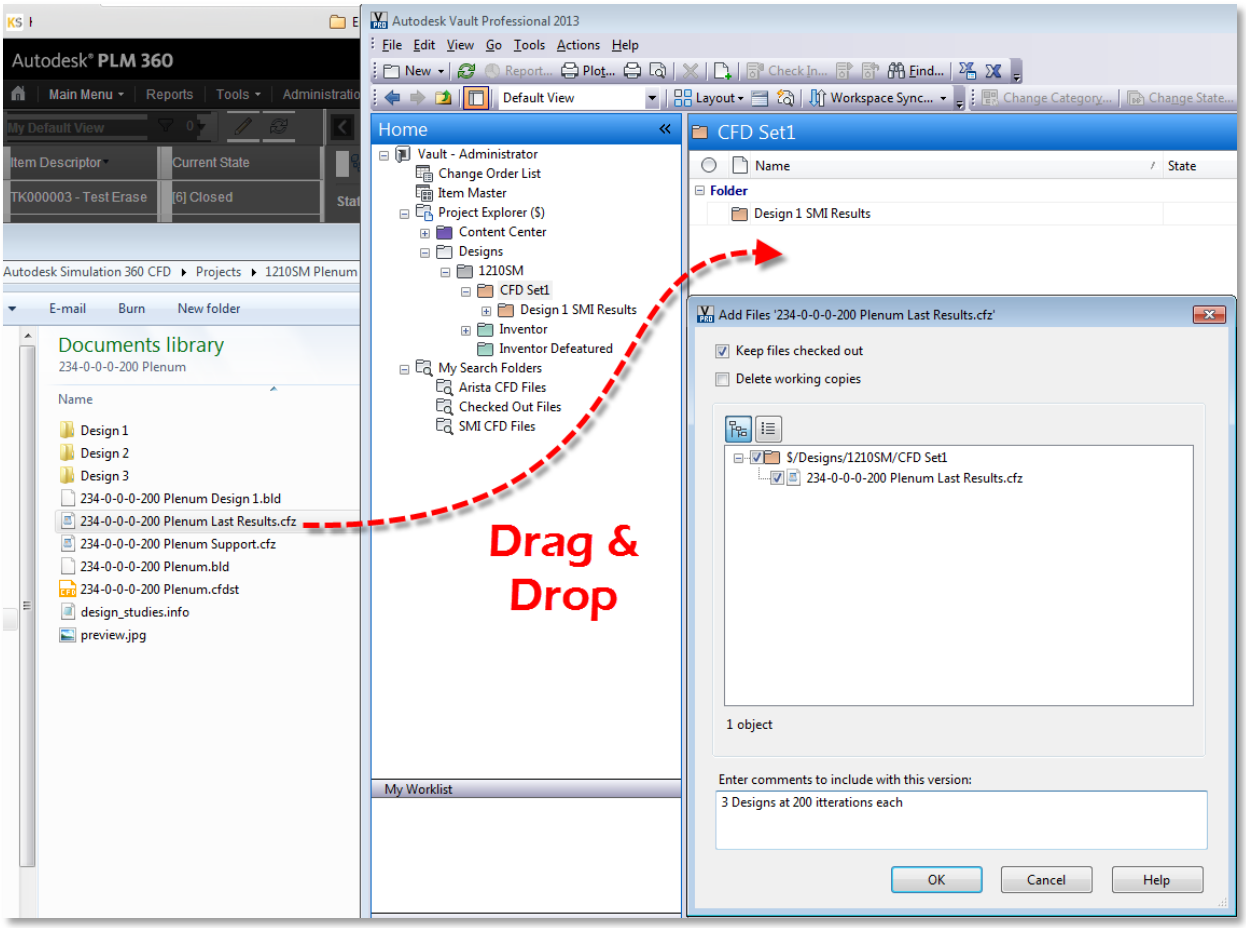


The Share files are accessible from the Application Menu, Save As button. Once picked, a number of options are available. We save the Support option to check in the setup and configuration. When results come back, we use the Last Result Sets option, to incrementally back up the results. Optionally, and a better option when you have wads of space, is to use the Everything option incrementally.



In order to check the data into Vault, simply use the drag & drop method for any of the options you chose. If you choose to incrementally save the Share File data, ensure that you check the Share File out of the Vault database before you overwrite the Share File with CFD.

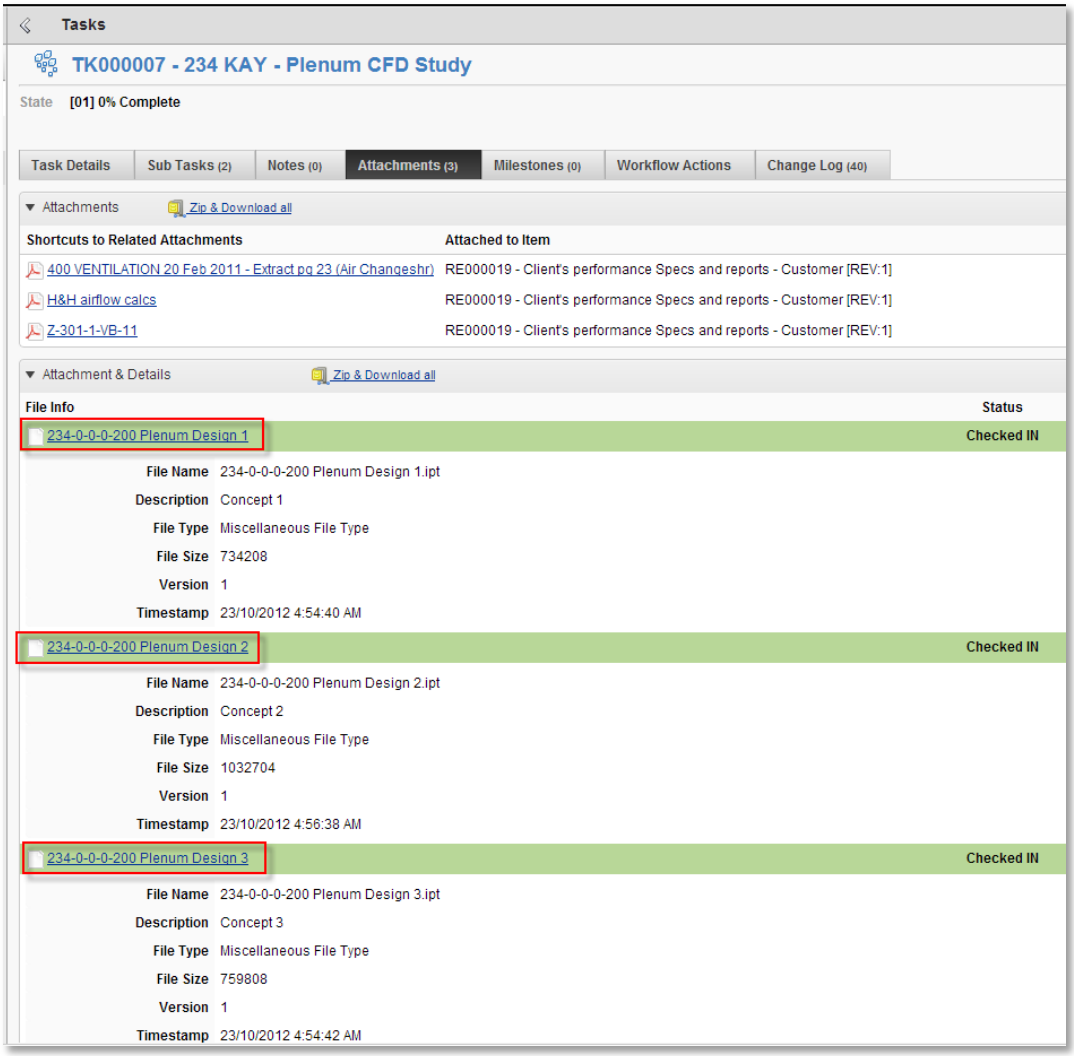
After the initial check-in, the operation is the typical 'check-out / overwrite / check-in' workflow.



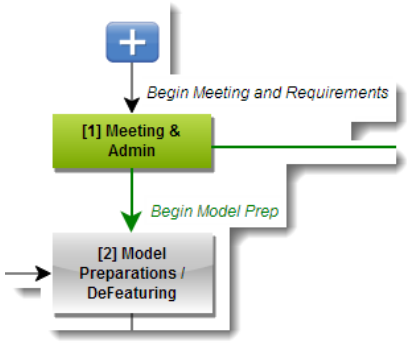
Note: *Keep track of the CFD Share file Icons I have at relevant locations during my workflow in our discussion. I will also continue the use of the Vault icons with the addition of the Check Out icon.*

PLM 360

PLM 360 sent an email containing a link to the SMI Task item. This item contains the specifications and models to be analyzed. I downloaded each model straight to my local machine.



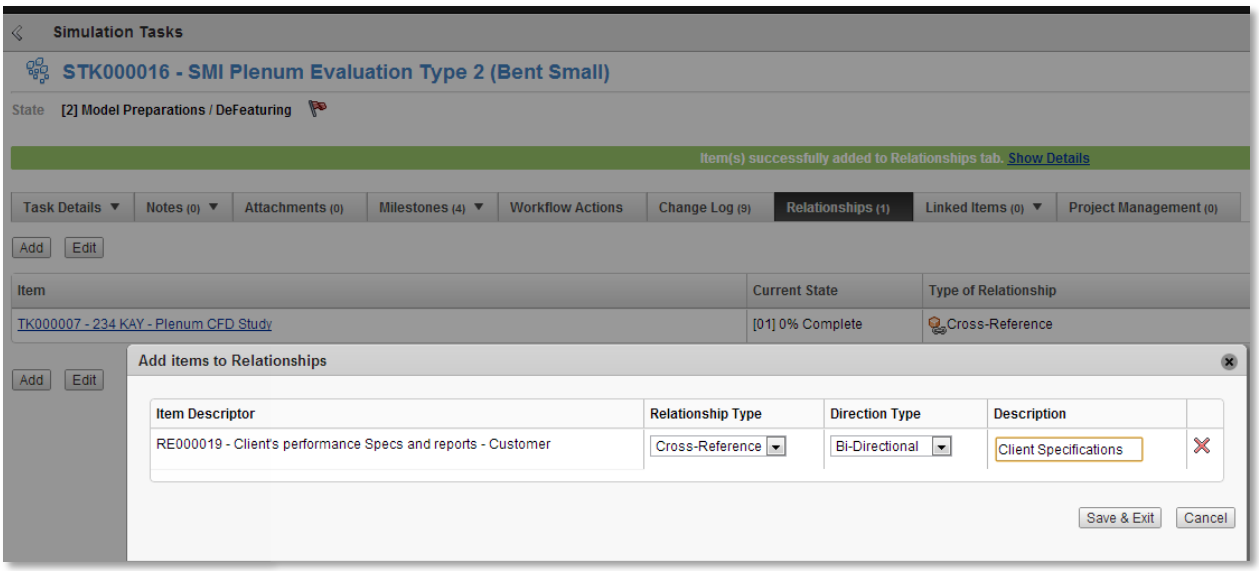
I created a new Simulation Task for each of the three model variations. It contains a detailed workflow designated for this operation that automates the Design Review Items as needed. This allows me to track the work for each variation much easier than if it were all lumped into one task.

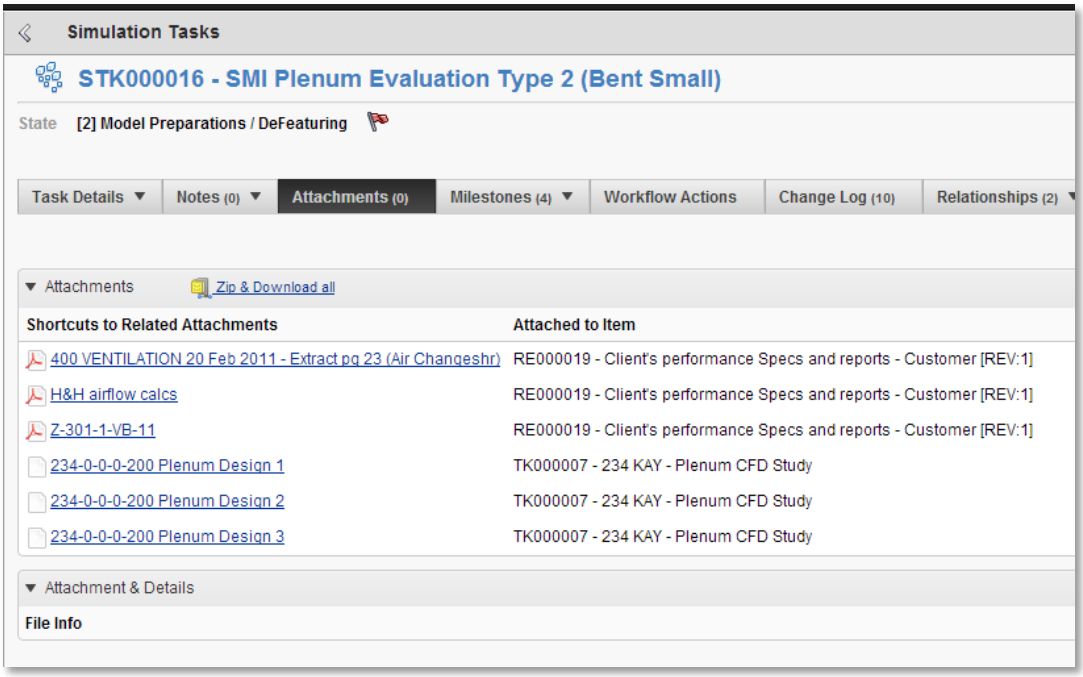


Immediately after creating the Simulation Task item, I add the appropriate relationships for the initiating client task, as well as the requirements. This provides 2 things:

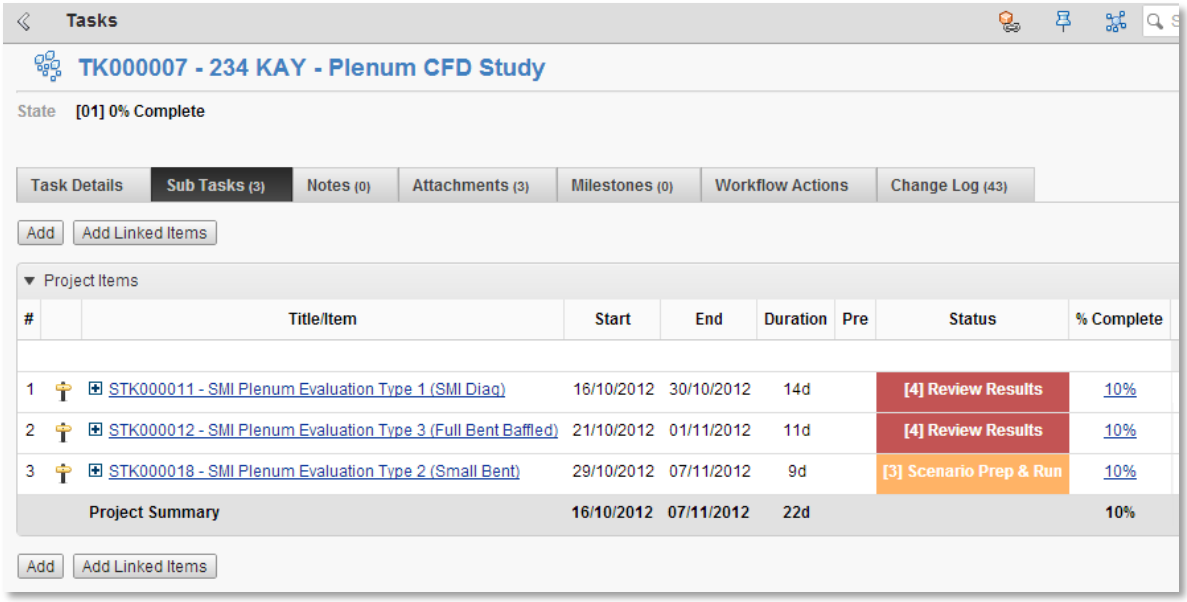
- A fast path to important information
- Attachments are automatically imported from the top-level related items.

In the Attachments example below, notice how numerous shortcuts to related attachments are present, even though I have not attached anything. This is one of the benefits of the Relationships. Now all the relevant information is available in my working space, and I don't need to navigate around to find it.





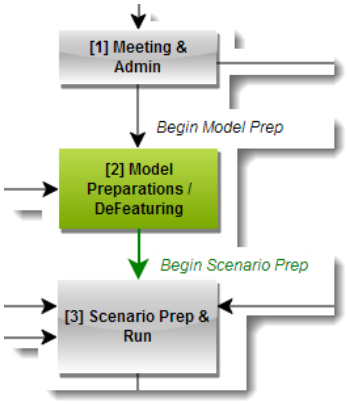
Before proceeding on, I return to the client task item, and attach the Simulation Task items to the schedule (sub-task space).



Now on to the testing.

PREPARE MODELS

Inventor

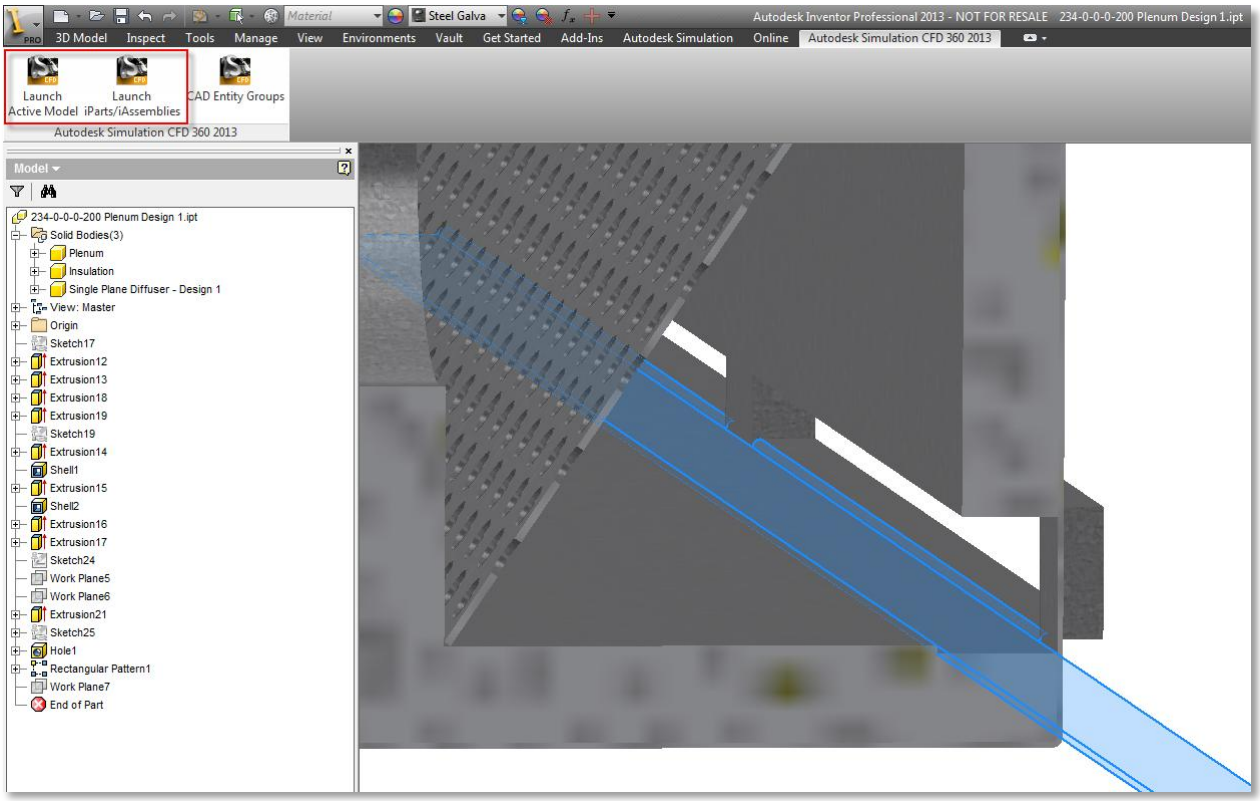


I open each model in Inventor, in order to get a good feel for the model layout, and to prepare for what operations need to be performed. I could go straight to Fusion, in which I will likely end up for defeaturing, however I like the control that Inventor offers, and some simplifications can be made there.

Before proceeding on, I perform the following tasks to each file:

- Identify areas that need to be simplified
- Set the model configurations (how I want them) if iParts are present
- Log the part into Vault
- Export to CFD (or save and open in Fusion)

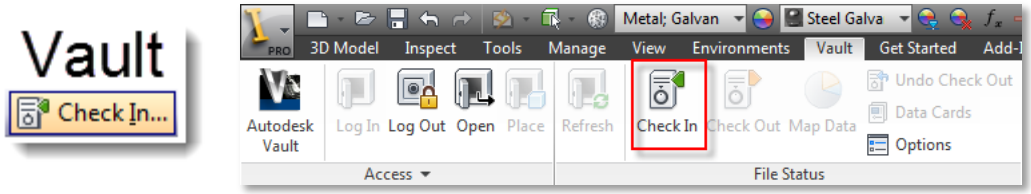
Note: *CFD cannot open most model files and as a result, either Inventor of Fusion must be used to initiate the CFD operation.*



In this case the defeaturing requirement is a toss-up. There is some detail here that will weigh down the mesh unnecessarily; however CFD is quite efficient, and deals with a mild amount of detail quite well. You have to make a judgement call.

Discussion Point

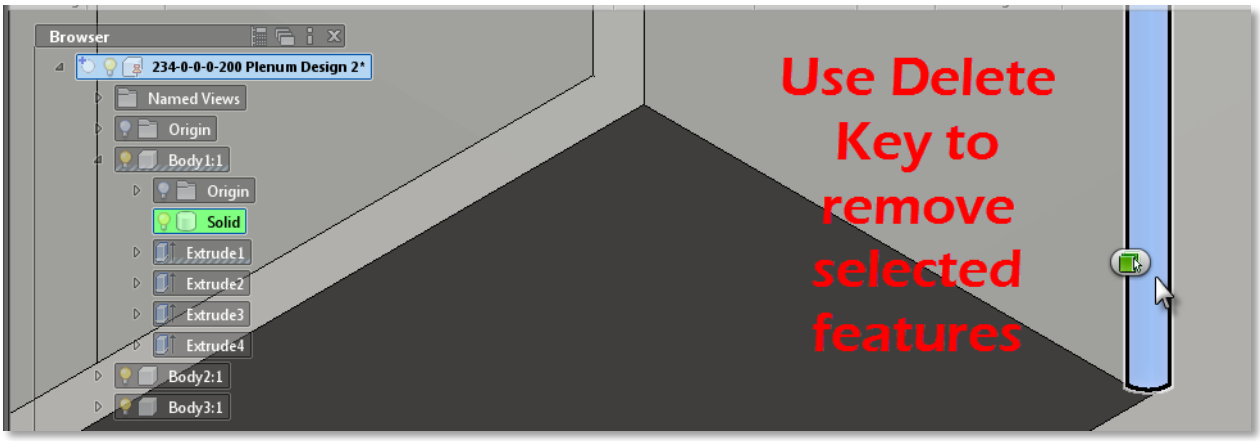
It should be noted here that Inventor offers the single part configuration (Current Model) or the iPart configuration export. The latter will allow users to export any or all of the iPart configurations in the part file, directly into CFD as a multiple design/scenario simulation file. Additionally, materials and boundary conditions can be selected and ready to use when the new file opens. Ours was not configured in this manner. Additionally noteworthy is the fact that Fusion does not offer this option.

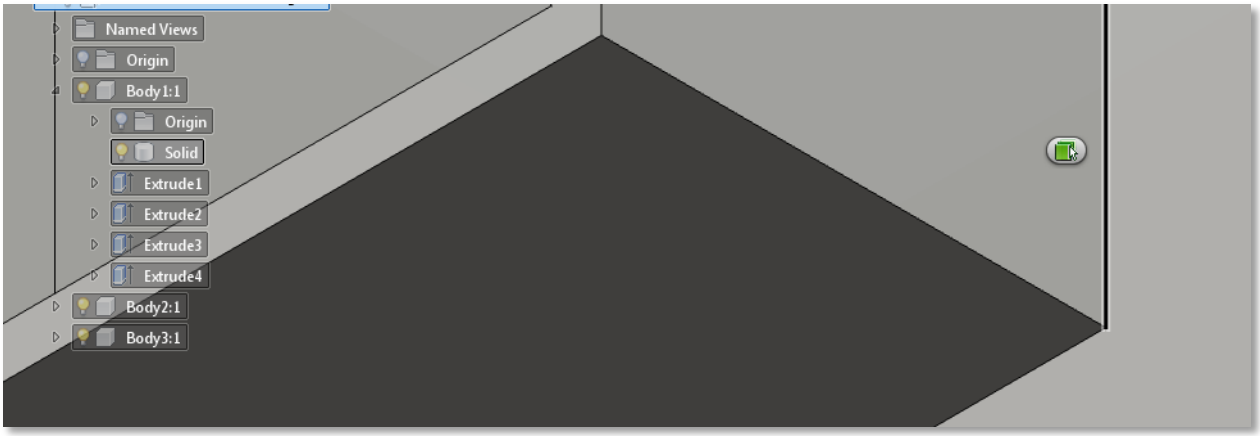


Fusion

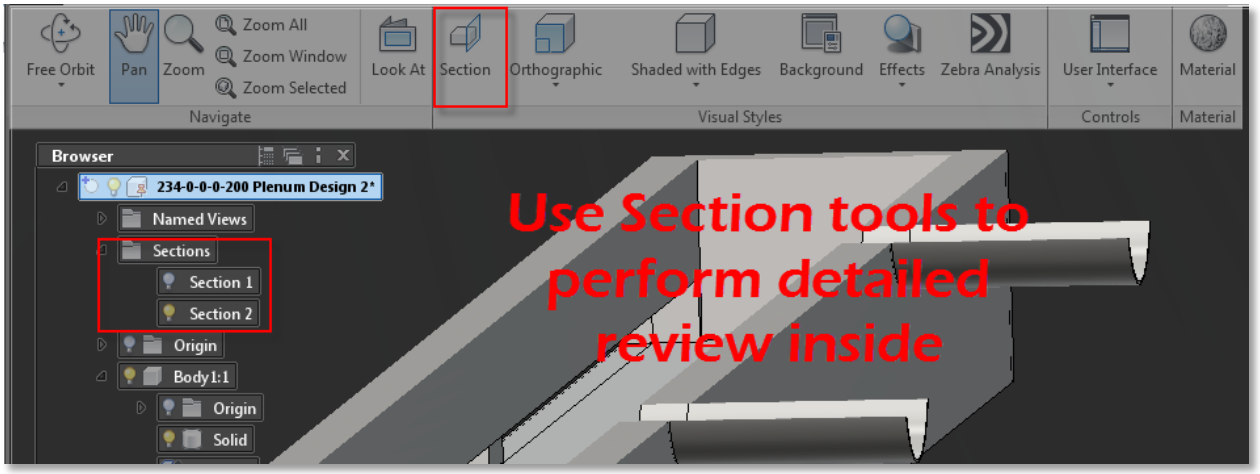
Fusion is the king of defeaturing tools. The tools I like to use the most are show here in the examples below:

- Press/Pull Tool
- Remove features using delete key
- Part Visibility
- Cross Section

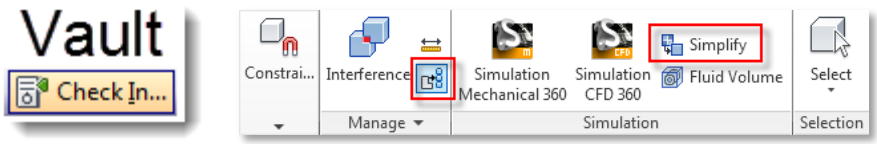

Browser
234-0-0-0-200 Plenum Design 2*
Named Views
Origin
Body1:1
Origin
Solid
Extrude1
Extrude2
Extrude3
Extrude4
Body2:1
Body3:1
Use Delete Key to remove selected features


Named Views
Origin
Body1:1
Origin
Solid
Extrude1
Extrude2
Extrude3
Extrude4
Body2:1
Body3:1


234-0-0-0-200 Plenum Design 2*
Named Views
Sections
Origin
Body1:1
Origin
Solid
Extrude1
Extrude2
Extrude3
Extrude4
Body2:1
Body3:1
Use Press/Pull to pick a feature then a face to align to
Press/Pull
Move
Plane



Find Features & Simplify tools



These tools were not shown here as an example because I find they are best used with consistent features like certain fillets and holes. These examples contained scattered, obscure issues that were mostly inside, and needed attention to ensure they were attended to. However, I highly recommend using these two when the opportunity rises.

Once the defeaturing process is complete, I save the Fusion .dwg file, and log it into Vault as a defeatured version. If and when I need to do any more work with these, I'll need to return to this version.

When complete, I use the Simulation CFD 360 Export tool to start CFD.

SIMULATION CFD

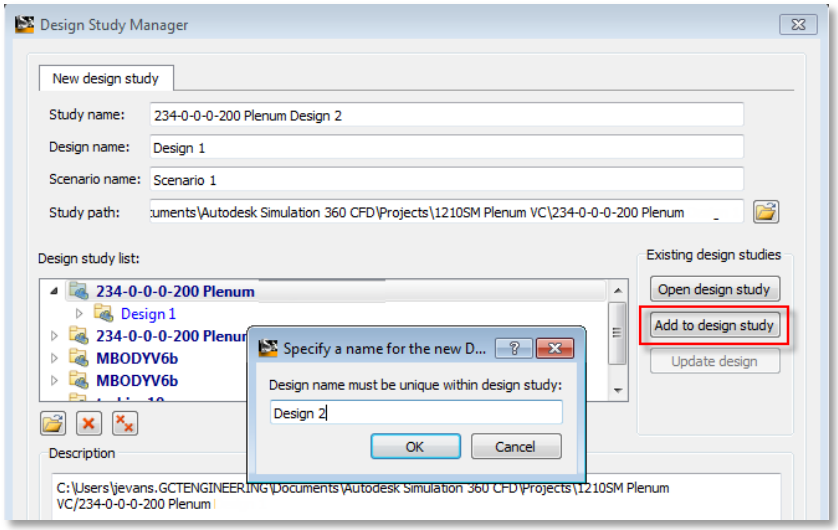
The import process starts with an intermediate dialog that allows users to:

- Create a new design study
- Add to an existing design study

- Open an existing design study

I created a new design study during the first model import. However, once the initial design was imported and in place, I used the Add to design study option to bring in the second and third component sets.

As the part(s) are imported into CFD, the application sniffs the geometry for problems and reports any issues in the status window that is shown by default. Review the information carefully for problems that may cause the simulation to fail. It would be better to know there is a problem up front.



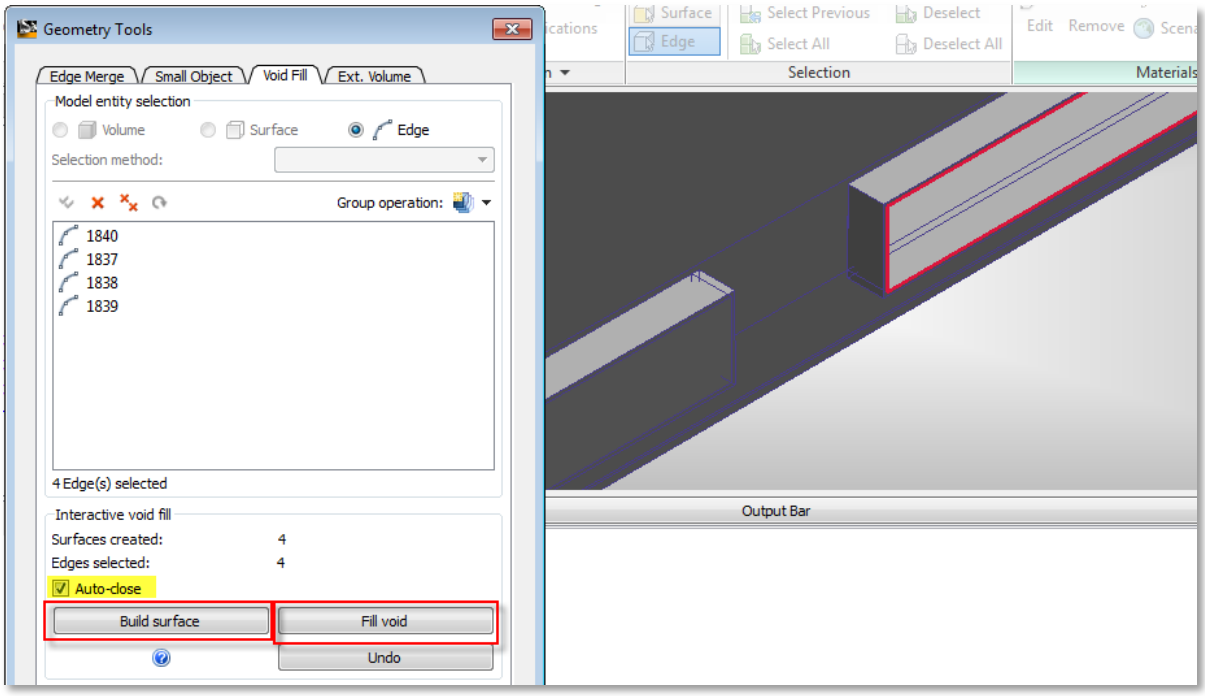
Geometry Tools

When CFD completes the process, the Geometry Tools will appear. The options available are:

- Edge Merge
- Small Object
- Void Fill
- Exterior Volume

The first two tabs help users detect and remove very small features that may not have been detected. If possible, the system will remove these for you if desired

Void Fill is the nicest tool for developing a fluid volume. I find that it is better than other tools such as Inventor and Fusion to do this quickly (Fusion running a close second with its Fluid volume tool).

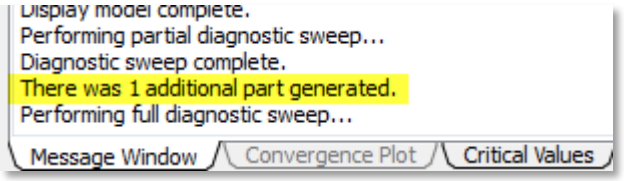


It operates by taking the edges provided by the user, and creates surfaces until the part is effectively sealed off. I used the exterior edges of the inlet and outlet areas, picking 'Create Surface' after each perimeter was surrounded by selected edges.

Hint: *There is a great feature called 'Auto-Close' which will sniff out the complete perimeter after selecting two edges. Fantastic option.*

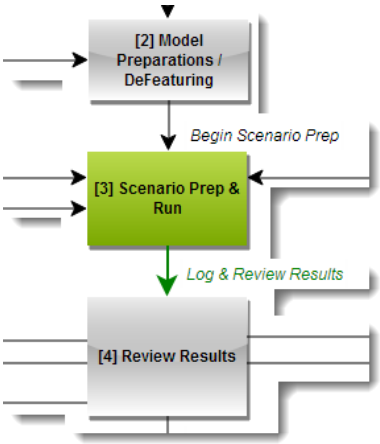
Once all the surfaces have been created, I use the Fill Void tool to create the resulting interior volume object.

Note: *The only way to understand what happens next is to read the status window. If successful (or not), the system will tell you. A successful fill will create a new 'Volume' part in the 'Unassigned' section of the Materials Browser.*



Simulation Setup & Run

Once the Geometry tools are closed, users can then operate a standard workflow from left to right along the Ribbon. These Ribbon tabs include:



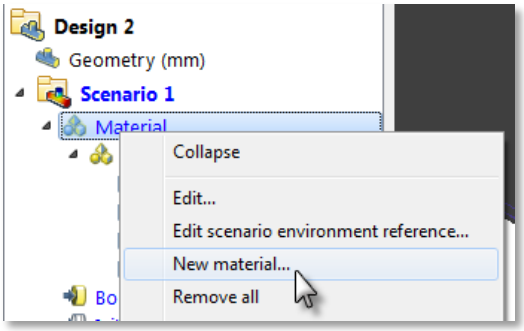
- Geometry Tools
- Materials
- Boundary Conditions
- Initial Conditions
- Mesh
- Solve

Materials

This tab focusses the simulation preparation tools towards applying materials to all components. Every component, including those which are suppressed must have a material assigned.

There are two ways to assign materials:

- Pick the part, and select the edit glyph
- Drag the material header from the Material Browser directly onto the volume body



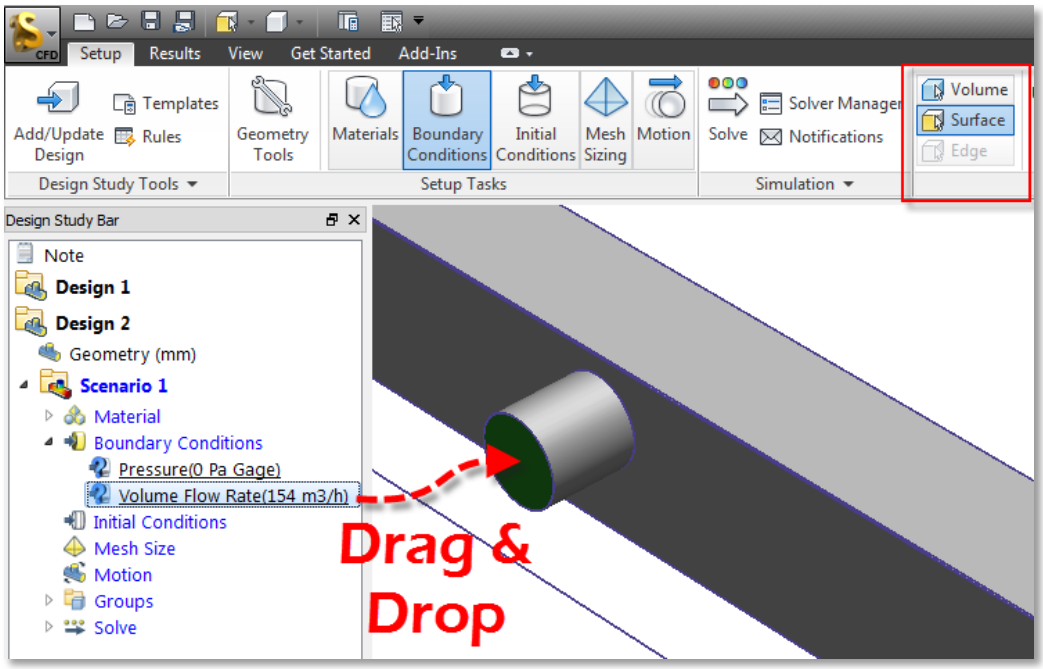
You can create the materials through the Material Browser header if desired. Then all the remaining operations are drag and drop. I cannot explain just how damn cool this workflow is. It really is a snazzy operation.

I selected stainless steel for the body and diffuser, and fiberglass insulation for the insulation baffle. The remaining air volume was specified as … well air. Here, the key is to be selecting VOLUME bodies, and not surfaces.

Boundary Conditions

The similar workflows are available for Boundary Conditions. I created mine ahead of time in the Boundary Condition browser, and dragged them onto the inlet and outlet surfaces. We need to be targeting SURFACES this time.

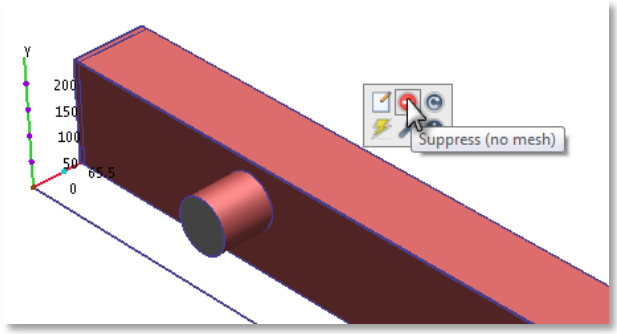
- Inlet condition: 154 m^3/s (PLM Requirements) volumetric flow
- Outlet condition: 0 Pa gage pressure



Mesh

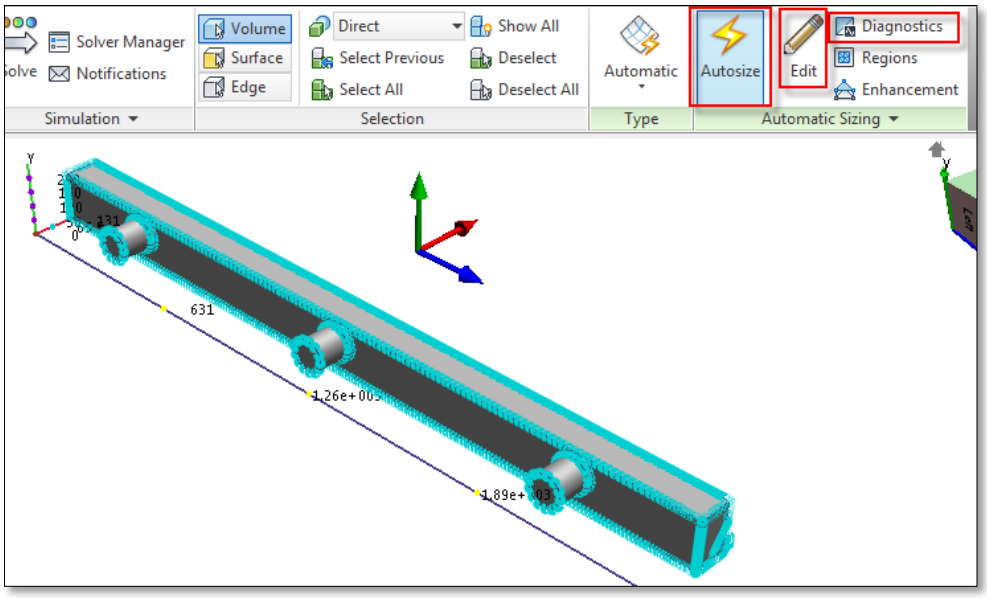
The most important thing I can suggest in meshing is to suppress any components that will not be involved in the simulation. Remember, the fluid space is what is being analyzed, not the exterior. Furthermore, if temperatures and stresses are not being utilized in the analysis, it is often only the fluid volume that needs to be meshed.

I start by picking each item from the outside in; like peeling an onion. I suppress anything I do not want to mesh. I like to pick the part, and then select the suppress glyph (red circle glyph with the white dash). After I have decided to suppress or not, I turn off the display of that part.



Hint: *Middle-pick a part to turn off its visibility.*

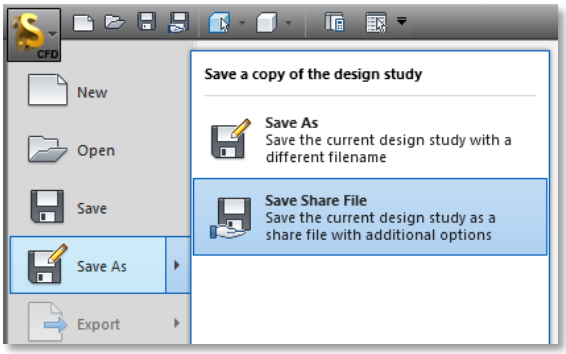
When I have gone through every part, I turn all of them on again, and pick the Autosize button on the ribbon.



In the event that geometry problems are present, there are a few tools to help.

Select the part and pick Edit from the Ribbon (or context menu). Various settings are here to relax and adjust the mesh.

Pick the Diagnostics tools to have the application review the mesh and identify where some problems are.

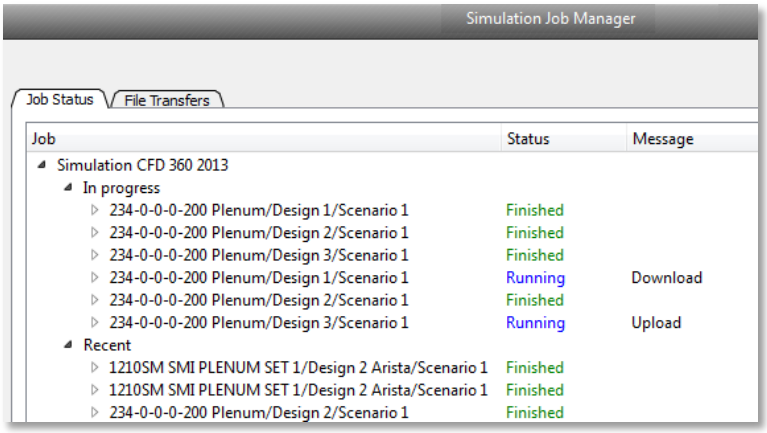


Solve

After I have all the relevant designs prepared in the design study file, I run the cloud solver request. Pick the solve button, and review the options. For a steady state analysis, such as the one I am running the options are pretty simple:

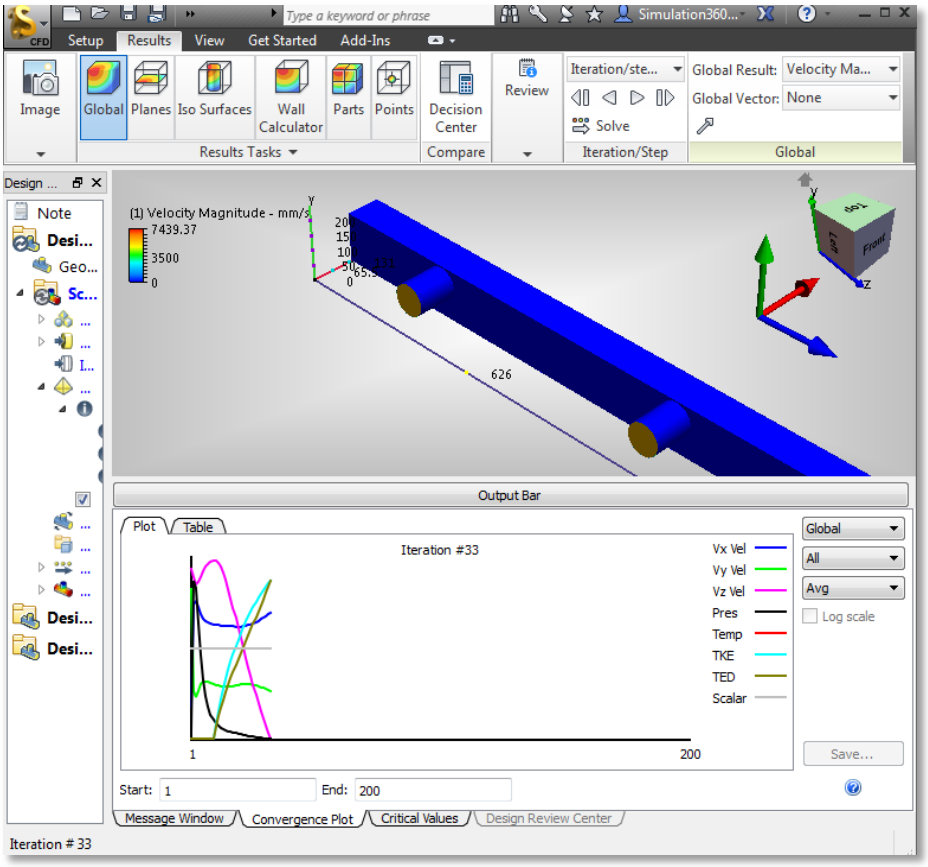
- Start at 0 itterations
- End at 200 itterations
- Save interval is 0

The save intervals are important when you need to go through the steps as the model was converged. I do not need that option, and would rather lose the overhead and only have the result after the 200 itterations have completed. In the meantime, the convergence data is updated while the solution is being developed on the cloud.

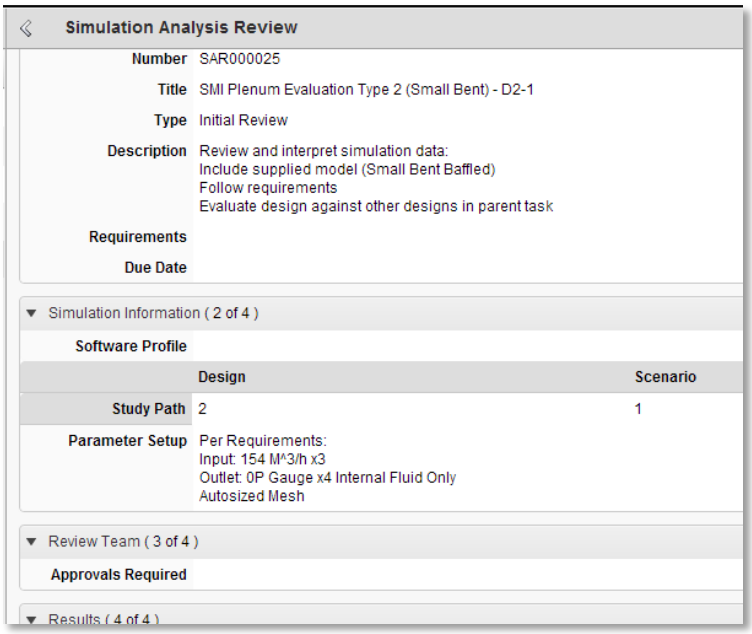


One other point to make here is that all three designs were fired off, one after the other. Simulation 360 solves these all as separate requests, and solves them simultaneously.

When the cloud server has completed the operation, the results are returned and can be analyzed with the CFD tools as needed. The image below shows results streaming back from the cloud server as the solution is converged.



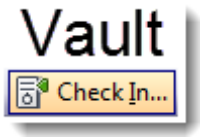
Logging the Setup in PLM 360



(In the sequence above it was easier to discuss without breaking, rather than showing the logged data until now.). The solving process can take a little time, which presents a good opportunity to check the Support Share file in Vault, and to log my progress into PLM 360.

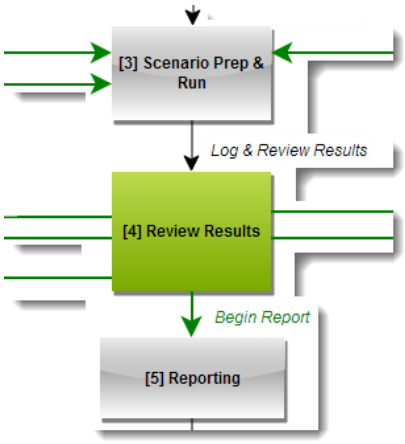
I use the Workflow Actions to show my progress, and to automate many steps, including the creation of specific reporting documents such as the Simulation Analysis Review item. Once I move into the Scenario Prep & Run action, a Simulation Analysis Review document is automatically created, and various portions are already filled out when I begin logging results.

Check-In Share File to Vault



As mentioned previously, now is the best time to log the Share File(s) into Vault.

INTERPRET RESULTS



While interpreting the results I use the CFD tools to collect data, and save images related to the velocity as well as the pressure and turbulence experienced in the plenum.

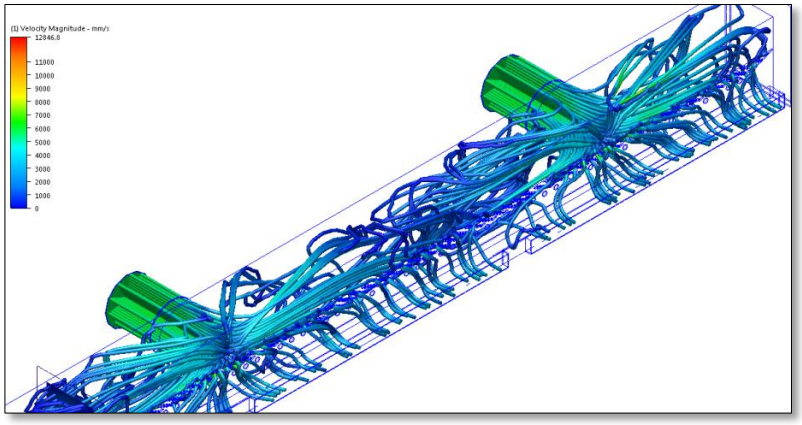
Once the results are coming back, the reporting can begin. I perform basic steps to collect data that I interpret:

- Review the convergence data
- Add traces through all inlets
- Add cross section planes
- Review a cross section xy plot through the length of the outlets
- Review the summary file

Convergence Data

This is the first thing that gets reviewed and shows the state of the solution. Since this is a steady state analysis, I'm looking for confirmation of a steady state. If the mesh convergence is still in flux, there is no sense in interpreting data at this point.

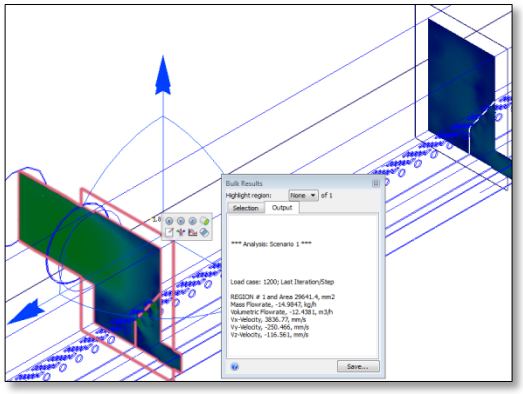
Traces



Once in the Planes tab on the results Ribbon, new planes can be added with the push of a button. Picking the plane activates a context menu, on which the realignment glyph will allow users to pick a surface to align the plane. In my case I picked the inlet surface and the plane appears on the inlets.

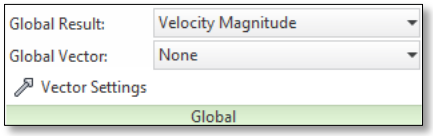
I added Traces to the plane using the Traces dialog. I use the circular grid option, and entered a 10 x 10 array, centered on each inlet. The application pushes the traces from these points through the mesh until they run out.

Cross section planes



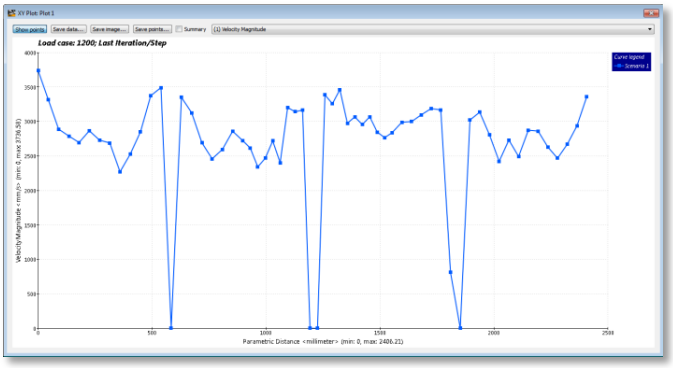
These are added by simply picking the Add plane button again. Use the X, Y, and Z, axis realignment glyphs to align the plane, and then the origin arrow contols to to position the plane. In my case, I picked the z axis realignment glyph on the new plane's context menu, which caused it to turn normal to the z-axis, and displays the velocity or pressure values of the mesh as it intersects various elements.

In all cases, the criteria being reviewed can be changed through the Global Result pulldown on the Global panel on the Ribbon.

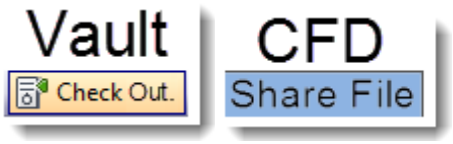


XY Plot

I position a plane at the outlet surface. Using the XY Plot dialog, I create a graph using the pick point's option to set a point on each outlet, passing from left to right, along the entire length of the bank of outlets. Picking 'Plot' then creates a graph in a dialog. I also save the point coordinates for use in the other scenarios.

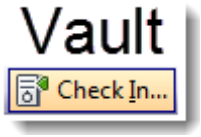


Summary File



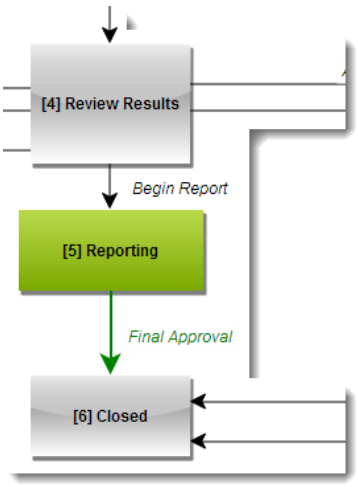
The CFD summary file is a very well assembled document, with most of the data needed about the steady state analysis, including input and output data.

Decision Center

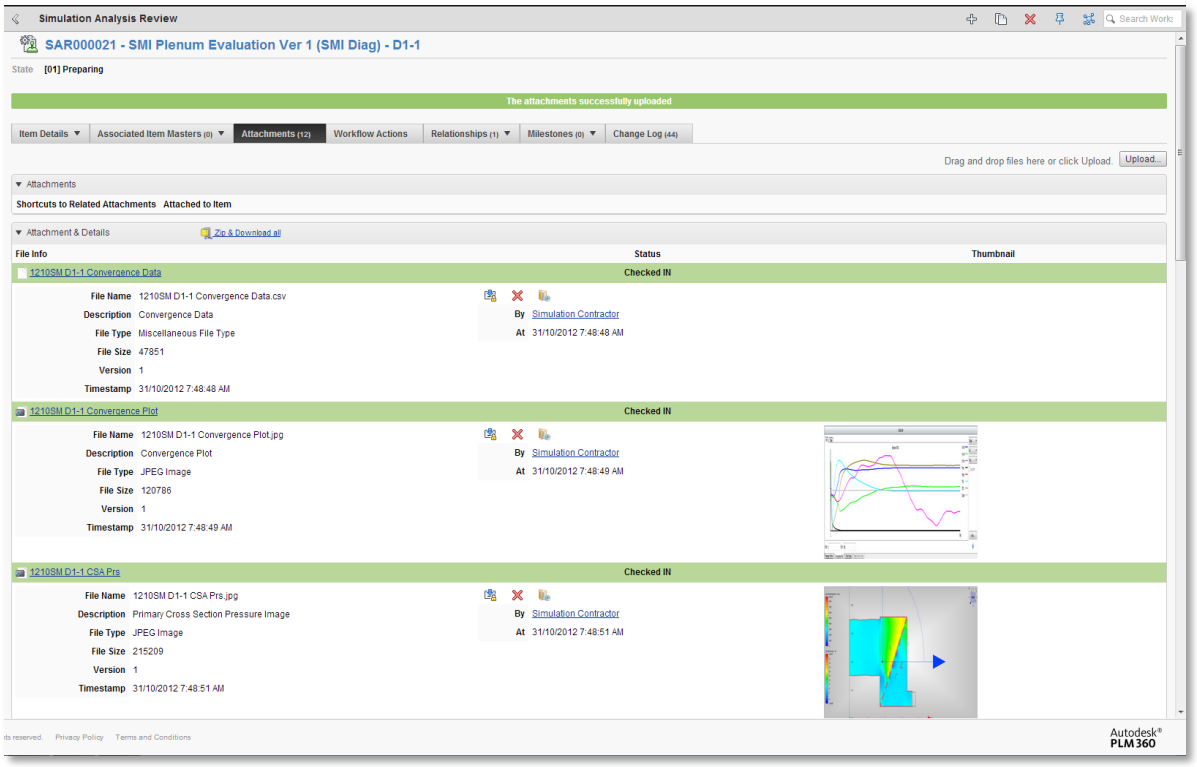


CFD offers a Decision Center tool, that enables users quickly compare result images from the separate design studies within the same CFD file. I didn't use this feature in this study, but the tool can be very valuable in making comparisons.

PLM 360



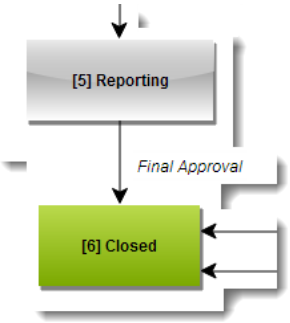
In each case, I have stored the results, mostly culled from the summary file, into the results area of the Simulation Analysis Review. I add all my reporting datasets and images to the attachments of the Review item. I list any of my concerns and design deficiencies I discover. When complete, I have a reasonable review document set for any reviewing party.



REPORTING

The reporting process is quite different from project to project. In simplified terms, most reporting I perform includes at a minimum, the following:

- Project summary
- Specifications (from the Requirements item)
- Scenario Summaries (from the Simulation Analysis Review Item)



- Key data summary highlighting important points (from attachments in Simulation Analysis Review Item)
- Closing paragraph stating deficiencies and recommendations comparison (From Simulation Analysis Review item)
- Attachment with each Scenario Summary data file

This set of information is then packaged up, usually in a Zip file, and attached to the client's PLM 360 Task item.

Once the report is issued, I note it in the PLM 360 Simulation Task item Workflow Actions, and I close each task.

FULL ROOM ANALYSIS TASK

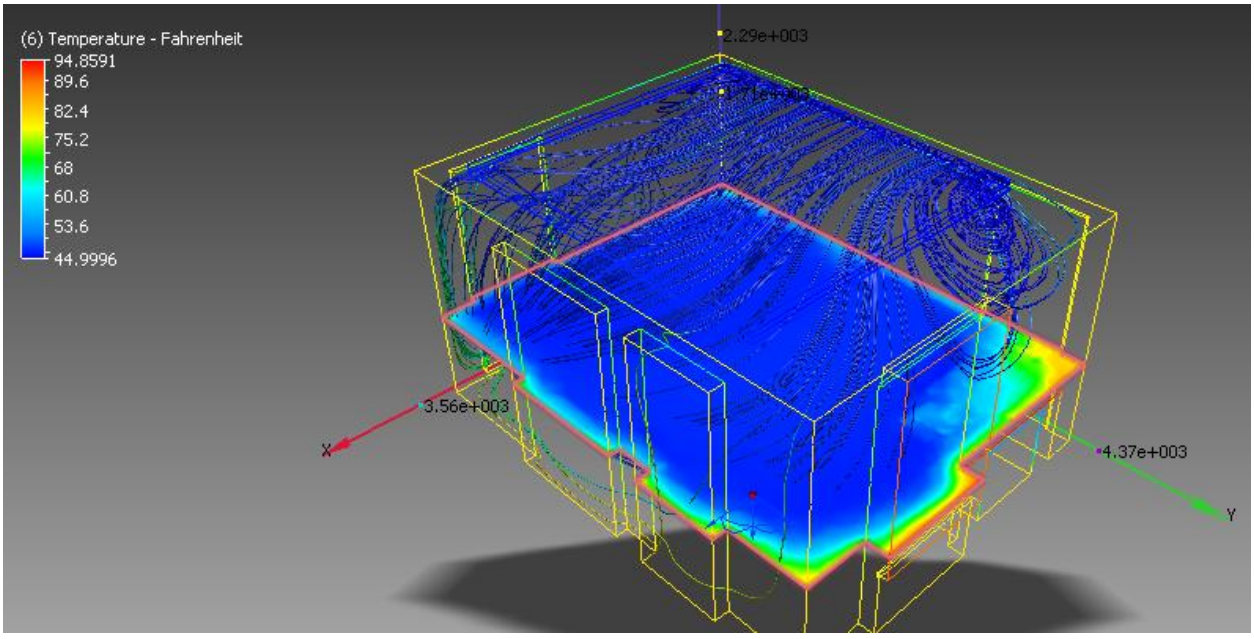
While we did not feel the need to discuss in any detail, the additional task of analyzing comfort of the full room, we did want to mention a few points that will be benenficial to the class.

Management

All management workflows used in this task were identical to those already demonstrated in the preceding plenum work. This collaborative and streamlined process works well in many different types of analysis requirements.

More Simplification

The simplification process was a substantial work in progress. Numerous gaps and tabs still existed in the model after the Inventor substitutions were created. Additionally, it was necessary to remove additional features and simplfy geometry in order to present CFD with a straight-forward understanding of what the fluid volume should be. The plenum is hidden in an attractive raised ceiling, above some crown molding type reliefs. These protruding cross section affected the airflow and were left in tact, however the mounting and mating regions were substantially simplified in order to bypass issues in the Inventor–>CFD transferred model.



Inventor Defeaturing Process

The defeaturing process was handled by Inventor, using the 'Edit Solid' capabilities which:

- Load the individual solids in Fusion for editing
- Return the Alias edit feature to the Inventor model browser when completed

This is the best workflow to utilize for defeaturing when presented with issues such as:

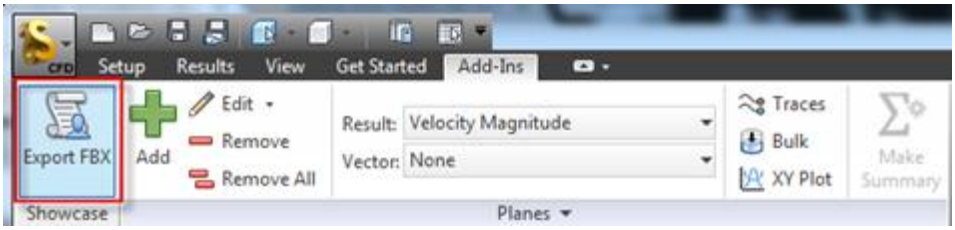
- Fusion has issues with the geometry
- Working with complex assemblies and multi-body part files becomes too cumbersome in Fusion
- Level of comfort in Inventor outweighs the speed of a full Fusion workflow
- Ability to remove a simplification edit later

Note: Simulation CFD Fluid-Only Analysis

The significant issues in CFD that should be mentioned involved the fluid-only analysis that was performed. This resulted in the requirement for applying the calculated heat and environment factors by way of the exterior surfaces of the fluid volume, rather than by way of exterior factors mitigated by insulation and material types available in CFD. This is a reasonable option for faster runs, where the environment is expected to be adjusted.

Exporting Traces to Autodesk Showcase

The results visualizations (traces, planes, etc.) can be exported to Showcase to be rendered with the textured model. This produces fantastic results and is really indispensable for offering the flexibility to convey results and interpretations in a meaningful manner to most any audience. With the CFD results options, and the seemingly limitless possibilities with materials and lighting, almost any effect can be delivered.



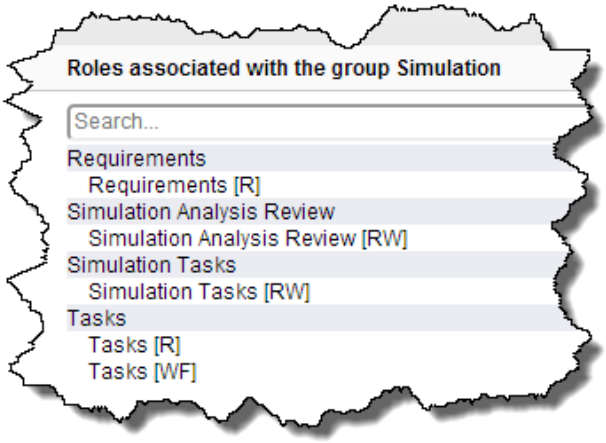
The export function is carried out through a free software install that is available from the Autodesk Exchange App Store. After installation, the Export function appears on the Add-Ins tab of the ribbon and exports any results through an Autodesk FBX file. Showcase then uses the Import option to read in the results models, and place them at their origin points. The rest is up to you.

DEFAULT PLM 360 TENANT MODIFICATIONS

SUB-CONTRACTOR USER SETUP

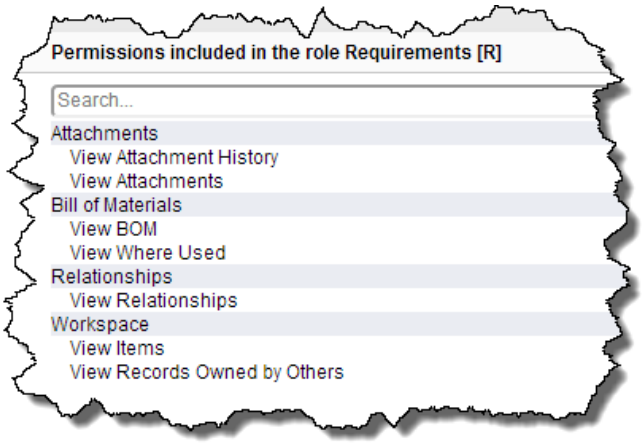
Created a 'Simulation' group

The Simulation group has the following roles:

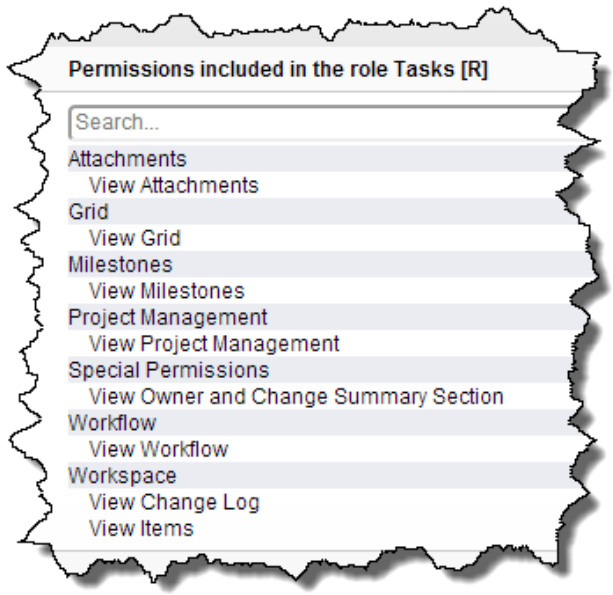


The roles contain the following permissions:

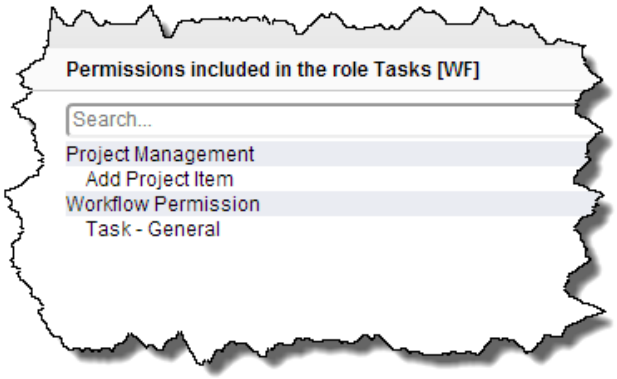
Requirements [R]:



Tasks [R]:



Tasks [WF]:



Note:

- *The Task - General Permission is created in the workflow editor for the Tasks workspace*
- *If the sim contractor user account was set to 'Participant' then the Add Project Item permission would be overruled by the read only nature of the Participant user type.*

TASKS WS

Relationships Tab added:
When adding to this tab allow to add items from the Requirements workspace

Project Management Tad added:
Renamed tab to Sub Tasks

When adding to this tab allow to add items from the Simulation Tasks Workspace

Workflow modified:
Added some extra transitions to allow the user to skip some percentage complete states.

REQUIREMENTS

Relationships Tab added:
Relationships aren't added here. It's been added so everytime a relationship is made to this requirements item they can all be viewed here, from a single convenient location.

'View Associated Workflow' Permission added to the Requirements [R/W] role.

SIMULATION TASKS

Custom Workspace developed by John Evans Design

SIMULATION ANALYSIS REVIEW

Custom Workspace developed by John Evans Design

PROJECT MANAGEMENT

Relationships Tab added:

When adding to this tab allow to add items from Vault Sync or Items & BOM's WS

'View Associated Workflow' Permission added to the Requirements [R/W] role.