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## **Introduction**

### **CATIA Version 5 Electrical Harness Design**

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

- Define geometric bundles
- Define complete harnesses of a dynamic length
- Define complete harnesses of a static length
- Develop harnesses within the context of a product
- Develop and utilize a harness in multiple products


















## **Electrical Harness 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 Harness Assembly and the Electrical Harness Installation workbenches. The Electrical Harness Assembly workbench will allow you to work with the geometric bundle as a whole. The Electrical Harness Installation 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 Harness Installation workbench is a separate workbench, it is generally only accessed through the Electrical Harness Assembly 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 Harness Assembly workbench works in the product environment, whereas the Electrical Harness Installation 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 Installation Workbench

		Selection options		Creates a point
		Exits the Electrical Harness Installation workbench back to the Electrical Harness Assembly workbench		Creates a line
		Defines a bundle segment		Creates a plane
		Defines a branch		Deletes a bundle
		Adds a branch point		Light Protective Covering
		Removes a branch point		

## Electrical Harness Assembly Workbench

	 Selection options		Splits a bundle
	 Product selection options		Adds a branch point
	 Creates a geometrical bundle		Removes a branch point
	 Creates a multi-branchable bundle segment		Transfers branches
	 Creates a bundle segment		Duplicates a harness
	 Adds local slack to bundle		Adjusts a bundle
	 Adds a protective covering to a bundle		Arranges bundle segments within a support
	 Deletes a bundle		Copies a bundle segment's position from one support to another
	 Links a bundle		Updates a bundle from the support
	 Unlinks a bundle		Allows changes in the branch route for a more realistic curvature
	 Adds a support		Displays the related objects to a selected electrical device
	 Removes a support		

---

## **Bottom Toolbar**

These options appear when you are in the Electrical Harness Assembly workbench.

### **Measure**

There is only one new icon within this toolbar.



Measures the inertia of a geometrical bundle

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## 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 Harness Assembly and Electrical Harness Installation workbenches. These two workbenches work together to define the harness and the bundles.

### Defining Geometric Bundles

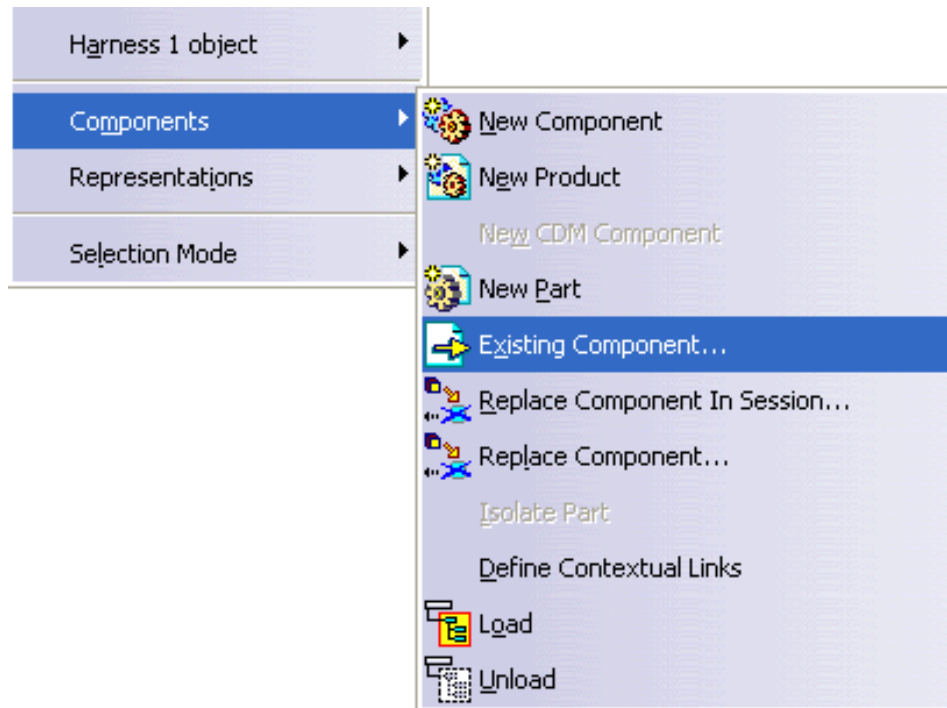
In this first exercise, you are going to look at creating a basic geometric bundle between two connectors. As you continue through this book, you will find the harnesses and bundles becoming more and more complex as the options are covered in more detail.

**Create a new product named Harness 1.** This new product will serve as your first harness.

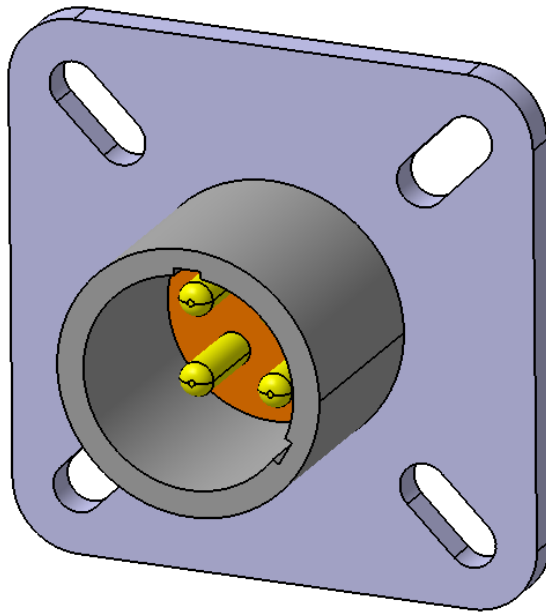
**If not already there, switch to the Electrical Harness Assembly workbench.** This will allow you to build the electrical harness. It is available under the *Equipment & Systems* solution and the *Electrical Harness Discipline*.

Notice there is not an icon to insert an existing component into the product. This is not an issue since you can use the *Insert* pull down menu or right click on the product.


**Right click on *Harness 1* in the specification tree and select *Components, Existing Component*.** This will display the *File Selection* window.



Insert the **4 Pin Mount Connector** document from the *Electrical Harness I* directory. This will be a simple four pin mounting connector.

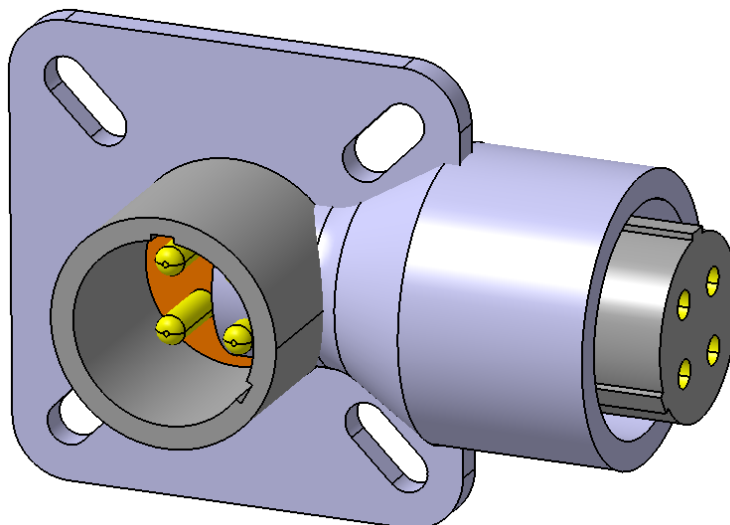


Remember, you can also insert components from the catalog.

Select the **Catalog Browser** icon from the bottom toolbar.  This will display the *Catalog Browser* window.

Open the **Electrical Catalog** from the *Electrical Catalog* directory, then open the **Connectors** chapter and the *Single Insert Connectors* family. Remember, to open the chapters and families, all you need to do is double select on them.

Find the **4 Pin Connector** and double select it, then select **OK** to insert it into the product. This method will insert a connector into the assembly as well.




Close the catalog browser when done.

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 have simply added a couple of connectors to your product. Now you are going to turn the product into a geometric bundle.

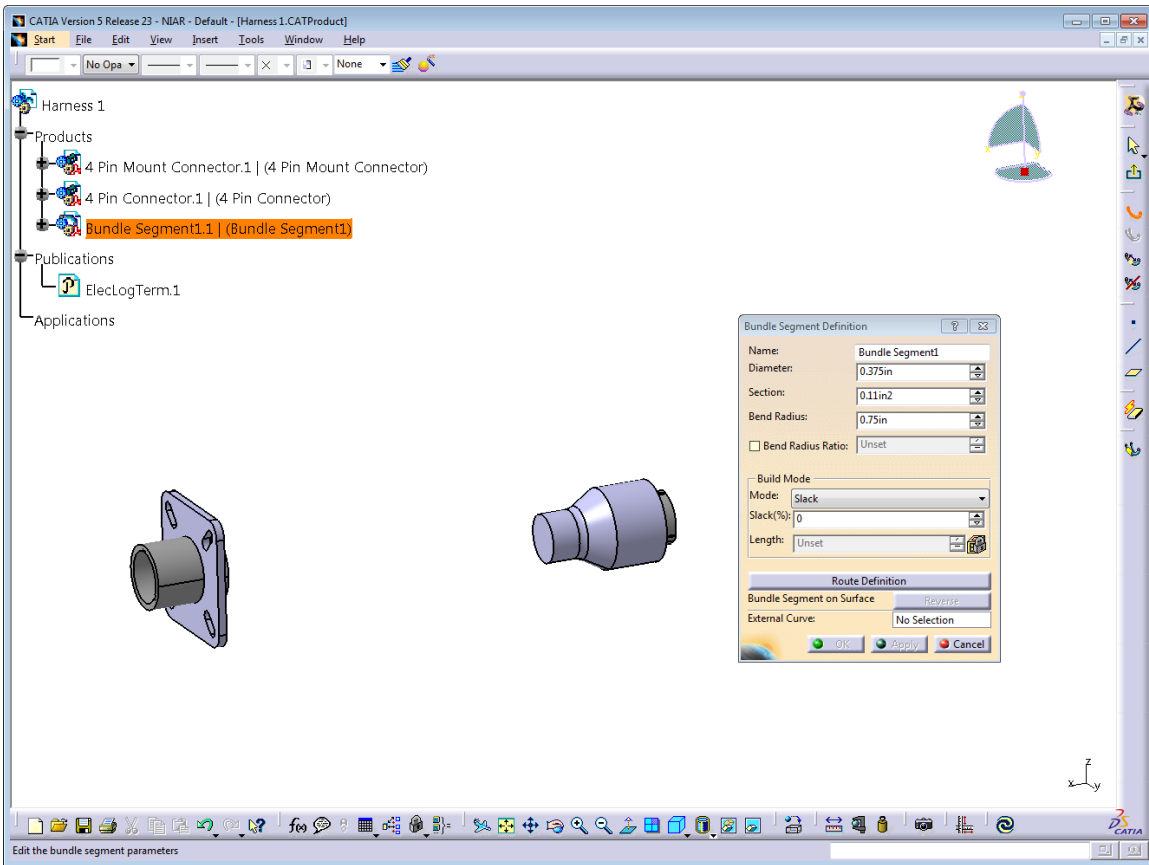
Select the **Geometrical Bundle** icon, then select *Harness 1* from the specification tree.  Notice a few things happen in the specification tree.



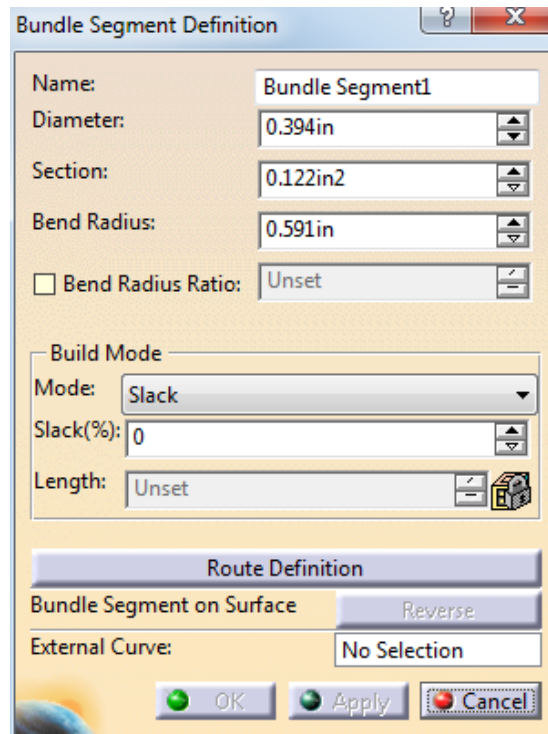
At this point, you are ready to define a bundle between the two connectors.

Select the **Bundle Segment** icon.  This icon may be under the Multi-Branchable Document icon. When you select the icon, a few things will happen.

By selecting on the **Bundle Segment** icon, you will automatically be switched into the Electrical Harness Installation workbench, as well as have a bundle segment created in the specification tree.



At this point, you are ready to define the bundle segment. Take a moment to examine the *Bundle Segment Definition* window.



<i>Name</i>	Specifies the name of the bundle
<i>Diameter</i>	Specifies the outside diameter of the bundle
<i>Section</i>	Specifies the cross sectional area of the bundle
<i>Bend Radius</i>	Specifies the minimum bend radius allowed for the bundle
<i>Bend Radius Ratio</i>	Defines the bend radius based on the diameter of the bundle. A ratio of 1 will set the <i>Bend Radius</i> to the same size as the bundle <i>Diameter</i> .
<i>Build Mode</i>	
<i>Mode</i>	
<i>Slack</i>	Bundles are computed with a minimum distance, and then a percentage of slack is added to the bundle
<i>Length</i>	Bundles are a set length, regardless of the amount of slack
<i>Bend</i>	CATIA will compute the minimum length possible while respecting the <i>Bend Radius</i>
<i>Slack (%)</i>	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.

<i>Length</i>	Defines the length of the bundle when in <i>Length</i> mode. The length must be as long, or longer than the distance between the two connection points.
<i>Route Definition</i>	Defines the bundle route
<i>Bundle Segment...</i>	Allows for the bundle to swap sides of a surface that is attached to the bundle
<i>External Curve</i>	Allows selection of a curve to define the bundle route

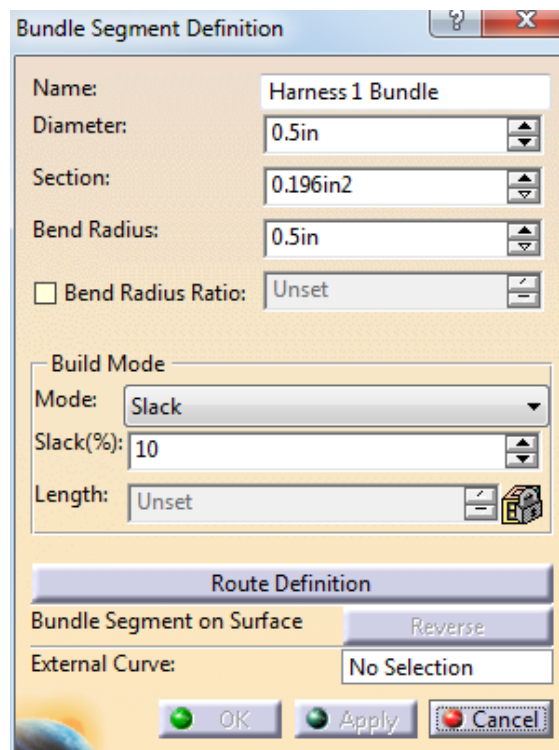
Many of these parameters will be tested further once the route is defined.

**Change the *Name* to Harness 1 Bundle.** This will define the name for the bundle.

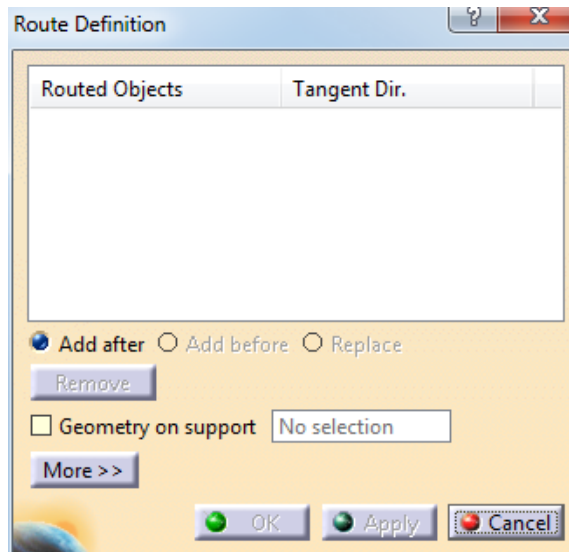
**Unless already set, change the *Diameter* to 0.5in.** You will notice the Section will automatically change to 0.196in<sup>2</sup>. This is due to the two fields being computed based on each other.

**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 bundle options defined. Now to generate the bundle via the route definition.

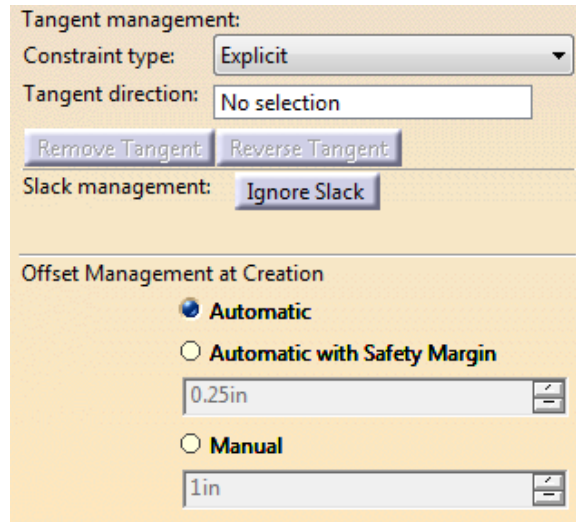


**Select *Route Definition*.** This will allow you to define the route for the bundle. The *Route Definition* window will display. Take a quick look at the various options in the *Route Definition* window.



- |                                      |  |
|--------------------------------------|--|
| <i>Routed Objects / Tangent Dir.</i> | This area displays the objects and points for the route definition |
| <i>Add after</i>                     | Adds points and connection points after the selected point         |
| <i>Add before</i>                    | Adds points and connection points before the selected point        |
| <i>Replace</i>                       | Replaces the selected point with another selection                 |
| <i>Remove</i>                        | Removes the selected point   |
| <i>Geometry on support</i>           | Allows bundles to be placed on surfaces or other support parts     |

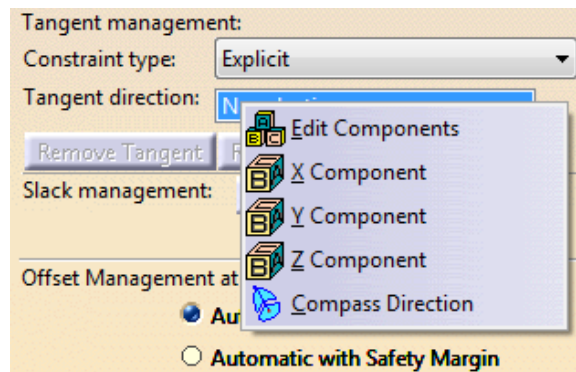
By selecting the *More>>* button, you get a few additional options.



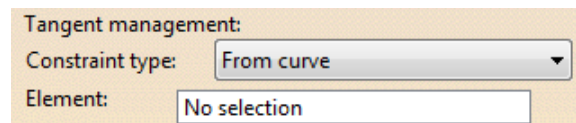
*Tangent management*

*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, Ignore Slack* Ignores or removes slack between points

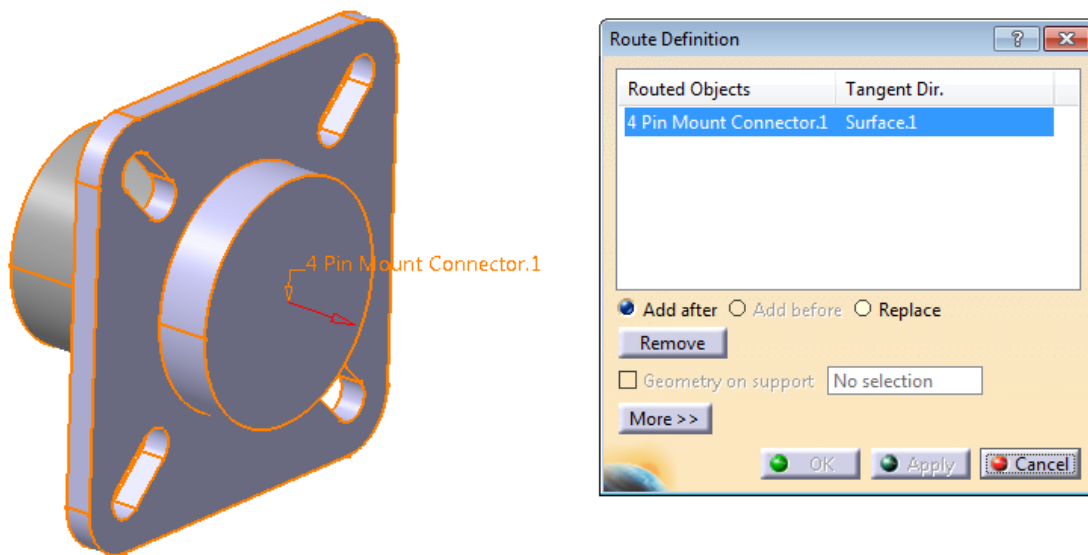


Offset Management at Creation

<i>Automatic</i>	Lays the bundle on the surface
<i>Automatic with Safety Margin</i>	Lays the bundle on the surface with an additional offset of the safety margin distance
<i>Manual</i>	Allows you to specify a specific distance for the bundle to exist off the surface

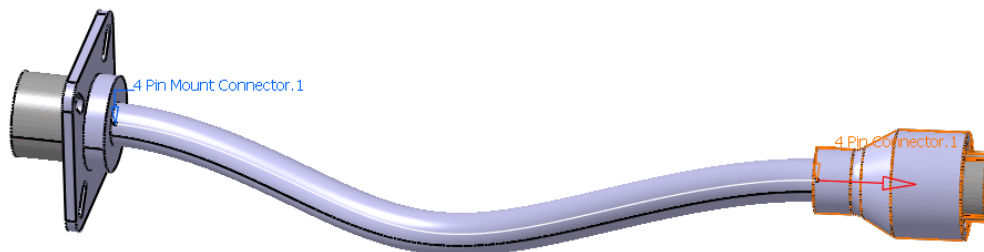
Now you are ready to define the route.

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



Anytime you select an electrical device with a bundle 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 bundle 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.

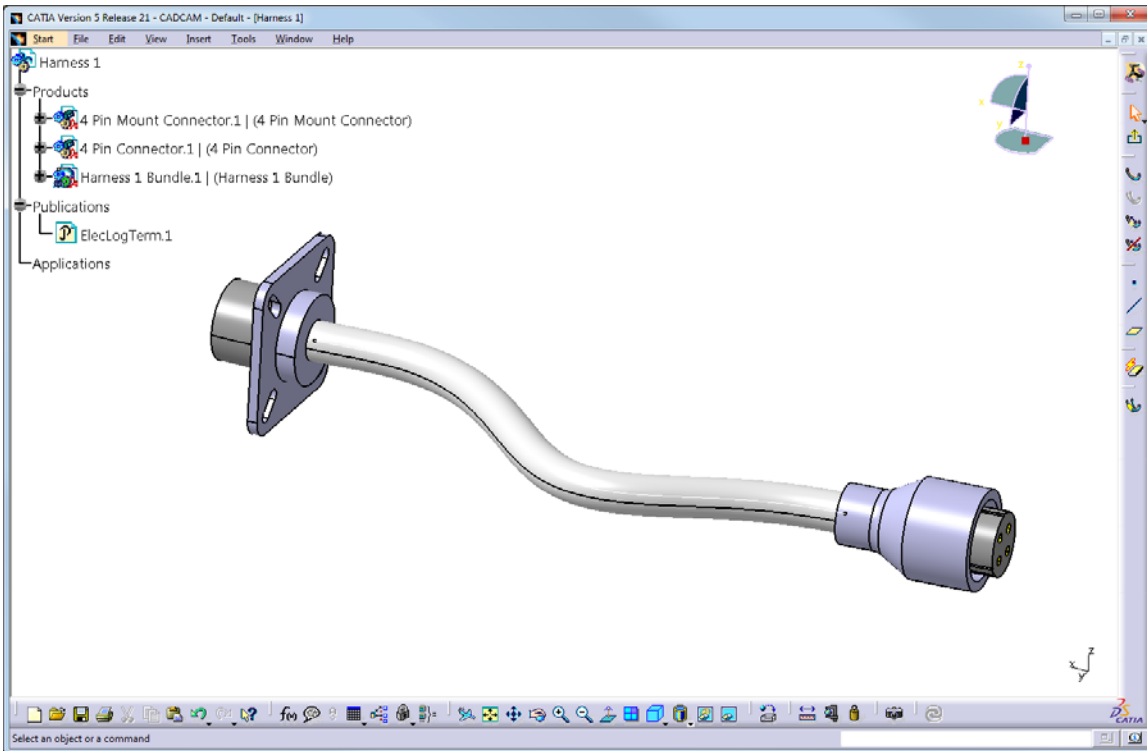



*Note: The physical shape of the bundle may vary based on the position of the two connectors.*

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

Select **OK** to the **Bundle Segment Definition** window. The bundle is defined.

Notice that you are still in the Electrical Harness Installation workbench.



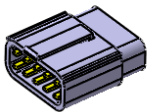
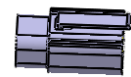
Select the **Exit** icon.  This will take you back to the Electrical Harness Assembly workbench.

**Save your harness.** When you save, you will be prompted to save the Harness 1 Bundle as well. Be sure you save the bundle into the same directory. Save Management 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-Branchable Bundles

Although single branch bundles 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 bundle. The most common type of bundle used, even for a simple straight geometric bundle, is a multi-branchable bundle.

**Open the Multi-Branchable 1 document from the *Multi-Branchable 1* directory.** 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 Harness Assembly workbench.** Defining a multi-branchable bundle initially is going to be no different than a single branchable document.

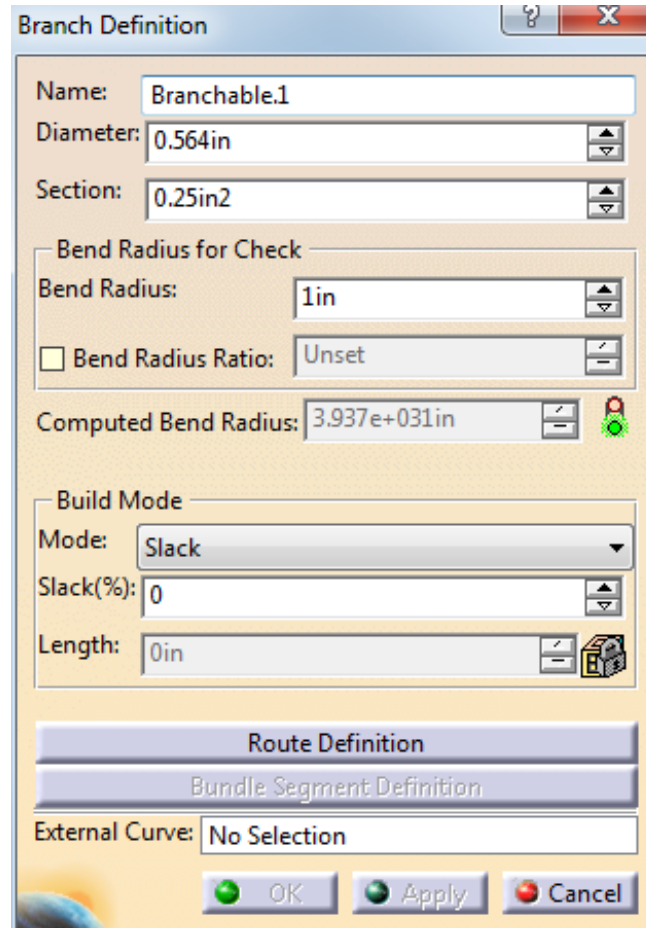
**Select the Geometrical Bundle icon, then select the *Multi-Branchable 1* product.**



This will convert the entire product into a geometric bundle.

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

Select the **Multi-Branchable Document** icon.  This will start a multi-branchable bundle segment. You will notice the branch definition is very similar to the bundle segment definition used before. Also, take note that you were automatically switched into the *Electrical Harness Installation* workbench, just as before. Take a moment to notice the few differences.



### *Bundle Segment Definition*

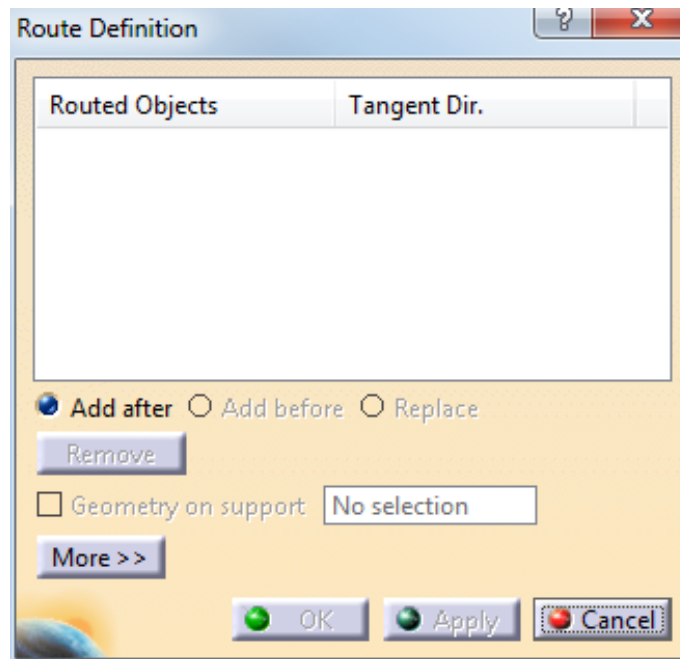
This will allow you to control each specific bundle segment. This option is only available after you define the route of the branch.

**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.** Just as the single bundle segment, it is a good rule of thumb to make sure that your bend radius is larger than your bundle diameter.

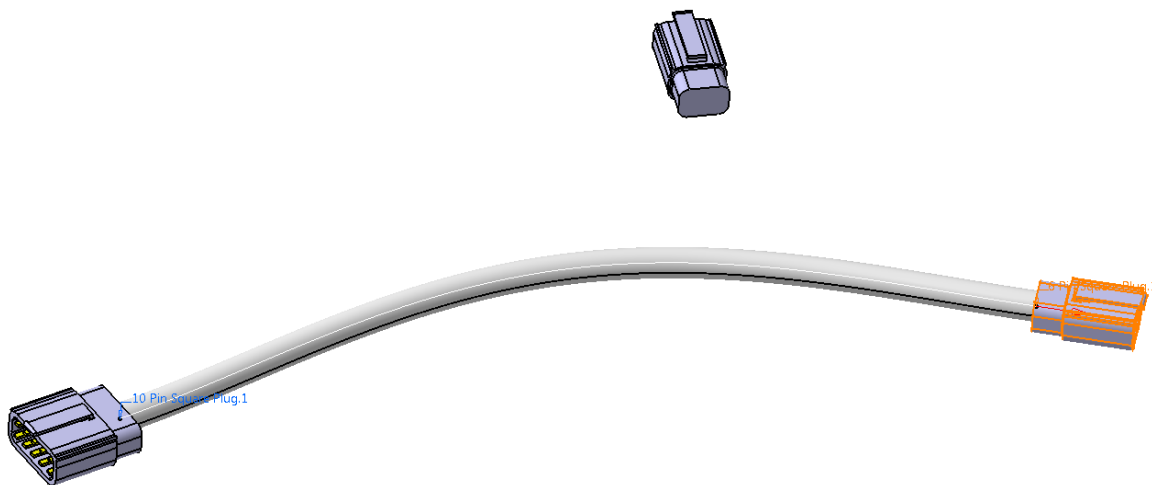
**With the Build Mode set to Slack, set the Slack percentage to 5.0.** Now you are ready to define the route.

**Select *Route Definition*.** This displays the same *Route Definition* window that you used before.



The only slight change between a single bundle and a multi-branchable bundle is the restriction that multi-branchable bundles cannot be associated to geometry. Notice the *Geometry on support* option is not available for selection.

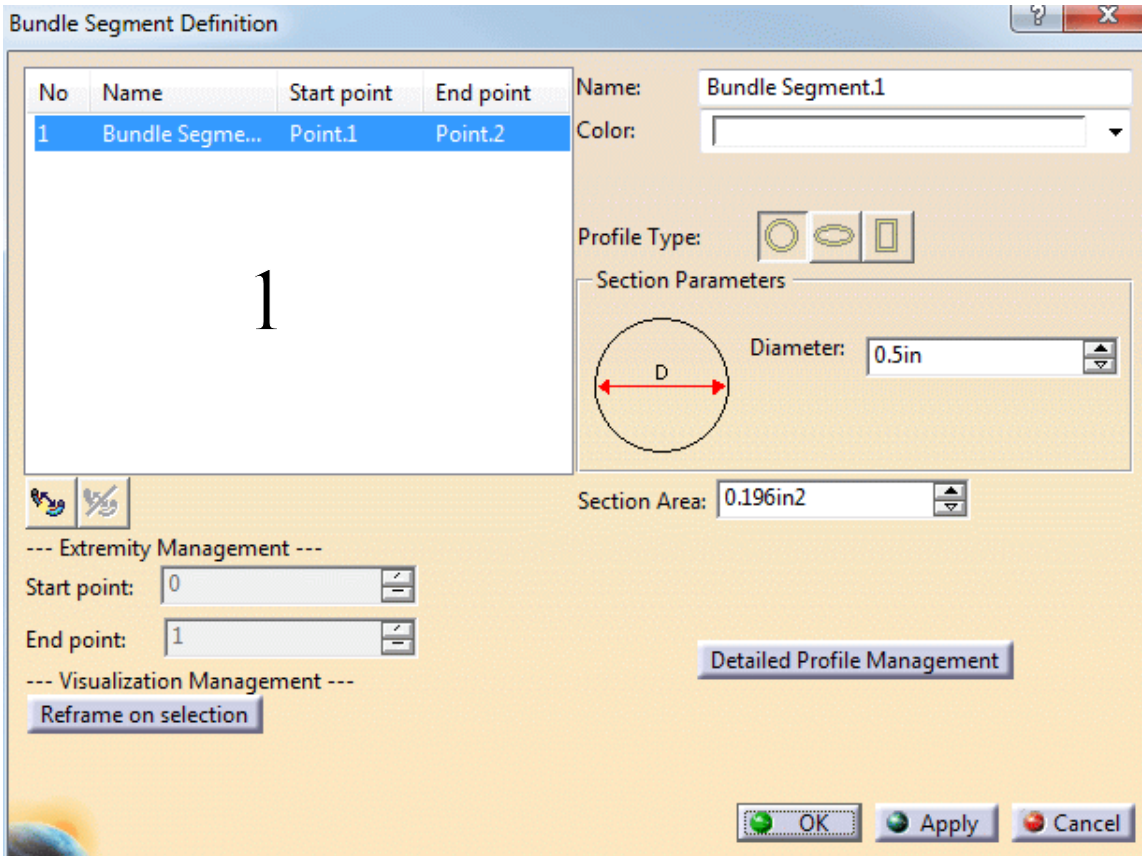
**Select the 10 pin square plug, then select the 6 pin square plug on the right.** This will connect the two bundle connection points for each of the connectors.



**Select *OK* to the *Route Definition* window.** Notice now the *Bundle Segment Definition* button is available.

**Select *Bundle Segment Definition*.** This will display the *Bundle Segment Definition* window.

Take a moment to look over the various options.



*1 – Bundle Segment Definition*

This area allows you to view the various bundle segments in a multi-branchable geometric bundle

*Name*

Specifies the name of the bundle segment

*Diameter*

Specifies the diameter of the bundle segment

*Color*

Specifies the color of the bundle 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*

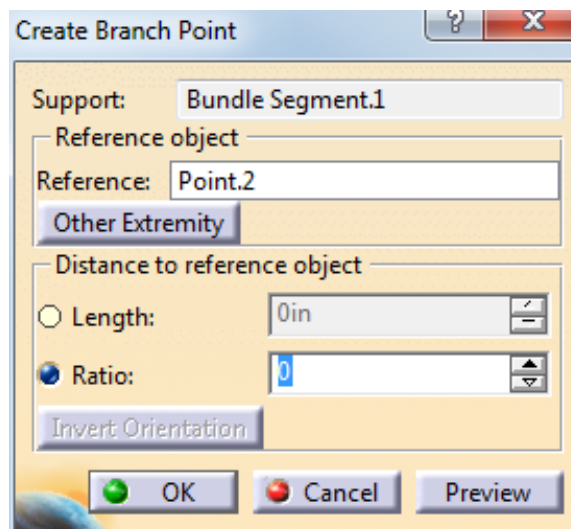
*Reframe on Selection*

Reframes and fits the bundle segment in the display



**Add Branch Point**

Creates an additional branch point along the curve. Displays the *Create Branch Point* window when a bundle is selected



<i>Support</i>	Defines the bundle segment selected
<i>Reference</i>	Defines the reference point the ratio or length is derived from
<i>Other Extremity</i>	Changes extremity used when referencing the endpoints of a bundle segment
<i>Distance to reference object</i>	
<i>Length</i>	Defines the distance along the curve the branch point will exist
<i>Ratio</i>	Defines a percentage distance along a curve the branch point exists
<i>Invert Orientation</i>	Inverts and reverses the reference direction



**Remove Branch Point** Removes branch points in a bundle


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

**Change the *Name* of the bundle segment to **Segment 1**.** You will notice this changes the name of the bundle segment in the bundle segment definition area.

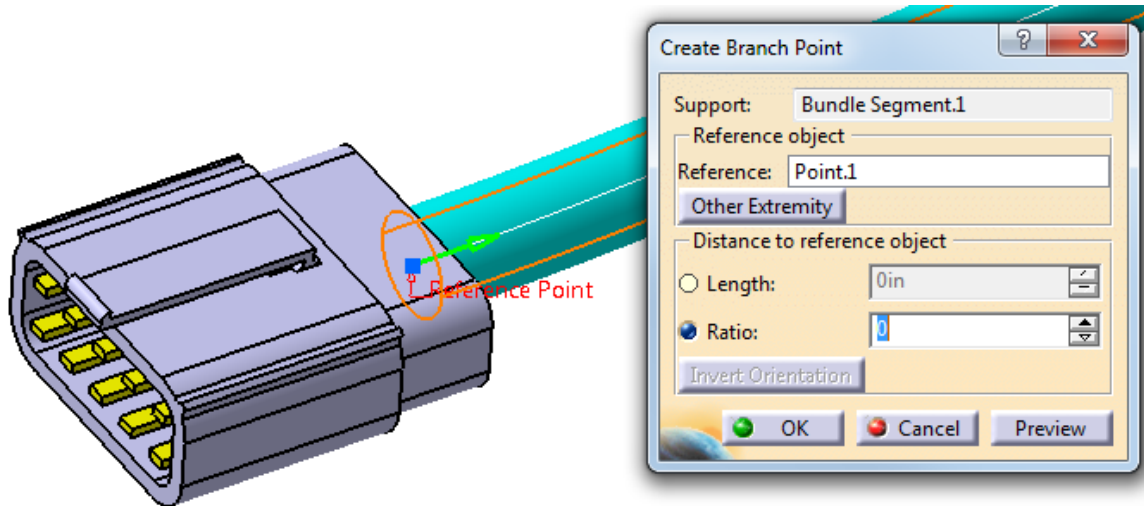
**Change the *Color* to light blue.** The exact shade of blue is not important, you just want to see that the color of the bundle can be changed.

Now to add a branch point.

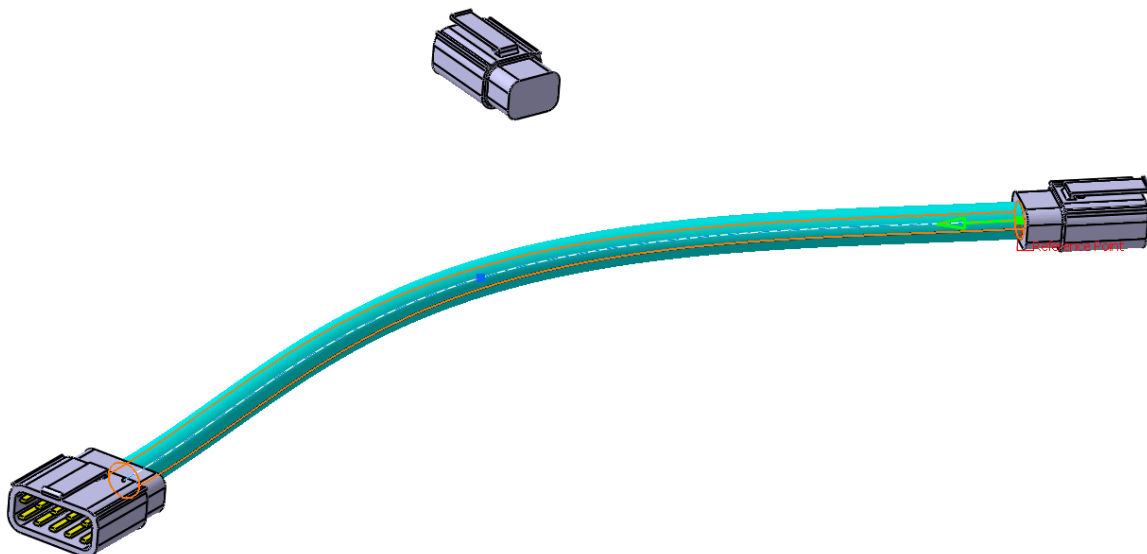


Select the **Add a Branch Point** icon.  Once you select the icon, the system will wait until you select the bundle segment you want to add the branch point in.

Select your **blue bundle segment near the 10 pin square plug**. This will display the *Create Branch Point* window, as well as show the reference point and reference direction.



Select *Other Extremity*. This will switch sides of the reference point.

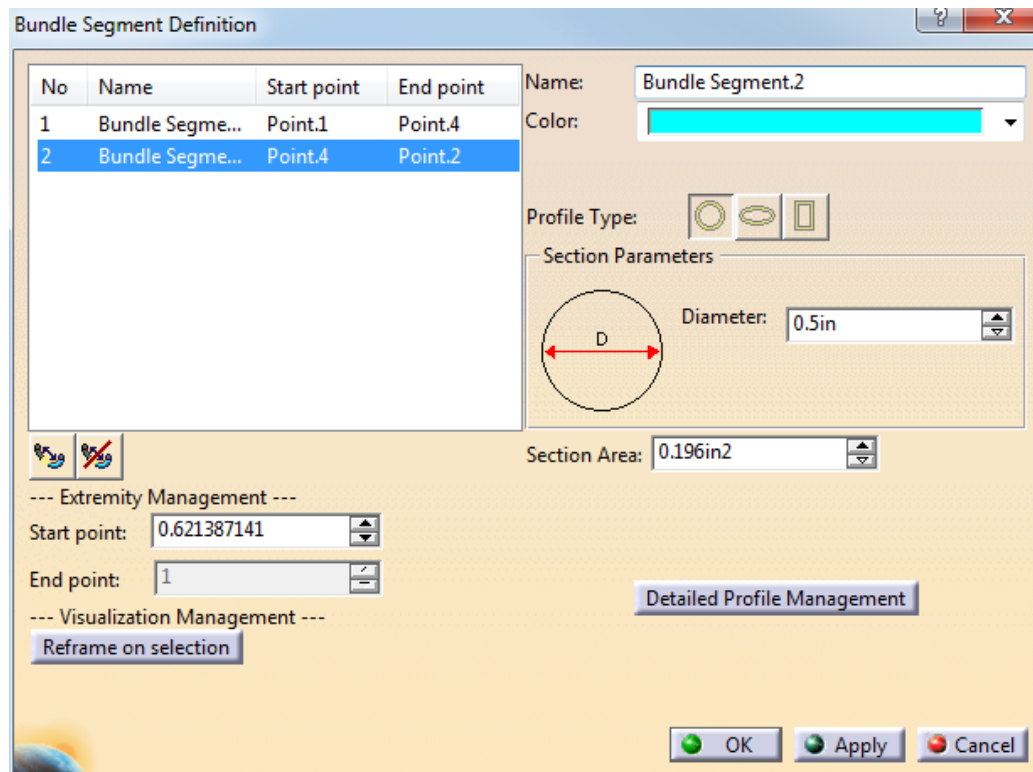


At this point, you need to determine how you want the branch point defined. In this case, assume you want the branch point defined a particular distance away from the other connector.

**Change the *Distance to reference object* definition to *Length*, then set a *Length* of 6.0in.** 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.



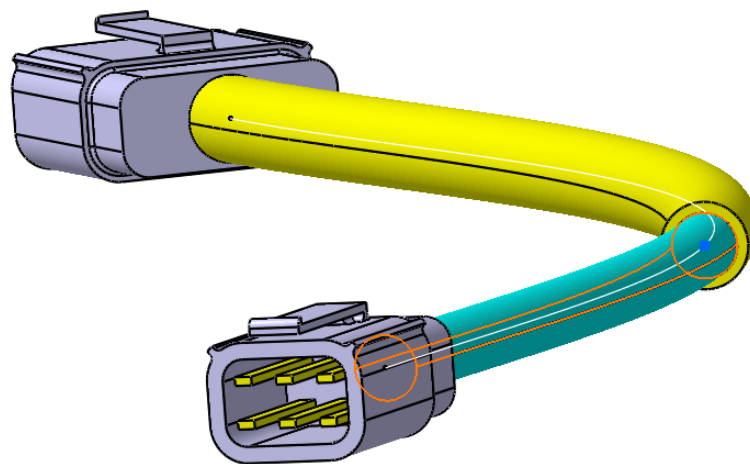
Select **OK** when done. This will split the bundle into two segments. Notice your bundle segment was renamed back to the default naming scheme.



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

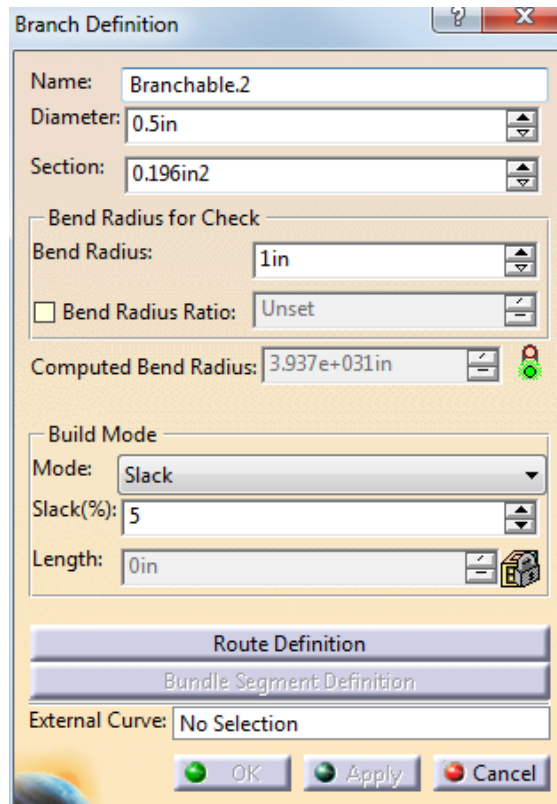
Select bundle *No 2* and change the *Diameter* to 0.375in. You may need to select *Apply* to get the bundle to update properly.



Select **OK** to the *Bundle Segment Definition* window. This will have the new bundle segment defined.

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

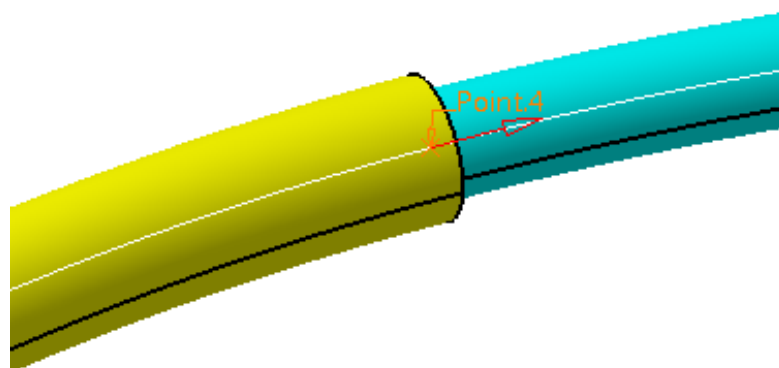
While in the **Electrical Harness Installation** workbench, select the **Branch Definition** icon.  This will allow you to create a new branch within the bundle.



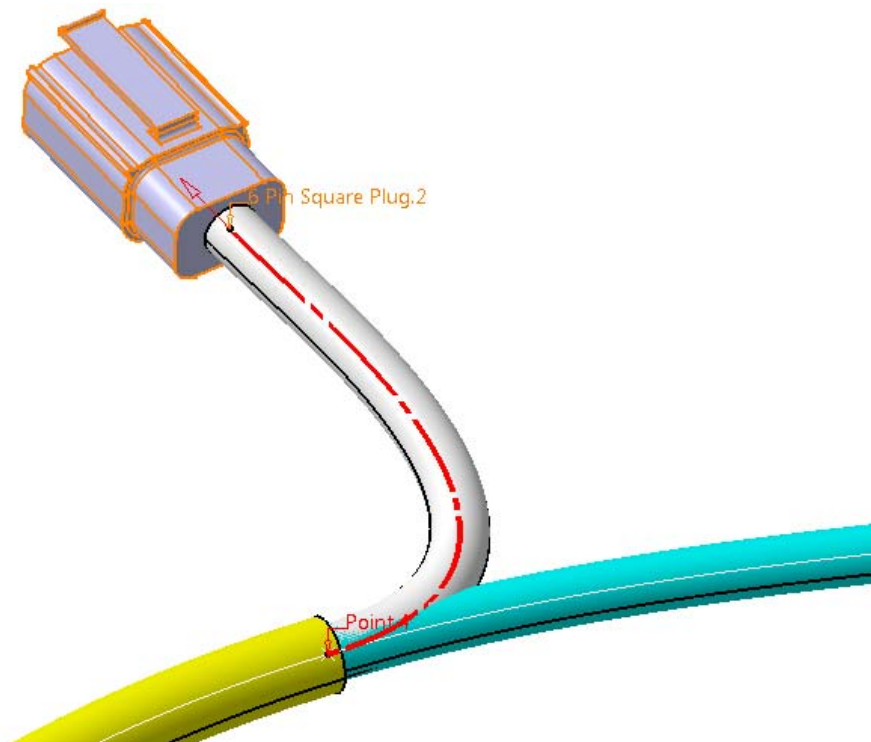
Change the **Name** to **Side Branch**, then set the **Diameter** to **0.375in**. Now you are ready to define the route for the side branch.

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 bundle you select will help determine what extremity the branch will associate to.

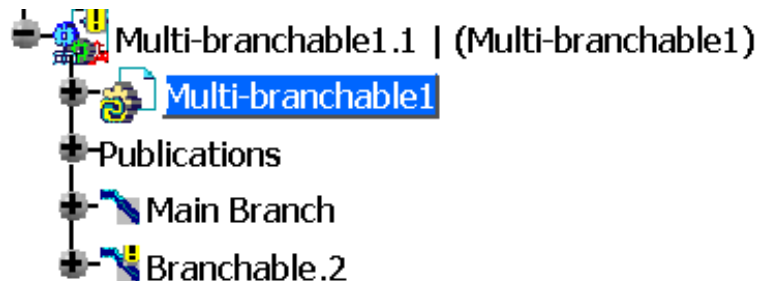
Select the **yellow bundle near the split**. Notice a point and arrow is shown on the bundle.



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



Look closely at the specification tree.



Both the part instance and the branch itself have 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.

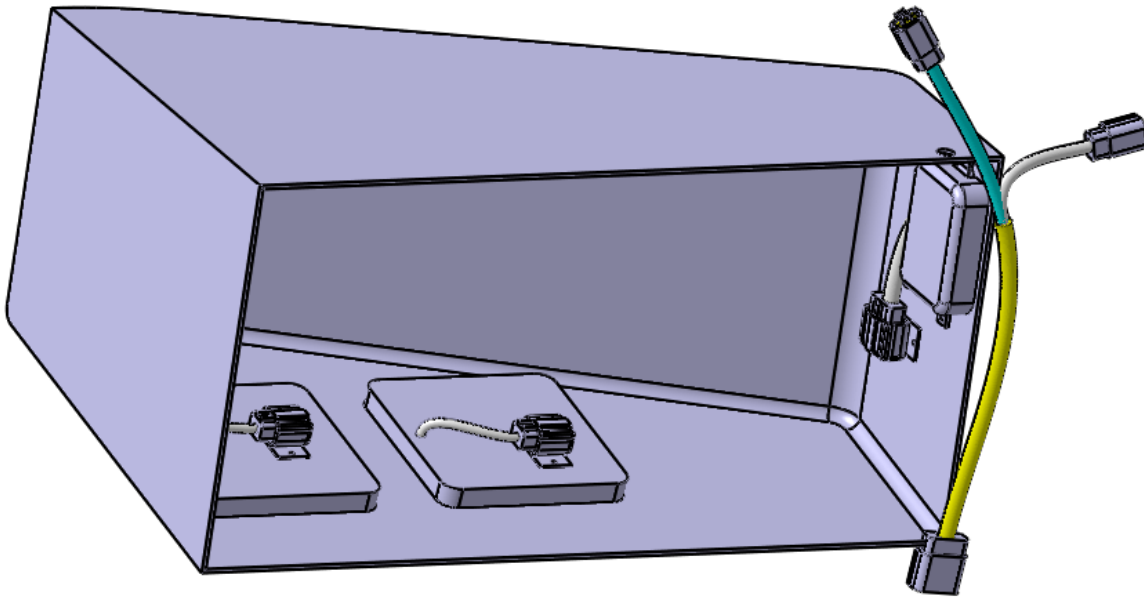
Select **OK** to the *Route Definition* window and the *Branch Definition* window. This will have the next bundle segment defined.

**Exit the Electrical Harness Installation workbench, then save and close your document.**

Open the **Connections** product in the *Multi-Branchable 1 Installation* directory. This is a simple box to put the wire harness you just created into.


With the right mouse button, select on the *Connections* product from the specification tree. Select *Components, Existing Component*. This will display the *File Selection* window to allow you to insert your harness.

Select the wire harness you just created. You could also select the Multi-Branchable 1 product from the *Multi-Branchable 1 Installation* directory. This is the same product you just created.

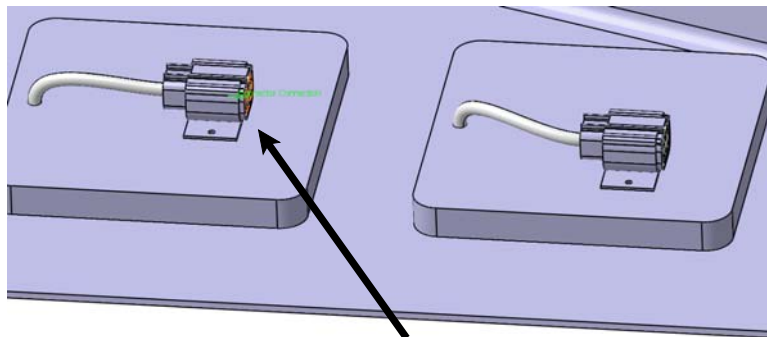


At this point, you are ready to begin making the necessary connections to install the harness into the box.

If not already there, switch to the **Electrical Assembly Design** workbench. Since you are connecting two electrical connectors together, you can use the assemble electrical devices tools from the electrical assembly design workbench.

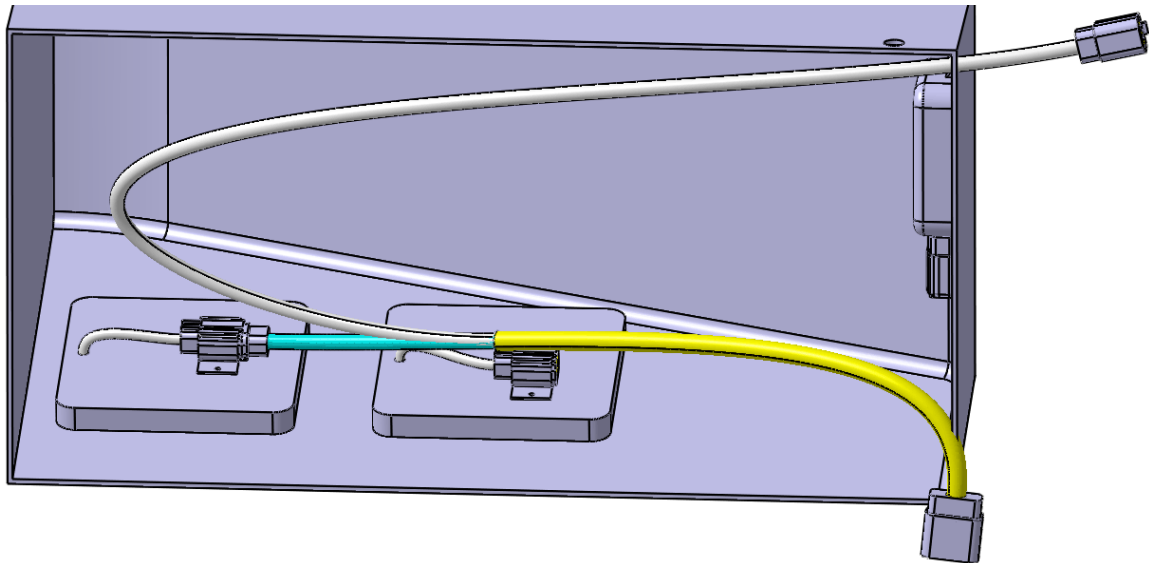
Select the **Connect Electrical Devices** icon, then select the connector on the **blue bundle segment**.  This will indicate what connector you are going to connect first.

Select the **left connector**. This connector is shown here.




You may get a *Computation Warning Report*, close it

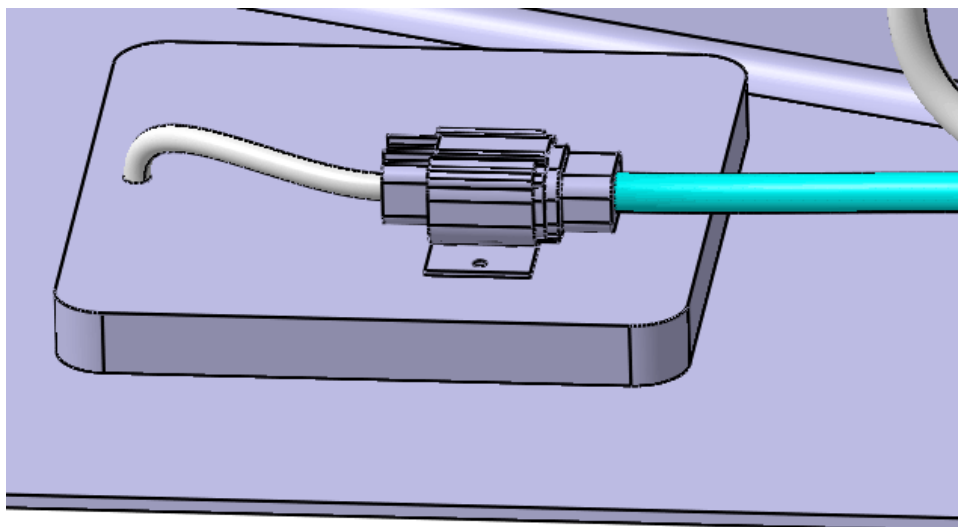
Take note of the resulting wire bundle.



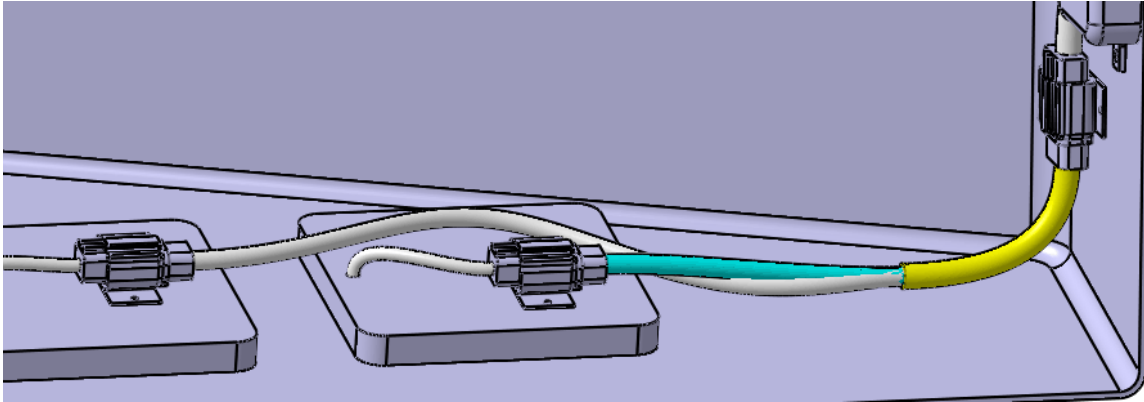
Notice the bundle split. Since you defined the split point to be 6 inches from the end of the blue bundle, no matter how long the main bundle segment becomes, the split point will always be 6 inches from that end. The white and yellow bundle segments will dynamically resize since they were not limited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

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

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



**Connect the other connectors.** It should appear as shown.



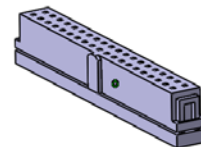
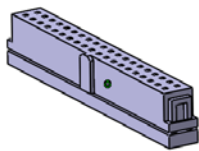
Notice the twisted bundle. This will get fixed as you begin adding supports and other links to your bundles.

**Save and close your document.**

### Bundle Profiles

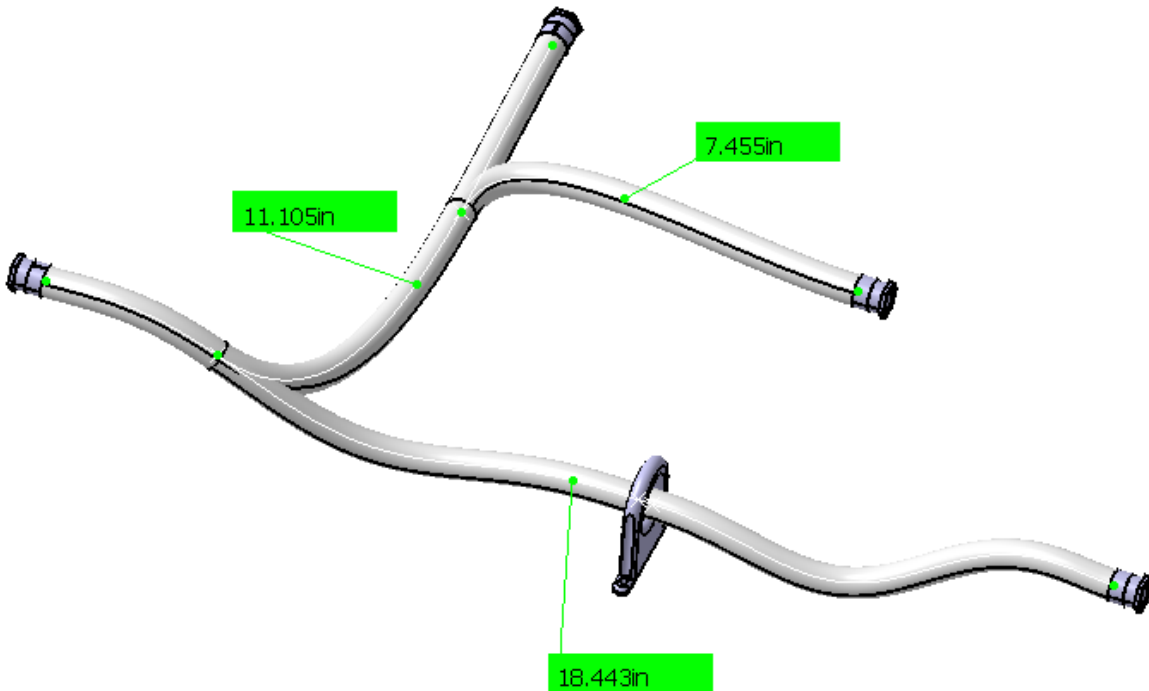
Although currently you are solely working with round bundles, you will have situations where you want to work with different shaped bundles. CATIA will allow you to automatically generate a few different shaped profiles.

**Open the Flat Bundle product from the *Flat Bundle* directory.** This will be a simple straight bundle segment from one flat connector to another.



In this exercise, you are going to make a simple flat bundle from one connector to the other. In order to make your bundles a different shape, other than round, you must set a *Tools, Option* that allows this to happen.

When you are finished your model should look similar to the picture below.



Double select the *Flattening Parameters* and select the *Flattening Scaling* tab.

Under the *Apply factor to area*, select the *Additional length > Limited length* option.

This option changes the scaling so that a scaled segment will never be shorter than a non scaled segment. If the *Additional length > Limited length* option is checked, then CATIA will take the amount that the segment is over the *Limited length* divided by two and add it back to the *Limited length*. For example: For a 9 inch segment with a 6 inch *Limited length*, the segment is three inches over the limit length. Half of three inches is 1.5 and 1.5 plus 6 yields a final bundle segment length of 7.5 inches. Using this option guarantees that longer bundle segments will not end up shorter than original bundle segments. In the above example, with the *Bundle segment whole length* option, a nine inch segment becomes 4.5 inches and would be shorter than a 5 inch segment that was flattened and scaled at the same time. This might cause visualization problems.

Change the *Limited length* to 8.0in and select *OK*.

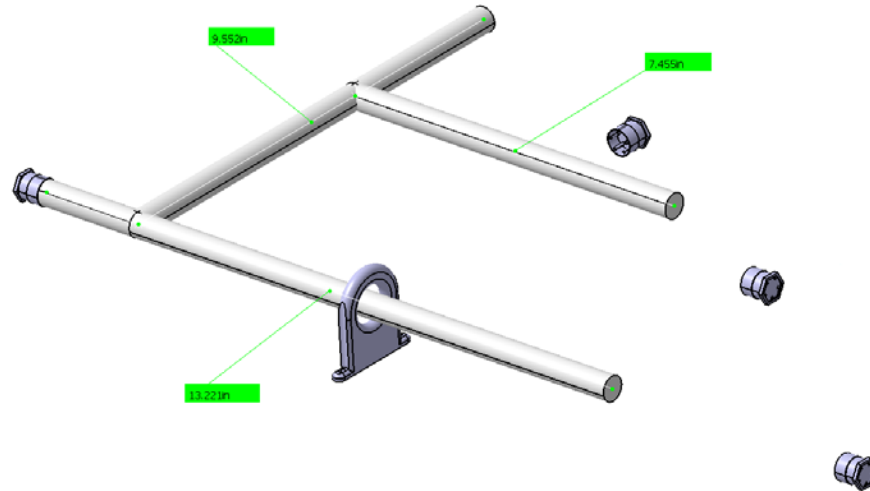
Select the **Flatten** icon and select *Geometrical Bundle3.1* from the specification tree.



This will specify that the entire bundle should be flattened.



Select **OK**. Notice the model is flattened and scaled, while the dimensions and connectors remain in their original locations.




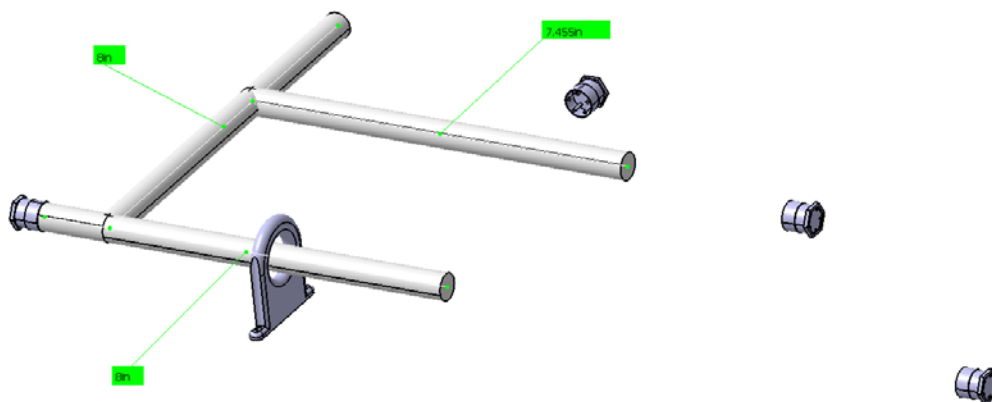
Notice the bundle that was under 8in remained the same length while the others were scaled.

Double select the **Flattening Parameters** again and select the **Flattening Scaling** tab. Notice that the measurements all update so you will have two identical measurements of each length.

Select the **If the bundle segment length is greater than option**. This option will change any segment that is greater than the set length back to the set length.

Enter a value of 8.0in and select **OK**.

Select the **Flatten** icon and select the geometrical bundle from the specification tree and select **OK**.  The bundle should be scaled down smaller than it was for the first scaling. In this manner you can scale geometric bundles more than once and you can also scale just one segment at a time by selecting the segments in the graphical display. The model should appear as shown.



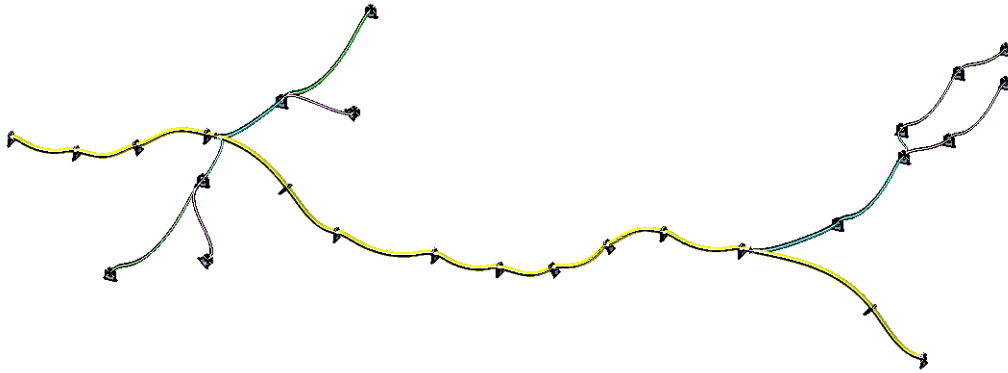
Save and close your document.



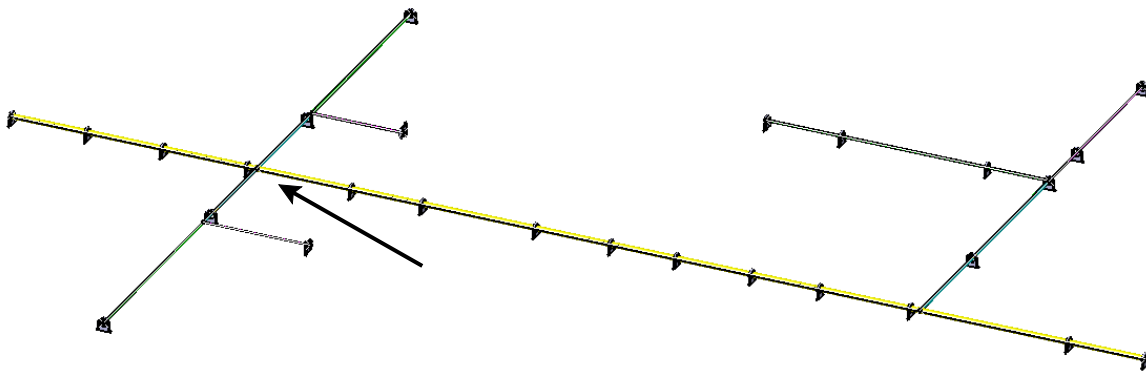
## Roll - Rotate - Scale

Once a bundle has been flattened it may need to be modified to fit within a certain area like a form board. The following options will help orient a flattened bundle.

**Open the Roll - Rotate - Scale document from the *Roll - Rotate - Scale* directory.** It should appear as shown.



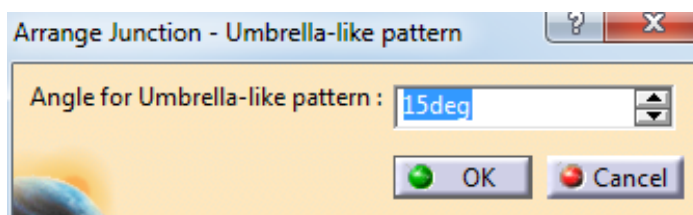
**Flatten the geometrical bundle.** The model should appear as shown.



Select the **Arrange Junction - Umbrella-Like** icon.



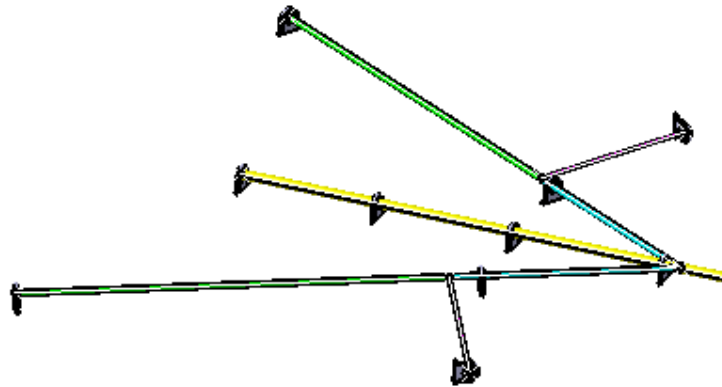
Select the junction as shown above. The *Arrange Junction* definition window will appear.



The angle entered will be the angle from one to two and two to three. The graphical area will have a preview of how the harness will be modified.

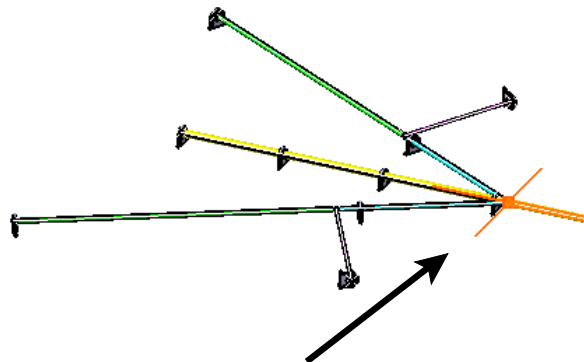


Change the value to 30deg and select *OK*. The segments will move to the locations indicated in orange above.

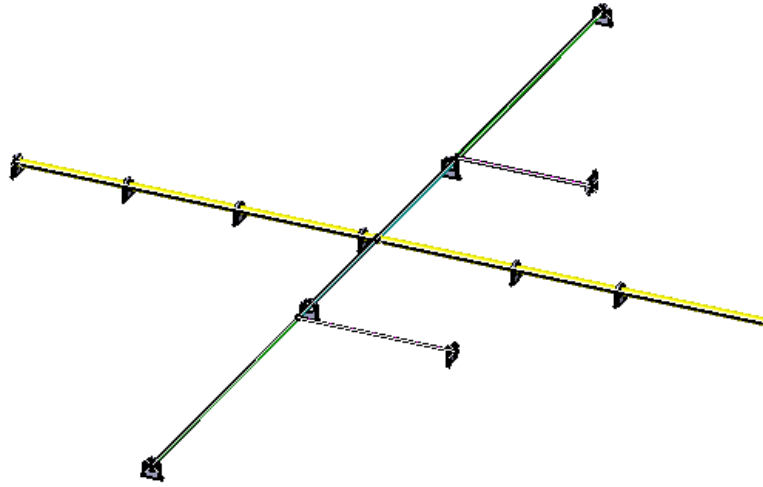



Select the **Arrange Junction - Equal Angle** icon.  This icon is located under the Arrange Junction - Umbrella-Like icon.

Select the **geometric bundle** in the same location selected previously. There is no definition window for this icon but the graphical area will still give a preview of what is going to happen. If the displayed result is not the desired result select escape on the keyboard twice.

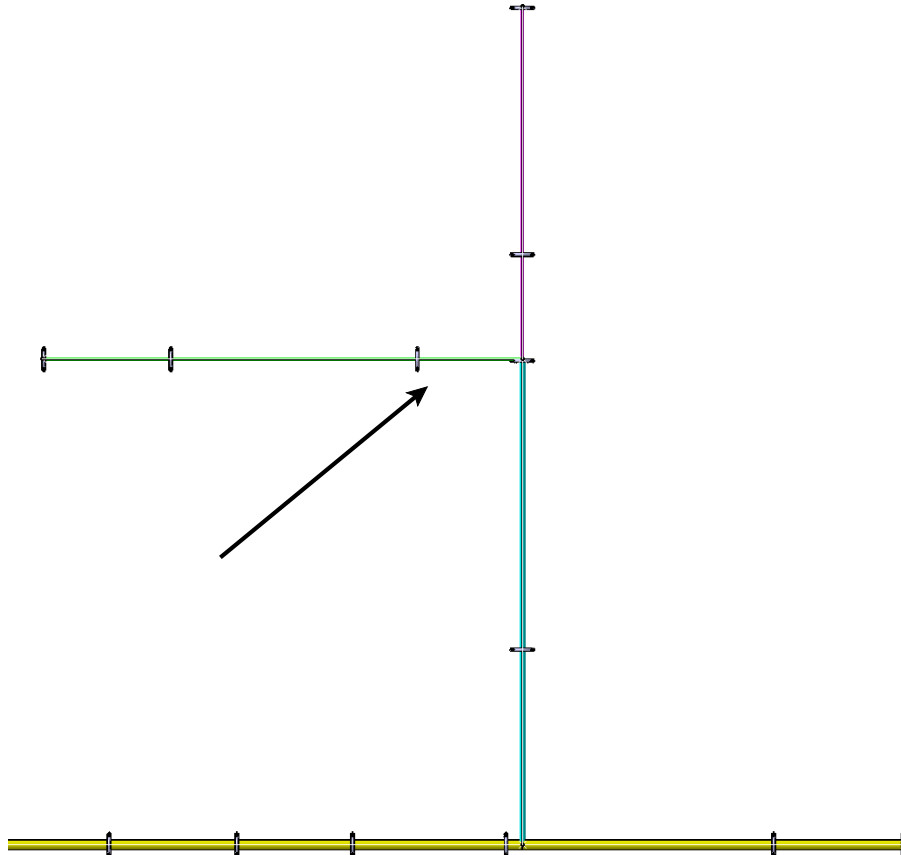


**Select in space.** Since there is no definition window there is not an *OK* button. Selecting in space is confirming that the displayed action is the desired action. There is no history in the specification tree for this workbench, but if the result is not acceptable undo will remove the last action. Your model should look like it started.

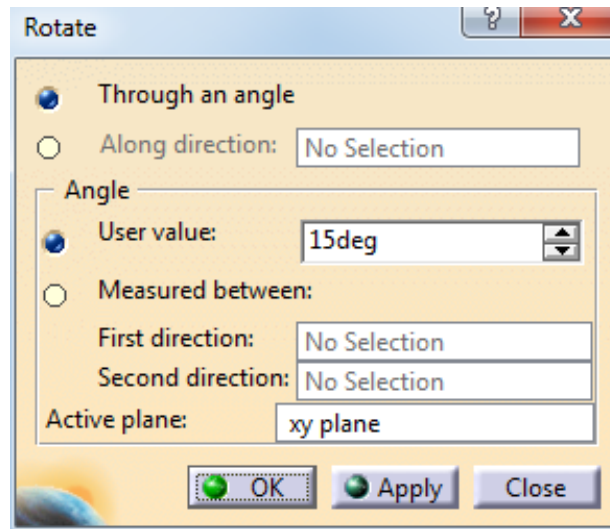


**Select the Rotate icon.**  You are going to rotate a branch so that it will point in another direction.

**Select the branch as shown.** Make sure you select just the branch.



The *Rotate* window appears along with a green arrow in the display.



*Through an angle* Bases the rotation off one of the ends of the bundle segment

*Along direction* Specifies the direction you want the bundle segment to go

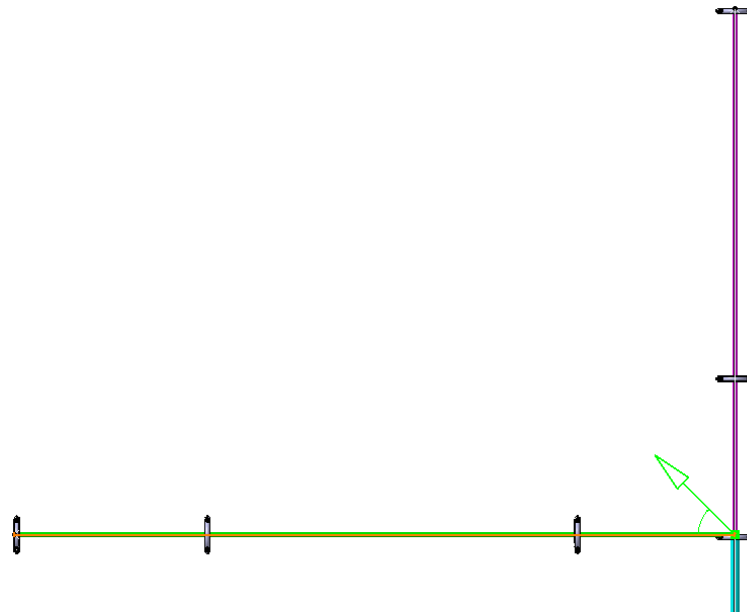
*Angle*

*User value* Defines the angle the bundle will be rotated from where it started

*Measured between* Defines the angle based on selections

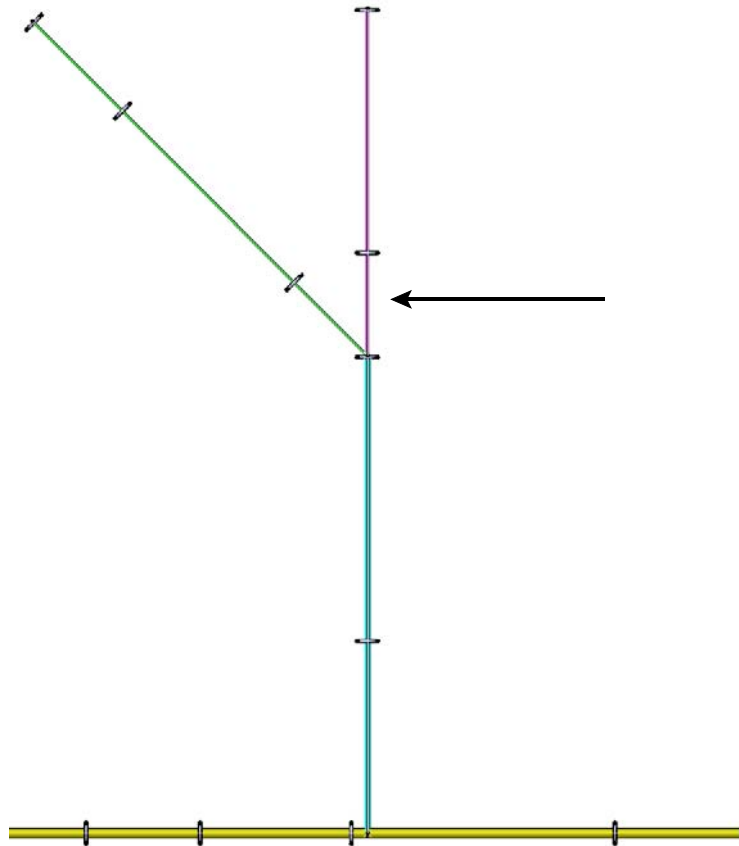
*First/Second direction* Specifies the two lines which will define the angle

**Select the *Through an angle* option and enter a value of -45deg.** If you are having trouble determining the positive and negative side select the tab key on the keyboard and the arrow will update to indicate the direction the segment will be moved to.



Select **OK**. The bundle will move to the desired location.

Select the **Rotate** icon and select the branch as shown.



Select the **Along Direction** option and select in the **Along Direction** box.