Customer PTC E-Newsletter
Date: 6/25/03

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PTC Product Focus

ProductView Realizer : Constraint Concepts

The Constraints tool allows you to model the functionality of a product by simulating the motion properties of mechanical devices. Constraints allow you to connect components together in such a way that when you move them they behave in a more useful manner. For example, for a model of the undercarriage of a plane, you could define constraints to cause the undercarriage to lower or retract. Or, you could add constraints to the model of a car to cause the suspension to go up and down, the doors to hinge open and closed, and the wheels to rotate in a logical fashion.

The logical constructs involved in defining constraints are explained next.

- The term mechanism is applied to a combination of bodies connected together so that they transmit motion in a determined manner. For example, you would create a mechanism to constrain the undercarriage of a plane. Mechanisms are listed in the Mechanism window.

- A body is the building block of a mechanism. The body defines a set of components that will move together. A body can either be a single component or a rigid body. All bodies in a mechanism must be connected by constraints.

- A ground is a defined object (or rigid body) which does not move. Every mechanism must have at least one ground. Grounded bodies are marked with the 🖥 icon in the bodies interface.

- A constraint (also known as a joint) is a connection between two bodies to constrain, or restrict, their movement in some way. For example, you could constrain a wheel component to an axle component so that the wheel only rotated around the axle. ProductView supports a number of different constraints types. Constraints are defined by connecting pairs of markers. The list of constraints for a mechanism is shown in the Constraints window.

- A marker is similar to an orientation frame, but it is attached to a part and moves with it. Markers are used to define and illustrate locations where parts are constrained. A constraint is not directly attached to two components, but actually attached to two markers, which are each attached to components. Markers are listed in the Markers window.

All bodies in a mechanism must be connected by constraints. As a result, if you want to constrain two car doors so that each door is hinged, you would need to define two mechanisms, as each door works separately from the other one.

Once you have created a mechanism, you can enable and disable it as needed to apply the constraints. When a mechanism is disabled, all of its bodies will have free motion. When a mechanism is enabled, the constraints for that mechanism are applied.

Mechanisms are stored in annotation files.

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Tips of the Week

How to Use Flexible Components in Wildfire

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# Tips of the Week

Creating a Mechanism in ProductView

Pro/COLLABORATE and Windchill ProjectLink both provide built-in reporting capabilities.

The following is a step-by-step process for creating a simple mechanism using ProductView Realizer. The first step in the process is to load the appropriate geometry and create an annotation set that will hold our mechanism. Then we will proceed to create the mechanism and associated constraints.

1.   Open the assembly of interest and load the geometry for which you want to create a mechanism. This can be the entire assembly, or a sub-set of the assembly. In this example, I'm using a sub-set of the PTC motor demo assembly.
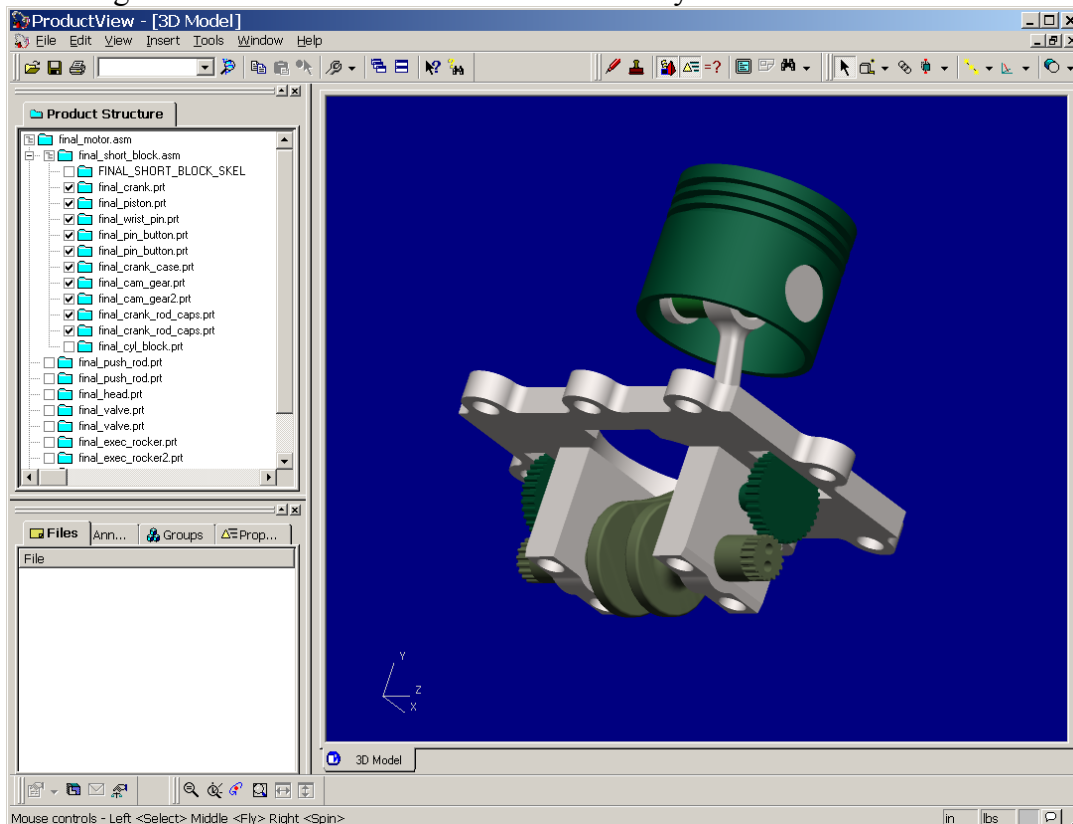
2.   Create an annotation set to store your mechanism. You must first enable the Annotation tool. To do this, choose **Tools > Annotation**, and then **Annotation > New Annotation Set**. Give the annotation a name and select **OK**. For information on creating a new annotation set, see the on-line help for ProductView (choose **Help > Help Topics** or press F1 in the ProductView client).

3.   To define a constraint, you must first enable the Constraints tool. To do this, choose **Tools > Constraints**. The Constraints toolbar and menu commands are added to the ProductView window. To view the mechanism window, choose **Constraints > Show Mechanisms**   or   select   the   icon   from   the   constraints   toolbar.
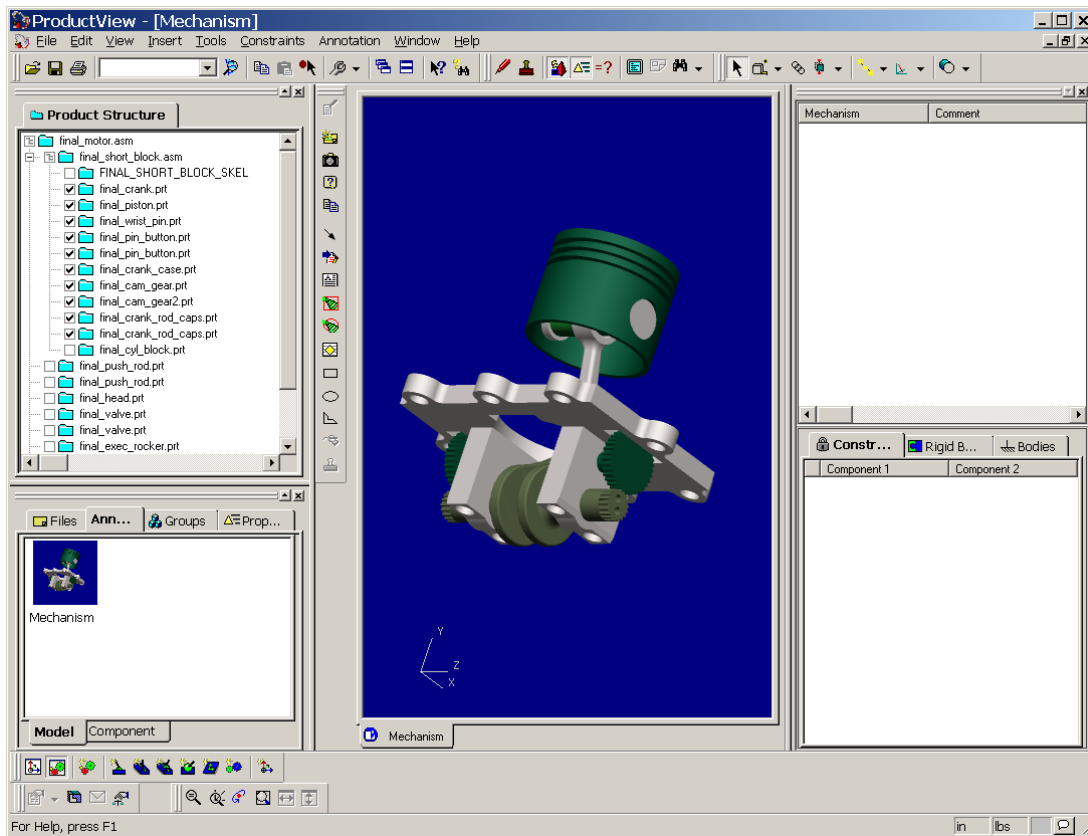

4.   Every constraint begins with a mechanism. This stores the constraint information in one place. Choose **Constraints > Mechanisms > Create Mechanism** to create a new mechanism. You can rename the mechanism by selecting it in the mechanism window.

5. (Optional) To define a rigid body in your mechanism, choose **Constraints > Rigid Bodies > Create** (Make sure that the mechanism is selected in the mechanism window prior to creating the rigid body or you will not be able to create it!). To view the rigid body, you must select the rigid body tab in the mechanism window (see image below). A rigid body is a collection of components that you want to appear as a single component, so that when one component moves, they all move. In this example we want the two cam gears (shown in red below) to function as one unit. These components can be modeled as separate parts, but for purposes of simulation, we want them all to appear to move together. To add components to the rigid body, select the two cam gears (final_cam_gear.prt and final_cam_gear2.prt) and choose **Constraints > Rigid Bodies > Contents > Add Selected Components**.
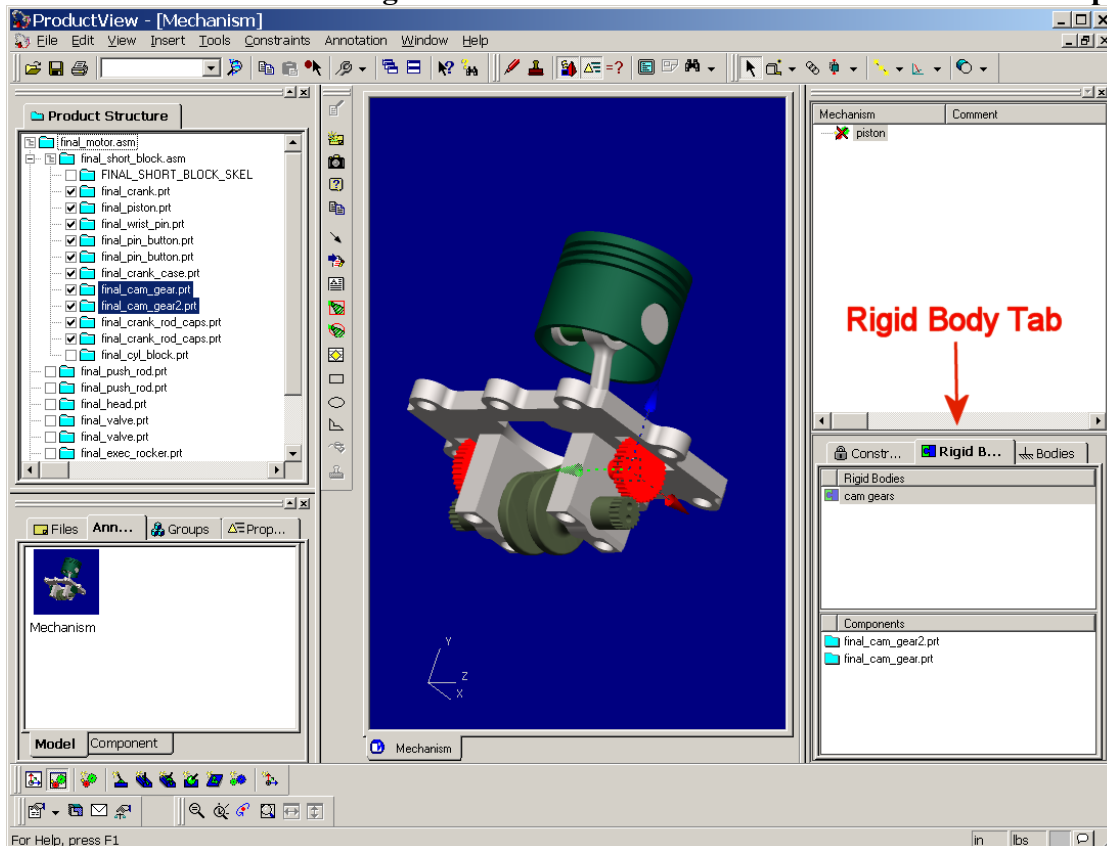

6. Next we will add a constraint to the mechanism. Each constraint defines how two components (or rigid bodies) interact. We will create a revolute constraint between one of the cam gears (final_cam_gear.prt) and the crank case (final_crank_case.prt). You will notice that because the two cam gears are part of a rigid body, the two gears will act as a single component when rotating the gear.

7. The simplest method for creating a constraint is to use construction geometry. First, create a construction axis down the center of the cam gear:

   a. Select your **pick target** by choosing **View > Pick Target > Centerpoint of Arc**.

b. To create the construction axis, choose **Insert > Axis > Primary Axis of Geometry** and then pick on the outside curve of the cam gear teeth. You may need to zoom in close to one of the teeth to select it. If you hold the left-mouse button while selecting, you will see a highlight point in the center of the gear when you've hit the correct spot. The axis should go down the center of the cam gear.
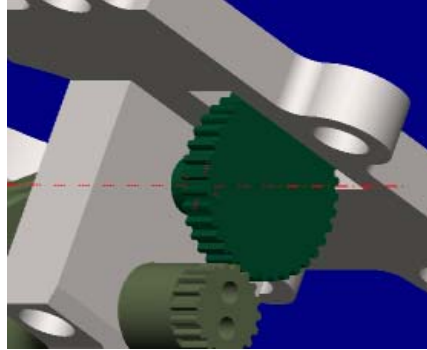

8. Next, highlight the construction axis (don't forget to switch back to select mode by selecting the ⬉ icon) and, using the control key, select the cam gear and crank case. You should now have the construction axis and the two parts highlighted in red.
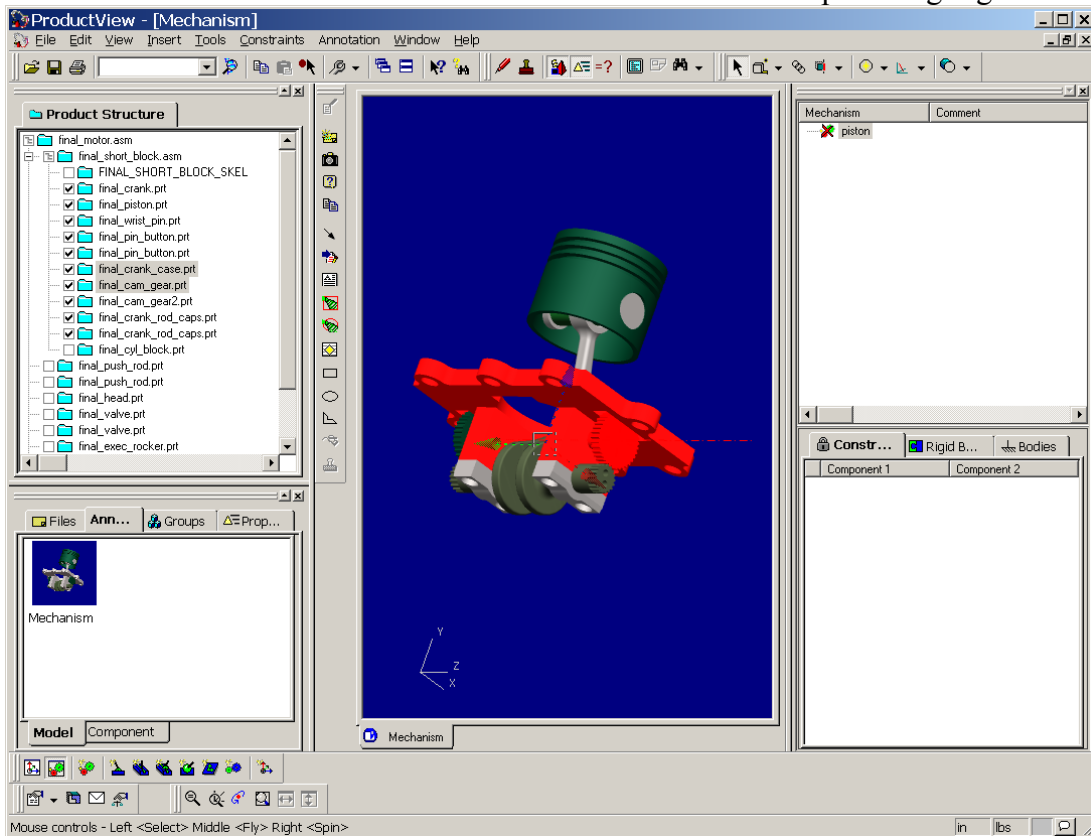
9. Create the constraint by choosing **Constraints > Constraints > Create Constraint > Revolute**.   The   following   dialog   window   will   open:
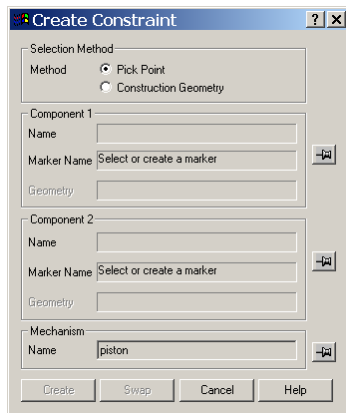

10. Choose **Construction Geometry** as the Selection Method. You should notice that the **Name** fields contain the appropriate component names for **Component 1** and **Component 2** (final_cam_gear.prt and final_crank_case.prt, respectively). The Geometry fields should both contain "Have construction geometry". If this is not the case, go back to step 8 and repeat. Select **Create** to create the constraint.
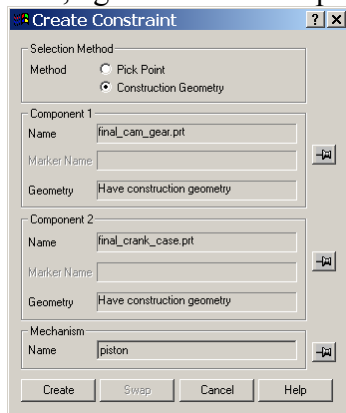

11. You should now have the "final_cam_gear.prt" and "final_crank_case.prt" listed in the constraints window. You will find this under the **Constraints Tab** in the mechanism

window (see below).
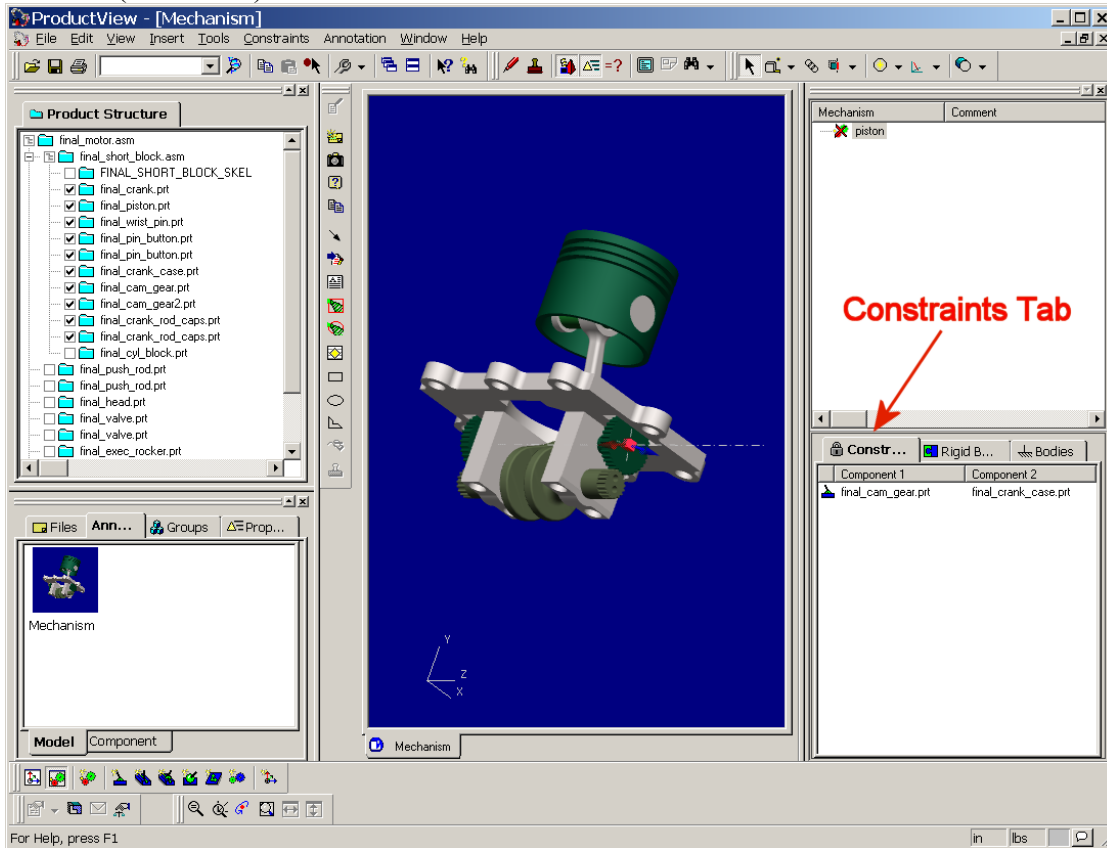
12. Before we can check the mechanism, you will need to ensure that at least one component in the mechanism is grounded. Do this by selecting the ⚓ Bodies tab in the mechanism window. Right-click the crankcase part and select **Toggle Ground**. The icon should now look like this ⚓.

13. Now that the mechanism is grounded, we can test it to see if it works. Select **Constraints > Mechanisms > Enable Mechanism**. You can select one of the cam gears (either one because they are defined as a rigid body) and try to move them. They will only rotate about the construction axis that we defined with respect to the "final_crank_case.prt" (grounded body). Note: Remember to hit the "tab" key after selecting the cam gear to switch from translate mode to rotate mode.

14. To add additional constraints to your mechanism, make sure to disable the mechanism. Do this by choosing **Constraints > Mechanism > Disable Mechanism** or right clicking on the mechanism name and selecting **Disable Mechanism**.

15. Now, lets create another revolute constraint for the final_crank.prt.

a. First, create the construction axis down the center of the crank gear (see step 7b above). It should look like this:
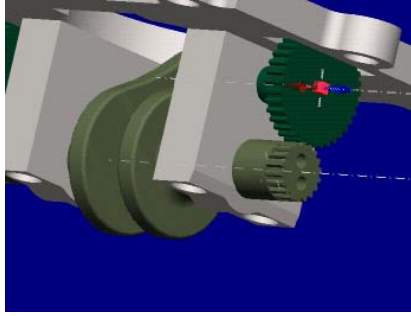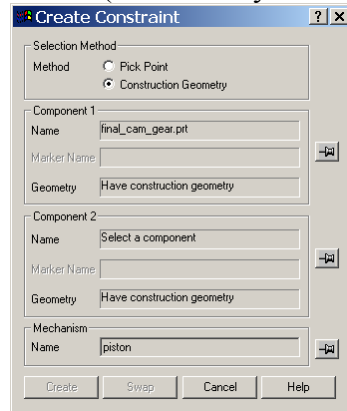

b. Next, select the construction axis, the crank part (final_crank.prt) and the crankcase part (final_crank_case.prt). Use the [Alt] button for multiple selections.

c. Create the constraint by choosing **Constraints > Constraints > Create Constraint > Revolute**.

d. Choose **Construction Geometry** as the Selection Method and select **Create**.

16. You should now have a revolute constraint defined for the final_crank.prt and the final_crank_case.prt parts. Enabling the mechanism should allow you to only rotate the crank within the limitations of the constraint. You should also notice that there is no need to create a "ground" because the final_crank_case.prt is already grounded from the previous constraint definition.

17. Finally, let's create a gear constraint between the cam gear and the crank.

a. Make sure that the mechanism is disabled by choosing **Constraints > Mechanism > Disable Mechanism.**

b. Create construction axes for the cam gear (final_cam_gear.prt) and crank (final_crank.prt). This step can be skipped if the axes were not deleted from the previous examples.

c. Here we will use a slightly different method to create the constraint. Ensure nothing is highlighted in the graphics window and choose **Constraints > Constraints > Create Constraint > Gear**. The following window will appear:
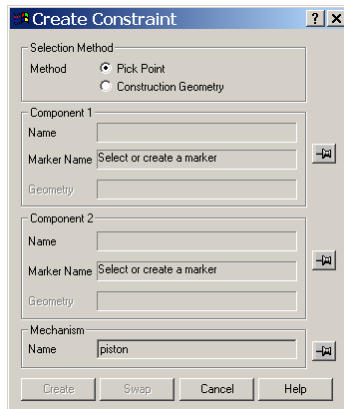

d. Select **Construction Geometry** for the **Selection Method**.

e. Now, select the cam_gear part (final_cam_gear.prt) and it's construction axis. The **Name** and **Geometry** fields for **Component 1** should be populated as shown

below (don't worry that the geometry field for Component 2 is also filled in).

f. Select the push-pin for **Component 1** so that it is locked .

g. Now, select the crank (final_crank.prt) and it's construction axis. Also select the push-pin for **Component 2** so that it is locked . Select **Create**.
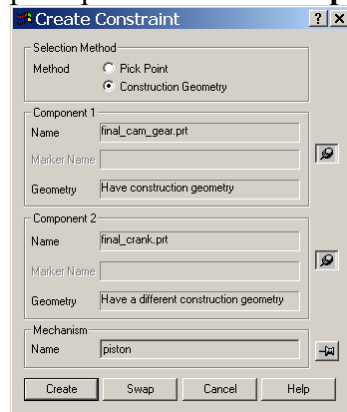
18. You now have a gear constraint between the cam_gear and the crank. Enable the mechanism to test your mechanism. You'll notice now that rotating either the cam_gears or the crank will allow the entire mechanism to function. Also, don't forget to update your annotation set (by selecting the capture view state icon and then saving the .ed file) to preserve your mechanism for later use. In fact, it's a good idea to do this frequently throughout the process to save your work incrementally.

For more information on creating mechanisms, construction geometry and annotation sets, see the on-line help for ProductView (choose **Help > Help Topics** or hit F1 on your keyboard).

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Announcements

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Pro/USER International Conference
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PTC

Note: This PTC E-Newsletter will continue to be used for the following:

1) Inform you on events related to PTC products (user groups, conferences, training schedules, etc.)

2) Educate you on products that are available at PTC

3) Tips & Techniques using PTC Products

Note: These messages are compiled in the local PTC office and will be distributed via e-mail.

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