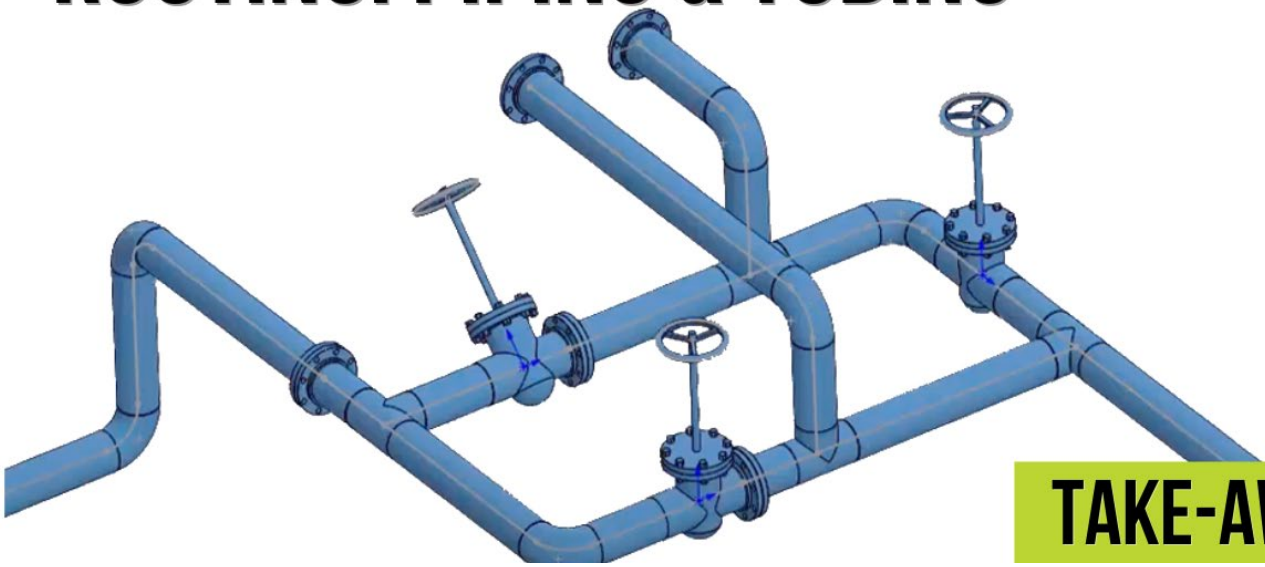
goengineer

SOLIDWORKS

ROUTING: PIPING & TUBING



TAKE-AWAY

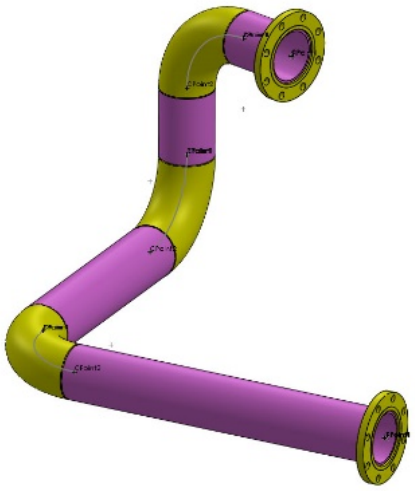
Lessons

Disclaimer: This document is a comprehensive summary of critical key takeaways from lessons within SOLIDWORKS Routing: Piping & Tubing offered by GoEngineer. This document should not be considered a substitute for an official SOLIDWORKS training course.

LESSON 1: FUNDAMENTALS OF ROUTING

Types of Routes

Piping
Tubing
Cable and wires (Electrical class)
Conduit (Electrical class)
Electrical ducting
Cable trays
HVAC



SOLIDWORKS Routing uses a 3D route sketch to create a path of pipes, tubes, or electrical cables between starting components like flanges or connectors. The subassembly uses folders to collect common routing parts as well as route-specific pipes and tubes.

Routes

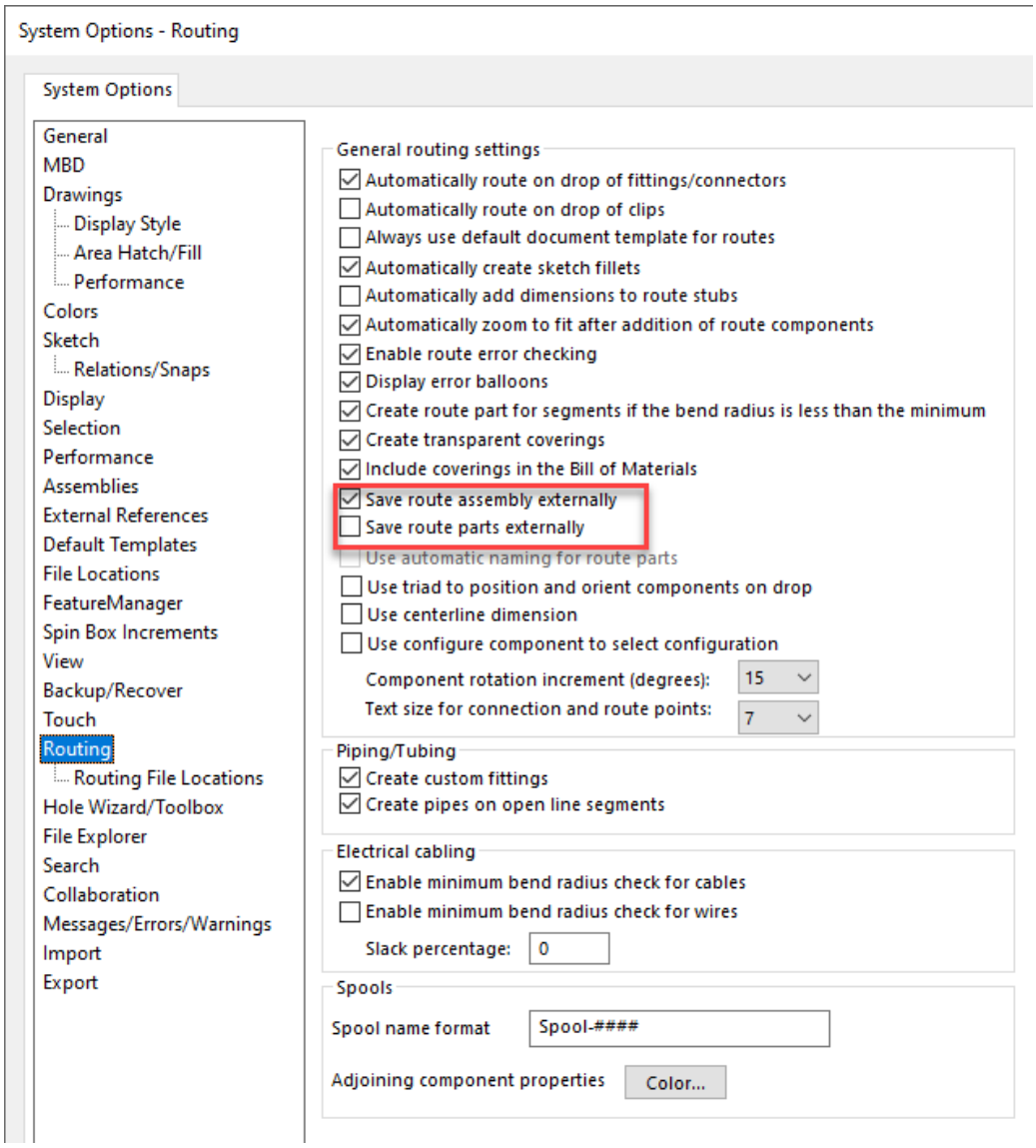
The Route assemblies folders contain the following components:

- **Route parts** – individual parts for lengths of pipe, cables, or other assembly specific parts
- **Route sketch** – a 3D sketch that defines the centerline of the path
- **Route components** – library of components like flanges, elbows, connectors, valves, and tees

External components are parts that the routes connect to from the assembly. The 3D sketch is created in context of the main assembly for easy updates.

External vs. Internal

We have options to make the route sub-assembly and route-specific components external or internal to the assembly.



Personal preference for this setting could be based on the number of individual pipe files that might be created for a route, but it also has data management implications as well. Renaming virtual components may be easier than external files, but you can always save externally later or convert to a virtual component (internal) when needed.

Component Library

Many say that the power of SOLIDWORKS Routing comes from the files in your component library. SOLIDWORKS comes with a small library of components, but it does not contain all of the files that will be required. They will be great examples of how to set up additional components.

The default library contains several different categories of components:

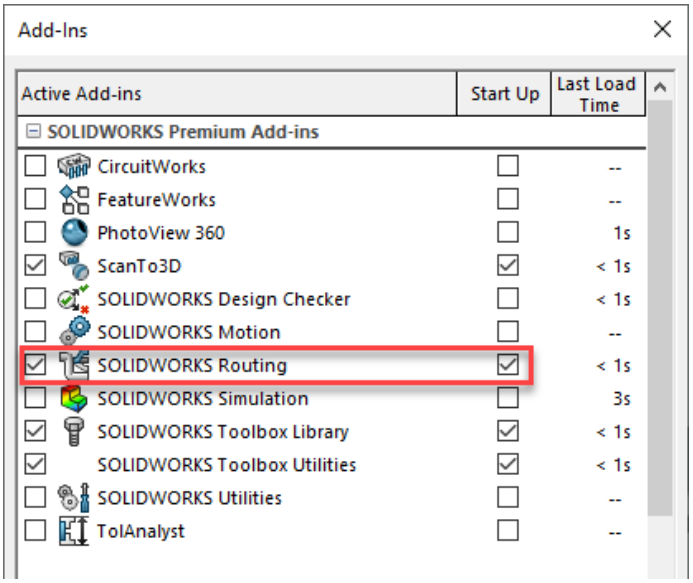
- Connectors
- Clips
- Electrical Conduit
- Flanges

- Tubes/ Pipes/ Cables
- Electrical Ducting/ Cable Trays/ HVAC
- Elbows
- Fittings (crosses, tees, reducers, valves, etc)
- Assembly Fittings (same as regular fittings but made up of assemblies instead of parts)
- Equipment (tanks, pumps, nozzles) – examples of external components for the assembly

Routing Setup

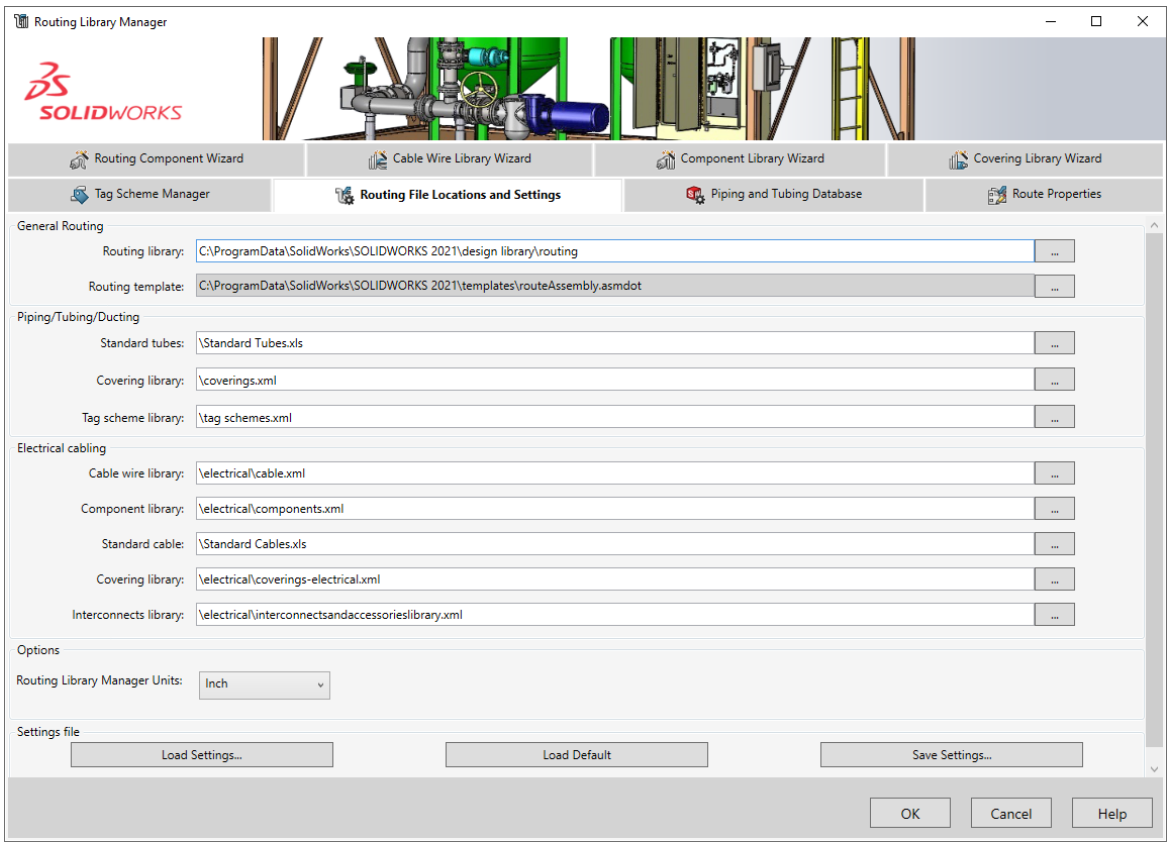
There are many different options for SOLIDWORKS Routing but before getting started we must turn it on first. Routing is included with SOLIDWORKS Premium as an add-in. To turn the add-in on, go to Tools > Add-ins.

Checking the box on the left will turn Routing on in the current SOLIDWORKS session; the one on the right will add it for every session.

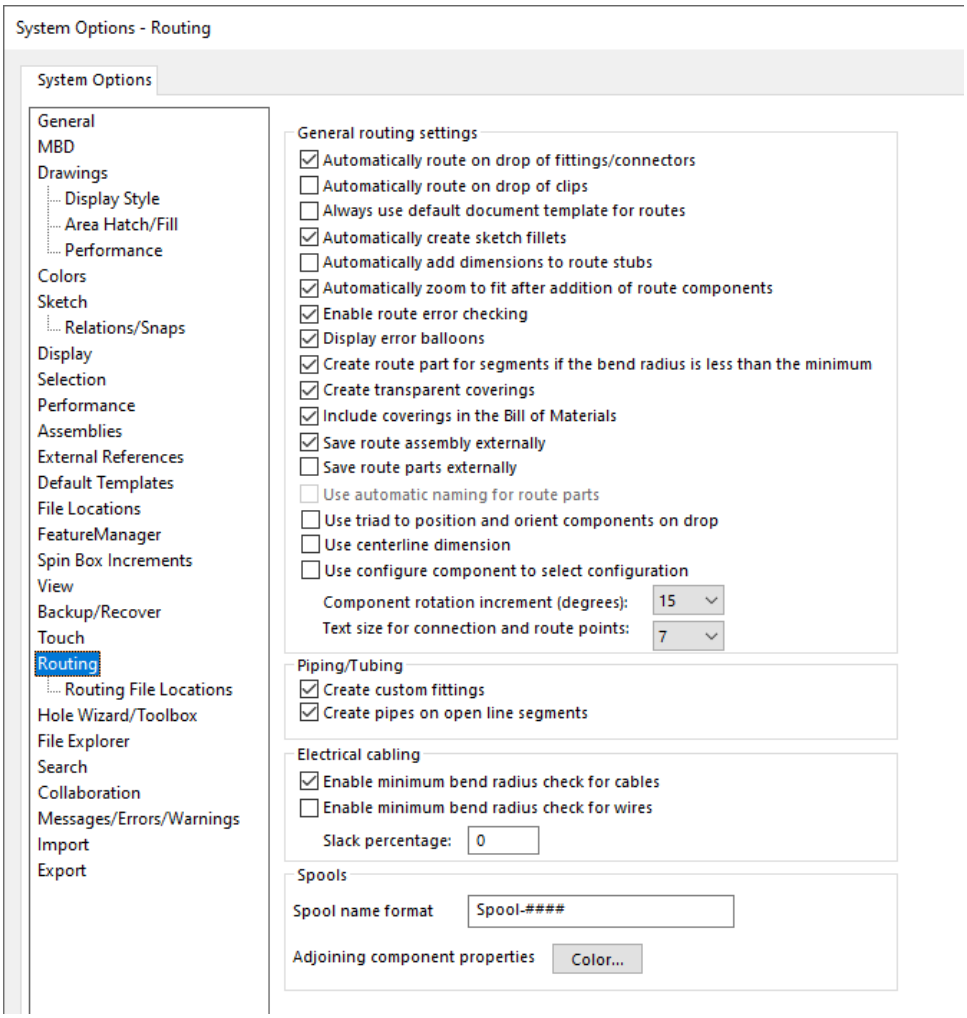


Routing Library Manager

Additional Routing settings can be found in the Routing Library Manager. The Routing Library Manager can be found as a separate application in the Start > All Programs > SOLIDWORKS > SOLIDWORKS Tools folder or in the Tools > Routing > Routing Tools menu inside SOLIDWORKS.



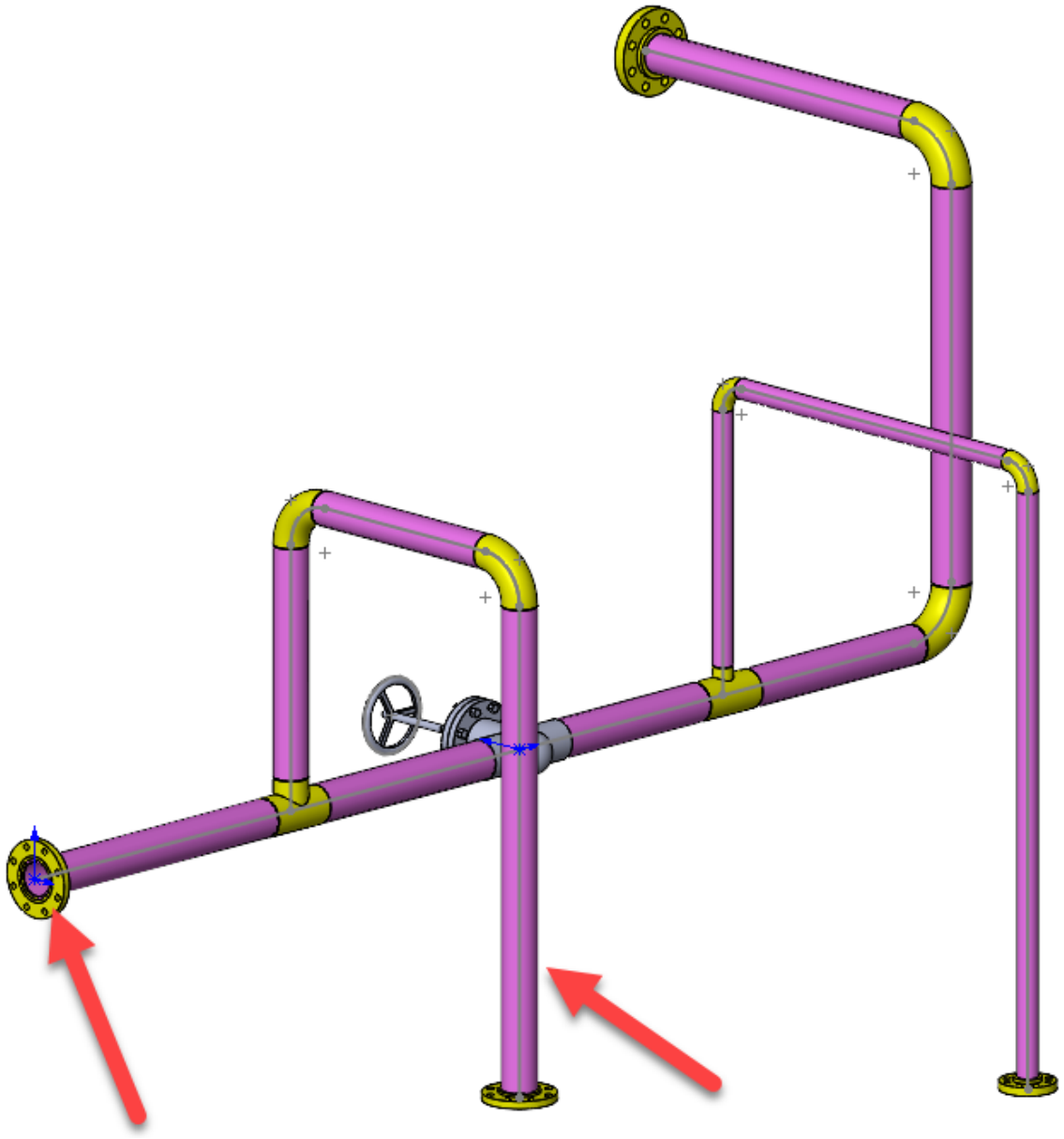
Additional options can be found back where we saw the options for internal versus external options.



Options like “Automatically route on drop of fittings/connectors” and “Automatically create sketch fillets” are some of my favorite default options. The Routing File Locations area has a link to start the Routing Library Manager mentioned above.

LESSON 2: PIPING ROUTES

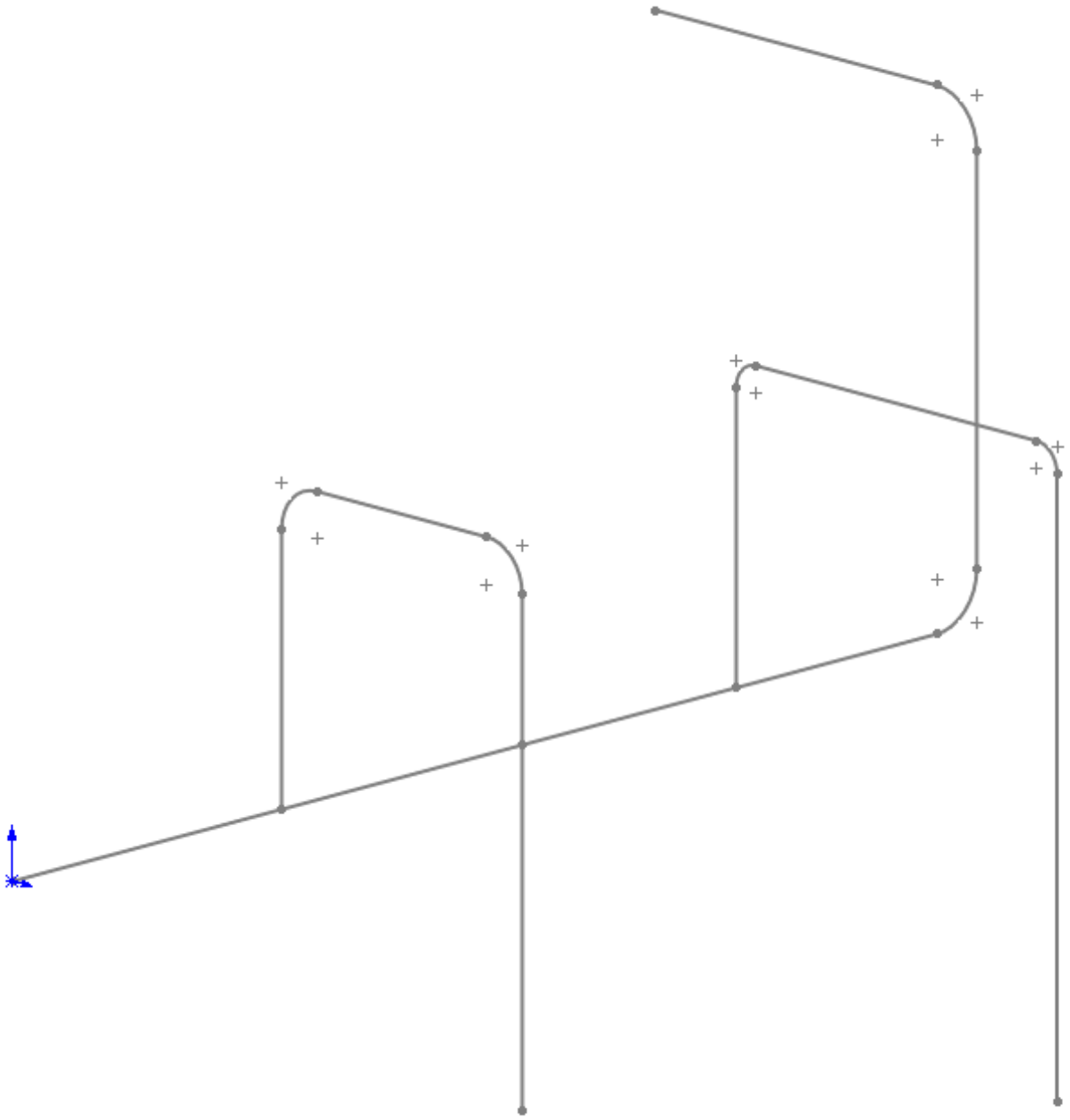
Typical Piping Route



Components

Route Parts

Route Sketch

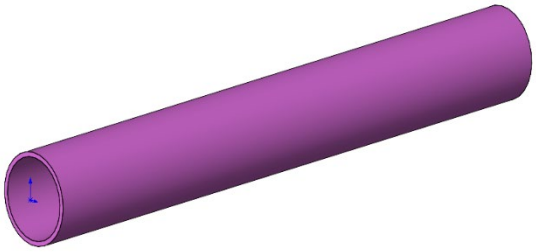


Pipes and Piping Components

Routing components use Connection Points (CPoints) and Routing Points (RPoints) to tell SOLIDWORKS how to treat these components (see Lesson 6 for more info). Mate References are also very handy for snapping the components into place as we drag and drop them into the route.

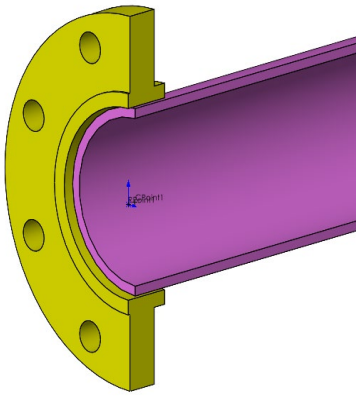
Pipes

Placed on the lines in the route and cut to length by the other components. It is created with a simple extrude feature.



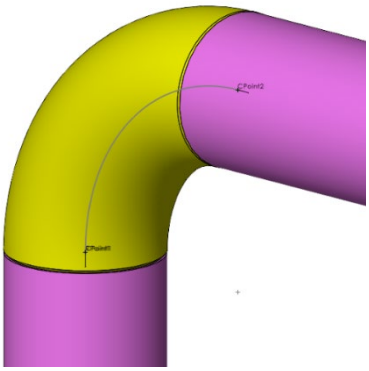
Flanges

Placed on the lines in the route and cut to length by the other components. It is created with a simple extrude feature.



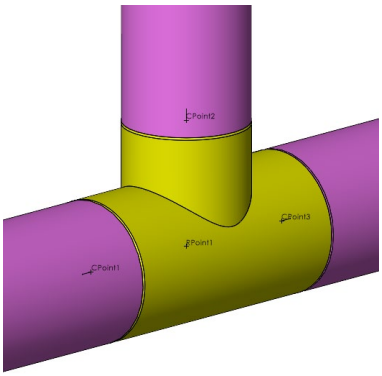
Elbows

An inline component that is placed over sketch fillets. Is most commonly 90 degrees, but can also be 45 degrees or even custom angles. Elbows contain 2 CPoints and 1 RPoint. The elbow cuts the pipe at the CPoint locations.



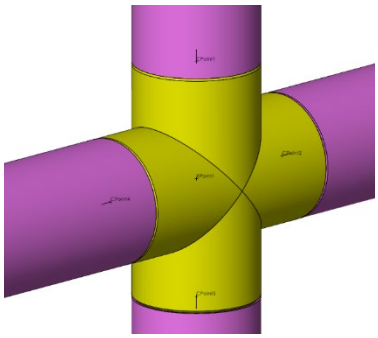
Tees

Placed where three lines share a common endpoint, a tee can have the same diameter or can be a reducing tee. Tees contain 3 CPoints and 1 RPoint. The tee cuts the pipe at the CPoint location.



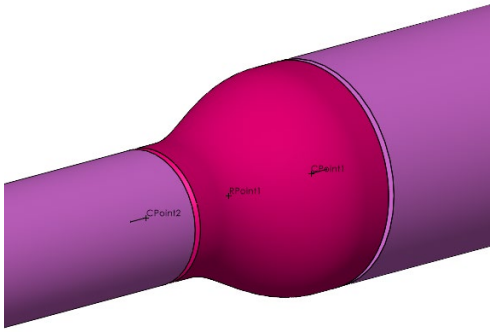
Crosses

Crosses are very similar to a tee, but with 4 outlets. Crosses contain 4 CPoints and 1 RPoint and could also include reducing outlet(s).



Reducers

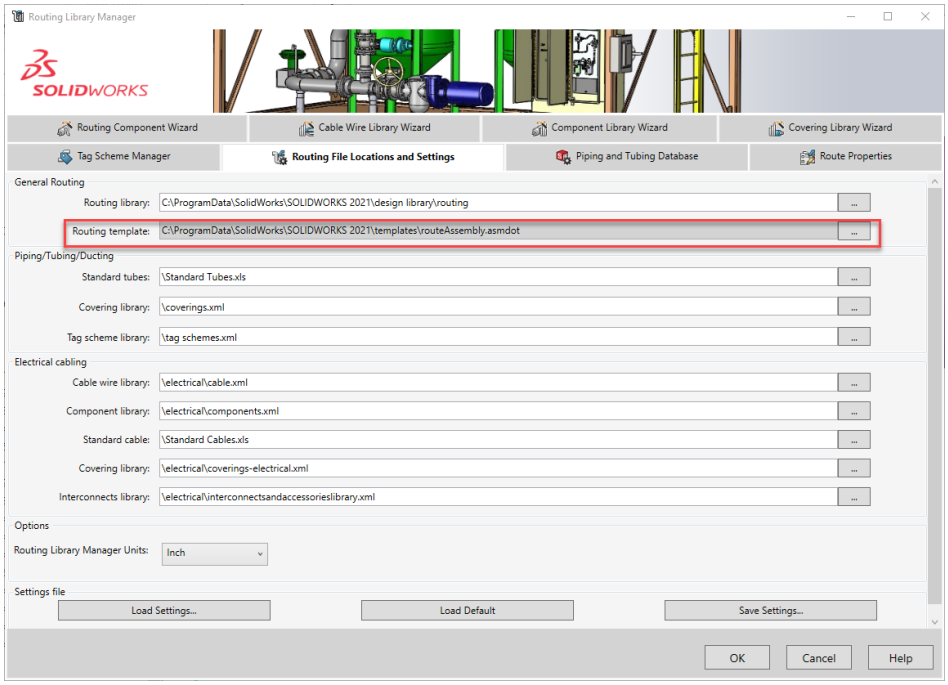
Placed on the lines in the route and cut to length by the other components. It is created with a simple extrude feature.



We don't have to have to memorize how many CPoints and Rpoints each component needs because the Routing Component Wizard (see Lesson 6) will walk us through all of the different Routing features that each category of component needs.

Routing Assembly Templates

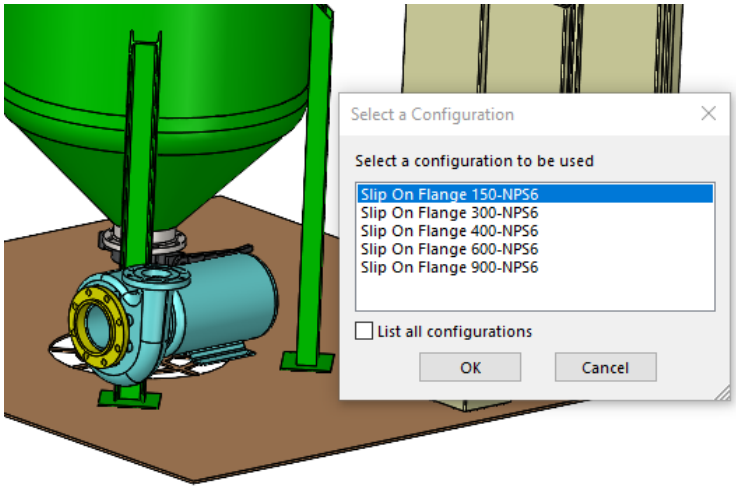
They are very similar to regular part and assembly templates (unfortunately not exactly interchangeable) and contain options for drafting standard, font, and units. They can be defined in the Routing file Locations and Settings tab in the Routing Library Manager.



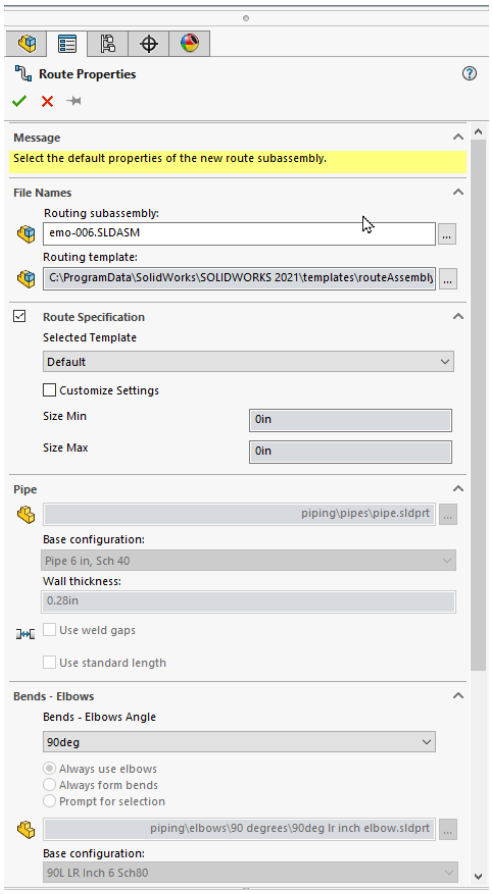
Creating a Piping Route

When we have the option turned on to automatically start a route on drop of fittings/connectors, several things will happen:

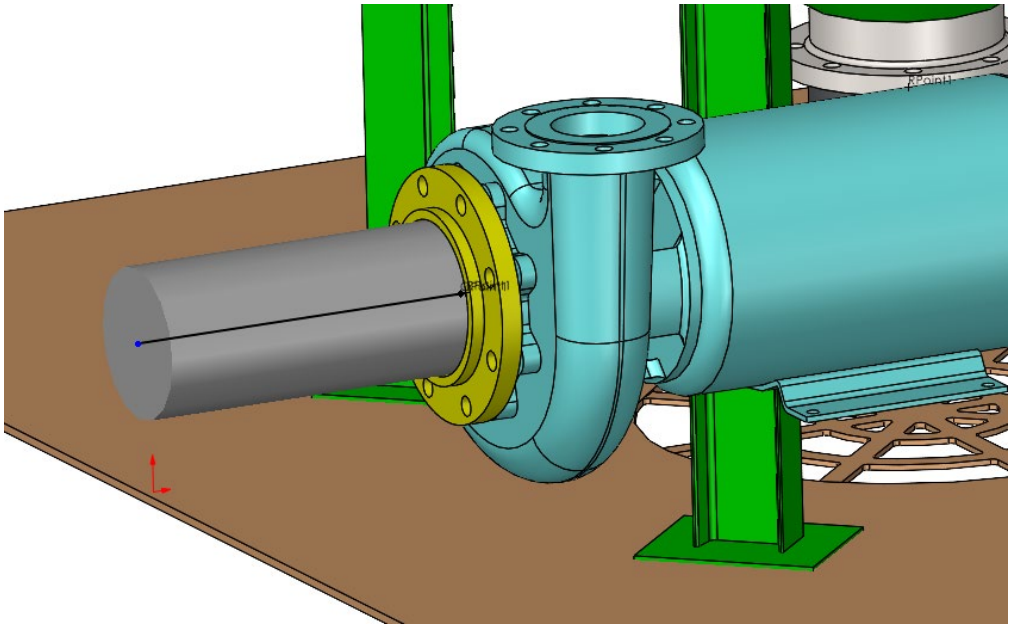
- Choose a configuration of the flange to use.



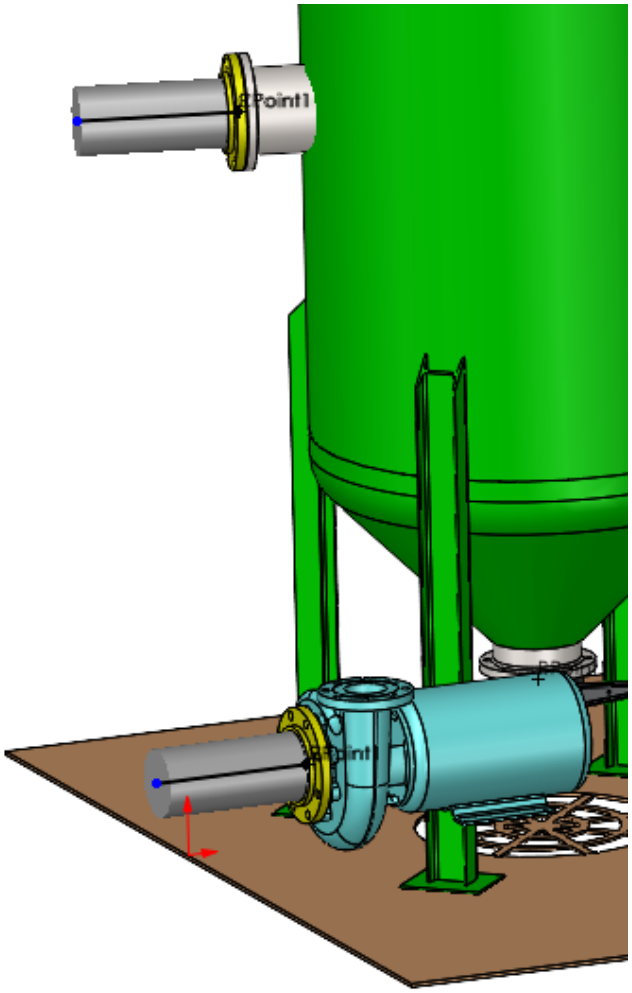
- Select the different Route Properties that you need.



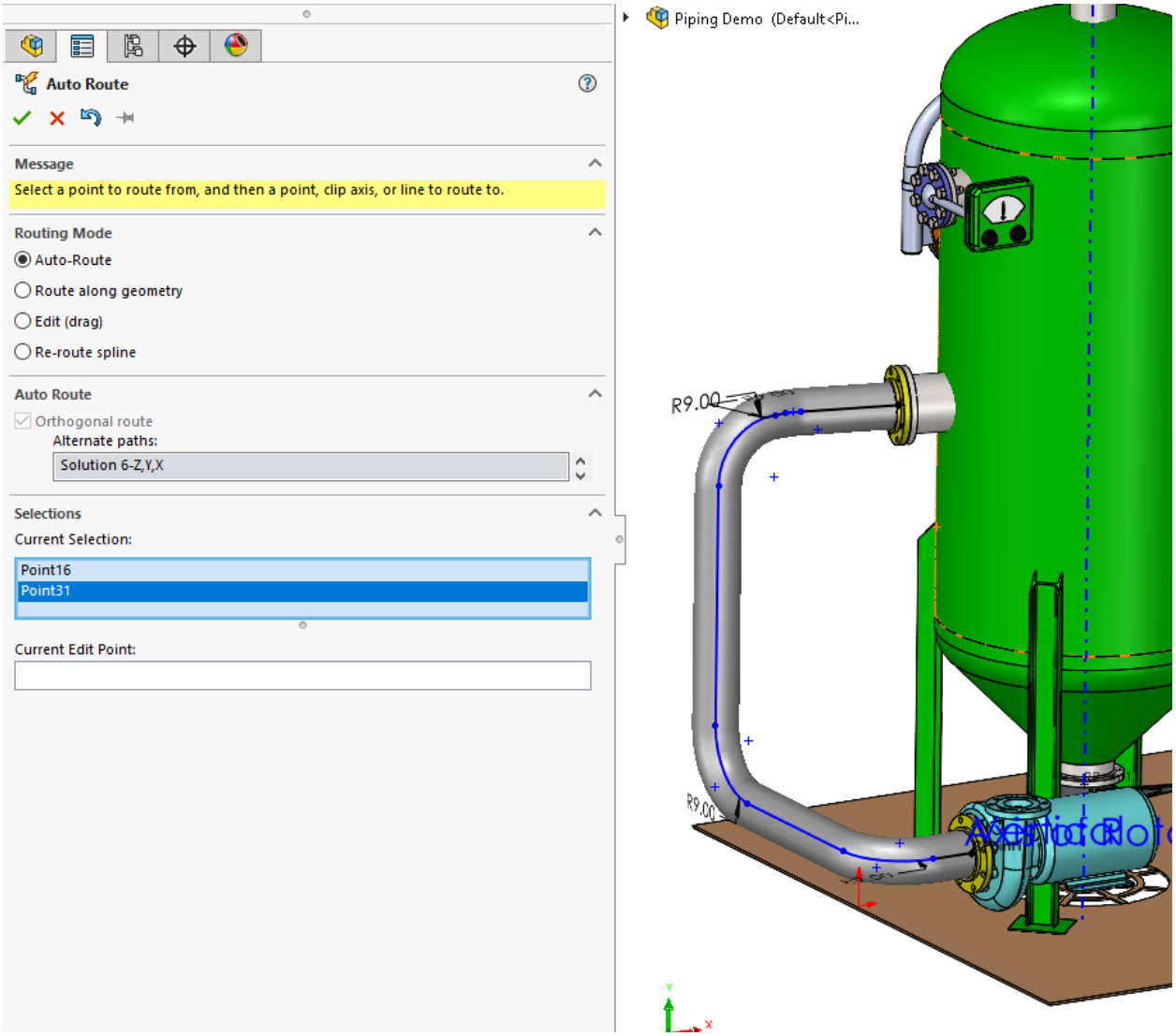
- A 3D sketch will be created and a stub length of pipe will be added.



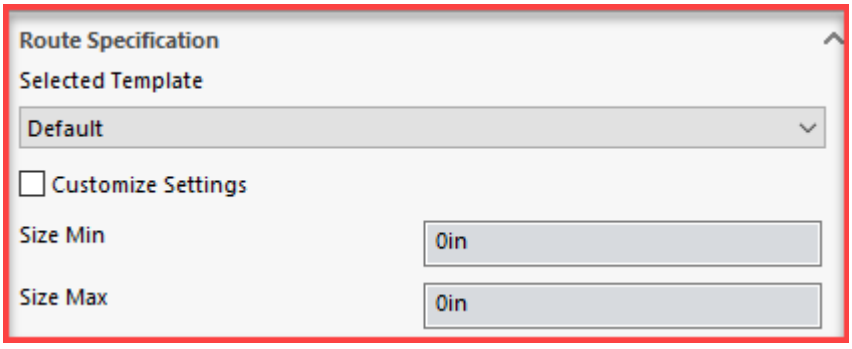
- Continue adding a flange(s) to the other end of the route.



- Manually complete the 3D sketch or use the Auto Route tool to find suggested solutions for the connecting pipes.



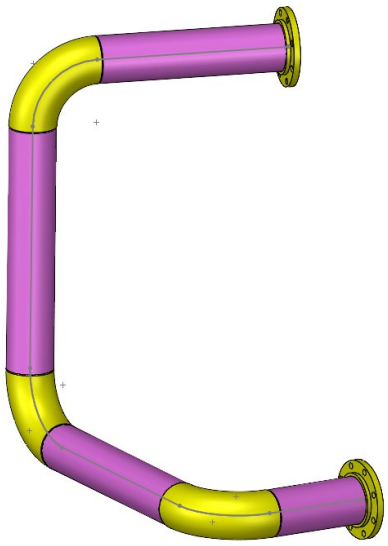
Using Route Specification Templates



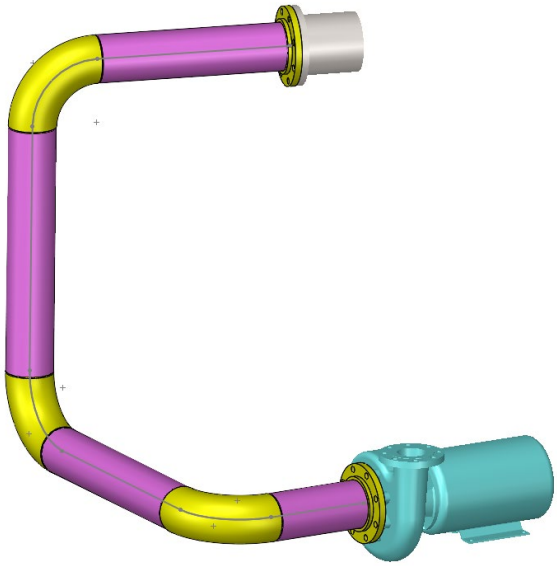
In the Route Properties options at the beginning of the route, we can specify which pipes and elbows we need to use to match our particular requirements. This could include options like what pipe schedule we want to use or which elbow option options we might want to use.

Isolate Options

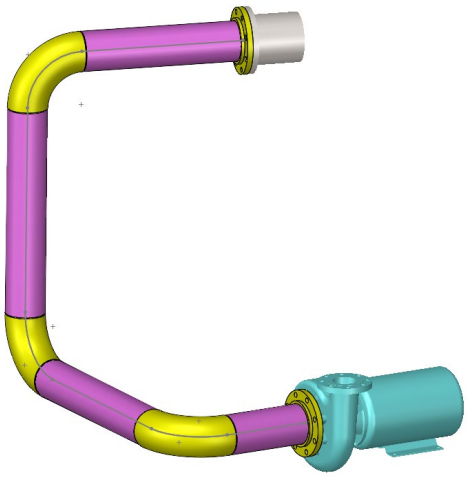
In regular assemblies, we can pick which component or components that we want to temporarily concentrate on in the assembly by hiding (or changing the display style of) the rest of the components. If we right-click on the components that we want to Isolate in a Routing assembly, we have a few more options:



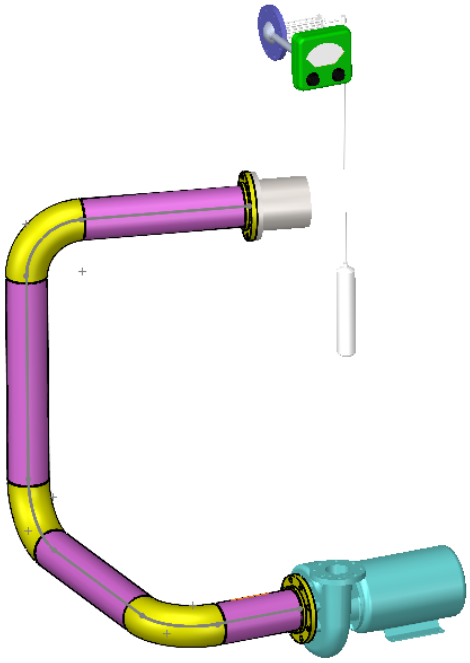
Route only



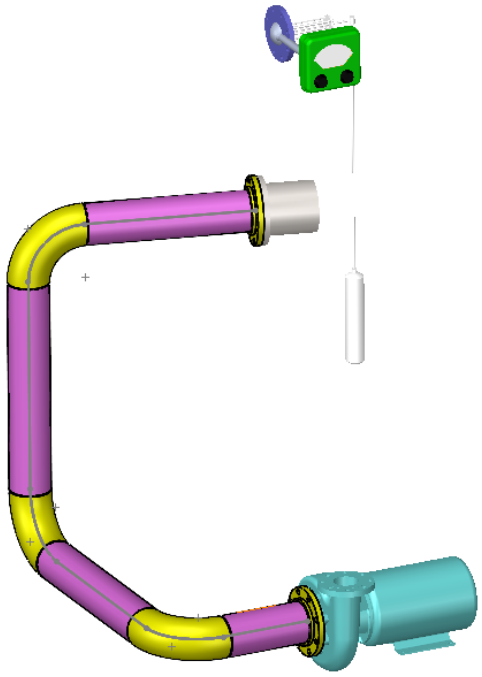
Route and Direct References



Route and Secondary References (the same as above in this case)



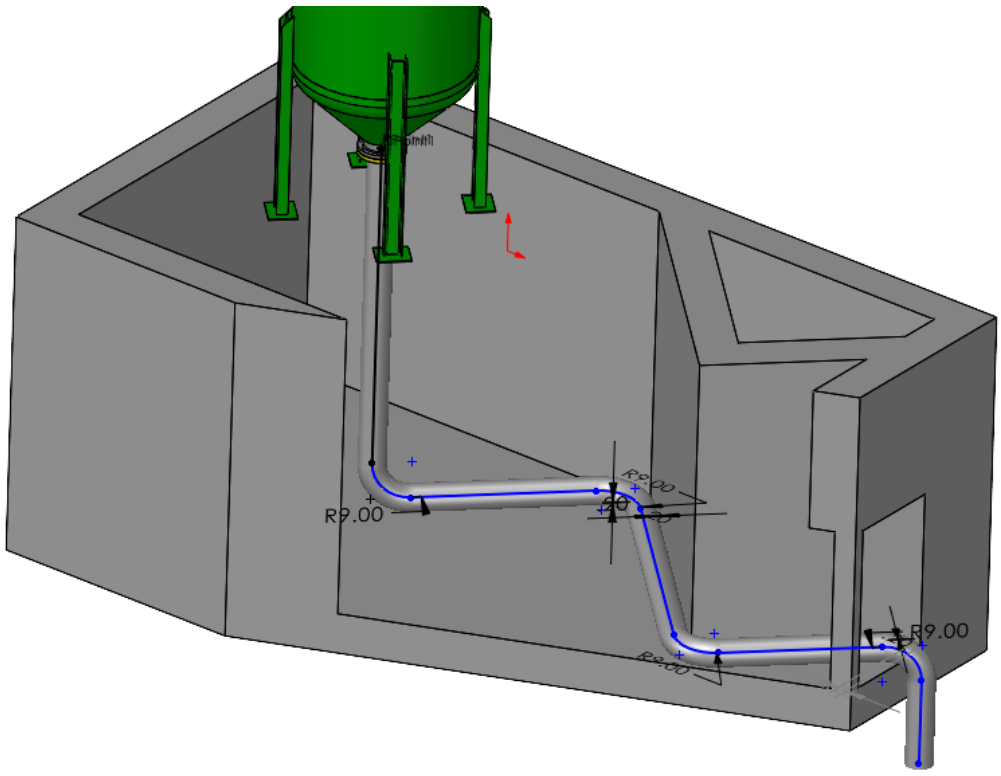
Route Bounding Box



Route Segments Bounding Box

Route Along Existing Geometry

The is an option in the Auto Route tool where you can select on a face in the assembly and have the route use an offset (possibly for the bend radius to clear) to extrude up to. Additional faces may be selected to extrude up to (offset) to continue the route.



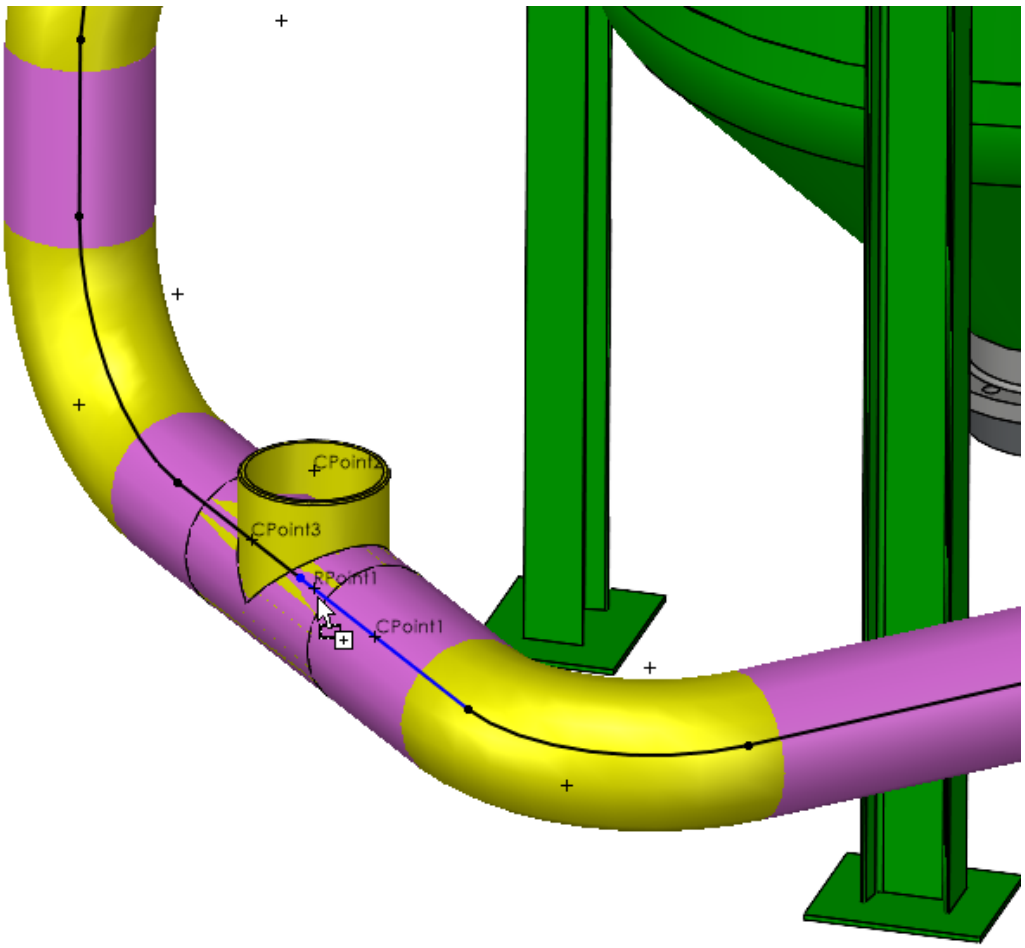
LESSON 3: PIPING FITTINGS

Piping Fittings

While editing a route, we have the ability to drag and drop a fitting into the middle of a route. The route can be split manually, but dropping the fitting (e.g., tees, crosses, reducers, and valves) onto the 3D sketch line will automatically split the route in the position where the fitting is dropped. The fitting will be dropped in the default orientation, but in cases like a tee, you can hit the **Tab** key to flip the fitting 90 degrees.

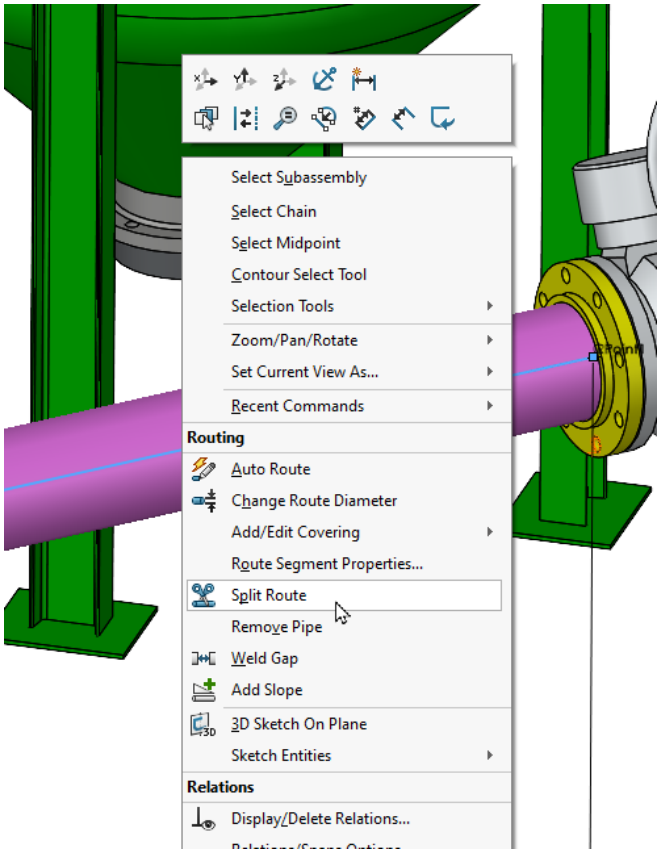
You can use the **Shift+Arrow** keys to rotate the component along the Axis of Rotation.

You can use the **Triad** to rotate or move the component to a desired location and orientation.



Split Route

If we want to split the 3D sketch line before we drag and drop the fitting (or maybe for more control), then we can right-click on the sketch line and use the **Split Route** option.



Other Options for Defining 3D Sketch and Components

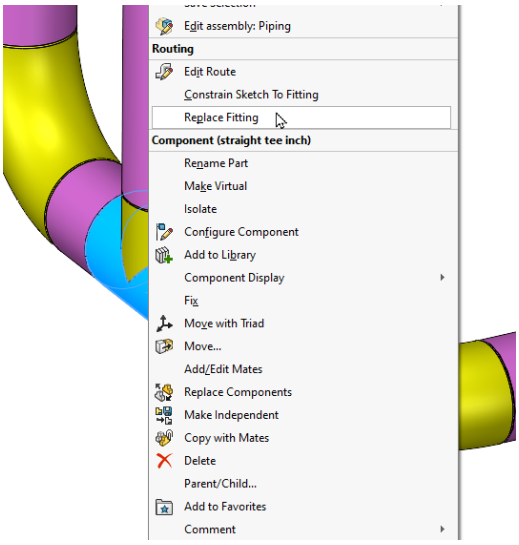
- Dimensioning 3D sketch by dimensioning to flat face or plane for a perpendicular distance.
- Use **Move Fitting with Triad** to change the orientation of a fitting after it is placed.
- **Remove Tube/Pipe** can be used to remove the pipe or tube so that elbows or other fittings can contact each other directly (where appropriate).
- Use **Shift+Arrow Keys** to rotate a component with a specific angle (defined in Tools > Options > System Options > Routing settings area).

Creating Custom Fitting

We will go over the steps to use the Routing Component Wizard in Lesson 6, but if we have an existing component that is already set up in our library, we could Save As a copy and modify the existing component instead of starting from scratch.

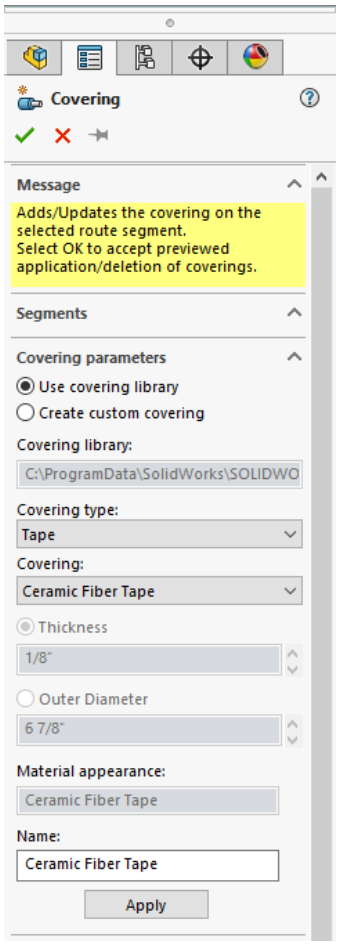
Replacing Piping Fitting

If we need to swap out an existing fitting, we can use the **Replace Fitting** tool to browse and replace the component.



Coverings

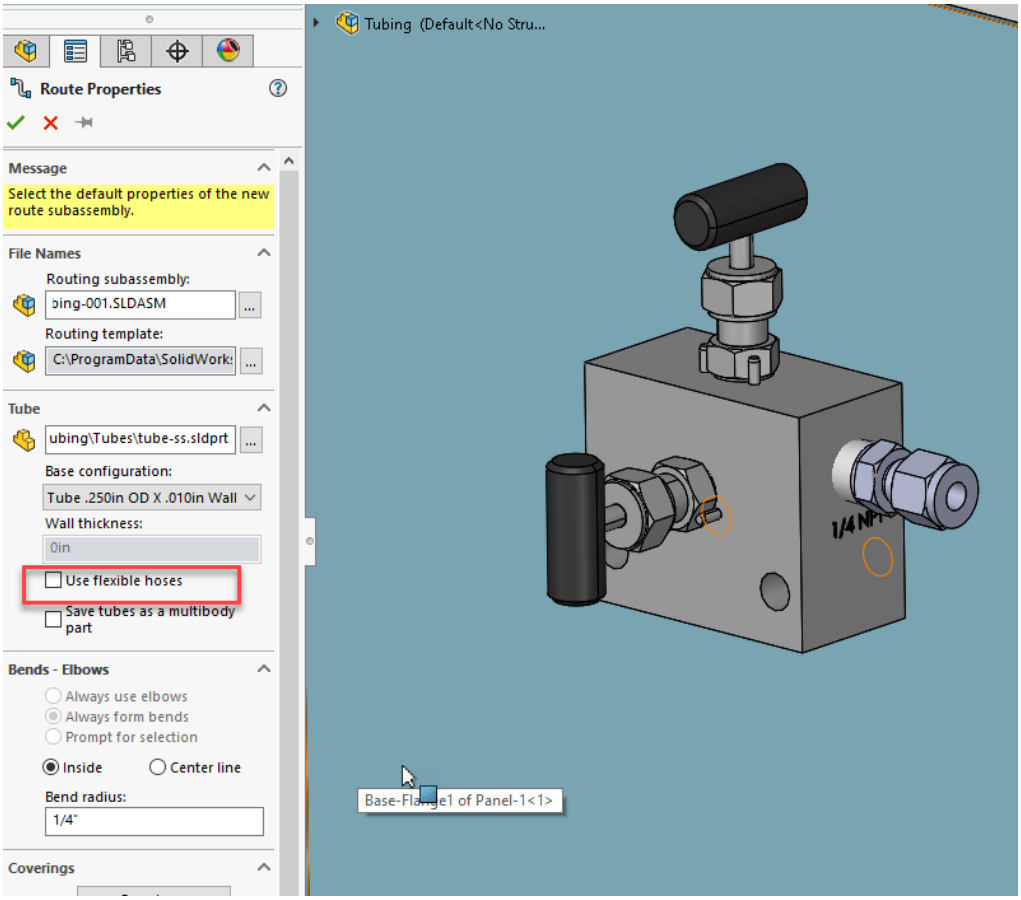
If we need a covering over a route (for example, insulation), we can use the options in the Route Properties to pick which covering we want to use.



LESSON 4: TUBING ROUTES

Tubing Routes

Tubing routes are very similar to pipe routes, except we have a few more options/differences. Tube routes have the option to be either rigid or flexible:



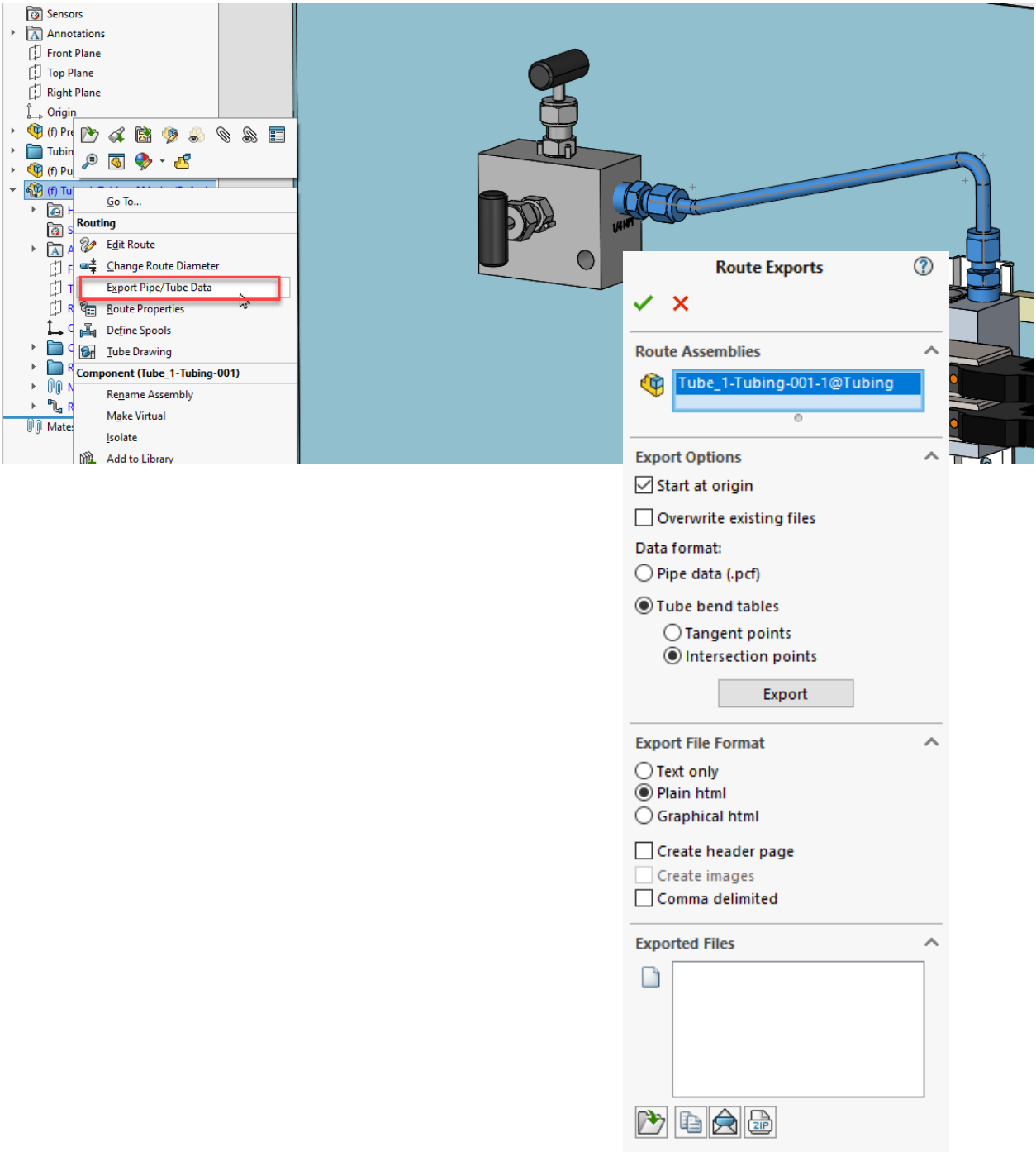
Because of this option, the default tube part does not use an extrude feature like a piping route, but it will use 3D splines and a sweep to create the tubes.

Bend and Spline Errors

Fully defining 3D sketches of regular piping routes can be difficult at times, but for a tubing route....throw in the added difficulty of dealing with splines and minimum bend radius options. Areas, where the bend radius is too small, will be identified with red highlighting. The bend radius should be larger than the diameter of the tube.

Export Pipe/Tube Data

Some automated tube and pipe benders have the ability to import detailed information from a tube route that we can use for fabrication. If you right-click on the route subassembly, you have the option to **Export Pipe/Tube Data** to a text, PCF, or HTML file.



Start Route and Add to Route

So far, we have started a route by dragging and dropping a starting component into the assembly. We have options to use existing components (as long as they have the required CPoints) to **Start Route.**

The **Add to Route** tool can also be used to continue an existing route.

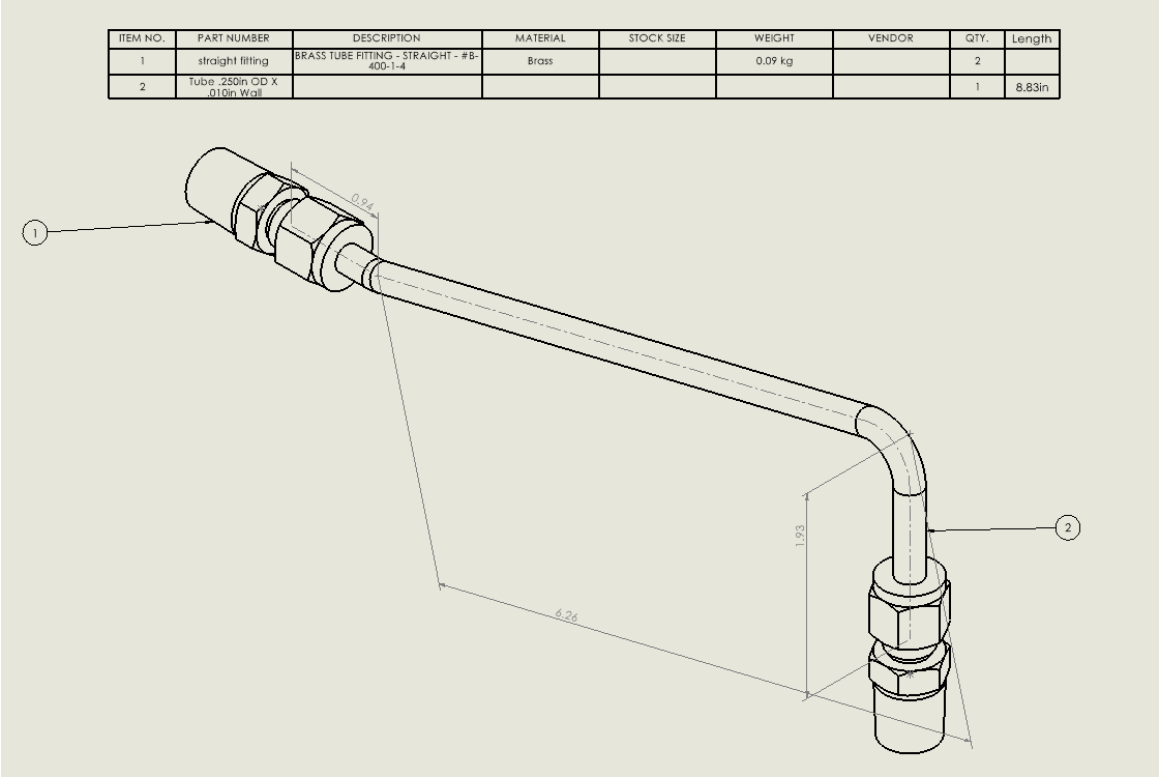
Routing Tubes Through Clips

The use of clips can help control 3D sketch splines. Clips contain a **Mate Reference** to assist in adding the clips to the assembly, but they also should have a **Clip Axis** which is a straight section where the tube will be routed.

Clips can be added to the assembly before starting the route or during the creation of the route. Some consideration should be given to where you want the clips to be added to the BOM since the clips added during the creation of the tubing route will actually get added to the subassembly itself.

Tubing Drawings

There are automated tools to create a tube drawing that will allow you to select the drawing template, sheet format, BOM template and control adding of auto balloons, and showing the route sketch. The tube length can be added to the BOM as well.

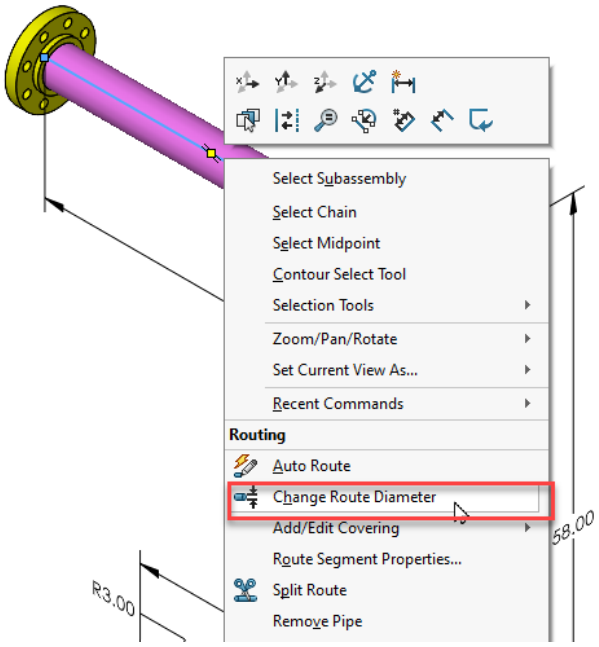


ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	STOCK SIZE	WEIGHT	VENDOR	QTY.	Length
1	straight fitting	BRASS TUBE FITTING - STRAIGHT - #B-400-1-4	Brass		0.09 kg		2	
2	Tube .250in OD X .010in Wall						1	8.83in

LESSON 5: PIPING & TUBING CHANGES

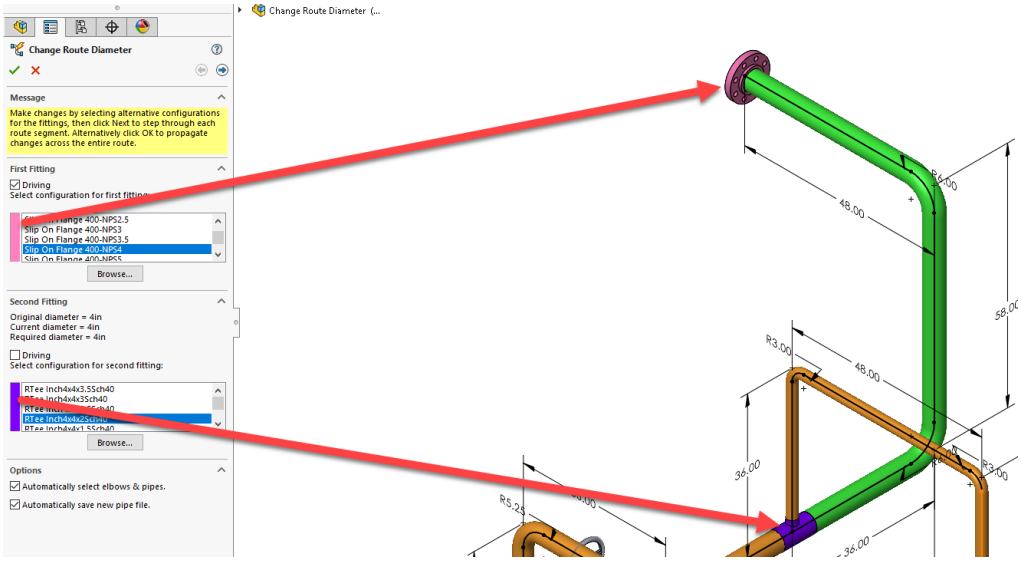
Change Route Diameter

Design changes happen all of the time. When it comes to routes, changing the diameter of a route is fairly common. The problem, however, is the amount of ramifications through the rest of the route.



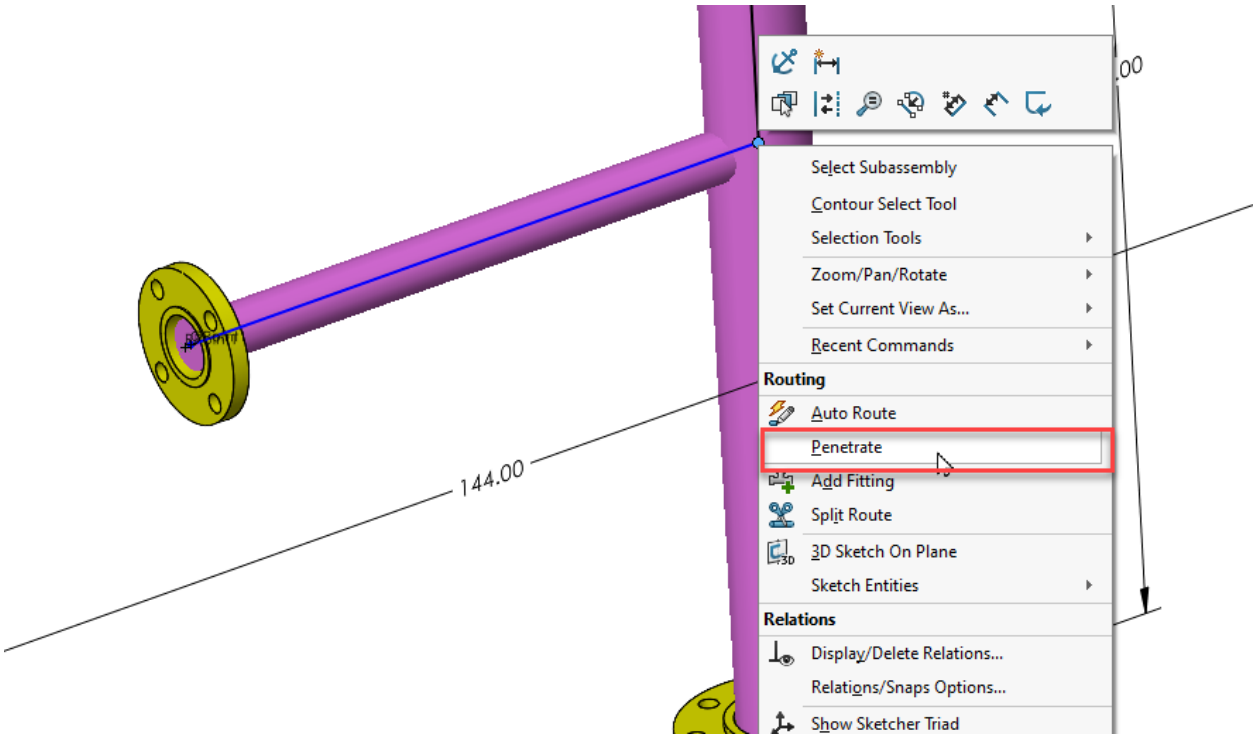
This tool will try to guide us step by step through the route with color-coded tips.

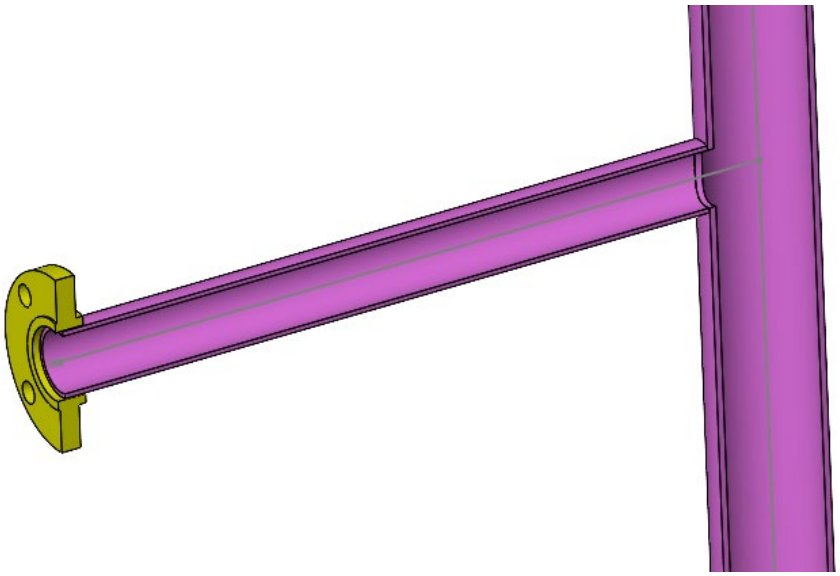
Just keep hitting the Next arrow to proceed through the route.



Pipe Penetration

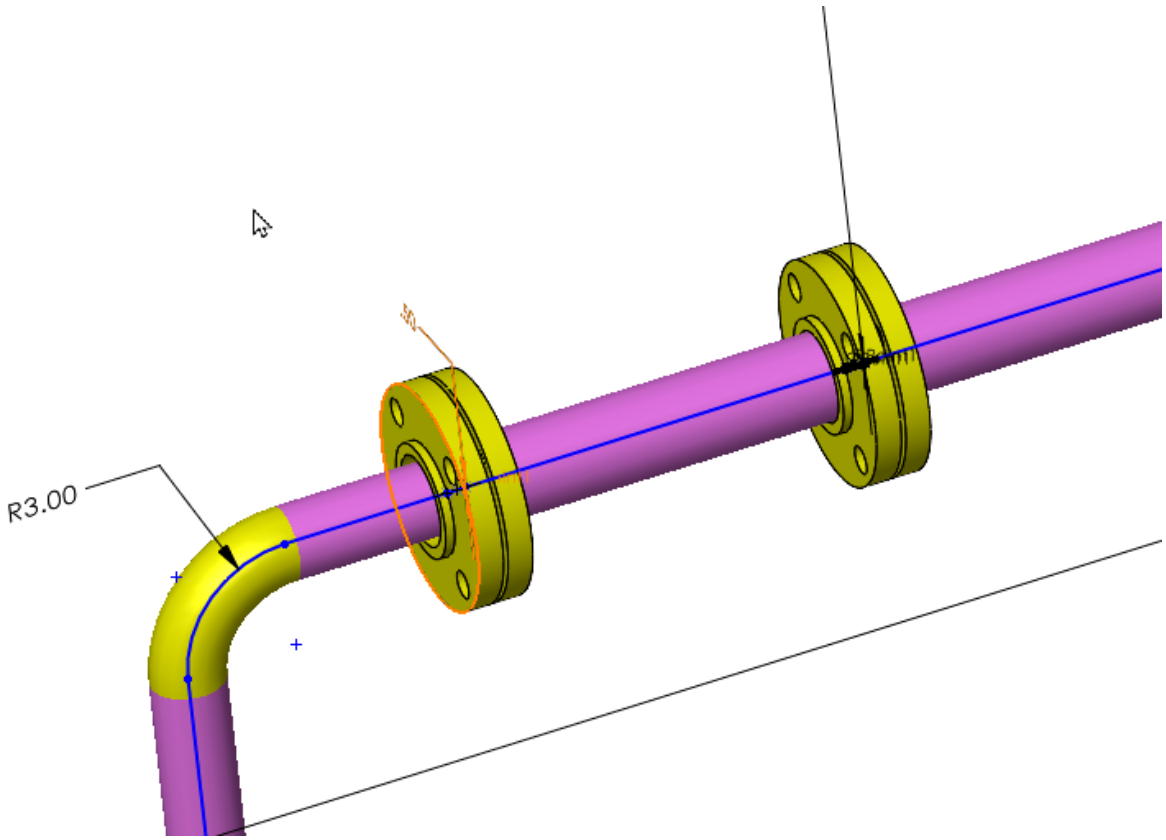
To connect two pieces of pipe without a tee, we can use the **Penetrate** command. If you draw in a new line and add the appropriate flange to the end of the new pipe (Routing needs the flange added so it will know the size of pipe to add), you can right-click on the endpoint of the new line to cope the new pipe and add the hole to the existing pipe.





Flange to Flange Connections

Direct flange to flange connections can be created by dragging and dropping a flange onto another flange.

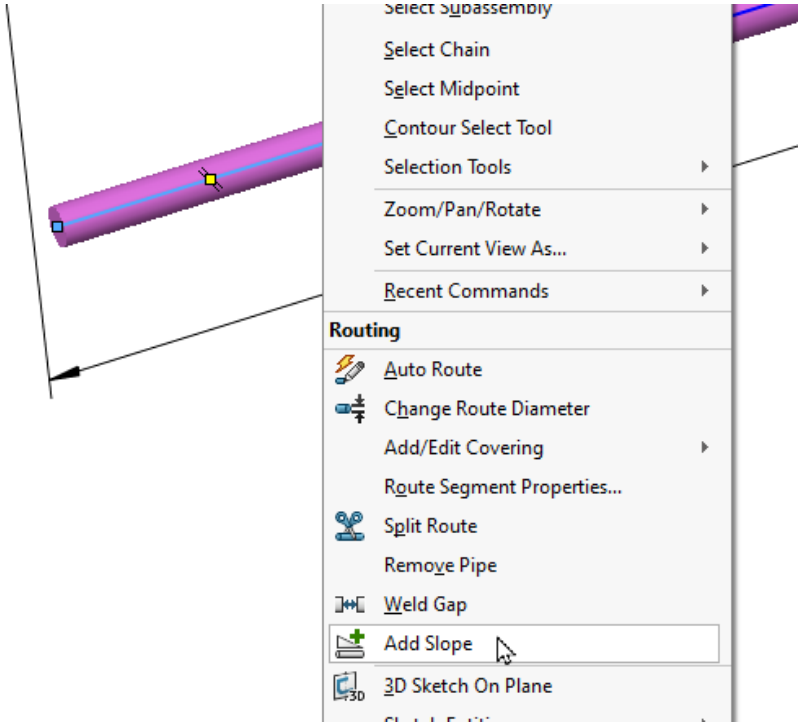


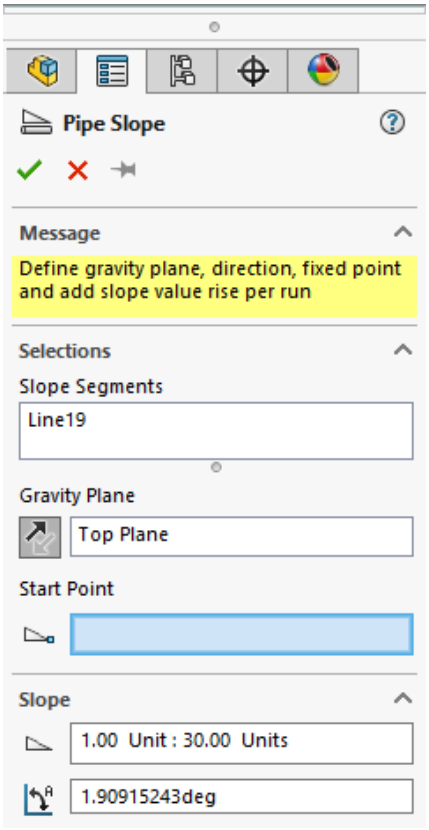
Pipe Spools

If we create multiple flange to flange connections inside the same route, then we can use the **Define Spools** tool to create and name these sections of the pipe route so that we can create drawing views of the different spools (uses Display States).

Adding Slope

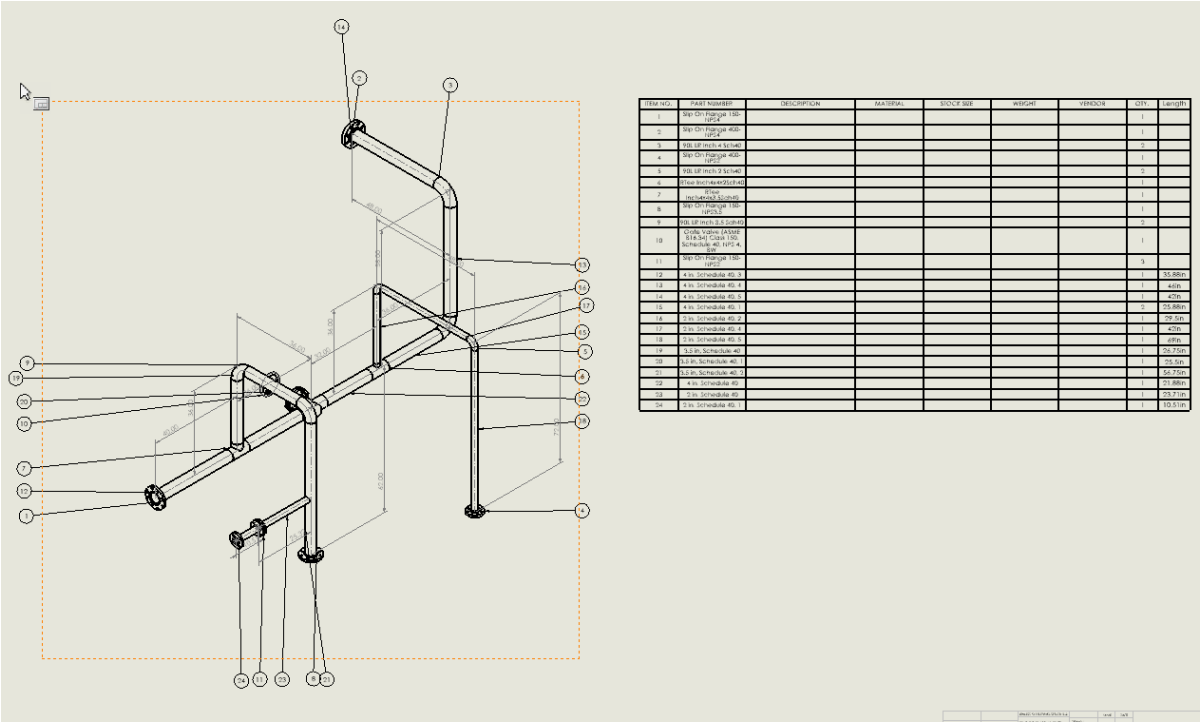
A Gravity Plane can be defined in situations when we need a piece of pipe to drain naturally.





Piping Drawings

Just like in Lesson 3, we have tools to create **Pipe Drawings**. The automated tool will create drawing views, show centerlines and centermarks, and add dimensions to component locations.



LESSON 6: CREATING ROUTING COMPONENTS

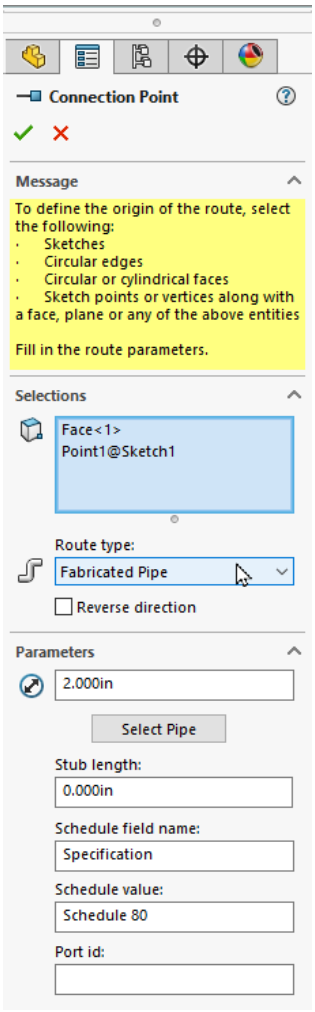
Routing Functionality Points

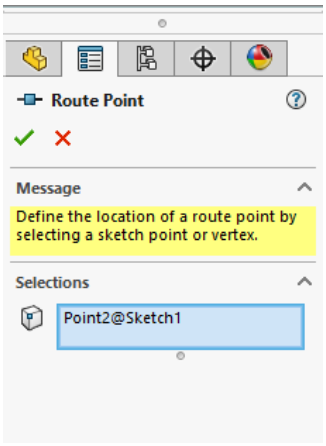
Connection Points – CPoints

- Determine where the route ends
- Determine the direction the route enters the fitting or connector
- Specify the nominal diameter of the route
- Specify the type of route

Routing Points – Rpoints

- Used to place the fitting on the endpoint of a 3D sketch
- Define the path of the flexible path through clips



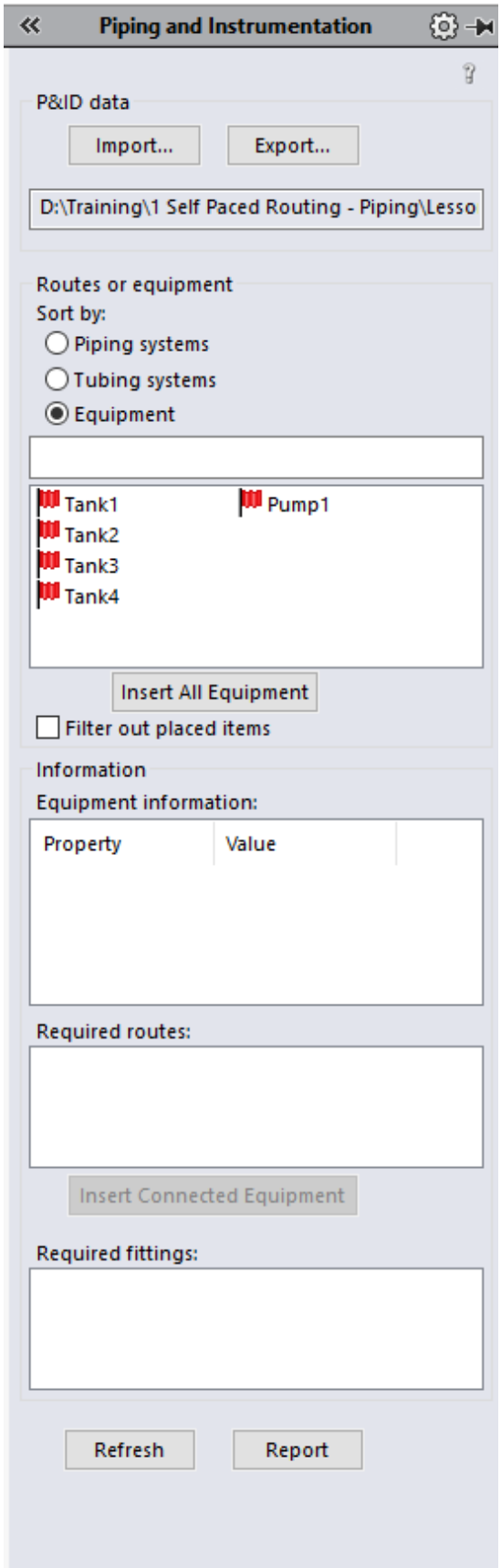


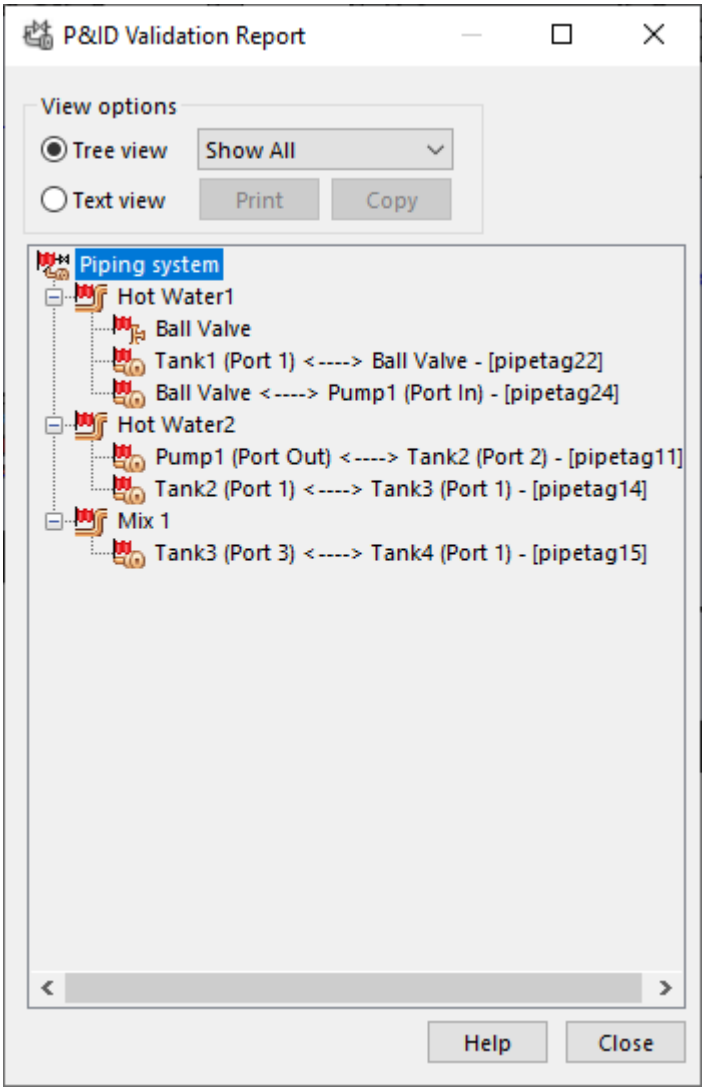
LESSON 7: USING P&ID FILES

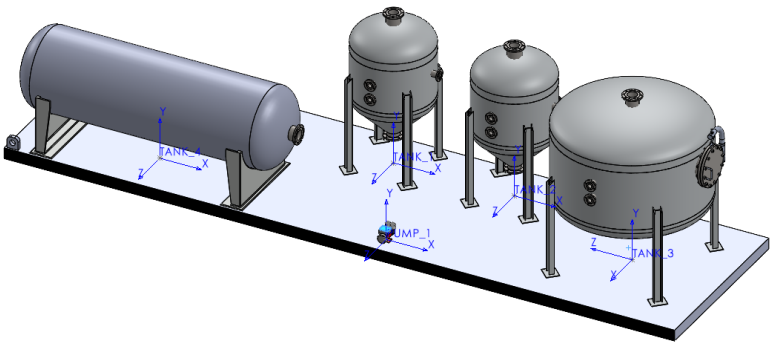
Piping and Instrumentation

An XML file guides the creation of piping and tubing routes by describing routes, lines, connections, and equipment in a text format.

```
<!--###PIPELIN INFO 2###-->
        <PipelineInfo>
                <Description value="Pump Out"/>
                <Comment value="Pump Out"/>
                <Name value="Pump Out"/>
                <Tag value="Pump Out"/>

                <In-lineFittings>
                        <fitting>
                                <ID value='10'/>
                                <Tag value='Check Valve Pump Out'/>
                                <Description value='Check Valve Pump Out'/>
                                <PartNumber value='swing check valve  fl - 150-2500.SLDPRT'/>
                                <Config value='Default"'/>
                        </fitting>
                </In-lineFittings>


                <connections>

                        <PipeSegment>
                                <ID value='12'/>
                                <Tag value='pipetag12'/>
                                <Diameter value='2"'/>
                                <FromEquip value='Pump1'/>
                                <FromEquipPort value='Out'/>
                                <FromEquipSize value='2"'/>
                                <ToEquip value='Check Valve Pump Out'/>
                                <ToEquipPort value=''/>
                                <ToEquipSize value='2"'/>
                        </PipeSegment>

                        <PipeSegment>
                                <ID value='13'/>
                                <Tag value='pipetag13'/>
                                <Diameter value='2"'/>
                                <FromEquip value='Check Valve Pump Out'/>
                                <FromEquipPort value=''/>
                                <FromEquipSize value='2"'/>
                                <ToEquip value='Tank1'/>
                                <ToEquipPort value='1'/>
                                <ToEquipSize value='2"'/>
                        </PipeSegment>

                </connections>
        </PipelineInfo>
```


Piping and Instrumentation
P&ID data
Import...
Export...
D:\Training\1 Self Paced Routing - Piping\Lesso
Routes or equipment
Sort by:
Piping systems
Tubing systems
Equipment
Tank1
Pump1
Tank2
Tank3
Tank4
Insert All Equipment
Filter out placed items
Information
Equipment information:
Property
Value
Required routes:
Insert Connected Equipment
Required fittings:
Refresh
Report

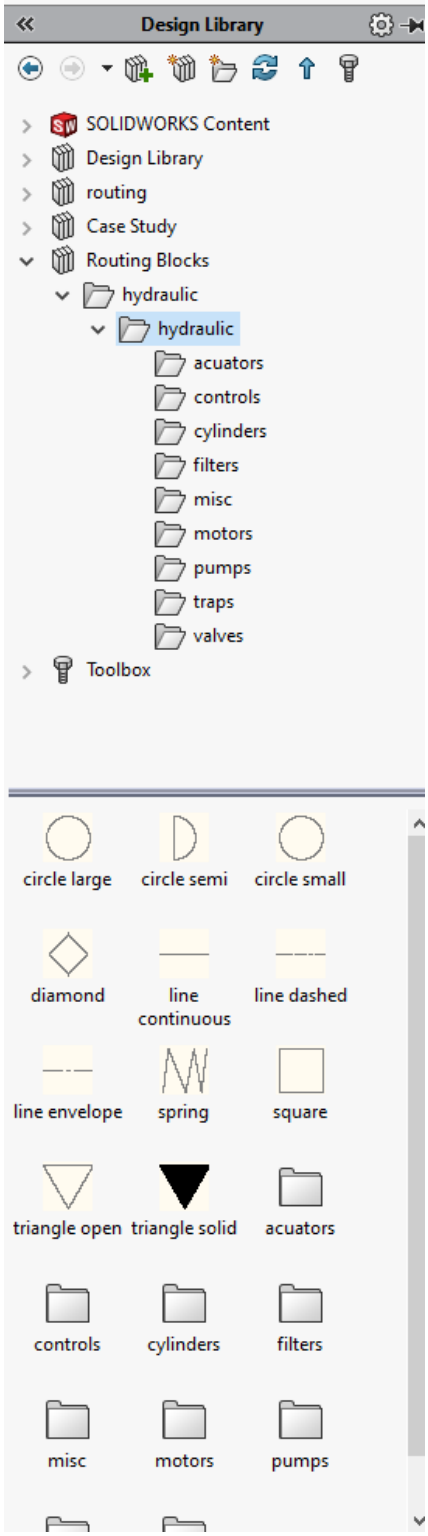

P&ID Validation Report
View options
Tree view
Show All
Text view
Print
Copy
Piping system
Hot Water1
Ball Valve
Tank1 (Port 1) <----> Ball Valve - [pipetag22]
Ball Valve <----> Pump1 (Port In) - [pipetag24]
Hot Water2
Pump1 (Port Out) <----> Tank2 (Port 2) - [pipetag11]
Tank2 (Port 1) <----> Tank3 (Port 1) - [pipetag14]
Mix 1
Tank3 (Port 3) <----> Tank4 (Port 1) - [pipetag15]
Help
Close



Process Drawings

Create and use SOLIDWORKS blocks to create process drawings. Download from SOLIDWORKS the Content/Blocks folder:

Drag and drop into the SOLIDWORKS Drawing.

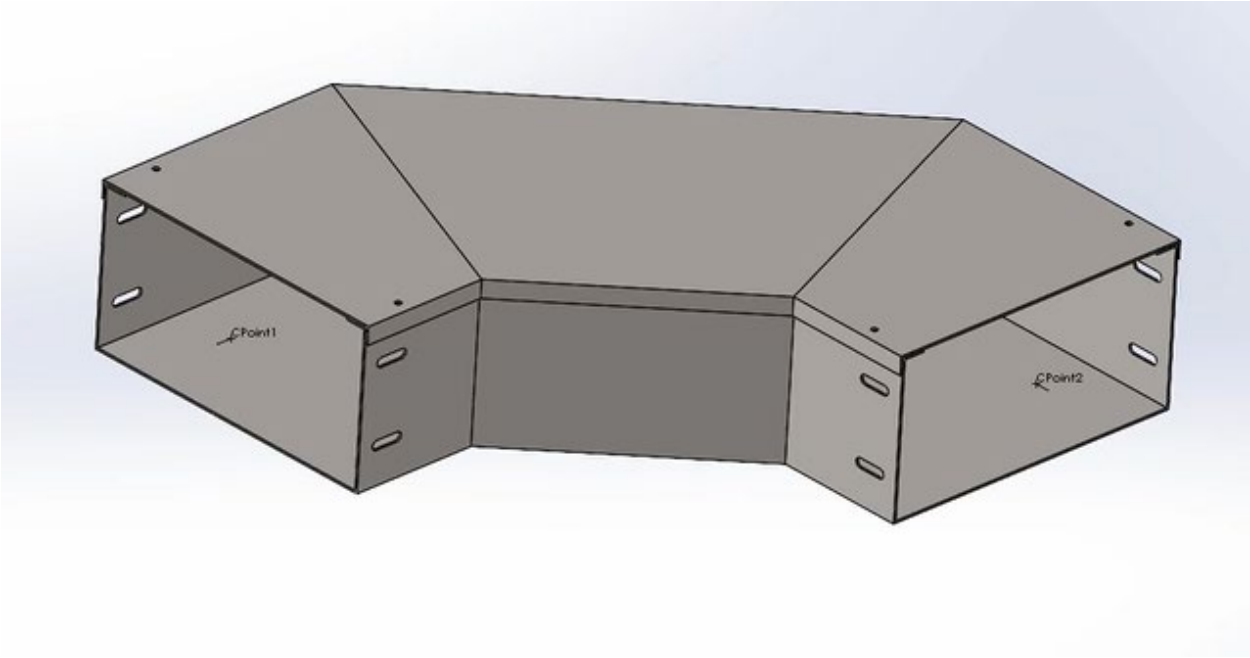


LESSON 8: ELECTRICAL DUCTING, CABLE TRAY, AND HVAC ROUTES

Electrical Ducting, Cable Tray, and HVAC Routes

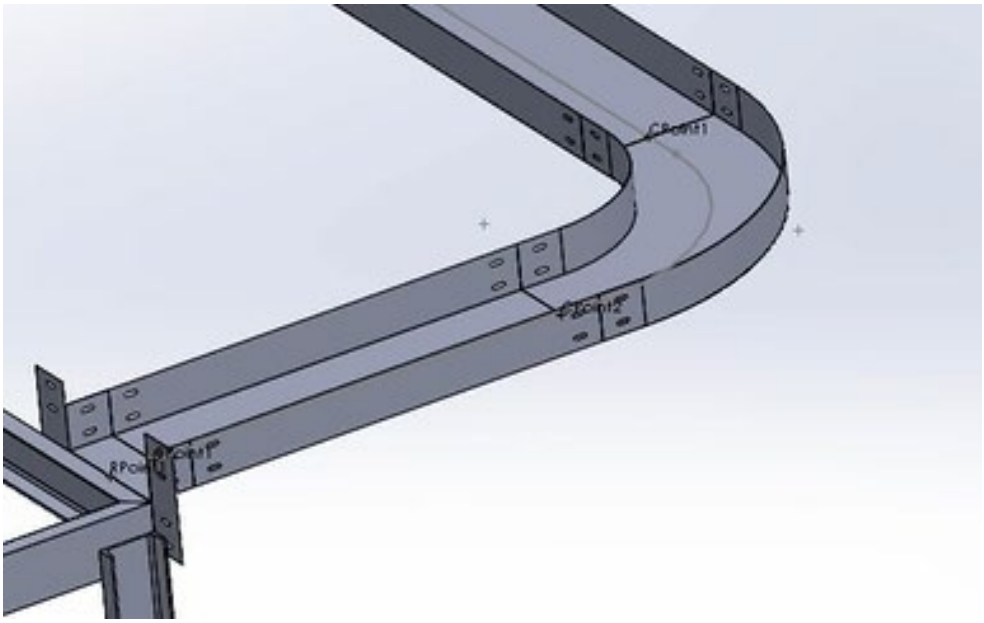
Electrical Ducting – Routes used to transport insulated electrical cables in a building.

- Closed, thin-walled, rectangular shapes



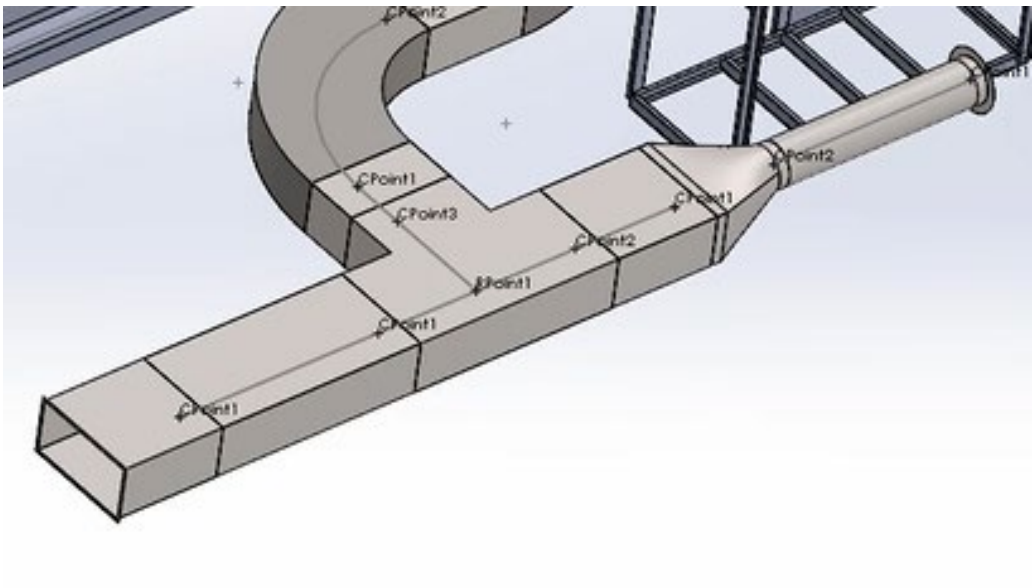
Cable Trays – Route used to transport insulated electrical cables in a building.

- Open, thin-walled, rectangular shapes



HVAC – Heating, ventilating, and air conditioning routes used to transport air in a building.

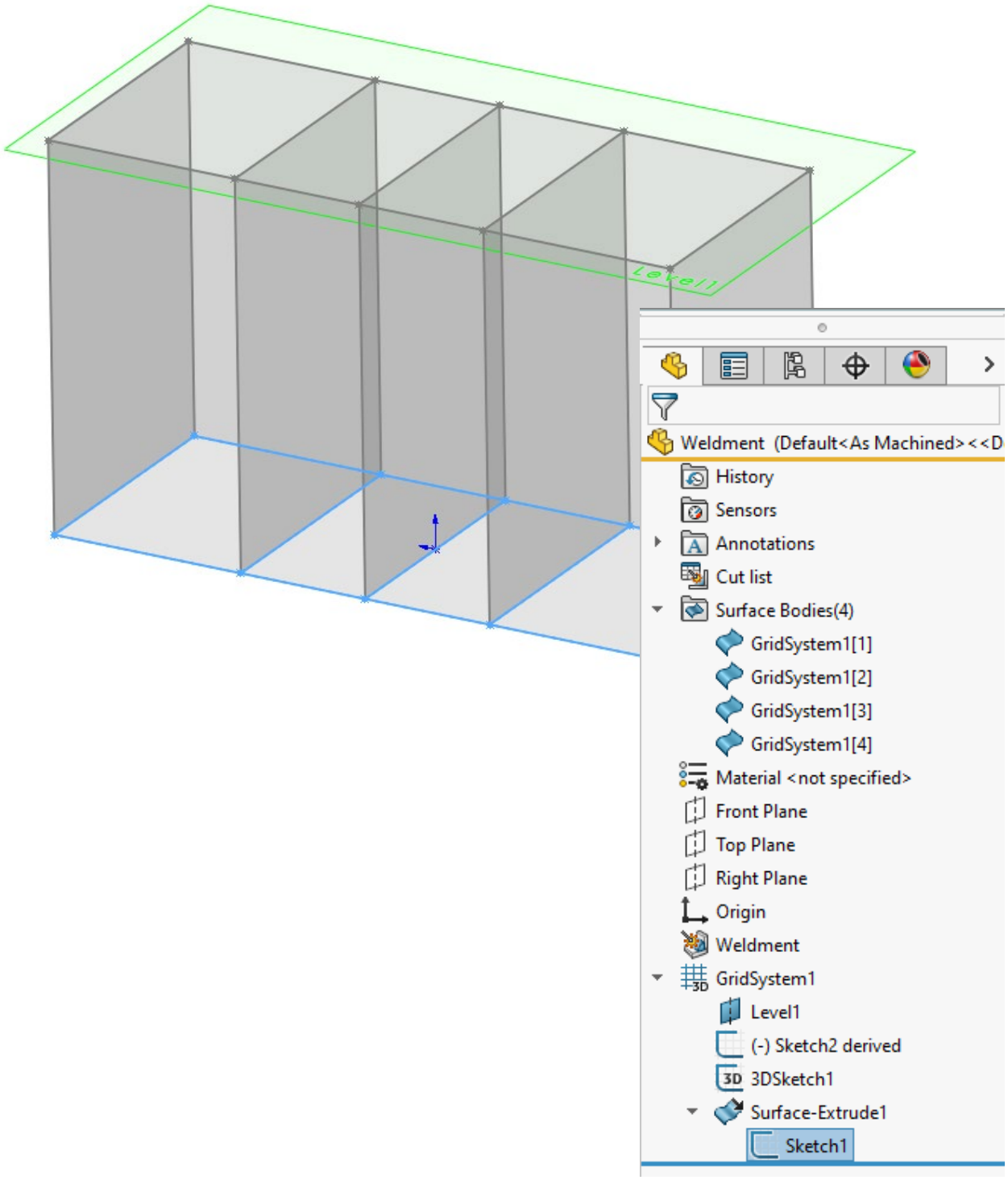
- Rectangular and circular, closed, thin-walled shapes



LESSON 9: PIPING SKIDS

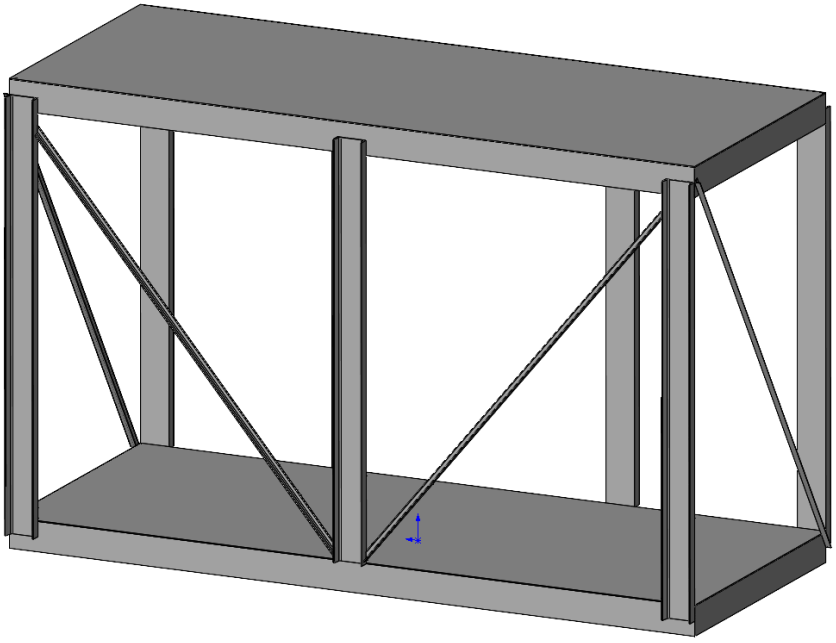
Grid Systems

The **Grid System** uses an initial sketch to generate 2D and 3D geometry as well as planes and surfaces to represent the skeleton of a welded frame.



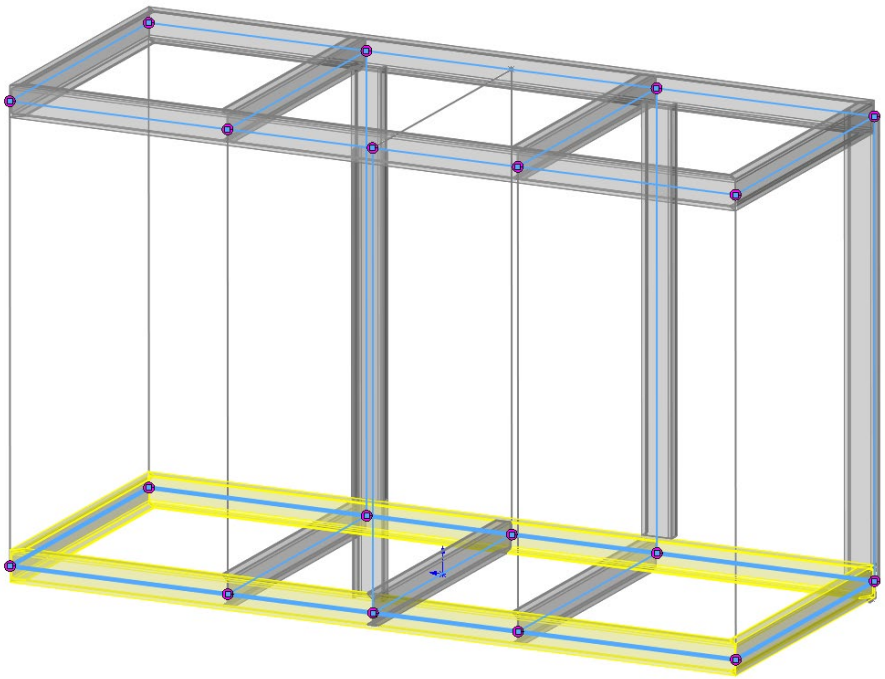
Weldments

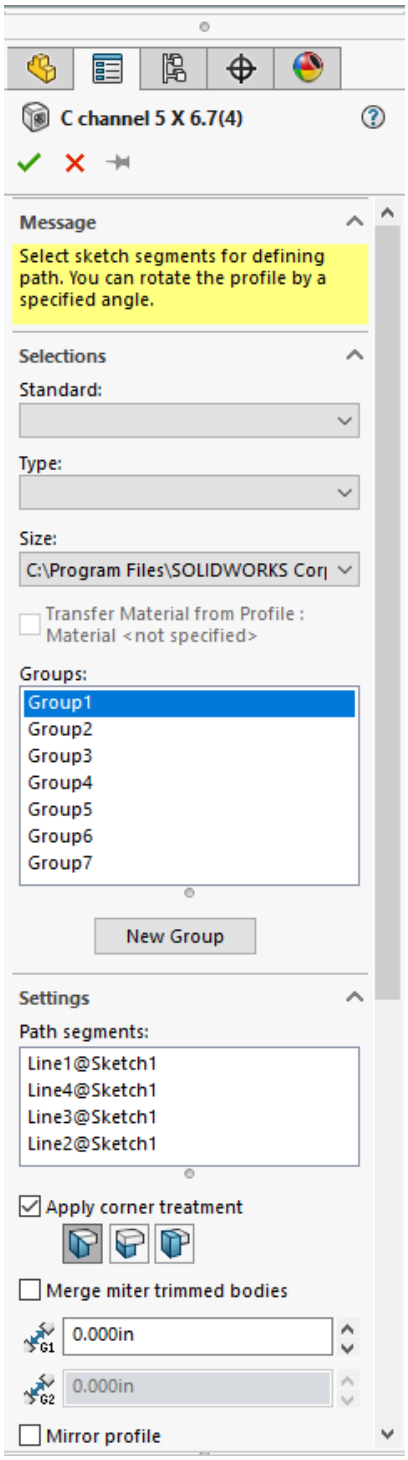
Weldments are multi-body parts that are made up of structural shapes and/or un-merged bodies to represent welded or bolted structures.



Structural Members

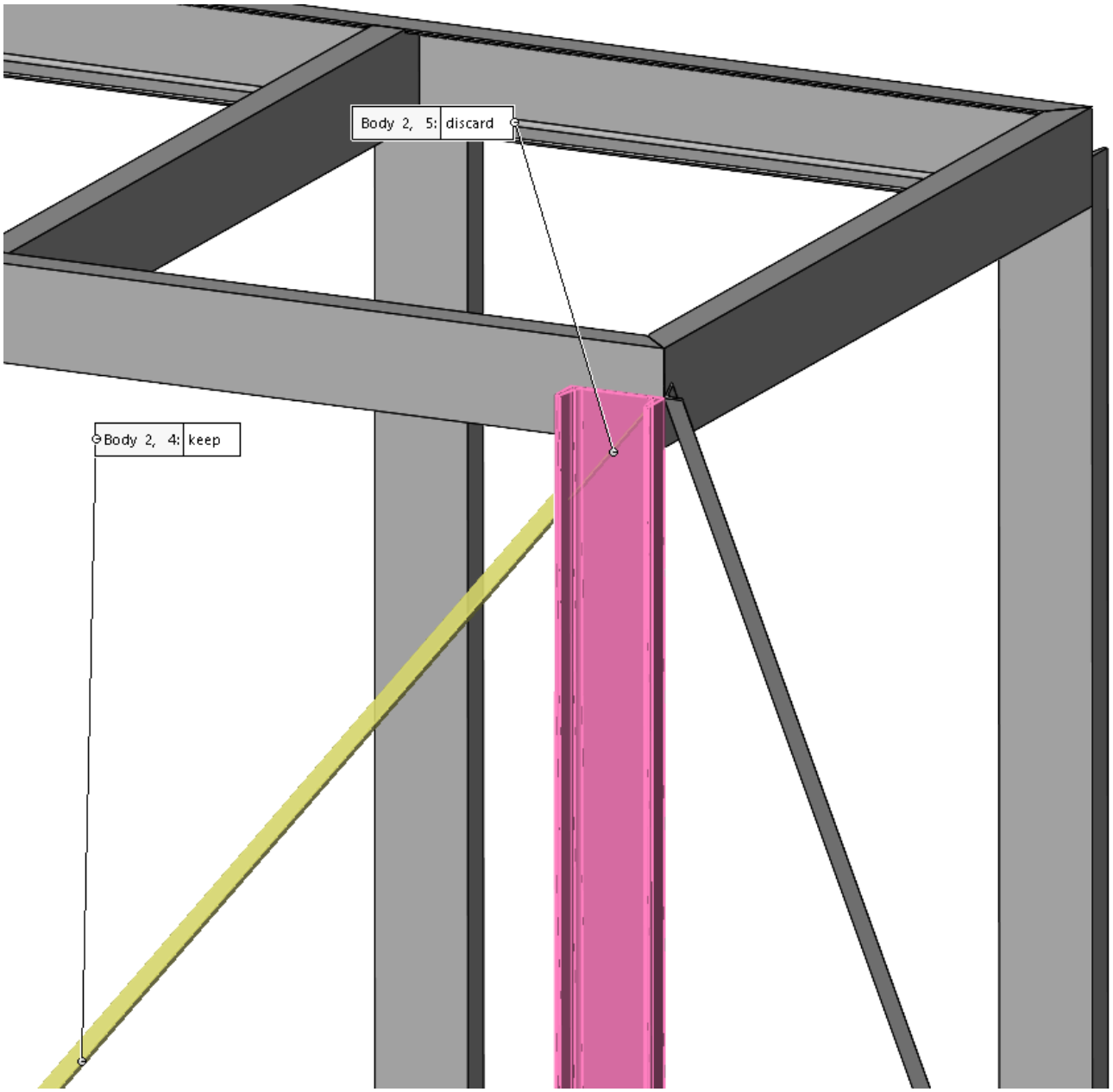
Structural members use sketch lines to sweep weldment profiles to create geometry.





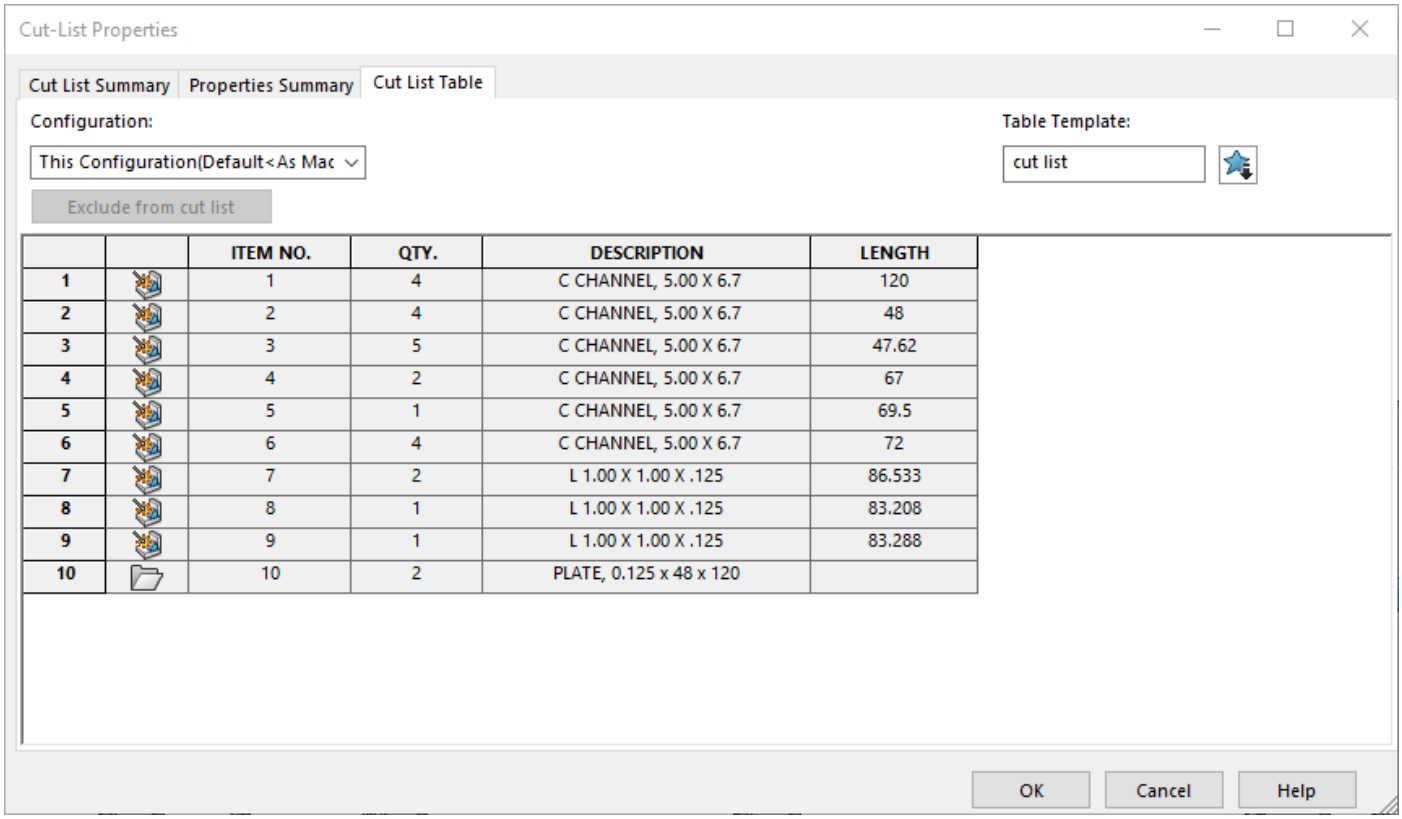
Trim/Extend

Groups inside the Structural Members feature can automatically cope members, but there may be times where you need to manually trim and extend bodies up to other bodies and faces.



Cut-List

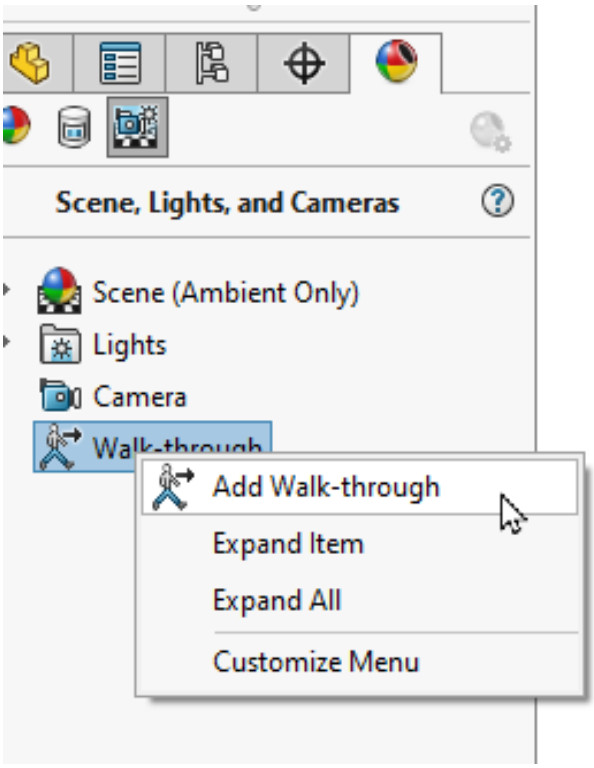
The **Weldment Cut-List** creates a List (similar to a regular Bill of Material) where we can track the size, length, and quantity of structural members.

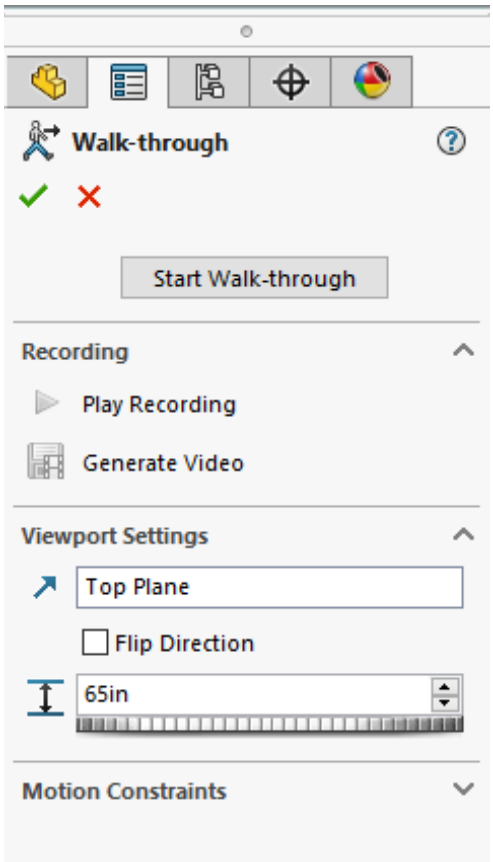


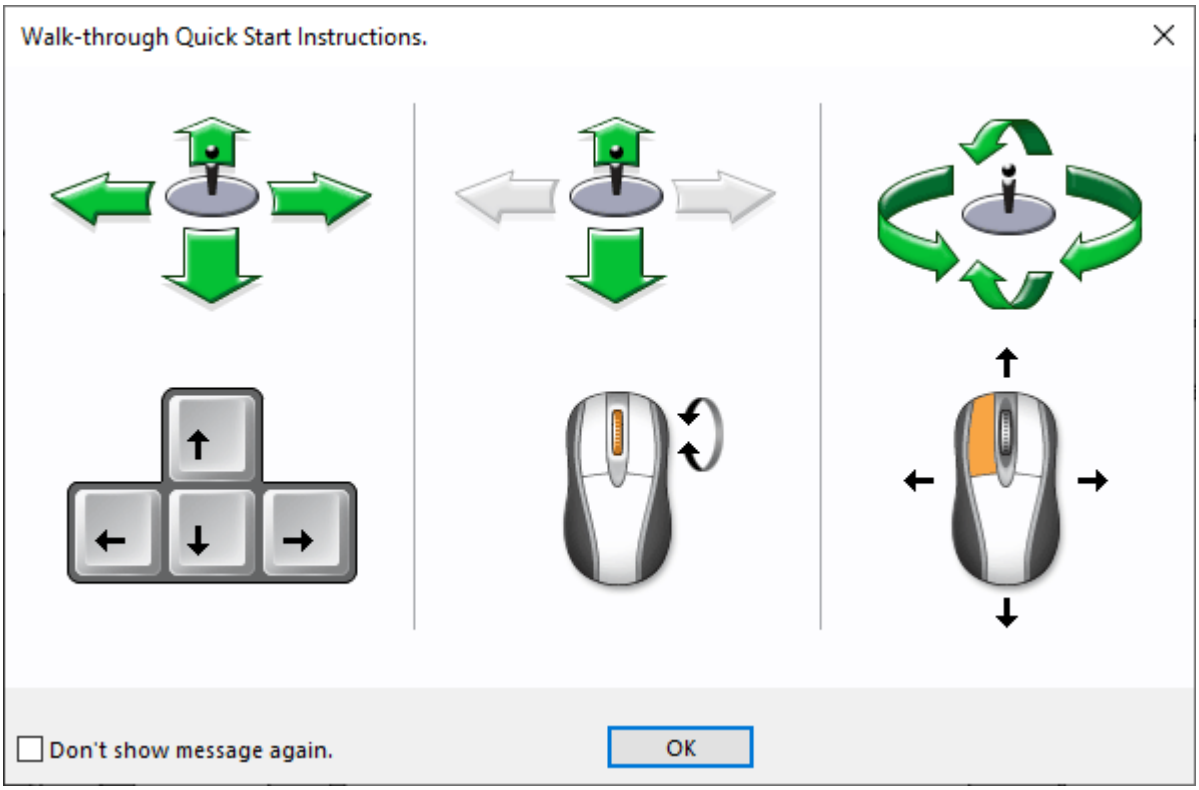
		ITEM NO.	QTY.	DESCRIPTION	LENGTH
1		1	4	C CHANNEL, 5.00 X 6.7	120
2		2	4	C CHANNEL, 5.00 X 6.7	48
3		3	5	C CHANNEL, 5.00 X 6.7	47.62
4		4	2	C CHANNEL, 5.00 X 6.7	67
5		5	1	C CHANNEL, 5.00 X 6.7	69.5
6		6	4	C CHANNEL, 5.00 X 6.7	72
7		7	2	L 1.00 X 1.00 X .125	86.533
8		8	1	L 1.00 X 1.00 X .125	83.208
9		9	1	L 1.00 X 1.00 X .125	83.288
10		10	2	PLATE, 0.125 x 48 x 120	

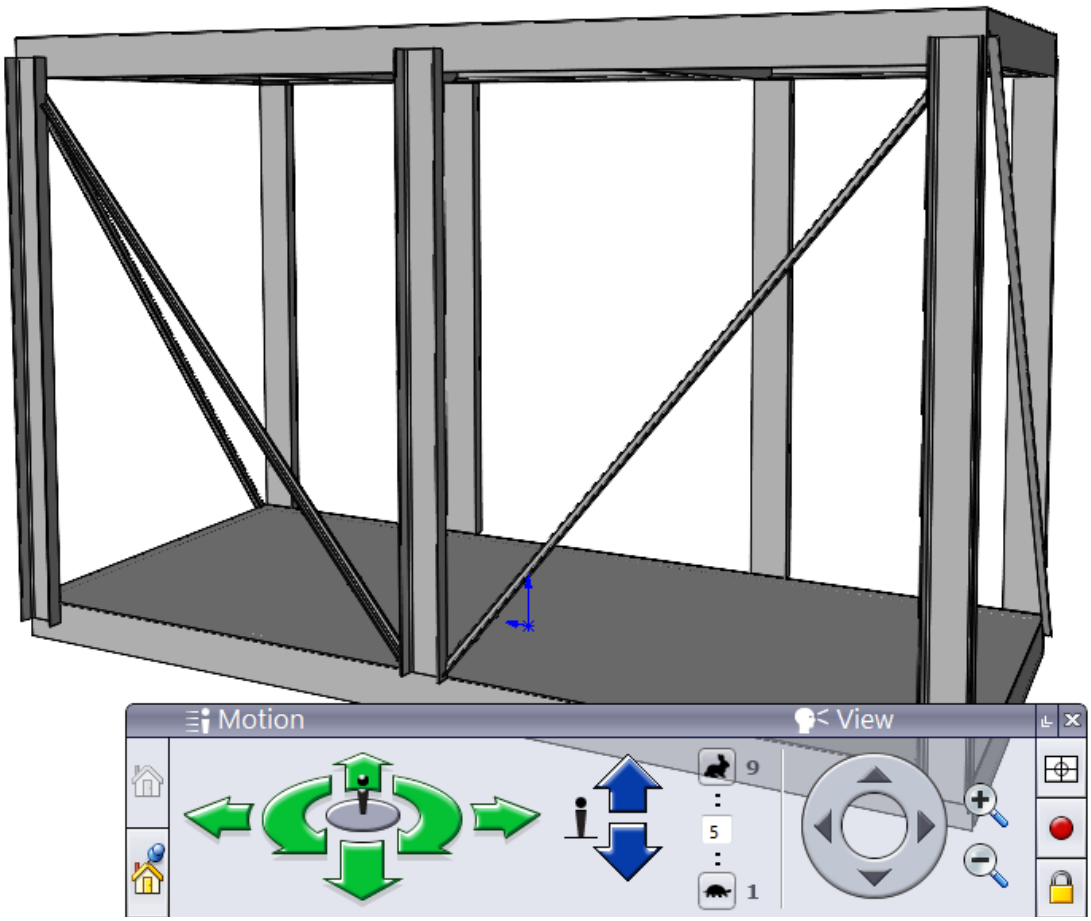
Walk-through Animations

We can create animations as we walk through and travel around a part or assembly. We can move freely or travel along a constrained path.






Walk-through Quick Start Instructions.
Don't show message again.
OK


Motion
View
9
5
1

		Keyboard Shortcuts	
	**Move Forward**	**W** up arrow	Moves the avatar forward.
	**Move Backward**	**S** down arrow	Moves the avatar backward.
	**Move Left**	**A** left arrow	Moves the avatar to the left.
	**Move Right**	**D** right arrow	Moves the avatar to the right.
	**Turn Left**	**Shift** + **A** or **Ctrl** + left arrow	Turns the avatar to the left.
	**Turn Right**	**Shift** + **D** or **Ctrl** + right arrow	Turns the avatar to the right.
	**Move Up**	**Shift** + up arrow	Moves the avatar up.
	**Move Down**	**Shift** + down arrow	Moves the avatar down.
	**Increase Speed**	=	Increases the speed. Maximum speed is 9. You can also press a number key to change the speed.
	**Choose Speed**		Lets you select a speed from the menu. Click the box to see the menu.
	**Decrease Speed**	-	Decreases the speed. Minimum speed is 1. You can also press a number key to change the speed.

LESSON 10: USING SOLIDWORKS CONTENT

SOLIDWORKS Content

SOLIDWORKS provides access to several different types of files that do not get installed by default.

Here are some examples of different files available:

- Routing files – Several different standards of flanges, elbows, tees, crosses, and unions.
- Blocks – 2D representations/symbols that can be used in process control drawings.
- Weldment profile – Multiple standard profiles useful for Weldments and Skid Systems.