AUTODESK UNIVERSITY 2013

Design to Fabrication: Design, Validate, and Fabricate Anything between Autodesk® Revit® and Inventor®

William Spier – Autodesk, Inc.

FB2938 In my role as a design-to-fabrication subject matter expert (SME), I get requests twice a week on average from around the world, asking if and how Autodesk Revit-based software and Autodesk Inventor software work together, with the most challenging workflow being curtain wall design, fabrication, and installation. In the 2014 release of these products, Autodesk has added technology that vastly improves that workflow. We look at how to use Revit and Inventor together, regardless of which product the design starts in, and we cover all the ways that you can fabricate from either of these products while sharing data back and forth along the way to validate and/or change design intent. We use real-life situations in class as examples, including curtain wall design and concrete formwork, and I encourage participants to bring their own challenges to class for us to tackle together.

Learning Objectives

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

- Use Revit for fabrication and Inventor for translating Inventor files for Revit consumption.
- Repurpose Revit for direct CNC fabrication, and use Inventor to consume Revit files. Design and/or fabricate directly in and/or from either Revit or Inventor.
- Understand and utilize workflows between Revit and Inventor to overcome real world design flow and accuracy challenges between manufacturers and AEC design professionals.
- Think outside of the box and be able to identify/recognize various design scenarios and challenges that can be resolved using Revit and/or Inventor.
- Share with your contemporaries the latest design software innovations, and plan for implementing them to best position your company for leading edge success.

About the Speaker

William is an MEP and Design to Fabrication SME (Subject Matter Expert) with Autodesk. He got his start as a plumbing designer with a consulting engineering firm in Seattle, WA, where he worked on a high-end, national department store chain account. During his nineteen years in the industry, he has gained experience power and lighting design, HVAC, architectural & energy design, CFD (computational fluid dynamics) and design to fabrication solutions across numerous disciplines. William has worked in several disciplines within the AEC industry, including O&M design work on a major pharmaceutical account for Johnson Controls, Inc., as well as plumbing and piping design coordination for a major mechanical contractor in Kansas City where he also currently resides with his wife Wendy and their five children.

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Revit / Inventor Built-in (Native) Translation Functionality

From Revit to AIP

Per the 2014 releases, Inventor (AIP) can now open Revit project (rvt) files, and also produce both ADSK files and RFA file formats. Note that in neither direction do the AIP parameters translate to Revit types, nor do Revit types translate to AIP iParts or iAsseblies. To validate this, I created a simple cube in both Revit and AIP (see files included for this class – FB2938, AU 2013). In both files there are two types/iParts, respectively named Type 1 & Type 2 – one 1'x1'x1' and the other 2'x2'x2', both with Length, Width & Height parameters driving the types/iParts. When you convert the AIP to Revit or the vice versa, you'll see that the parameters do not come over. So later in the curriculum, I will cover workarounds and alternative methods to cover those needs.

It's often necessary to translate Revit geometry & resources to an Inventor file for coordination purposes, and to reutilize Revit sketches in AIP, and I'm sure there are many other reasons I cannot even think of.

When opening an rvt file in AIP using the Open command, you have the choice of opening as a Single Composite Feature, or as a Multi-body Part (see fig. 1) – meaning respectively, you can simplify (combine) multi-geometry Revit files into a single body part (ipt) file, or import all the Revit geometry pieces into AIP as a multi-body part (ipt) file (ipt file that maintains discrete bodies).

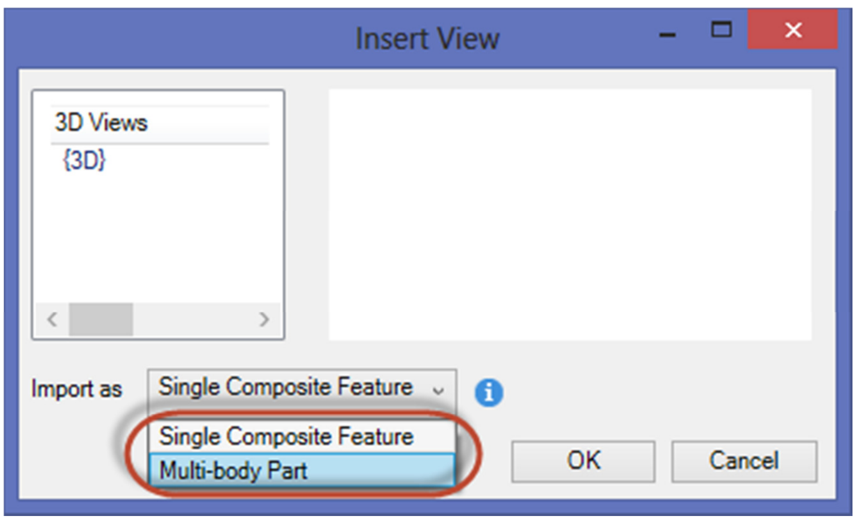


fig. 1

Once the Revit file is in AIP, if you need more detailed, precise geometry, you can use some of the AIP export tools such as the BIM (or Environments) tab –> BIM Ready Content (or Environments) panel –> Recognize Revit Features tool to convert solid, base elements to recognizable extrusions, revolves, etc. with included sketches. You can convert elements automatically or manually for more control over design intent. See fig. 2.

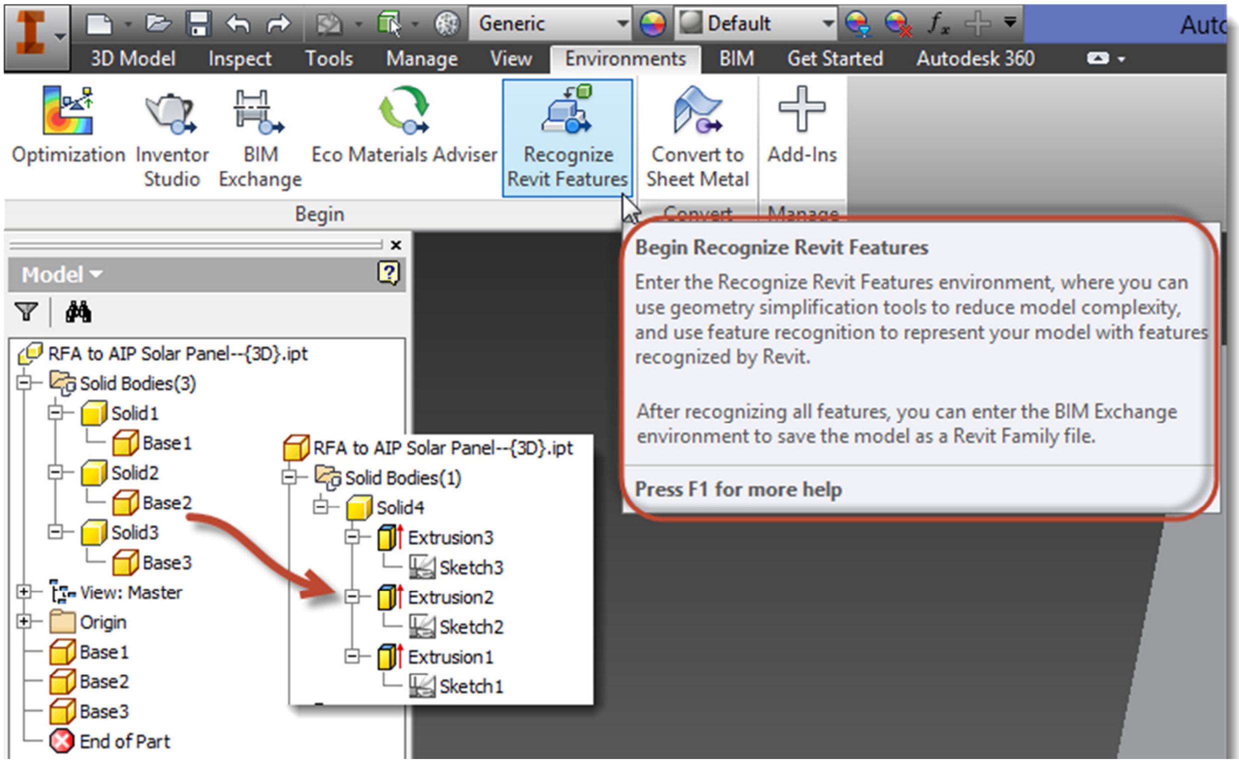


fig. 2

From AIP to Revit

You can also use AIP to produce both .ADSK and .RFA file formats directly from AIP (via the BIM Exchange Environment see fig. 3).

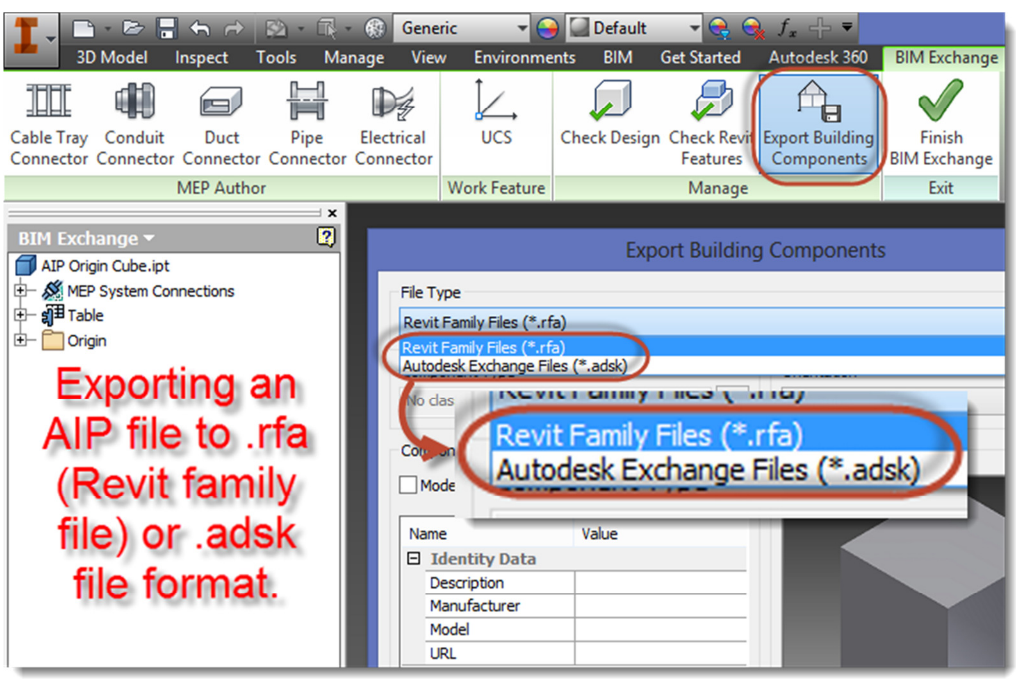


fig. 3

ADSK files are DWG based Autodesk Exchange files without parameters, that can be created using Export Building Component without any additional workflow steps. However, you can use some of the tools listed in the Inventor to Revit Family File (RFA) Workflow chart (see fig. 4) included in the Helps to provide greater complexity to the exported ADSK file. This workflow chart is an excellent resource, and while you're there see the BIM Exchange Environments Help file more information.

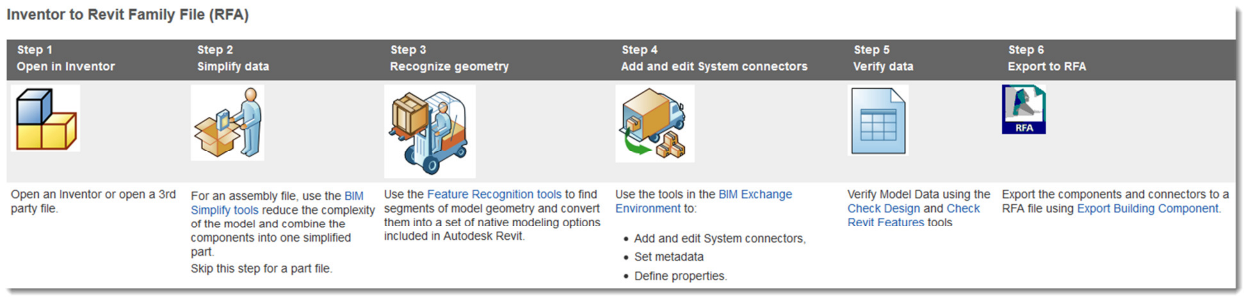


fig. 4

Simplification

If you're exporting an assembly file (.iam file format) you will have the Simplify tool palette available to simplify the assembly, not only to remove complex geometry for ease of consumption (making it non-graphically taxing) in Revit, but also for intellectual property (IP) removal. For an excellent, 10 min., comprehensive treatment of the simplification process applied to an AIP water heater assembly file being converted to a Revit family, see: Inventor 2014 BIM Exchange to Revit Family - Video - CADline Community.

Note that if you want to simplify an IPT (a part file) you will **not** have the simplification tools you need in AIP *when you're in an IPT file*. So to fix that, simply start a new assembly file and use the Place tool to bring the IPT into the IAM to create a single component IAM file, then you can simplify from that.

Feature Recognition

And for converting non-Revit, neutral 3D CAD models files such as STEP, SAT, or IGES solids into full-featured Autodesk® Inventor® models, there is an additional AIP Feature Recognition application for on Autodesk Exchange Apps. Its feature mapping can also be executed automatically or interactively as needed to control design intent.

Note About Class Materials/Collateral

I have included all the files you could possibly need for this class in the online Materials download section for the class. In addition to the video links here in the handout, I've included actual videos, plus all the files and content needed to follow along and actually validate and practice these processes yourself.

Curtain Wall Conversions

One of the more enigmatic Revit/Inventor workflow challenges I get asked how to overcome more frequently than any other is how to best convert curtain wall assemblies.

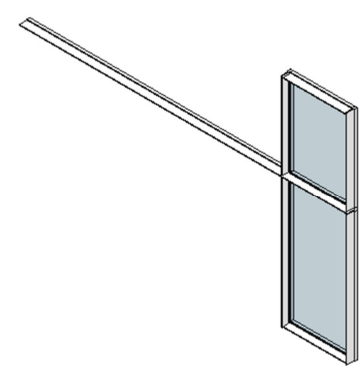
So here are two common workflow scenarios… Sometimes an architect will design a building in Revit, using Revit to create the curtain walls as well, and then hand that curtain wall design over to the curtain wall fabricator or fabricators for it to be manufactured. Other times, the architect will ask the curtain wall manufacturer(s) for several design options/variations based on the architect's building layout and/or perhaps based on a verbal or written design intent description from the owner or architect. In the first case, the design starts in Revit, but to be fabricated somehow the design intent has to be migrated to Inventor. In the second case, the design originates in AIP and then has to be migrated to Revit and applied to the building. And after the process begins in either scenario there's going to be a lot more design migration back and forth to validate both variations and iterations as the design and fabrication progress.

Without using any direct translation techniques between the two platforms (Revit & AIP), most stakeholders would (and most do) have to resort to reading values, shapes and forms output from one software (e.g. reading plotted 2D dimensioned designs) and manually entering those values in the other software to create the needed geometry. What follows are workflows anyone can employ using Revit's and AIP's built in functionalities to translate/migrate geometry back and forth with no human translation (read from one – input to the other) is necessary. This also minimizes the chance for human error to creep into the process, as is common, especially when we're rushing to meet deadlines.

Side note - AEC Inventor Template Files

Before you start this exercise, you may want to download and paste (probably into C:\Users\Public\Documents\Autodesk\Inventor 2014\Templates) the AEC version AIP template files I included in the class materials. I reconfigured these files so when you start a new IPT, IAM or Sheet Metal IPT, the Z axis in AIP's triad is aligned with the Z axis in Revit and ACAD.

Curtain Walls from Revit to AIP

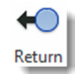


In this exercise, launch Revit, open the *Curtain Wall Bldg Example R2014.rvt* file and isolate everything but one upper and one lower pane of glass with surrounding mullions, as well as the entire center horizontal mullion. It should look like the image to the right. Then:

1) Under the Application Menu go to Export –> CAD Formats –> ACIS (SAT), and save the file where you want to.
2) Now launch Inventor, start a new AIM file and use the Place tool to place the SAT file you just exported.

Note that if you now expand the Assembly in the Model Browser, all the curtain wall assembly components already converted as IPT files. This is why we start in an IAM file – the sorting's already done!

3) Hover over the IPT files in the Model Browser until you identify the horizontal mullion. Note that it has a different icon than the rest because it is a surface element rather than a solid like the rest. To fix this, right click on it in the browser and select Edit.

4) Now in the ribbon, find the Stitch tool, click on the mullion itself in the drawing area and stitch the horizontal mullion. Select Apply & Done, and then Return 

to the assembly.
5) You can also turn off the Visibility for the glazing at this point if it makes it easier to work in the assembly (right click on the glazing IPTs in the browser, select Visibility, and then choose the *Modify Design View Representation* radio button if prompted).
6) Now right click a mullion piece in the browser and select Open. You should find AIP has taken you into that part's IPT file. (If you have the Feature Recognition app installed and are asked if you want to recognize features, select No. We won't need that for this exercise.)

Mullion by Tube Extrusion

Here we can treat this mullion as a mullion that would be fabricated either by extrusion or by sheet metal bending. This time we will treat it as a piece of tubing to be extruded.

7) Select the Shell tool to shell the mullion, selecting the two ends to Remove Faces, and enter 0.12 in. for the Thickness value. Select OK.
8) Now zoom up to one of the ends, right click the end face and select New Sketch – see fig. 5. Hit the Home key to zoom all if the part goes out of view. Now click Finish Sketch, right click on the sketch in the browser, and select Export Sketch As… and select dwg.

Congratulations – you have just converted a Revit component into a dwg file (or dxf if you need it) that a mullion fabricator can now use to create the exact extruder die he'll need to extrude the mullion shape from Revit.

Mullion from Sheet Metal

Now we're going to treat it as a mullion that will be fabricated from sheet metal.

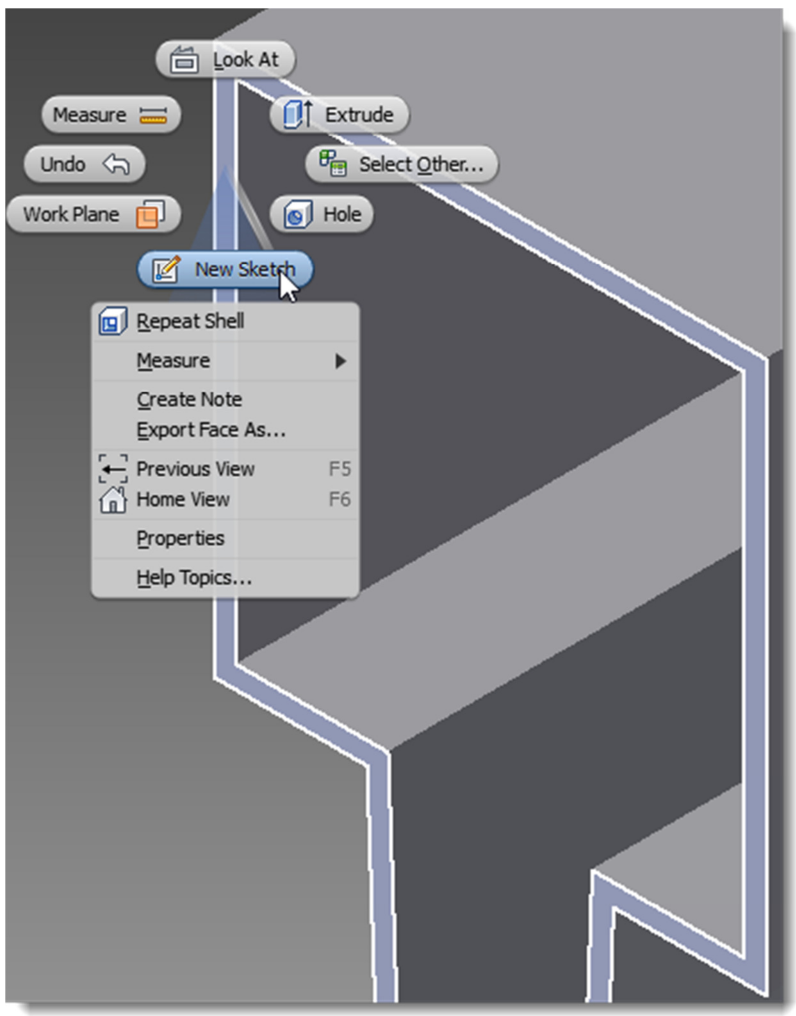
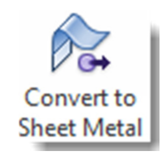


fig. 5

To create sheet metal parts we will have to unfold the piece, meaning we will need to add a tear or a rip. So first we need to switch to AIP's Sheet Metal environment.

9) While you're still in the mullion we just shelled, use the Convert to Sheet Metal tool on the 3D Model tab to convert the part to the Sheet Metal environment. When you do, you'll see a message pop up stating that for proper unfolding, the model thickness needs to match the Model Parameter Thickness preset in the Sheet Metal Styles. Select OK.



10) To insure the thicknesses match, select the Sheet Metal Defaults and check. In our case, see that in the dialog box "Use Thickness from Rule" is checked, and the "0.120 in." value to the right of it is greyed out. If you uncheck "Use Thickness from Rule," then you can change the thickness value. But because we shelled to 0.12 in. already in step 7 above, they already do match, so go ahead and select Cancel on the Sheet Metal Defaults dialog box.

11) In order to unfold our mullion geometry, we need to add a rip (in reality we're fabricating from a sheet of material and not a tube, so with a rip we're actually creating the two edges of the sheet metal to be mitered). Select the Rip tool, pick the face you want the rip on, and then select the rip start and end points. See fig.6. You can select the points shown, or it will also snap to the midpoint of the upper face, etc. – i.e. whatever makes sense for a fabricator is possible. Notice AIP gives you a red outline of the rip to preview & validate design intent before you execute.

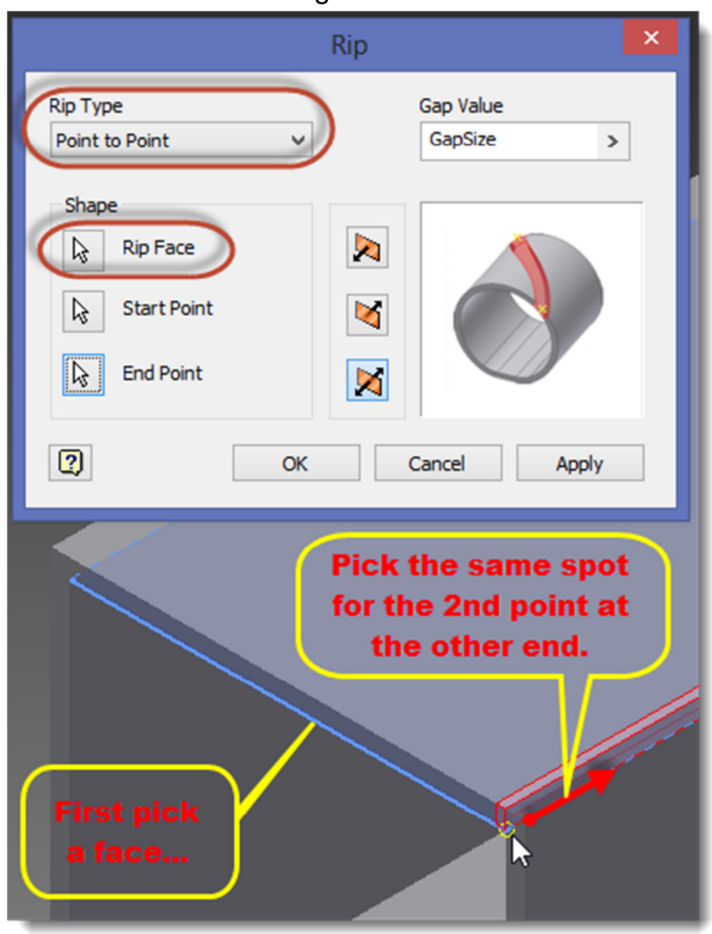


fig. 6

12) The last step to conform the geometry to real world conditions is to fillet all inside and outside corners along edges to be mitered (since no miter actually reveals 0" (zero in.) fillet corners). Let's start with the outside edges – where I ripped my mullion leaves seven outside edges to be rounded. If you ripped yours down the center of the face, you will have eight rounds to fillet. On the 3D Model tab, select the Fillet tool. Set Radius to 0.24 in (= 2 x 0.12 in. which is 2 x material thickness) and set Select Mode to Edge, and then pick all seven (or eight) outside edges to be rounded. Select the Fillet tool again, this time setting the radius to 0.12 in., Select Mode to Edge, and this time check All Fillets and note that all inside corners select. Hit OK to accept.

13) Now all that's left is to unfold and view the flat pattern. To do this select the "Go to Flat Pattern" tool on the Sheet Metal tab. If you want to see the bend order as well, select the "Bend Order Annotation" tool and note the bend sequence callouts are automatically placed. To go back to the folded part, simply select the "Go to Folded Part" tool.

So in literally minutes you have taken a Revit component and developed it into two fabricatable parts – both an extrudable part as well as a foldable sheet metal part. Not bad!

Fabricator Design Option Back to Architect

So the fabricator has an idea for a better mullion style that he/she would like to give back to the architect to try out on his/her model to see if the owner likes it.

1) Using the same mullion we're already in, Undo back through the Rip command to get us back to the extrudable part. Insure you are also back to a 3D Model environment. If not, select the "Convert to Standard Part" tool (located under the "Sheet Metal Defaults" tool).
2) Right click on the face at one end and select New Sketch (like fig. 5). All of the edge geometry will already be copied up. Here I create something memorable and not necessarily fabricatable, just to evince the workflow. You or a fabricator can create whatever you like. So in my sketch I delete the outer four fin lines, I draw a circle centered on the end, and add two more circles on the sides and trim away any overlap. Again, you can create whatever you want here. When done, extrude the sketch back through the existing mullion using Join and (To) to create solid geometry all the way to the other end – see fig. 7.

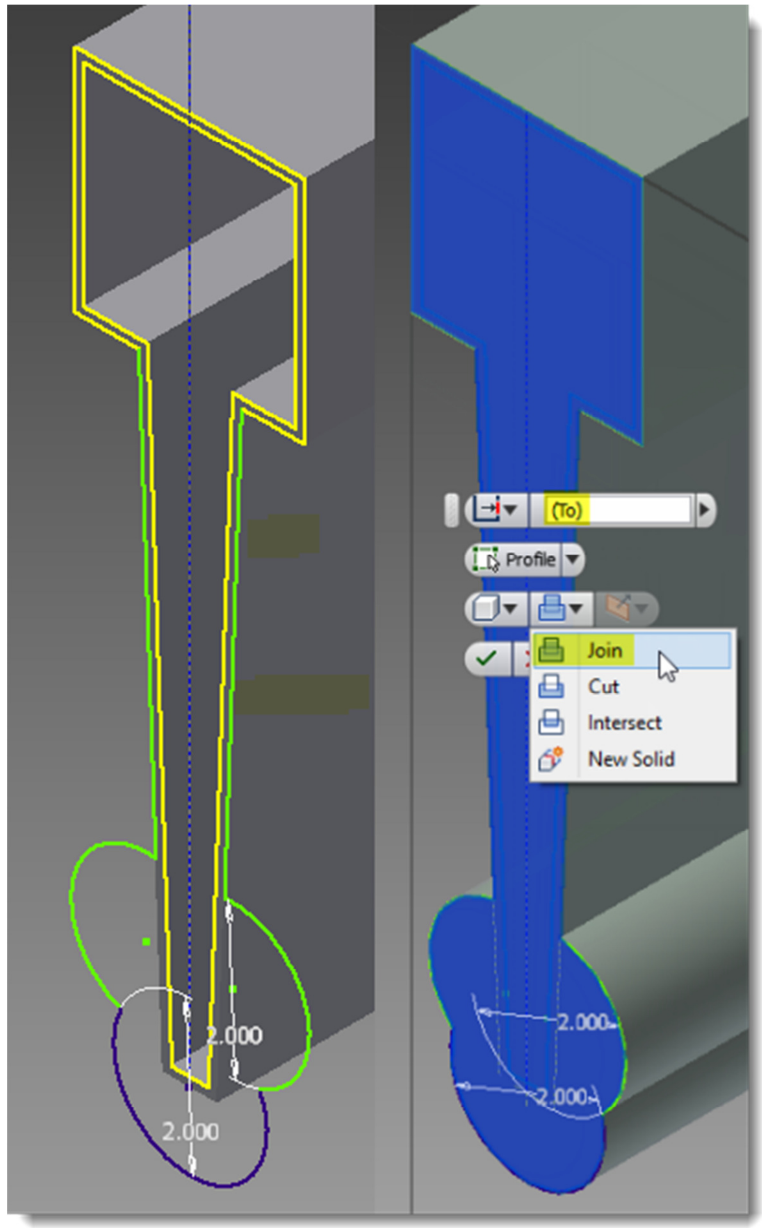


fig. 7

3) Now you have your new solid geometry that you could export out of AIP as an RFA (Revit Family file), or ADSK, or SAT, etc. Or using AIP's iCopy technology, you could create the entire curtain wall right here in AIP and ADSK that back to the architect. (**!Note -** For an excellent treatment on iCopy for curtain walls, see Rob Cohee's [10 min video] and [3 min video], in that order.) But in the case of curtain walls, there's a workflow even more expedient not just for the architect, but for the fabricator as well. It is to make a sketch of the mullion end and export *that* as a dwg. If I make a sketch of the end *after I shell the mullion* and export as a dwg (see figs. 8 & 9), I have all the information I need as a fabricator to create the extrusion die shape I need. If I *sketch the end the mullion as a solid* and export that as a dwg, I have a dwg outline file that in the case of Revit curtain walls, I can send back to the architect that will just *THRILL* him or her. Why?? That's a very good question – I'm glad you asked!
4) So save your dwg with an appropriate name and in a location you can find later. I named mine Clover Mullion.dwg.

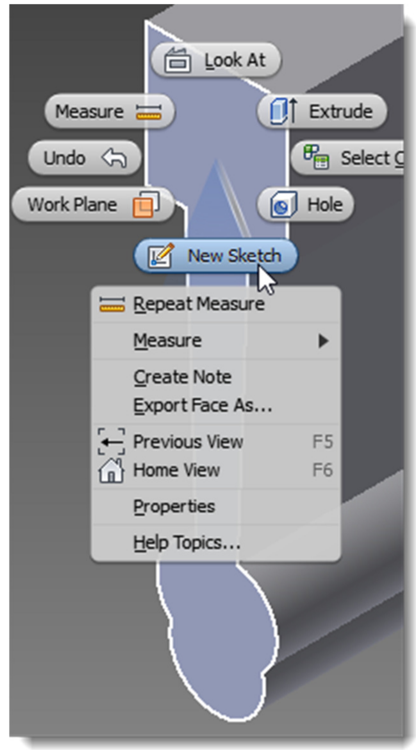


fig. 8

5) Let's go back to Revit to see what the architect will do with the dwg file from the fabricator. Open the curtain wall assembly file we started from. Go ahead and Undo back to the start of the Revit file (un-isolate everything).
6) Now in Revit, we need to create a new family, so select New –> Family and in the Template Selection dialog box, select the Profile-Mullion.rft template file and select Open.
7) Now select Insert tab –> Import CAD and point to the dwg we just exported from AIP.
8) Note that on the Profile-Mullion Ref. Level view, it states "*Curtain Panels are trimmed to where the profile sketch intersects the Center (Front/Back) Ref Plane.*" This means that you control where the glazing will rest relative to the mullion sketch features, based on alignment with the Front/Back plane.

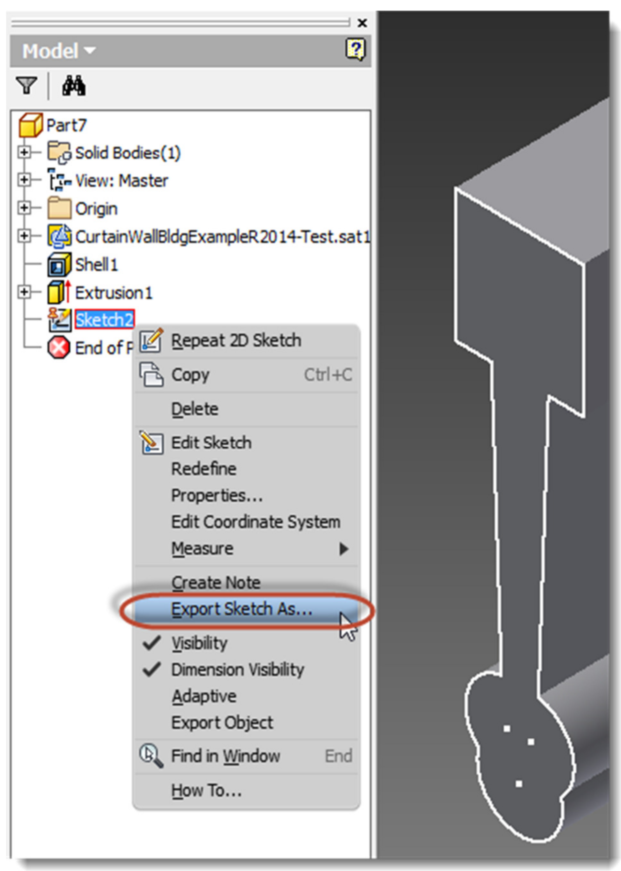


fig. 9

9) First use the Move command to select the dwg object, hit Enter, and then click the midpoint of the top of the square and move it to a point anywhere on the Wall Face plane (which controls the mullion center line). Now use the Align command to click the Front/Back plane and align it to the bottom lines of the square shape where the fin lines attach. See fig. 10.

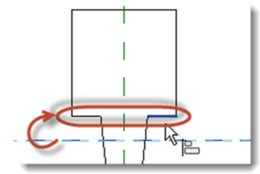


fig. 10

10) (Note that if any of these directions is/are unclear, I have included a video of the entire process with the class materials.)
11) Now under the Create tab select the Line tool, and in the Draw panel select the Pick Line tool, and pick all the dwg line work to copy it up and make it native Revit line work.
12) Now you have to delete the dwg reference line work, because while you can draw or model over ACAD geometry or line work in the Revit family editor, you cannot leave it there when you save or try to load into a project. Revit don't play that.
13) So if you haven't already guessed what we're accomplishing by all this, here's the genius in this workflow… Save the Revit family file you're with the same filename you used for the dwg you inserted into this file.
14) Note that in the Revit Family Editor (the environment you're in now – where you create and edit family files), under every tab there is a "Load into Project" command. Select that command, and since you still have Curtain Wall Bldg Example R2014.rvt in an open session, you can load the new profile will into it (and if it's the only RVT (Revit project) file open, it will automatically (without prompting you to select the RVT file) load it into that RVT file and switch windows to that project file).
15) Now if you select a mullion in the curtain wall system (tap the tab key to cycle through objects), you can right click and use the Select Mullions option to choose the specific mullions you want to modify.
16) Make your selection and then in the Revit Properties select Edit Type, In the Type Properties dialog box, click the Profile Value field and you will see the profile name you created in the family editor (for my creation it's the Clover Mullion profile). Select that, and observe all the mullions selected now adopt that new profile. Across a giant curtain wall this is a huge time saver, and gives credence to Revit's name – a contraction of "Revise Instantly."

This concludes this exercise. Remember that in some situations where the design is more altered, it may be better for the fabricator to rebuild more or all of the curtain wall in Inventor and export it out as an ADSK, RFA or SAT and import that into Revit. In Rob Cohee's videos that I adduced back in step three, he shows how to do just that – to bring the Revit building into Inventor and develop the curtain wall in Inventor, over the building geometry. Then you can take that back to Revit using Revit's Insert tab where you'll find options to Import or Link, CAD (including DWG, SAT, SKP et. al.) or Revit resources.

Create Concrete Formwork in Inventor, Directly Over Revit Walls

Real World Scenario

We had a contractor ask if it was possible to use foundation walls modeled in Revit to estimate and/or model the formwork that would be needed for the concrete pours. So this exercise covers two ways of doing that. There is a third and more involved way using AIP's Ground & Root functionality that will not be covered here, but any reseller that covers AIP should be able to demonstrate how to do that.

1) Start a new file in AIP, and select the *AEC Content Creation.iam* template file. You can use the IPT version if you rather, depending on how you want to create the panels.
2) Select the Place tool and place an instance of the *FoundationFtg&Wall.sat* file.
3) Select the Create tool, and in the Create In-Place Component dialog box, browse to a file location for your formwork representation and select a filename, and for the template, select the *AEC Content Creation Sheet Metal.ipt* file and select OK.

(Why sheet metal for wood formwork? Good question. You can think outside the box with these solutions, and in this case using Inventor's sheet metal functionalities allows us to "unfold" the geometry you create. Who cares if you call sheet metal wood and unfold that? It still gives you the overall linear dimensions as well as the corners/fold lines.)

4) AIP now takes you into the part where you need to select the top face of any of the wall sections for the sketch plane. To get to the sketch mode of the new sheet metal IPT file, select the Return button to go back to the parent IAM. In the Model Browser, under the new part you just created, expand the Folded Model to expose the sketch, and double click the sketch to edit the sketch.
5) Now you can create an outline of the outer edge of the top of the wall. In the real world, you would need to do both the inside and outside edges.
6) Here there are several ways to create the outline. My suggestion is on the Sketch tab, Format panel, select the Construction toggle, and then select the Project Geometry tool to copy up either edge lines or points – elements you can use to draw over with regular line work next.
7) Now use the Line tool to draw over these elements. You want to finish up with a contiguous perimeter, all but for a very slight gap at only one corner. You can set the gap to be 1/64 in. so it's negligible for our purposes. You can use another cutting line to trim against if you need to, in order to create the gap. Once you have this completed, finish the sketch.
8) In the Sheet Metal Defaults, uncheck the "Use Thickness from Rule" and set the Thickness to 3/8 in. (or whatever the *actual* (not nominal) plywood thickness is). Select OK.
9) Now select the Contour Flange tool, pick the perimeter line you just created, and adjust the tool settings so the geometry develops down & not up, set the Bend Radius to something very small like 0.01 in, and for the Distance use the measure tool and select a corner wall vertical edge. Select OK.
10) If you want to, you can right click on the Contour Flange element in the Model Browser, select Properties and change the material to Plywood or something different looking.

11) Now select the Create Flat Pattern tool and see the plywood a.k.a. sheet metal unfold.
12) Here's where there's even more payoff though. Right click on the face of the flat pattern and select Export Face As and choose dwg.
13) Then in ACAD you can draw over the dwg file with a 4'x8' grid and have exactly the cut dimensions you need for all the stock you'll need to buy.

At this point you can repeat the Contour Flange process over the layer of plywood you just built, to build the second and third layers since there are usually several layers of plywood in a concrete form. As you take each layer out to ACAD, be sure to stagger the cutline grid so as to overlap seams appropriately.

Another approach to this is at step 3, select the *AEC Content Creation.iam* file and follow the same process to sketch the perimeter, but this time, offset the perimeter by the plywood thickness, and then extrude to the footing. This give you a different kind of solid geometry that I feel is less workable, but you never know – you guys may find something useful with it that I would have never thought of. If you do, surprise me and send me an email! william.spier@autodesk.com.

Revit ETO (Engineered to Order)

The DAS Video Says it ALL…

Revit ETO Selections by DAS (Design Automation Systems). The actual MP4 video of is also included in the class materials.

So you think what we just did with formwork was cool? Watch this. This is up & coming technology that you would have to contact DAS about – it is not Autodesk technology. This is how the concept of Engineered To Order (ETO) is being brought to bear in the Revit AEC world.

CNC Fabricating Directly from Revit Architecture

From Revit to CNC – Gyp Wallboard & Plywood as Examples

It occurred to me one day that even the most sophisticated, eleven axis milling machine can read a DXF file, and I knew that Revit can export DXF files. So I thought what if you could section a Revit wall or roof up into 4'x8' panels, and then with the openings for doors, windows, receptacles and so on included, export those 4'x8' panels out to a 2 ½ D CNC machine (a cutting table) to be cut?

That would mean all gyp wallboard and plywood that gets delivered to the jobsite would be prefab'd and immediately ready for installation. None would have to go through the laborious process of field labor measuring, snapping lines, cutting & re-cutting, looking for more stock etc. Instead they could just scan the barcode on each piece using their iPads and BIM 360 Field, see where it goes in the model, and then install it. Everything would fit the first time (okay - at least most everything), cut lines would be clean, openings for piping can be set to the pipe diameter + 1/8" meaning I would now have a 1/16" gap between the pipe and the wall, further saving on fire stopping, caulking and so on. All positives.

So I set about trying it and found one problem – Revit exports a multiple entity selection as a single, combined dxf, so I had to have my compatriot in Switzerland – Jeremy Tammik, program some custom functionality into Revit for me. Before you being this exercise, and while exited out of Revit, you will need to copy the ExportCncFab.addin file and the ExportCncFab.dll file (included with the class materials) into your Revit Addins folder, which for 2014 should be C:\ProgramData\Autodesk\Revit\Addins\2014. Note: this functionality is not provided by Autodesk. This is my own unofficial customization of Revit I am providing for whomever would like to test it.

This primary purpose of this exercise is to demonstrate that you can actually export elements directly from Revit to CNC. Gauging how useful and effective it is to do so with gyp wall board and plywood, is secondary, as the use cases are not relegated only to gyp wall board and plywood. Hopefully this will put your antennae up to more & more various possible use cases like for insulation panels, ceiling tiles, floor tiles, molding, or any other stock materials you may model in Revit.

So let's dig in:

1) Open the *Wm's Test Wall.rvt* file and note the wall on the left has already been parted not only into its component layers (gyp wallboard and core metal stud) but the gyp wallboard's also been divided into 4'x8' panels. The wall on the right has not.
2) With nothing selected, look for "Parts Visibility" in the Properties window and in the pull down you'll see three options – Show Parts, Show Original and Show Both. See fig. 11. As you cycle through them, observe the left, parted wall to see how the visibility states change. For this exercise we'll leave it set on Show Parts so we can see the components.

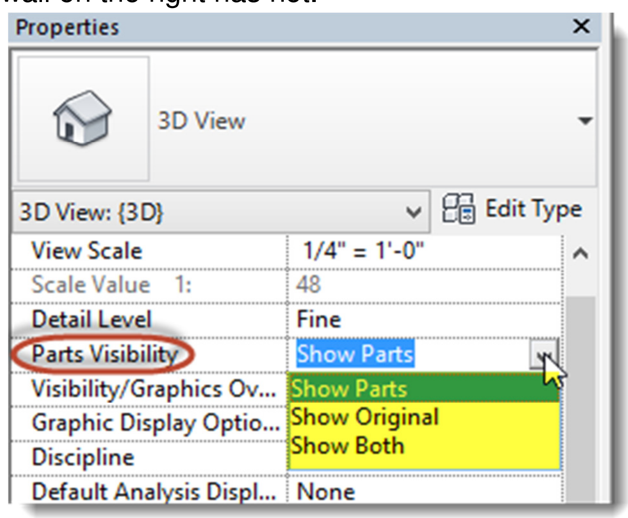


fig. 11

3) Select the wall on the right and under the Modify Walls tab –> Create panel select the Create Parts tool. Note the right wall now shows both sheetrock and core.
4) In the 3D view you're in, select the view cube Front view, or activate the South Elevation view in the Project Browser. In the Project Browser scroll down to Families –> Generic Models –> *4'x8' Panel Array* and select Create an Instance, or drag it over to the right wall (you have to hover your cursor over the right wall for the grid family to appear) and left click to place an instance of the grid.
5) To align the grid, simply select the bottom left most grid intersection (intersection snap) and move it to the bottom left (endpoint snap) corner of the wall.
6) To divide the gyp wallboard into stock 4'x8' panels, select the gyp layer facing you and note that with Revit being context sensitive, the Divide Parts tool is now available under the Modify | Parts tab –> Part panel. Select the Divide Parts tool, then on the Draw panel select Edit Sketch and finally select the Pick Lines tool. Now you can select the four vertical grid

lines intersecting the wall and the one horizontal line over the door. Select Finish Edit Mode (green check mark) twice to back out of the editor.

7) Go ahead and delete the grid and in the 3D view select Top view on the view cube. Zoom into the top of the right wall so you can select one of the gyp panels. In the View Control Bar at the bottom left of the UI, select the Temporary Hide / Isolate tool (sunglasses icon) and pick Isolate Category.
8) Now using a left to right surrounding window, select only the panels we just divided. Return to the 3D home view if you want to confirm your selection.
9) Now would be a good time to go to the Add-ins tab and select Create Shared Properties which will add three shared params – 1) If Exported (i.e. yes/no), 2) First Export Date, and 3) Last Export Date. You can create whatever you want, but these demonstrate that users can see in a view (via an applied color legend) which panels have been exported to DXF, or in a schedule see both if (color conditional statement) and when (date field) the panels have been exported.
10) With the panels still selected, under the Add-Ins tab, on the Export to CNC Fabrication panel, select the DXF tool, and when prompted select the folder location you want the DXF panels propagated to. The DXF panels will be created with the following file naming convention: Level_#_Parent Element ID_Child Element ID.dxf. (e.g. Level_1_182166_186331.dxf) Now you have the media you need to send to any CNC machine to be milled (cut to match) – see fig. 12. If you want to preview the DXF parts, you can open them in any ACAD application.

fig. 12

11) The last thing to point out is how

you can use schedules and view filters to provide visual cues for situational awareness.

a. Under Schedules in the Project Browser you'll see two schedules I created called "Part Material Takeoff" and "Part Schedule." You can reverse engineer these to see how they're made, but more important than showing just basic part information, but I also the first and last export dates as well as the "if exported" value (the same three parameters as above), and added a condition to the latter that if it = true (i.e. has been exported) then make the column red.
b. And if you browse the Project Browser under Floor Plans and under 3D Views you'll see two that are labeled with an "Exported Panels" extension. Each has a view filter set to show any wall parts that have been exported in a very noticeable pink. Type VG for the Visibility Graphics dialog box to see how conditions are set to effect that. See How to Schedule Parts Material in Revit.

There are even more ways to leverage what we've created.

- At this point you can also use any number of barcoding software available online, many for free, to tie into Autodesk® BIM 360™ Field so as each panel is prefabricated, it is also barcoded so that when a palette of precut stock arrives on site, all the recipient does now is scan each one with an iPad, and BIM 360 Field will indicate in the model, where each one goes.
- If you want to cut wall openings for Revit elements that don't normally cut, like beams, pipes, ducts and other system family elements, you can use Tools4Revit.com's tool called Cut Opening. This is a very robust tool that performs batch cutting against almost all geometries, and even allows user defined offsets, etc.

Piping Fishmouth & Cope (and Round Column Cope)

Rapid Pattern Development in AIP & ACAD – A Reusable File

So I had a pipe fabricator ask me if one of our products – CADmep can unwrap pipe geometry to reveal pipe fishmouth or pipe cope openings (used for direct connection welded joints). While I am told it can, I was not aware of any designed method, so I thought about how I could accomplish that in Inventor, and do it in a repeatable way – that is so a user can use the same file over & over for infinite pipe size and joint angle & offset conditions. After two or three tries, I came up with a solution that works like a charm, even though Inventor wasn't intended for that use. I also learned from my structural compatriots that this same solution is useful not just for piping but also applies nicely to the end cuts on the round structural column braces commonly used for things like oil drilling platforms, water towers, etc. See fig 13.

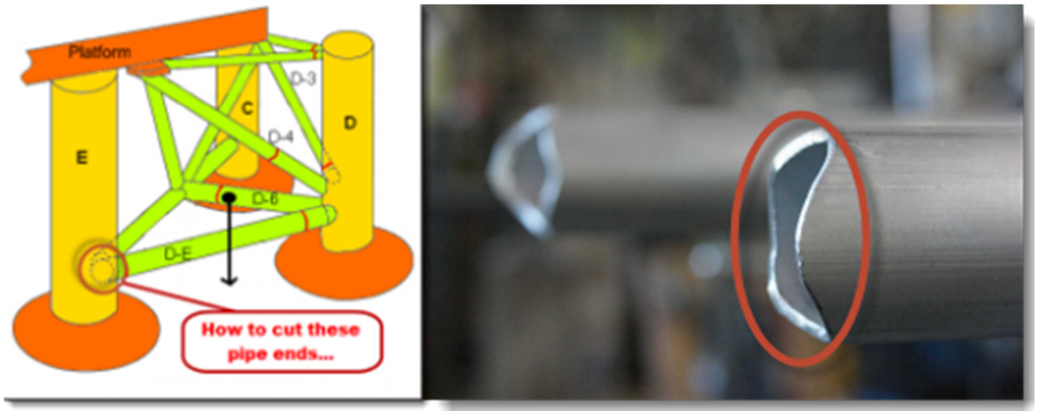
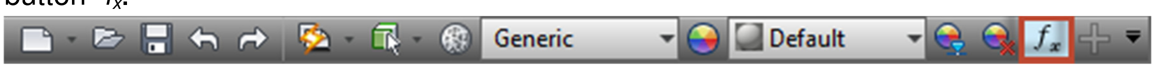


fig. 13

Open the *Pipe Fishmouth & Cope.iam* file in AIP. Note at the top of the Model Browser are the assembly relationships. The two we're going to control are the Pipe Centerline constraint and the Angle constraint. Further down the design tree are four other planes – Lateral & Main Pipes with TOP & BOP for each. Here's how they work.

- To control the angle between the two pipes, double click the Angle constraint, edit the dimension and the pipe angle will adjust accordingly.
- To control the offset between centerlines, double click the Pipe Centerline constraint and the value you enter will offset the centers by as much.
- Alternatively, if you want to align the tops or bottoms of the pipes, right click on the Centerlines Constraint and select Suppress. Now you can use the Constrain command on the Assembly tab to apply a flush constraint between the two TOP planes or the two BOP planes.
- To control the pipe sizes you need to adjust the Pipe Solids and not the Unfolds as both Unfold pipes are driven by its associated Solid pipes. So right click on Main_Pipe_Solid:1 or Lateral_Pipe_Solid:1 and select Edit. On the Quick Access toolbar select the Parameters button "f_x."



- Look for Main_Pipe_Solid_OD or Lateral_Pipe_Solid_OD and change the value to what you need. Note that the lateral pipe diameter can be equal or smaller than the main's, but not greater than the main's/ It will not cause the model to fail – it just won't make sense.

What makes this assembly work, and what Inventor was not intended for, is both pipe pieces are actually folded sheet metal parts that I used to represent pipes, adding a negligibly narrow rip to allow for unfolding.

The following steps are recorded on YouTube video I made: [Create Piping Fishmouth Templates with Autodesk Inventor & AutoCAD](). Before you start, if you want to turn off the workplanes, go to the View tab –> Visibility panel –> Object Visibility –> and uncheck User Worplanes, or just key in " alt+] "

So once you have the pipes adjusted to match your real world situation, it's time to cut the fishmouth opening either on the lateral end or on the side of the main. Let's start with cutting an opening into the side of the main (Main_Pipe_Unfold:1). To do this:

1) Select Main_Pipe_Unfold:1 (the part to be cut), right click and Edit.
2) Go to the 3D Model tab and on the Modify panel, select Copy Object command and pick the Lateral_Pipe_Solid:1 *actual geometry* (not the listing in the Model Browser). (If you have a hard time selecting the Lateral_Pipe_Solid:1 geometry, turn off the visibility for the Lateral_Pipe_Unfold:1 by right clicking on it in the Model Browser and unchecking Visibility.)

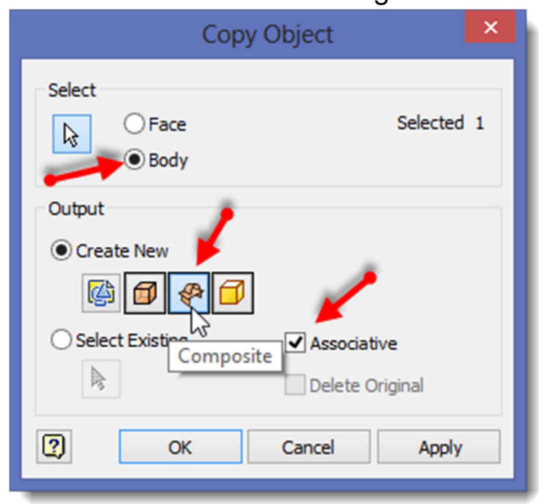


fig. 14

3) Once selected, in the Copy Object dialog box, check the settings to make sure Body is selected, Create New Composite is selected, and Associative is checked. Select OK. See fig. 14.
4) While still in the 3D Model tab, go over to the Surface panel and select the Sculpt tool and pick the Lateral_Pipe_Solid:1 *actual geometry* again (you're selecting the cutting object). The settings need to be Remove, and Out Side direction. Hit OK and select the Return command or Ctrl+Enter (to return to the assembly).
5) Now if you right click Main_Pipe_Unfold:1 and select Open, you'll see the fishmouth opening in the side.
6) Simply select the Go To Flat Pattern tool, right click on the unfolded part and select Export Face As and you can export the face as a dwg file that you can print/plot, wrap the plot paper around the actual pipe, trace over and you have the exact opening you need to cut out of the main pipe. Note that you can tell the grey side is the outside of the pipe as I assigned "Rusted" material to the inside of the pipe.

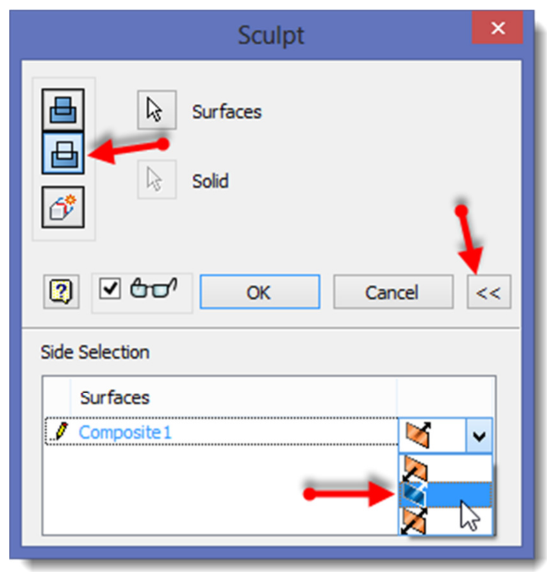


fig. 15

A file management consideration here would be to either save the file as a new name if you need to archive your cut, or save without closing and effectively restore the file to its original, uncut state. Remember that you have the dwg you can plot over and over again. Alternatively, if all you will ever use the file for is lateral openings, then save it as it is now. This last option allows you to leave the hole geometry you created for future lateral openings – just change the pipe diameters, angle and offset relationships as needed and the hole just updates.

7) If you want to cut the fishmouth on the end of the lateral (as structural fabricators would need for round column bracing), simply repeat steps 1-6 and just switch the objects you select. So for step 1. edit the Lateral_Pipe_Unfold:1; steps 2-3. copy the

Main_Pipe_Solid:1; step 4. sculpt the Main_Pipe_Solid:1; and Return to the assembly file. Then just open the Lateral_Pipe_Unfold:1 and unfold it.

The following are samples of results you should get if done correctly.