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Introduction

CATIA 3DEXPERIENCE Electrical 3D Design

Upon completion of this course the student should have a full understanding of the following topics:

- Define electrical geometry and branches
- Define complete harnesses with supports
- Develop harnesses within the context of a product
- Develop and utilize a harness in multiple products
- Create formboards for flattening and optimizing a harness for manufacturing

Electrical 3D Design

Defining an electrical harness requires two steps. You must first define the required connectors and connection points. Once you have these connections, you are ready to begin defining the geometric bundle that links the various connection points. These geometric bundles will behave as a space reservation for the wiring they will contain. In this section of the course, you will not be defining the actual wires within the geometric bundle, but rather just the overall size and shape of the geometric bundle that will contain the wiring.

There are two workbenches involved in electrical harness design. They are the Electrical 3D Design and the Electrical 3D Part Design workbenches. The Electrical 3D Design workbench will allow you to work with the geometric bundle as a whole. The Electrical 3D Part Design workbench will allow you to define the specific bundle segment and route the bundle. The two workbenches are used simultaneously to define the geometric bundle. Although the Electrical 3D Part Design workbench is a separate workbench, it is generally accessed through the Electrical 3D Design workbench when defining a specific bundle segment. This is a similar behavior to the Sketcher and Part Design workbenches. You generally do not access the sketcher workbench directly, but instead you access sketcher through the Part Design workbench. In our case, the Electrical 3D Design workbench works in the product environment, whereas the Electrical 3D Part Design workbench works with a specific branchable part in the product.

In this course, you will not be defining the specific wires within the geometric bundle. Instead, you will be defining the bundle as a whole for space reservation and connectivity information and not to define pin to pin connectivity. To define pin to pin connectivity, you will need to study the Electrical Wire Routing workbench. With that said, keep in mind, you can always define a geometric bundle per wire if desired. This will emulate defining specific connectivity, but you will find that it requires a lot of time and work when dealing with smaller wires.

Electrical Harness Design

In this section, you will look at developing a simple single branch harness. Keep in mind, you will be using both the Electrical 3D Design and Electrical 3D Part Design workbenches. These two workbenches work together to define the harness and the bundles.

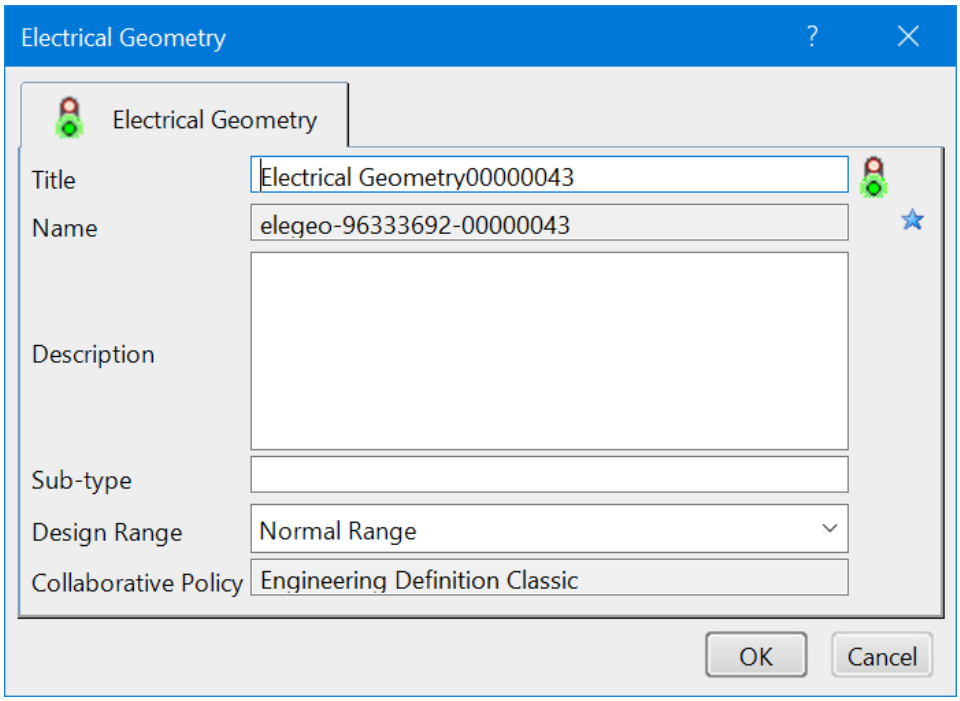
Defining Electrical Branch Geometry

In this first exercise, you are going to look at creating a basic electrical branch between two connectors. As you continue through this book, you will find the harnesses and branches becoming more and more complex as the options are covered in more detail.

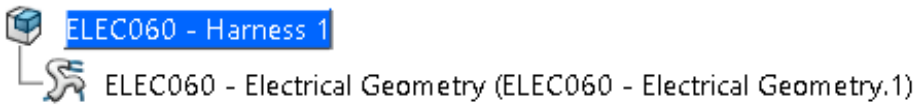
Create a new product named <u>ELEC060 - Harness 1</u>. This new product will serve as your first harness.

If not already there, switch to the Electrical 3D Design workbench. This will allow you to build the electrical harness.

Select the Electrical Geometry icon, then select *ELEC060 - Harness 1* from the specification tree.  The *Electrical Geometry* window appears.

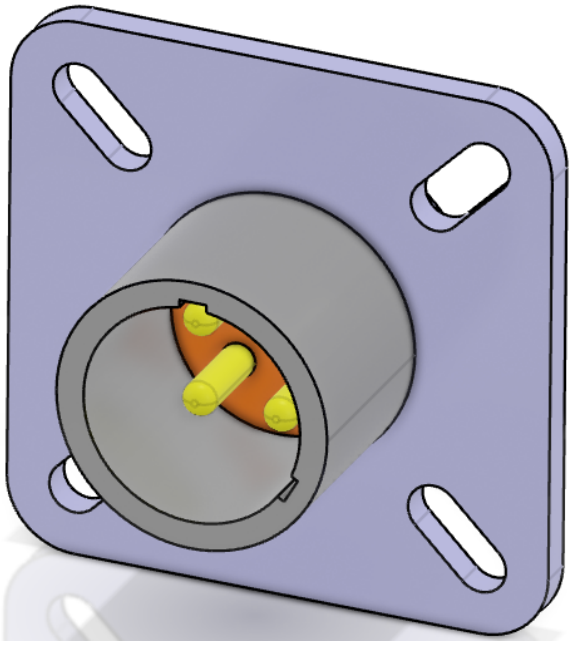


Change the *Title* to <u>ELEC060 - Electrical Geometry</u> and select *OK*. It should appear as shown.



Right click on *ELEC060 - Electrical Geometry* in the specification tree and select *Insert, Existing 3D Part.* This will display the *Search Selection* window.

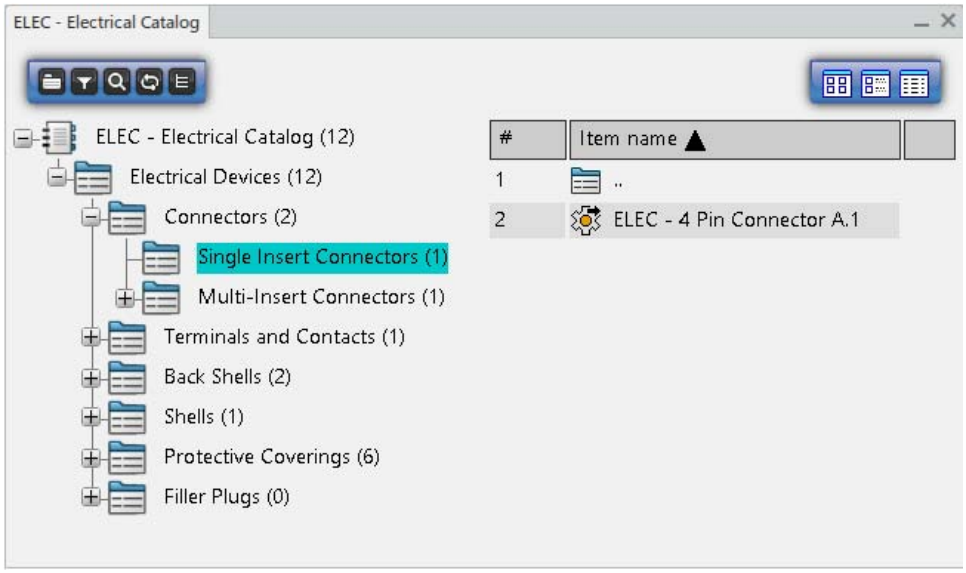
Search for and select the ELEC - 4 Pin Mount Connector document from the *Electrical Harness I* directory. This will be a simple four pin mounting connector.



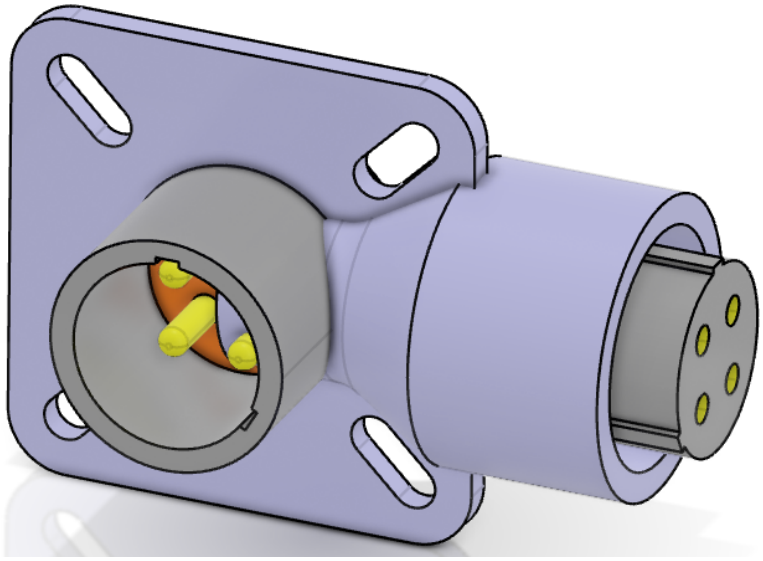
Remember, you can also insert components from the catalog.

Select the Catalog Browser icon from the bottom toolbar.  It is in the *Tools* section. This will display the *Catalog Browser* window.

Search for and select the ELEC - Electrical Catalog, then expand the *Connectors* chapter and select the *Single Insert Connectors* family. It should appear as shown.



Select the *ELEC060 - Electrical Geometry* branch in the tree and then double select the ELEC - 4 Pin Connector from the catalog to insert it. This method will insert a connector into the assembly as well.



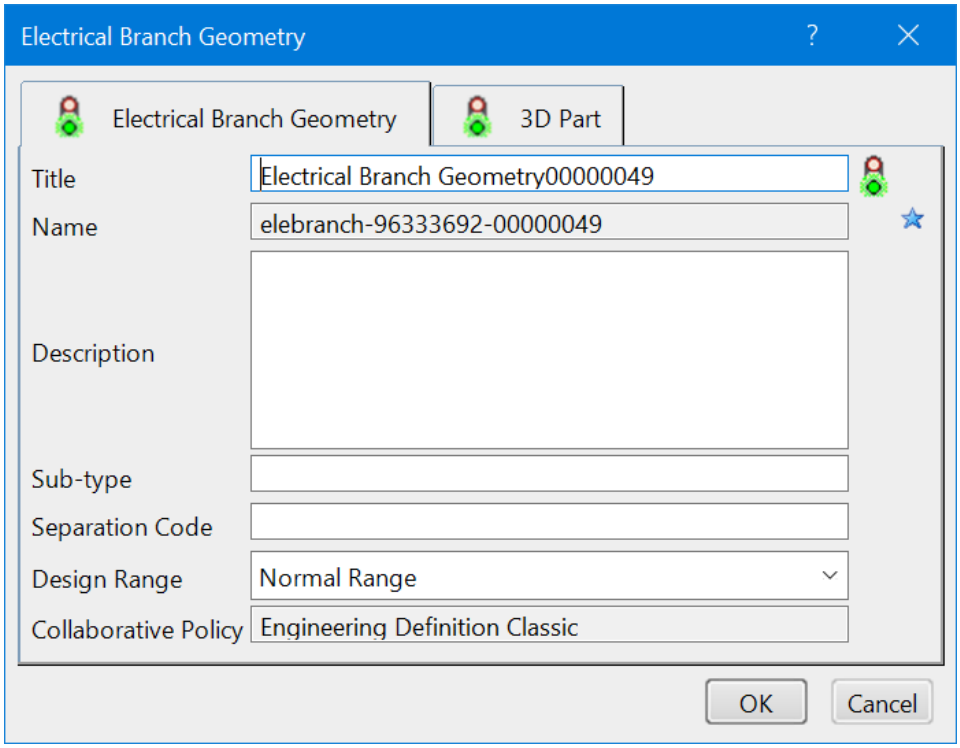
Close the catalog browser when done.

Double select on the *ELEC060 - Electrical Geometry* branch to activate it. This will allow you to manipulate the components within it.

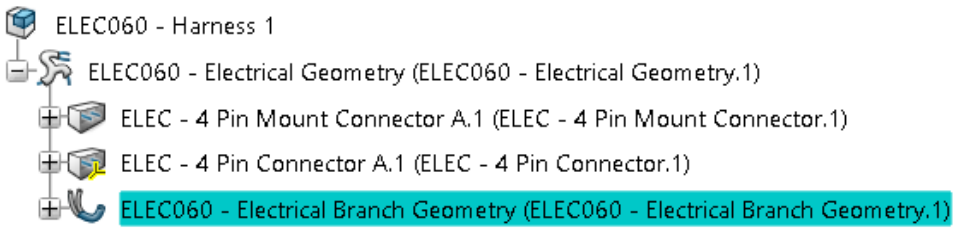
Using the compass or other manipulation tools, manipulate the 4 pin connector to the approximate location shown. The exact position is not required, just separate the two parts.

At this point, you are ready to define a bundle between the two connectors.

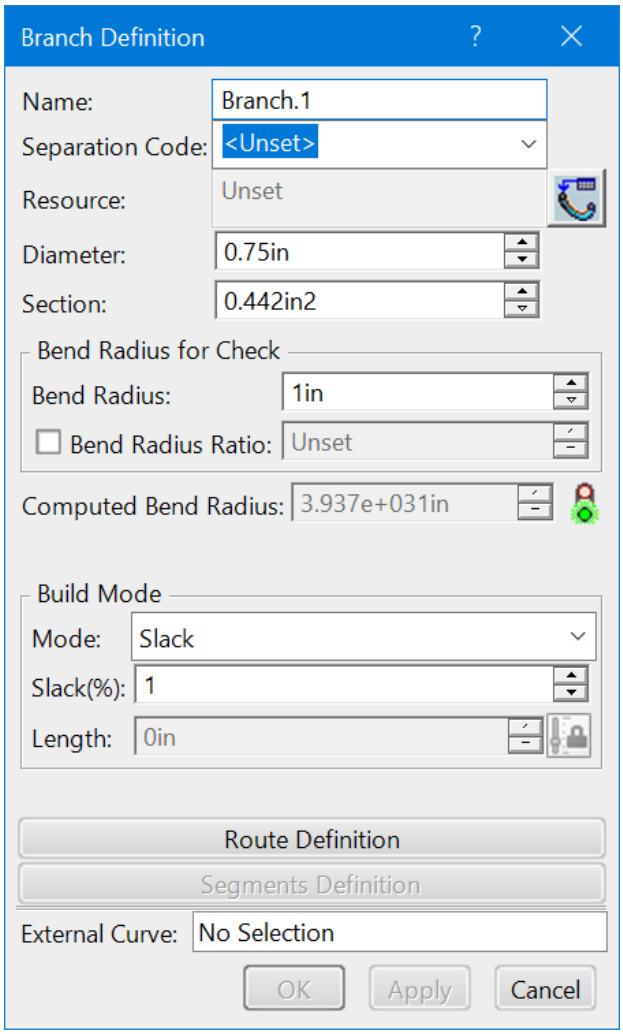
Select the Electrical Branch Geometry icon.  It is located under the Electrical Geometry icon. The *Electrical Branch Geometry* window appears.



Change the *Title* to be <u>ELEC060 - Electrical Branch Geometry</u> and select *OK*. It should appear in the tree.



The *Branch Definition* window also appears.



Name	Specifies the name of the branch
Separation Code	Specifies the separation code value for the branch
Resource	Displays the unique identifier for the branch
Diameter	Specifies the outside diameter of the branch
Section	Specifies the cross sectional area of the branch
Bend Radius	Specifies the minimum bend radius allowed for the branch
Bend Radius Ratio	Defines the bend radius based on the diameter of the branch. A ratio of 1 will set the *Bend Radius* to the same size as the branch *Diameter*.

Build Mode

Mode

Slack	Branches are computed with a minimum distance, and then a percentage of slack is added to the branch
Length	Branches are a set length, regardless of the amount of slack
Bend	CATIA will compute the minimum length possible while respecting the *Bend Radius*
Straight Bend	Segment length corresponds to the path defined by arcs of circles of fixed radius and straight lines going through points.
Cornered Polyline	Segment length corresponds to the shortest path defined by arcs of circles of fixed radius and lines. The curve does not go through the points, except if the bend radius is equal to zero. Tangency at route points is ignored.

Slack (%)	Defines the percentage of slack between connection points. Although 0% is allowed, there needs to be a slack of at least .1% to avoid update errors with Harness Flattening tools.
Length	Defines the length of the branch when in *Length* mode. The length must be as long, or longer than the distance between the two connection points.

Route Definition	Defines the branch route
Segments Definition	Allows for the branch to swap sides of a surface that is attached to the branch
External Curve	Allows selection of a curve to define the branch route

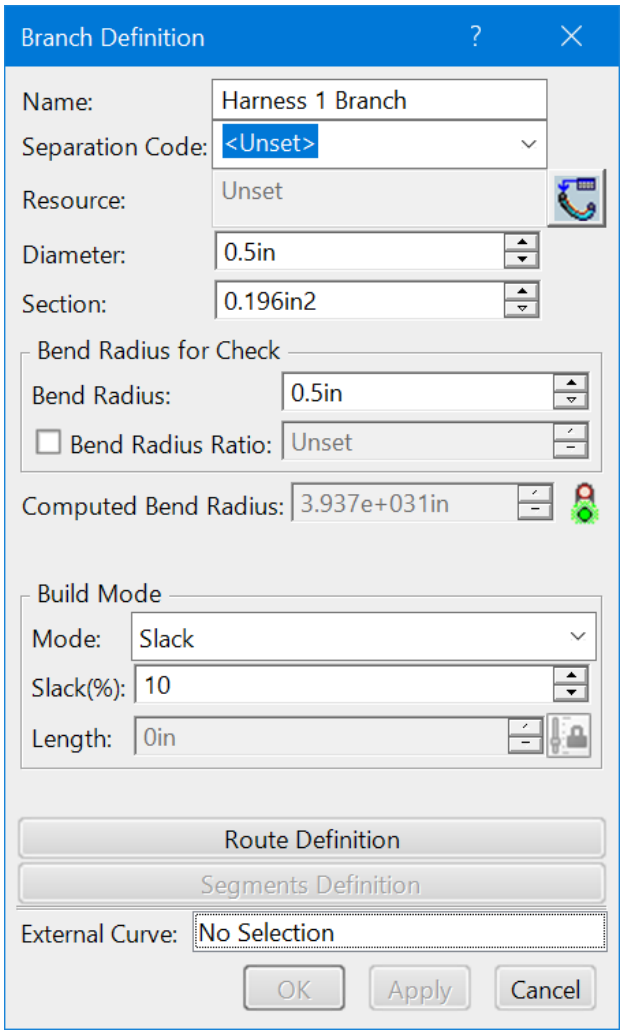
Many of these parameters will be tested further once the route is defined.

Change the *Name* to <u>Harness 1 Branch</u>. This will define the name for the branch.

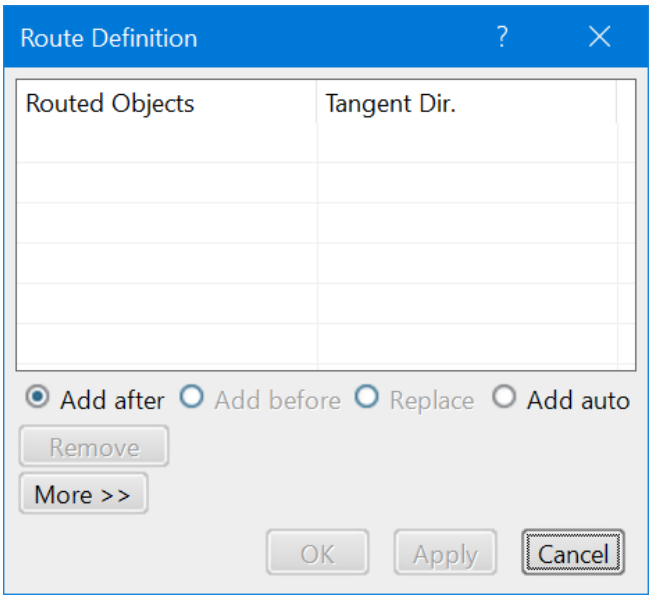
Unless already set, change the *Diameter* to 0.5in. You will notice the *Section* will automatically change to 0.196in2. This is due to the two fields being computed based on each other.

Change the *Bend Radius* to 0.5in. Typically, your bend radius will be equal to or greater than the diameter. If you set the bend radius smaller than the diameter, CATIA will display an error message about the impracticality of this.

Change the *Build Mode* to *Slack*, and set the *Slack* percentage to 10. This will have all the branch options defined. Now to generate the branch via the route definition.

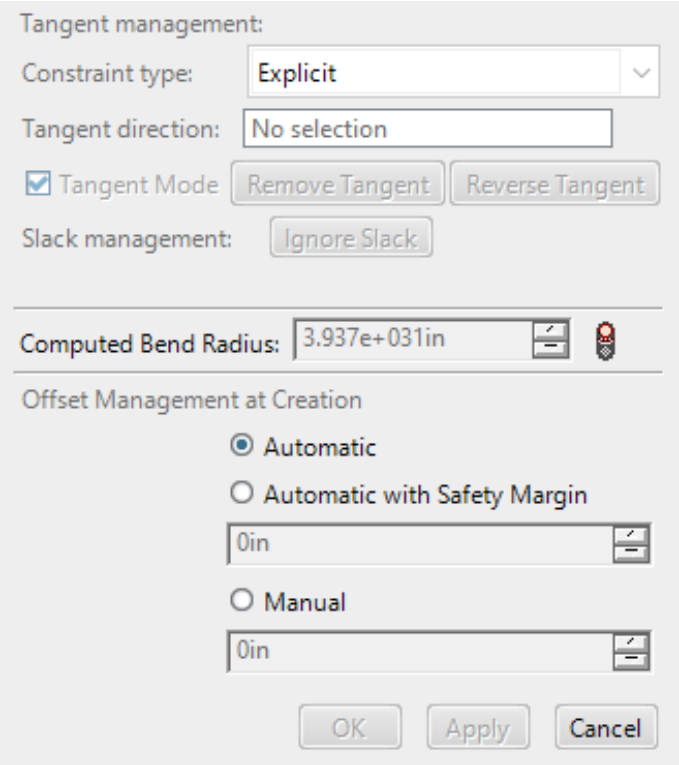


Select *Route Definition*. This will allow you to define the route for the bundle. The *Route Definition* window will display. Take a quick look at the various options in the *Route Definition* window.



Routed Objects / Tangent Dir.	Displays the objects and points for the route definition
Add after	Adds points and connection points after the selected point
Add before	Adds points and connection points before the selected point
Replace	Replaces the selected point with another selection
Replace	Replaces the selected point with another selection
Add auto	Automatically orders the route selections based on their type

By selecting the *More>>* button, you get a few additional options.



Tangent management

Constraint type	Defines the type of tangency to be defined
Explicit	Tangency is defined via a manual vector definition. Tangency definition is defined through a right click in the *Tangent Direction* field.
From curve	Tangency is defined from a curve or line selection. When *From curve* is selected, the *Tangent direction* changes to *Element*.

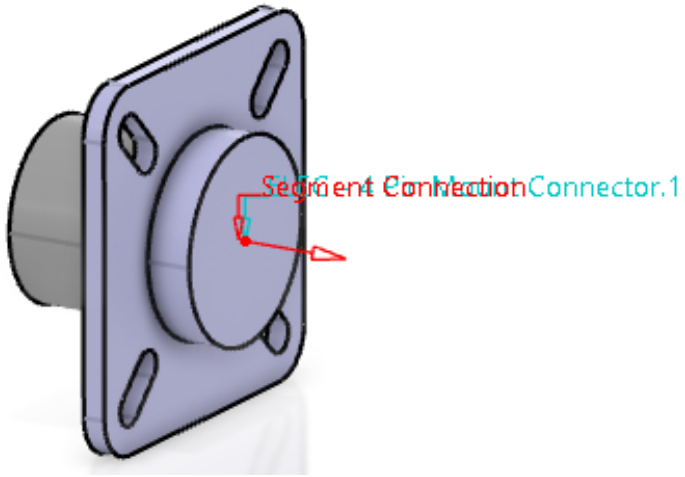
Slack management Ignores or removes slack between points

Offset Management at Creation

Automatic	Lays the bundle on the surface
Automatic with...	Lays the bundle on the surface with an additional offset of the safety margin distance
Manual	Allows you to specify a specific distance for the bundle to exist off the surface

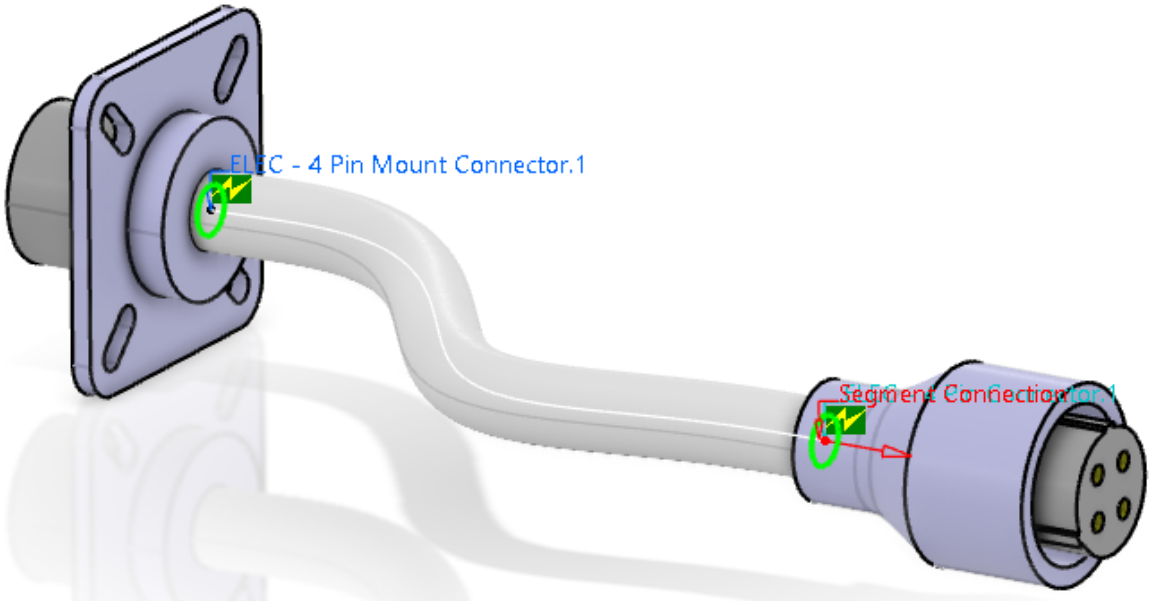
Now you are ready to define the route.

Select the 4 Pin Mount Connector. Notice the connector is automatically added to the *Route Definition* window, as well as the segment connection point is automatically defined.



Anytime you select an electrical device with a segment connection point, the connection point will automatically be selected and the tangent direction will automatically be defined in the *Initial Condition* direction defined in the segment connection point's placement constraints.

Select the 4 Pin Connector. This connector will also be defined in the routed objects. Notice the bundle is now present.



Note: The physical shape of the branch may vary based on the position of the two connectors.

Select *OK* to the *Route Definition* window. This will take you back to the *Branch Definition*.

Select *OK* to the *Branch Definition* window. The branch is defined.

Notice that you are still in the Electrical 3D Part Design workbench.

Select the Exit icon. This will take you back to the Electrical 3D Design workbench and activate the electrical geometry branch.

Next, you will create the same branch using a different method.

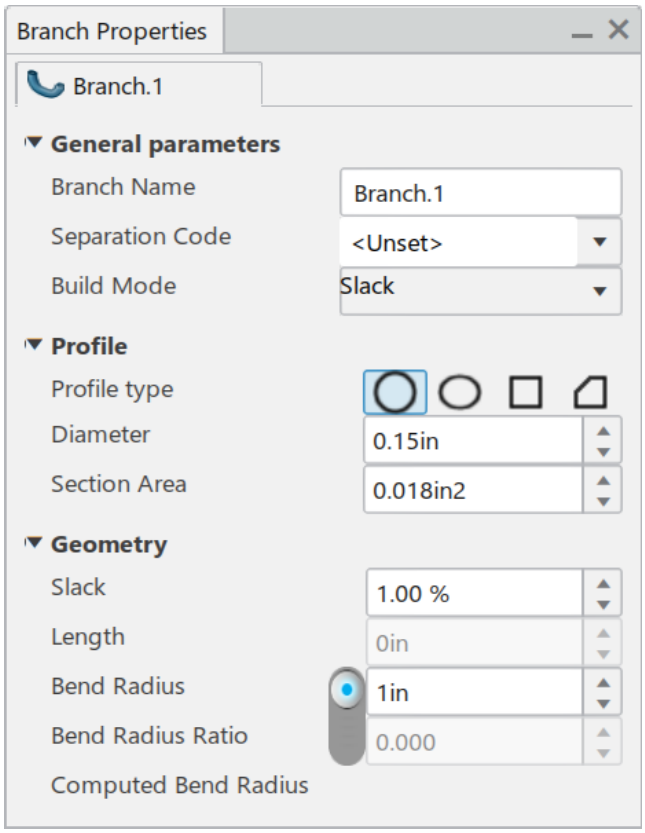
Delete the Electrical Branch Geometry from the tree. Select *No* when asked about saving.

Select the Electrical Branch Geometry icon. It is located under the Electrical Geometry icon. The *Electrical Branch Geometry* window appears.

Change the *Title* to be ELEC060 - Electrical Branch Geometry and select *OK*. It should appear in the tree and the *Branch Definition* window appears.

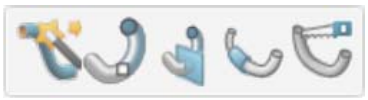
Select *Cancel* in the *Branch Definition* window. A different method will be used.

Select the Immersive Branch Definition icon. The *Branch Properties* window appears.



Notice at toolbar appears in the display as well.

	Auto Routing Mode	Allows you to select branch locations on the fly for routing the branch.
	Route on Branch Point	Routes on an existing branch point
	Removal Mode	Removes branch points
	Creation Mode	Displays the creation options

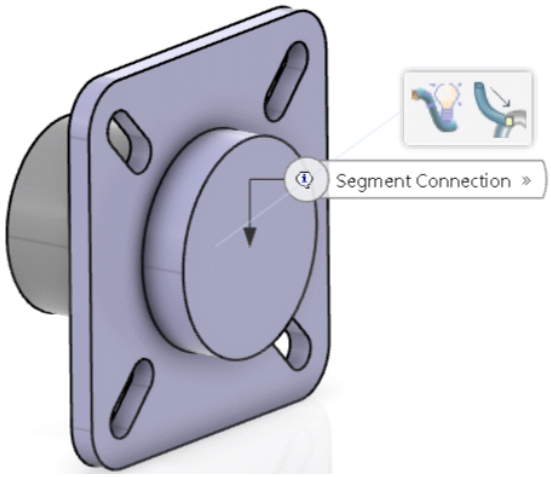


	Add Standard Branch Point	Adds a standard branch point to an existing branch
	Add Associative Branch Point	Adds an associative branch point to an existing branch
	Add Protective Covering	Adds a protective covering to a branch
	Split Branch	Splits an existing branch
	Transform Mode	Displays the transform options

	Translate Branch	Translates a branch
	Detailed Profile Management	Modifies the profile of the branch

Change the *Diameter* to 0.5, the *Slack* to 10%, and the *Bend Radius* to 0.5. Now you are ready to route the branch.

Move your mouse over the 4 Pin Mount Connector and select the segment connection that appears. Notice a yellow sphere appears at the connection point.



Anytime you select a segment connection point, the connection point will automatically be selected and the tangent direction will automatically be defined in the *Initial Condition* direction defined in the segment connection point's placement constraints.

Select the segment connection for the 4 Pin Connector. This connector will also be defined in the routed objects. Notice the bundle is now present.

Note: The physical shape of the branch may vary based on the position of the two connectors.

Select in space. The branch is completed.

Select the Exit icon.  This will take you back to the Electrical 3D Design workbench and activate the electrical geometry branch.

Save your harness. Save with Options would be a good option to use when saving your bundles. Leave your harness open, it will be used in the next section.

Defining Multi-Branches

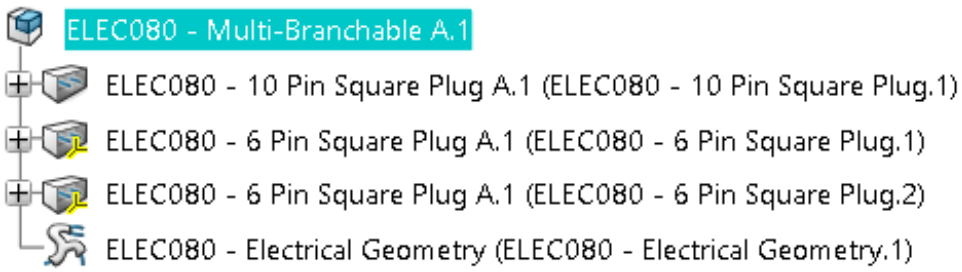
Although single branches are very useful for simple geometric bundles, you will often find that you are not able to create the necessary bundles with just a single branch. The most common type of bundle used, even for a simple straight geometric bundle, is a multi-branchable.

Open the ELEC080 - Multi-Branchable document. You will create a multi-branchable document of a simple harness of three connectors in a "Y" configuration.

If not already there, switch to the Electrical 3D Design workbench. Defining a multi-branch initially is going to be no different than a single branch.

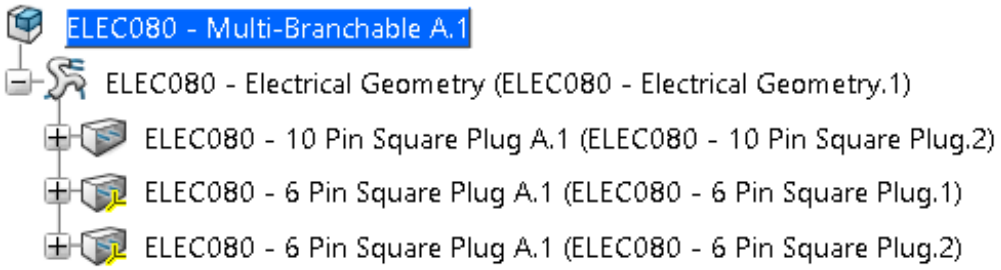
Select the Electrical Geometry icon, then select the *ELEC080 - Multi-Branchable* product.  The *Electrical Geometry* window appears.

Change the *Title* to be <u>ELEC080 - Electrical Geometry</u> and select *OK*. It should appear as shown.



In this case, you will move all of the connectors into the electrical geometry so the entire thing will be self contained.

Drag each of the connectors into the *ELEC080 - Electrical Geometry*. It should appear as shown when you are finished.

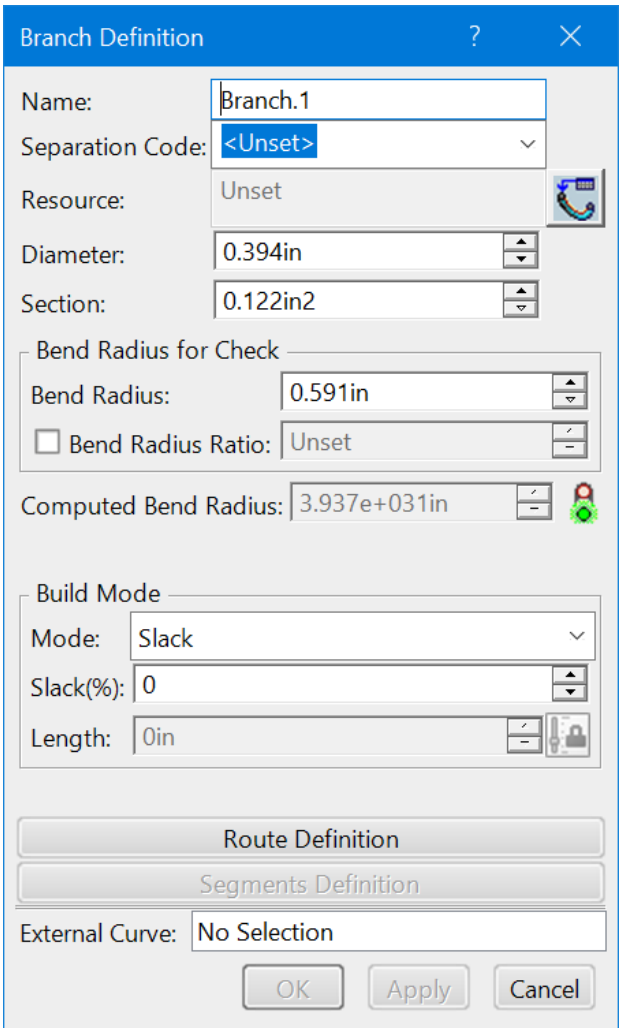


At this point, you are ready to define the branch segment.

Activate the *ELEC080 - Electrical Geometry*.

Select the Electrical Branch Geometry icon.  The *Electrical Branch Geometry* window appears.

Key in ELEC080 - Electrical Branch Geometry for the *Title* and select *OK*. This will start a branch.

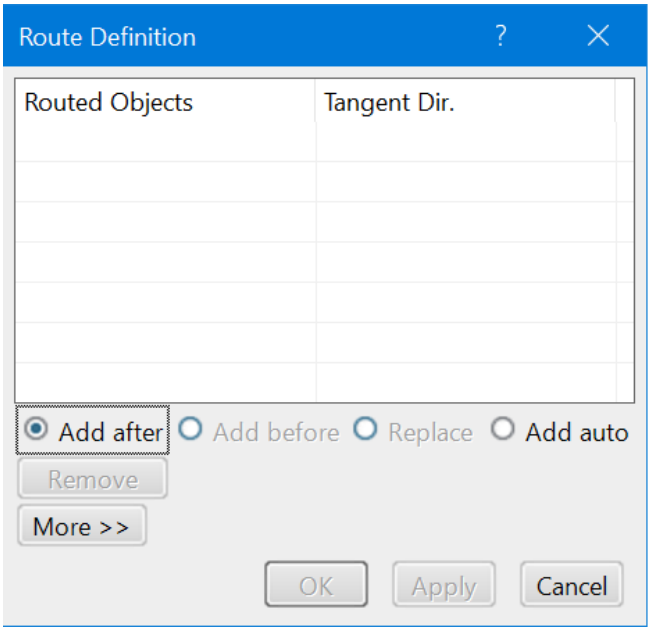


Change the *Name* of the branch to Main Branch. This will set the name of the first branch you are going to create.

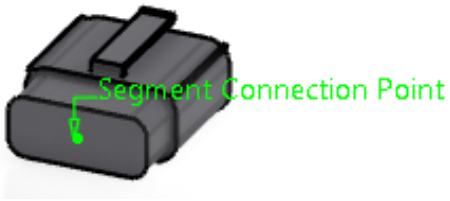
Change the *Diameter* to 0.5in and the *Bend Radius* to 1.0in. Again, it is a good rule of thumb to make sure that your bend radius is larger than your branch diameter.

With the *Build Mode* set to *Slack*, set the *Slack* percentage to 5.0. Now you are ready to define the route.

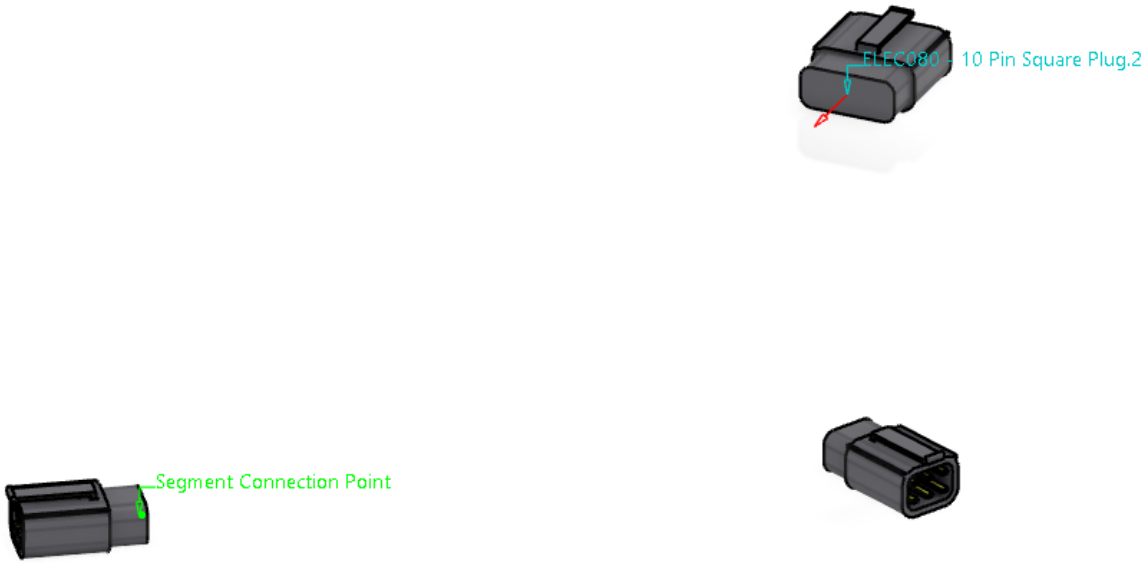
Select *Route Definition*. The *Route Definition* window appears.



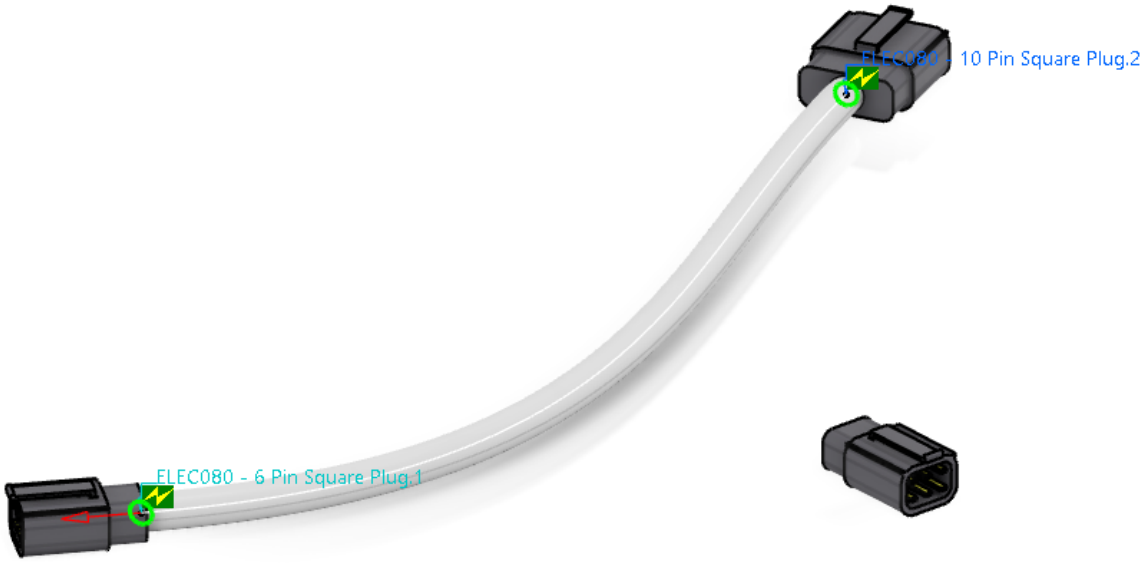
Select the 10 pin square plug. The *Segment Connection Point* text should appear.



Select the *Segment Connection Point* text to begin the route and then select the 6 pin square plug as shown.

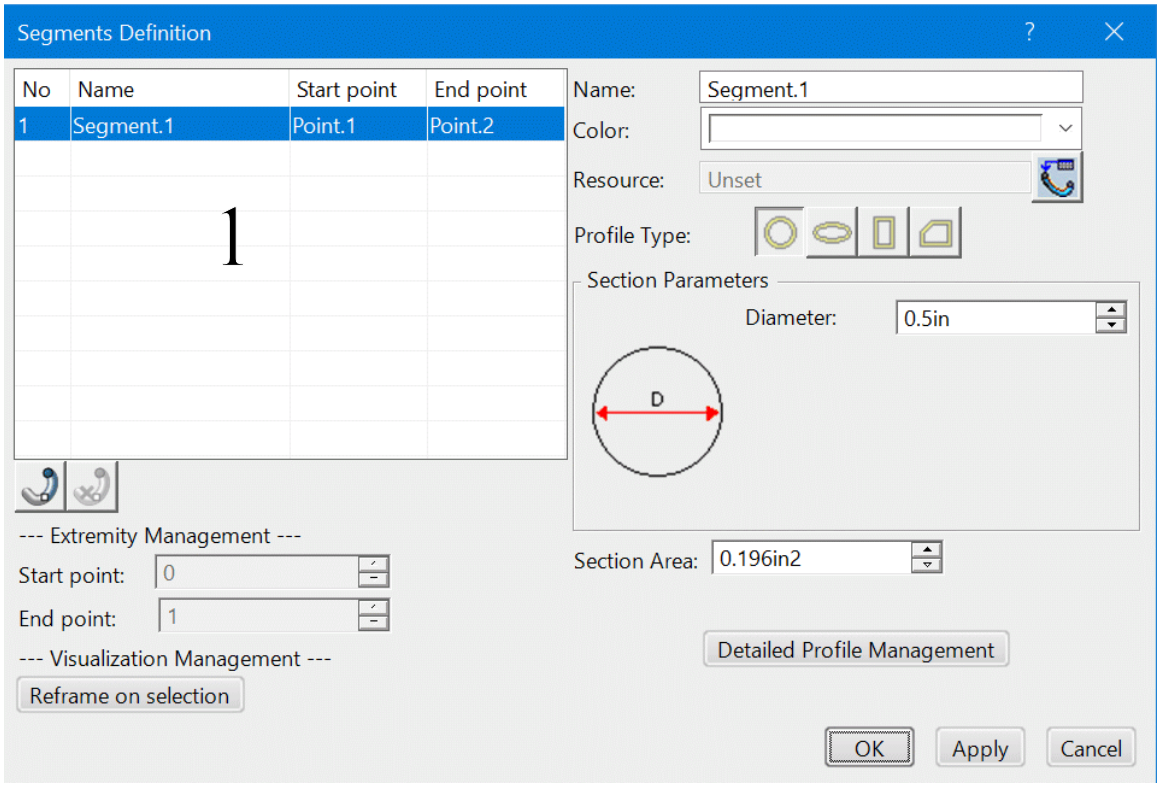


Select the connection point for the 6 pin square plug. This will define the route.



Select *OK* to the *Route Definition* window. Notice now the *Segments Definition* button is available within the *Branch Definition* window.

Select the *Segments Definition* button. This will display the *Segments Definition* window.



1 – Segment Definition This area allows you to view the various segments in a multi-branch

Add Branch Point — Creates an additional branch point along the curve

Edit Branch Point — Modifies the location of the branch point

Change Branch Point Unit — Switches the branch point units between length and ratio along the branch

Change Reference Object — Modifies the reference point being used to locate the branch point

Change Branch Point Type — Switches between Standard and Associative type branch points

Remove Branch Point — Removes the branch point

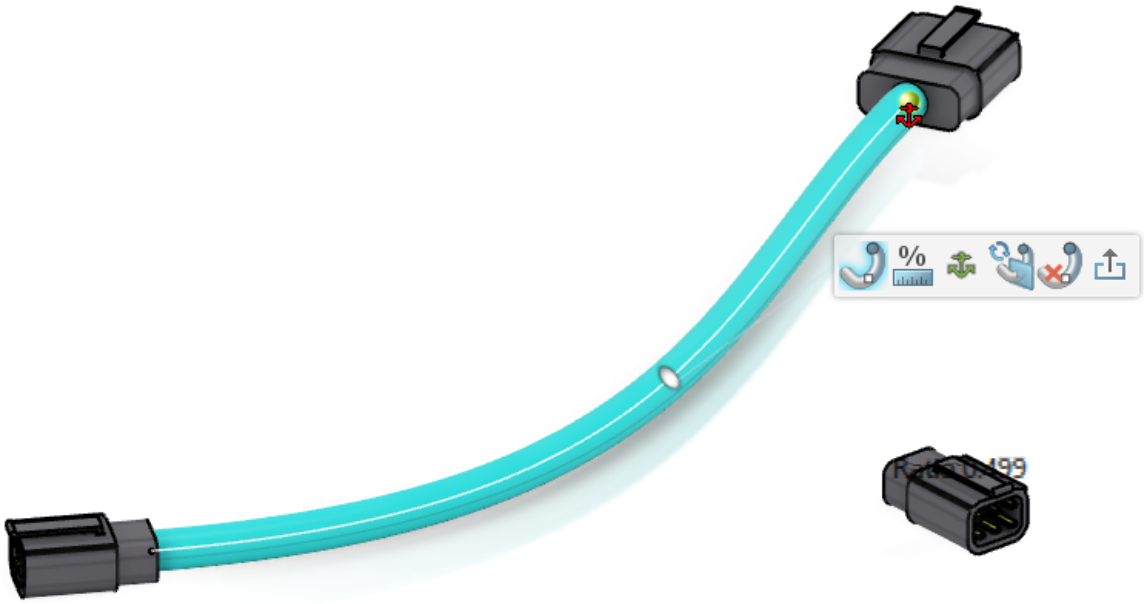
Exits Branch Point Edition	Exits the branch point edition
Remove Branch Point	Removes branch points in a bundle
Name	Specifies the name of the segment
Color	Specifies the color of the segment
Resource	Displays the unique identifier for the segment
Profile Type	Specifies the shape of the segment
Section Parameters	Specifies the size characteristics of the segment
Section Area	Specifies the cross section area of the segment. It is linked to the *Section Parameters*, so modifying one will update the other
Detailed Profile Management	Allows more in depth modification of the profiles along the segment
Extremity Management	
Start point	Defines the ratio of the curve the branch point starts
End point	Defines the ratio of the curve length the branch point ends
Visualization Management	
Reframe on Selection	Reframes and fits the bundle segment in the display

At this point, you are ready to define the branch point.

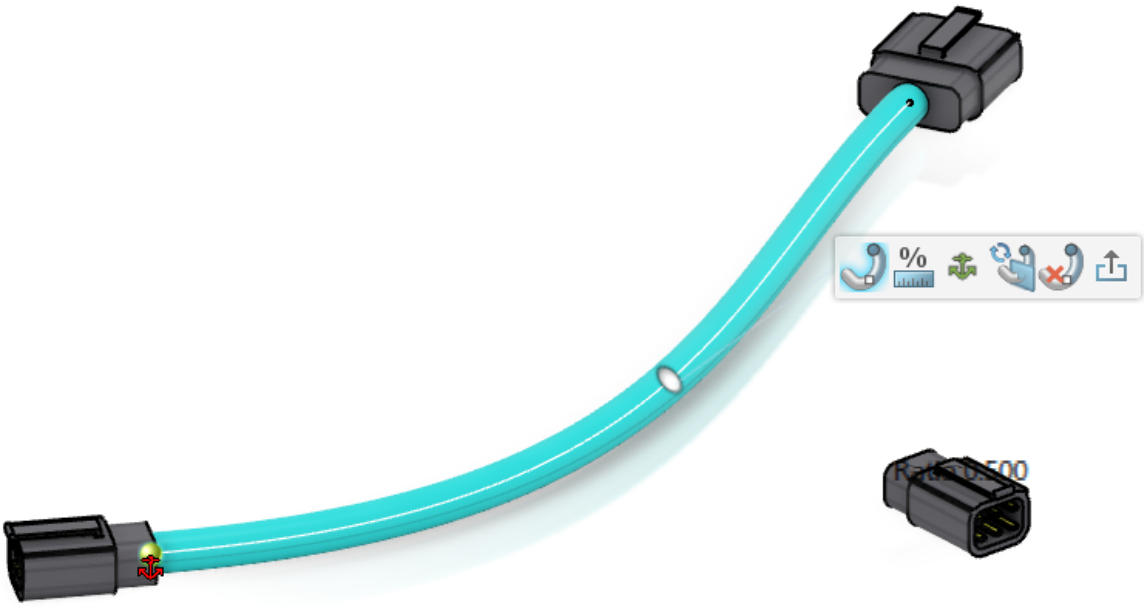
Change the *Color* to light blue. The exact shade of blue is not important, you just want to see that the color of the bundle can be changed.

Now to add a branch point.

Select the Add a Branch Point icon. Once you select the icon, the system will wait until you select the bundle segment you want to add the branch point in.



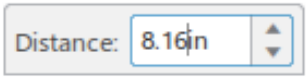
Select the Change Reference Object icon and select the symbol near the 6 pin square plug. This will switch sides of the reference point.



At this point, you need to determine how you want the branch point defined. In this case, assume you want the branch point defined a particular distance away from the other connector.

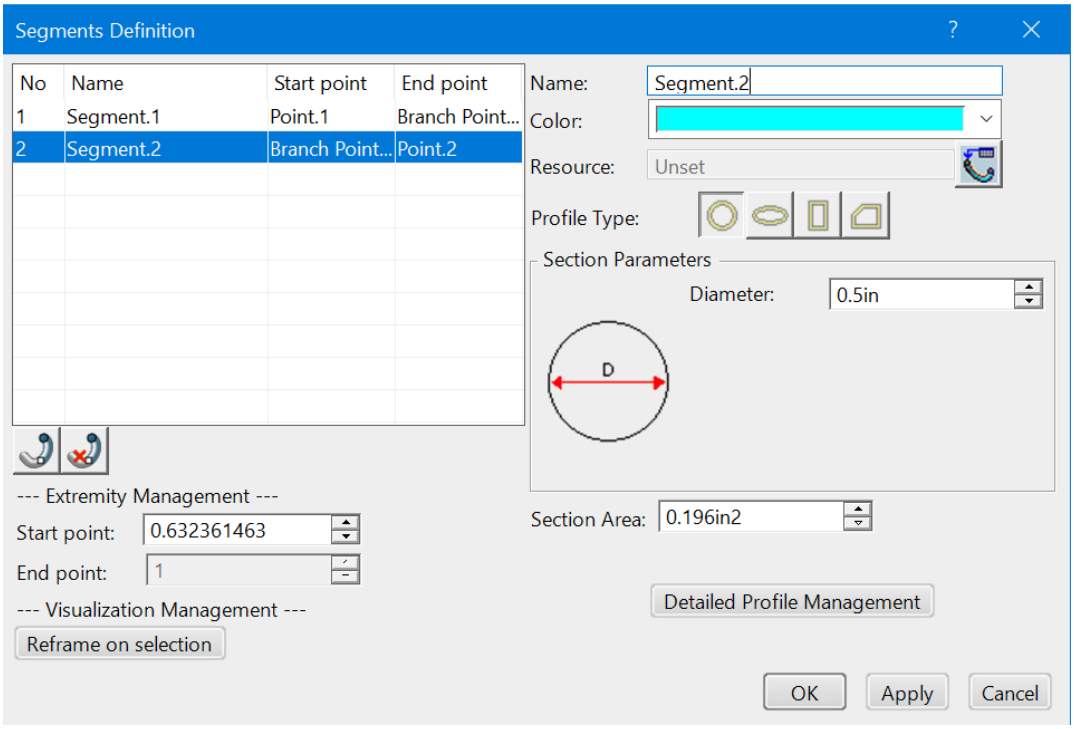
Select the Change Branch Point Unit icon.  The text in the display should change from *Ratio* to *Distance*.

Select the *Distance* text. This will allow you to edit the value.



Key in 6.0 and select Enter. This will set the distance exactly to 6 inches. Now, no matter how long the geometric bundle becomes when you install it, the distance to the break point will always be 6 inches. If you were to set it to a ratio, then the distance would adjust based on the length of the bundle.

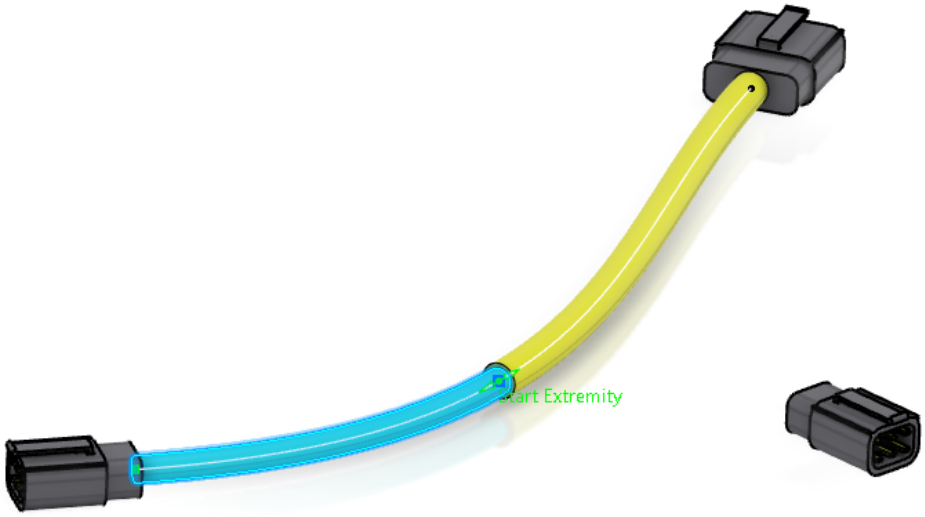
Select the Exit icon when done.  This will split the branch into two segments. Notice the segments were renamed back to the default naming scheme.



With the first segment selected in the window, change the *Color* to yellow. This will help you keep track of the various segments.

Also, notice the start and end points in the *Extremity Management*. These values are now accessible to adjust the start and end locations of the segments.

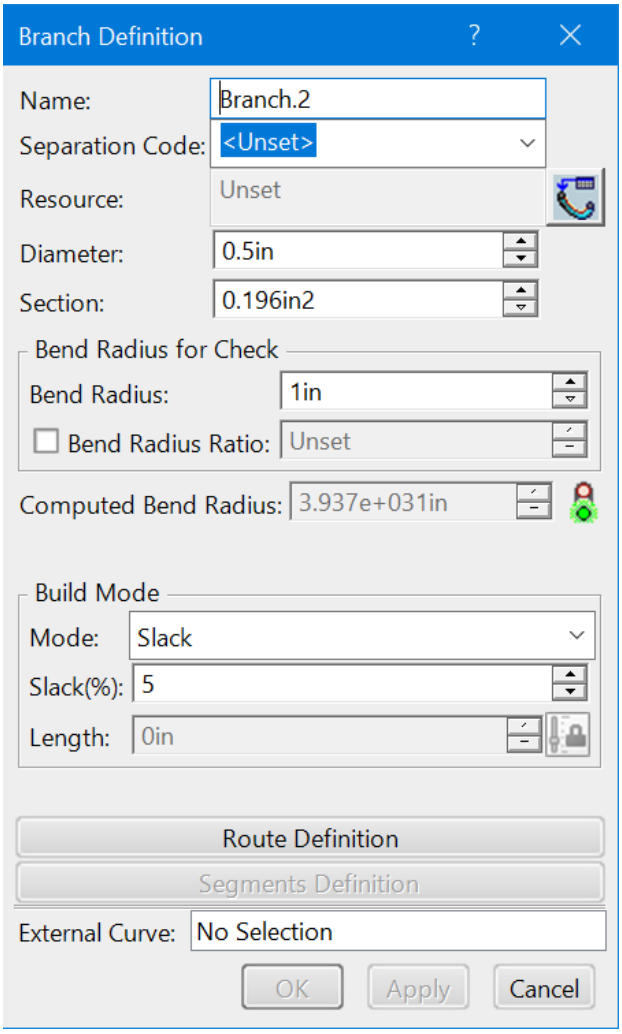
Select *Segment.2* and change the *Diameter* to 0.375in. You may need to select *Apply* to get the bundle to update properly.



Select *OK* to the *Segments Definition* window. This will have the new segments defined.

Select *OK* to the *Branch Definition* window. This will create the branch.

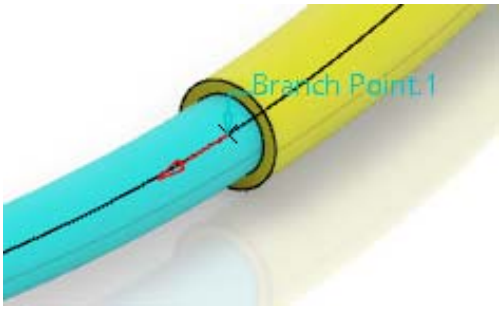
Select the Classic Branch Definition icon.  This will allow you to create a new branch within the existing branch set.



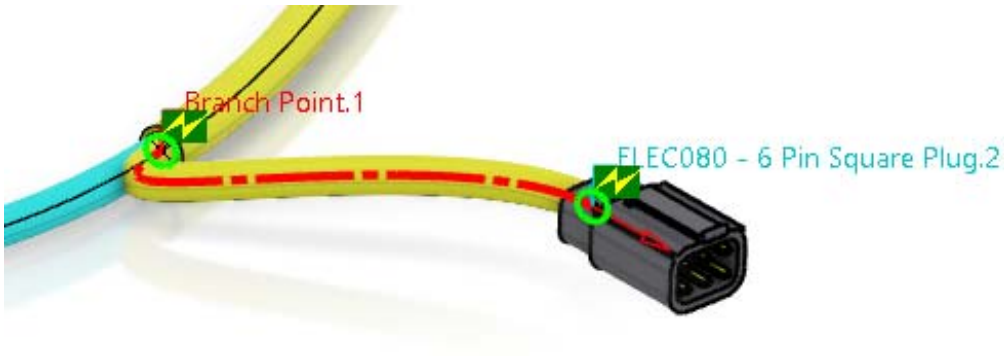
Change the *Name* to <u>Side Branch</u>, then set the *Diameter* to 0.375in. Now you are ready to define the route for the side branch.

Select *Route Definition*. At this point, you can select any of the connectors or branch points to start the route. When you select a branch point, the segment you select will help determine what extremity the branch will associate to.

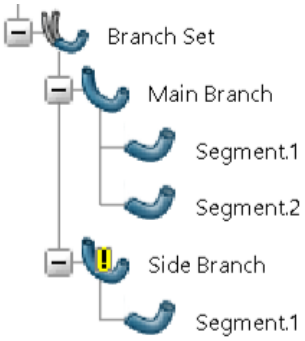
Select the yellow bundle near the split. Notice a point and arrow is shown on the bundle.



Select the other 6 pin square plug. This will add the branch.



Look closely at the specification tree.



The new branch has an exclamation point with a yellow oval around it to indicate that the bend radius might not have been respected. This is not a critical error, but it is something you will want to watch for when you install the harness into your assembly. If you find that you still have radius issues at installation, then you may need to look at adjusting the branch point or adding additional slack.

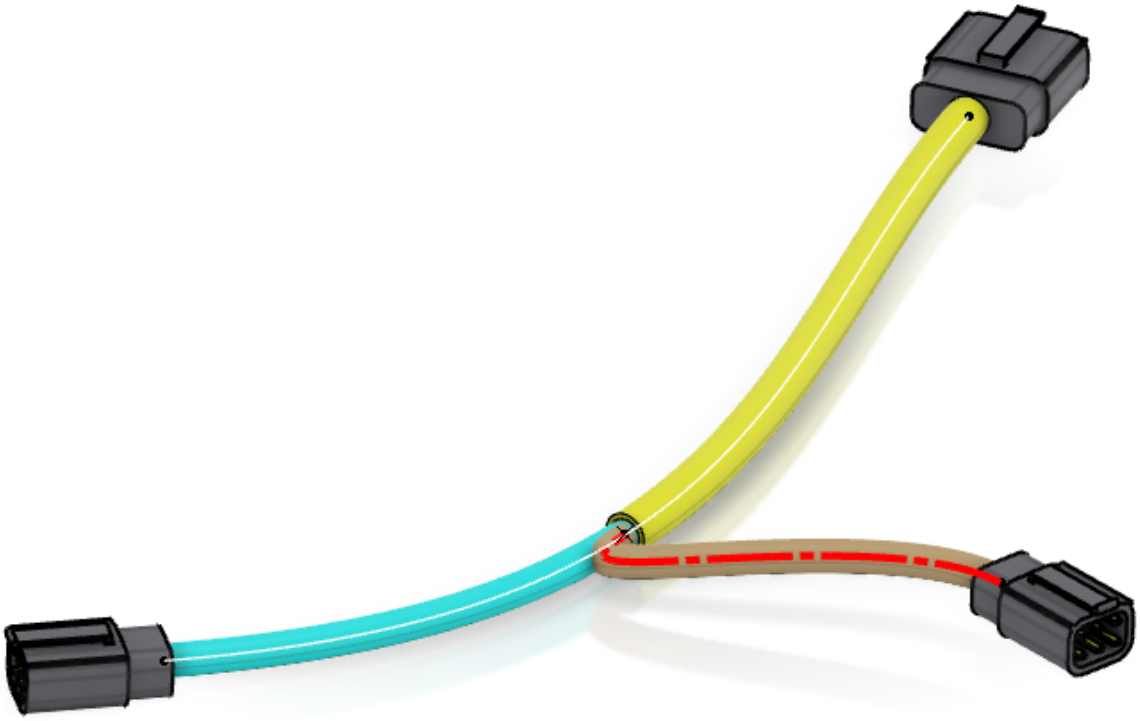
Select *OK* to the *Route Definition* window.

Select the *Segments Definition* button. The *Segments Definition* window appears.

Change the *Color* to tan. This will better differentiate the segment.

Select *OK* to the *Segments Definition* window.

Select *OK* to the *Branch Definition* window. This will have the next branch defined. It should appear as shown.



Select the Exit icon to return to the Electrical 3D Design workbench. 

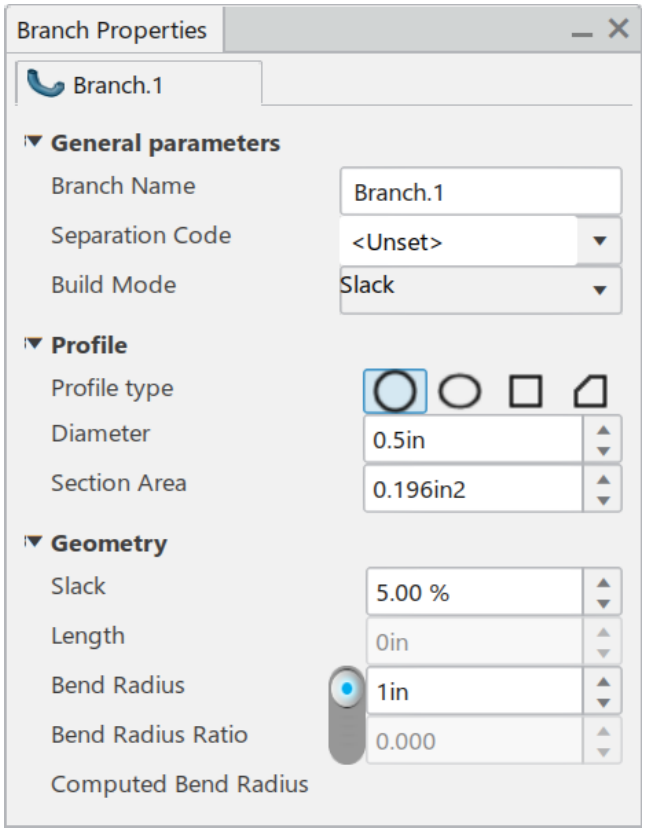
Delete the *ELEC080 - Electrical Branch Geometry* from the tree. You will create the same harness using the immersive options.

Select the Electrical Branch Geometry icon.  The *Electrical Branch Geometry* window appears.

Key in ELEC080 - Electrical Branch Geometry for the *Title* and select *OK*. This will start a branch and the Branch Definition window appears.

Select *Cancel*.

Select the Immersive Branch Definition icon.  The *Branch Properties* window appears.

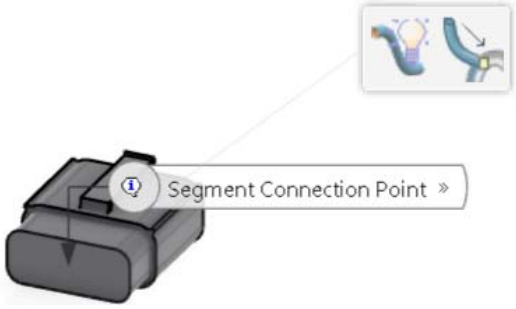


Change the *Name* of the branch to <u>Main Branch</u>. This will set the name of the first branch you are going to create.

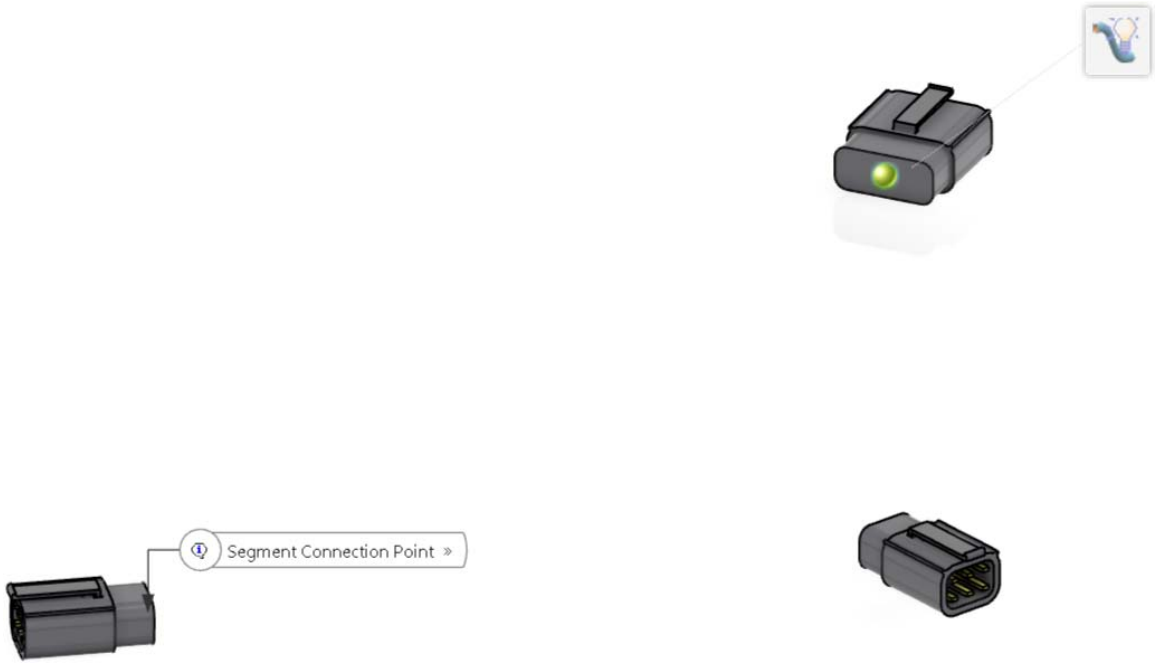
Change the *Diameter* to 0.5in and the *Bend Radius* to 1.0in. Again, it is a good rule of thumb to make sure that your bend radius is larger than your branch diameter.

With the *Build Mode* set to *Slack*, set the *Slack* percentage to 5.0. Now you are ready to define the route.

Select the 10 pin square plug. The *Segment Connection Point* text should appear.



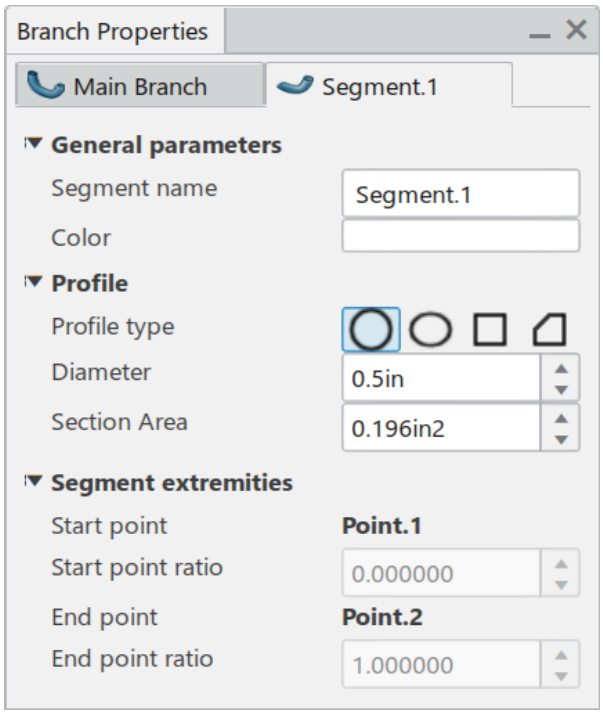
Select the *Segment Connection Point* text to begin the route and then select the 6 pin square plug as shown.



Select the connection point for the 6 pin square plug. This will define the route.

Notice now the *Segment.1* tab appears within the *Branch Properties* window.

Select the *Segment.1* tab. It should appear as shown.



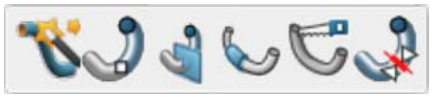
Segment name	Specifies the name of the segment
Color	Specifies the color of the segment
Profile Type	Specifies the shape of the segment
Diameter	Specifies the diameter of the segment
Section Area	Specifies the cross section area of the segment. It is linked to the *Diameter*, so modifying one will update the other
Start point	Defines the ratio of the curve the branch point starts
End point	Defines the ratio of the curve length the branch point ends

At this point, you are ready to define the branch point.

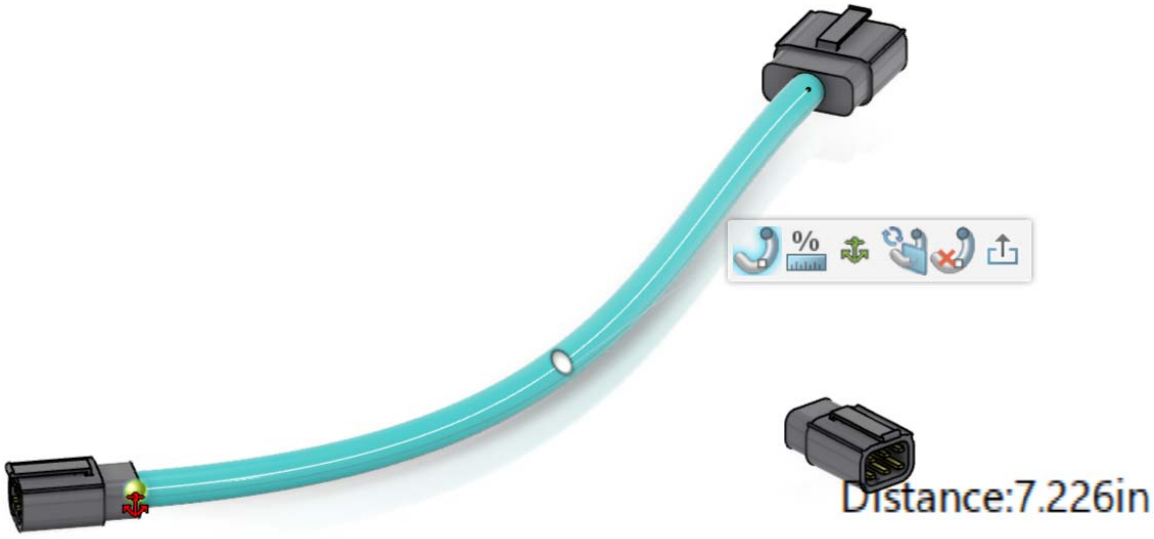
Change the *Color* to light blue. The exact shade of blue is not important, you just want to see that the color of the bundle can be changed.

Now to add a branch point.

From the toolbar in the display, select the Creation Mode icon.  The toolbar expands as shown.



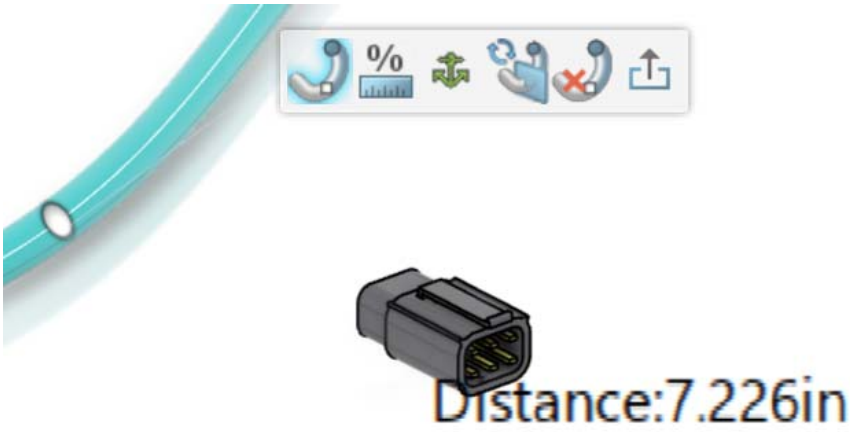
Select the Add a Branch Point icon.  The point appears as shown and the toolbar changes.



Use the Change Reference Object icon to get the red anchor near the 6 pin square plug if needed.  This will switch sides of the reference point. It should appear as shown above.

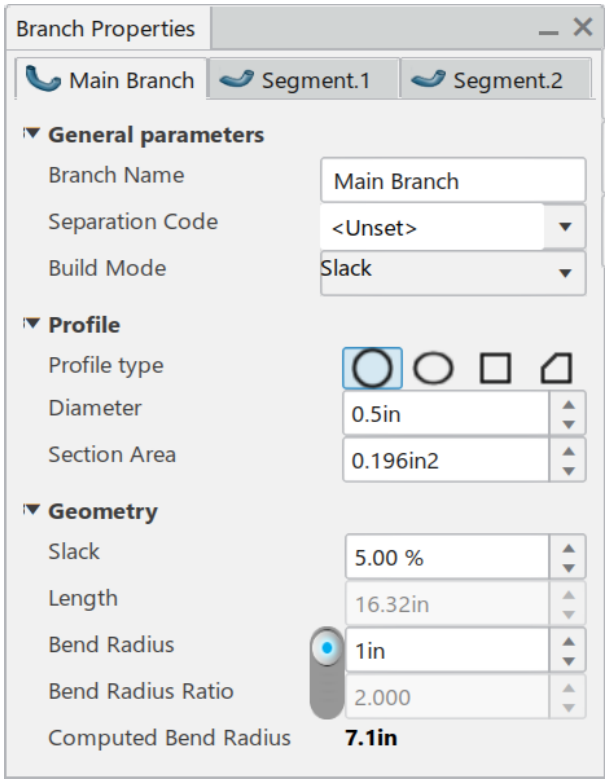
At this point, you need to determine how you want the branch point defined. In this case, assume you want the branch point defined a particular distance away from the other connector.

Use the Change Branch Point Unit icon if needed to switch to *Distance*.  The text in the display should be *Distance* rather than *Ratio*.



Select the *Distance* text, key in 6.0 and select Enter. This will set the distance exactly to 6 inches. Now, no matter how long the geometric bundle becomes when you install it, the distance to the break point will always be 6 inches. If you were to set it to a ratio, then the distance would adjust based on the length of the bundle.

Select the Exit icon when done.  This will split the branch into two segments. Notice the segments were renamed back to the default naming scheme.

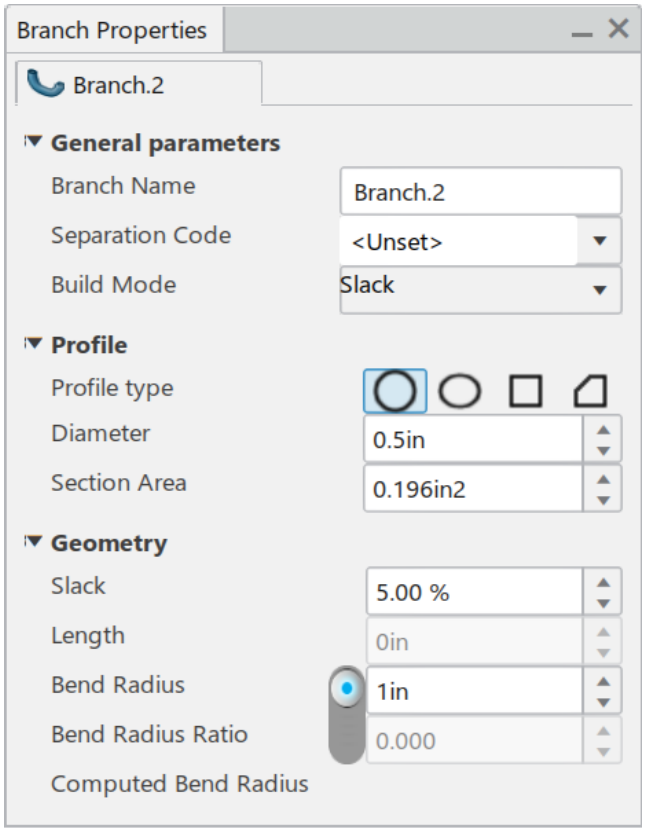


Switch to the *Segment.1* tab in the window and change the *Color* to yellow. This will help you keep track of the various segments.

Also, notice the start and end points in the *Extremity Management*. These values are now accessible to adjust the start and end locations of the segments.

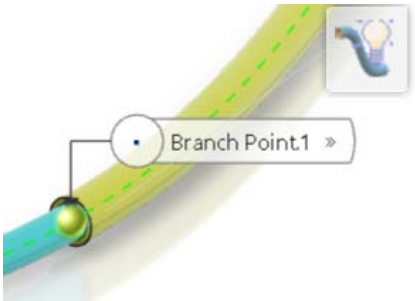
Select the *Segment.2* tab and change the *Diameter* to 0.375in. You may need to select the Tab key to get the bundle to update properly.

Select the Start New Branch icon from the toolbar.  This will allow you to create a new branch within the existing branch set.

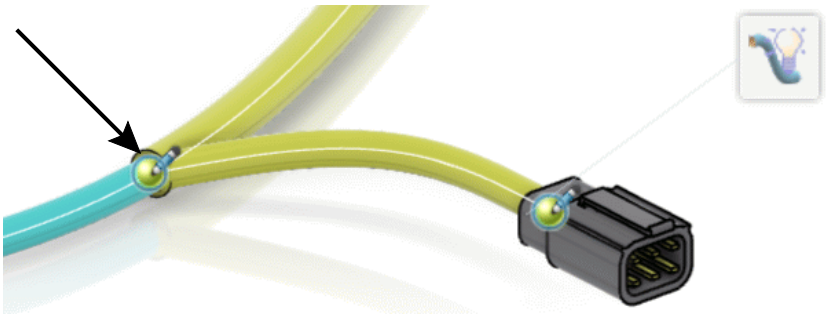


Change the *Name* to <u>Side Branch</u>, then set the *Diameter* to 0.375in. Now you are ready to define the route for the side branch.

Select the yellow bundle near the split. Notice a point and arrow is shown on the bundle.

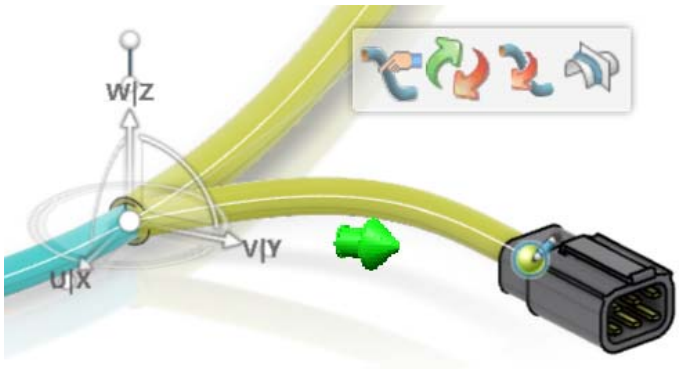


Select the other 6 pin square plug. This will add the branch.

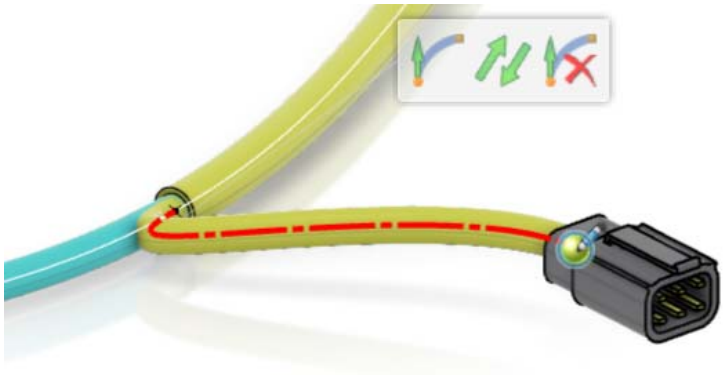


Notice the tangency doesn't look right.

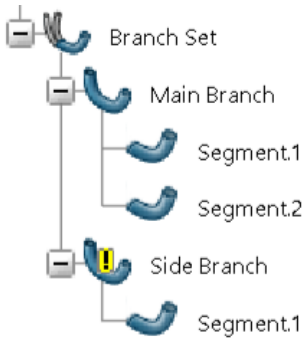
Select the branch point symbol as shown above. The display should appear as shown.



Select the Tangency Mode icon in the toolbar and select the main curve.  It should appear as shown.



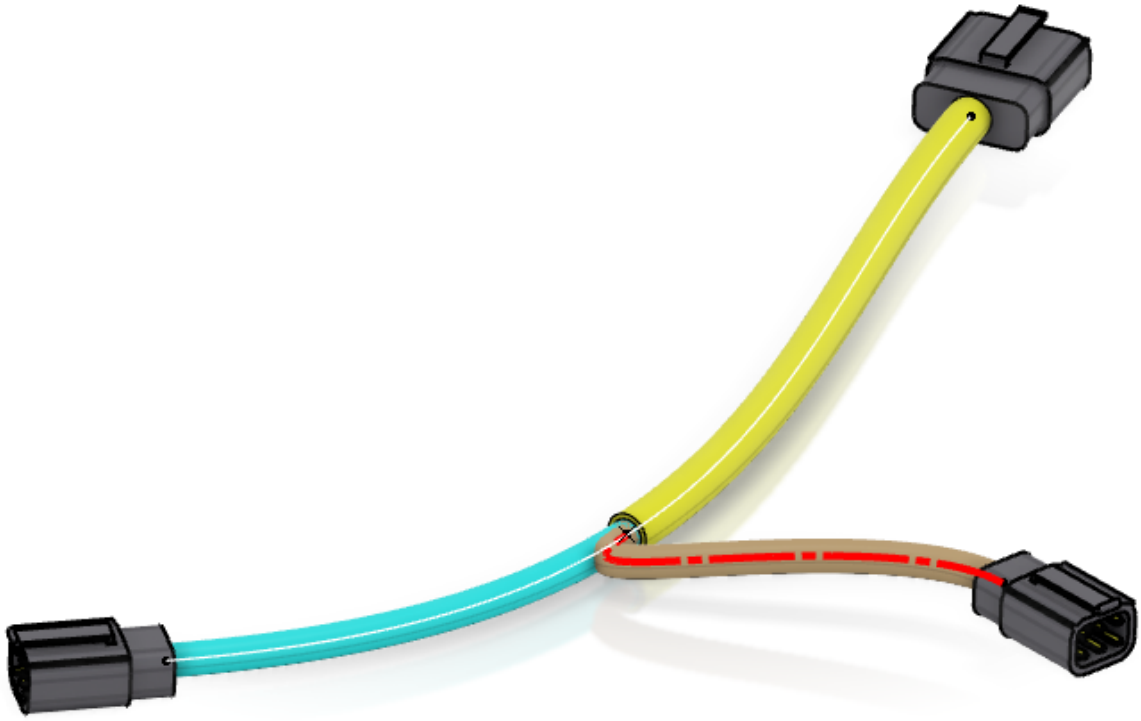
Look closely at the specification tree.



The new branch has an exclamation point with a yellow oval around it to indicate that the bend radius might not have been respected. This is not a critical error, but it is something you will want to watch for when you install the harness into your assembly. If you find that you still have radius issues at installation, then you may need to look at adjusting the branch point or adding additional slack.

Select the *Segment.1* tab and change the *Color* to tan.

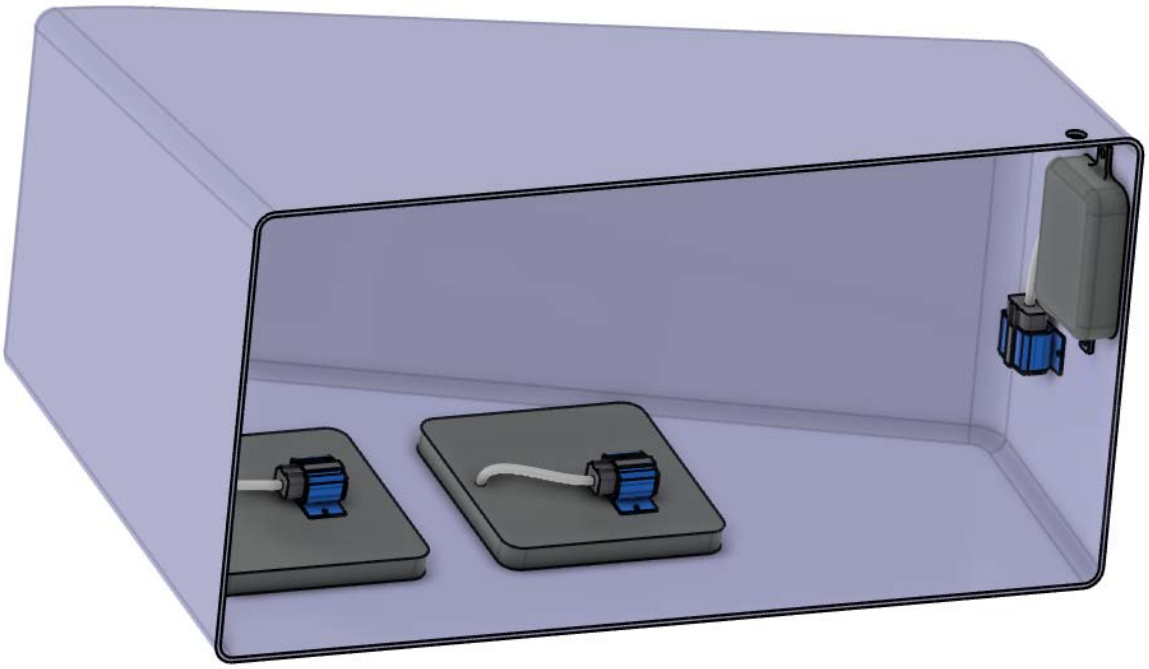
Select in the display to complete the branch. This will have the next branch defined. It should appear as shown.



Select the Exit icon to return to the Electrical 3D Design workbench. 

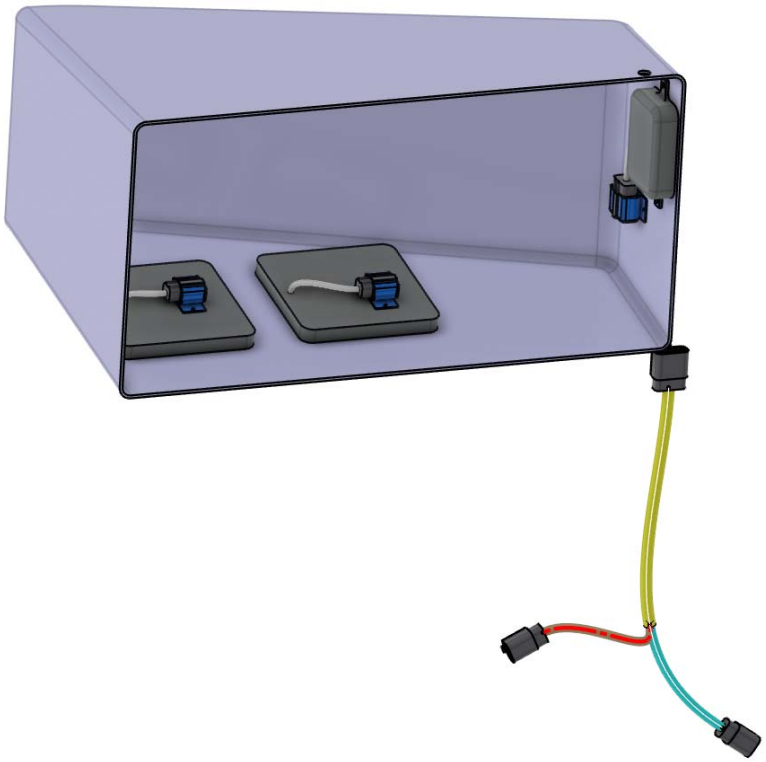
Save and close your document.

Open the ELEC090 - Branch Installation product. This is a simple box to put the wire harness you just created into. It should appear as shown.



With the right mouse button, select on the *ELEC090 - Branch Installation* product from the specification tree and select *Insert*, *Existing Product*.

Search for and select the ELEC090 - Multi-Branchable product. It should appear as shown.

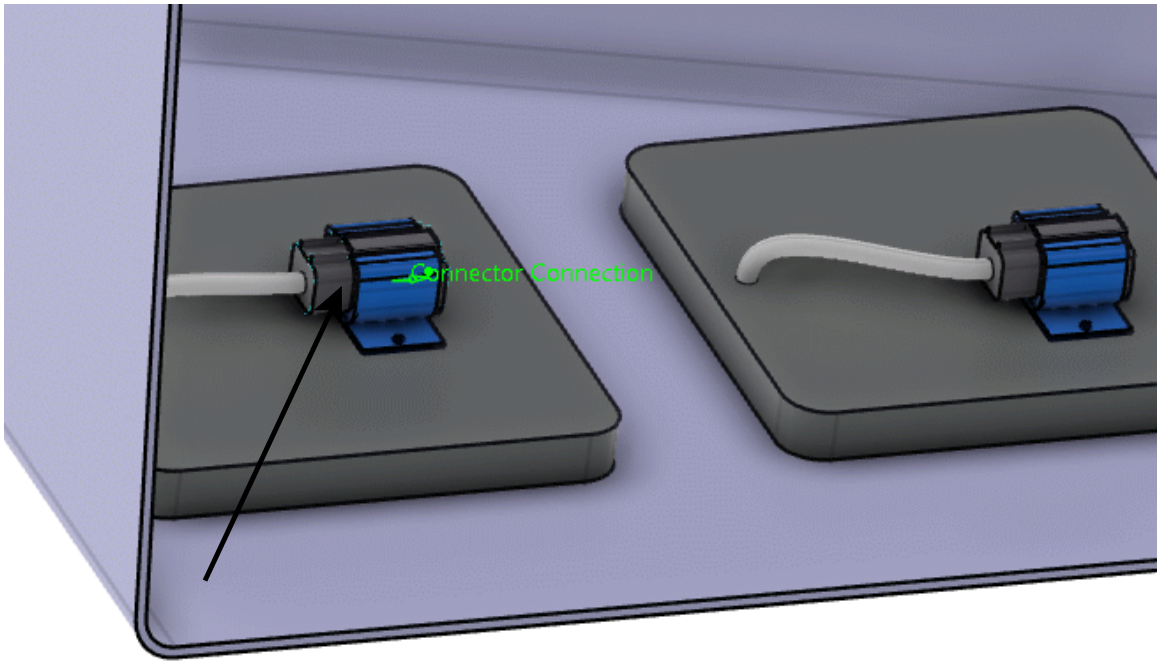


At this point, you are ready to begin making the necessary connections to install the harness into the box.

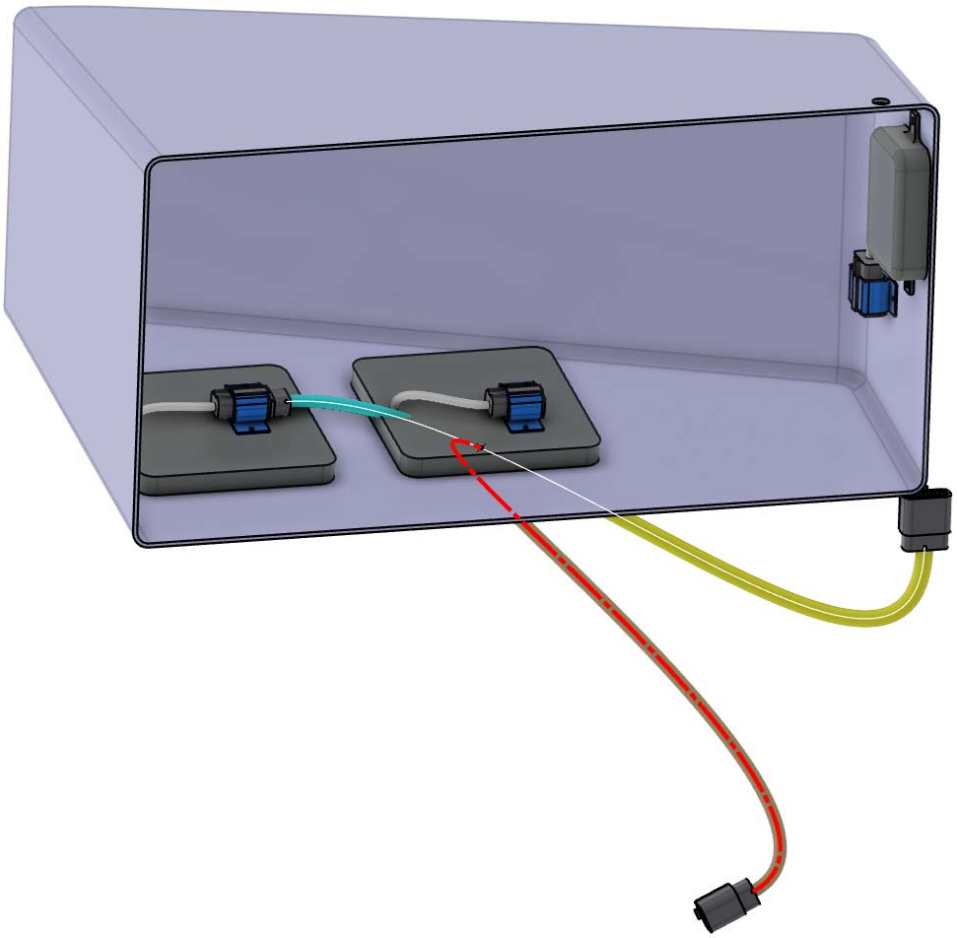
If not already there, switch to the Electrical 3D Design workbench. Since you are connecting two electrical connectors together, you can use the connect devices tools.

Select the Connect Devices icon, then select the connector on the light blue bundle segment.  This will indicate what connector you are going to connect first.

Select the 6 pin connector on the left as shown. You may have to select the connector twice if it is in visualization mode.



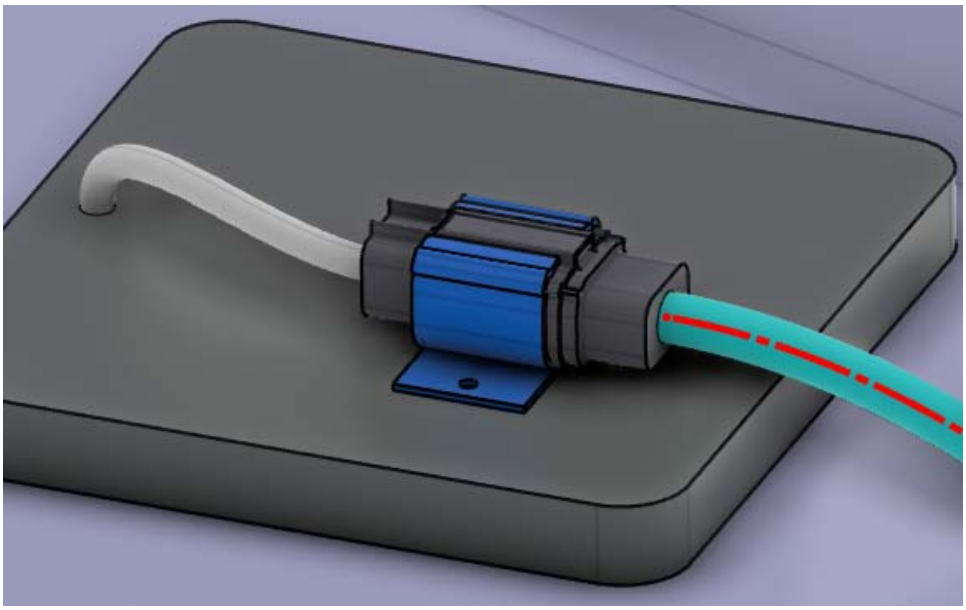
Take note of the resulting wire bundle.



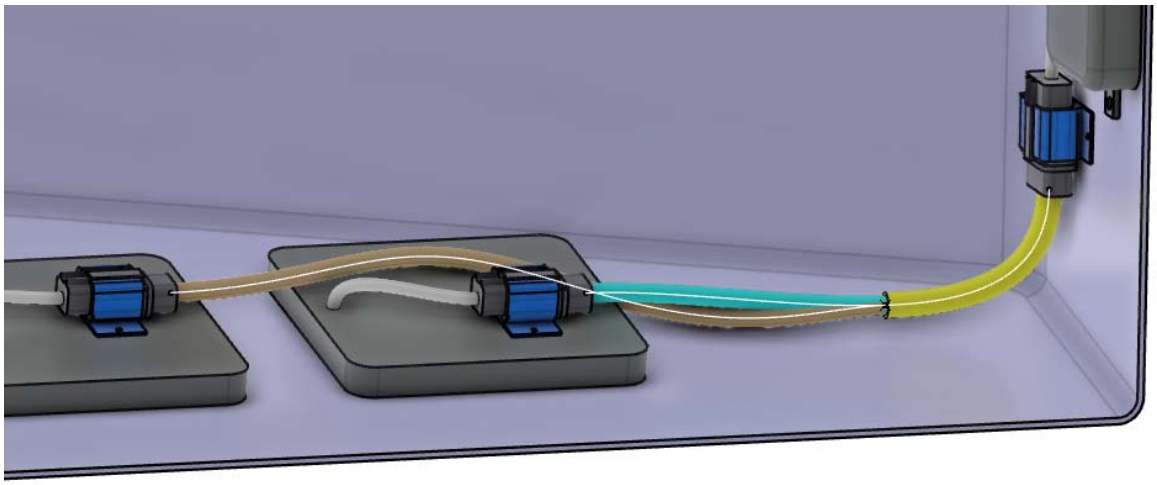
Notice the segment split location. Since you defined the split point to be 6 inches from the end of the blue segment, no matter how long the main segment becomes, the split point will always be 6 inches from that end. The tan and yellow bundle segments will dynamically resize since they were not limited by length.

Select the Disconnect Devices icon, then select the two connectors you just attached together.  This will electrically disconnect the two connections.

Select the Connect Devices icon again, then select the connector on the blue bundle segment and the 6 pin connector on the right.  This will connect it to the other connector.



Connect the other connectors. It should appear as shown.



Notice the twisted branch. This will get fixed as you begin adding supports and other links to your branches.

Save and close your document.

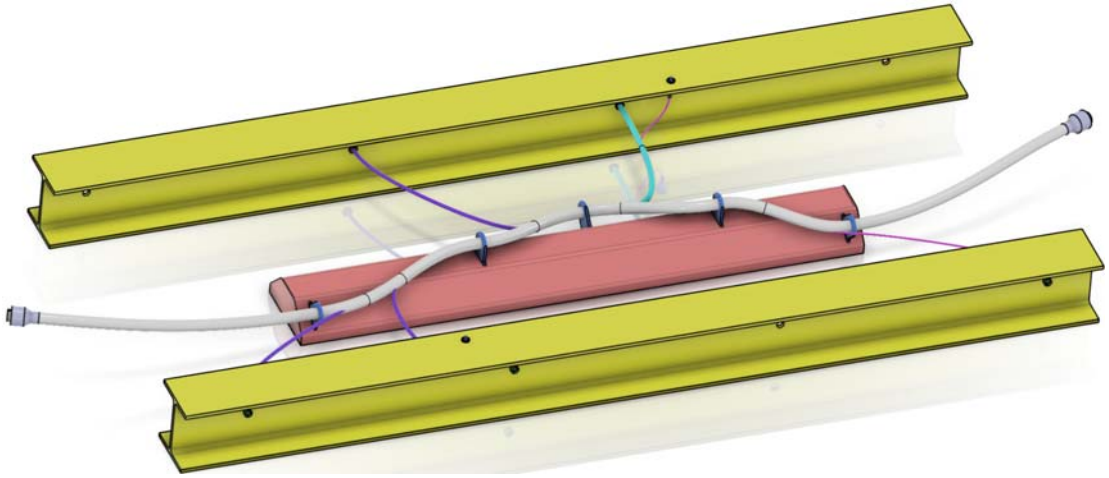
Electrical Manufacturing Preparation

Flattening the bundle is generally the final step to any development of a geometrical bundle. Before a bundle can be manufactured, it will generally need to be flattened for dimensions on wire length, as well as form board development and connector call outs. There are a few key points to keep in mind when flattening your geometric bundle. First, the flattened geometric bundle is separate from the bent geometric bundle. This allows the flattened geometric bundle to maintain associativity in dimensions and geometry, but not in the shape of the bundle. The second thing to keep in mind is that the flattened document is generally used for drafting and FTA markup and annotations. Although this will be touched on here, this will not be the focus of this section.

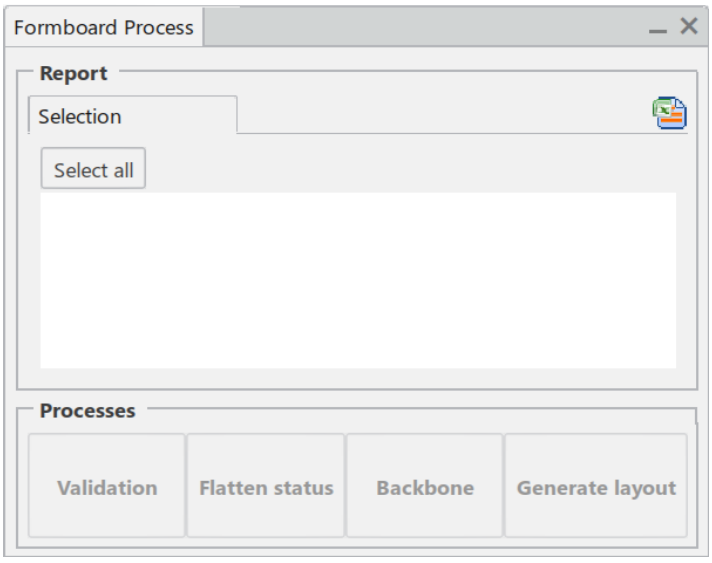
Formboard Creation

The formboard and prepare layout options are the newest methods for creating harness flattening. This section will demonstrate the process.

Open the ELEC340 - Flattening Orientation document. It should appear as shown.

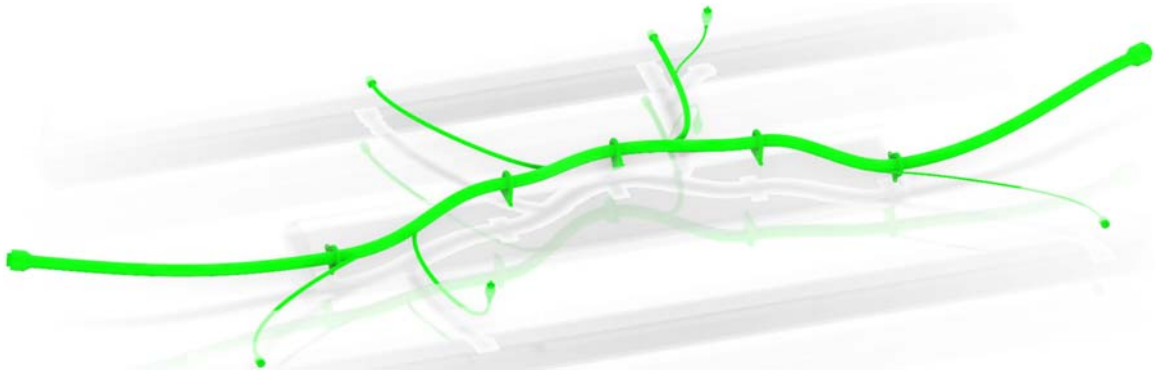


Select the Formboard icon.  The *Formboard Process* window appears.



Select the *ELEC340 - Electrical Geometry* in the tree to define what will be included. It should appear in the window and it should highlight in the display.

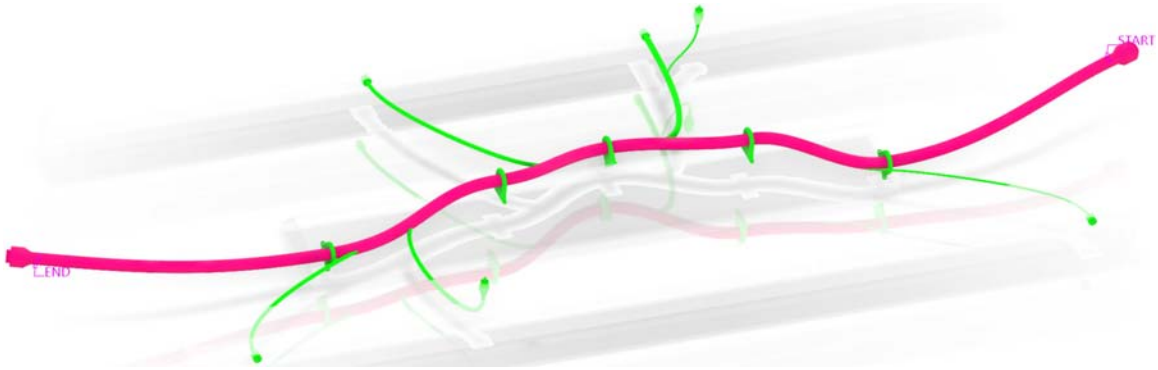
Select the *Validation* button. The harness should highlight green as shown.



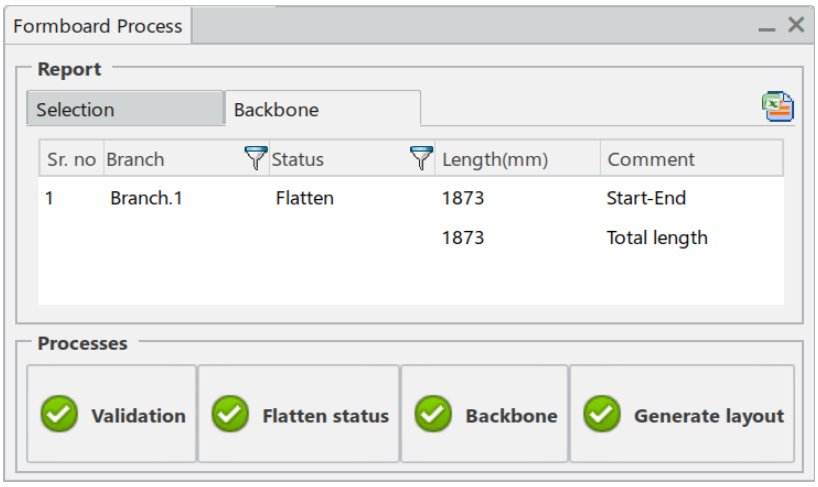
Green	Specifies the branch can be flattened
Yellow	Specifies the branch cannot be flattened
Magenta	Specifies the branch can be flattened, but will not be straightened
Blue	Specifies the branch is already flattened

Select the *Flatten status* button in the window. Everything should remain green.

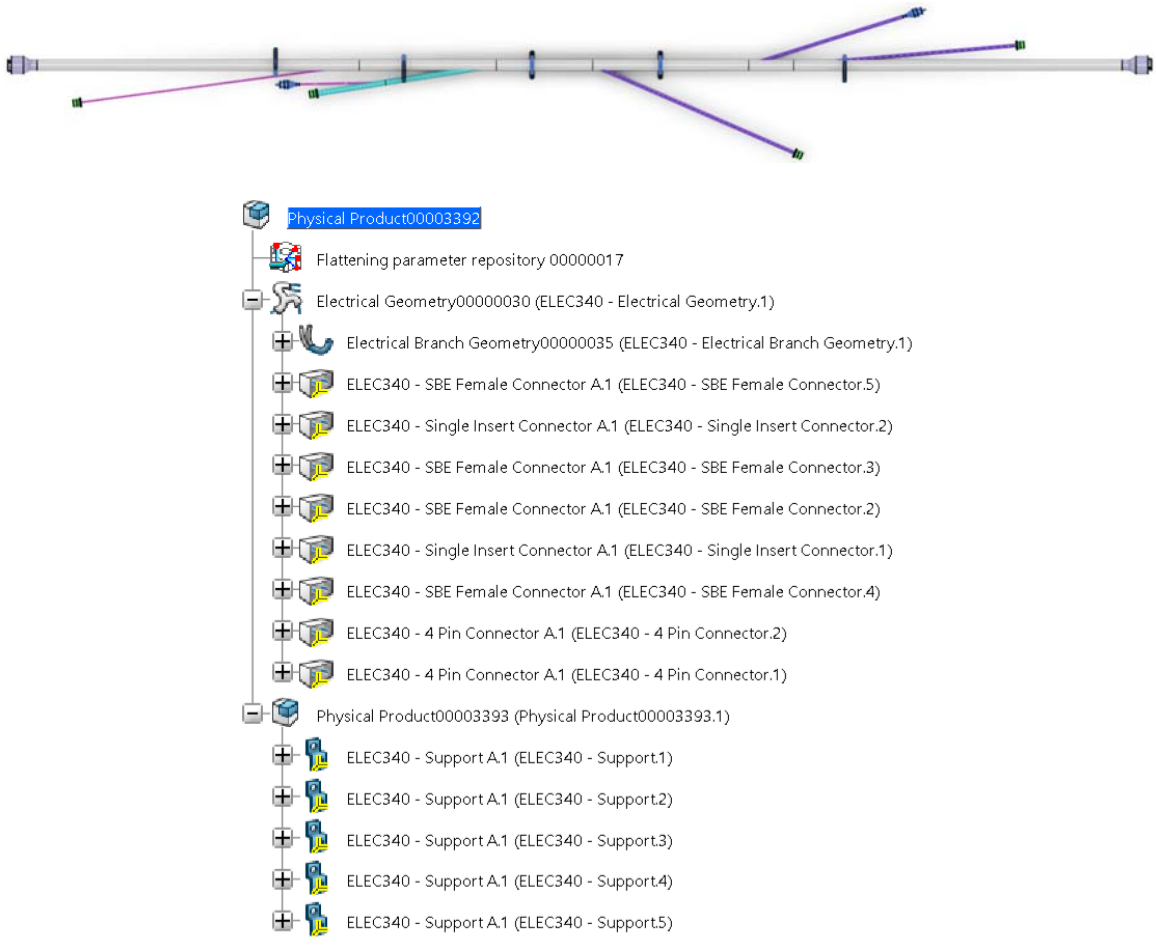
Select the *Backbone* button. The main branch should change to pink and should have the start and end labled.



Select the *Generate layout* button. A new product is created in a new tab. The *Formboard Process* window should appear as shown.



Close the *Formboard Process* window and switch to the new product tab. It should appear as shown.



The entire harness was brought over including any internal electrical connectors. Notice a separate product was also created that includes any supports that were used by, but not internal to the harness.

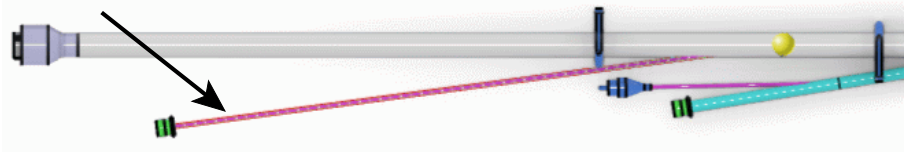
Prepare Layout

The prepare layout option allows you to modify the flattened harness in order to optimize the layout for manufacturing.

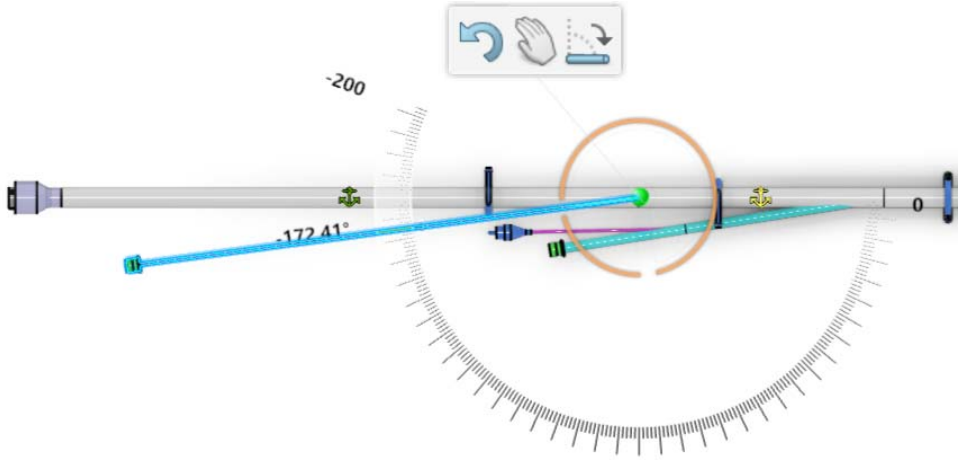
Select the Prepare Layout icon.  The layout toolbar appears.

	Undo	Undoes the previous modification
	Punctual Mode	Allows modification of a segment
	Local Mode	Allows modification of a branch
	Global Mode	Allows modification of a junction or GBN
	Rotate	Performs a rotation
	Roll	Performs a roll (bend)
	Arrange Junction	Arranges a junction around the bundle extremity
	Scale	Scales a branch
	Straighten	Straightens a branch
	Close Loop	Closes the loop by positioning the open branch extremity near the second end of the loop

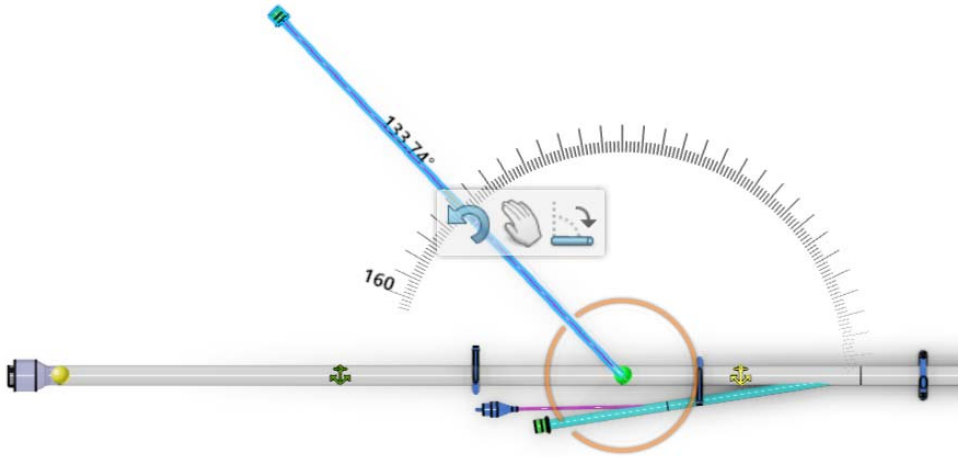
Select the Rotate icon and move your mouse over the branch as shown.  Notice the yellow sphere that appears at the opposite end of the branch. This specifies which end of the branch will be modified.



Once the yellow sphere appears at the base of the branch, go ahead and select the branch. A rotational object will appear as shown.

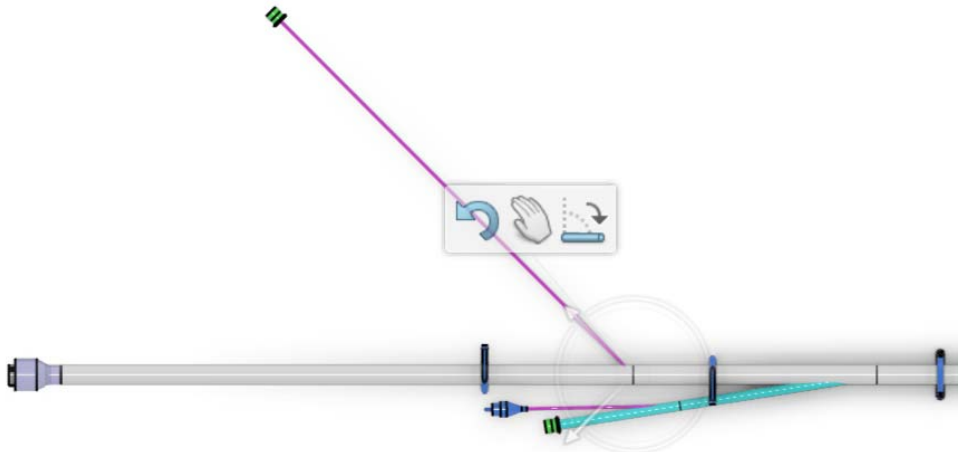


Drag the branch around approximately as shown.

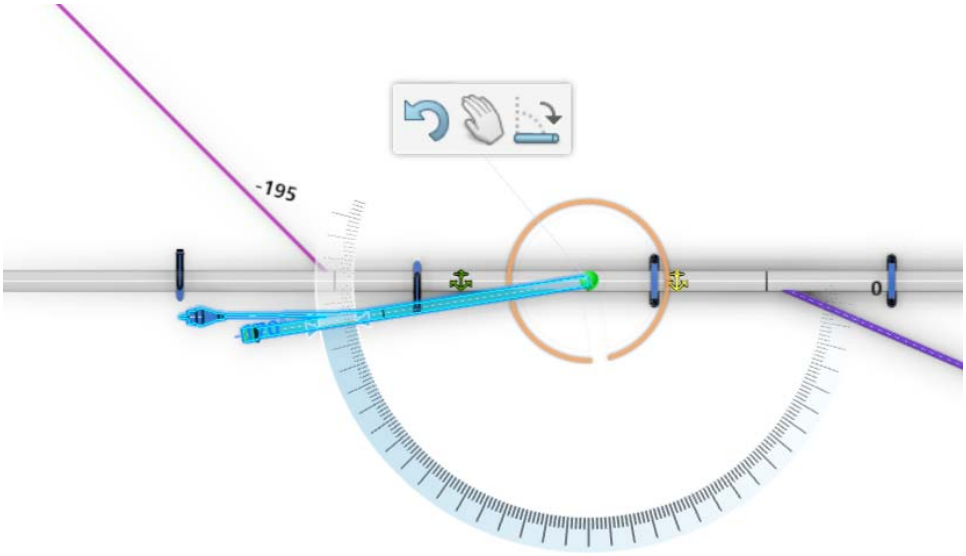


Select the value near the branch, key in 135 and select Enter. This will set the angle for the branch rotation.

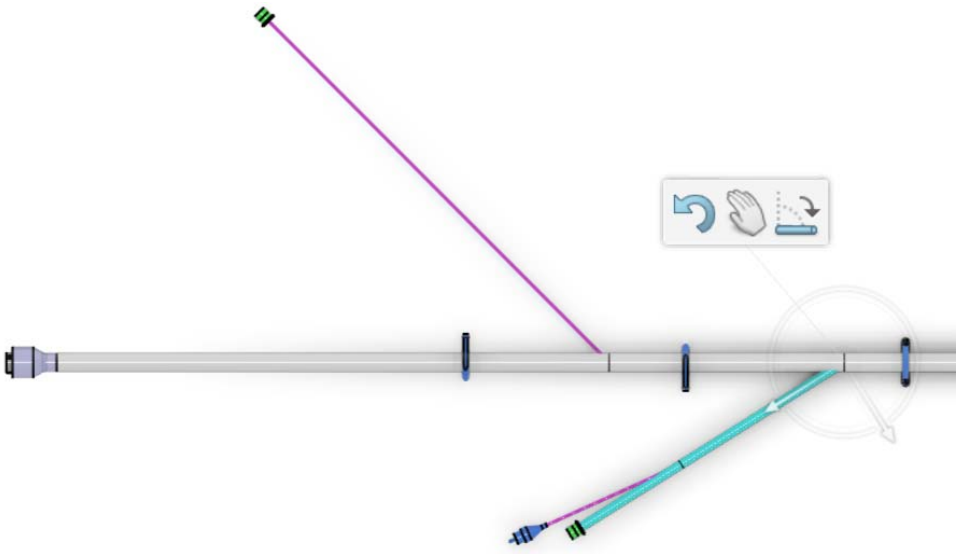
Select in space. The branch should appear as shown.



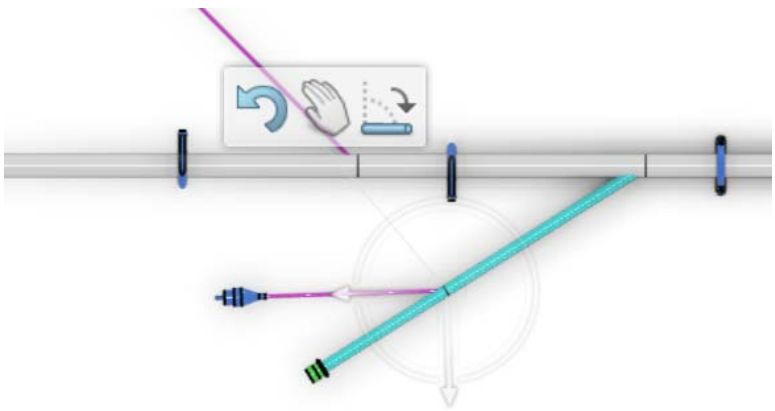
Select near the end of the teal branch. The rotation object should appear as shown.



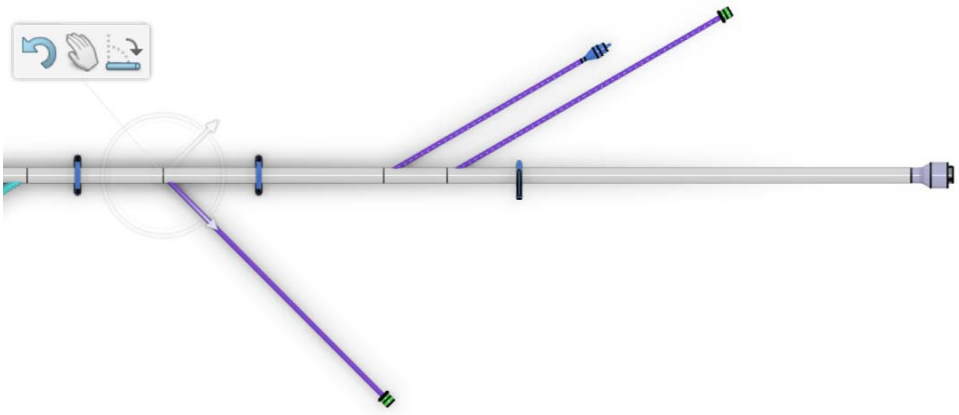
Rotate the branch to -150 degrees and select in space.



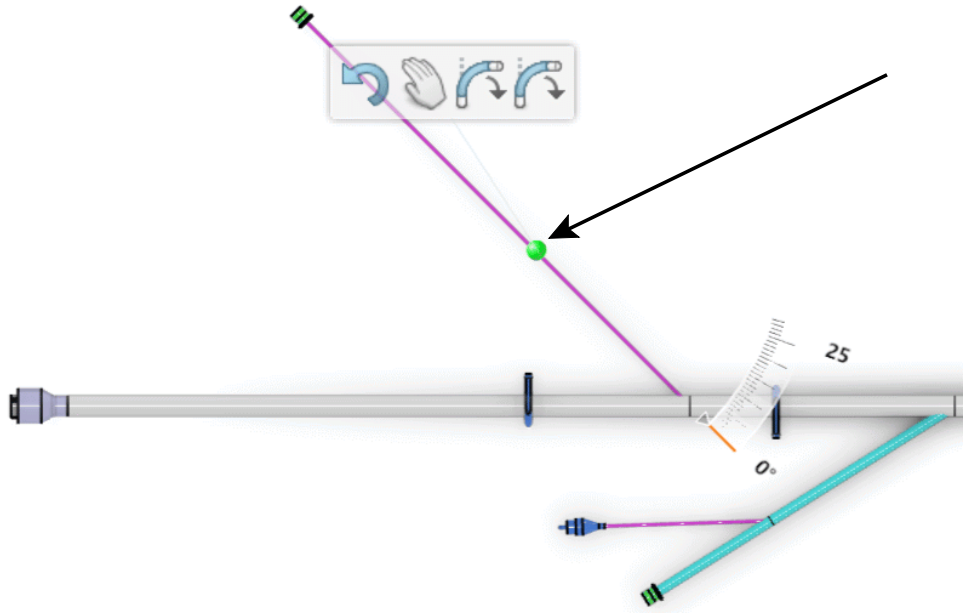
Select the end of the small branch protruding from the teal branch and rotate it to be -30 degrees. Select in space when done. This will put it parallel to the main branch.



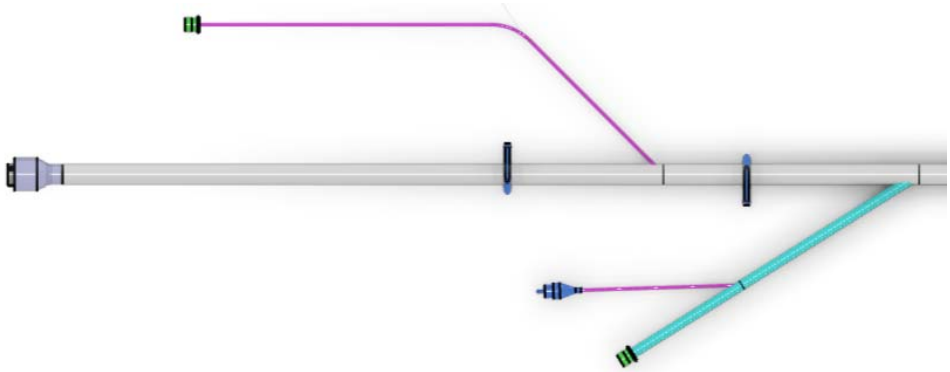
Rotate the 2 purple branches on the top of the main branch to be 30 degrees from the main branch and rotate the purple branch on the bottom to be -45 degrees. They should appear as shown.



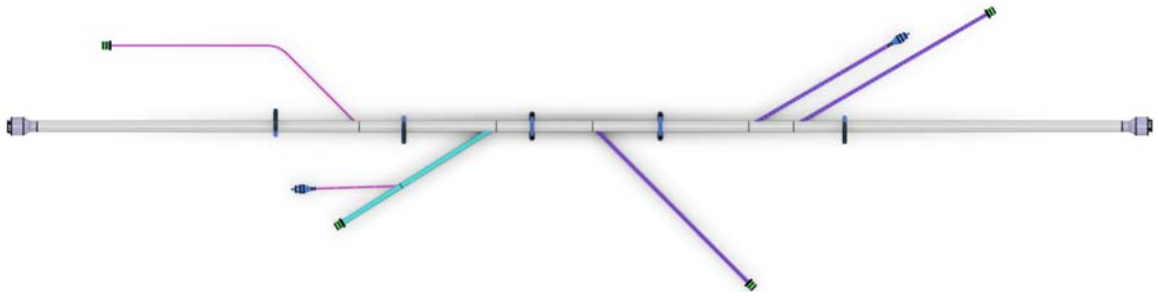
Select the Roll icon and select the branch as shown. 



Roll the end of the branch to be 45 degrees and select in space. It should appear as shown.



Select the Prepare Layout icon to complete the manipulation.  The harness should appear as shown.



Rename the top level product and the sub assembly as shown.

Save the document. Leave it open for the next exercise.

