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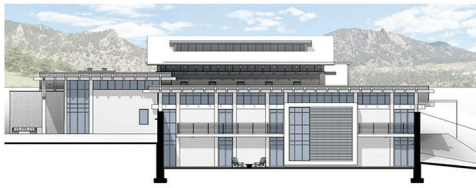
October 2015

Customizing and Other Productivity Boosters



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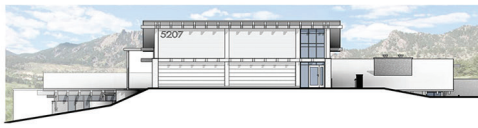

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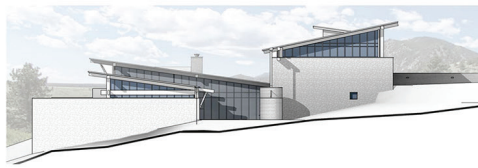
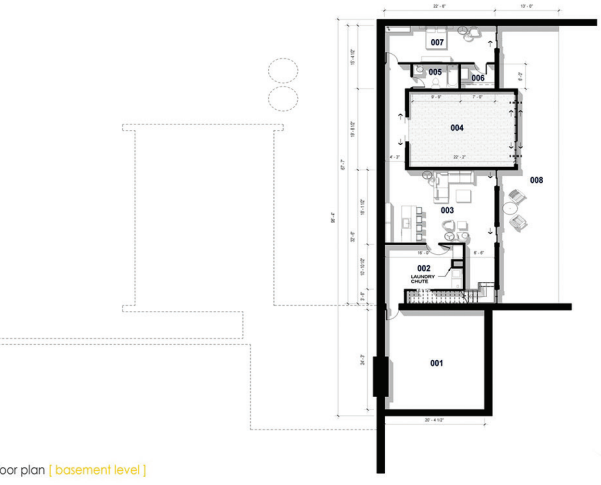
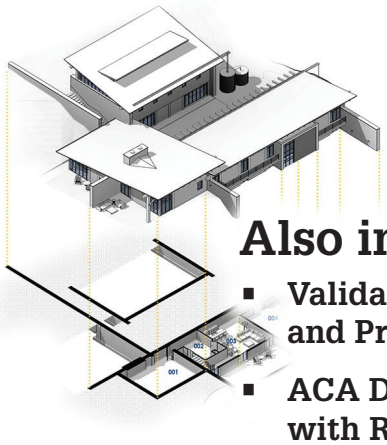




001 STORAGE / MECH./ PANIC
002 LAUNDRY ROOM
003 LIVING ROOM
004 YOGA ROOM
005 BATHROOM
006 CLOSET
007 BEDROOM
008 BASEMENT PATIO

oor plan [basement level]



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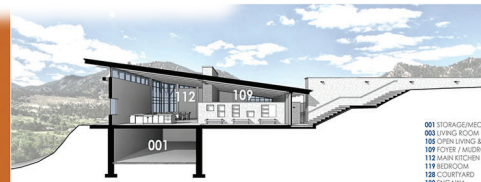

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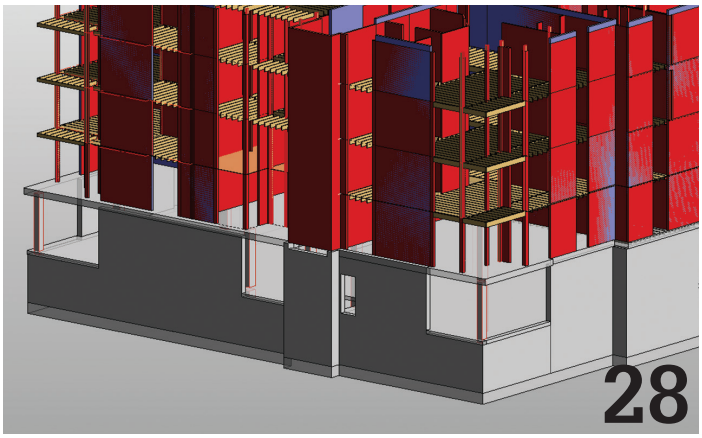

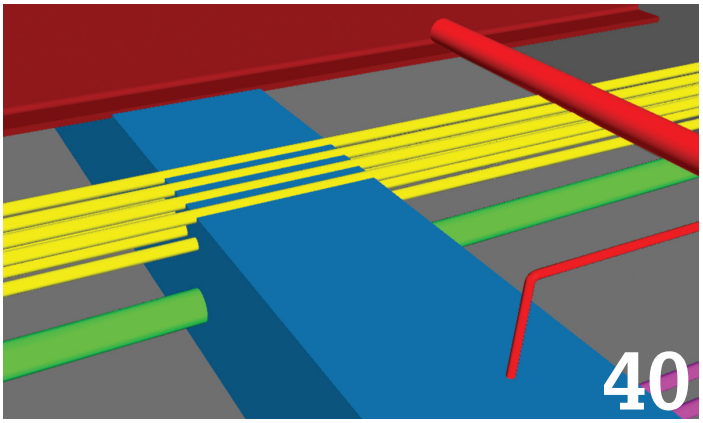

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Letter from the President

COMMUNITY DAY

Over the years I have had the pleasure of working for companies that have a strong spirit of giving back to the community. They encourage such giving throughout the year and the last few companies have organized a special "Community Day" each year where many of the employees take a few hours or the entire day to meet at a location with a great need. I am always amazed at what can be accomplished over a short period of time when you have a lot of people working toward the same goal.

It makes up for the aches and pains I feel this morning after all the hard work I did yesterday <grin>.

My local Stantec office had close to 50 people working in two separate shifts at a local boy/girls club that needed some TLC. Yes, there were a lot of tasks that required some hard work to finish the job. But when you have a lot of people all working on that job it will get done faster than you believe possible. And there will be a lot of jokes and fun along the way. The appreciation expressed by the club staff was heartfelt and generous. I am sure that they will remember this day for quite a while to come.

Even better is how you feel as an individual after volunteering like that. You become closer with your fellow coworkers when you all labor together toward the same goal in a spirit of giving. It is a far different experience than working on a project back at the office with some of those same folks. Everyone left the club with a smile on their face.

The same thing can be said about volunteering for AUGI. There are many members who have volunteered for years on AUGI's behalf. Why do they do this for so long? It's certainly not because of the pay! If you ask any one of them, their answer will be along the lines of, "I wanted to give back to the community."

AUGI is a community of people that share common goals and needs. When you have an issue with an application or process you are almost assured that someone else in the AUGI community has had the same issue. You might be able to benefit from their experience if they have solved the issue, or you can work together toward finding a solution when alone you could not. The time you spend on the Forums, building the community, is a form of volunteering. The more active you are in the Forums, the stronger that sense of community becomes.

There are many other ways in which you can volunteer to help AUGI. Reach out at volunteering@augi.com to find out how you can help build the AUGI community.

R. Robert Bell
AUGI President

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by: John Evans

Product Review: 3DConnexion CadMouse

I have always been a big fan of 3DConnexion's hardware, and the innovation and thought that go into their products. I am definitely not alone; just go by the 3DConnexion booth at Autodesk University and look at the very long line of people trying to win a SpaceMouse. The company's desire to produce robust, well-assembled products has never changed.

Recently, 3DConnexion has released a new product: the CadMouse. I get what many are thinking: *"Seriously, it's just a mouse?"*

The statement that "you get what you pay for" in the US still holds true. This is a good mouse, and in this article I'll describe just what you will be getting and why I recommend you buy one.

3D CONNEXION CADMOUSE

The 3D Connexion CadMouse is a mouse—yep, just a mouse. And as you probably suspected, there's no genie inside that will do your work for you. What you may not know is that CadMouse is a professional grade mouse meant to make CAD work (as well as typical mouse tasks) more comfortable, and a bit more efficient.

Features

- 7 buttons total (including dedicated middle mouse button)
- 8200dpi / 1000Hz laser sensor
- QuickZoom
- Smart Scroll wheel
- Gesture / radial menu button
- PTFE feet
- 1.8m braided USB cable

- Dimensions (LxWxH): 128mm x 80mm x 44mm / 5" x 3.15" x 1.7"
- Weight: 130g / 0.29lb (without cable)
- 2-year warranty

Dedicated Middle Button
The CadMouse comes with three forward buttons, left/right/middle. The dedicated middle button offers more precision and faster control. If you use "MButtonPan" to make your scroll wheel pan when pressed in AutoCAD®, this dedicated middle button will replace that functionality if you like.

Smart Scroll Wheel
With the middle button able to perform dedicated middle-click operations, the scroll wheel can be left to scroll-only, reducing the CAD operator's fatigue over time. If desired, the typical scroll-wheel button operation can still be used.

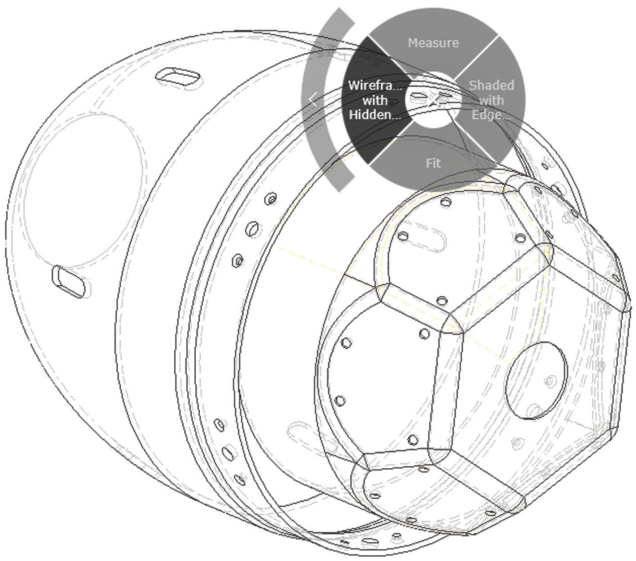
- Detent index type scroll damping
- Software-driven scroll acceleration

Quick Zoom (Two Side Buttons)
The CadMouse also offers two side buttons that activate the Quick Zoom feature. The software will zoom in and out to a preconfigured depth centered at the location of the cursor. This functionality is present in both 2D and 3D CAD environments.

- Configurable

The Gesture and Radial Menu Button
That little button behind the scroll wheel (positioned like the one that cuts the scroll wheel loose on some models) activates the radial menu. This menu appears translucently in any window, and offers four configurable command options.

- Pull gesturing
- 4-position radial menu
- Application-based adaptability
- Configurable



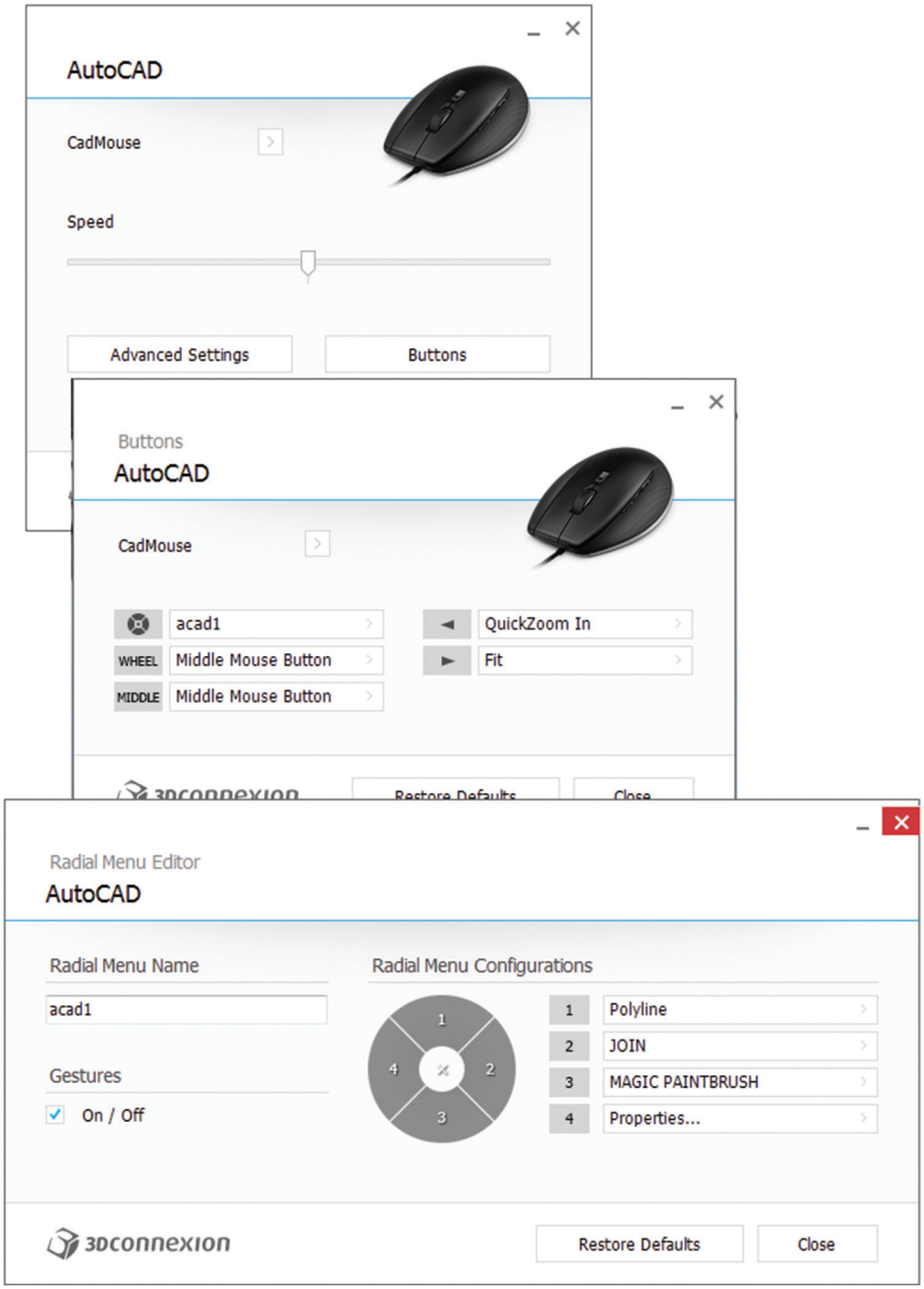
Okay, enough of the marketing stuff. How does it feel?

USING THE CADMOUSE

First—it's smooth. Somewhere between *"Slipperier than greased owl $#!^", and "Slicker than a cat's a**".* I use the mouse pad that accompanies the CadMouse, which provides a nice level of barely-imperceptible resistance and feedback, as well as better precision on the laser. It moves effortlessly, but doesn't fly off the table.

Second—it's comfortable. Now I will say that my style of mouse use has been awkward, to say the least. I tend to grip the mouse with thumb and ring finger, and I use my middle finger for the scroll wheel, which stays in a perpetually raised and tensed position. I think it was a poorly evolved use that came from keeping my index finger on the fire button at all time in games years ago (my associates were relentless, and you had to keep your

Inventor 2016



guard up… you know who you are ☺). In any case, I never learned to use the scroll wheel with my index finger as most people seemed to, and using my ring finger to right-click is absolutely foreign. If you are like me and want to get the most out of fine hardware, the CadMouse will take some adjustment.

The button springs offer a nice balance between firmness and crisp, easy response.

Third—it's solid. The feel of the buttons is similar to what you would expect from an up-scale mouse: positive reaction with a feel of quality; no loose or frail-feeling components.

Function Buttons

The remaining buttons handle functionality. These are driven by the control panel supplied with the mouse software. The control panel is part of the unified 3D Connexion interface, and those that already have a 3D Connexion device will understand it immediately.

Each button had a good, quality feel. Placement for each was acceptable. My fingers are not real long, but I still found the button placement comfortable. I think the company did a good job finding a middle ground that would be comfortable for most people.

Radial Menu

I was concerned that the limited four items on the radial menu would not react to different modes of the CAD software we use, functionality that is present in 3D Connexion's other high-end devices. I'm happy, for once, to be wrong.

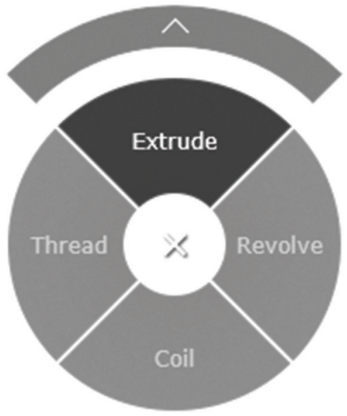
The Radial Menu can be altered for each environment in Autodesk Inventor®, such as Part and Assembly. Pre-configured panels already exist in the control panel, which you can select while using whichever portion of Inventor® you need. I opened a Part file, and then selected the pre-configured Part panel in the mouse Control Panel. The functionality updated immediately. I then jumped back and forth between assembly and part environments, and each time the CadMouse Radial Menu updated accordingly.

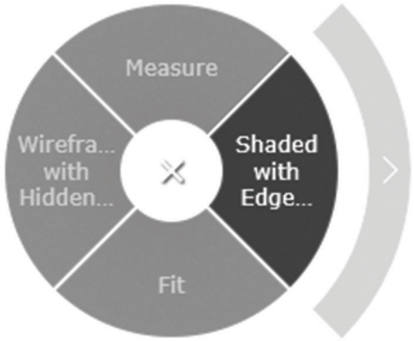
In addition, the menu functionality works in any application, not only CAD. I tried it while typing this review and I got a basic word processing menu.

Unfortunately, the application-based menu is singular in AutoCAD. There does not appear to be any different mapping of menus between Model and Paper spaces.

Gesturing

The gesture functionality is pretty simple. Once the Radial Menu is initiated, instead of picking one of the menu items simply drag the mouse beyond the menu. The latter will initiate the command that





the cursor passed over last. Finally, in order to cancel the menu, simply pick in the center of the menu, or push the menu button again.

The menu delay is very small, and I find the reaction time well within the margins of acceptability.

Quick Zoom

I am trying to get accustomed to the Quick Zoom feature. The functionality zooms the view in and out, according to a fixed scale setting, regardless of where you are in CAD or what you are doing. It works quickly and hasn't reacted negatively to anything else I was doing.

The zoom-in functionality worked well, but the OEM zoom-out functionality was set to "fit" and I didn't realize that. It kept zooming to the limits of components in the drawing or space (both AutoCAD® Civil 3D and Inventor). This was not cool and I was a bit disappointed until I found that this could be changed to anything on the control panel! I found the complementary quick-zoom out function and now it zooms right back where I was before. Ahhhhhhh…

Scroll Wheel

The Scroll Wheel damping is good. The feel is that of a medium length and moderate damping, which gives me the impression that it won't weaken quickly.

I typically use a weighted scroll wheel (from that other company), allowing fast scrolling in extremely long lists in Word and Excel. As cool as they are, the release mechanism on those break after a year, without fail. The CadMouse instead uses drivers to mimic that type of weighted scrolling behavior, and senses how fast you want to scroll. It does a pretty good job of it; give it a good push and it really scoots. I'm starting to get a feel of how it behaves in different documents.

CONCLUSION

The CadMouse is a well-built, smooth-action mouse. It offers precise positioning in a reasonably comfortable package. My biggest hurdle is that I use an Engineering Mechanics book to elevate my wrist a bit to lessen fatigue, and I tend to use a medium-sized mouse. The CadMouse is a large mouse and was designed to glide smoothly, rather than to be gripped and man-handled. It is quite a fatigue-relieving design, but I need to relax a bit in order to get the benefit.

The biggest ticket in this show is probably the radial menu. The only improvement suggestion I have with regard to the layout is that perhaps there is a tiny location on the radial menu to access the control panel. The radial menu seems like a great opportunity for those who don't need a 3D mouse (yet) but still want the application-based menu functionality. I really like how 3D Connexion offers a list of AutoCAD and Inventor commands right inside the menu control panel, allowing me to pick the tool I want without having to make a macro to drive it.

John Evans is the Managing Director and Technical Specialist at Design & Motion, an international R&D firm, helping customers with product design, manufacturability, and validation. He is a US Air Force veteran and has over 20 years of design, manufacturing, and fabrication experience in aerospace and industrial machinery, and holds various industry certifications including Autodesk Inventor Professional. John is a devout fan of simulation technologies, material sciences, and continues to pursue his education in aeronautical and mechanical engineering. John's role at Design & Motion includes technical research and journalism related to engineering software from around the world, with published articles in various design related journals and magazines, as well as the company website. John speaks Japanese and English, loves aircraft, loves his wife and 2 boys, and would rather be on a 1000 yard rifle range right now. You can reach him at john@designandmotion.net

by Robert Green

3D Viewing: HP Zvr Virtual Reality Display

Particularly, doesn't it stand to reason that when you design in 3D that your monitor should be in 3D as well? HP's new Zvr Virtual Reality Display makes great strides towards being able to design in 3D by simply loading up some interface software and throwing on a pair of glasses.

Figure 1 - The HP Zvr has infrared tracking cameras mounted on the top of the screen bezel that interface with the user's glasses to control viewing manipulations.

WHAT IT IS

The Zvr is not just a monitor but a collection of systems that combine to present a virtual-holographic 3D image[1] that seems to hover over the monitor while interaction with the model is accomplished via a stylus and head motion tracking. Here's a breakdown of the key components:

The screen: 23.6" diagonal full HD[2] (1920x1080) backlit LED panel that delivers separate left/right eye signals in 60Hz refresh rates which are then converted to 3D images via the user's glasses.

Glasses: The glasses[3] themselves are totally passive (no cables) and look like a normal pair of wire frame glasses with the exception of five sensor elements around the front part of the frame.

Infrared cameras: The screen's bezel contains four infrared (IR) cameras that track the user's glasses to manipulate the 3D image via head motions.

Stylus: Think of the stylus[3] as a two button mouse that allows you to reach into the model and manipulate it while your glasses allow you to view the results.

Optional 2D interface: With additional hardware[4] the 3D image can be connected to a standard monitor, HDTV or data projector so others may see it without glasses.

THE USER EXPERIENCE

From an installation point of view the Zvr itself is simply plugged in then the optional zSpace Studio software (or another similar utility) is installed to allow for 3D model processing and display. Before you can look at something in 3D the following two step process must be performed:

Export your model to zSpace Studio: Autodesk users must first load the 3D model into your CAD application and then export it to Collada (DAE) or Stereolithography (STL)

format as supported by your application. (Note: STL files do not convey color information so DAE is the preferred format.)

Load your file into zSpace Studio: Start zSpace Studio[5, 6] and open the DAE or STL file.

Now put on your glasses and get ready for a jolt. It's hard to describe how realistic and deep the field of vision is when you first use the Zvr, it really must be experienced. As you look at the model the Zvr's IR cameras are actually watching the reflective sensors on your glasses to track[7] your head's movement so the software can orbit/zoom/pan about the 3D image just as if you were looking at the model itself. The tracking is crisp and the image motion is uncannily natural looking as you change your viewing perspective.

Figure 2 – This is a simulated, yet accurate, portrayal of what the Zvr display looks like through the included user's glasses.

If you've ever used 3D viewing goggles and experienced disorientation or eye strain as a result you'll find that the Zvr's passive glasses eliminate this issue entirely. Since the focal length of the glasses are very near the screen's surface there is no spatial disorientation – looking at the Zvr is just like a regular monitor but with a hologram projecting from it.

The stylus/pen can be used to "grab" objects within the model and manipulate them to, say, explode a mechanical assembly. The stylus usage does take some getting used to but the visual reward of being able to peer inside buildings, assemblies and parts is worth the effort.

APPLICATIONS

After five minutes using the Zvr you'll say to yourself, "This would be awesome for presentations and/or design reviews." In Autodesk software environments, where performing walkthrough or orbit maneuvers require mastery of a mouse driven interface, the Zvr could be a great way for non-CAD users to really see what a design looks like. Or, alternately, using a hardware interface to display the 3D hologram onto a large 2D monitor could be a great way to convey concepts in a presentation room.

Clearly Autodesk users are just starting to examine virtual-holographic 3D image based design but the Zvr is a powerful tool that illustrates how realistic and easy this new form of design visualization is. If at all possible do try to have a look at the Zvr and experience the technology for yourself.

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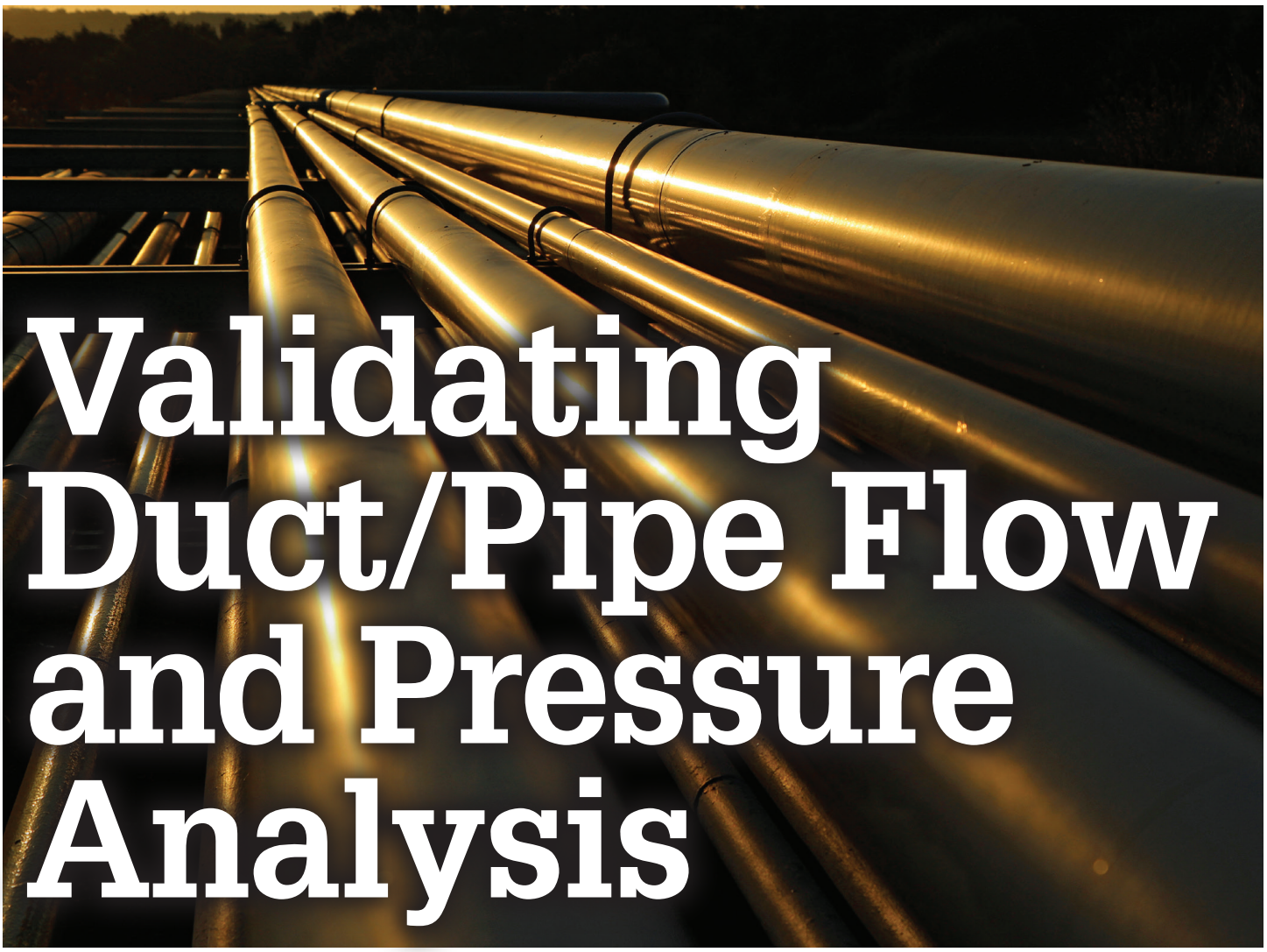
ABOUT ROBERT GREEN

Robert Green provides CAD management consulting, programming, speaking, and training services for clients throughout the United States, Canada, and Europe. A mechanical engineer by training and alpha CAD user by choice, Robert is also well known for his insightful articles and book, Expert CAD Management: The Complete Guide. Reach Robert at rgreen@greenconsulting.com

1. 3D content is required for 3D performance
2. High-definition content required.
3. 3D glasses, 3D glass clip-on, and stylus pen are included.
4. Sold separately.
5. Sold separately. License required."
6. Downloadable from http://developer.zspace.com. See zSpace site for exact configuration requirements. License required.
7. User must be wearing 3D glasses for tracking to occur.
8. All specifications represent the typical specifications provided by HP's component manufacturers; actual performance may vary either higher or lower

by: Douglas Nachtrieb



Validating Duct/Pipe Flow and Pressure Analysis

Using Autodesk® Revit® MEP for 3D design, coordination, and documentation has tremendous advantages over working in a 2D world. For engineers, being able to coordinate space for ductwork, piping, and equipment using Revit has allowed MEP engineers to provide a higher quality deliverable and product to our clients.

However, even with this new technology at hand, not many engineers are leveraging all of the tools and functionality within Revit MEP. One of these tools is pressure and flow calculations for duct and piping system. Engineers currently still turn to other software platforms they have used in the past that specialize in specific calculations to justify to their clients the designs they produce. As there is an increase in demand for design build, joint venture, and Integrated Project Delivery (IPD) projects, there is a reduced amount of time to produce designs. Instead of replicating work in another software platform or spreadsheet, why not focus on integrating the analytical model into the physical model?

Let's take a dive into calculations that Revit is performing and see if we really can lean on the calculations it is providing us.

First, we should have a good understanding of how they should be performing the calculations as compared to what the industry standards are. So what are the industry standards and where do they come from? As a HVAC and piping mechanical engineer, my go-to reference is the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, otherwise known as ASHRAE.

Chapter 22 of 2009 ASHRAE Fundamentals, "Piping Design," gives us the direction and frame of reference that we need. To quote a paragraph from the introduction of this chapter:

"The emphasis in this chapter is on the problem of sizing the pipe, and to this end design charts and tables for specific fluids are presented in addition to the equations that describe the flow of fluids in pipes. Once a system has been sized, it should be analysed with more detailed methods of calculation to determine the pump head required to achieve the desired flow. Computerized methods are well suited to handling the details of calculating losses around an extensive system."

To start, we will follow ASHRAE's recommendations and compare how each platform performs its calculations to produce the data that we see here (Figure 1).

Mechanical - Flow	
Additional Flow	0.000
Flow	97.269
Reynolds Number	131123.440016
Relative Roughness	0.000067
Flow State	Turbulent
Friction Factor	0.011107
Velocity	17.66
Friction	43.0583
Pressure Drop	5.295

Figure 1: Revit Flow and Pressure Drop

Please bear with me, as I know some of these calculations can get a bit dry and drawn-out; however, the content is valuable and at the heart of the discussion.

PIPING

Darcy-Weisbach Equation

Revit MEP uses the Darcy-Weisbach equation to calculate the pressure drop in a length of pipe. For us to understand how to calculate the pressure drop through a pipe, we need to be able to calculate the Reynolds number and friction factor; both are required for the calculation and both are dependent on the pipe material, pipe size, fluid type, and fluid velocity.

Reynolds Number

The Reynolds number is a dimensionless number that represents a ratio of the inertial forces of the fluid over the viscous forces of the fluid. The faster the fluid flow, the higher the Reynolds number. The higher the viscosity, the lower the Reynolds number.

$$Re = \frac{D_h v \rho}{g_c \mu}$$

Where:

Re = Reynolds Number

D_h = hydraulic diameter, ft

v = average velocity, $feet/second$

ρ = fluid density at mean temperature, lbm/ft^3

g_c = units conversion factor, 32.2 $ft \cdot \frac{lb_m}{lb_f} \cdot s^2$

μ = absolute (dynamic) viscosity, $lbf \cdot sec/ft2$ (temperature dependant)

It is important for engineers to know the Reynolds number for a section of piping as it can give us an indication of what is happening in the system and if the expected heat transfer or appropriate mixing is occurring.

There are three kinds of flows that we can have in piping system: laminar, transitional, and turbulent. Knowing the Reynolds number lets us know which flow type the pipe is experiencing. Laminar flow is generally described as having a Reynolds number of less than 2000 and can be characterized as being very smooth and uniform with a parabolic velocity profile across the pipe cross section. If the Reynolds number is between 2000 and 4000 it is said to be in critical or transition phase with some mixing beginning to happen. Reynolds numbers greater than 4000 are considered to be turbulent. Turbulent flow can be considered to be fairly chaotic in nature with lots of mixing and eddies with an overall velocity profile that averages out to be near uniform velocity profile across the pipe cross-section.

Friction Factor – Colebrook Equation

Once the Reynolds number is determined, the friction factor can be calculated. For laminar flow where the Reynolds Number is less than 2000, the friction factor can be determined by the equation:

$$f = \frac{64}{Re}$$

Where:

f = friction factor, *dimensionless*

Re = Reynolds Number, *dimensionless*

When the Reynolds Number is greater than 2000, the friction factor can be calculated a number of different ways. Revit offers three methods for calculating the friction factor: Altshul-Tsal, Colebrook, and Haaland equations. For simplicity we will focus on the using ASHRAE recommended Colebrook equation.

$$\frac{1}{\sqrt{f}} = 1.74 - 2 \cdot \log_{10}\left(\frac{2\epsilon}{D} + \frac{18.7}{Re\sqrt{f}}\right)$$

Where:

f = friction factor, dimensionless

ϵ = absolute roughness of pipe wall, ft

D = internal diameter of pipe, ft

Re = Reynolds Number (see above)

Note that the Colebrook equation has to be solved iteratively due to the friction factor variable being included on both sides of the equation. This can be done using Excel. Another means of determining the friction factor without having to provide an iterative calculation is the Swamee-Jain equation. This version has been claimed to have less than a 1 percent variation from the Colebrook equation and can be calculated as such.

$$f = \frac{0.25}{\left[\log_{10}\left(\frac{\frac{\epsilon}{D}}{3.7} + \frac{5.74}{Re^{0.9}}\right)\right]^2}$$

Both the Colebrook and Swamee-Jain equations are used to provide a means of determining the friction factor in a more consistent and repeatable manner as opposed to trying to read the friction factor from the Moody diagram. The Moody diagram is read by referencing the relative roughness to the Reynolds number. This can be a very challenging task given that the Reynolds number scale is logarithmic and the relative roughness curves are so close together.

Pressure Drop in Pipe/Conduit

Now that we have the friction factor for our specific condition, we can apply it to the Darcy-Weisbach Equations and determine the pressure drop for our length of pipe.

$$\Delta p_{pipe} = f\left(\frac{L}{D}\right)\left(\frac{\rho}{g_c}\right)\left(\frac{V^2}{2}\right)$$

Where:

Δp_{pipe} = pressure drop from the pipe, lbf/ft^2

f = friction factor, dimensionless

L = length of pipe, ft

D = internal diameter of pipe, ft

ρ = fluid density at mean temperature, lbm/ft^3

V = average velocity, $feet/second$

g_c = units conversion factor, 32.174 $ft \cdot \frac{lb_m}{lb_f} \cdot s^2$

Valve and Fitting Losses
In order to determine the losses from valves and fittings we need to know the size and type of each within the system. Each fitting can be given a loss coefficient factor dependant on size and type and have the following equation applied:

$$\Delta p_{fitting} = K\left(\frac{\rho}{g_c}\right)\left(\frac{V^2}{2}\right)$$

Where:
$\Delta p_{fitting}$ = pressure drop from fittings, lbf/ft^2
K = loss coefficient, dimensionless
ρ = fluid density at mean temperature, lbm/ft^3
V = average velocity, $feet/second$
g_c = units conversion factor, 32.174 $ft \cdot \frac{lb_m}{lb_f} \cdot s^2$

It should be noted that there are a number of ways to determine the pressure drop through a fitting and that the exact results do not always align to the real world. ASHRAE cites that the variation in K factor can vary anywhere from ±10 percent to ±40 percent. This is due to the assumption that the flow through the fitting is fully developed, meaning there are no irregularities or disturbances in the flow, which is often not the case. This can lead to over- or under-estimating the actual pressure drop. ASHRAE conducted a study of how the geometry or orientation of back to back elbows affected pressure drop; the effects were different for different sizes. The conclusion was that given the situation where fittings are close together and will affect each other, the traditional method of adding each loss coefficient from each fitting gave a conservative estimate of the actual expected pressure loss.

The loss coefficient for valves generally appears in the form of:

$$Q = C_v\sqrt{\Delta p}$$

Where:
Q = volumetric flow, gpm
C_v = valve coefficient, $gpm\ at\ \Delta p = 1\ psi$
Δp_{valve} = pressure drop, lbf/ft^2

Elevation
The last component we need to address for piping is the elevation gain or loss. This is simply taken by subtracting the ending elevation from the initial elevation.

$$\Delta p_{elev} = Z_1 - Z_2$$

The elevation change is only applicable in an open system, where you have a source or discharge that is open to the atmosphere—for a cooling tower or a domestic cold water system, for example. For a closed loop system, any elevation gain or loss is made up on the return loop and the only energy required is the energy to move the fluid through the system.

The total loss can then simply be calculated as adding each loss together:

$$\Delta p_{total} = \Delta p_{pipe} + \Delta p_{fittings} + \Delta p_{elev}$$

DUCTING

For ducts it is important to distinguish head from pressure as they are often used interchangeably. The term "head" is the height of a fluid column that is supported and sustained by a fluid flow. Pressure is a force that is normal to a unit area. Gasses, or air, generally measure pressure on a column of liquid.

Static Pressure
Static head can be defined as:

$$\frac{pg_c}{\rho g}$$

Where:
p = static pressure, lbf/in^2
g_c = units conversion factor, 32.174 $ft \cdot \frac{lb_m}{lb_f} \cdot s^2$
ρ = density of gas or air at mean temperature, lbm/ft^3
g = acceleration caused by gravity, $ft \cdot s^2$

Velocity Pressure
Velocity pressure is defined as:

$$p_v = \rho\left(\frac{V}{1097}\right)^2$$

Where:
p_v = velocity pressure, lbf/in^2
ρ = density of gas or air at mean temperature, lbm/ft^3
V = average velocity, $feet/min$
g = acceleration caused by gravity, $ft \cdot s^2$

The velocity is simply calculated as:

$$V = \frac{Q}{A}$$

Where:
Q = air flow rate, cfm
A = area of the cross section of the duct, ft^2

For standard air conditions where the air density equals $0.075 lb_m/ft^3$:

$$p_v = \left(\frac{V}{4005}\right)^2$$

For standard air conditions where the air density equals 0.075 $lb_m ft^3$:

$$p_v = \left(\frac{V}{4005}\right)^2$$

Total Pressure
The total pressure is simply the sum of the static and velocity pressure components.

$$p_t = p_s + p_v$$

Where:
p_t = total pressure, lbf/in^2

Darcy-Weisbach Equation
For calculating friction losses in the ductwork our friend, the Darcy-Weisbach Equation, is used again with a few modifications to account that we are now moving air, a gas, versus water or a liquid.

$$\frac{1}{\sqrt{f}} = -2 \cdot \log_{10}\left(\frac{12\epsilon}{3.7 \cdot D_h} + \frac{2.51}{Re\sqrt{f}}\right)$$

Where:
f = friction factor, dimensionless
ϵ = material absolute roughness factor, ft
D_h = hydraulic diameter of the duct (see below) $inches$
Re = Reynolds Number (see below)

For ducts, the Reynolds number can be calculated using the following equations:

$$Re = \frac{D_h V}{720 \cdot v}$$

Where:
Re = Reynolds Number
D_h = hydraulic diameter, ft
V = average velocity, $feet/min$
v = kinematic viscosity, ft^2/s

For standard air temperatures between 40 and 100°F (which most HVAC applications are) the following simplification can be used:

$$Re = 8.50 \cdot D_h V$$

Hydraulic Diameter

The hydraulic diameter is used as a way of providing an average of the wall shear stress to pressure drop per unit length for ducts that are not circular. There are lots of instances where rectangular ductwork or flat oval duct is appropriate for the design.

Noncircular Ducts

$$D_h = 4\frac{A}{P}$$

Where:

D_h = hydraulic diameter of the duct, *inches*
A = area of the cross section of the duct, in^2
P = perimeter of the cross-section of duct, *in*

Rectangular Ducts

$$D_e = 1.30\frac{(ab)^{0.625}}{(a+b)^{0.250}}$$

Where:

D_e = circular equivalent of rectangular duct for equal length, *inches*
a = length of one side of duct, *in*
b = length of adjacent side of duct, *i*

Flat Oval Ducts

$$D_e = 1.55\frac{(AR)^{0.625}}{(P)^{0.250}}$$

Where:

D_e = circular equivalent of rectangular duct for equal length, *inches*
AR = cross sectional area of duct, in^2

$$AR = \left(\frac{\pi a^2}{4}\right) + a(A-a)$$

P = perimeter of the flat oval duct, *in*

$$P = \pi a + 2(A-a)$$

A = major axis of the flat oval duct, *in*
a = minor axis of the flat oval duct, *in*

Fitting Losses

Much like fittings in piping, fittings in ducts cause pressure drop. This pressure drop is dependent on the air flow velocity and the geometry of the fitting. For standard air conditions, the velocity pressure equation is used to determine the loss across a fitting by:

$$p_f = C\left(\frac{V}{4005}\right)^2$$

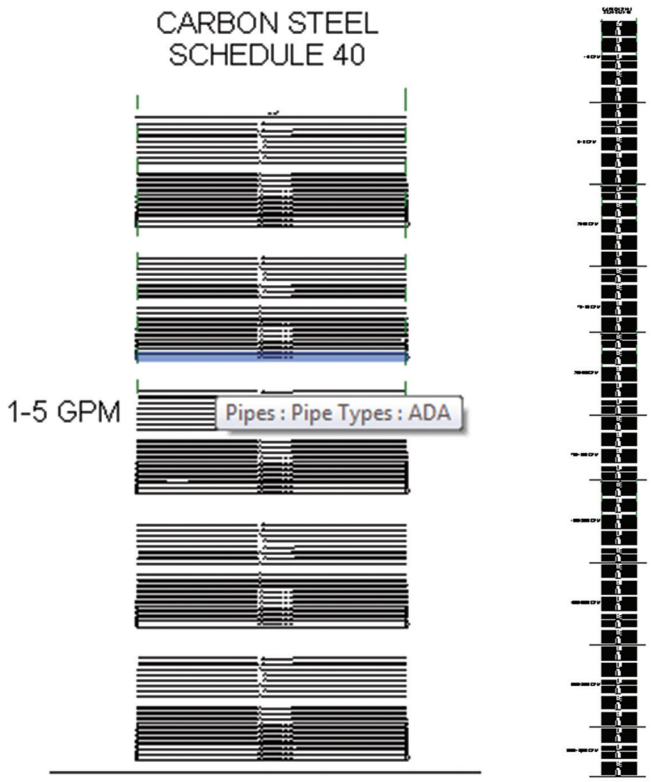
Where:

C = local loss coefficient, *dimensionless*
V = average velocity, *feet/min*

REVIT PRESSURE DROP CALCULATION VERIFICATION

As part of my verification of the calculation capabilities of Revit, I set up an experiment to see how accurate Revit would compare to the spreadsheet I had built for the comparison of calculating friction factors using the Colebrook and Swamee-Jain equations. To get a good sample set I used all of the typical sizes used for piping (1/2" – 24") and put the same flow through 100 feet of piping for flows ranging from 1 – 10,000 GPM.

This resulted in 828 calculations to compare. To model the piping in Revit, I created a set of piping that had each end locked to two separate reference planes located 100 feet apart, and put a piping accessory end cap with a hydronic supply connector on one end and a hydronic return on the other. This allowed me to control the flow through each set of pipes by simply selecting all of the end caps for each group and assigning the correct flow. The result of this comparison was very reassuring with regard to Revit's ability to calculate pressure drop in a pipe or duct using the Colebrook equation.



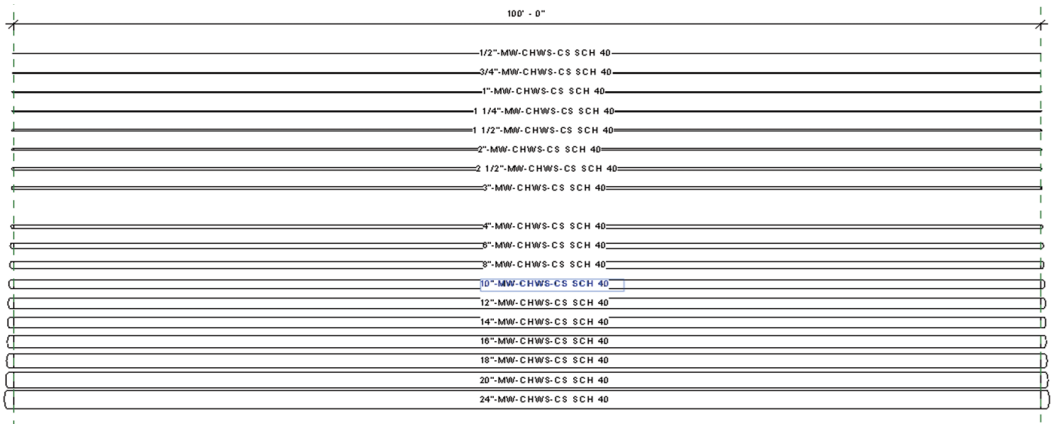


Figure 2: Pressure drop validation

Revit MEP 2016

Mass Colebrook Equation Comparison														Calculations from Revit		COMPARISON Revit vs. Excel					
pipe spec	nominal pipe size D in	flow gpm	length of pipe L feet total	internal diameter	average velocity ft/sec	absolute viscosity lb_f-sec/ft^2	roughness ft	actual pipe internal diameter in	Relative Roughness dimensionless	Reynolds Number dimensionless	friction factor solving Colebrook Equation dimensionless	iterative calculation for Colebrook Equation. Dimensionless	pressure drop lb_f/in^2 - psi	pressure drop ft head H_2O	Schedule/ Type	Size	Velocity	Relative Roughness	Reynolds Number	Friction Factor	Roughness	Pressure Drop	Friction
-	D	gpm	L	D_i	V	μ	ε	D	-	Re	f	f	Δp	Δp					1.674%	0.084%		2.548%	2.550%
STEEL ANSI SCHEDULE 40	0.500	10	100.000	0.052	10.627	3.228E-05	1.500E-04	0.620	2.41935484E-04	32999.079	2.951E-02	2.951E-02	43.448	100.222	Schedule 40	1/2"	0.639%	1196.187%	1.507%	-0.077%	---	1.545%	1.547%
STEEL ANSI SCHEDULE 40	0.750	10	100.000	0.068	6.075	3.228E-05	1.500E-04	0.820	1.82926829E-04	24950.523	2.919E-02	2.919E-02	10.620	24.497	Schedule 40	3/4"	0.975%	1193.920%	1.674%	-0.117%	---	2.342%	2.344%
STEEL ANSI SCHEDULE 40	1.000	10	100.000	0.088	3.705	3.228E-05	1.500E-04	1.050	1.42857143E-04	19485.170	2.943E-02	2.943E-02	3.110	7.174	Schedule 40	1"	-0.184%	1201.200%	1.084%	-0.127%	---	---	---
STEEL ANSI SCHEDULE 40	1.250	10	100.000	0.115	2.145	3.228E-05	1.500E-04	1.380	1.08695652E-04	14825.673	3.023E-02	3.023E-02	0.815	1.880	Schedule 40	1 1/4"	0.001%	1199.680%	1.180%	-0.147%	---	---	---
STEEL ANSI SCHEDULE 40	1.500	10	100.000	0.134	1.576	3.228E-05	1.500E-04	1.610	9.31677019E-05	12707.720	3.090E-02	3.090E-02	0.385	0.888	Schedule 40	1 1/2"	-0.004%	1199.987%	1.180%	-0.155%	---	---	---
STEEL ANSI SCHEDULE 40	2.000	10	100.000	0.173	0.953	3.228E-05	1.500E-04	2.070	7.24637681E-05	9883.782	3.232E-02	3.232E-02	0.115	0.265	Schedule 40	2"	-0.279%	1201.980%	1.033%	-0.138%	---	---	---
STEEL ANSI SCHEDULE 40	2.500	10	100.000	0.206	0.670	3.228E-05	1.500E-04	2.470	6.07287449E-05	8283.170	3.353E-02	3.353E-02	0.049	0.113	Schedule 40	2 1/2"	-0.064%	1200.420%	1.139%	0.000%	---	---	---
STEEL ANSI SCHEDULE 40	3.000	10	100.000	0.256	0.433	3.228E-05	1.500E-04	3.070	4.88599349E-05	6664.309	3.526E-02	3.526E-02	0.017	0.039	Schedule 40	3"	-0.133%	1201.393%	1.114%	0.000%	---	---	---
STEEL ANSI SCHEDULE 40	4.000	10	100.000	0.336	0.252	3.228E-05	1.500E-04	4.030	3.72208437E-05	5076.781	3.778E-02	3.778E-02	0.005	0.012	Schedule 40	4"	-0.189%	1200.940%	1.080%	0.000%	---	---	---
STEEL ANSI SCHEDULE 40	6.000	10	100.000	0.506	0.111	3.228E-05	1.500E-04	6.070	2.47116969E-05	3370.581	4.234E-02	4.234E-02	0.001	0.002	Schedule 40	6"	-0.118%	1201.860%	1.097%	0.000%	---	---	---
STEEL ANSI SCHEDULE 40	8.000	10	100.000	0.665	0.064	3.228E-05	1.500E-04	7.980	1.87969925E-05	2563.838	4.595E-02	4.595E-02	0.000	0.000	Schedule 40	8"	0.231%	1202.320%	1.193%	0.000%	---	---	---
STEEL ANSI SCHEDULE 40	10.000	10	100.000	0.835	0.041	3.228E-05	1.500E-04	10.020	1.49700599E-05	2041.859	4.934E-02	4.934E-02	0.000	0.000	Schedule 40	10"	-0.770%	1202.400%	1.180%	0.000%	---	---	---
STEEL ANSI SCHEDULE 40	12.000	10	100.000	0.995	0.029	3.228E-05	1.500E-04	11.940	1.25628141E-05	1713.520	5.221E-02	5.221E-02	0.000	0.000	Schedule 40	12"	-1.209%	1201.960%	1.163%	0.000%	---	---	---
STEEL ANSI SCHEDULE 40	14.000	10	100.000	1.094	0.024	3.228E-05	1.500E-04	13.130	1.14242193E-05	1558.220	5.387E-02	5.387E-02	0.000	0.000	Schedule 40	14"	-1.286%	1199.207%	1.149%	0.000%	---	---	---
STEEL ANSI SCHEDULE 40	16.000	10	100.000	1.250	0.018	3.228E-05	1.500E-04	15.000	1.00000000E-05	1363.962	5.634E-02	5.634E-02	0.000	0.000	Schedule 40	16"	0.856%	1200.000%	1.180%	0.000%	---	---	---
STEEL ANSI SCHEDULE 40	18.000	10	100.000	1.407	0.014	3.228E-05	1.500E-04	16.880	8.88625592E-06	1212.051	5.866E-02	5.866E-02	0.000	0.000	Schedule 40	18"	2.348%	1204.107%	1.156%	0.000%	---	---	---
STEEL ANSI SCHEDULE 40	20.000	10	100.000	1.568	0.012	3.228E-05	1.500E-04	18.810	7.97448166E-06	1087.689	6.092E-02	6.092E-02	0.000	0.000	Schedule 40	20"	-3.937%	1203.840%	1.202%	0.000%	---	---	---
STEEL ANSI SCHEDULE 40	24.000	10	100.000	1.886	0.008	3.228E-05	1.500E-04	22.630	6.62836942E-06	904.084	6.506E-02	6.506E-02	0.000	0.000	Schedule 40	24"	-0.293%	1206.933%	1.153%	0.000%	---	---	---

Figure 3: Revit vs. Excel validation

I compared the values of the calculated Reynolds Number, Friction Factor, pressure drop, and friction loss for each. Most of the calculations were within a tolerance of ±0.01. In order to keep the data clean I only looked for differences that were greater than ±0.1. When doing so, the greatest differences were only ~2.5 percent off what I had calculated in Excel, which could definitely be considered accurate.

PRESSURE CALCULATIONS & RESULTS

I was unsuccessful in finding any documentation on how Revit actually provides its pressure balance calculations for a piping or duct system. It appears that it is providing some form of balancing; however, it does not affect the boundary inputs in any way. Revit assumes the flows that are set at each connector (fan/ pump inlet or outlet) are absolute and sums the greatest pressure path and determines the index run, or run with the greatest pressure differential.

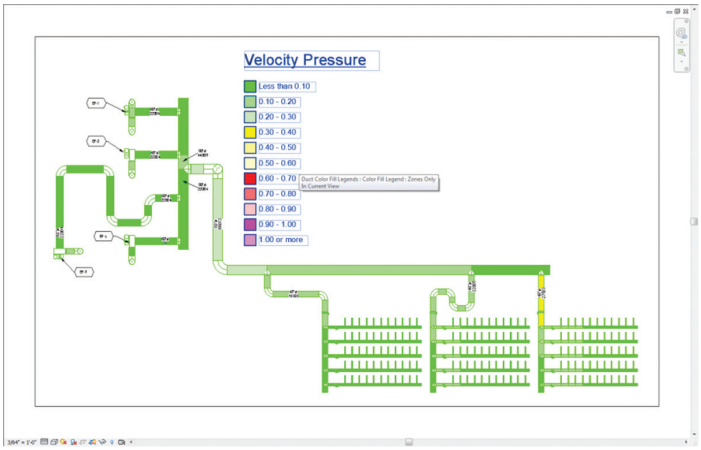


Figure 4a: Simple industrial exhaust sample - Revit

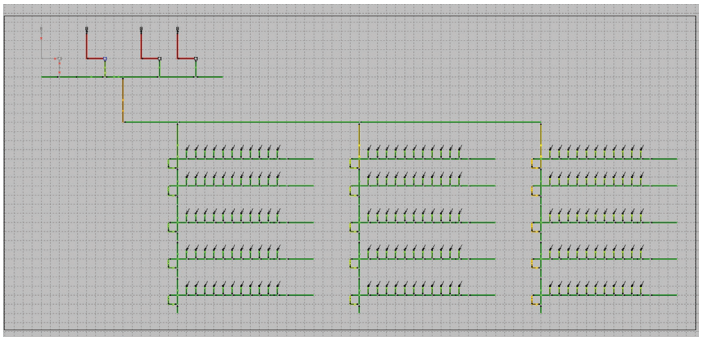


Figure 4b: Simple industrial exhaust sample - PIPE-FLO

To help demonstrate this I built a simple exhaust model in both Revit and PIPE-FLO to compare. PIPE-FLO is a software program developed by Engineered Systems, Inc. that is specifically designed to perform pressure drop calculations. Each system has an 80" main duct, three 48" sub mains, and five 24" branches per

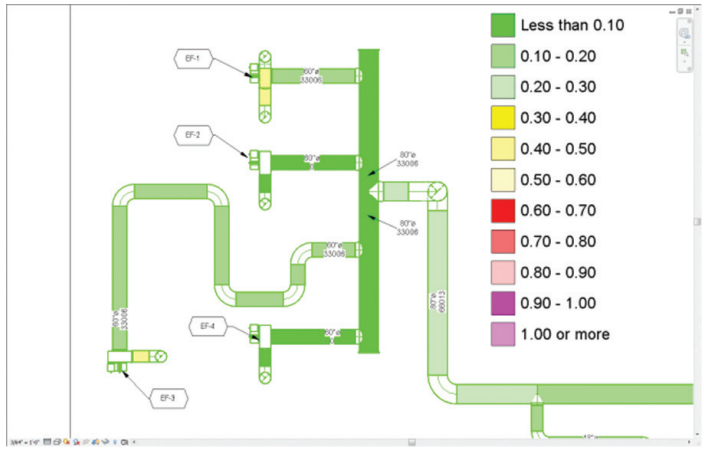


Figure 5a: Simple industrial exhaust sample - Revit

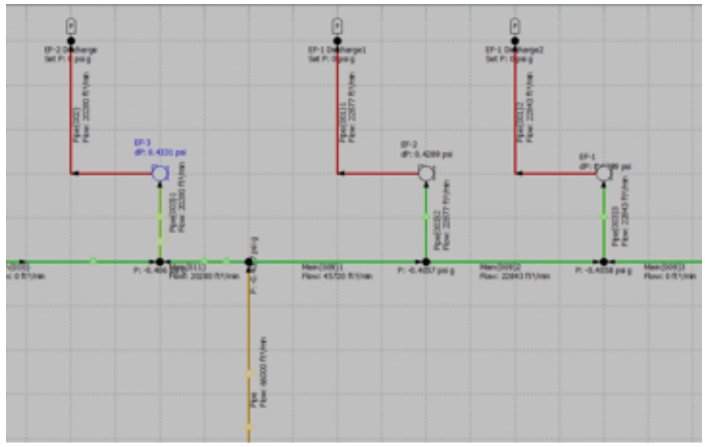


Figure 5b: Simple industrial exhaust sample - PIPE-FLO

submain. Each branch has 11 8"points of demand with the end of the each branch also having an end of line pressure control point. The first sub main group has all of the flows set to 300 CFM; the second, 400 CFM; and the third, 500 CFM. All of the demands in Revit are modeled as air terminals. Four exhaust fans have been

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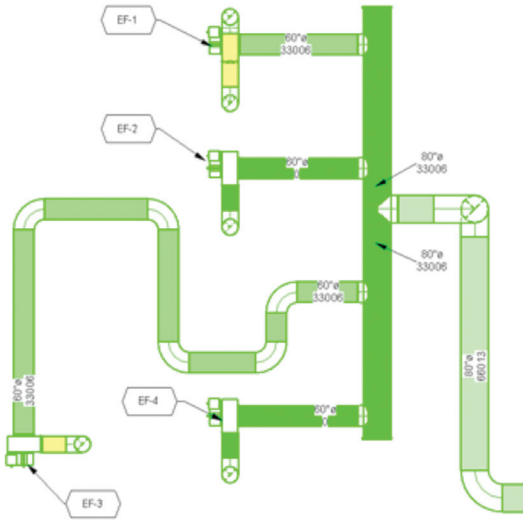


Figure 6a: Simple industrial exhaust sample - Revit

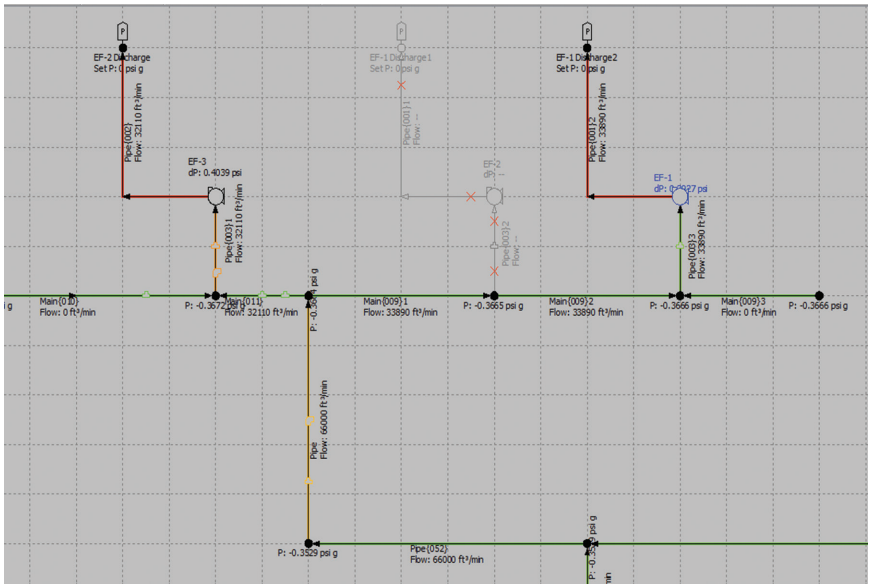


Figure 6b: Simple industrial exhaust sample - PIPE-FLO

modeled with three being operational or a (N+1) configuration. This is representative of a typical industrial exhaust system

When we calculate both systems, we can already see the differences between the two platforms. Revit simply applies the flow factor to the system flow and distributes the load accordingly, such that each fan sees 22,000 CFM of the 66,000 CFM total load. PIPE-FLO distributes the flow based on the pressure differentials in the system and calculates the following results: EF-1/22,843 CFM, EF-2/22,877 CFM, and EF-3/20,280. If we remove the second fan and try to distribute the load to fans EF-1 and EF-3 we see this effect of the pressure difference even better. Revit still evenly distributes the loads 50/50 for 33,000 CFM each and PIPE-FLO calculates EF-1/33,890 CFM and EF-2/ 32,110 CFM.

The way that PIPE-FLO produces the calculation is much more realistic and representative of what is experienced when a system is live. Additional pressure drops and system affects can have compounding affects on a system and can affect the system's total capacity to where you only end up seeing some percentage of that flow.

You can definitely add more pressure drop to elements in the Revit model, as I did with the extra elbows leading up to EF-3, but this does not change the flow that the fan is calculating in Revit.

In addition, when Revit is faced with making a decision on how much flow to put through multiple direction pipes, it currently does not have the functionality to perform these calculations. This can be shown in the following example. I have modeled a simple network of piping and connected a supply connector with 400 GPM. Revit cannot determine where the flow needs to go, or how it gets there when it gets to the first junction. Because of this the rest of the system defaults to zero flow. This can be seen in Case 1 below. In Case 2 I have removed the tee on the left branches and provided pipe caps. This allows Revit to determine that there is a simple path from the supply to discharge. In Case 3 I have added more supply connections at the same previous tee location, which shows that Revit can add branch connections in the same direction of flow.

When modeled in PIPE-FLO we can see the expected flows based on the pressure differential through each pipe. This is more

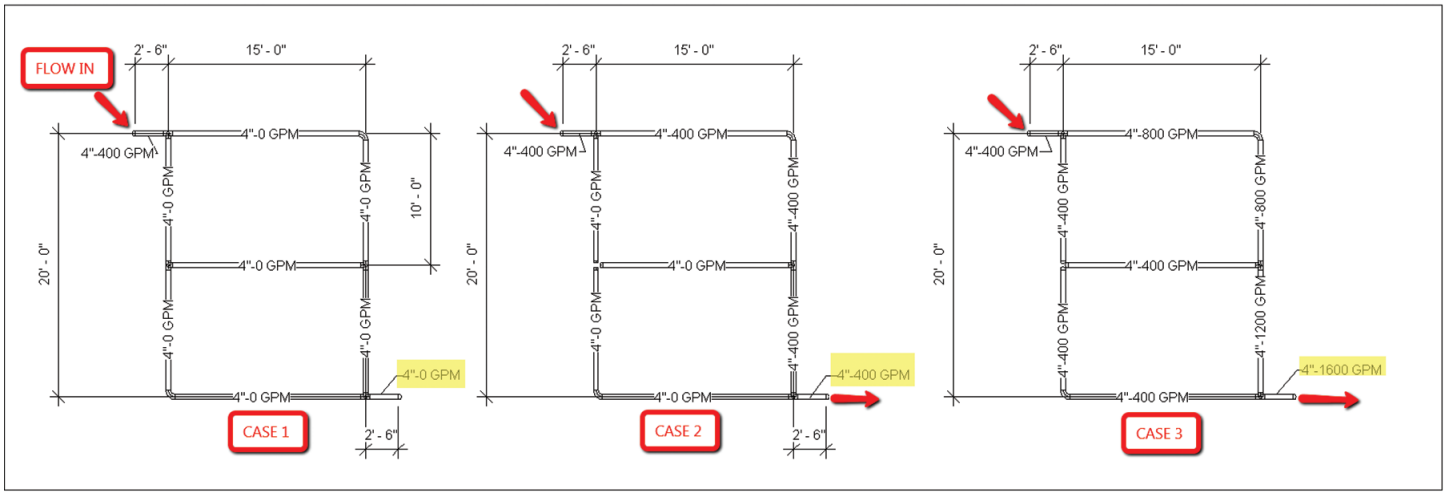


Figure 7a: Pressure balance missing in Revit

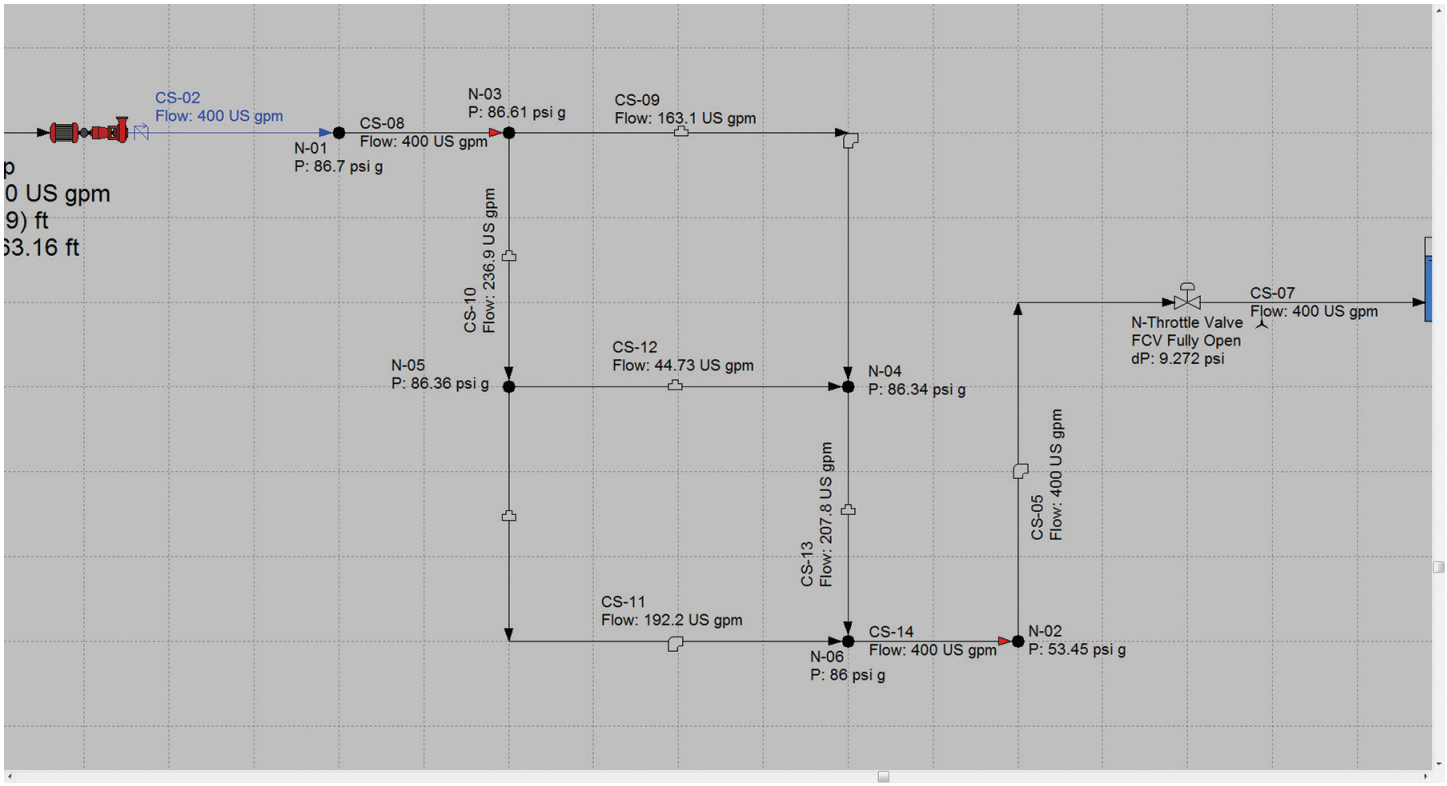


Figure 7b: Pressure balance in PIPE-FLO

realistic to how the pipe system will actually work and the results that engineers need to design real-world systems.

STATIC PRESSURE

Another issue I have come across is that I do not believe Revit takes into account the pipe elevation to determine the static pressure when the system being used is a hydronic system. I believe that the reasoning behind this is that most hydronic systems are closed loop and any pipe elevation gain or loss is negligible due to the fact that any energy that is required for the fluid to come up is regained on the way down and the majority of the losses in the system are due to friction losses and pressure drop across valves and fittings in the system. This may be the case, but there are a number of conditions and situations where a hydronic system will have an open portion to it.

An open draft cooling tower is a very common system and is a hydronic system that has a condenser water supply and return.

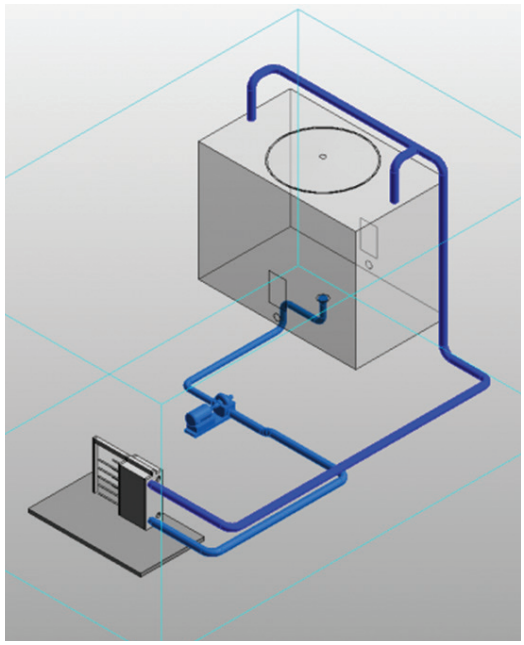


Figure 8a: Simple open draft cooling tower arrangement

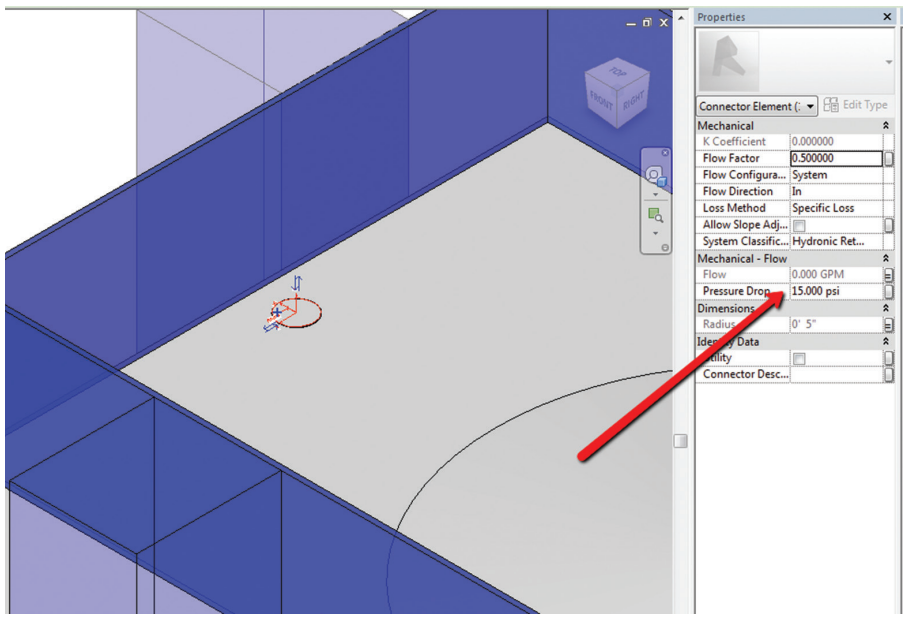


Figure 8b: Adding pressure requirement to cooling tower discharge

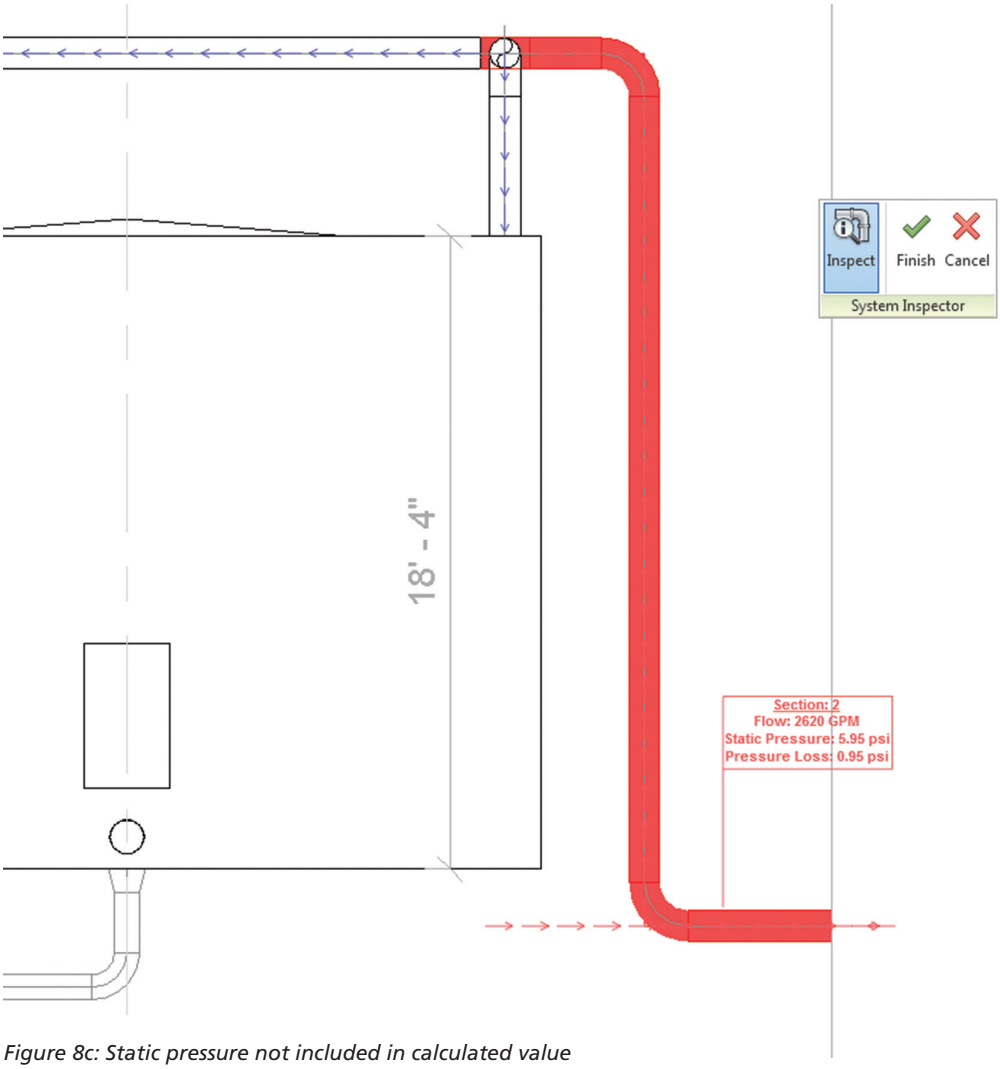


Figure 8c: Static pressure not included in calculated value

Generally, a condenser water system will have a basin or sump that drains to the condenser water pump return side and is pumped to a chiller or heat exchanger of some kind and then back to the cooling tower to reject the heat that it has gained from its system.

At the discharge of the cooling tower it is typical to require ~15 PSI of discharge pressure. In order to size your pump, you need to know what your discharge pressure is, the elevation gain up to the top of the tower, the pressure drop through your chiller/HX, and the total line and fitting losses you have.

If you model a simple system like this, Revit only calculates the pressure drop as seen from the line losses. At the base of the tower we should have a pressure of approximately 23 PSI to accommodate the 15 PSI set at the discharge and the 18 feet of differential height required to pump up the water to the elevation required. Revit only displays that the pressure required is 5.95 PSI to cover the line and fitting losses at the given flow rate.

FUNCTIONALITY

Revit is a tremendous tool to create 3D drawings, spin, coordinate, clash, visualize, and document updates everywhere instantly with every change that is made to the configuration of the piping. These are things we hold near and dear to our hearts and it is why we love Revit the way we do. Revit is capable of providing a very wide range of information and will continue to be a primary resource and tool for me to use.

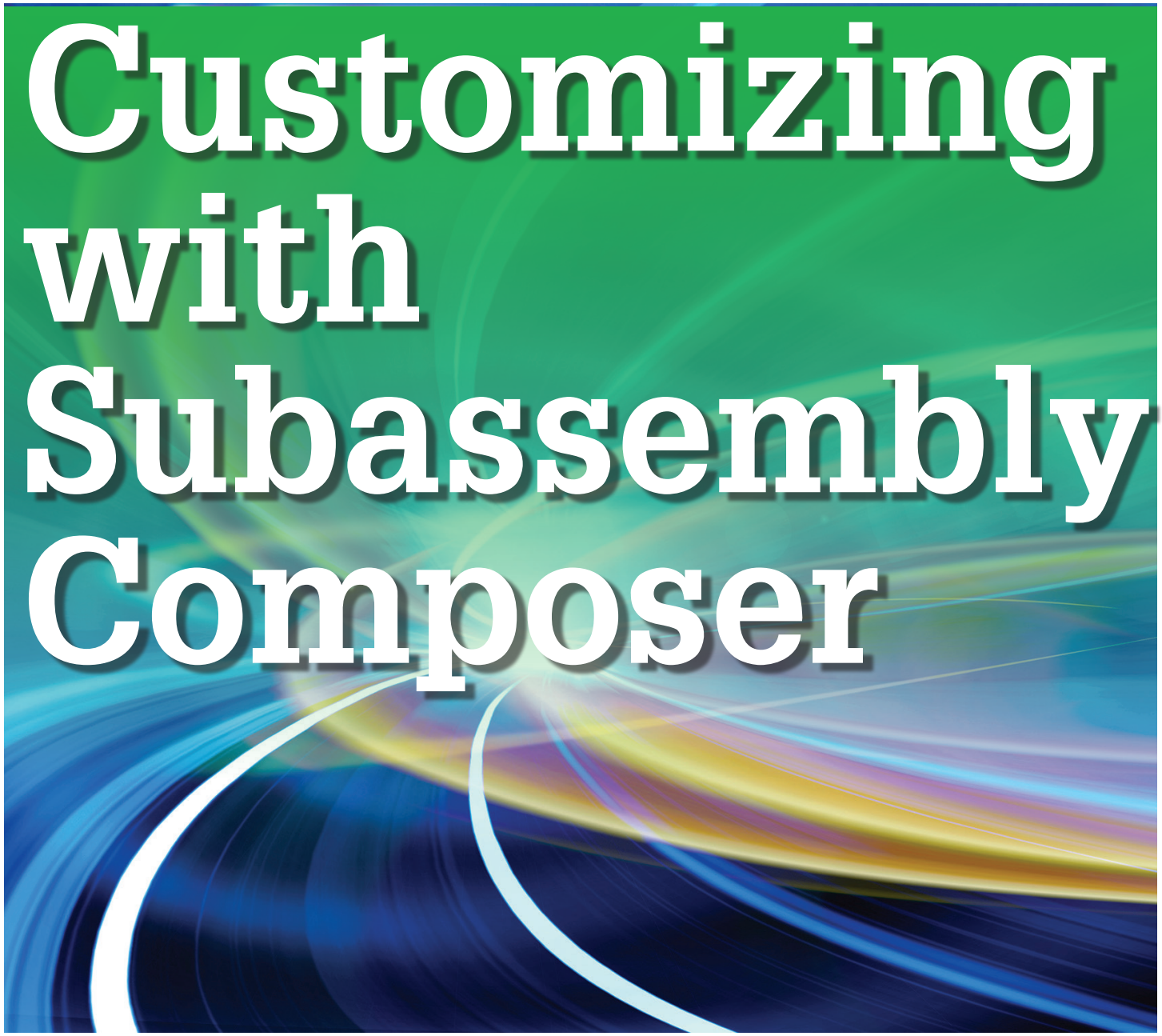
However, until there are more improvements made to the pressure drop calculation engines I believe I will still be using software outside of Revit for pressure drop calculations. This is unfortunate in the sense that we will still be creating two separate models. However, having a good understanding of the limitations of Revit as a calculation tool is also important. Just recently we have begun to discuss with PIPE-FLO if there might be a workflow to assign data from PIPE-FLO into Revit. This would allow us to correlate data from PIPE-FLO into a Revit model.

For each project and application, I think that there still needs to be a judgment call made at the beginning of a project to the level of detail and effort that should be put into a Revit model with regard to pressure flow calculations. A determination needs to be set for the end goal, product, or what the information generated will be used for.

We work in an industry where being able to quickly visualize a system or a space has tremendous value, and Revit is very efficient at providing that. This is something a lot of engineering calculation platforms simply cannot do. And given the time and capacity, including calculations into Revit can be used as a means of providing a good back check or sanity check to see if things make sense. In the end, as engineering and design professionals we simply need to know and understand the limitations and advantages of the tools that we have at our disposal.

Douglas Nachtrieb, P.E., SSOE Group, has more than eight years of experience as a mechanical engineer and three years as an officer in the United States Air Force. He is adept at identifying client's needs, developing project scope, and managing projects. Combined with his skills in Revit, Doug has crafted unique solutions and processes to satisfy the client needs, expedite the design, and validate the engineering.

Customizing with Subassembly Composer



Whether you have been using AutoCAD® for one year or 15, you can attest to its power as a drafting and design platform for many industries. AutoCAD has some verticals with specialized tools to design and draft elements pertaining to different industries. One of those verticals is AutoCAD® Civil 3D, which has specialized tools to create road corridors, ditches, river beds, and more. Those tools are great the way they are, but we can make them even better through customization and by using Autodesk Subassembly Composer.

In this article we will see how to use the Subassembly Composer, we will look at its components and create two subassemblies to see how it works.

CUSTOMIZE IT AND MAKE IT YOURS

When we customize a program or a graphical user interface it usually is because we want to modify the way things look and behave. In AutoCAD we have been doing this for years by using workspaces containing specific combinations of tools, user profiles with specific configurations for system variables, and templates with pre-existing objects and styles. When we customize a program we enhance our productivity because we adapt it to our specific needs. With this in mind let's take a look at Subassembly Composer.

SUBASSEMBLY COMPOSER AND ITS APPLICATIONS

Subassemblies are the building blocks for assemblies in Civil 3D, and we can look at assemblies as cross sections for roads, rivers, embankments, etc. Out of the box, Civil 3D has many great

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subassemblies for multiple applications; however, in some cases those subassemblies are limited because they either don't work the way we would like them to or don't do the things we would like them to.

Subassembly Composer is a program where you can create subassemblies from scratch and then use them in Civil 3D just like you would with any other subassembly.

Subassembly Composer has five sections: Toolbox, Flowchart, Properties, Preview, and Packet Settings. Toolbox is where you find all the elements that make up the subassembly such as its geometry, operators that determine geometry, tools to organize these elements, etc. Flowchart is where you lay out the workflow: what comes first, what comes after, what decisions are made, calculations performed, and so on. Properties is where you set the properties for each of the elements you bring in from the toolbox; properties include geometry, calculations, and overall behavior. Preview is where you see how the subassembly looks as you are putting things together. Packet Settings is where you create and set up the subassembly parameters, targets, and so on.

To understand what Subassembly Composer does, we need to review how subassemblies work, what their components are, and what they do; specifically, we need to understand codes, points, links, and shapes. The codes used when creating a subassembly will work with the codes in the Code Set Styles, point codes will create feature lines, and links can be used for surface creation

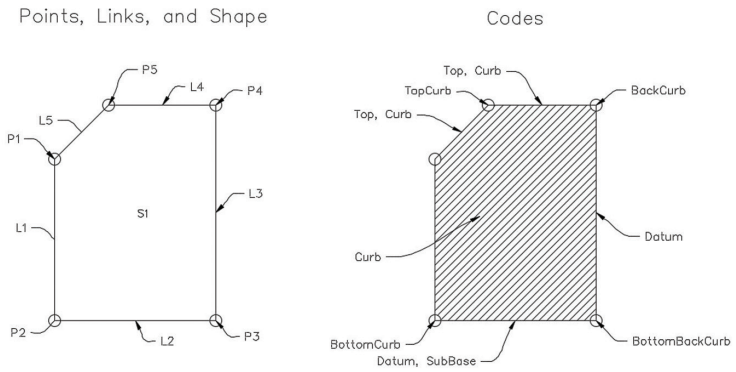

Figure 1: Subassembly parts

Figure 1 shows the basic anatomy of a subassembly with codes, points, links, and shape. The information found in the help menu for each subassembly gives you more information about each subassembly, shows you its anatomy, the components for which you can override dimensions by using targets, etc. All of this information can help you to reverse engineer these subassemblies, have a better grasp of how they work, and create parametric subassemblies in Subassembly Composer.

As an AutoCAD user, you are accustomed to drawing lines in a very visual way. This makes the way Subassembly Composer works seem a little weird, so when you design a subassembly it is always a good idea to start by drafting an outline by hand.

Subassembly Composer also requires communicating with the program using its own language, almost like coding; in this case it uses .NET framework. All of this will make more sense once we start working with Subassembly Composer in the following exercises.

SLANTED CURB SUBASSEMBLY

Let's say that you are working on a project that calls for slanted curbs. You open the Tool Palettes and realize that there is nothing there that looks like what you want, so you can't use any of the existing subassemblies. You can solve this in Civil 3D if you create a closed polyline, turn it into a subassembly, then assign codes, links, and shape and it probably would be fine. The problem is that if you want to use different dimensions, you would have to create a new one. Instead of doing that, let's create a parametric subassembly in Subassembly Composer.

The steps below outline the process to create a simple slanted subassembly.

1. Open Subassembly Composer.
2. In the Packet Settings section go to the Packet Settings tab, then in the Subassembly Name field type SlantedCurb. This is the name that this subassembly will use in Civil 3D.
3. Switch to the Input/Output tab; by default the only parameter shown is side, but no default side. Set the side to Right.
4. Click Create Parameter to create a new parameter. The direction is input because it is an input parameter, meaning that the user will input the value.
5. Make sure the type is set to double, which is the type of parameter that will let you input values with decimal figures.
6. Name this parameter TopWidth with no spaces. For display name, type Top Width. The display name can have spaces and that is how it is going to display in Civil 3D.
7. Set a default value for this parameter of 0.5. At this point this value is unitless—the units will depend on the units you use in your drawing.

Input/Output Parameters

Name	Type	Direction	Default Value	DisplayName	Description
Side	Side	Input	Right		
TopWidth	Double	Input	0.5	Top Width	
Depth	Double	Input	0.75	Depth	
BottomWidth	Double	Input	0.75	Bottom	
Height	Double	Input	0.25	Height	
Create parameter					

Packet Settings | Input/Output Parameters | Target Parameters | Superelevation | Cant | Event Viewer

Figure 2: Input/Output parameters for slanted curb

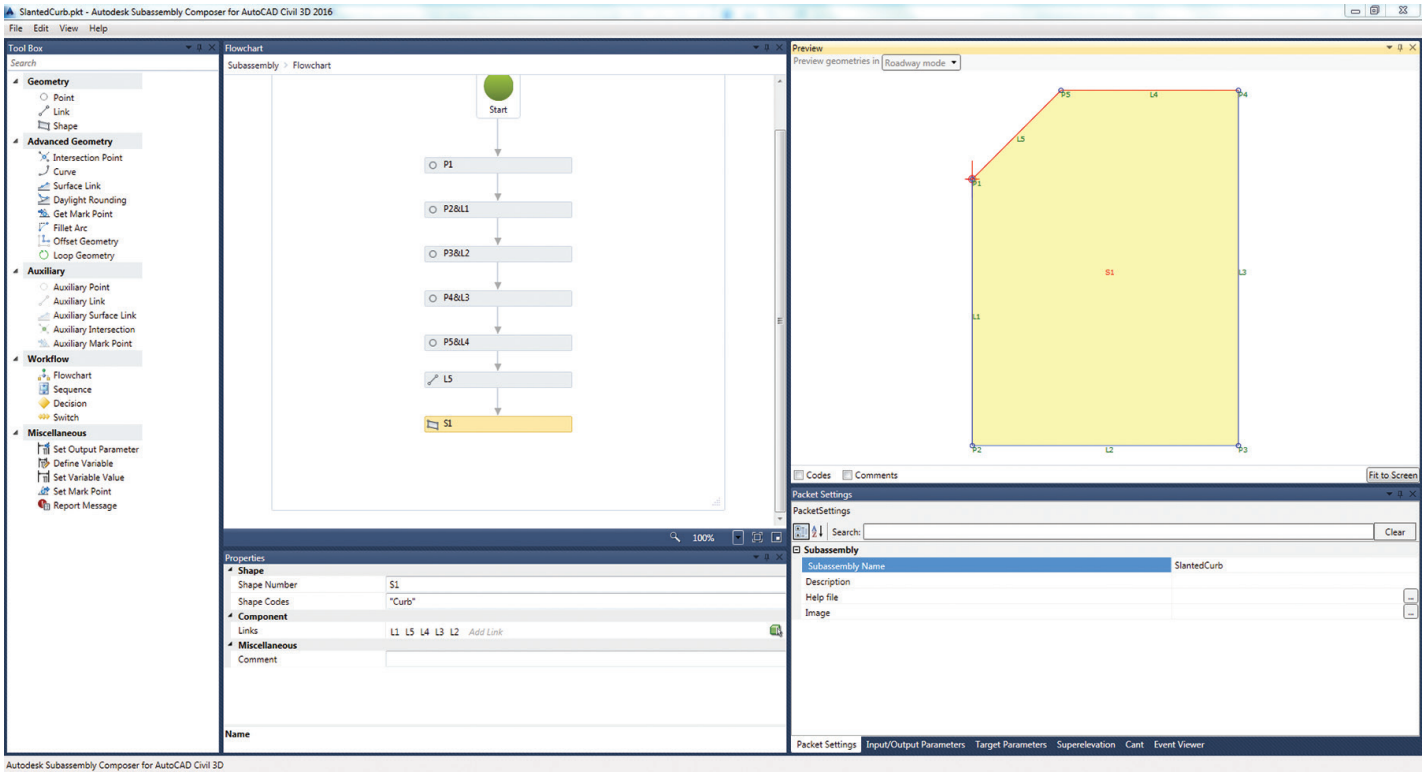

Figure 3: Slanted Curb in Subassembly Composer

8. Repeat the previous steps for the other parameters and make sure your parameters match what is shown in Figure 2.
9. From the toolbox under the Geometry category, drag a Point component and drop it into the Flowchart window. This point will be used as the origin and as a reference for positioning the next point. For this point there is no need to modify anything else.
10. Drag and drop another point component. This point will use a point code so a feature line can be created when connecting multiple sections using this subassembly. For point code type "BottomCurb"; make sure you use quotation marks or Subassembly Composer will assume that you are trying to enter a variable.
11. For Point Geometry Type select Delta X and Delta Y. Set From Point to P1, enter 0 for Delta X, and type -Depth for Delta Y. The location of this point will be measured in terms of deltas in the X and Y direction with respect to the origin point. It will be directly below the origin at a distance of negative Depth, which is a parameter previously defined, and no displacement in the X direction. Make sure "Add Link to From Point" is checked and this will create the first link, which will be automatically named L1. For this link there is no need to modify anything else.
12. Add another point element, which will be the bottom right corner of the subassembly. For point codes type "BottomBackCurb." For Point Geometry Type select Delta X and Delta Y. Under Point Geometry Properties set From Point to P2 which is the previous point. For Delta X type BottomWidth—in this case it is going to go to the right from P2 so the value would be positive. For Delta Y enter 0. Make sure Add Link to From Point is checked and for codes type "Datum" and "SubBase" divided by a comma.
13. Add another point element, which will be the top right corner of the subassembly. For point codes type "BackCurb." For Point Geometry Type set Delta X and Delta Y. For Point Geometry Properties set From Point to P3. For Delta X type 0 since there is no horizontal displacement and for Delta Y type Depth+Height. Make sure "Add Link to From Point" is checked and for codes type "Datum."
14. Add another point element, which will be the top left corner of the subassembly. The point code will be "TopCurb." Point Geometry Type will be Delta X and Delta Y; it will go from P4, Delta X will be –TopWidth and Delta Y will be 0, in this case it is going to the left from P4 so the X value is. Make sure "Add Link to From Point" is checked and codes are "Top" and "Datum."
15. The curb subassembly is almost ready—we just need to close it. Add a link component to the flowchart; no need for points here because the link will connect to existing points. For link codes type "Top,""Curb." For position, set Start Point to P5 and End Point P1.
16. At this point the subassembly is closed, but it is empty. Drag and drop a Shape component and for Shape Codes type "Curb." To assign a shape click the green cube with a white arrow in the Links field and then click somewhere inside the subassembly in the preview window.

At this point the subassembly is ready and it should look like Figure 3. You can now save the file and close Subassembly Composer.

17. In Civil 3D press Ctrl+3 to open the Tool Palettes.
18. Hover over one of the tabs in the tool palette, right-click and select New Palette.

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19. Name the new Palette Custom Subassemblies.
20. Switch to the Insert tab and from the Import panel select Import Subassemblies.
21. In the Import Subassemblies dialog, browse to where you saved your subassembly and open it. Toggle on Import to and select the Custom Subassemblies palette you just created and then click OK.

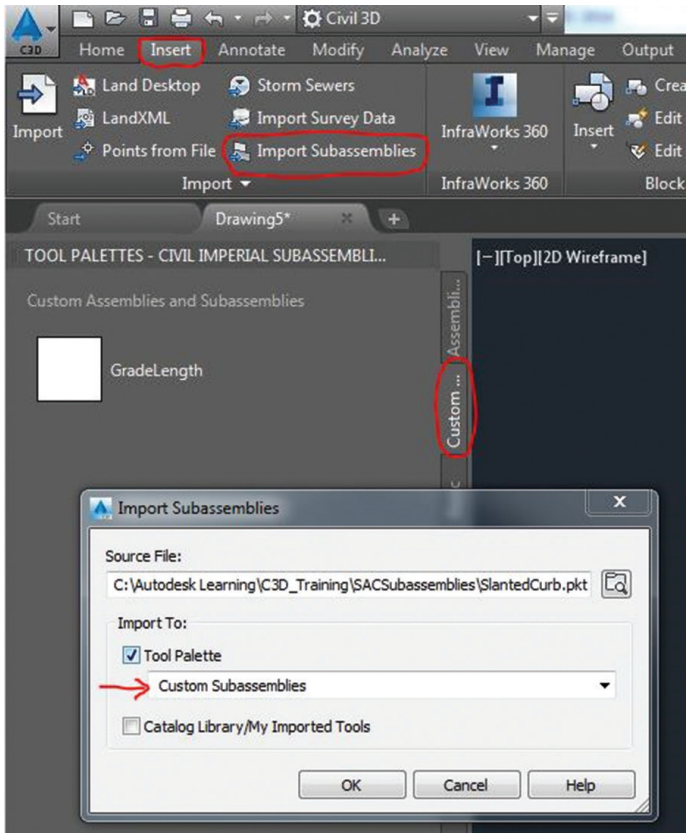

Figure 4: Import into Civil 3D

Now you can use the slanted curb subassembly like a regular curb subassembly.

CONSTANT LENGTH AND VARYING SLOPE SUBASSEMBLY

This subassembly works similar to the LinkWidthAndSlope generic subassembly, but this one keeps the length constant regardless of the slope. Figure 5 shows the schematics of what we want to do and how it will look.

1. In Subassembly Composer go to Packet Settings and for Subassembly Name type GradeLength (Figure 6).
2. Switch to the Input/Output Parameters tab and set the parameters as shown in Figure 6. For this subassembly we will use output parameters that can be viewed as variables used for calculations. Notice that here you have to use both input and output parameters. For the output parameters there is no need to type in a display name because the user will not be able to edit these values. These values are calculated and used for other parameters.
3. Add a point component by dragging it from the toolbox and dropping it into the flowchart window. This will be the origin and insertion point.
4. Add an output parameter. From the toolbox in the Miscellaneous category, drag Set Output Parameter and drop it into the flowchart.
5. Set Output Parameter to Slope, which is one of the output parameters that was created in the packet settings.
6. For value type 1/Grade. By doing this we are converting the grade value into a slope value.
7. Add another Output parameter from the toolbox. For Output Parameter select Atan and for value, type Math.Atan(Slope); this will give you the slope in radians.
8. Add another Output Parameter. For Output Parameter select

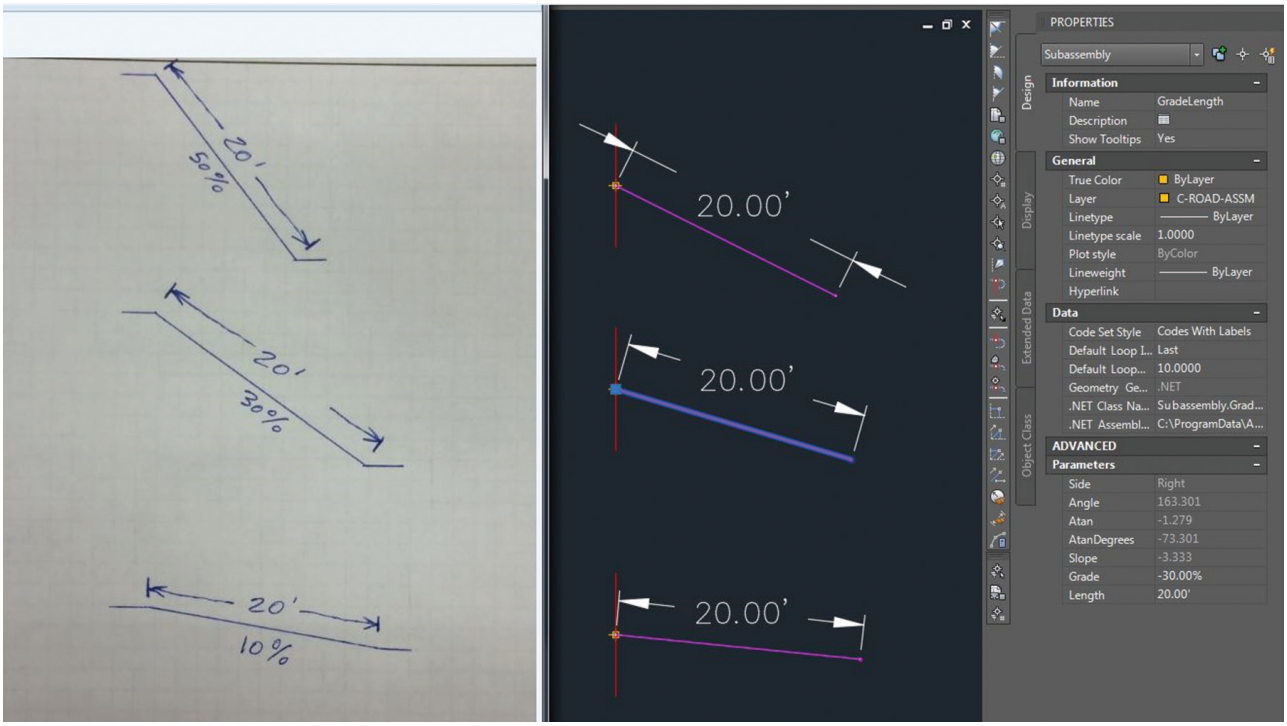

Figure 5: Hand-drawn schematics

Input/Output Parameters

Name	Type	Direction	Default Value	DisplayName	Description
Side	Side	Input	Right		
Grade	Grade	Input	-10.00%	Grade	
Angle	Double	Output	0		
AtanDegrees	Double	Output	0		
Atan	Double	Output	0		
Slope	Double	Output	0		
Length	Double	Input	20	Length	
Create parameter					

Packet Settings | Input/Output Parameters | Target Parameters | Superelevation | Cant | Event Viewer

Figure 6: GradeLength parameters

AtanDegrees and for value type Atan*180/Math.PI; this will convert the Atan into degrees.

9. Add another Output Parameter. For Output Parameter select Angle and for value type 90-AtanDegrees to find the angle.

At this point you have already calculated all the parameters you need, so now it is time to create a point and a link using those parameters. We want to be able to use positive and negative grade values because depending on that, you will draw something different. And because we have two different options, we will use a conditional operator.

10. From the toolbox, drag and drop a Decision operator, which is in the Workflow category. This will work just like an "If" operator.
11. For Condition type Grade>=0, for False Label type False, and for True Label type True.

Let's work on what to do if Grade>=0, meaning that the slope is either flat or positive.

12. Drag and drop an Auxiliary point and place it below the True label.
13. For Point Geometry Type select Delta X and Delta Y.
14. For From Point select Origin, for Delta X enter 5 and for Delta Y enter 0. Auxiliary points are used as references for other points and they are not shown in the subassembly.
15. Add a point below the auxiliary point you just created and set its properties as shown in Figure 7.

Properties

Point	
Point Number	P2
Point Codes	"P2"
Point Geometry Type	
Type	Angle and Distance
Point Geometry Properties	
From Point	P1
Reference Point	AP1
Reverse Angle Reference	☐
Angle	Angle
Distance	Length
Link	
Add Link to From Point	☑
Name	L1
Codes	"Top","Datum"
ApplyAOR	☐
Miscellaneous	
Comment	

Delta Y

Figure 7: Point properties

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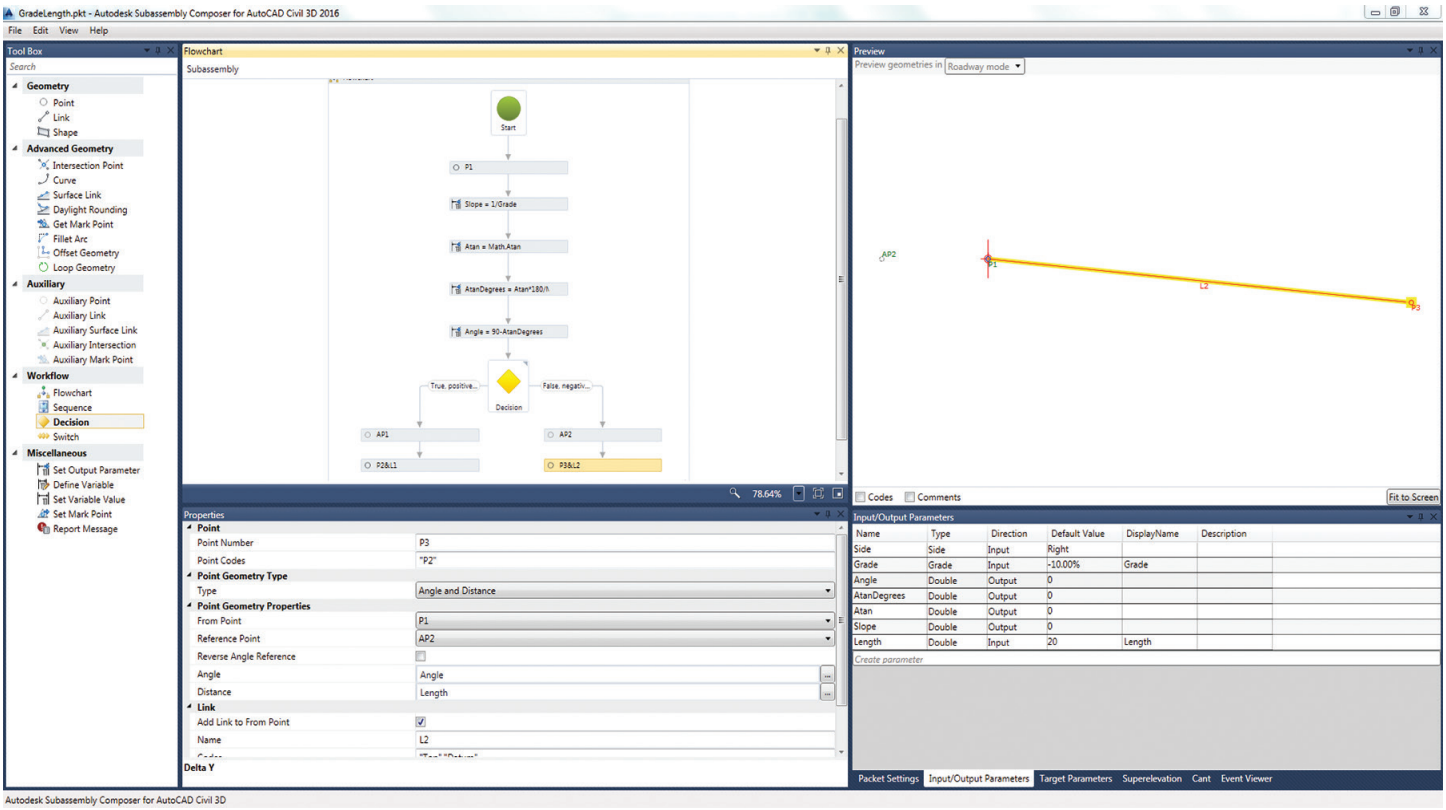

Figure 8: GradeLength subassembly

We just created a workflow for what to do when the grade is positive, but we haven't created one for when it is negative. That is why you can't see anything yet—because the default grade is negative. Let's take care of that.

16. Drag and drop an Auxiliary point and place it below the False label. For From Point select Origin, for Delta X enter -5 and for Delta Y enter 0.
17. Add a point below this new auxiliary point. Set its properties the same way you did for the previous point. The point will be numbered P3 and this time the Reference Point will be AP2.

18. Now the subassembly is ready and it should look like Figure 8. Save the file and close Subassembly Composer.
19. Add this subassembly to the Custom Subassemblies palette the same way you did with the other subassembly.

CONCLUSION

Now you have two parametric subassemblies made from scratch. I hope these two exercises shed some light on how to use Subassembly Composer. These subassemblies are rather simple, but I think you can see the potential of Subassembly Composer.

Think about the subassemblies you use when building corridors. Some of them use targets to override slopes, widths, etc. In Subassembly Composer you can also create subassemblies that work with targets. The process is similar in that you have to create parameters and use those parameters to define targets. Now that you know how to use Subassembly Composer, go ahead and create your own subassemblies, draw them in your mind, then on paper, and then build the subassembly. Customize it and make it yours!

Miguel Medina is a Civil Application Engineer for ProSoft, an Autodesk Gold Partner based out of Utah. He has worked in construction management and design since 2008 and has implemented and trained companies on Civil 3D for the past year. Miguel can be reached at mmedina@prosoft-net.com

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by: Steve Carrillo

Using Modeled Groups Structurally

The idea of coordinating "Unit Plans" structurally has always been a nightmare in wood construction. There has to be a better way to monitor changes, right? Maybe? Because we currently cannot copy/monitor "Modeled Groups," here's my initial pass at a workaround that can help alleviate some of the pain.

When I think of customization the first question that comes to mind is, how can I be more productive if I find myself doing a repetitive task over and over again? The solution is basic: find ways of cutting time while being more efficient.

After you target the time-consuming, repetitive areas that can be improved, then you can start exploring the possibilities of using the programming platform of your choice. Some prefer writing code (Macros/Plug-ins) while others prefer visual programing (Dynamo/ Rhynamo).

THE PROBLEM

If you ever tried using Copy/Monitor you may have come across the never-ending messages such as "Openings Moved," "Wall centerlines are different," and others.

After endless messages and constant design changes, trying to keep up with all the changes can become someone's full-time job.

After a few meetings between design teams and contractor, the results will be that MEP needs to know where shear walls are located to avoid penetrations, Arch needs to know what the framing spans are and directions, and the contractor would like everything modeled for estimating purposes. BIM is in full effect the design teams have bought into process.

COPY MODEL GROUPS FROM ARCH

If the design teams are experienced, most will agree that grouping modeled instances are the way to go.

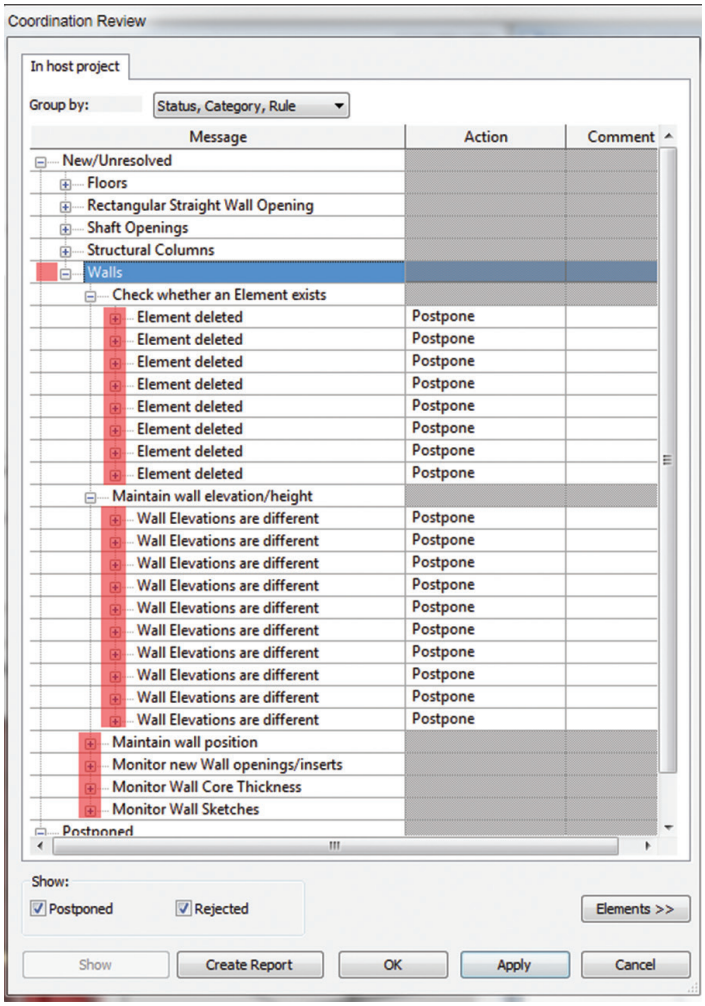

Figure 1: CIM Issues with coordination

Modeling in groups saves design teams hundreds of hours coordinating. The system may vary from architect to architect, but the overall concept is very similar. Some architects will model an instance off to the side of the building. Others will model the entire instance hundreds of feet above the building.

Having an understanding of how models are set up architecturally will help determine the best method of tracking the changes and working with groups structurally. The way the arch tracks the groups will ideally be the same method of tracking the groups structurally.

I find it easiest to open both models in the same Revit session. Highlight all groups in the architectural model, then copy the groups into your structural model.

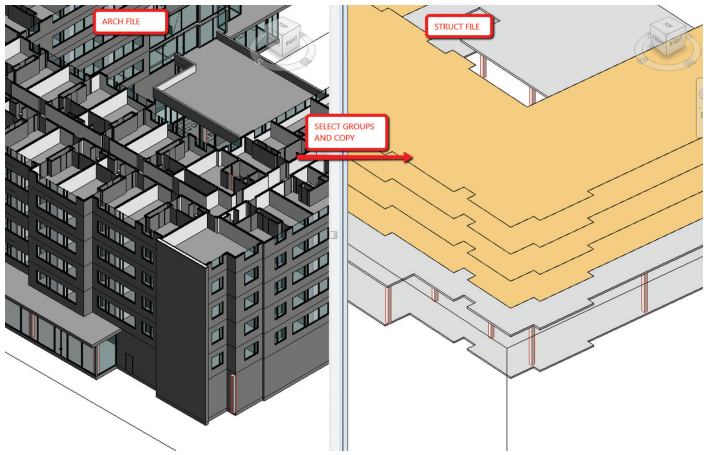

Figure 3: Both Revit and Arch files opened in the same Revit session

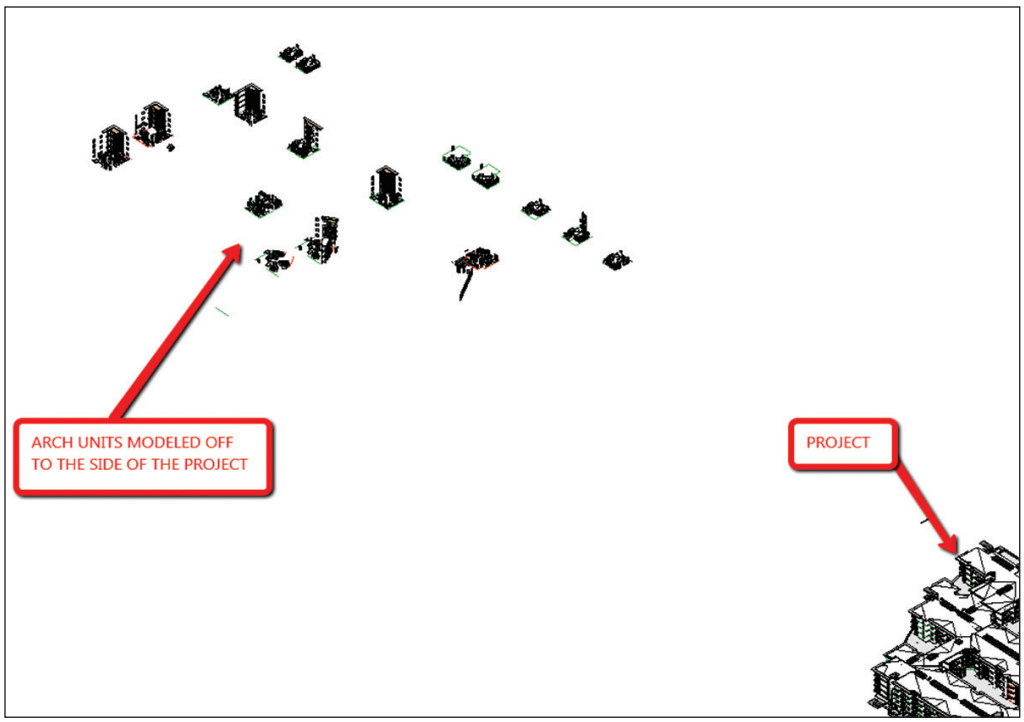

Figure 2: Units modeled off to the sides for coordination purposes

If the process is that simple, sometimes you don't need to create anything complex yet. Creating a macro or using Dynamo to track the changes would be something to think about.

CLEANING UP THE MODELED GROUPS

Once the groups are in your model you will need to strip the groups to only the information valuable for plans. For Structural we only care about the bearing walls, shear walls, and openings for documentation, so anything else can get deleted.

With Dynamo we can select walls and switch them out for structural walls. There is a custom package called "archi-lab.net" which has a node "change family type." This will get you the node that will allow you to select and replace (see Figure 4).

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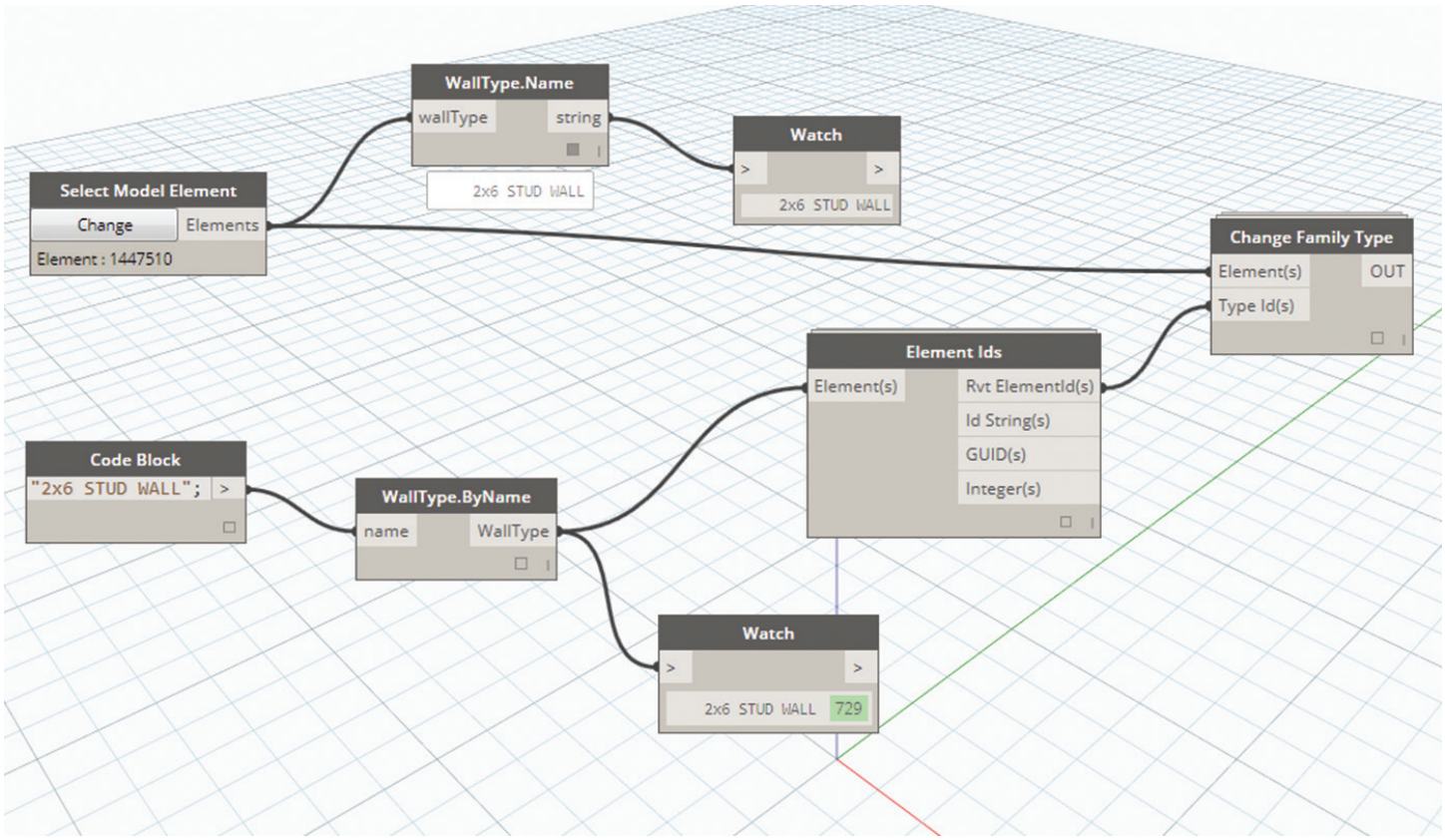

Figure 4: Dynamo wire to replace wall type

Once groups are stripped out and only the walls and openings are showing you can then start documenting your plans. You can use a combination of attached groups.

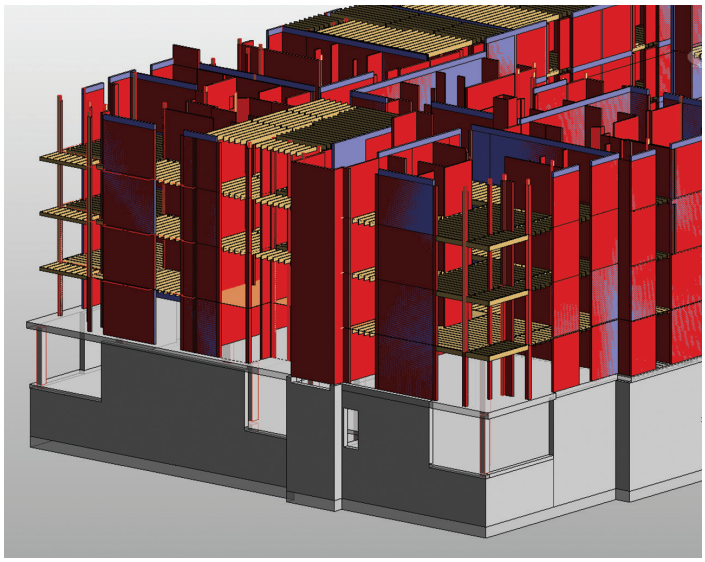

Figure 5: 3D of Struct with modeled groups

ATTACHING "DETAIL GROUPS"

Detail groups work great when documenting your span directions and misc. notes. Because we have already used modeled groups to set up the unit plans, attaching "detailed groups" is pretty straightforward.

Figure 6: Framing plans using detail groups for annotation

You can also use detail groups to provide clients with different design schemes as an alternative to using design options.

COLLABORATION

The best way to monitor the groups will vary. Once you receive an architectural model update, the procedures to check for updates must be clearly shared among your design teams. The order of checking for updates works best in the following manner.

1. First check the groups that are off the model. If those groups are not coordinated, most likely your overall plans will have overlapping line work. If you try and update the units on your overalls first you may be going back and forth with updates. That, of course, won't help with the issue.
2. After your units off the building are coordinated, if the overlaps still show it means the groups were shifted in plan.
3. You then have to shift your modeled units on the overall plans. Select the groups and move them to align with the arch.
4. If groups were deleted and new groups were added to the plans, repeat the process for that specific group. Most of the time the change is pretty obvious. Setting up Unit plan views that you can simply tag the unit room helps with units that are deleted or shifted.

CONCLUSION

Tackling wood construction can be very intimidating when you don't have an approach in hand. Using copy/monitor is not always helpful when coordinating walls for a huge magnitude of a projects. Because copy/monitoring modeled groups is not an option, this custom workaround to the approach, with a little visual programming introduction, has proved very valuable on all projects. The introduction of Dynamo has opened up the possibilities for future coordination of this process. Stay tuned….

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by: Jennifer Lanzetti and Travis Beecher

Family Matters: Essential Clearances and Boundaries

If you've ever played the "I'm not touching you" game as a child, you know the importance of boundaries and our need for space. Autodesk® Revit® families are no different. A 3D element provides a great parametric visual of what we can expect outside of the virtual world, but without the proper clearances the equipment may not be given the space it truly needs to function.

A book could be written about Revit families; this article will focus on adding a correct clearance zone to your family while keeping it separate from the model element. During design review and clash detection we want to be sure the clearance zone is easily identifiable versus the actual family.

To demonstrate adding a clearance to an existing family, we will be using the "Condenser – Air Cooled – Horizontal – 301-455 MBH.rfa" file.

With this family open, navigate to your Visibility Graphics (VG), select Object Styles, click New under the Modify Subcategories and call your New Subcategory Clearance Zone, making sure that the correct "Subcategory of" is selected (Figure 1).

Clearances Reasons

ADA Access

Installation Space

Code Clearance

Access & Maintenance

Air Movement

Aesthetics

Safety

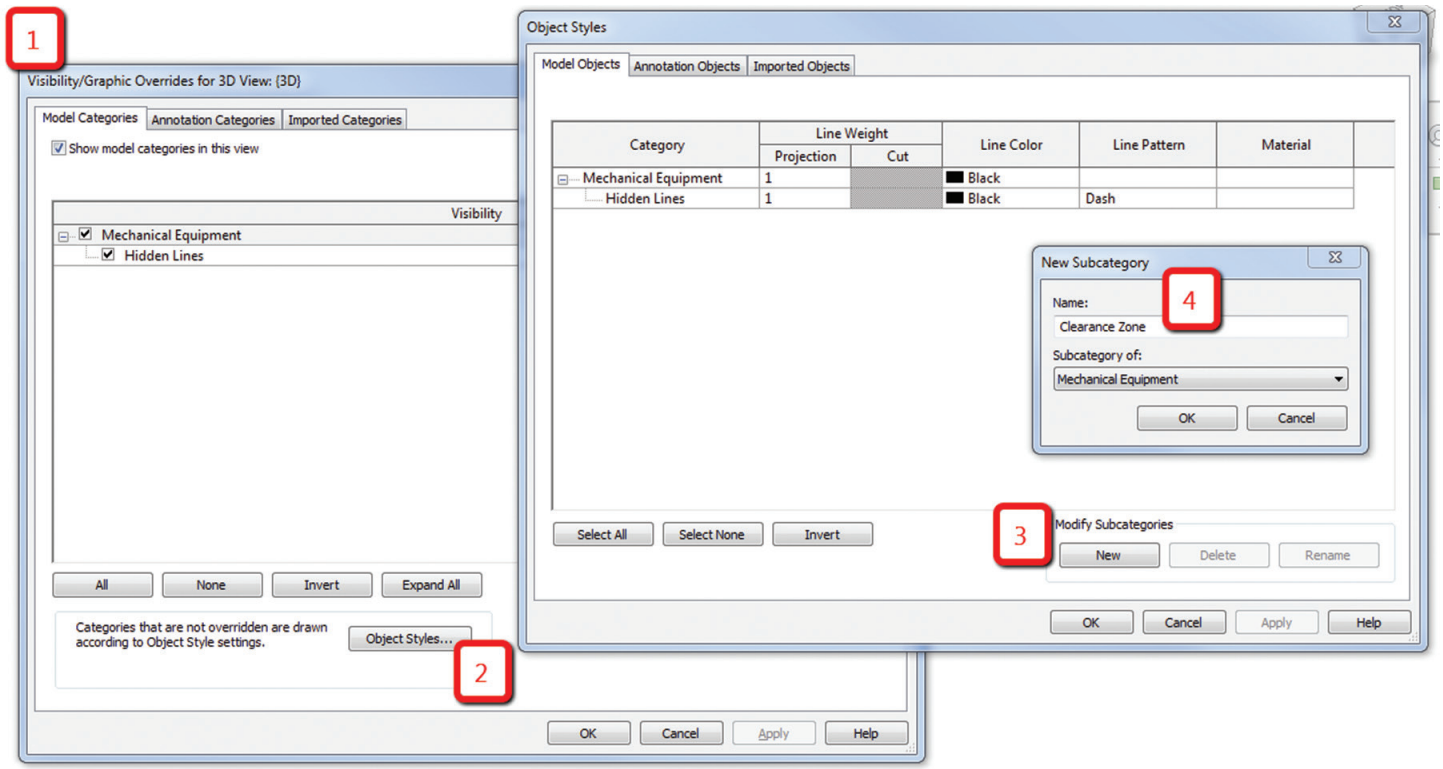


Figure 1

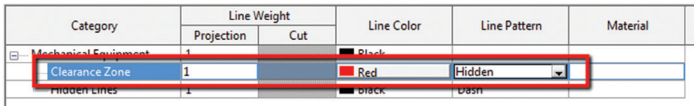


Figure 2

In the Object Styles box, change your Clearance Zone Line Color to "Red" and Line Pattern to "Hidden" (Figure 2).

Next we need to create a Clearance Zone material. A semi-transparent material is ideal. I prefer to duplicate the glass material and change the color. In the Manage tab, select Materials. Select "Glass," then "Duplicate Selected Material" (Figure 3).

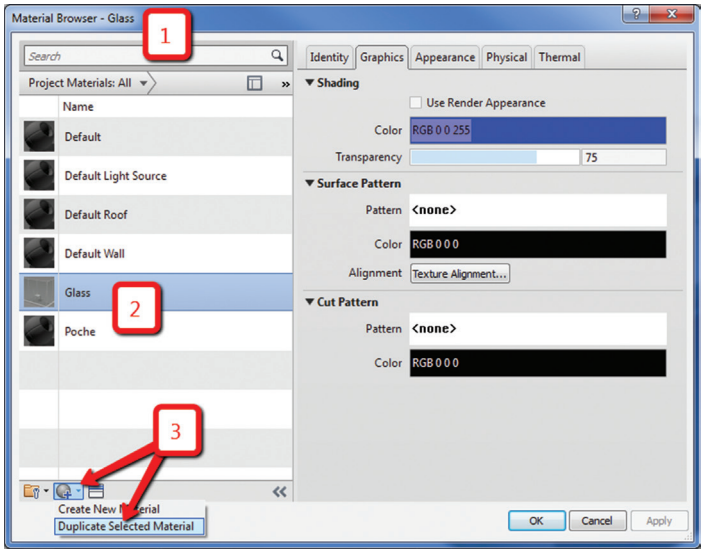


Figure 3

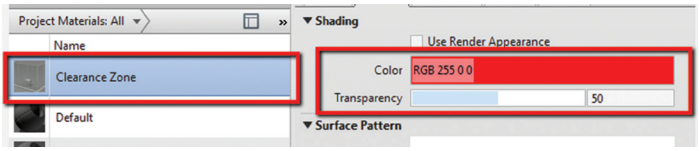


Figure 4

Rename the duplicate to "Clearance Zone," change the color to Red and choose your transparency setting (Figure 4).

Now the best part, adding our clearance to the family. If only it was this easy in our real lives. Revit provides you with two Reference

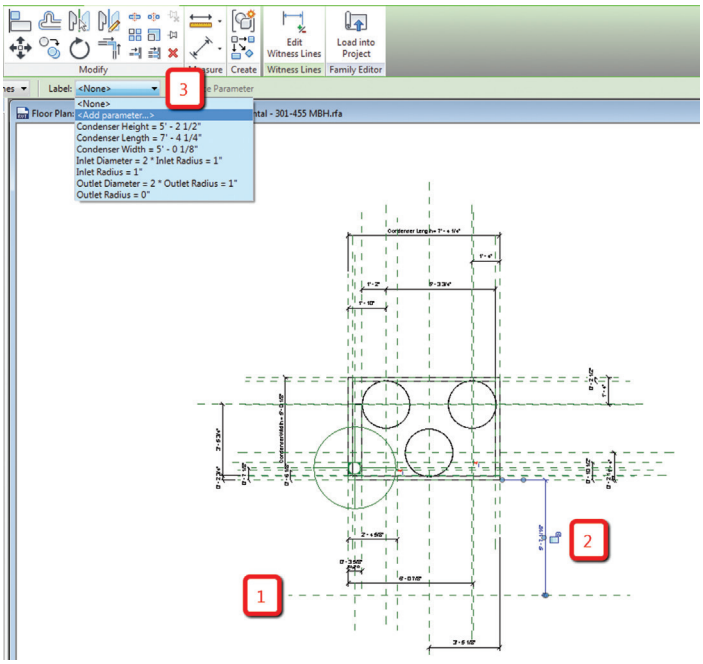


Figure 5

Revit Architecture 2016

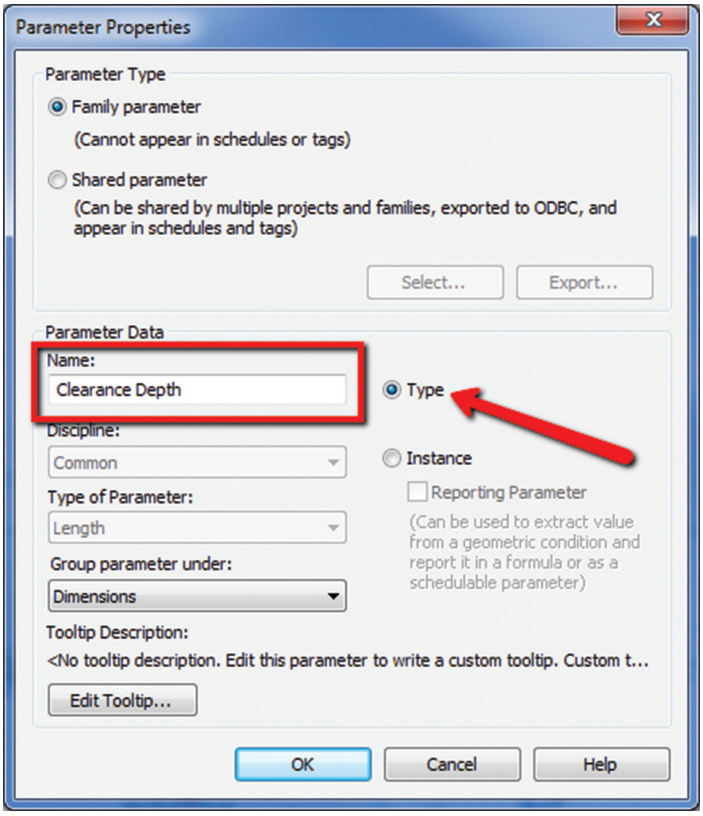


Figure 6

Planes [Center (Front/Back) and Center (Left/Right)] and one for the elevation. (Note: If you are customizing a current Revit family, you will notice many reference planes are already created.) In order to create a 3D boundary, you will need a reference plane on each side of the equipment that needs the clearance—front, side, back bottom and/or top.

The condensing unit needs access on the connections side only, although it is important to always check the submittals! When creating your reference planes, make sure to name them and apply a reference line priority (high, weak, or none).

Open up your plan view, front, and right elevation view. Navigate to the Create Tab and select Reference Plane. Add the needed reference planes and dimension. In the Options Bar, Select Label and "Add Parameter."

Name it clearance depth or something to that effect. This is how you name all your reference planes.

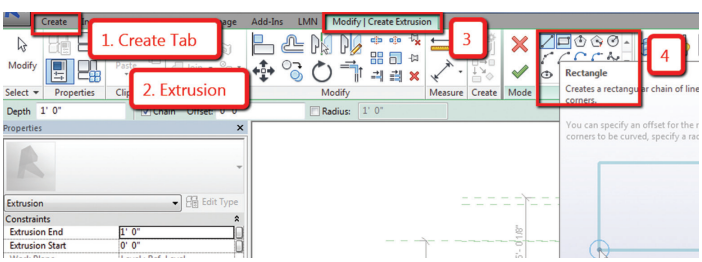


Figure 7

Tip: "Type" is a parameter that is consistent throughout a project, whereas "Instance" is for one-of-a-kind families. If you change a Type parameter, it adjusts all of those families simultaneously (Figure 6).

Next we will create the extrusion for the clearance. Open the floor plan, navigate to the Create Tab, and select Extrusion. This will activate the Modify/Create Extrusion Tab. You can select whichever Draw function is easiest. For this example we will use the Rectangle option (Figure 7).

Tip: Make the rectangle larger than the reference planes. Hit ESC twice. Now you can align the extrusion model lines to your reference planes. After each alignment, lock it so it cannot be moved.

Hit the green checkmark when finished. Go to an elevation view so we can correct the depth. Repeat process of Align and Lock. Open up your 3D View and admire your work! Select the clearance and change the Material and Subcategory settings.

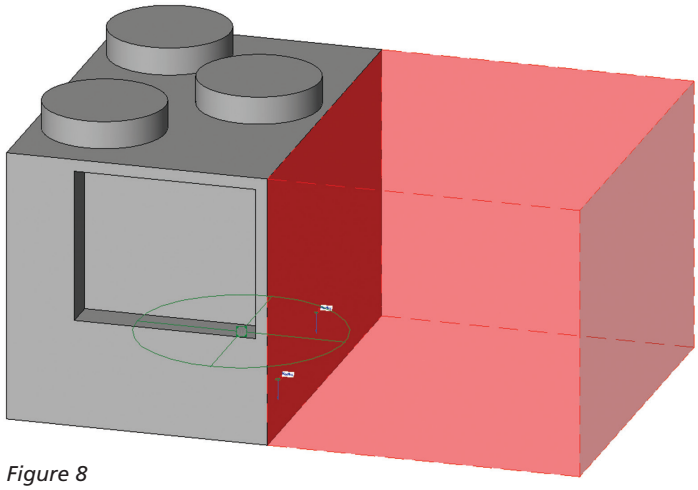


Figure 8

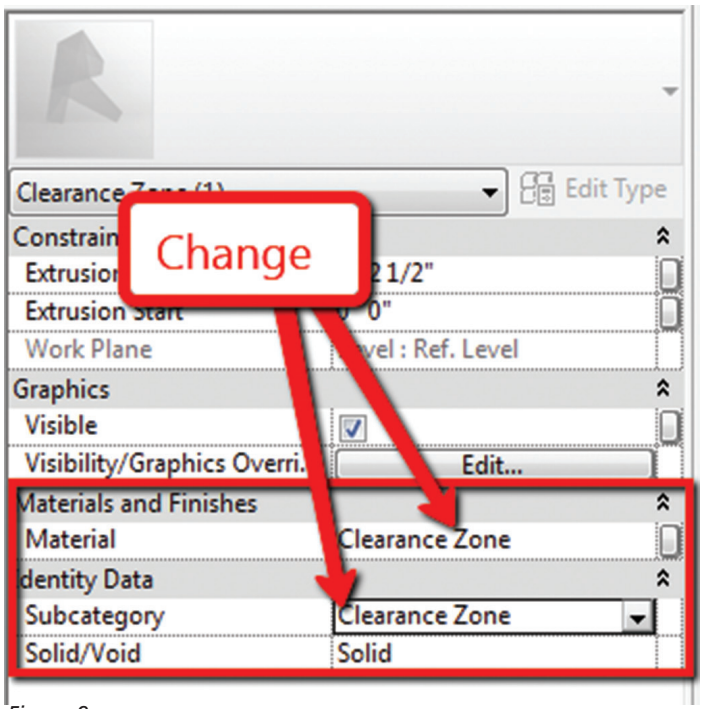


Figure 9

Tip: You create a subcategory so you can manipulate it in your Revit project without having to open up the family (change color, change visibility, etc.).

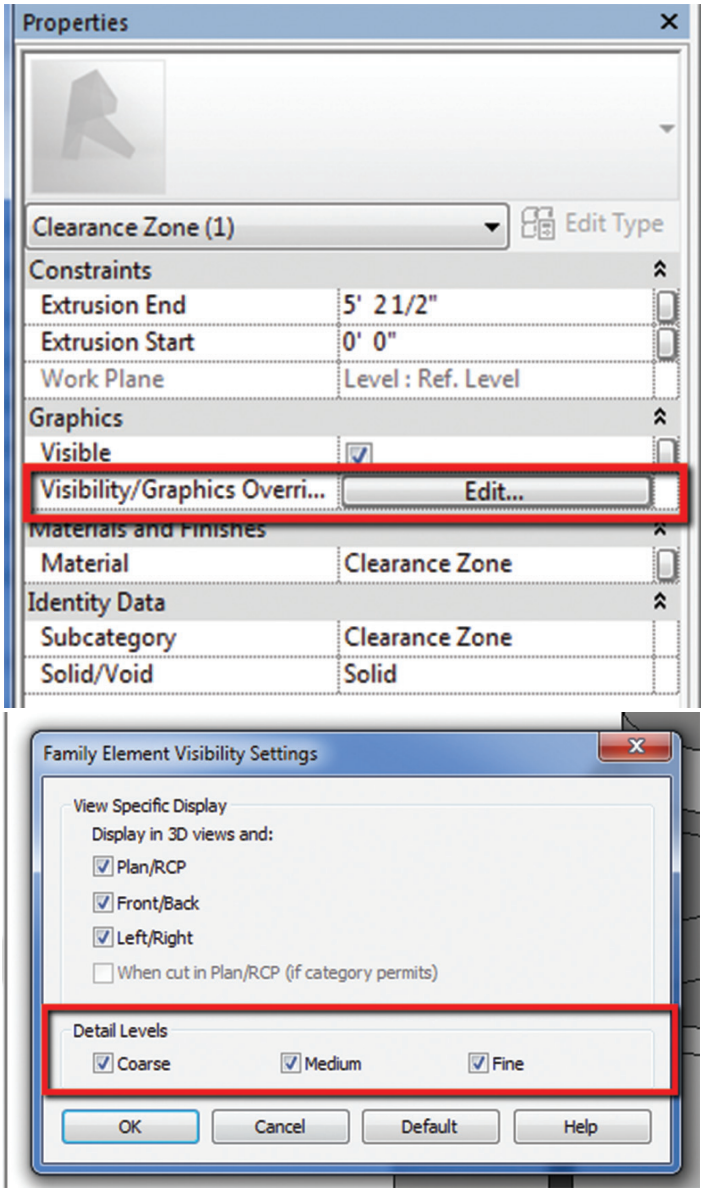


Figure 10

A final adjustment option is in Family Visibility settings. If you have 57 VAV boxes with clearances in a project, having to generate the clearances with each view change could slow your model down. You can adjust how and when your clearances are shown here (Figure 10).

If you choose this option please notify the design and construction team so they select the correct Detail Level when exporting out the model.

Tip: One final word on families. Adjust the Revit Family Template to match your company standards. That way you can create your material and subcategory once versus individually with each family.

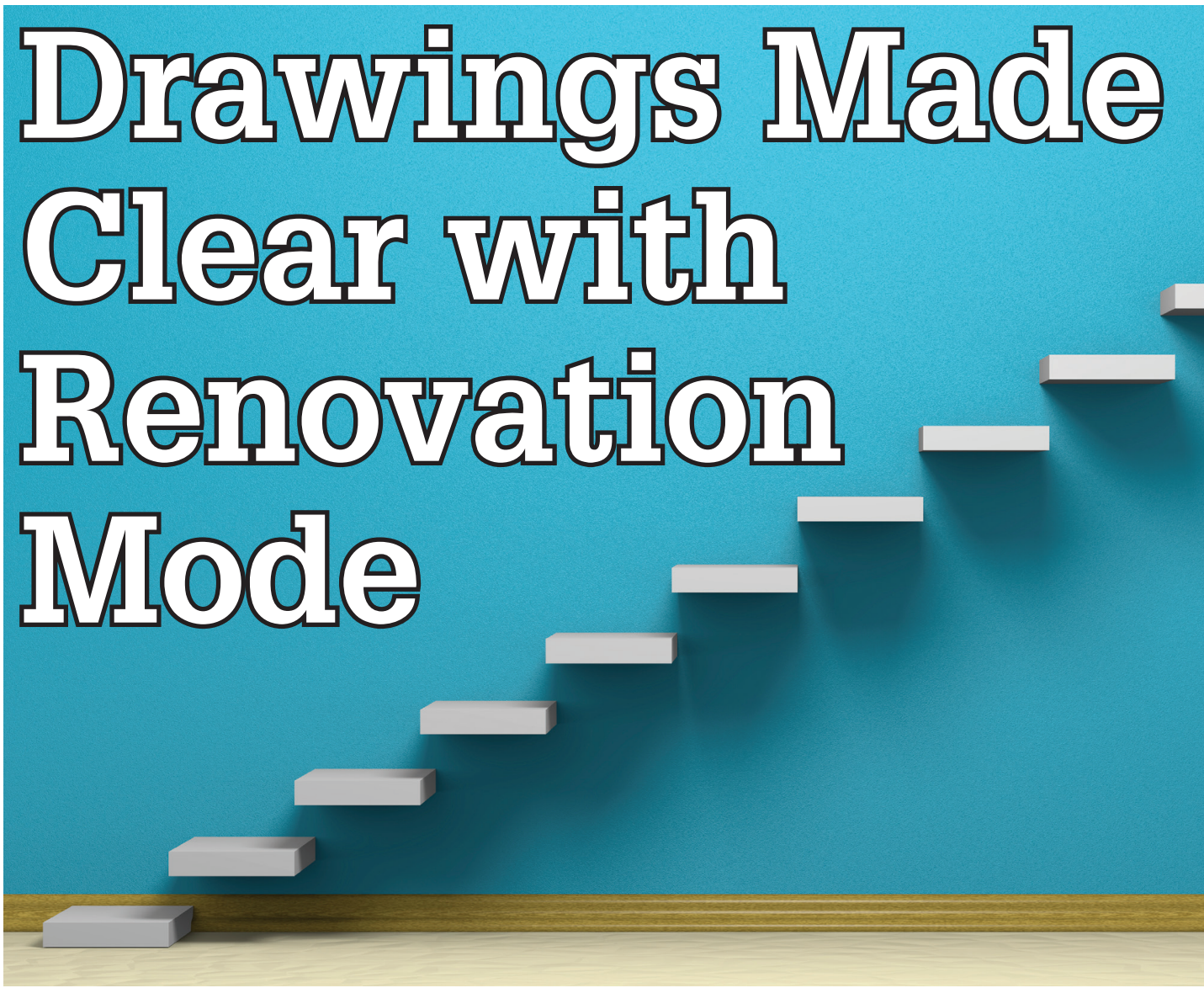
Voilà! We have an excellent clearance that is part of this family, but easily manipulated for your needs.

Jennifer Lanzetti is a principal of Cn3D Construction; assisting the AECO industry to fill the gap between great building technologies and the implementation of these tools. Her career in construction began as a laborer in high school and has progressed to overseeing all phases of commercial construction. With a passion for Building Information Modeling, lean construction, the integrity of information she understands the need for a different approach to construction. She is a prominent voice supporting the industry shift away from the design-bid-build delivery method to an Integrated Project Delivery process. Her energy is dedicated to the evolution of building, and living, in a collaborative world; given the immense and noble responsibility we have of providing people shelter and public resources.

Travis Beecher is no stranger to the BIM world and Revit modeling. Travis graduated from ITT Technical Institute in 2001. He started his career in engineering with lighting design. From there he jumped into the mechanical side of the engineering field and has helped create and run mechanical drafting departments. He is consistently asked by Autodesk to join the Gunslinger program to help develop and Beta test future releases of Revit. Travis currently works as a Senior BIM Engineer, bringing strong Revit skills along with intimate knowledge of MEPF systems to the Cn3D team. In his spare time, Travis enjoys spending time with his three children, playing music, going to the races, and spending time outdoors.

by: Melinda Heavrin

Drawings Made Clear with Renovation Mode



Renovation Mode is a feature that I tend to use a lot. Renovation Mode in AutoCAD® Architecture 2016 easily identifies objects and associates them with different phases of a renovation project, allowing for clear construction drawings each and every time. With this feature, you can display existing, demolished, and new construction all in one, easy-to-read drawing. Working within one drawing and having the ability to switch between renovation plan types allows you to avoid errors that are typically caused by editing multiple drawings.

ACTIVATING RENOVATION MODE

The first time Renovation mode is activated, a specific Renovation display configuration is created. Once activated, you will notice that this specific configuration is a copy of the existing display configuration with "Renovation" added as a prefix (see Figure 1).

To begin Renovation Mode, click the Manage tab of the ribbon, Style & Display panel, Renovation Mode. This brings up the First Activation of Renovation Mode dialog box that allows you to give a name to the new display configuration. Note that it is best to maintain the default prefixes for display configurations to eliminate confusion later. Next, select the Options button to change settings using the Display, Layers and Styles, Blocks and Materials tabs. Click OK and you are now working in Renovation Mode.

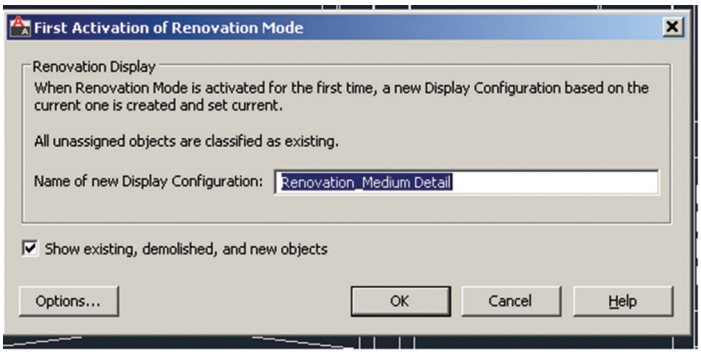


Figure 1: First Activation of Renovation Mode dialog box

WORKING IN RENOVATION MODE

When working in Renovation Mode and following the recommended workflow, objects are automatically assigned to existing, demolition, or new categories. You can assign two-dimensional (2D) and three-dimensional (3D) objects to different categories, easily view the drawing as a renovation plan, demolition plan, or revision plan, and view objects by category. In plan, section, and elevation views, 2D and 3D objects display according to the categories to which they are assigned. The display configurations are controlled by Renovation styles, and these can be customized in the Renovation Options dialog box. With tools on the ribbon you can end Renovation Mode, add objects to categories, and freeze and reset walls to make manual corrections to the edges. This Renovation ribbon panel is visible and available only while you are working in an active Renovation session.

Two-dimensional objects, blocks, and multi-view blocks keep their own display representation when Renovation Mode is started and are categorized as existing objects. When you delete, modify, or create new 2D objects, they display according to the applicable Renovation category. You can explicitly assign them to a category and change their display. Objects that were already categorized in an earlier Renovation phase keep their category and representation. Objects that are created new in active Renovation mode are automatically marked as New. When an object is selected and a command such as Delete, Move, Rotate, and Copy is initiated, objects are assigned to categories and displayed based on the command. For example, pressing Delete identifies objects as Demolition, and moving a door creates both a new and a demolition door and the corresponding wall openings. Existing and new walls automatically clean up with each other; however, demolition and new objects do not interact.

RENOVATION MODE SETTINGS FOR OBJECTS

Design rules for New, Demolished, and Existing categories by object type are controlled by Renovation styles. You can import Renovation Styles from external catalogs or export to external catalogs in the Renovation Options dialog box. For maximum flexibility, Renovation styles for display and layer assignment can be specified independently from each other and are saved to the current drawing.

In the Renovation options dialog box, the Display tab allows you to specify the Renovation Display Style as well as set specific design rules for objects such as walls and doors (see Figure 2). The layer tab allows you to set the Layer Assignment Style as well as to specify a prefix or suffix to layers in lieu of changing the layer name (see Figure 3). The Styles, Blocks and Materials tab allows you to add a prefix or suffix to style/block names to avoid naming conflicts between objects in different Renovation categories (see Figure 4). This is much quicker than having to manually rename each object! When the Duplicate Material Definitions box is checked, a copy of the material is automatically generated and assigned to the building object. The corresponding color settings will automatically display.

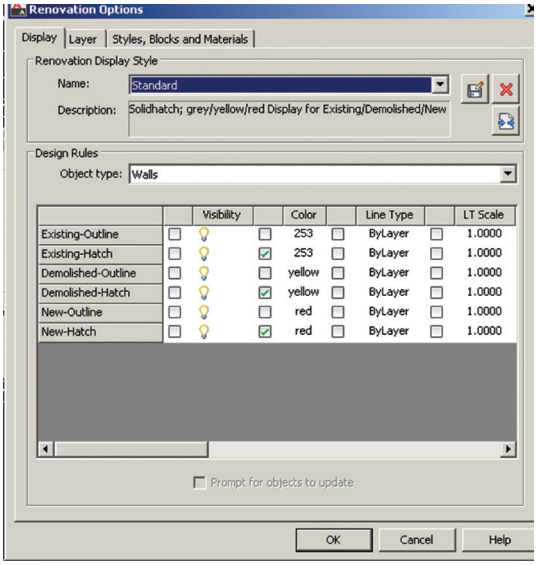


Figure 2: Display options

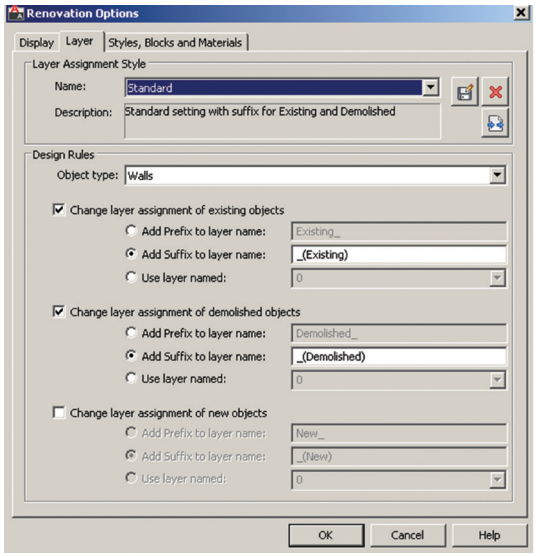


Figure 3: Layer options

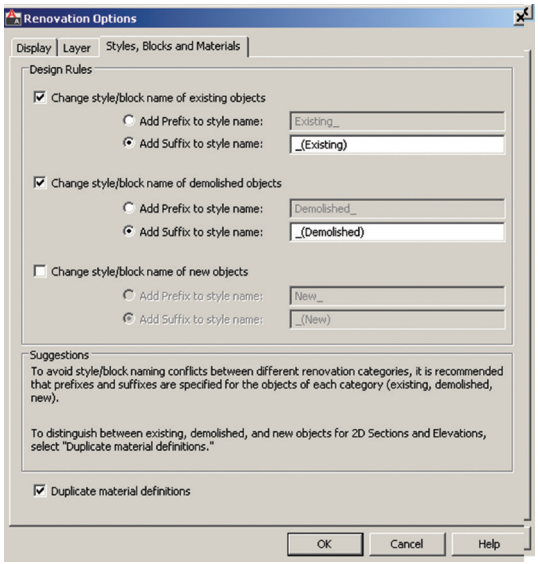


Figure 4: Styles, Blocks and Materials options

ENDING A SESSION IN RENOVATION MODE

Once you are finished working in Renovation Mode, ending the session is simple. On the Renovation panel, click the Close Renovation Mode tool. It is important to note that if changes are made to the drawing after Renovation Mode has ended, the uncategorized objects are automatically assigned to the Existing category when you reactivate Renovation mode.

MODIFYING THE RENOVATION DISPLAY

You can change how properties of objects within specific categories are displayed in the drawing by unlocking them, changing them individually per object type, and saving them as the Renovation display style. Modifications made are saved to the current drawing. The lock icon to the left of the property signals whether this property can be changed. If the property is unlocked, any changes made to the display are reflected in the drawing.

With the Renovation drawing open in an active Renovation Mode, click Options on the Renovation panel. The Renovation Options dialog box displays. On the Display tab, select the display style to apply to the current drawing and enter a description. Renovation styles can be modified and saved, deleted, and imported from and exported to an external catalog. Now, select the object type for the design rules and then select the checkbox to the left of each property value for the category you want to change. Modify the properties as desired and select Prompt for objects to update. Select the objects to modify or press Enter to select all objects. Changes to the selected properties for the specified object type are applied in the current drawing.

CONTINUING TO WORK IN RENOVATION MODE

When Renovation Mode is reactivated in your drawing, the existing Renovation display configuration can still be used or you can create a new one. The objects that were previously categorized in an earlier Renovation phase will retain their representation and category. Any objects that do not yet have a Renovation category will be automatically categorized and displayed as Existing objects. The Show Existing, New and Demolished Objects option is automatically selected by default. It is recommended that this option remain selected, as it ensures that categorized objects in your Renovation plan remain visible while switching between the Demolition, Renovation, and Revision displays.

To continue working in Renovation Mode, select the Manage Tab on the ribbon, then click the Style & Display panel, and then click Renovation Mode. This will display the Repeated Activation of Renovation Mode dialog box (see Figure 5). Next you will need to specify the settings in the dialog, depending on what you want to do. To begin with an existing Renovation display configuration, click the drop-down arrow next to Activate an Existing Renovation Display Configuration, select the display you wish to use, and click OK. To begin with a new display configuration, select the Create a New Renovation Display Configuration Named button, enter a name for the new configuration, and click OK. Next you can change the display style or design rules of objects by clicking the Options button at the bottom left of the dialog box. Click OK when finished, then click OK again to exit the dialog box. You are now working in Renovation Mode again.

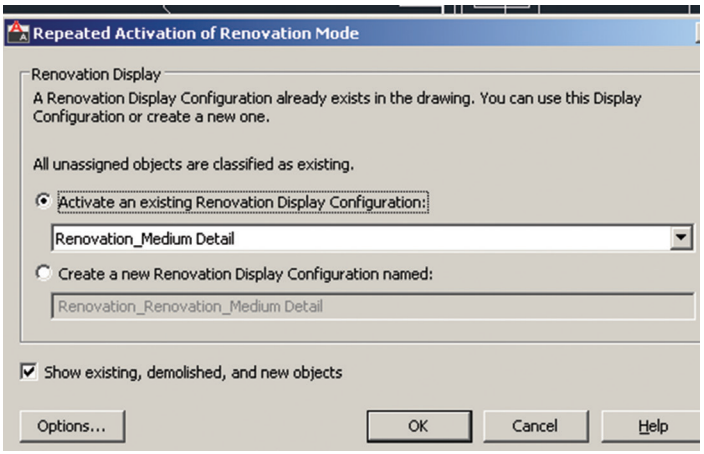


Figure 5: Repeated Activation of Renovation Mode

ACTIVATING A DEMOLITION PLAN

The display of a demolition plan shows existing construction and those objects categorized as demolished. All new objects, however, are hidden. Display settings for the demolition plan type are located in the options dialog box for Renovation Mode.

To create a demolition plan, activate Renovation Mode as previously discussed and then select the button for Demolition Plan on the Renovation panel of the ribbon. You can now select a Renovation Display Configuration to activate. The box next to Hide All New Objects is automatically checked. If you would like for New objects to show while you are working in the drawing, click in the box to de-select the item and then click OK. You can also click the New Show/Hide button on the Renovation panel. You are now ready to begin creating a demolition plan.

Please note that yellow is automatically assigned by default to demolition objects. This can be changed in the options dialog box for Renovation mode under the Layer tab.

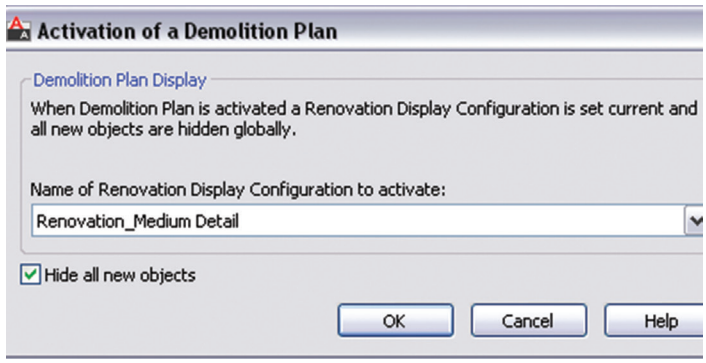


Figure 6: Demolition dialog box

ACTIVATING A REVISION PLAN

A revision plan displays new and existing construction objects but all demolition objects are hidden automatically. Display settings for the revision plan type are located in the options dialog box for Renovation Mode.

To create a renovation plan, activate Renovation Mode as previously discussed and then select the button for Revision Plan on the Renovation panel of the ribbon. You can now select a Revision Plan Display configuration to activate. The box next to Hide All Demolished Objects is automatically checked. If you would like for Demolition objects to show while you are working in the drawing, click the box next to de-select the item and then click OK. You can also click the Demo Show/Hide button on the Renovation panel. You are now ready to begin creating a revision plan.

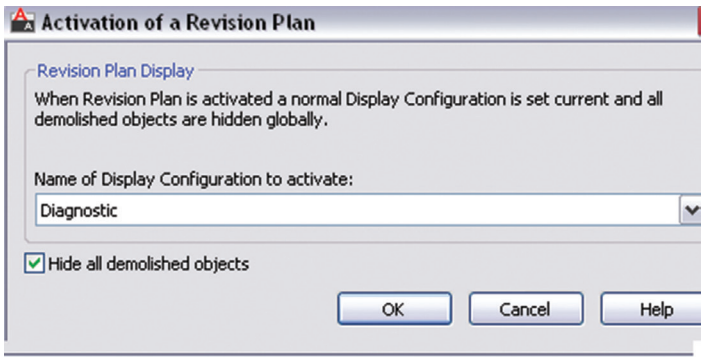


Figure 7: Revision dialog box

MANUAL MODIFICATIONS

Sometimes walls of different renovation categories do not intersect correctly so manual modifications become necessary. This can be done by temporarily suspending Renovation Mode. For example, you may have a plan that includes walls categorized as demolition and walls categorized as existing with wall edges that need to be corrected. Remember, objects categorized as New do not interact with objects categorized as Demolition. When you need to make a manual correction, you temporarily interrupt Renovation Mode by freezing the walls you want to modify and then correcting the edges. These changes are not considered part of Renovation. The option to freeze or thaw walls is only available when Renovation Mode is active.

Let's make this a little more clear. To do a manual modification, click the Freeze Walls button on the Renovation panel of the ribbon. Next, select the walls in question and hit Enter. Renovation Mode is now temporarily suspended. Proceed with correcting the wall edges and then click Thaw Walls when finished. Renovation Mode resumes.

RENOVATION STYLES CATALOG

The Renovation styles catalog contains display and layer assignment styles. AutoCAD Architecture-based styles for objects are managed with Style Manager. By default, the Renovation styles

catalog is installed in ProgramData\Autodesk\ACA <version>\enu\Styles. If the Renovation styles catalog is renamed or moved, the styles are disabled and cannot be accessed. Use the Renovation Styles Catalog Settings dialog box to specify a valid catalog.

With the Renovation drawing open in an active Renovation Mode, click Styles Catalog from the Options drop-down menu on the Renovation panel. The Renovation Styles Catalog Settings dialog box displays. Select the Import renovation styles from catalog checkbox for drawings to be populated with all Renovation styles in the specified catalog. Clear the Import renovation styles from catalog checkbox for new drawings to include standard styles only. Browse to the location of the Renovation styles catalog you want to use. Click OK.

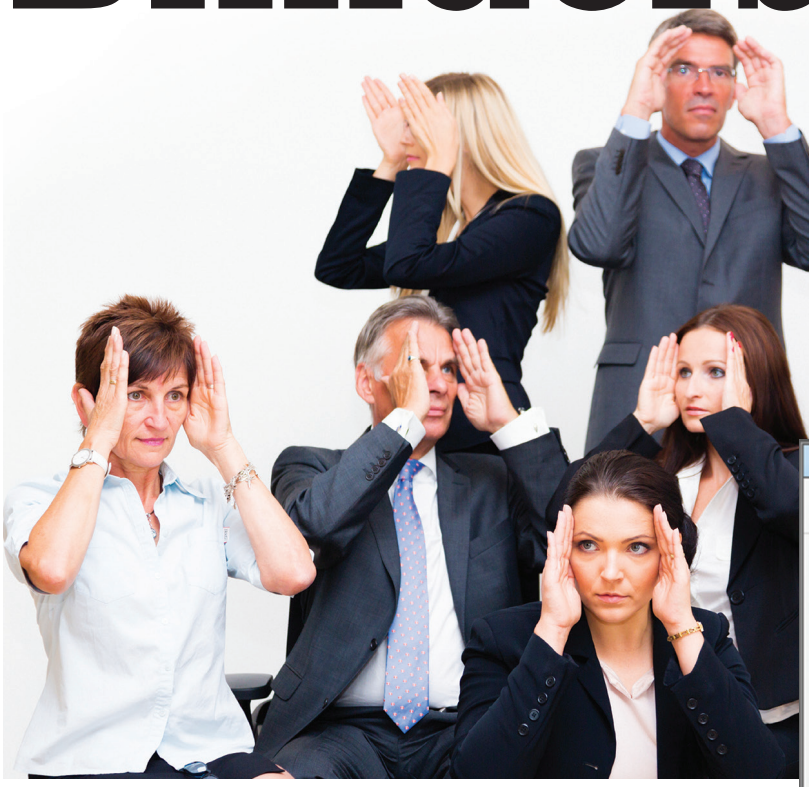
CONCLUSION

Renovation mode is an excellent tool for those needing to show new, existing, and demolished objects in a drawing. I challenge you to open a drawing and activate Renovation Mode. Explore the possibilities for yourself. You will be glad you did!

Melinda Heavrin is a CAD Coordinator & Facility Planner for Norton Healthcare in Louisville, Kentucky. She has been using AutoCAD Architecture since release 2000. Melinda can be reached for comments and questions at melinda.heavrin@norton-healthcare.org.

by: Mark Hunter

Remove Your Blinders



In March 2013 I wrote an AUGI article about easily managing thousands of clashes in Navisworks® without being overwhelmed; that article was only a part of my workflow. What I will cover in this article is actually more important than merely how you handle clashes. This article will show you how to utilize custom clash tests to gain a better understanding of coordination issues and cut meeting prep time in half.

BLINDERS

Before we get into custom clash tests we need to talk about the current workflows that I have seen from many BIM managers when preparing for a coordination meeting.

How many times have you seen 25 or more clash tests in one file waiting to be scrubbed?

Anyone who has had to comb through 25+ clash tests knows how long it can take.

Clash Detective

CLASH TESTS TO SCRUB

Name	Status	Clashes	New
HVAC VS FIRE	Done	142	142
HVAC VS ELEC	Done	473	473
HVAC VS PLUMB	Done	147	147
ELEC VS FIRE	Done	92	92
ELEC VS PLUMB	Done	44	44
PLUMB VS FIRE	Done	5	5
MPIPE VS FIRE	Done	18	18
MPIPE VS ELEC	Done	102	102
MPIPE VS PLUMB	Done	29	29
MPIPE VS HVAC	Done	1262	1262
Ceiling VS Elec	Done	13	13
Ceiling VS Plumb	Done	0	0
Ceiling VS Fire	Done	4	4
Ceiling VS HVAC	Done	64	64
Ceiling VS MPipe	Done	0	0
Struc VS Elec	Done	1157	1157
Struc VS Mech	Done	46	46
Struc VS Plumb	Done	313	313
Struc VS Fire	Done	77	77
Struc VS MPipe	Done	210	210
Framing VS Mech	Done	244	244
Framing VS Elec	Done	252	252
Framing VS MP	Done	31	31

Figure 1: 25+ clash tests

And how many times have you been flying through the model in your "Fire vs. HVAC" test and you run into a situation like that shown in Figure 2?

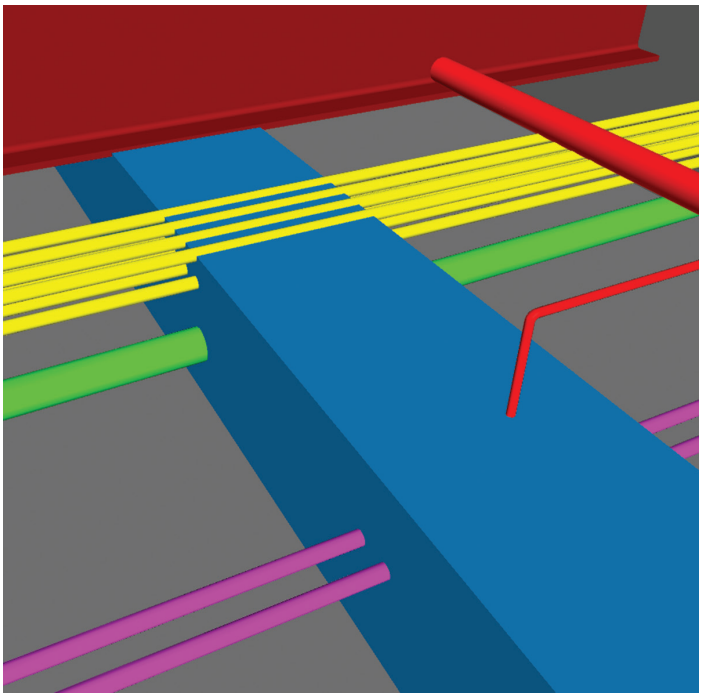


Figure 2: Train wreck

Even though you have multiple hits with multiple trades, you don't mark all of them because you're in the wrong clash test and worried about creating duplicates when you get to your "Plumbing vs. HVAC" test. Even more important than duplicates, what happens if you create a view for the plumbing hit in one clash test and a separate view for the electrical hit in another? You might end up telling the electrician to raise over the duct only to find out later that the duct has to move up to miss the plumbing lines. Even more frustrating are the issues that involve complex solutions that take a lot of time just to plan, and then finding out it won't work because another trade down the line wasn't taken into consideration.

When you have 25+ clash tests, whether they be trade against trade or priority against priority it is still like clashing with blinders on. In order to efficiently solve constructability issues you have to be able to understand the whole issue, which is almost never limited to just two trades. I've heard it asked before: "Why would you clash everything against everything?" To that I respond, "Why *wouldn't* you?"

There have been whispers of Navisworks one day being able to clash by area. Until that day comes, clashing multiple trades at the same time is essentially the same thing. Instead of marking clashes individually you can start marking areas of concern and working through areas instead of instances. Besides the huge time saver of scrubbing areas instead of instances, your comprehension of all trades involved and their limitations will be greater.

I don't actually clash everything against everything. I have four custom clash tests.

ONE FOR ALL

What is a custom clash test? Some of you may have seen the custom clash tests folder buried in your Navisworks root directory and wondered why it was there. And some of you may already know what custom clashes are, but have never seen a practical use for them. Whatever your experience with custom clash tests may be, my goal is to help you see their value and create your own.

Custom clash tests are a powerful Navisworks tool that enables you to combine multiple tests and rules into one clash test. Here are my four tests and what they include.

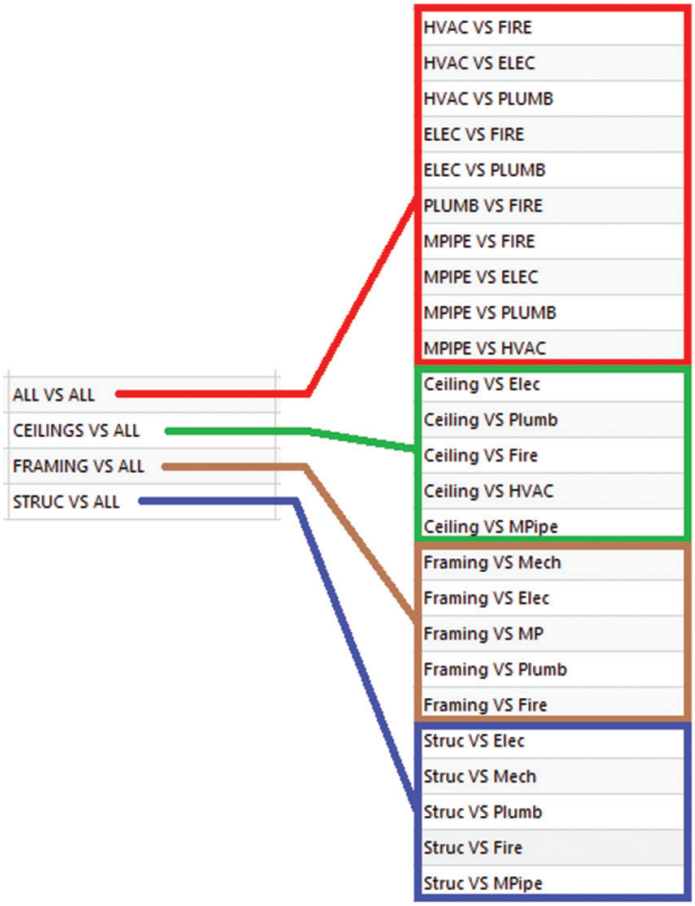


Figure 3: 4 = 25?

I'm sure one of the first questions that comes to mind when seeing this many clash tests being reduced to four is, "How do you manage the amount of clashes that kind of a test will produce?" That will take too long to explain in this article, but my 2013 article, "Thousands of Clashes in a Thousand Seconds," gives a good overview of how to manage that many clashes.

This article will show you how to create your own custom clash tests that can transfer to any job while keeping all your rules and search sets, as well as some of the sorting and filtering options you will have that normal clash tests don't offer.

Navisworks Manage 2015

I broke my workflow into four custom tests that I felt were manageable, but broad enough to give me a clear understanding of problem areas:

Structural vs. All Trades
Ceilings vs. All Trades
Framing vs. All Trades
All Trades vs. All Trades

You might decide you want to combine different tests. I would encourage you to evaluate your workflow and think about what tests you can combine. Even if you only combine half of your current tests it will still shorten your meeting prep time considerably and help you understand the issues more clearly.

CREATING CUSTOM TESTS

Creating a custom clash test is actually very simple. To begin with, create all the tests you want to combine into one custom test. Check all the rules you want to apply to each test and make sure you use search sets for all your tests. If you do not use search sets for your tests, the custom tests won't work on other projects. Creating unbreakable search sets is the first obstacle that people ask me about: "How do I create a search set that will work for every project?" Some turn to naming conventions in order to create search sets that transfer between all projects, but there are a number of issues that often occur when trying to control the deliverables from some contractors. Why not use something that you always have control over, such as the folder structure you copy from project to project?

The file name in Navisworks shows the entire file path. Because you have a standard folder structure you can create search sets to select everything in the plumbing folder and everything in the fire folder, then use those for your plumbing vs. fire clash test. Search sets based on folders on your computer that should never change will never break.

Now that you have your clash tests made using unbreakable search sets it's time to start the long process of creating your custom clash test. On the Output tab of the ribbon, click "Clash Tests" to export an XML of all your clash tests, then save that file to your custom

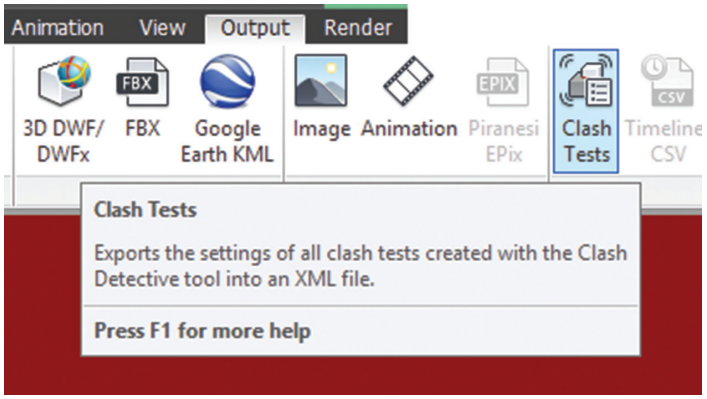


Figure 5: Export an XML

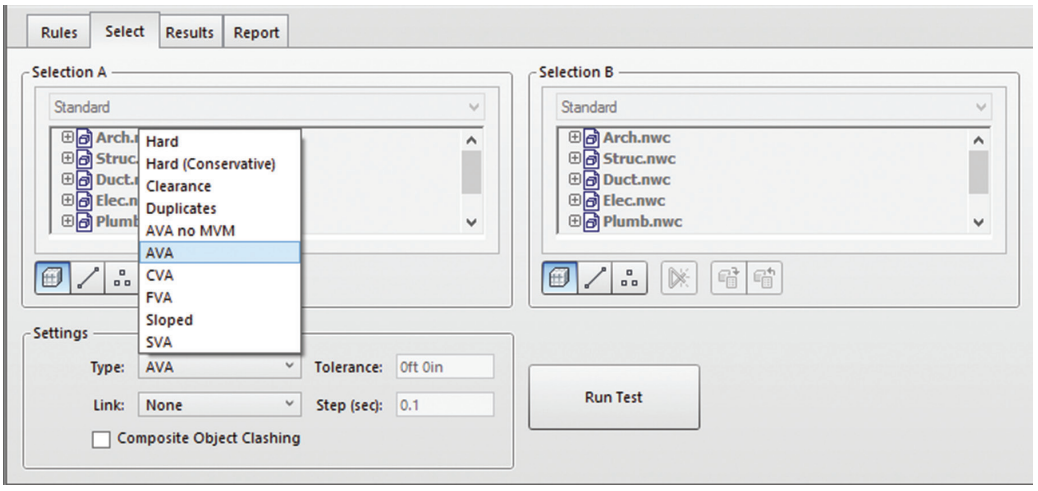


Figure 6: Your new custom clash test

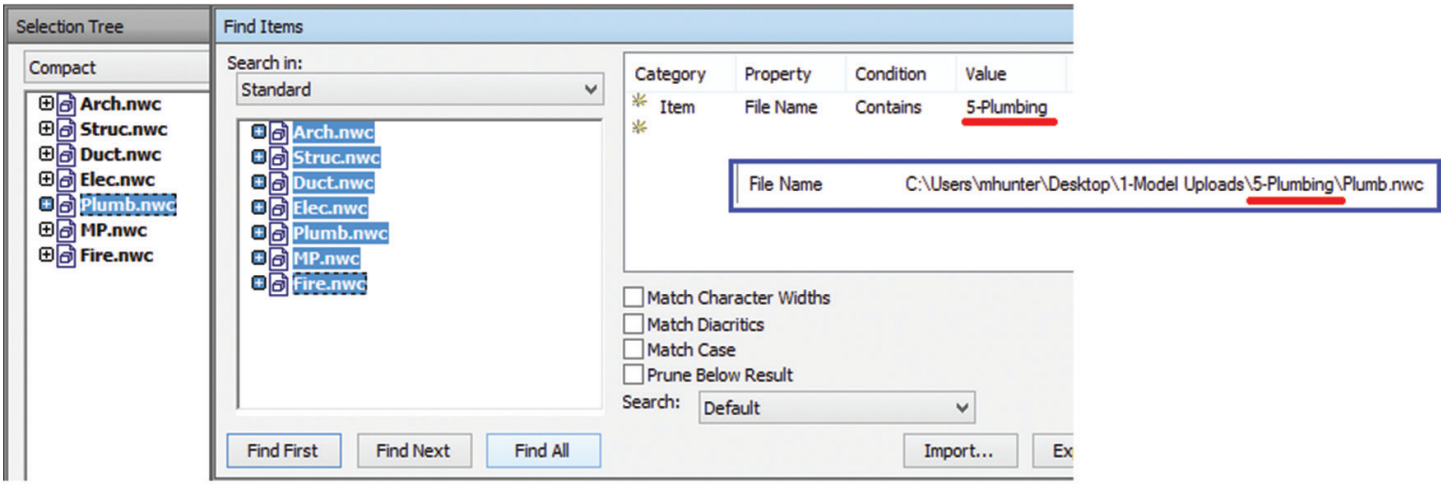


Figure 4: Search sets by folders

Name	Status	Description	Assigned...
Clash1	New	Hard	
Clash2	New	Hard	
Clash3	New	Hard	
Clash4	New	Hard	
Clash5	New	Hard	
Clash6	New	Hard	
Clash7	New	Hard	
Clash8	New	Hard	

Name	Status	Description	Assigned...
Clash1	New	ELEC VS FIRE	
Clash2	New	ELEC VS FIRE	
Clash3	New	ELEC VS FIRE	
Clash4	New	ELEC VS FIRE	
Clash1	New	HVAC VS ELEC	
Clash2	New	HVAC VS ELEC	
Clash3	New	HVAC VS ELEC	
Clash4	New	HVAC VS ELEC	
Clash5	New	HVAC VS ELEC	
Clash6	New	HVAC VS ELEC	

Figure 7: New description

clash tests folder here: C:\ProgramData\Autodesk Navisworks Manage 2016\custom_clash_tests. The "ProgramData" folder is a hidden folder so you need to make sure your computer folder settings allow you to see hidden folders.

That's it. You're done. Now after restarting Navisworks you will see a new test option under "Type." As soon as you select that new type of test, you will see the selection A and B become grayed out. This is because your new custom clash test has all of the information it needs stored inside that XML you exported.

ADVANCED SORTING AND FILTERING

Custom clash tests make sorting, filtering, and isolation much more powerful. One of the first things you will notice when reviewing a custom clash test is the description of your clashes no longer says "Hard," but instead it's replaced with the names of the individual clash tests you used to create the custom clash test.

With unique information in the description you can now sort and group by those original clash tests if you desire. But if I group all my clashes by their original tests, then what's the point of a custom clash test? With the "Highlight all clashes" box checked, the "Dim Other" and "Hide Other" commands will now allow you to clearly see everything that's hitting or just the trades that you want to see.

What if I want to clash very specific items inside my HVAC file? Easy. With the "Inclusive" filter, I can select those items through any means and then group the related clashes together. Then using "Hide Other" I can see where those specific clashes are, and "Dim Other" will let me see any surrounding issues that might affect me. My common workflow is to group all of the clashes together and review by area. This allows me to quickly break a building out into trouble areas and understand all the issues in each area so it's easier to determine a solution. Clashing by area also cuts scrubbing time in half. For example, instead of having six clash viewpoints each in different clash tests, I have one clash viewpoint.

I have been using custom clash tests for three years now and will never go back to the mind numbing task of scrubbing 25+ clash tests while wearing blinders.

With a little sorting and filtering, custom clash tests will be a powerful tool for you—no matter how you manage clashes.

The Navis Ninja, aka Mark Hunter, is an innovative and talented Navisworks professional. After being recruited by C.W. Driver as a BIM Manager, the Navis Ninja developed a new workflow for coordinating buildings that slashed the prep time in half. Key to the Navis Ninja's success was his ability to help his team members "take their blinders off" and shift the paradigm for coordination that made the process twice as efficient and twice as fun. Outside of coordinating some of the most complex and congested buildings for C.W. Driver, the Navis Ninja is known for vetting new technologies (i.e., integrating augmented reality through a high-end professional quadcopter) and constantly finds himself evading sleep while working on his next innovative project. To follow and track some of the Navis Ninja's latest developments, frequent www.navis-ninja.blogspot.com. Mark can also be reached at mhunter@cwdriver.com, or at 909.945.1919.

by: Kaitlin McVehil

Questions in Revit: Follow the Process

Thank goodness Autodesk® Revit® cleverly asks users questions that guide decisions. It's when questions are ignored and the process breaks down that consequences follow.

The movie *The Curious Case of Benjamin Button* is about a human's life in reverse. Unfortunately in architecture, no project starts at completion and then ends with the Request for Proposal. That would simply not work. Yet for some reason architects seem too often to want to skip steps in the process, jumping from A all the way to Z and not thinking about B to Y.

Revit is based on a simple understanding of processes, which are continually presenting themselves through Revit's user interface. Changes will happen in a project—this is unavoidable—which simply means that a new process *(or series of questions)* will begin in conjunction with the already established process, which may or may not be revised.

Through reviewing the simple creation of a Revit family, this article will demonstrate how Revit addresses the planning process and how this basic idea is repeated and evident throughout its functions and features.

WHAT WE LEARN FROM A SIMPLE BASE CABINET FAMILY

1. Type of Family

Before the mouse is clicked, Revit has already presented a question, or the first step in the process of creating a family. Is this base cabinet wall based? Floor based? Surface based? And it can go on and on. Based on one decision, certain functions of this family are assigned. Revit presents questions to help keep the users on track. It's like a guardian angel of the model—not telling you what to do, but rather presenting the options available to consider before making a decision.

Brainstorm before Beginning

2. Family Flexibility (Parameters)

Parameters are all about control and flexibility. Parameters in a family are asking: what might be required to change or adjust in this component within the project environment? The height, width, depth, material, and visibility are only a few of the many parameter options.

It is understandable that as a project develops, a family might need additional parameters previously not required. This change should not cause alarm; it is simply a reason to review the current condition and plan what course of action is required to successfully achieve the new requirement.

Revit wants the users to pause and think before creating. Dare I say, pick up a pen and paper and sketch out the intent and analyze the best action. Instead of making rash decisions, take the time to plan what is the best course of action given all the known factors. This "pause" should not be considered a waste of time or unnecessary. If efficiency and saving time is important (this is for most businesses), then this planning step should not be skipped. Like this base cabinet family in Revit, projects will most likely require a change or changes. Pause, Plan, and then Proceed.

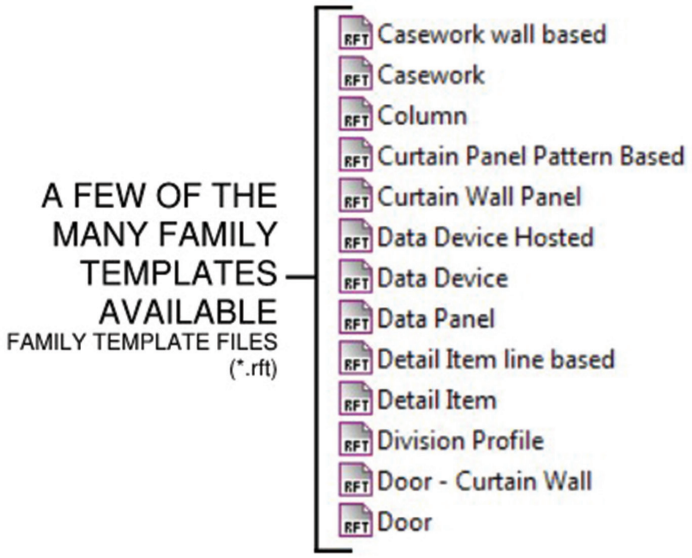


Figure 1

3. Building the Family

Now that there is an understanding of how the family needs to adapt, how should this component be built? Revit provides many ways to accomplish the goal. It's up to the user(s) to determine which option makes the most sense. This is where differences of opinion can be a hurdle. People have preferences, but the conversation should be about a team consensus. A difference of opinion should always be welcomed, but it should never be the cause of delay. In the base cabinet example, which orientation should an extrusion be created, will voids be utilized, and will there be nested families are only a few of the questions to discuss among the team. Conversation, Consensus, then Create.

EXAMPLES OF PARAMETERS SIMPLE TO COMPLEX W/ ENDLESS POTENTIAL

AN INSTANCE PARAMETER IS INDICATED W/ "(default)." ALL OTHER PARAMETERS ARE TYPE.

Materials and Finishes	
Pull Material	<By Category>
Cabinet Material	<By Category>
Base Material	<By Category>
Finish	
Dimensions	
Depth	2' 0"
Height	2' 8 1/2"
Width	0' 0"
Adjustable Width (default)	2' 0"
Adjustable Depth (default)	2' 0"
Visibility	
Wire Pull (default)	☐
Knob Pull (default)	☐

Figure 2

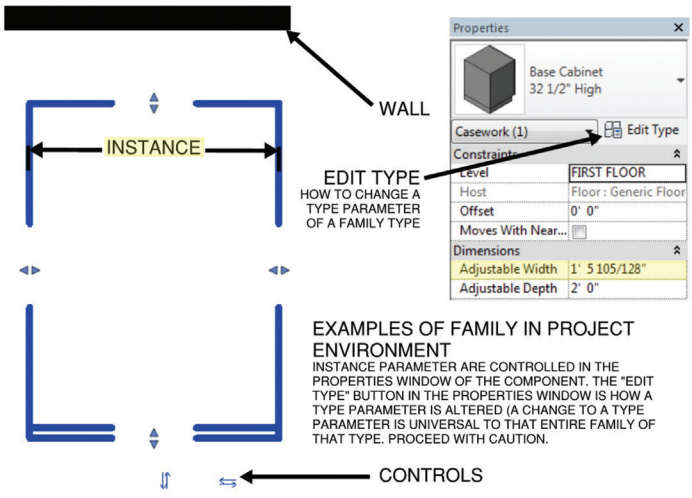


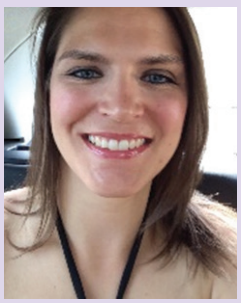
Figure 3

4. Using the Model

Although the family might be already loaded into the project, what information does that family contain and how is the information being shared in the documentation? Is the family being tagged? If tagged, what information does the tag convey? It should come as no surprise that questions are again being asked. Revit follows a simple rule: we must know the what, to determine the how, to act.

CONCLUSION

Frustration with Revit occurs when the user(s) want to skip steps (i.e., ignore the process). So the next time a team faces a challenge and points the finger at Revit, maybe the team will pause and begin to consider the questions previously ignored and change their course of action.



As a "younger" design professional at RTKL Associates in Chicago, Kaitlin McVehil is passionate about sharing knowledge with fellow professionals, but more importantly listening and learning from others. She has worked on a variety of project types, scales, and the challenges unique to each. Kaitlin excels at taking responsibility for her work and actions. As Kaitlin gains valuable architectural experience, she has learned that being responsible, even for mistakes, is where we learn the most.

by: Brian Chapman

Creating Custom Textures with the Viewport Canvas

It takes approximately 13 milliseconds for the brain to process what we see. That's not much time to create an impression. Sometimes, subtle changes to a scene can make a big difference.

Take the pillow and blanket in Figure 1 for example. The lack of contrast and colors doesn't leave much for us to think about. In comparison, the same blanket and pillow was used to generate the scene in Figure 2.

By simply changing the textures, providing some contrast, and adding a few more copies of the same exact pillow, the scene provides much more interest. Another example would be the chair in Figure 3. By adding a second chair and books, the same scene becomes considerably more interesting.

It is important to provide subtle details to objects and scenes to make our work stand out, but textures also play a significant role

Figure 1: Pillow scene

Figure 2: Modified pillow scene

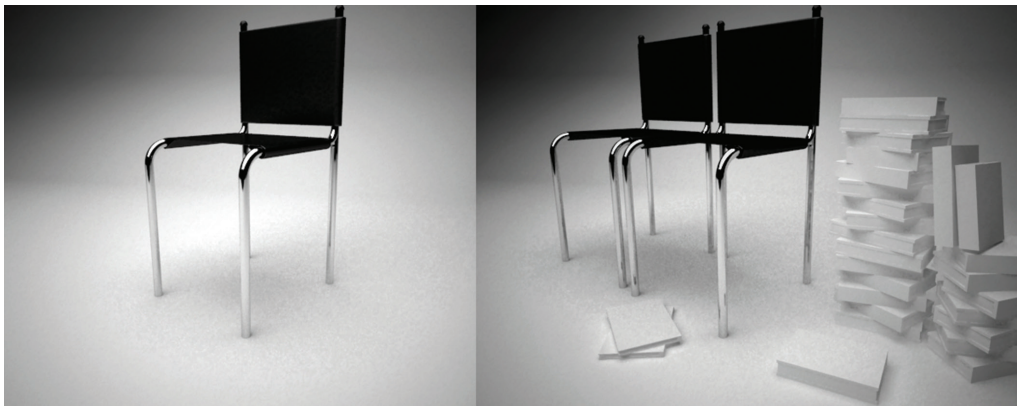


Figure 3: Chair scene

Figure 4: Concept car

when trying to capture the attention of a viewer. In perhaps just a few seconds, a viewer will determine if they've seen a graphic before (or something like it), if it's interesting (or not), and whether it is worth a second glance.

To customize a scene and make it unique, we can use the Viewport Canvas located under the Tools menu. Using the canvas we have the opportunity to customize our scene textures with many of the same paint and brush tools available in popular paint platforms used today. In addition, we paint directly on our object within our 3ds Max® environment. To demonstrate, I've rendered a concept car with default textures shown in Figure 4.

After subtle changes consisting of a few brush strokes and using the clone brush tool to apply a decal, I've created more interest in the scene. Let's discuss the basics of the canvas tools shown in Figure 5 to begin creating our own custom textures right inside 3ds Max.

The first tool is the brush (very top left icon in Figure 5). The first time we select the brush, a dialog will open asking if we would like to assign a new standard material or browse to select an existing one to modify. If we choose to assign a new material, we should select diffuse map and continue. At this point it will ask for the default texture information shown in Figure 6. Here we set the resolution, the base background color, and where to save the new file.

After assigning or selecting a texture, the brush will now be active for painting.

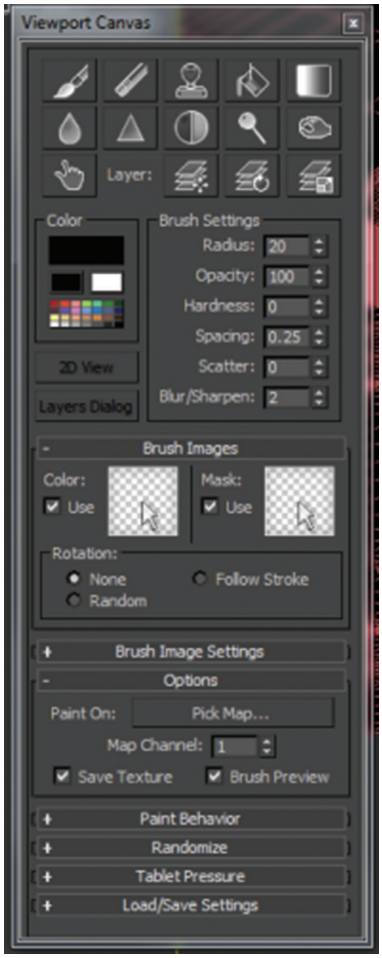


Figure 5: Viewport Canvas tools

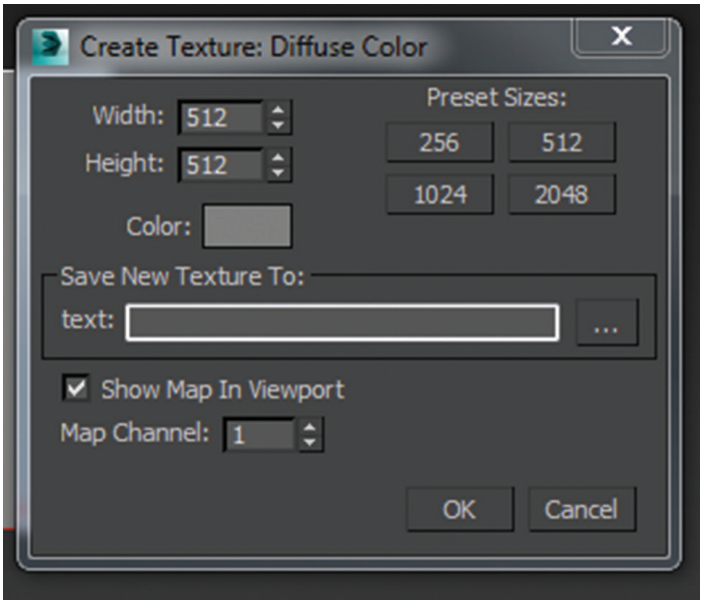


Figure 6: New Texture settings

The rest of the tools are identified in Figure 7 and represent more brush and layer controls. As you can see, we have the ability to layer changes to our textures as well as paint with many of the common tools required to create a unique and custom texture. A particular favorite of mine is the clone tool.

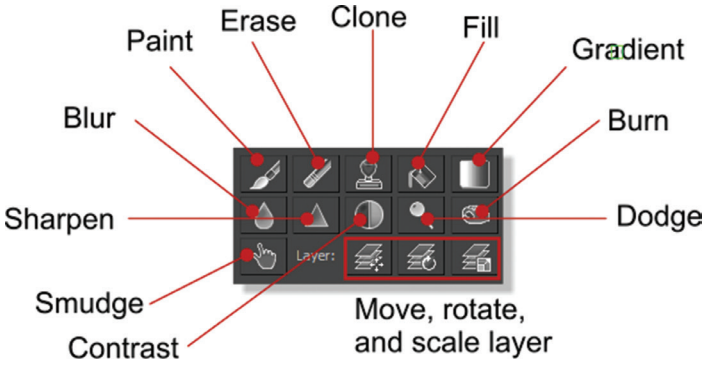


Figure 7: Brush and Layer controls

In order to add a decal to the car shown in Figure 4, I simply applied a texture to a second object and chose the Clone option in the viewport canvas tools. I insured my car contained a multi-layer bitmap (PSD file) for my diffuse map, but my box diffuse was simply the bitmap of my choosing. In this case my box diffuse map consisted of my car's decal. See Figure 8 for the example.

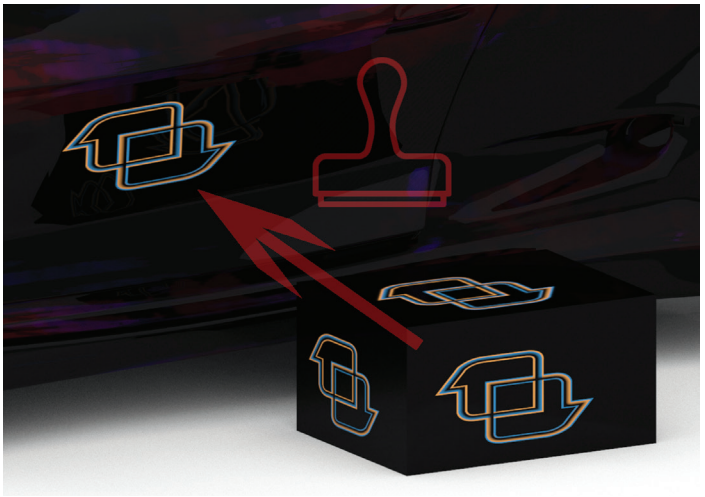


Figure 8: Cloning texture from box to car door

To clone, I simply held down the Alt key and selected the area I wished to clone and started painting directly onto my car. While painting, the Viewport Canvas updated my car's texture file to include the new decal, creating the customized texture I wanted and making the car appear a little more unique. If we choose to modify an existing texture rather than start with a new one, we should be careful here since the changes we will make modifies the original texture we are painting on.

The next set of tools, shown in Figure 9, control the brush settings, color, as well as the ability to open the layer dialog, allowing us to make changes and paint in layers that can be turned off, modified, or deleted.

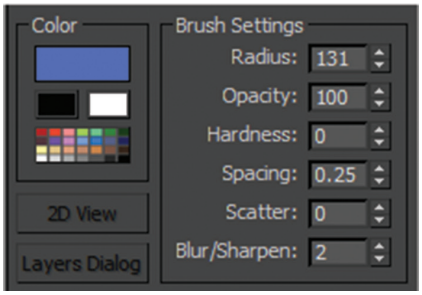


Figure 9: Brush settings

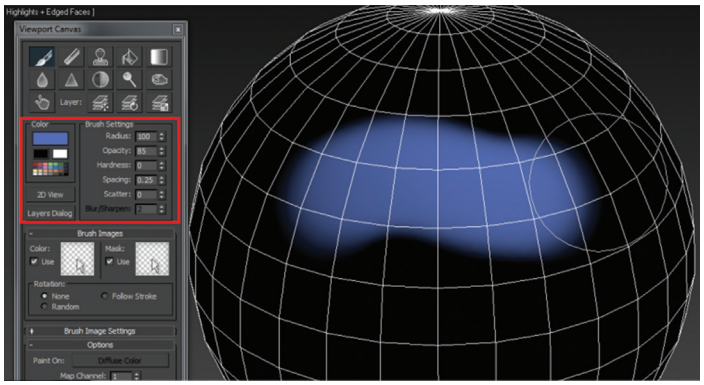


Figure 10: A painted object

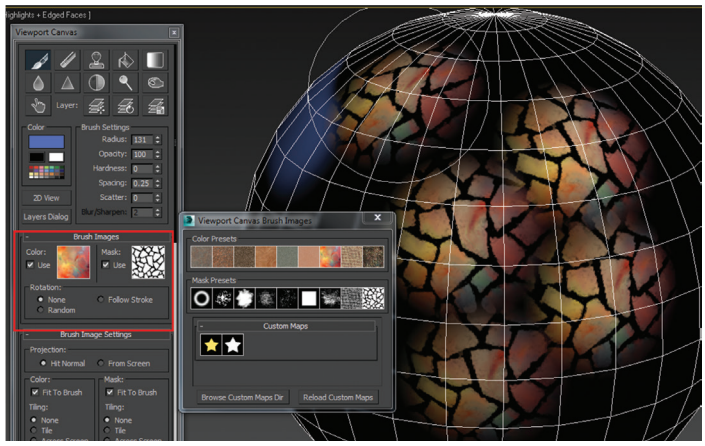
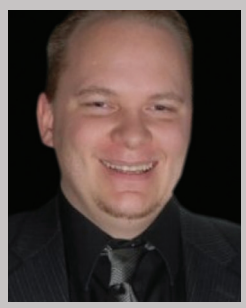


Figure 11: The Brush Image option

In addition, we have the ability to open a 2D view of our texture and paint directly on that if we prefer rather than painting on the 3D object itself. As you can see in Figure 9, we have the ability to control several options concerning our brush strokes. Figure 10 shows an example of an object being painted using the various settings.

The next set of tools is a favorite. The Brush Image options allow us to brush using templates for our shapes and colors. See Figure 11 for an example.

With the canvas tools you can create exciting, personalized custom and unique textures, whether starting with a new one or modifying one that exists. Many more options are available in the canvas tools and I hope you explore them and take advantage of everything they have to offer. You are welcome to download the chair and pillow scenes demonstrated in this tutorial for free at http://www.pro-cad.net/freemaxmodels.html



Brian Chapman is a veteran Autodesk-zealot, creator of pro-cad.net, and Senior Designer for Slater Hanifan Group, a civil engineering and planning firm dedicated to superior client service. Brian can be reached at procadman@pro-cad.net.

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Aconex is an online collaboration platform for construction, infrastructure, energy, and resources projects. This online collaboration platform is used on about $225 billion worth of projects all over the world.

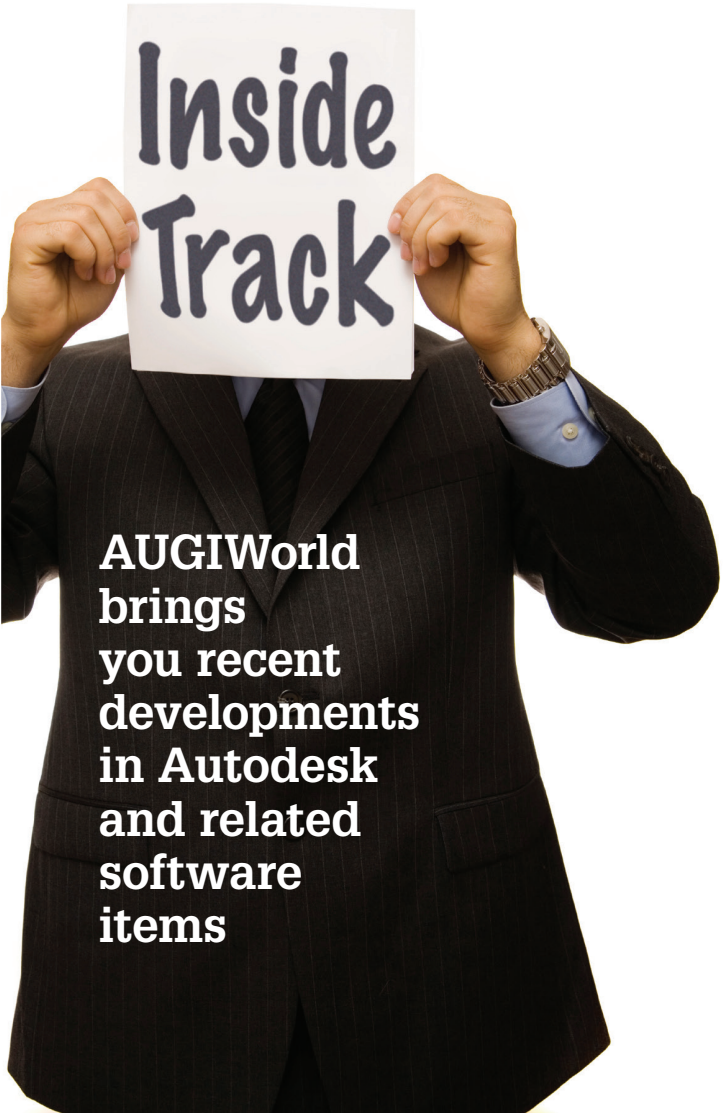
By getting everyone on the project to manage their information in the same system, more information is captured and a company can stay in control of what's going on. For an individual such as a document controller or project manager, Aconex can make life a lot easier as it finds information fast and automates repetitive tasks.

Aconex isn't really software; it's delivered over the Internet with a password, a bit like online banking. That makes it easy to use and fast to get started.

There are many parts that make up this process including the following:

- Aconex – the main collaboration application
- Local Copy
- Project Archive
- Aconex for Mobile
- Aconex Field
- Aconex for Outlook
- Aconex Handover
- The Aconex API
- BidContender

You can find out more at Aconex.com, twitter.com/Aconex, and facebook.com/Aconex.



http://bit.ly/1MbLgFH

3D Model-Inspector is a scalable Autodesk® Inventor® tool that makes it easier and faster to check the model and structure:

- Check if all sketches are fully constrained
- Check for elements behind the End-Of-Part-Marker in the Browser
- Check of filled iProperties in parts, assemblies and drawings; optional comparison with default data
- Check of first part fixed in assembly
- Check for inconsistent or redundant assembly constraints

3D Model-Inspector is available in several versions:

- A freeware Basic App (integrated Inventor add-in with limited functionality) for checking the current Inventor model, using simple Check Configurations including a handful of representative Check Options.
- A scalable add-in (integrated Inventor add-in with extended functionality), designed for quick and comprehensive check of the current Inventor model with optional check of all associated substructures.
- A standalone version (for Inventor "remote control"), designed for comfortable and automatic check of multiple files or entire project folders.

If you have some news to share with us for future issues, please let us know. Likewise, if you are a user of a featured product or news item and would like to write a review, we want to know. brian.andresen@augi.com

by: Mark Kiker

Proliferating Change

In previous articles, we discussed how to garner and coalesce great ideas as Step One – Generating Ideas. Then we defined a plan to test the idea in a measured way. Step Two – Proof of Concept. After that we press it into the real world in a small Step Three – Pilot. Now we move to Step Four—the embrace and extend period—Proliferation. The Push!

STEP FOUR – PROLIFERATION

After you have successfully gone through the first three steps you may start thinking that your job is done. You have proven that the idea is great, worked out the kinks, and just need to throw out the product and watch people gobble it up. That may not be the case. In fact, I have found that most times the final phase is the toughest… getting people to change the way they work and embrace the new. Having been down this road many times, I have seen a two-pronged process works well. It is a combination of pushing and pulling.

PUSH, PUSH, PUSH

You can start the proliferation of tools or ideas by defining a plan to push out the change. This portion of the proliferation is a push because you are pushing a change onto people. This is the typical place to start. You select a process and location for the push to start and you roll out the software or modification to workflow to a larger swatch of staffers. It might be an overnight automatic update, or a one-by-one install. It does not matter how it is done, as long as it is managed well.

Managing change means that you pay attention to the people involved and help them embrace the new. It does not stop at the install—it moves into workflow, project schedules, and more. Timing is often critical to success. Find a time when you will NOT impact projects or production. It may be a time between projects, after a major milestone, before a large design effort starts, or other gaps. You may be able to roll out to the entire organization, or divide it into smaller parts and move based on department schedules or staff downtime.

DON'T FORGET

Don't forget the training portion of the effort. You can train prior to the push or even during it. Some have pulled staff off the floor and into a one-hour training session while IT installed the upgrade. Then when staff went back, the new software was in place. Others have installed software next to the existing and let staff move when they wanted. Don't forget the entire team. If you are working with teams or project groups, move the entire team at once. Don't forget outsiders. If there are consultants using your files, inform them of the change if it will impact them.

PULL, PULL, PULL

The other side of the push is the pull. Pulling means that you may wait until staff is asking for the upgrade/change. You do not push the change on them, you wait for them to pull. Some tools and processes are optional. Staff can use them if they want, but at the time they are provided, it is optional to use them. These are prime for a Pull process. Even when tools are required, you can still use the Pull method of deployment.

Optional tools will expand within the firm based on users encouraging their use. Some of these may include online chat tools, messaging options, add-on utilities, and more. They enhance

the work process, but are not required for production. They can be used or not. You may think they are great additions to the tool belt, but others may not want to modify their workflow. These will expand organically when staff pulls them into their work efforts.

Required tools can still have a Pull method of deployment used. You can let early adopters gain some momentum by having them ask for the tool when they hear it is available. This generates a little "me too" kind of pull as others think they are being left out. Second-level adopters can then demonstrate that the tool goes beyond the "super user" level staff and should be used by everyone.

Another Pull method is to roll it out to a project team. It is like a Pilot Plus. This new team can sing the praises of the new methods (hopefully) and others will want to use it on their project. When project teams reform and team members are scattered, they take the expertise with them into the next project and "pull" others along.

Whether push or pull, the propagation of your next enhancement, upgrade, new tool, or change in process can benefit from a well-managed understanding that the tool needs to be escorted into your workflow and not just tossed over the wall.

TYING IT ALL TOGETHER

Through it all, you should be painting a word picture of what the future looks like after the embrace has been completed. Don't just let the message languish and the successes go unnoticed. Don't let the troubles fester and derail your efforts. Open, honest communication surrounding what works and what does not will help you make progress.

Having a few milestones that have been defined might help. When you pass them, celebrate. Having some defined quantities of staff trained, tools installed, projects completed, etc. and sharing with the firm when they have been achieved will remind others that they change is good.

Obviously, much more planning and task definition goes along with a proper rollout of new software, upgrades or process change. This is the tip of the iceberg in making a challenging effort easier on all parties. But taking the four main steps: Ideation, Proof of Concept, Pilot, and Proliferation and expanding on them can assist.

Mark Kiker has more than 25 years of hands-on experience with technology. He is fully versed in every area of management from deployment planning, installation, and configuration to training and strategic planning. As an internationally known speaker and writer, he is a returning speaker at Autodesk University since 1996. Mark is currently serving as Director of IT for SIATech, a non-profit public charter high school focused on dropout recovery. He maintains two blog sites, www.caddmanager.com and www.bimmanager.com.

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