OBJECTIVE

THE OBJECTIVE OF THIS TUTORIAL IS TO MAKE A PARAMETRIC CURVED ROLLER CONVEYOR.

GENERAL

To understand how the components are constructed one should understand the basic concepts of the component hierarchy.

A component has a node tree. This is a tree structure that is updated on every simulation step (e.g. a robot).

Because of the parametric nature of the software each node also has another hierarchy tree: a Feature tree. Feature tree is typically not updated on every simulation update, but only when setting parameters of the component such as height of a conveyor etc.

The feature tree consists of features. A Feature can be a primitive or an operator. A primitive can be a parametric solid primitive such as a Block or a Cylinder. An operator can be e.g. Linear Clone. When a feature tree is evaluated (Parameter value is changed) the end result is recalculated and the looks of the component changes.

Perhaps the most common Feature primitive is 'Geometry'. Geometry is a tessellated representation of an existing geometry read from a file. Depending on the original method of authoring the geometry and used file format the geometry may contain 1 or many sub elements. These sub elements are called geometry sets. A geometry set can be a logical set of polygons or lines or frames. These sets typically also have a material associated to it. To better understand the concept of a geometry set follow the steps of this tutorial.
STEPS

1. Clear the simulation world by pressing New

2. Define Parameters

2.1 Start the authoring of a component by creating one simple Block.

2.2 Accept the default properties, we will change them later.

2.3 Before we start further modelling lets define the driving parameters.
   We need 6 real type parameters. Generate parameters with following options.

   Default values can be as follows.

   - **ConveyorHeight** = 700
   - **ConveyorWidth** = 400
   - **ConveyorRadius** = 1000
   - **ConveyorAngle** = 45
   - **RollDistance** = 50
   - **RollRadius** = 20

   It is also possible to limit parameters to stay within certain limits with Range option.
   Set option defines a set of variables instead a continuous number.

   **NOTE!** The default settings for OnChange is Rebuild Geometry. This can be heavy operation, but in this case we need it for all parameters because every parameter change should cause a geometry to be rebuilt.
3. Create Feet Geometry

3.1 Edit the Block properties you created earlier by double-clicking its icon.

3.2 This feature is cloned, first to linear direction then to angular direction. However, let’s make the block height to adjust according to *ConveyorHeight* parameter first. Also change the other properties as follows.

3.3 Make a **LinearClone** feature.

3.4 Move *Block* under **LinearClone** and change the properties for LinearClone.
3.5 Make a Transform feature. This is used to control the radius of the conveyor.

3.6 Move LinearClone under Transform and change properties for Transform.

3.7 Make an AngularClone feature.

3.8 Move LinearClone under AngularClone and change properties for AngularClone.

Now your feature tree should look like this.

And component like this.
4. Create Rolls

Rolls are generated by creating a cylinder and cloning it to angular direction.

4.1 Create Cylinder primitive feature.

4.2 Change properties for Cylinder.

4.3 Rotate Cylinder 90 degrees around C-axis.

4.4 Translate Cylinder 40 mm to x- and y-directions.

4.5 Make a Transform feature. This translates the cylinder parametrically to correct position.

4.6 Move 'Cylinder' under Transform_2 and change properties for Transform_2.

4.7 Make an AngularClone feature.

4.8 Move Transform_2 under AngularClone_2 and change properties for AngularClone_2.
Expression are bit more complex than previous ones, since the formula of an arc is used.
\[ x = \frac{b}{r} \]

0.0174 is actually \( \frac{\pi}{180} \) (Degree to Radians). If you want you can define an invisible parameter called "DegToRad", assign it this value and use it in the expression.

Now your feature tree should look like this.

And component like this.

5. Revolve sides

The sides of conveyor are generated by revolving a rectangular line.

5.1 Create a custom Geometry feature. This will be the container for polyline.

5.2 Create a Block primitive. This is just a helper geometry used for sketching the polyline.

5.3 Set Length, Width and Height to 80 for Block_2.

5.4 Select Geometry feature from Node Feature Tree and trigger Create Line command.
5.5 Sketch the line by using the left most side of cube as reference.

**NOTE!** The selected feature will contain this line geometry.

5.6 Delete Block_2.

5.7 Make a LinearClone feature.

5.8 Move Geometry under LinearClone_2 and change the properties for LinearClone_2.

5.9 Make a Transform feature.
This translates Geometry parametrically to correct position.

5.10 Move LinearClone_2 under Transform_3 and change properties for Transform_3.

5.11 Make a Revolve feature.

5.12 Move Transform_3 under Revolve and change properties for Revolve.
6. Create Frames

Frames are the glue between the simulation and physical space.

6.1 Make 5 Frame features.

6.2 Rotate them all 180 degrees relative to A-axis.

6.3 Make 5 Transform features and move every frame under one transform feature.

6.4 Change properties for transform features as follows. Transform_4 is used for Frame (begin point) and Transform_8 is used for Frame_5 (end point).

Now your feature tree should look somewhat like this.
7. Create Movement Path

7.1 Make 'One-Directional Path'.

7.2 Adjust the basic properties of movement path.

It is important that the Interpolation is cubic instead of linear because it controls the position and orientation of components on path during the simulation.

7.3 Modify Path property.

7.4 Add all of the frames to path in shown order.

The order of frames on the path is important because components move on path from frame to another based on that order.

8. Create Interfaces

8.1 Make One to One Interface. This will be the interface for incoming material flow.

8.2 Modify Sections property.

8.3 Add a new section.

8.4 Select the first frame on the path for Section Frame.

Section Frame defines the location of interface in 3Dworld.
8.5 Add new Flow field to the section.

8.6 Select the created movement path for Container and Input for Port.

Container defines the behaviour where the material flow that comes to this interface is directed to. Port defines the port of the selected behaviour. Movement path has 2 ports but other behaviours can have different amount of ports.

The creation of interface for outgoing material flow is carried out similarly as for incoming interface except SectionFrame should be Frame_5 and Port in movement path should be Output.

Now the conveyor is ready.

9. Test the conveyor by connecting a feeder to its input interface.