Instructions for assembling the conceptual robot arm model

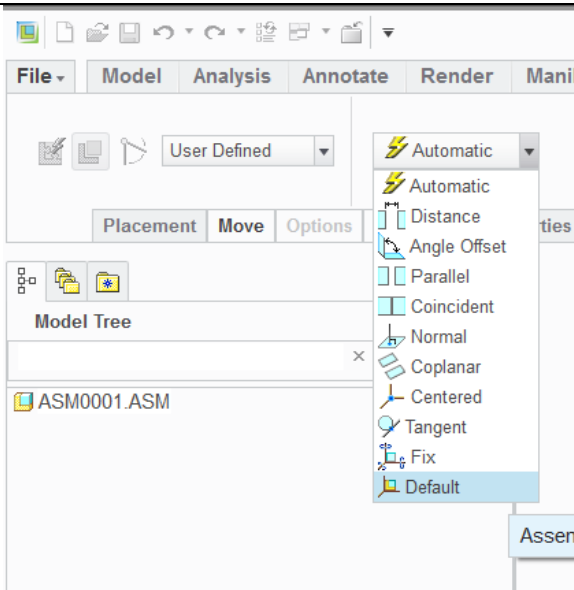
Task 1: Assembling the conceptual model

Objective: To assemble the parts you previously made into the kinematic conceptual model of the robot arm.

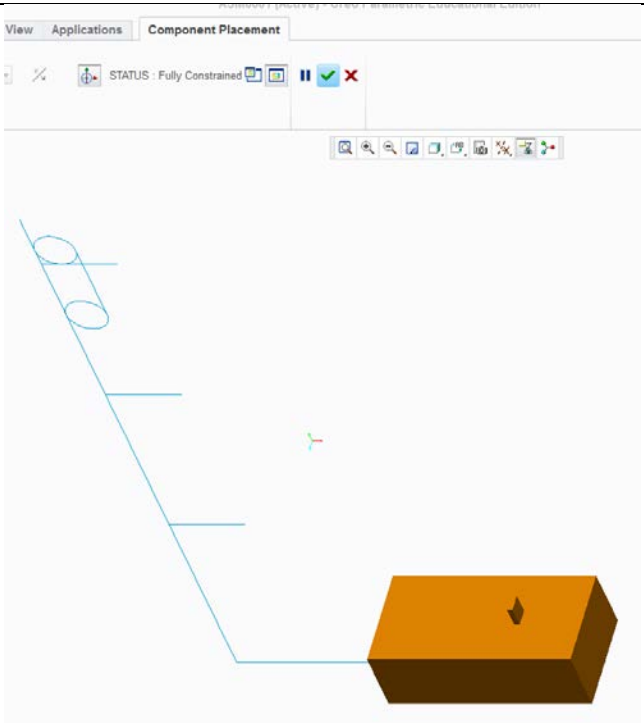
1. Start Creo Parametric and then open a new file. Make sure you pick an assembly file and name it "**conceptual_study**".

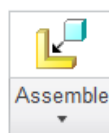
2. Use the **Assemble** tool and select the "**Base_Field_Elements"** part as the first part in the assembly.

Since the base is the first part in the assembly, it needs to be grounded to the origin. This is accomplished by using the **Default** constraint under the **Automatic** constraint pull-down menu.



3. Once it is in the default position, finish by clicking the green checkmark in the assembly dashboard.



4. Next, click on the **Assemble** icon again and select the "**Robot_Arm"** part. The arm will be introduced to the model display.	

Note: Assembling Parts Together

Assembling parts together requires consideration of the behavior of the parts in relation to each other. In this case the behavior is one of fixed position in relation to each other – we want the arm to be positioned firmly on the base!

To fix two rectangular prisms together we will use three ***coincident constraints****. Each coincident constraint will align the two parts in one direction (x-, y-, or z-). By defining three constraints we will fix the position so that no movement occurs.*

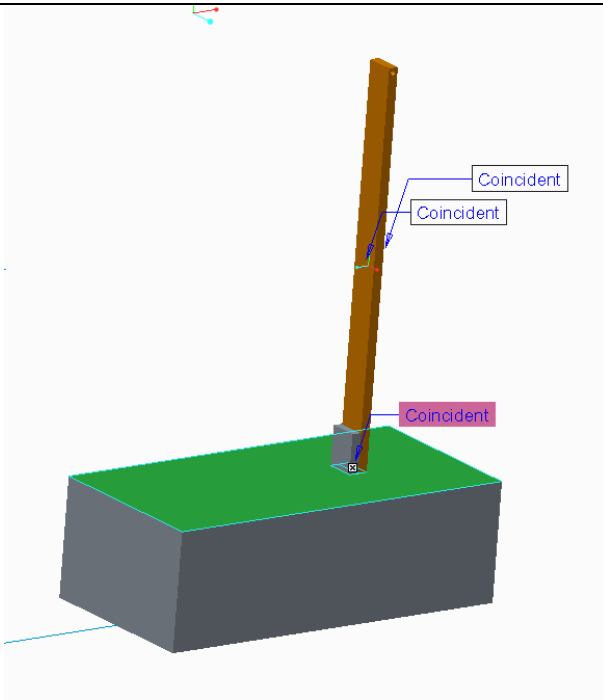
Defining constraints requires selecting both the geometry to which the constraint will apply (surfaces, edges, axes, points) and the type of constraint (coincident, distance, planar, etc.).

It takes some getting used to, but Creo enables you to edit the definition of a constraint so it is possible to fix a constraint that was not correctly defined.

5. This first segment of the arm needs to be attached to the base rigidly. In order to do that, three ***Coincident Constraints*** must be applied.

- Front of the Arm coincident with the Back of the Small Rectangle on the Base
- Side of the Arm coincident with the Side of the Small Rectangle on the Base
- Bottom of the Arm coincident with the Top of the Base (Big Rectangle)

This is an image of the fully constrained assembly!

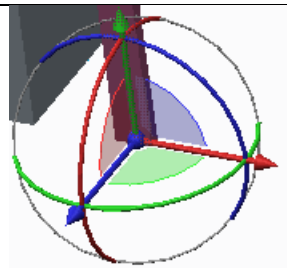


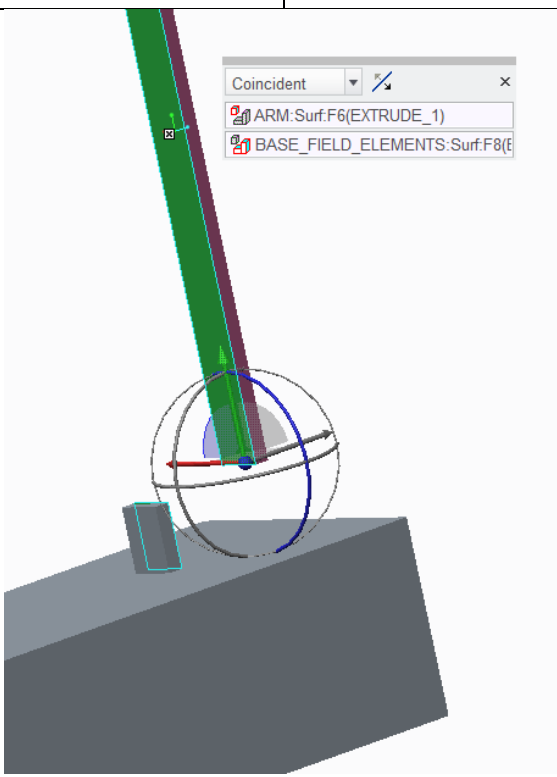
***Note*: Creo anticipates**

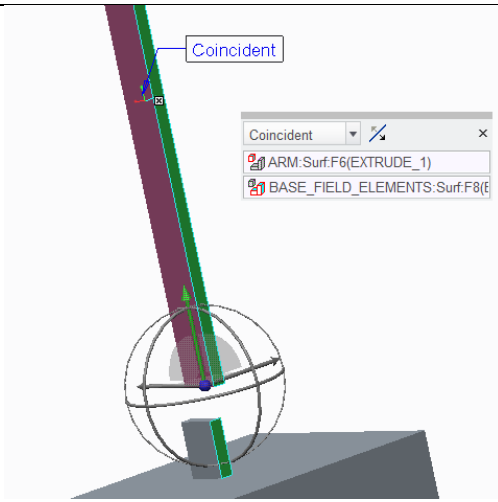
Creo will select a type of constraint based upon the surfaces that you select. It often chooses the correct constraint, but not always. For example, in the current assembly, selecting the wider face of the arm and the wider face of the bracket (prism) on the base will lead Creo to choose a Coincident Constraint.

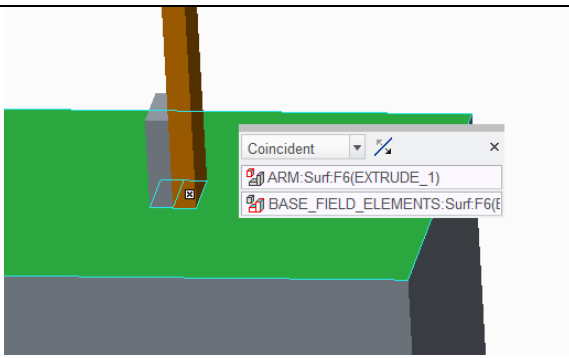
Follow the instructions below to complete the	

assembly of the arm to the base. As you do so you can use the sphere icon to drag and spin the component part.









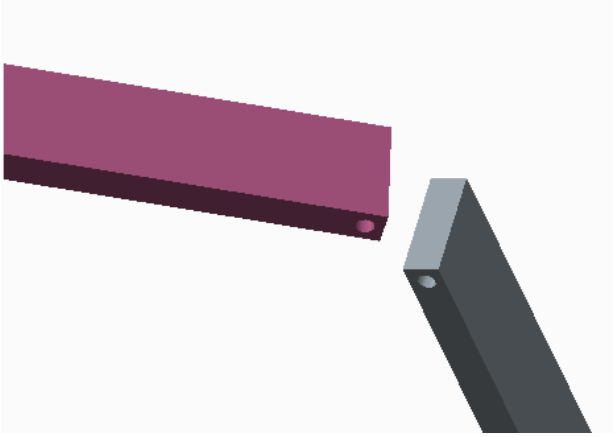
Finish this Assembly by clicking the green checkmark in the dashboard!

Using a Pin Assembly to Hinge Moveable Parts

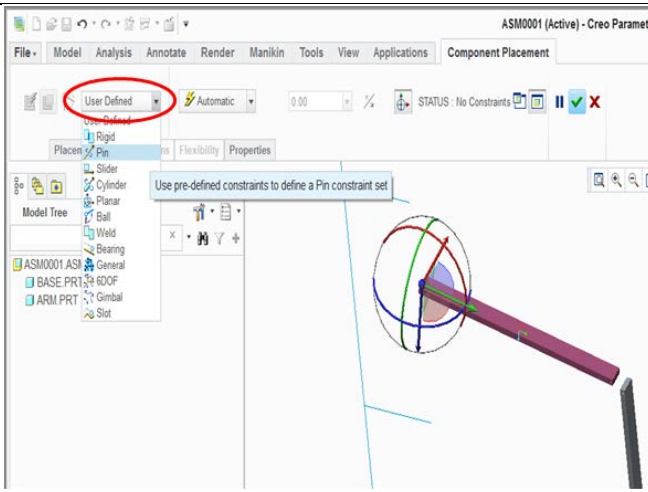
6. Use the **Assemble** icon again to bring in a second copy of "**Robot_Arm.prt**". You will assemble this part to the existing arm

so that the new arm rotates in the plane.

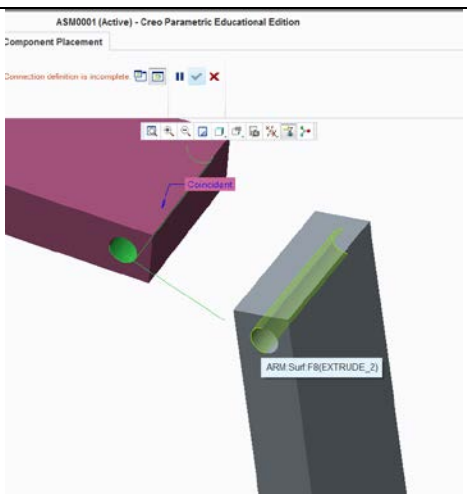
7. Use the orientation sphere to orient the new arm component so that the ends of both arm parts with the holes are aligned and close together as shown.



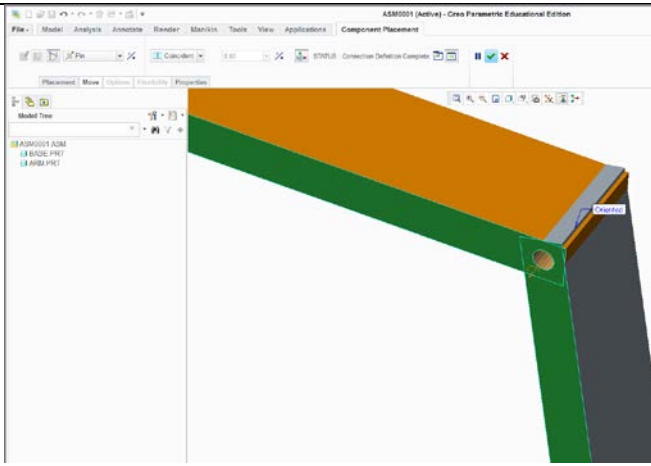
8. Since this arm is going to hinge or pivot with respect to the base, we need to use a kinematic constraint called a **PIN Constraint** to attach it to the end of the rigid arm. This is done by first selecting **Pin** from the **User Defined** pull down menu in the dashboard.



9. Next, click to select the cylindrical surfaces of the two holes in the ends of the arms.



10. Now select the two sides of the arms to align the edges.



11. At this point you can finish by clicking on the green checkmark. When complete the assembly will appear as below and you will be able to move the upper part of the arm.

Note: A Working Assembly

In order to move the arm, ***Left Click*** *on the arm while holding down the* ***Ctrl*** *and* ***Alt*** *keys. You should be able to drag the arm so that it rotates on the* ***Pin*** *connection that you defined.*

You will notice that it is currently possible to rotate the arm 360 degrees, straight through the other arm as if it has no mass. Why?

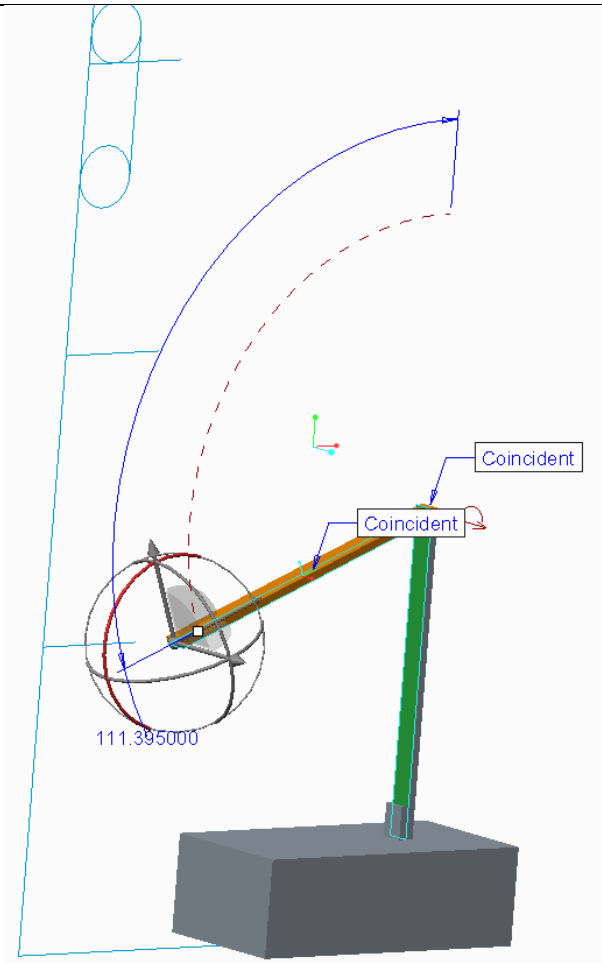
So far, we have defined the geometry of the assembly, not the physical properties of the model.

You will also notice that the current assembly cannot reach the ground to pick up a tube. So

let's limit the rotation of the arm and let's add a retractable arm segment so that we can reach the floor.

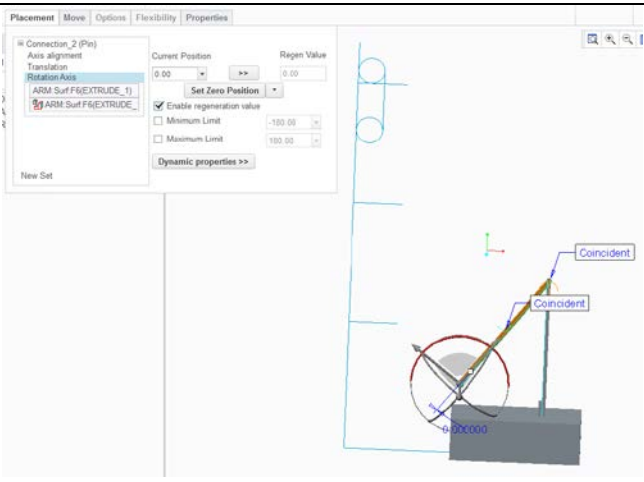
12. Find the second arm part in the model tree and right click on it and select **Edit Definition**. Then open the **Placement** tab in the dashboard. You will notice in the constraint list an entry called: "**Rotation Axis**". Click on this entry.

13. The first thing we need to do to limit the rotation of this arm is to define two reference planes. Select the face of the rotating arm that will meet the front face of the verticle arm. Then select the front face of the verticle arm.

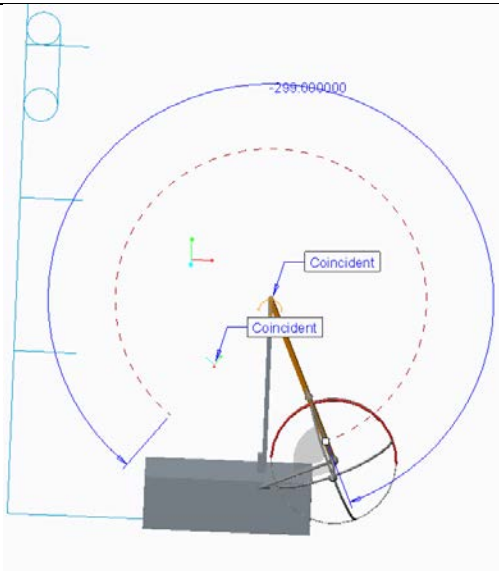


14. Now use the white box to rotate your arm so that it is at its lowest point as if it were trying to reach the floor. Then click on the Set Zero Position button and check the Enable regeneration value. This will make this rotation angle the default

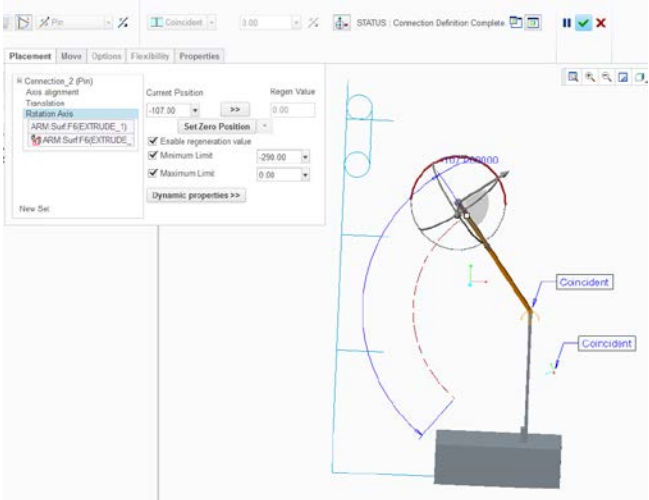
position.



15. Now use the white box again to rotate the arm to its farthest position. Then set the minimum limit and the maximum limit appropriately to restrict the arm's motion.



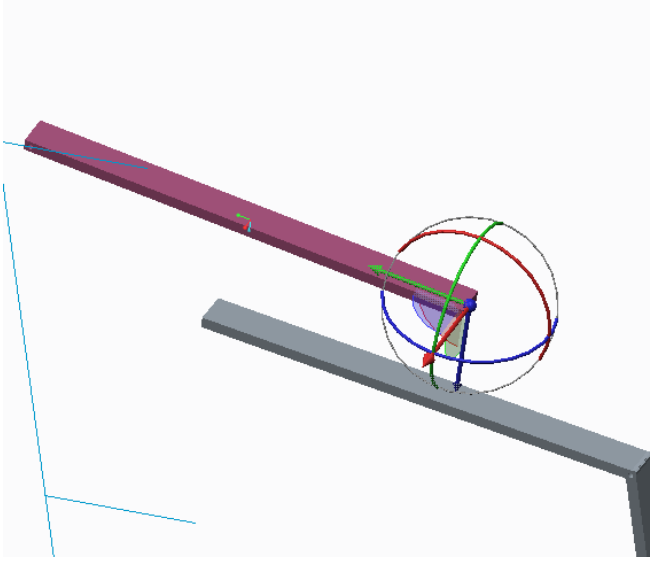
16. You can use the white box to check to make sure the limits are appropriate.



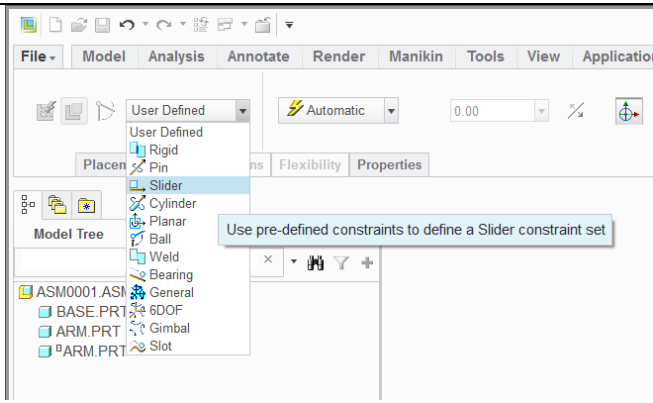
Adding a Retractable Arm

1. Click **Assemble** in the ribbon and insert another copy of "**Robot_Arm.prt**" into the assembly. We will constrain this part so that it slides along the surface of the upper arm extending to the ground.

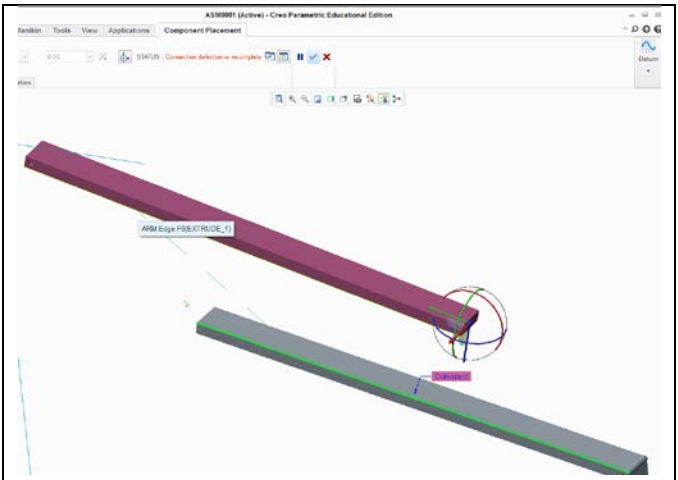
Use the orientation sphere to align the new arm component as shown below with the hole at the end of the arm (facing away from the assembly).



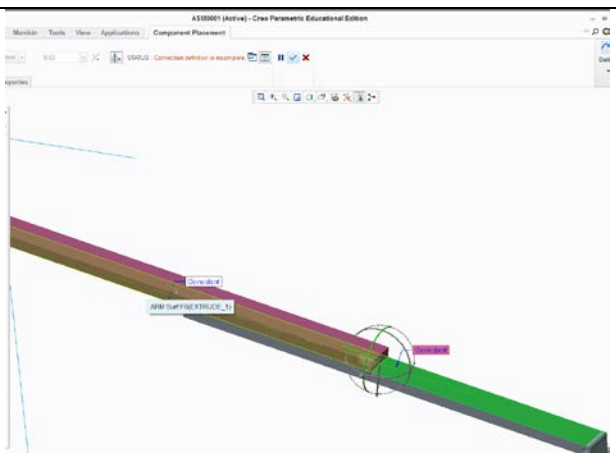
2. This time we want this arm component to slide along the arm component we just assembled, to do this, we must use a Slider constraint. Choose a Slider constraint from the User Defined pull down menu.



3. Now select the edges of the two arms as shown to constrain the axis (or direction) that the new arm will slide along the existing arm.

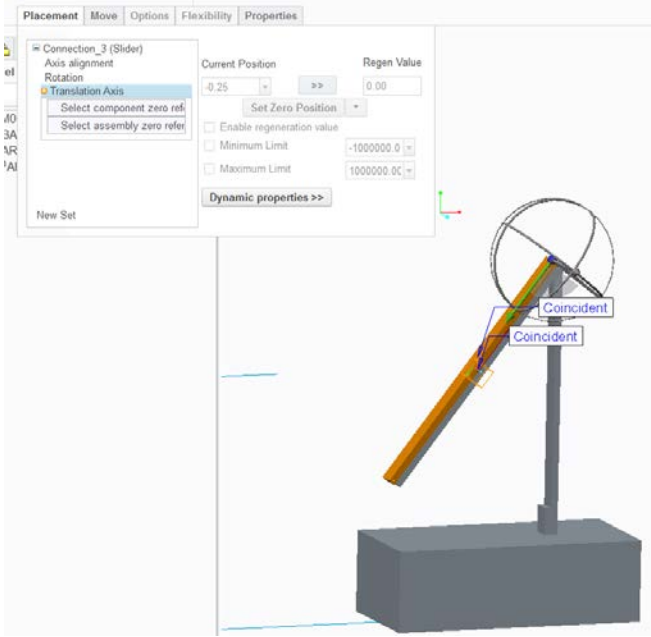


4. Now select the two faces that will slide against each other. Notice that you will need to either rotate so that you can select both of these faces, or use the right mouse button select to select the bottom surface of the top arm.

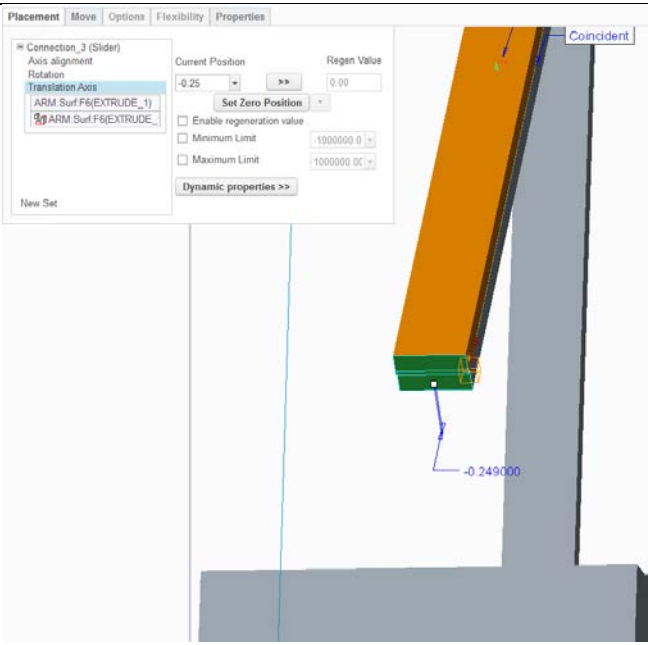


5. Once again we need to apply limits to this

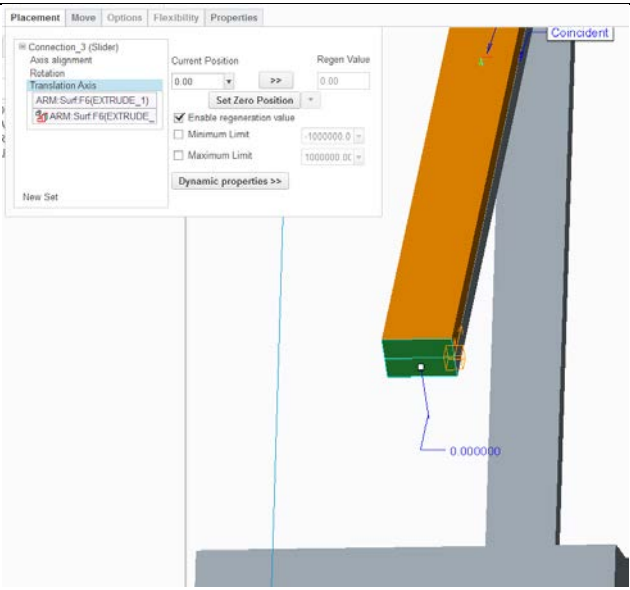
sliding arm so that it stays within reasonable motion. To do this open the **Placement** tab in the dashboard and then click on the **Translation Axis** in the list of constraints.



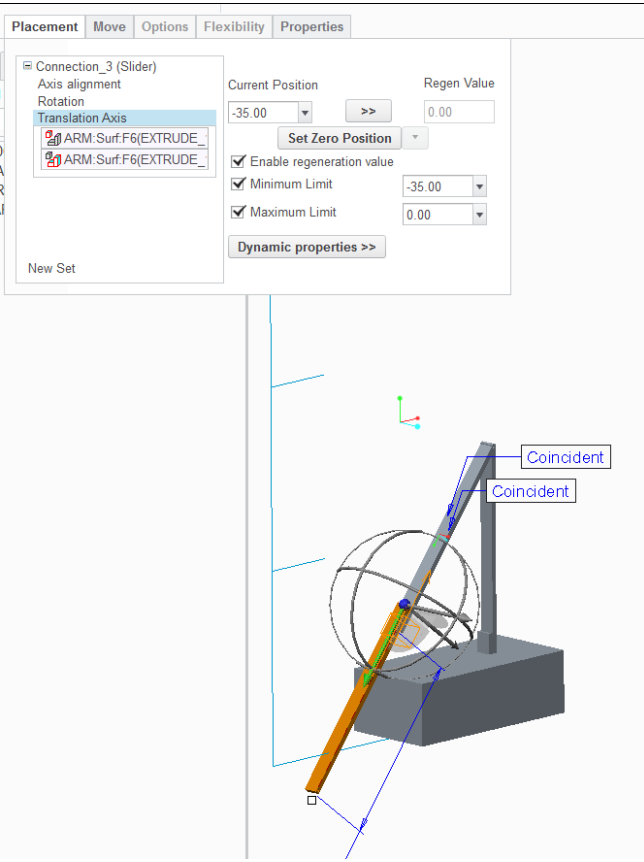
6. We need to set the reference surfacecs again which will be the two end facecs of the arms. Select these end faces.



7. Set the current position to zero by typing 0.0 in the Current Position tab. Hit enter and then set the zero position by clicking on the Set Zero Position button as well as checking the Enable regeneration value.



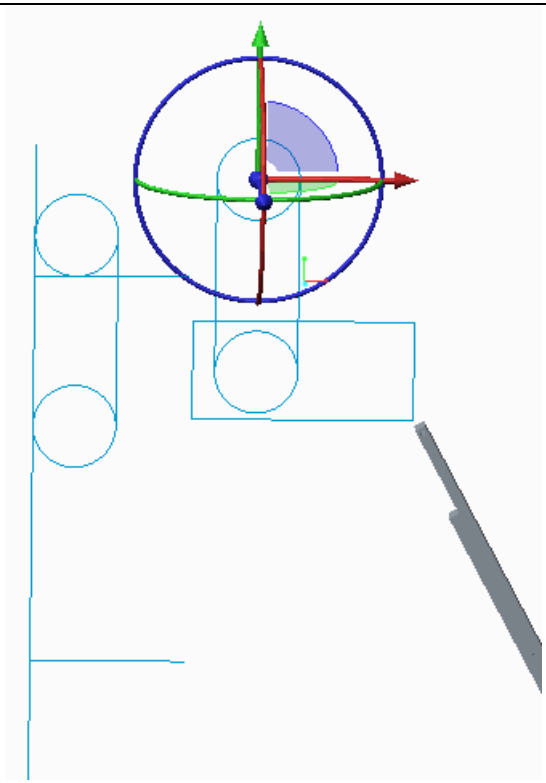
8. Now set the minimum limit and the maximum limit as we did before.



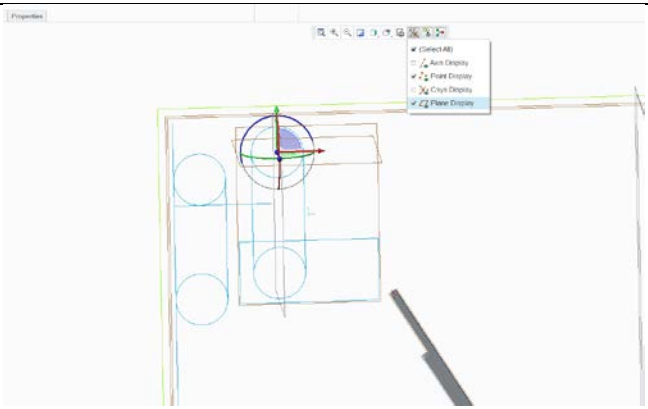
Adding the gripper

1. Click on the **Assemble** icon in the upper menu again and select the part called: "**Robot_Gripper**" that you created previously.

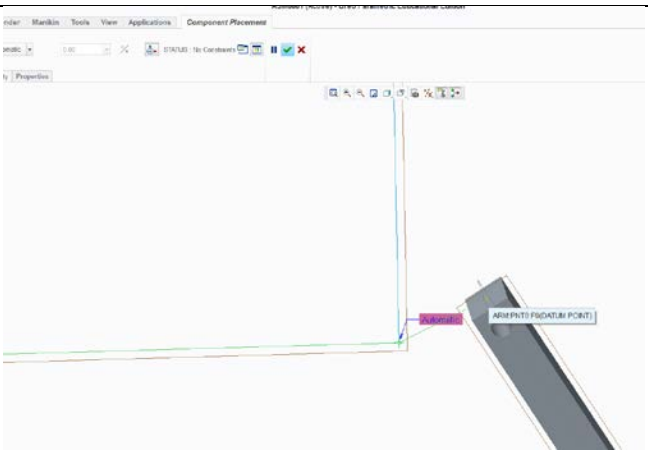
2. Use the orientation sphere to orient the gripper as shown.



3. Now turn the datum point display on as well as the datum plane display. We will use the datum point at the end of the arm as well as the datum planes to constrain the gripper.



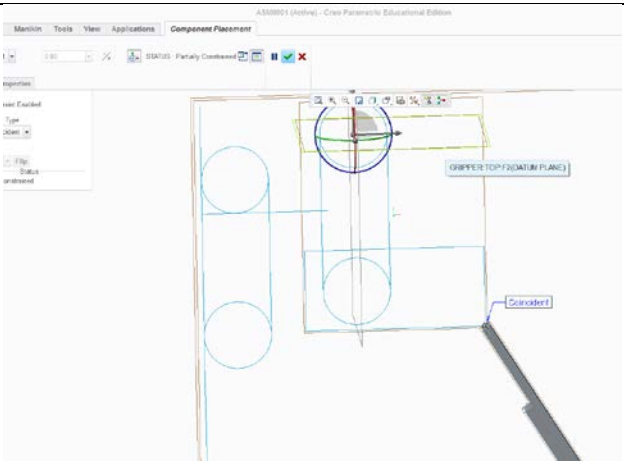
4. Now select the end point of the corner of the gripper closest to the arm and the datum point on the face of the arm.



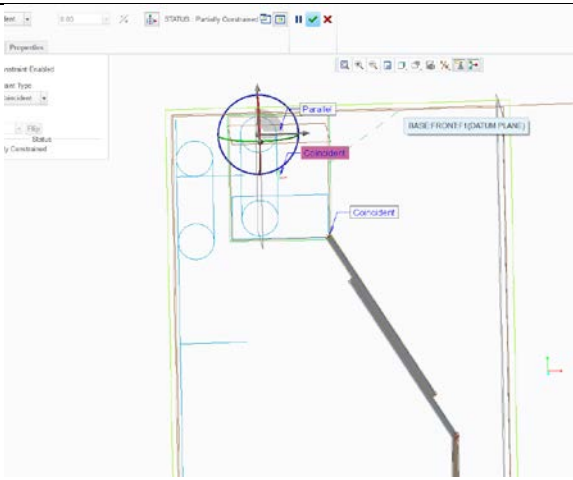
9. If you need to, change the constraint from a **Distance** constraint to a **Coincident** constraint.

10. Now select **New Constraint** and then **Parallel** as the type of constraint and then

select the datum plane on the gripper that is on top as shown, and the floor datum plane.



11. Now finish the assembly by selecting **New Constraint** and **Coincident** as the type and then selecting the plane that bisects the gripper and that bisects the robot arm.



12. Now finish by clicking the green checkmark.

13. Check to make sure your robot moves kinematically the way it should by using the **CTRL-ALT** keys on the keyboard as well as left clicking to select the composite robot arm and moving your mouse.

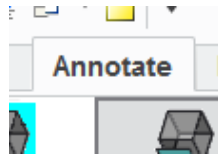
14. Make sure to save your model!

Congratulations! You have created a working conceptual model.

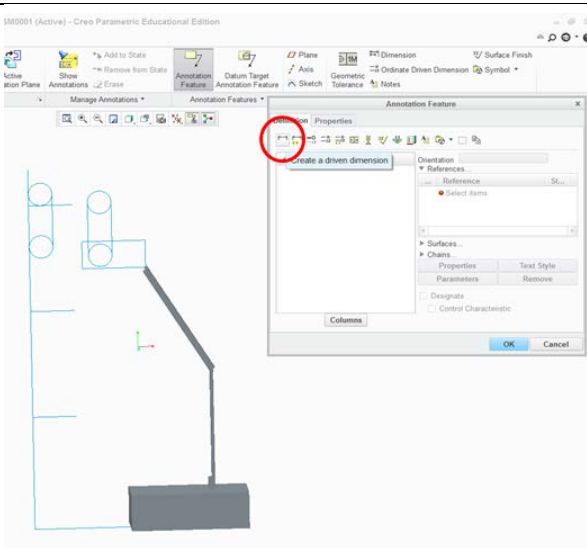
Task 6: Annotating the Creo model

Objective: In this task you will add annotations to the robot arm model to display angles and dimensions.

1. Now select the **Annotate** tab in the top level menu and then use the **Annotation Feature** tool to insert annotations you may wish to place on the model to display angles and lengths.

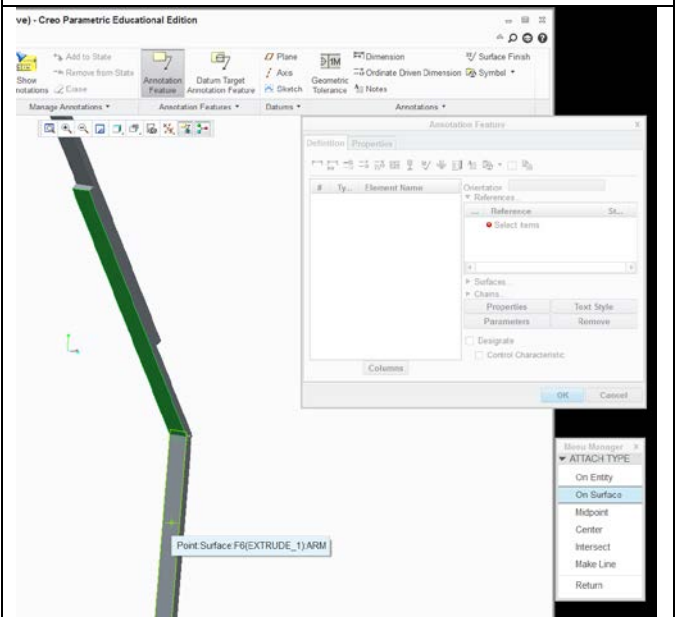


2. To do this, select the **Driven Dimension** tool.

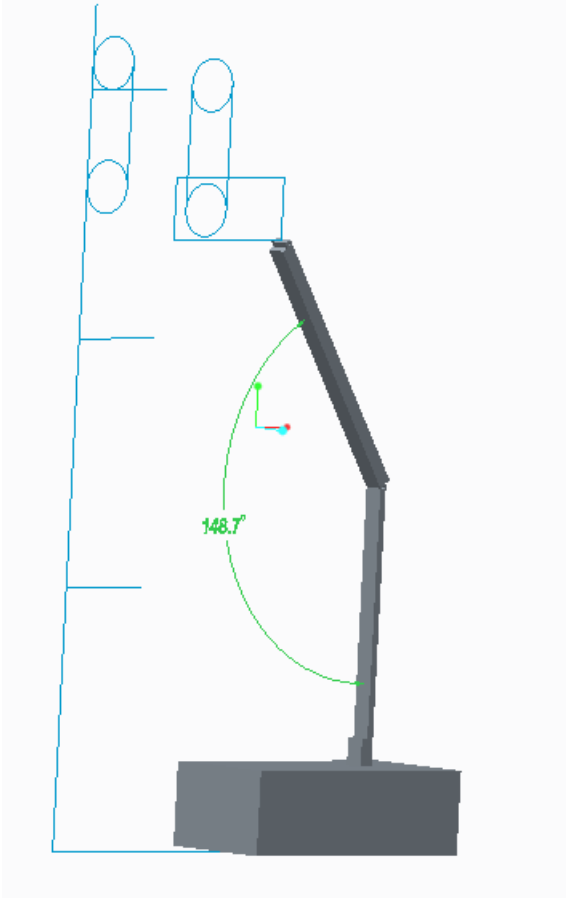


3. Now select **On Surface** and then select the underside of the rotating arm and the

front face of the rigid arm and middle click when finished. An angle dimension is placed on the assembly that changes as you move your robot arm.

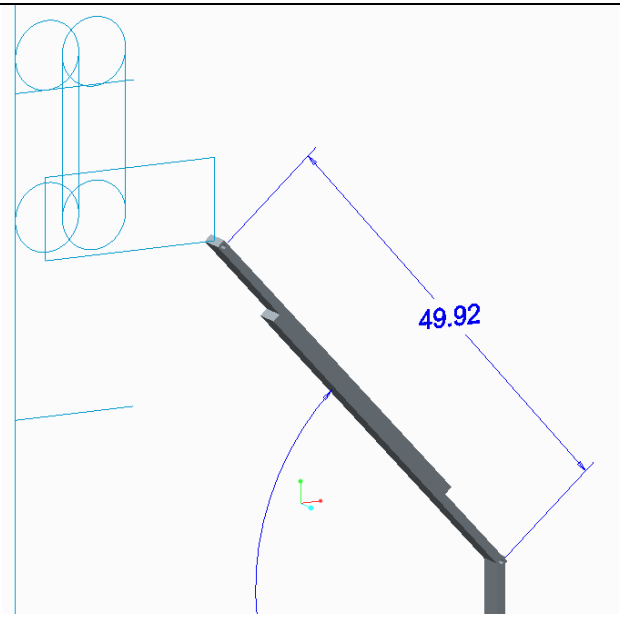


4. You should now have a driven dimension that updates as you move your robot arm using the **CTRL-ALT** keys.

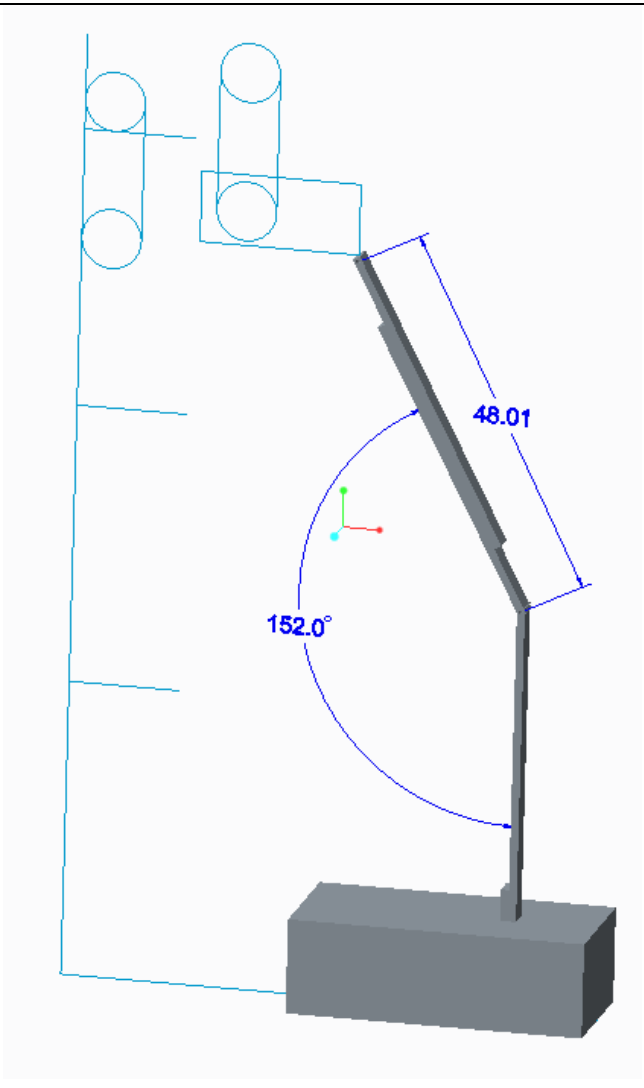


5. Now add a linear dimension by clicking on the **Driven Dimension** tool again and selecting **Center** and then selecting the edges of the hole at the hinge and the hole at the gripper end of the arm. Then middle click where you want the dimension. It will ask what orientation you want for the

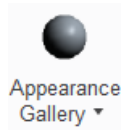
text. Choose **Slanted** and then click **OK**.

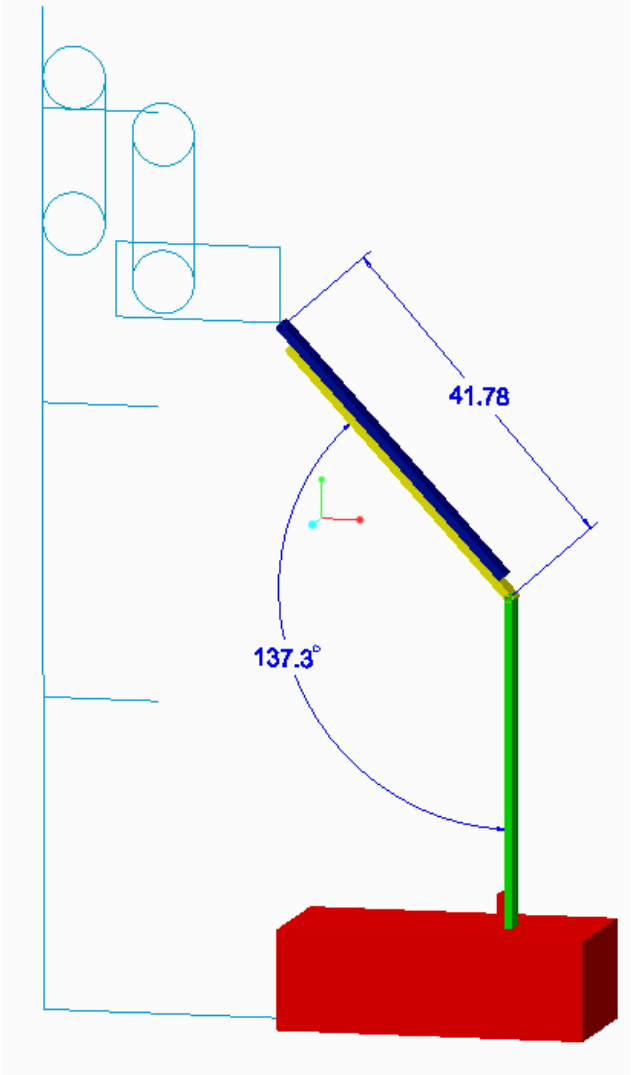


6. You can add as many driven dimensions as would be helpful.



7. The final part of this exercise is to add color to the model. This is done by choosing the **Render** tab in the top level

assembly.	
8. Now use the pull down menu named "**Appearance Gallery**"and click on the color you would like to use.	
9. A paint brush cursor will appear and you can select the surfaces or parts that you wish to apply the color to.	
10. When you are finished, click OK.	



Congratulations! You have completed the conceptual robot arm model.