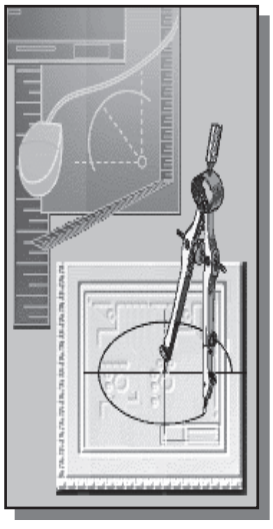
Chapter 18
Assembly Modeling with the LEGO® MINDSTORMS® NXT Set – Autodesk® Inventor®



Learning Objectives

- Creating an Assembly Using Parts from the LEGO® MINDSTORMS® NXT Set
- Understand and Perform Proper Constraints in Assembly
- Adjust Components' Orientations
- Create and Use Subassemblies in Assemblies

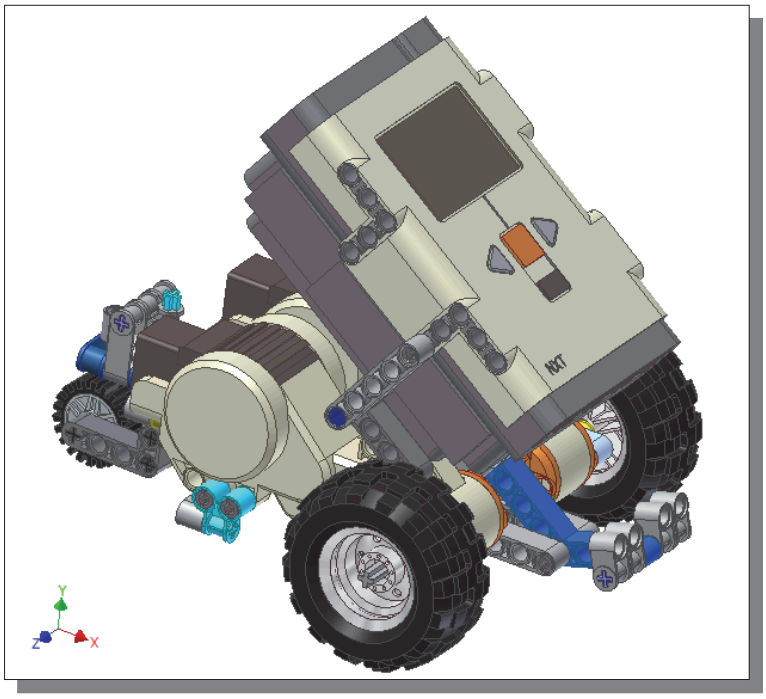
Introduction

The rapid development in computer hardware technology, during the past few decades, has brought many changes in the practice of engineering in general. Many areas that were traditionally identified as electrical engineering or mechanical engineering are now multidisciplinary, integrating digital electronics, kinematics analysis, and computing together. Additionally, the use of microcontrollers and embedded systems has become inevitable in almost every engineering field. Given these developments, engineering education has also witnessed significant changes, such as adapting to project-oriented courses that emphasize real world applications, and the use of new educational tools such as robot kits.

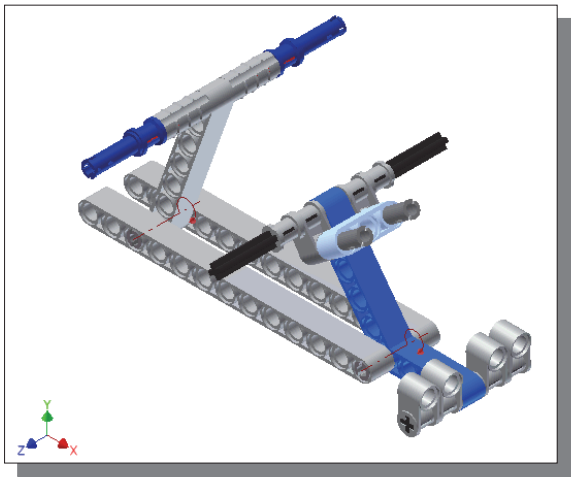
The use of robot kits provides many benefits, through assembling, building, and following instructions, which help develop fine motor skills and hand-eye coordination. Students are exposed to multiple subjects such as mechanics, electronics, and programming. By working together to create robots that perform exciting challenges, students also gain valuable critical thinking, problem-solving and team-building skills. Students can also participate in several national/world robot competitions held annually, which can provide a strong sense of accomplishment.

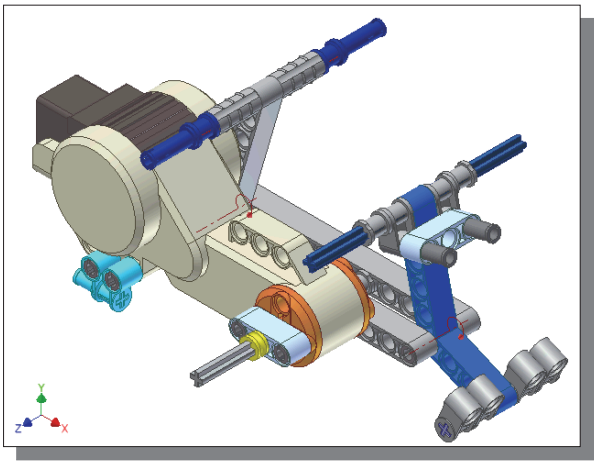
In this lesson, we will create a ***Basic Car*** assembly model using the **LEGO® MINDSTORMS® NXT Set**. The modeling process can be used as part of a design process, to simulate and confirm a design, prior to the actual construction of the project. All of the required parts/subassemblies have been modeled in Autodesk Inventor, and can be found on the publisher's website: www.SDCpublications.com/downloads/978-1-58503-873-2. Additional design ideas and resource information are also available. Unzip all of the parts/subassemblies under a folder in the **Parametric-Modeling-Exercises** project folder before starting on the next section.

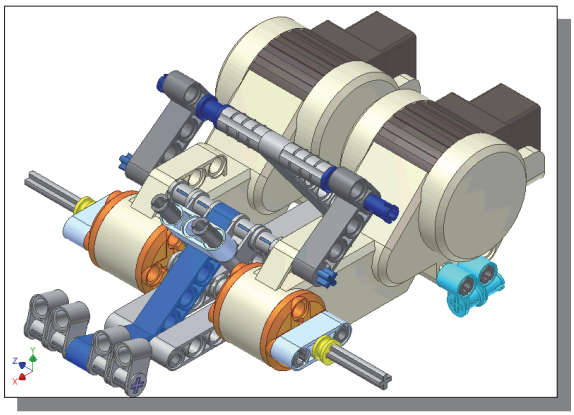
The *Basic Car* Assembly

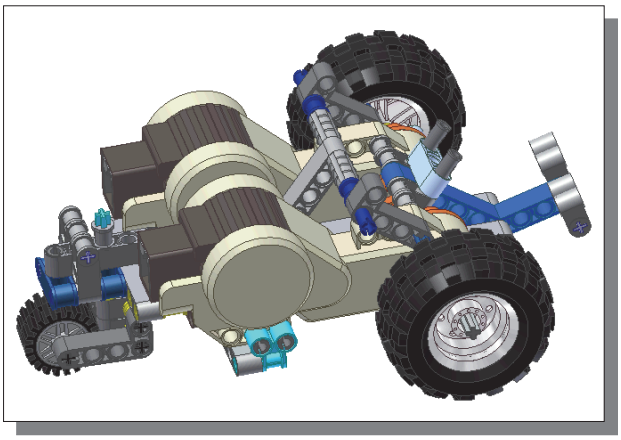


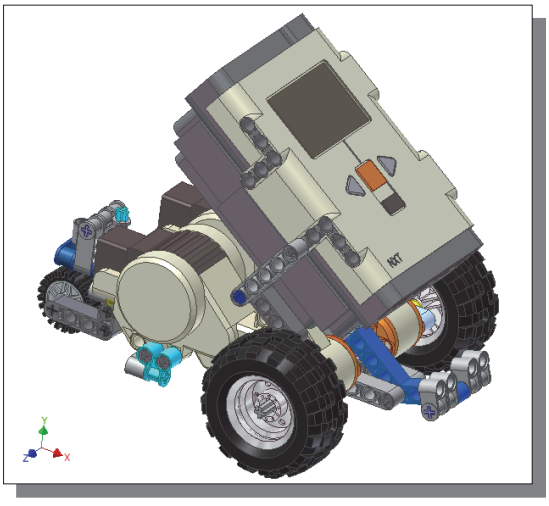
Modeling Strategy





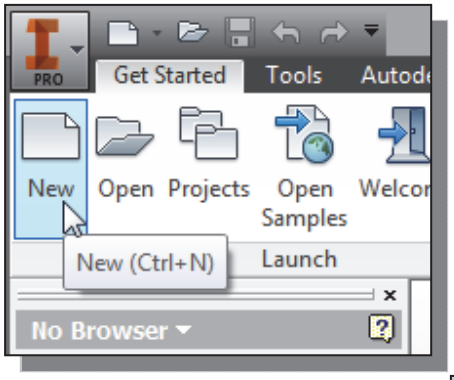






Starting Autodesk Inventor

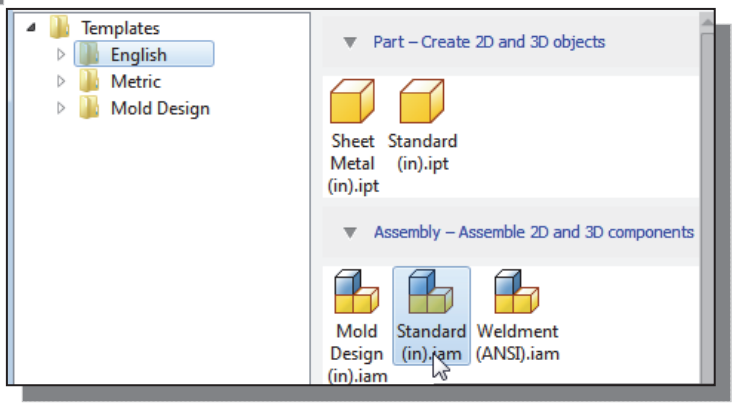
1. Select the **Autodesk Inventor** option on the *Start* menu or select the **Autodesk Inventor** icon on the desktop to start Autodesk Inventor. The Autodesk Inventor main window will appear on the screen.

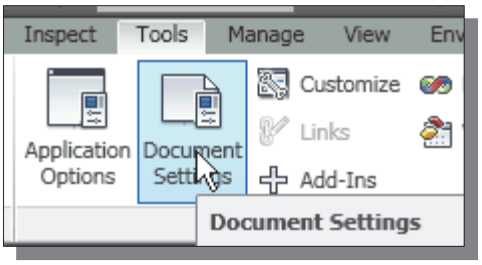


2. Select the **New File** icon with a single click of the left-mouse-button in the *Launch* toolbar as shown.

3. Select the **English** units set and in the *Template* list, select **Standard(in).iam** (*Standard Inventor Assembly Model* template file).

4. Click on the **Create** button in the *New File* dialog box to accept the selected settings.





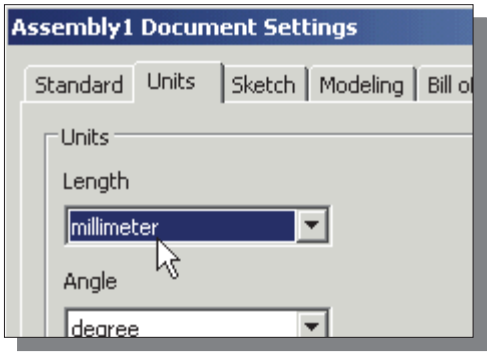
5. In the *Ribbon* toolbar, select the **Tools** tab.

6. Select the **Document Settings** command as shown.

7. In the *Assembly1 Document Settings* dialog box, click on the **Units** tab as shown.

8. Set the *Length Units* to **millimeter** as shown.

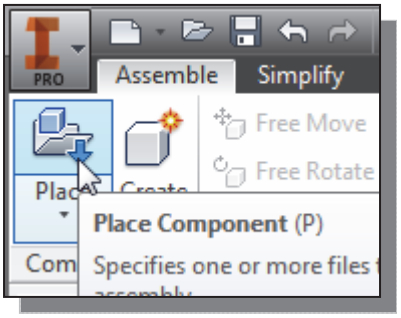
9. Click on the **OK** button to accept the selected settings.



- The *Standard Inventor Assembly Model* template file contains predefined settings including default 3D view orientation and default 2D drawing views setup. With Autodesk Inventor, we are allowed to mix units within the same file.

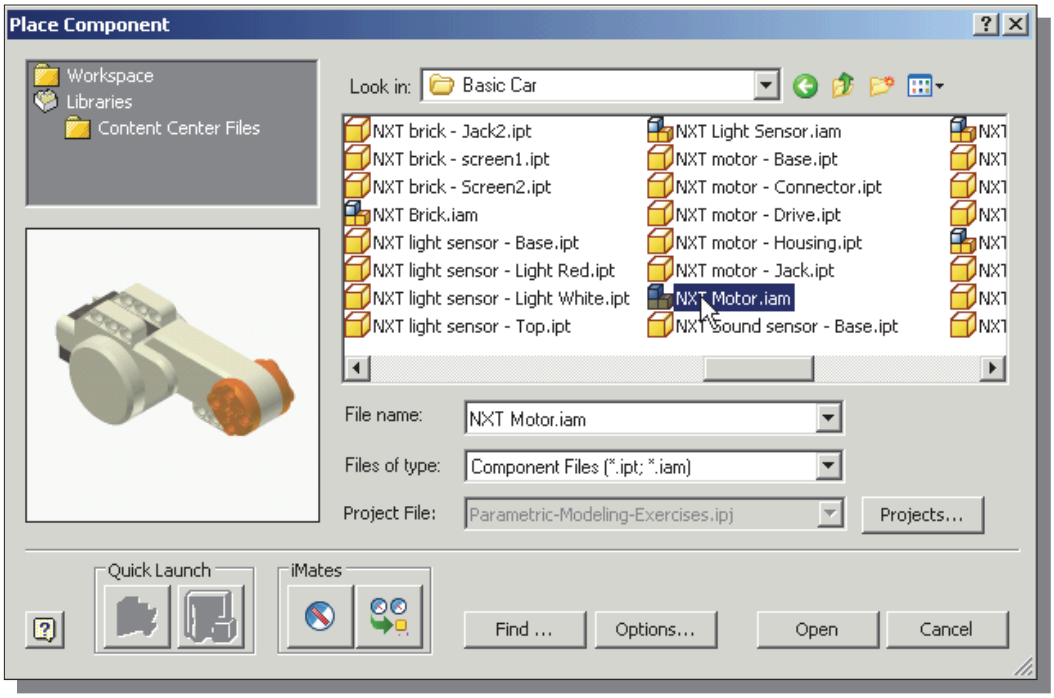
Creating a Subassembly

❖ We are now ready to assemble the components together. We will start by assembling the ***NXT Motor***, ***Bushings*** and ***Pegs*** into a ***Motor*** subassembly. A subassembly is a unit assembled separately but designed to fit with other units in a manufactured product. Subassemblies are commonly used to help manage complex designs and when the same configurations are used multiple times in a design. Note that a subassembly behaves just the same as a part within an assembly; i.e., a subassembly possesses only six degrees of freedom, just like a regular part. Any moving parts within a subassembly become fully locked inside the main assembly.



1. Switch to the *Assembly* panel, and select the **Place Component** command by left-mouse-clicking the icon.

2. Select ***NXT Motor.iam*** (switch to the appropriate folder if necessary) in the list window. Note this is a subassembly containing five parts.



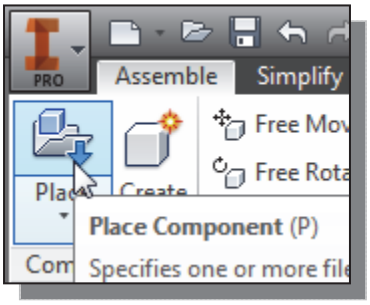
3. Click on the **Open** button to retrieve the model.

4. Right-mouse-click once to bring up the option menu and select **Place Grounded at Origin** to place the part.

5. Right-mouse-click once to bring up the option menu and select **OK** to end the command.

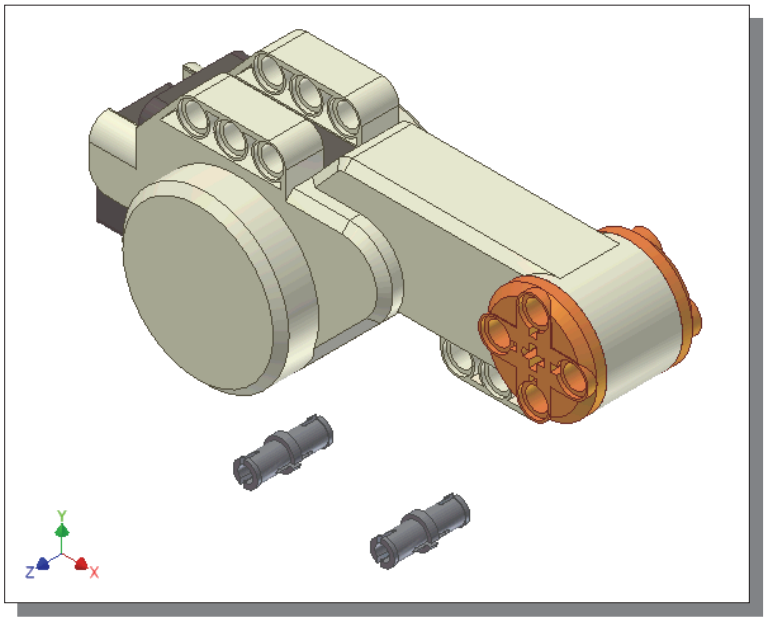
Placing the Next Component

➢ We will retrieve the ***Peg 1-module*** part as the next component of the assembly model.

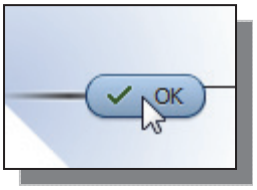


1. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.

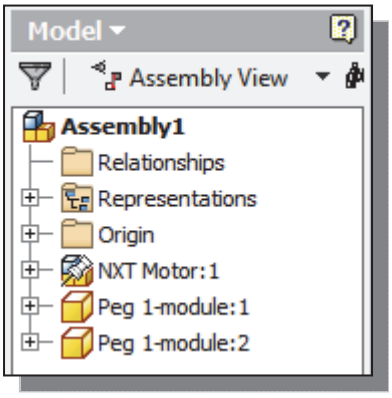
2. Select the ***Peg 1-module*** design in the list window. Click on the **Open** button to retrieve the model.



3. Place **two** copies of the *Peg 1-module* part toward the left side of the graphics window, as shown in the figure.



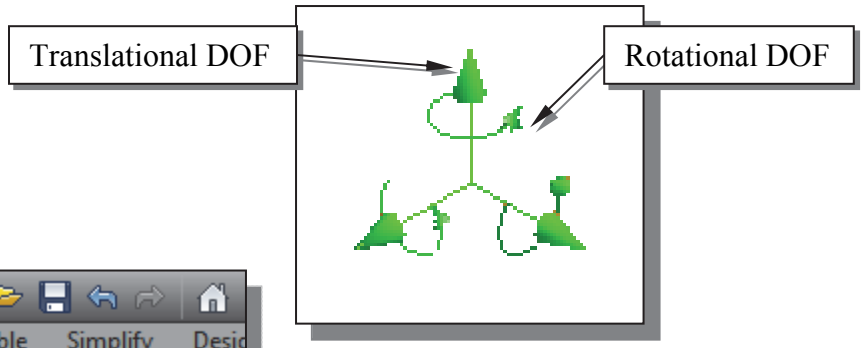
4. Inside the graphics window, right-mouse-click once to bring up the option menu and select **OK** to end the placement of the *Peg 1-module* part.

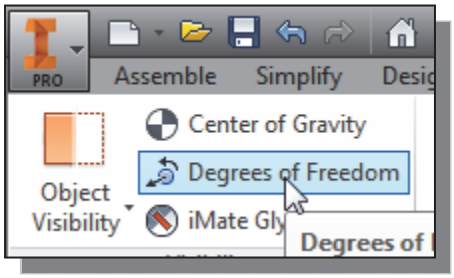


- Inside the *browser* window, the retrieved parts are listed in their corresponding order. The **pin** icon in front of the ***NXT Motor* assembly** signifies the component is grounded and all ***six degrees of freedom*** are restricted. The number behind the name is used to identify the number of copies of the same component in the assembly model.

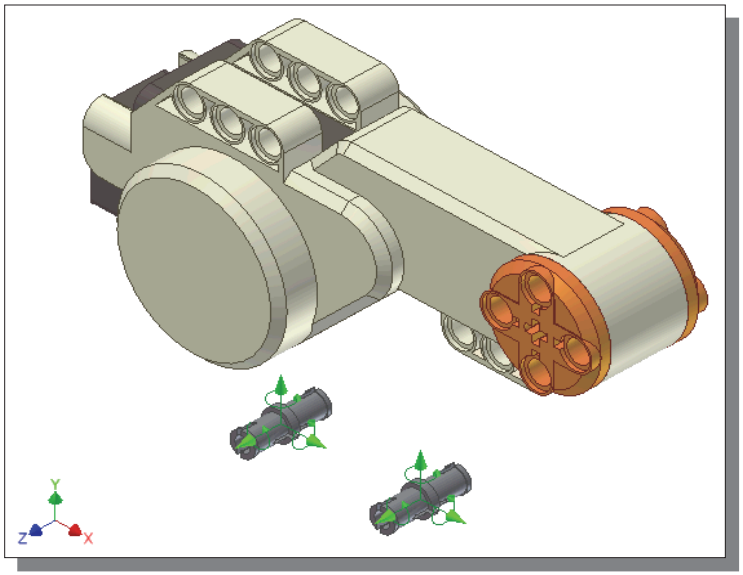
Degrees of Freedom Display

- Each component in an assembly has six **degrees of freedom** (**DOF**), or ways in which rigid 3D bodies can move: movement along the X-, Y-, and Z-axes (translational freedom), plus rotation around the X-, Y-, and Z-axes (rotational freedom). *Translational DOF*s allow the part to move in the direction of the specified vector. *Rotational DOF*s allow the part to turn about the specified axis.



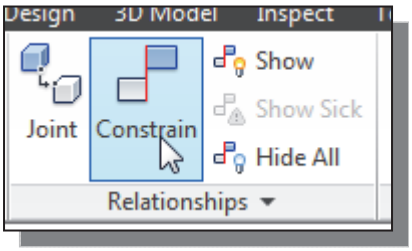


➢ Select the **Degrees of Freedom** option in the **View** tab to display the DOF of the unconstrained component.



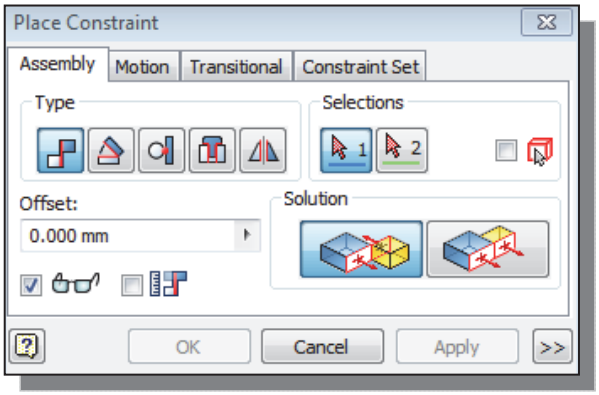
- In *parametric modeling*, the degrees of freedom symbol shows the remaining degrees of freedom (both translational and rotational) for the components of the active assembly. Note that each component has its own degrees of freedom, even if the same part is placed multiple times within the same assembly. The assembly constraints are also applied independently to each component. The set of degrees of freedom symbols, as shown in the figure above, signifies each copy of the *Peg 1-module* is unconstrained and should be constrained independently.

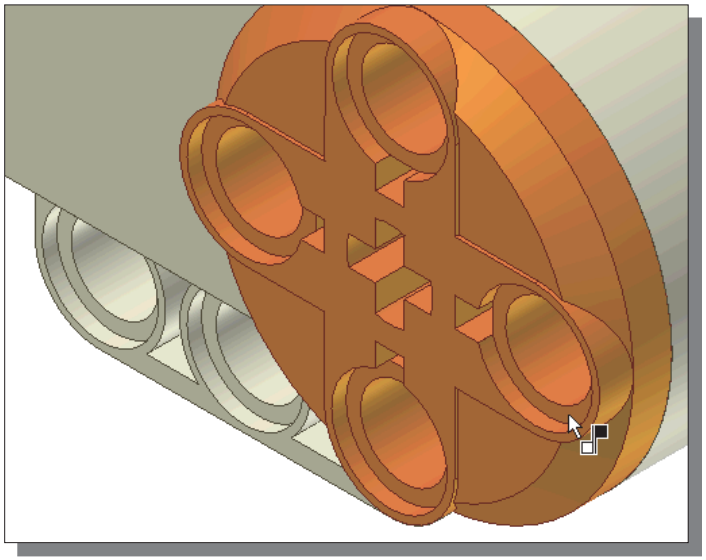
Apply the Assembly Constraints



1. In the *Assembly* panel, select the **Constrain** command by left-mouse-clicking once on the icon.

2. In the *Place Constraint* dialog box, confirm the constraint *Type* is set to the **Mate** constraint.



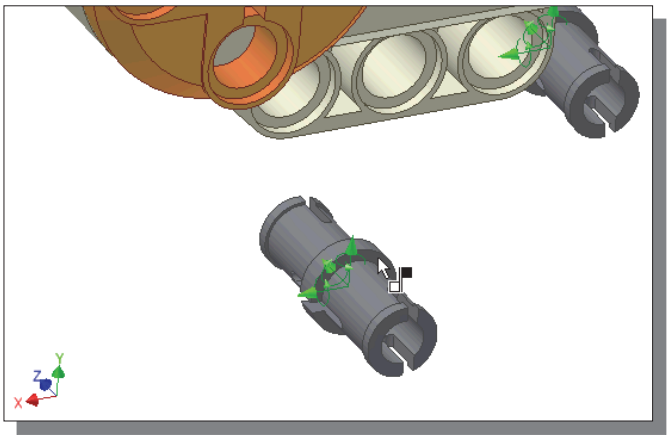


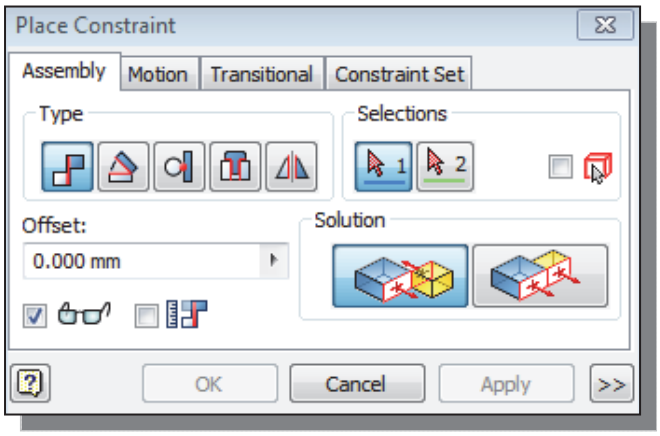
3. Select the ring surface of the ***NXT Motor Drive*** as the first item for the Mate Alignment command.

4. On your own, use the **View-Cube** and rotate the display to view the opposite side of the *Peg 1-Module* parts.

5. Click on the back ring face of the ***Peg 1-Module*** part as the second part selection to apply the constraint.

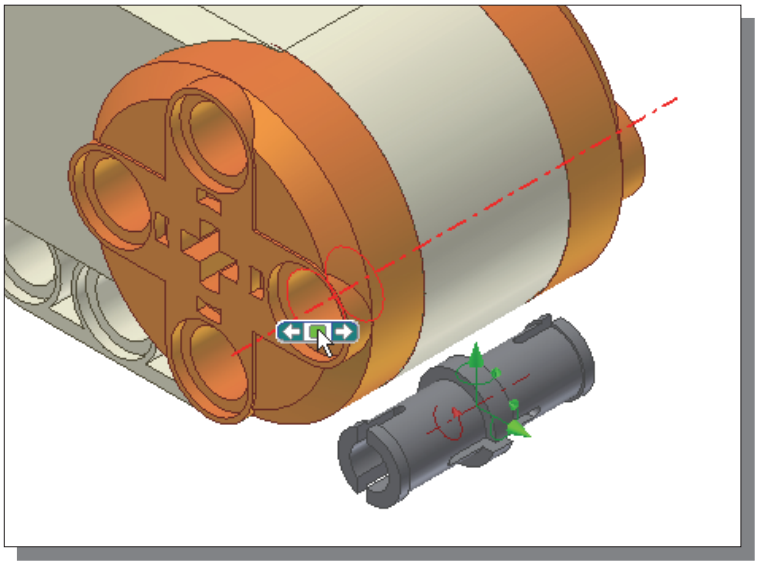
6. Click on the **Apply** button to accept the selection and apply the Mate constraint.

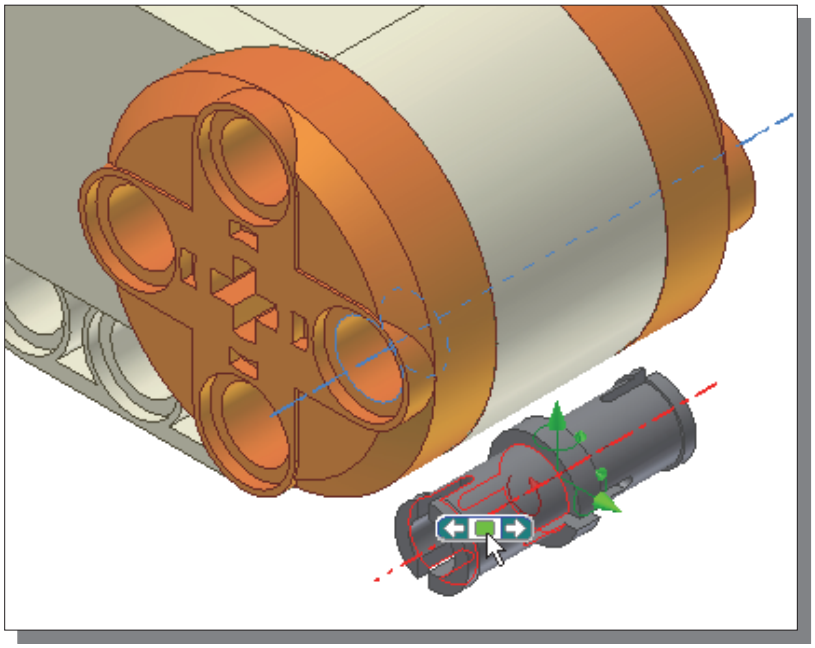




7. In the *Place Constraint* dialog box, confirm the constraint *Type* is set to the **Mate** constraint.

8. Select the **right cylindrical surface** of the base component, the chassis rail, as the first item for the Mate Alignment command.

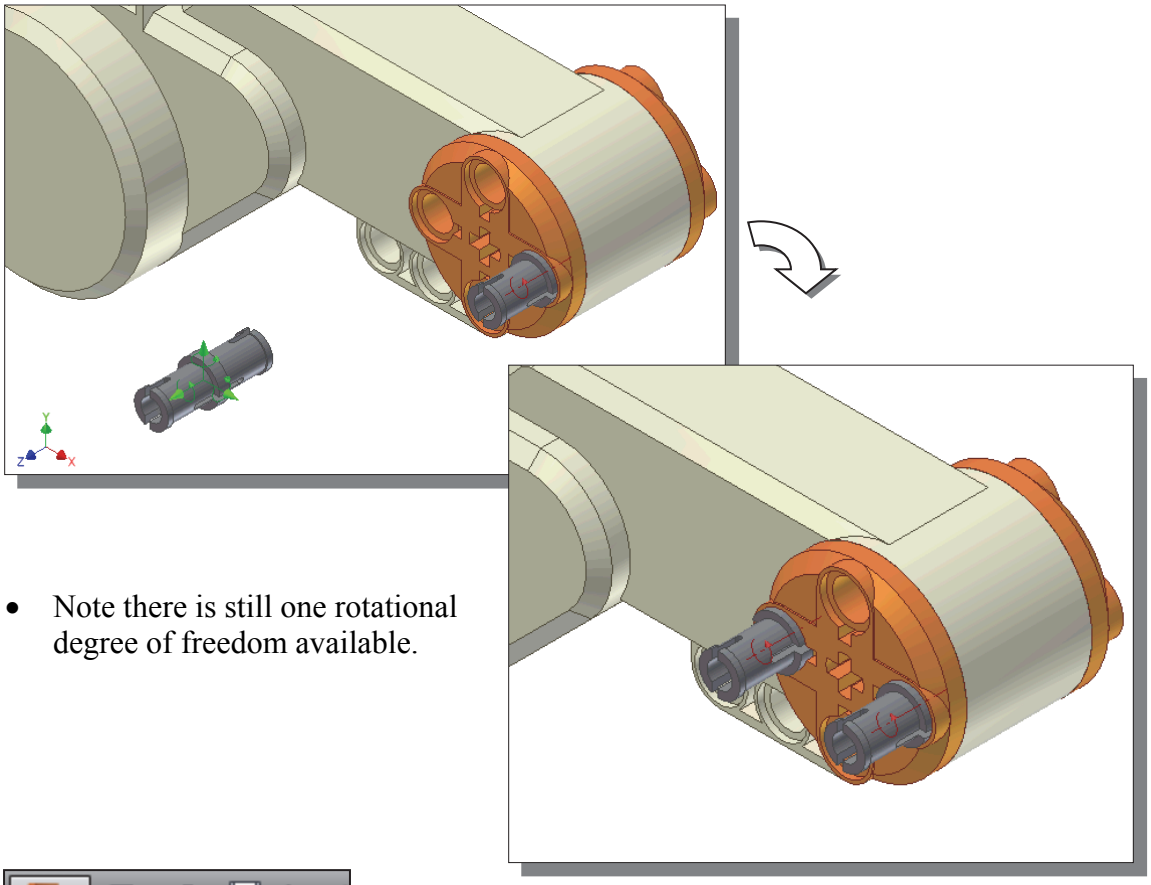




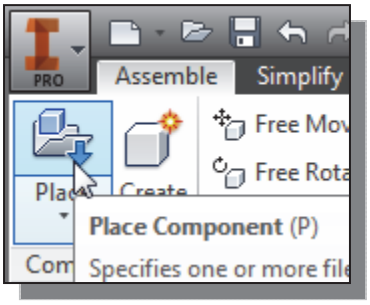
9. Click on one of the **outside cylindrical surfaces** of the ***Peg 1-Module*** part as the second item to apply the constraint.

10. Click on the **Apply** button to accept the selection and apply the Mate constraint.

11. On your own, repeat the above steps and constrain the other ***Peg 1-Module*** as shown.



- Note there is still one rotational degree of freedom available.

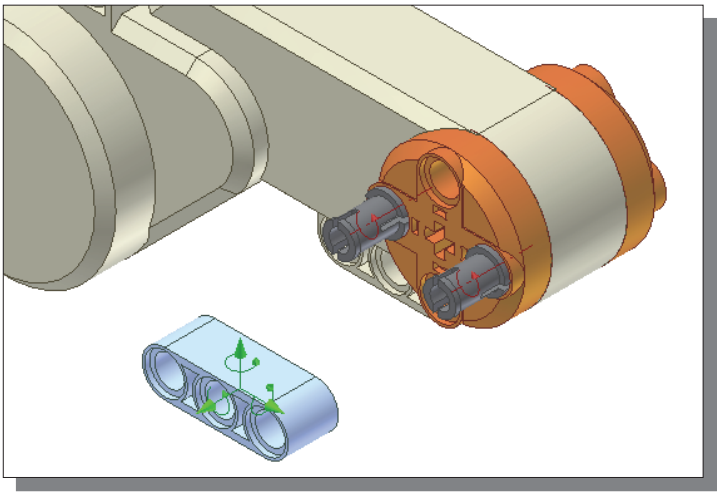


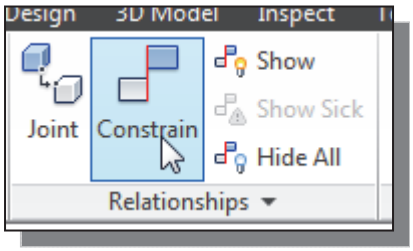
12. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.

13. Select the ***Beam 3-Module*** design in the list window. Click on the **Open** button to retrieve the model.

14. Place **one** copy of the *Beam 3-Module* toward the left side of the graphics window, as shown in the figure.

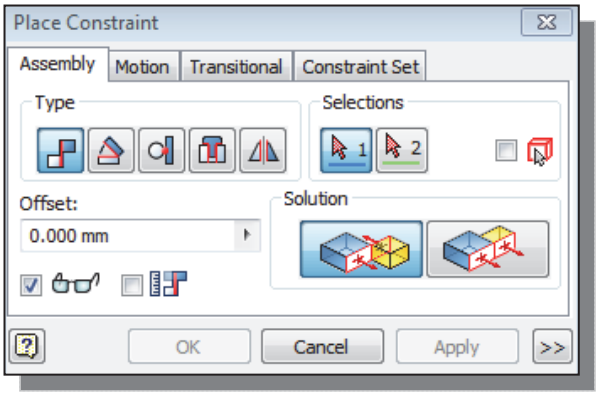
15. Inside the graphics window, right-mouse-click once to bring up the option menu and select **Done** to end the command.

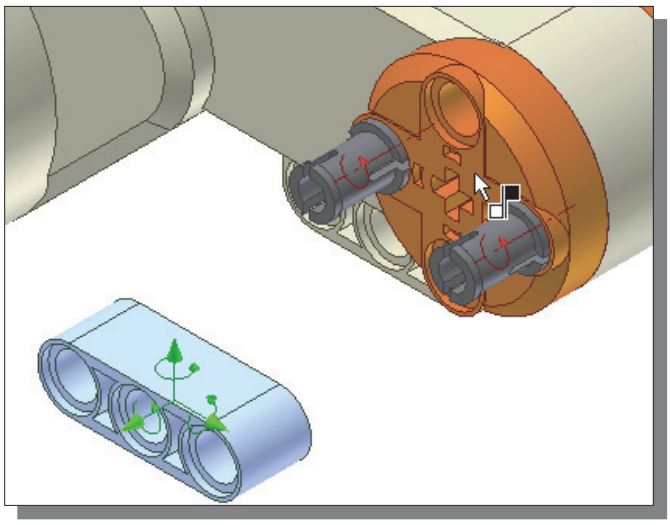




16. In the *Assembly* panel, select the **Constrain** command by left-mouse-clicking once on the icon.

17. In the *Place Constraint* dialog box, confirm the constraint *Type* is set to the **Mate** constraint.

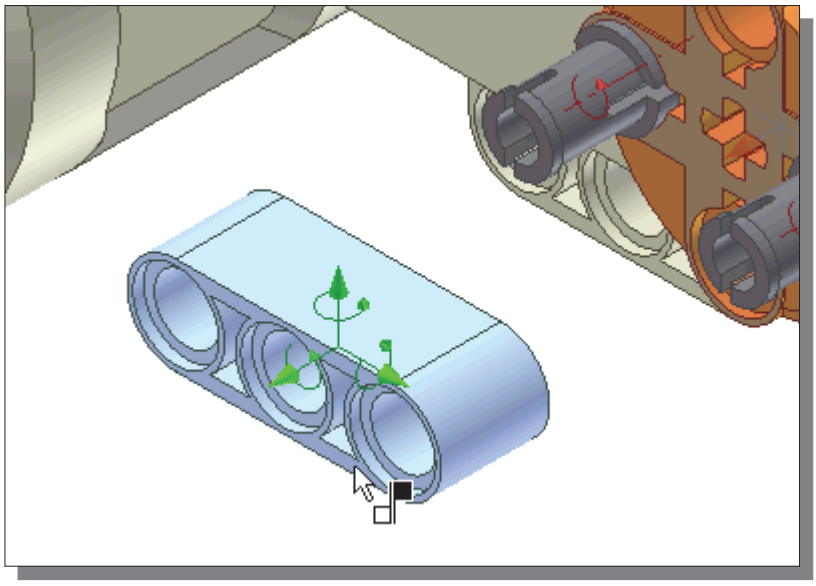


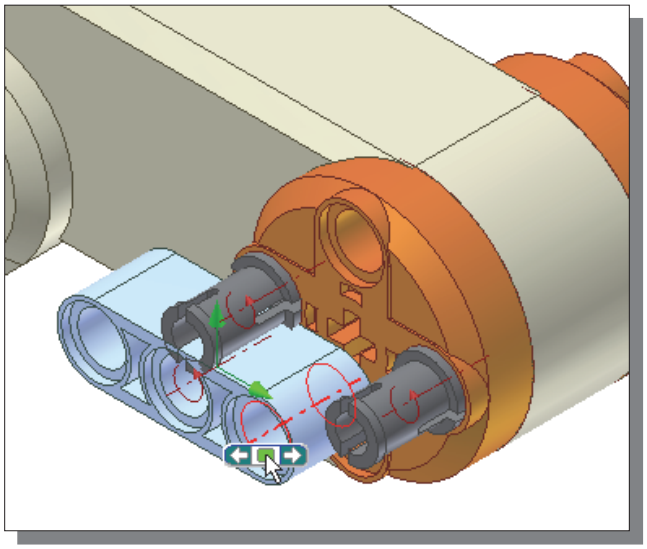


18. Select the **front vertical surface** of the base component, the chassis rail, as the first item for the Mate Alignment command.

19. Click on the front surface of the *Beam 3-Module* part as the second part selection to apply the constraint.

20. Click on the **Apply** button to accept the selection and apply the Mate constraint.

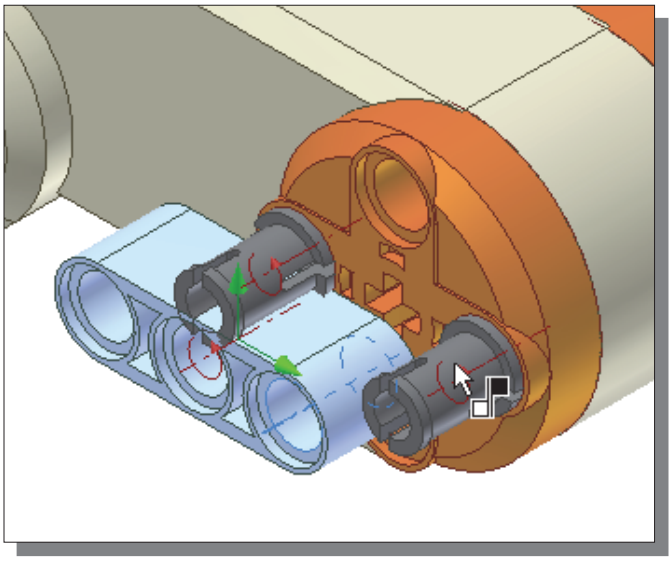


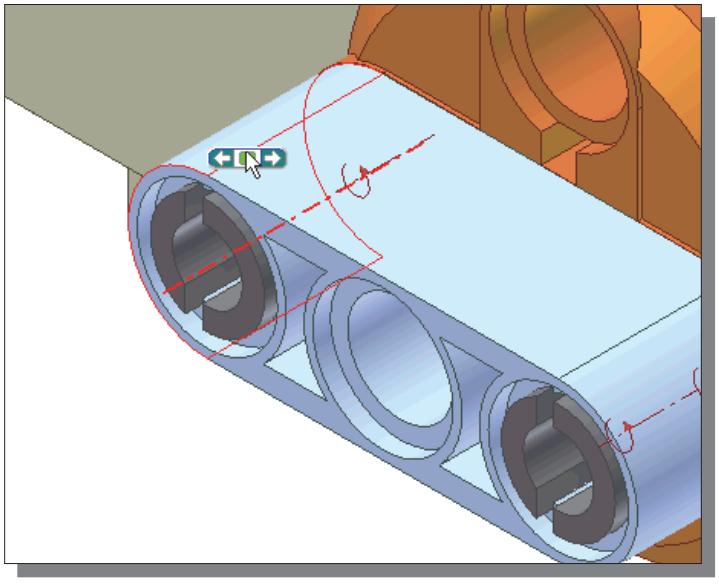


21. Select the **right inside cylindrical surface** of the *Beam 3-Module* component, the chassis rail, as the first item for the Mate Alignment command.

22. Click on the **outside cylindrical surface** of the right ***Peg 1-Module*** part as the second item to apply the constraint.

23. Click on the **Apply** button to accept the selection and apply the Mate constraint.

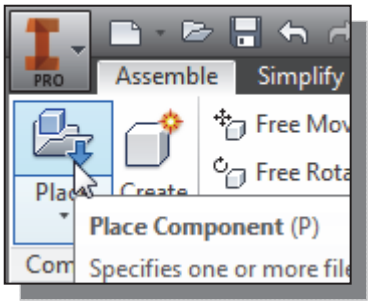




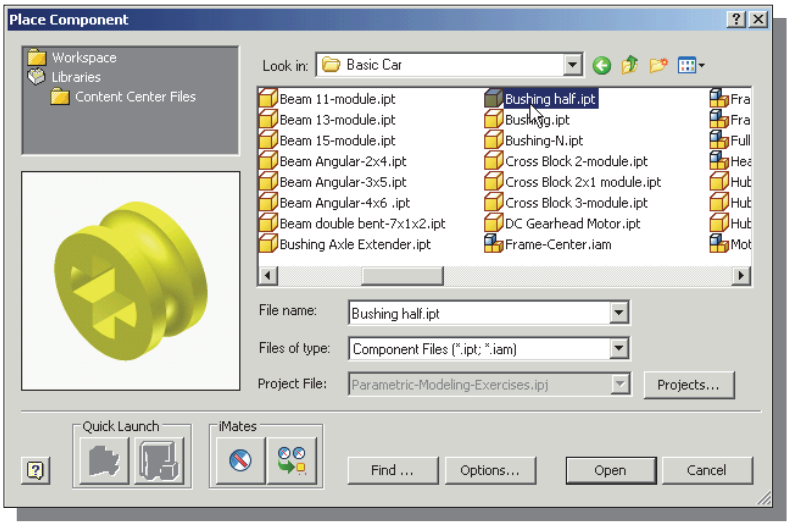
24. On your own, align the center axis of the left feature to the center axis of the other *Peg 1-Module* part as shown.

Assemble the Next Components

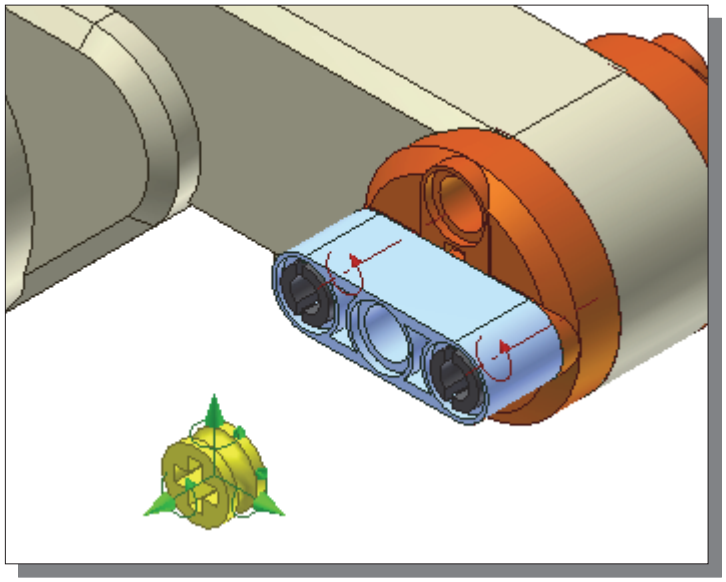
❖ Next, we will assemble copies of the *Bushings* and *Axle* parts.



1. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.



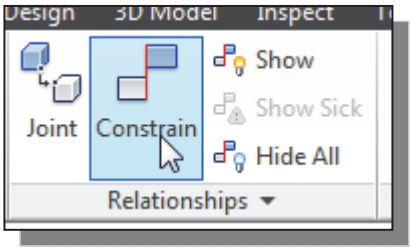
2. Select the ***Bushing half*** design in the list window. Click on the **Open** button to retrieve the model.



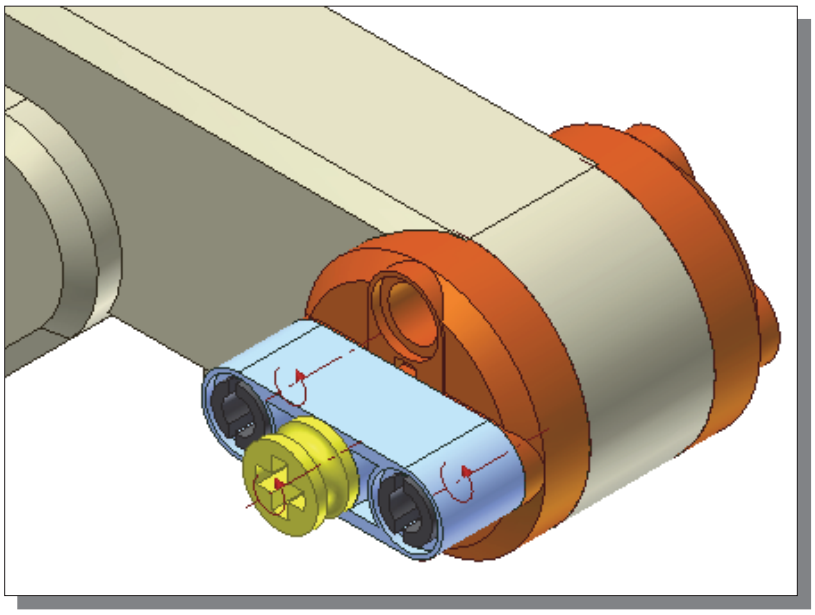
3. Place a copy of the *Bushing half* toward the left side of the graphics window, as shown in the figure.

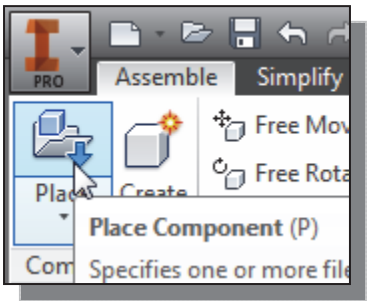
4. Inside the graphics window, right-mouse-click once to bring up the option menu and select **Done** to end the placement of the part.

5. In the *Assembly* panel, select the **Constrain** command by left-mouse-clicking once on the icon.



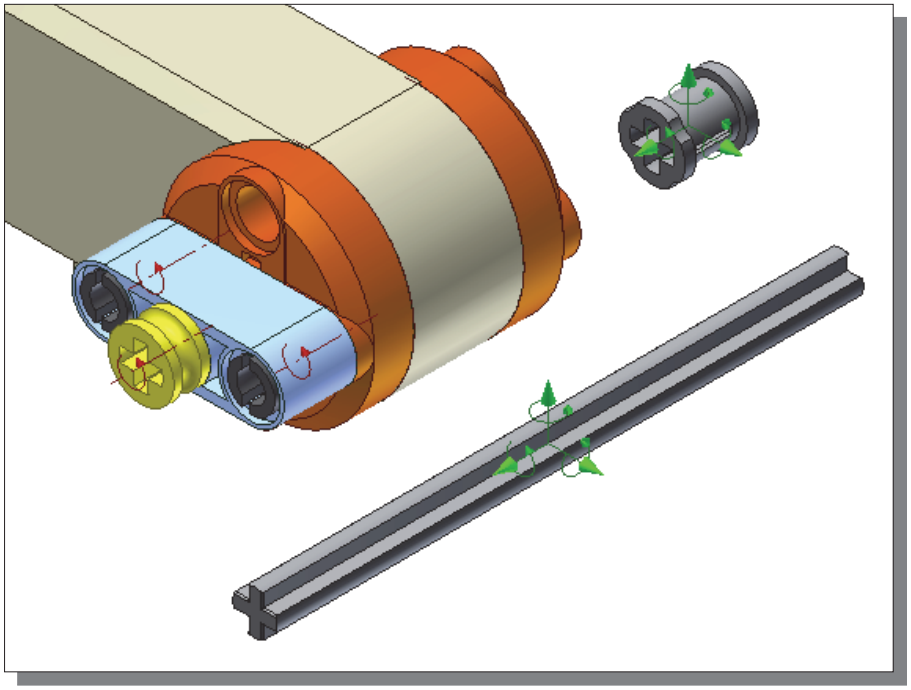
6. On your own, apply two **Mate** constraints to fully assemble the part as shown. Note the part still has one degree of freedom available; it can still rotate about the center axis.



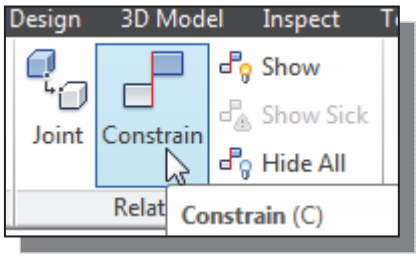


7. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.

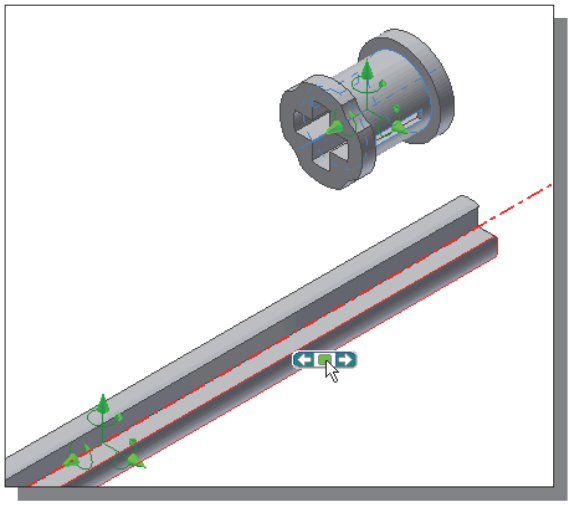
8. On your own, place copies of the *Bushing.ipt* and the *Axle-8.ipt* parts toward the right side of the assembly as shown.



Assembling *Bushing* and *Axle*

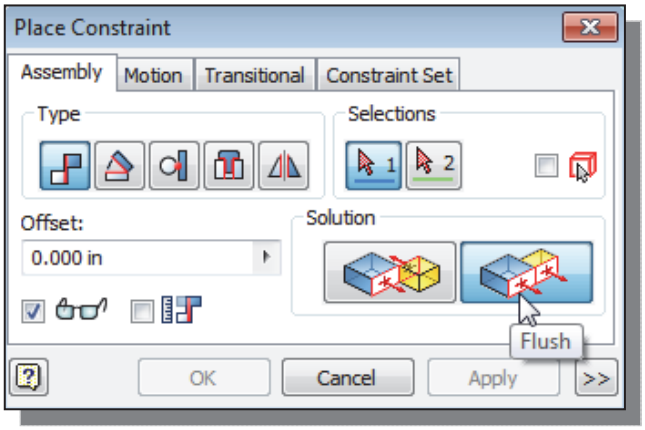


1. In the *Assembly* panel, select the **Constrain** command by left-mouse-clicking once on the icon.



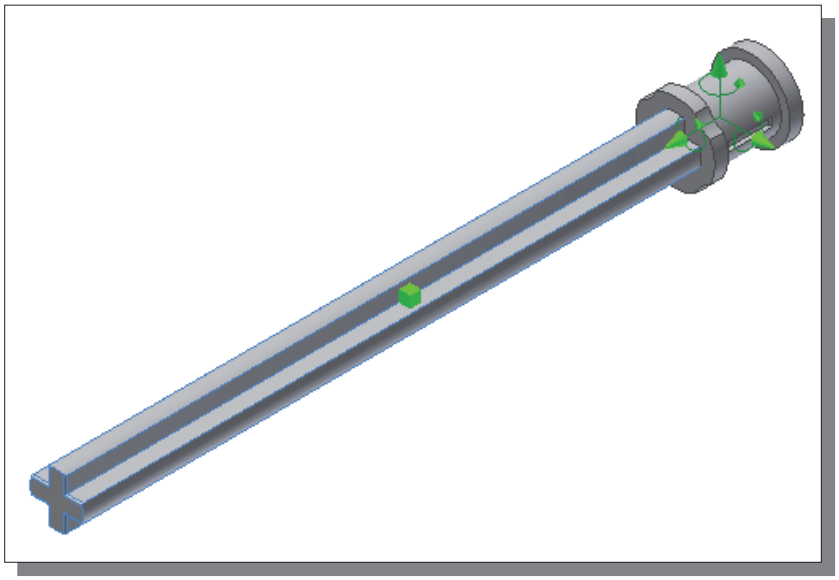
2. On your own, apply a **Mate** constraint to align the center axes of the two parts as shown.

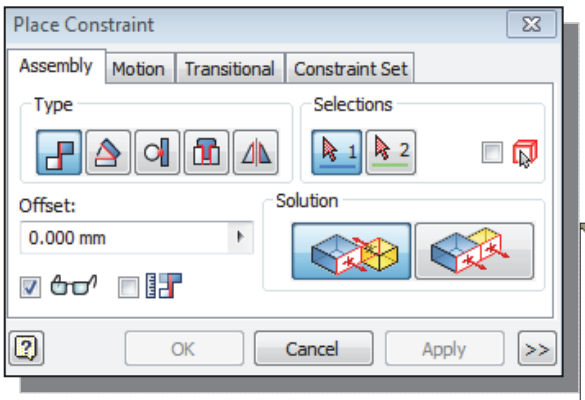
3. Also apply a mate constraint to align two of the flat surfaces on the two parts.



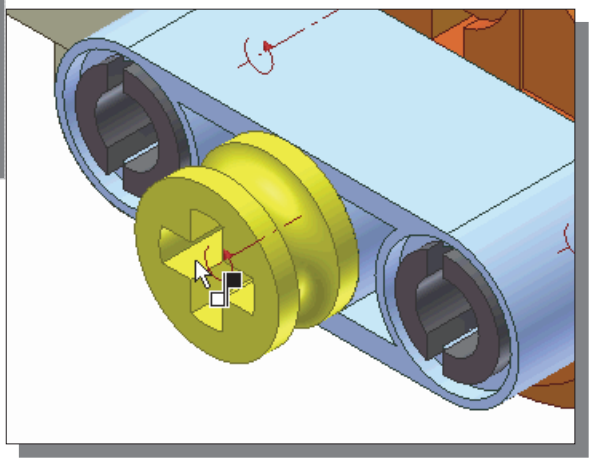
4. In the *Place Constraint* dialog box, set the constraint *Type* to the **Flush** constraint.

5. On your own, select the two **end surfaces** to align the *Axle* to the *Bushing* as shown.

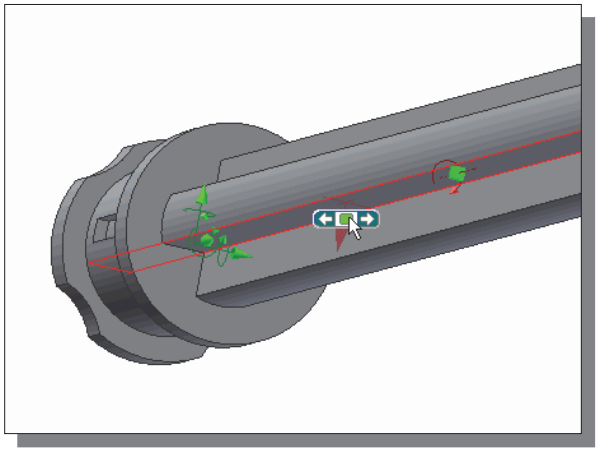




6. In the *Place Constraint* dialog box, set the constraint *Type* to the **Mate** constraint.

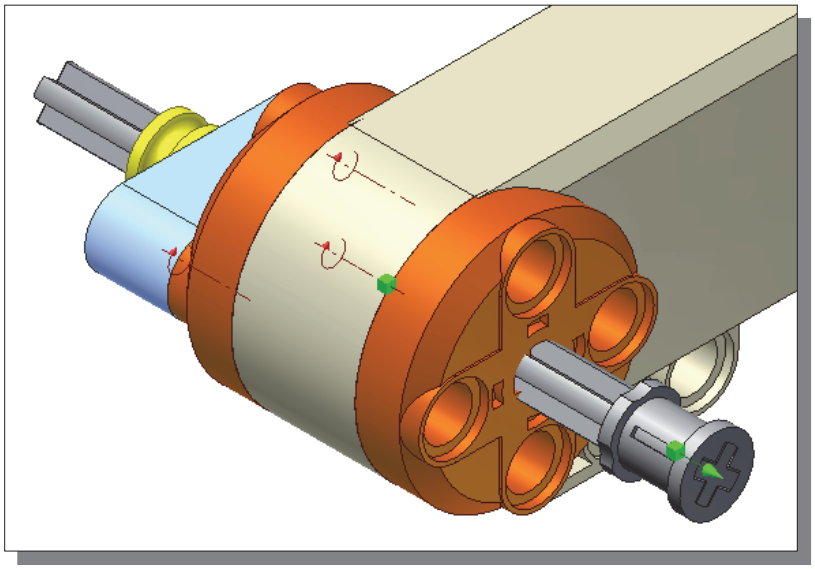


7. Select the **flat face** of the *Bushing half* part as shown.

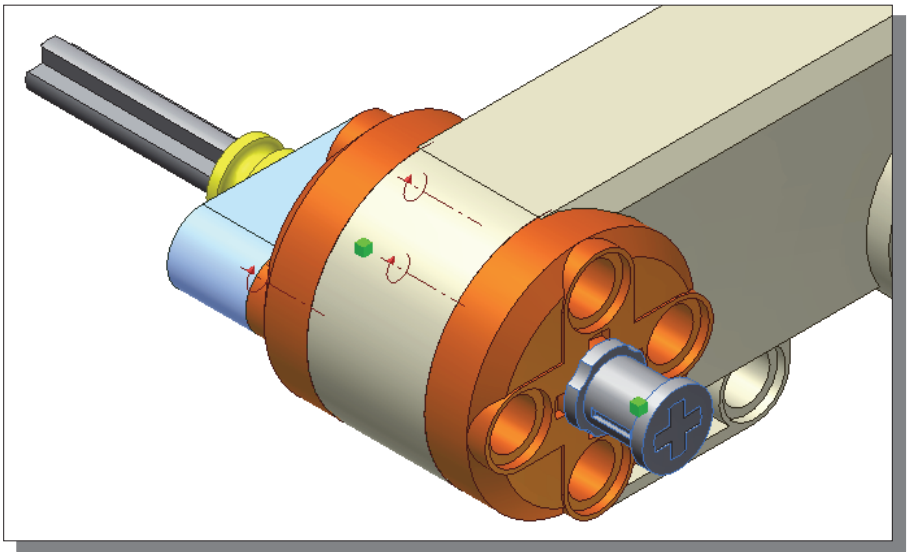


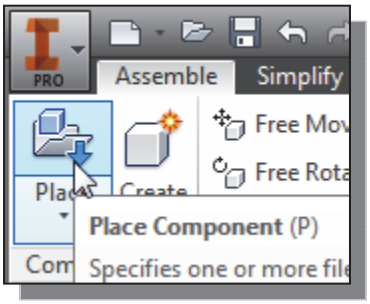
8. Select the corresponding **flat surface** of the ***Axle-8*** part as shown.

9. Click on the **Apply** button to accept the selections and apply the Mate constraint



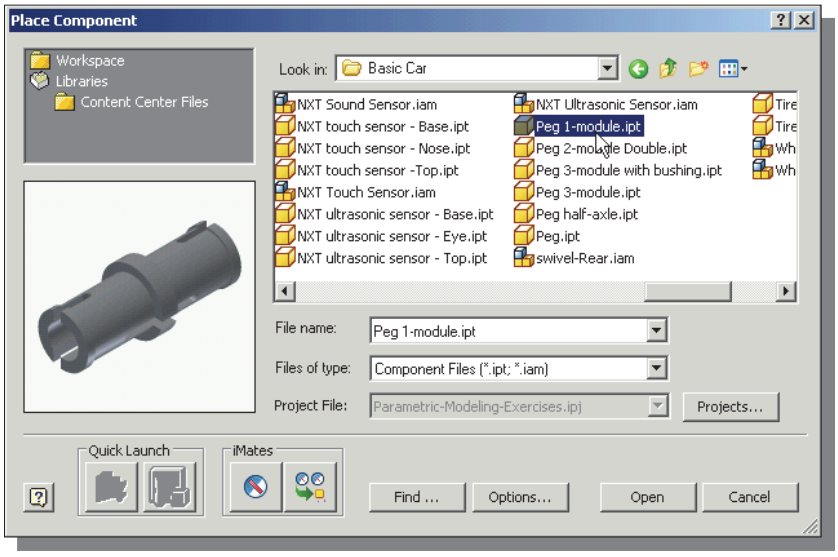
10. On your own, repeat the above steps and constrain the vertical face of the ***Bushing*** to the left side of the ***Motor-Drive*** part as shown.



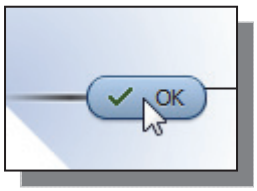


11. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.

12. Select the ***Peg 1-Module*** design in the list window. Click on the **Open** button to retrieve the model.

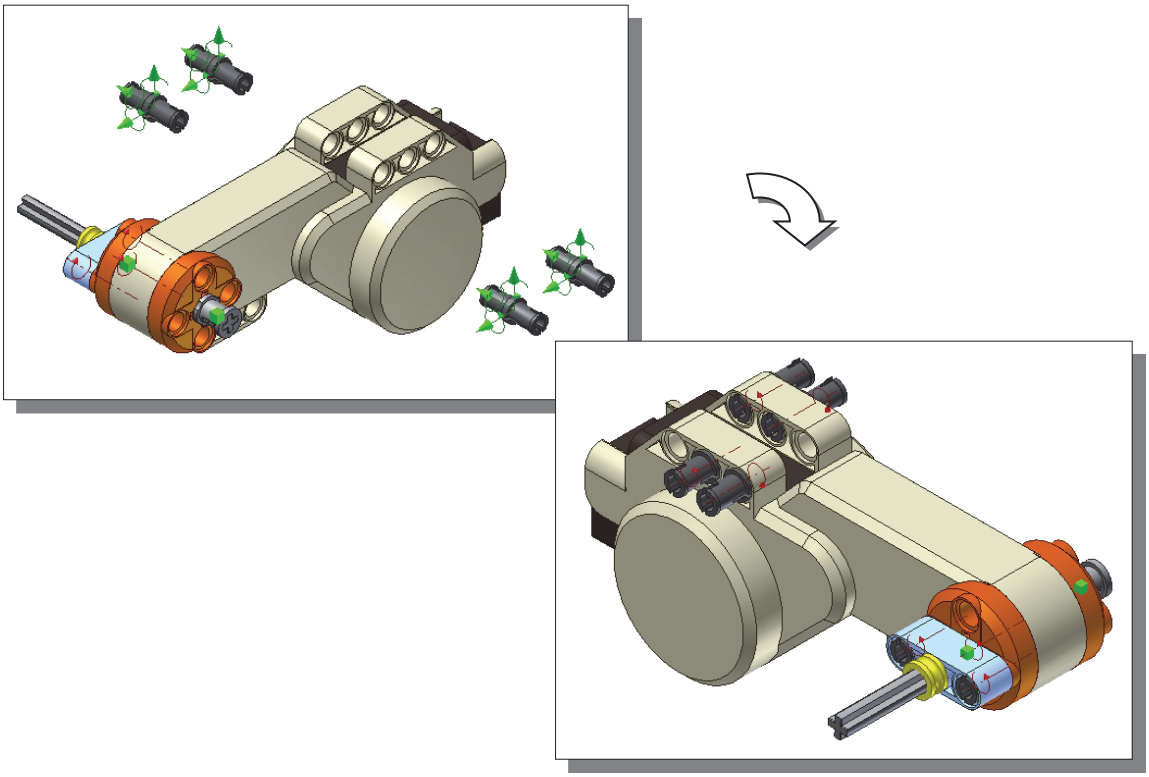


13. Place **four copies** of the part around the current assembly model.

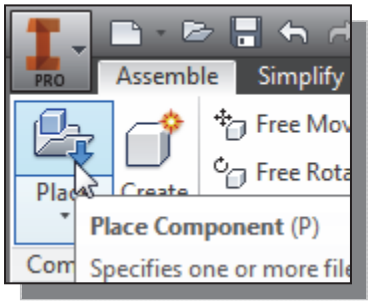


14. Inside the graphics window, **right-mouse-click** once to bring up the option menu and select **OK** to end the placement of the part.

15. On your own, apply the **Mate** constraints to assemble the four copies of the ***Peg 1-Module*** part as shown.

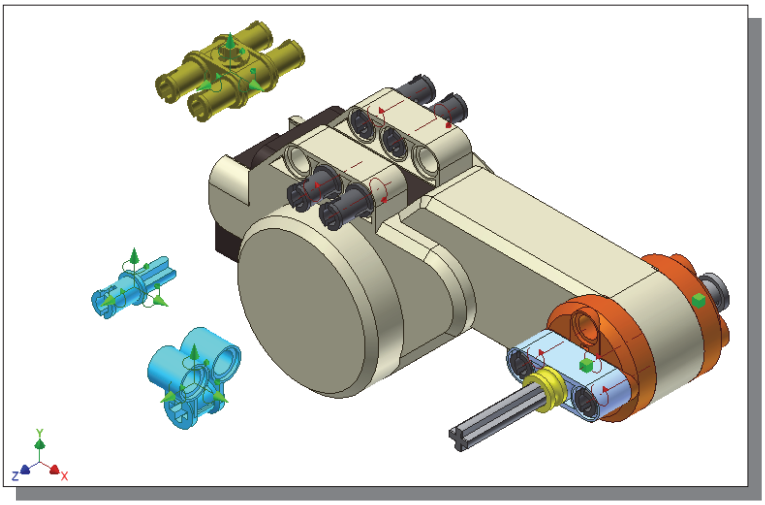


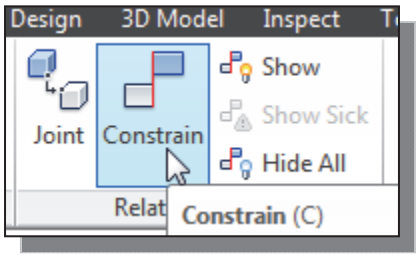
Completing the Motor-Right Subassembly



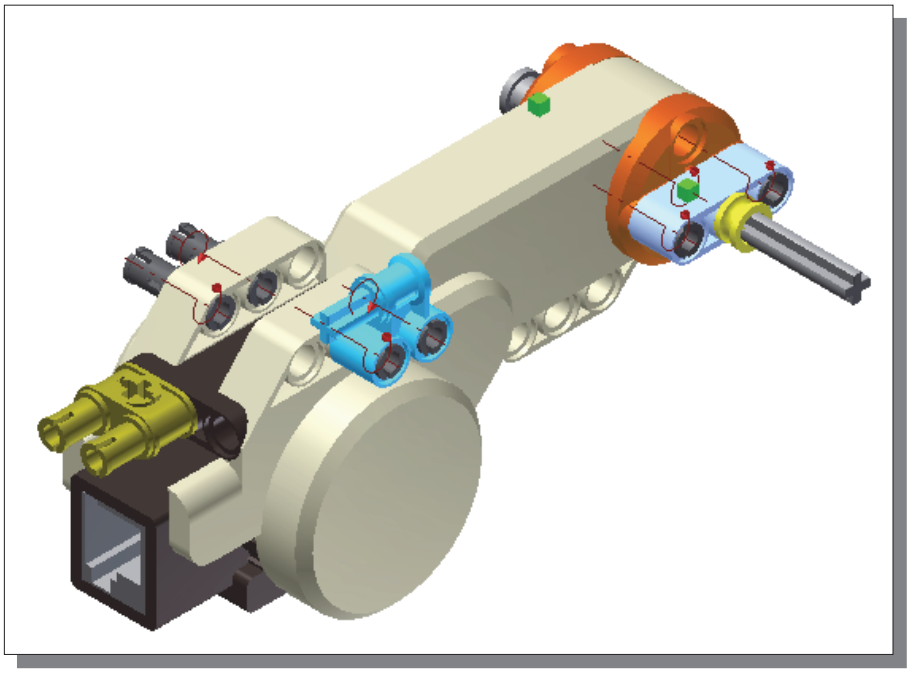
1. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.

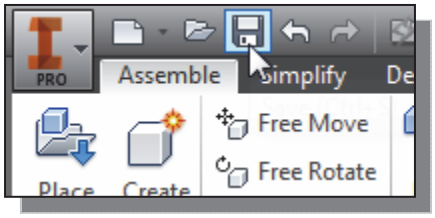
2. On your own, place one copy of the ***Peg 2-module Double*** part, ***Cross Block 2x1 module*** part and ***Peg half-axle*** part into the assembly.



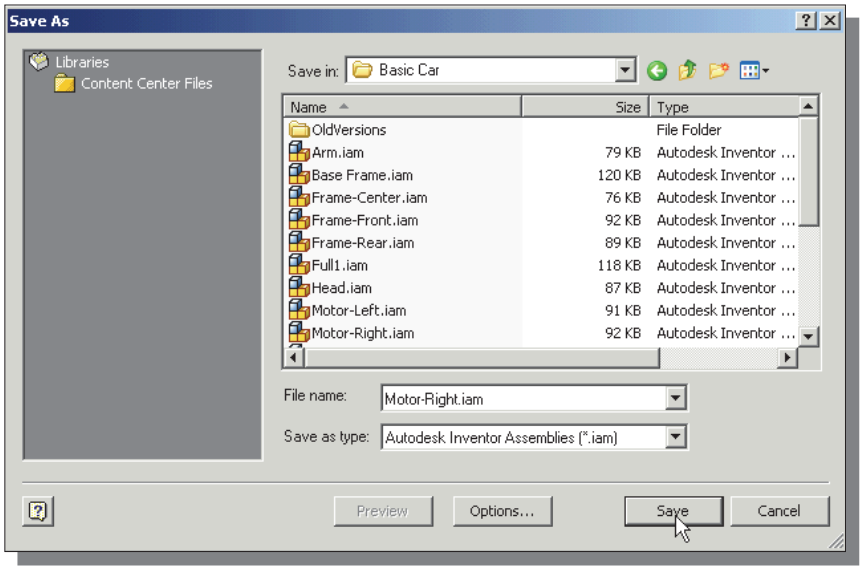


3. In the *Position* panel, select the **Constrain** command by left-mouse-clicking the icon. On your own, assemble the three parts as shown in the figure.





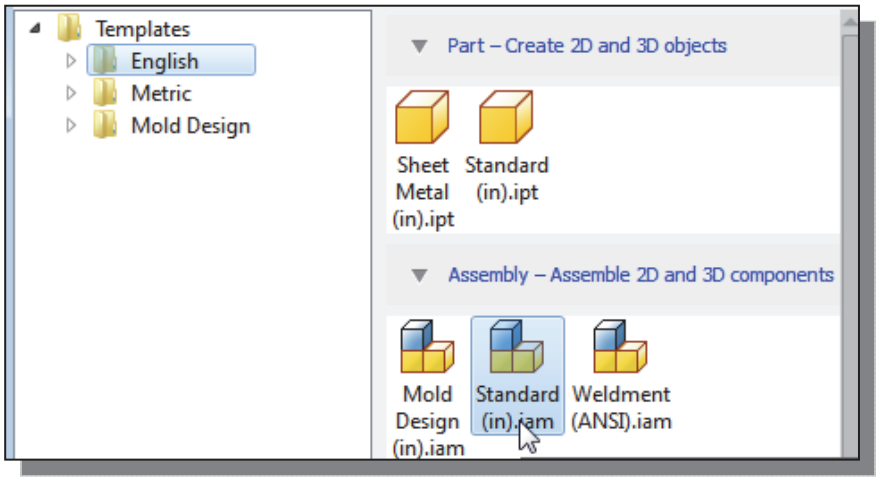
4. On your own, **Save** the completed model as a subassembly, using the name: ***Motor-Right.iam***.



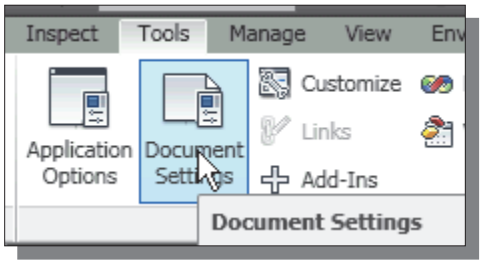
Starting the Main Assembly

1. Select the **New File** icon with a single click of the left-mouse-button in the *Quick Access Toolbar* as shown.

2. Select the **English** units set and in the *Template* list; select **Standard(in).iam** (*Standard Inventor Assembly Model* template file).



3. Click on the **OK** button in the *New File* dialog box to accept the selected settings.



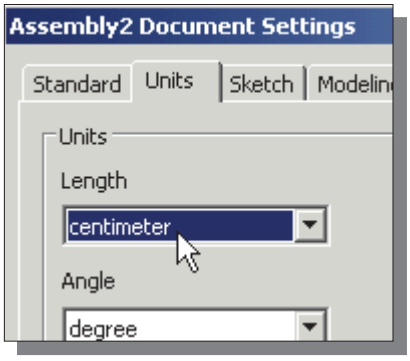
4. In the *Ribbon* toolbar, select the **Tools** tab.

5. Select the **Document Settings** command as shown.

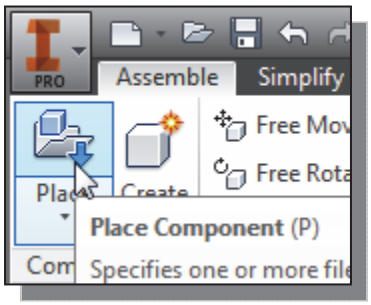
6. In the *Assembly2 Document Settings* dialog box, click on the **Units** tab as shown.

7. Set the *Length Units* to **centimeter** as shown.

8. Click on the **OK** button to accept the selected settings.

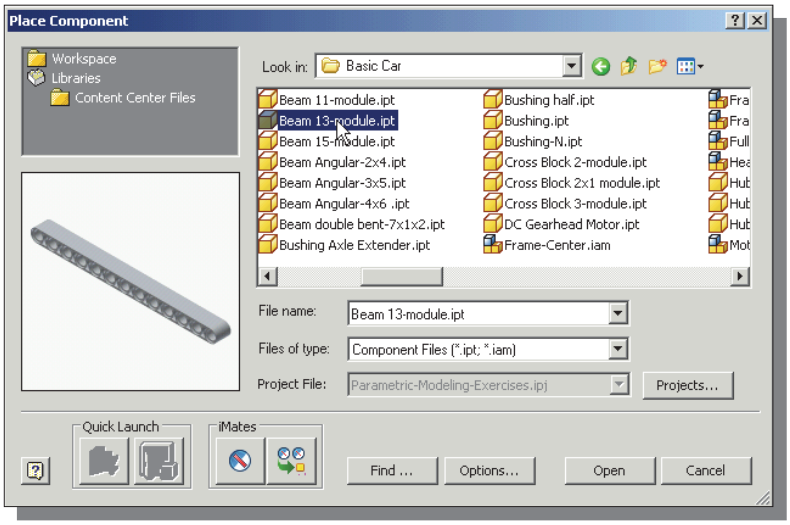


- The *Standard Inventor Assembly Model* template file contains predefined settings including default 3D view orientation and default 2D drawing views setup. With Autodesk Inventor, we are allowed to mix different units within the same file.

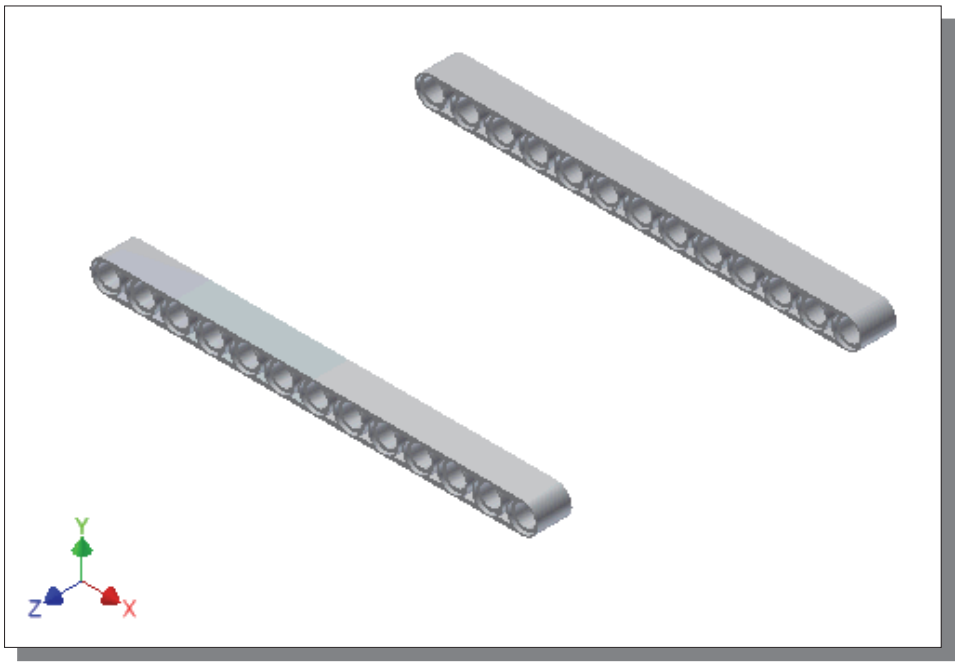


9. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking once on the icon.

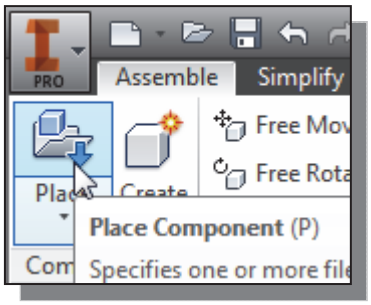
10. Select the ***Beam 13-module*** part in the list window. Click on the **Open** button to retrieve the model.



11. In the graphics area, place two copies of the part, with the first copy to the left side, as shown in the figure.

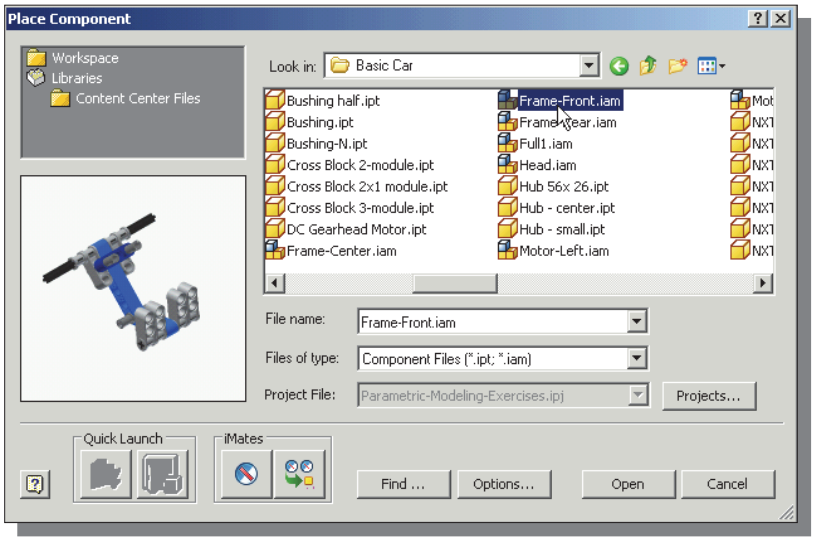


12. Inside the graphics window, right-mouse-click once to bring up the option menu and select **Done** to end the placement of the ***Beam 13-module*** parts.



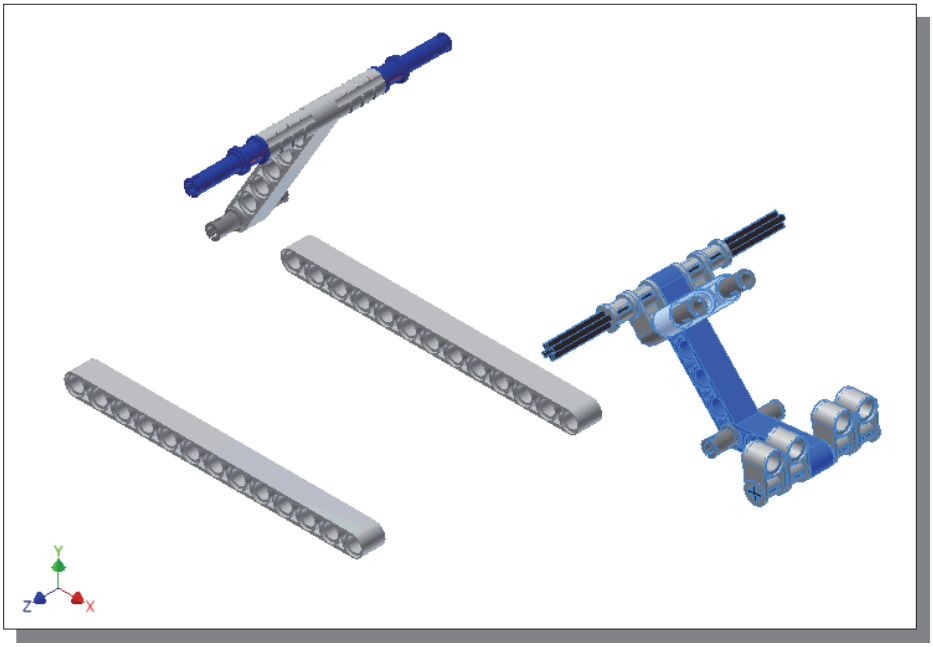
13. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking once on the icon.

14. Select the ***Frame-Front*** assembly in the list window. Click on the **Open** button to retrieve the model.

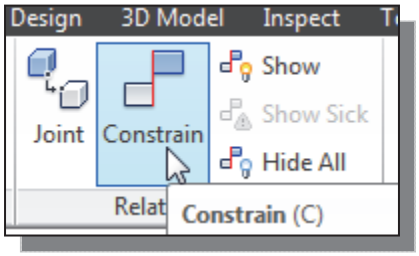


15. In the graphics area, place a copy of the ***Frame-Front*** subassembly to the right side of the other pieces.

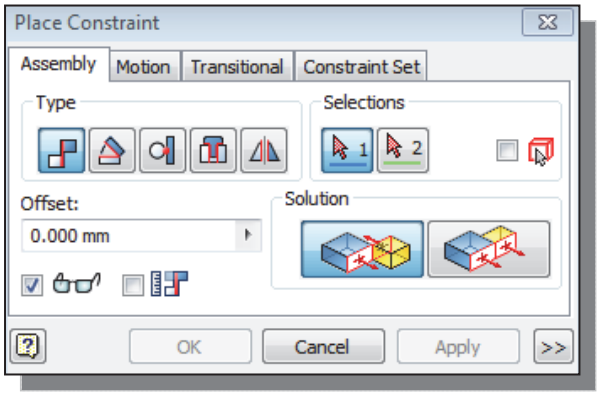
16. On your own, repeat the above steps and place a copy of the ***Frame-Center*** subassembly to the left side of the screen.



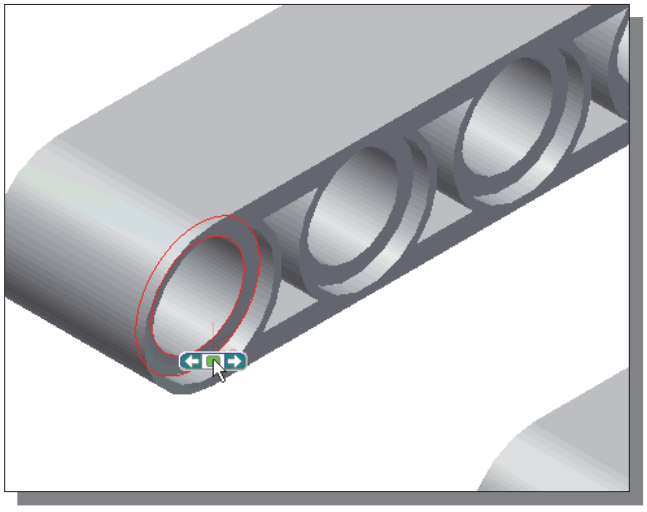
Assemble the Frame and Motors



1. In the *Assembly* panel, select the **Constrain** command by left-mouse-clicking once on the icon.

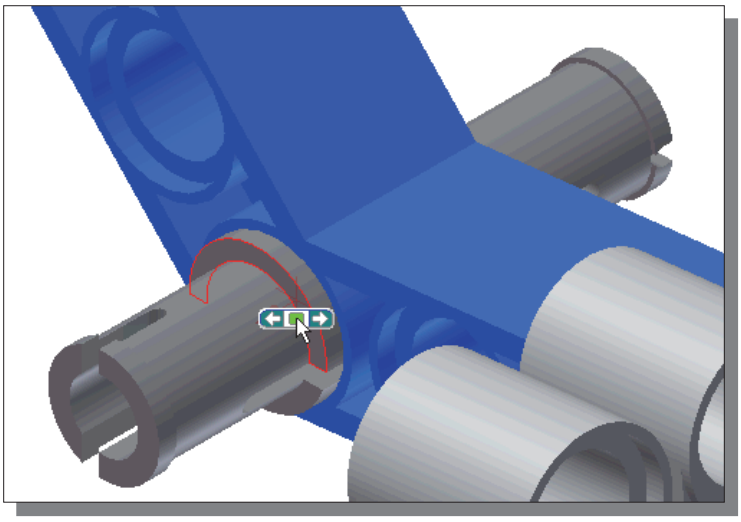


2. In the *Place Constraint* dialog box, switch to the **Mate** constraint.

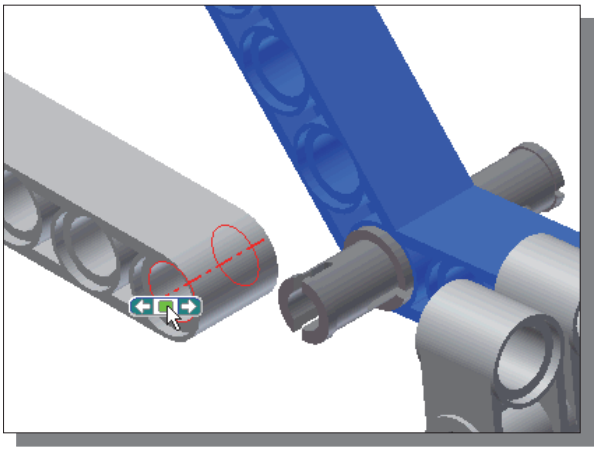


3. Select the inside face of the inner vertical face of the left ***Beam 13-module*** as shown.

4. Select the circular face of the ***Peg*** part of the ***Frame-Front*** assembly as the 2nd item for the Constrain command.



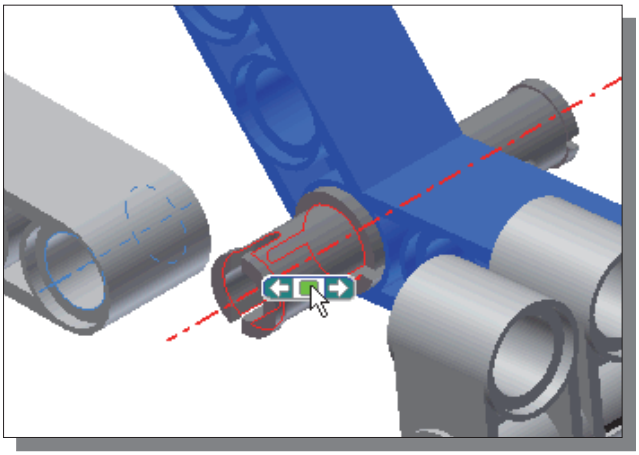
5. Click on the **Apply** button to accept the selection and apply the Mate constraint.



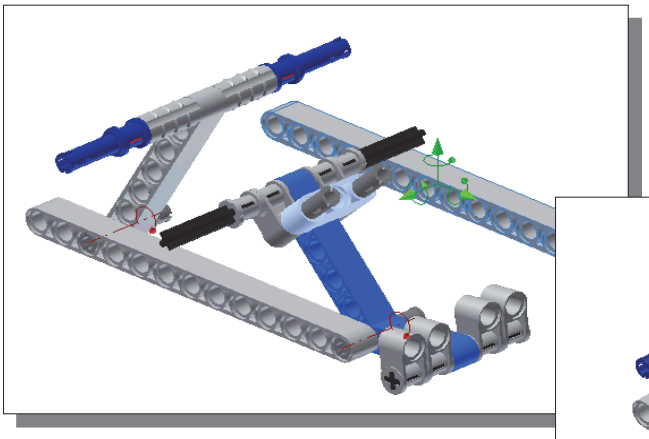
6. Select the first hole feature, on the inside cylindrical surface, of the left ***Beam 13-module*** as shown.

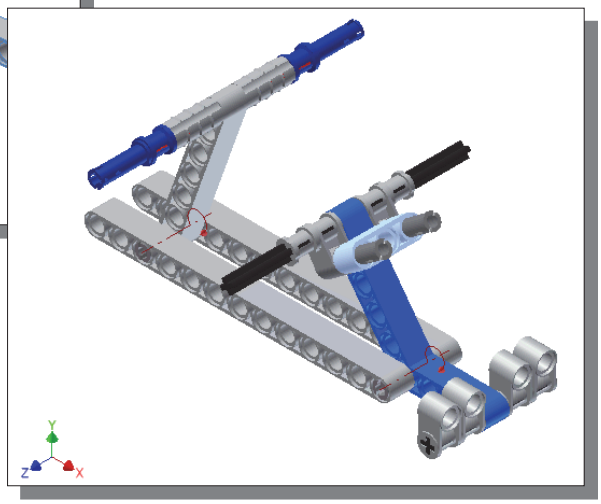
7. Select the circular face of the ***Peg*** part of the ***Frame-Front*** assembly as the 2nd item for the Constrain command.

8. Click on the **Apply** button to accept the selection and apply the Mate constraint.



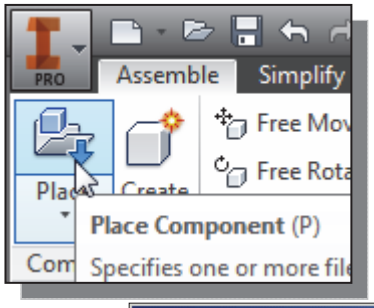
9. On your own, repeat the above steps and assembly the ***Frame-Center*** subassembly and the other ***Beam 13-module*** as shown.





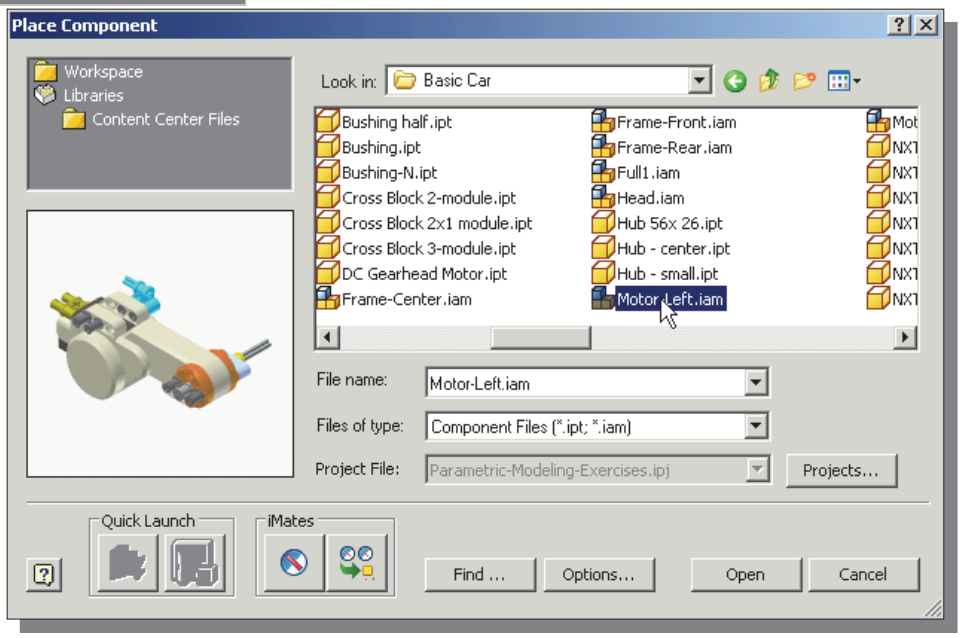
- Note the two subassemblies can still pivot about the center axes connected to the *Beam 13-module* parts.

Assemble the Motor Assemblies

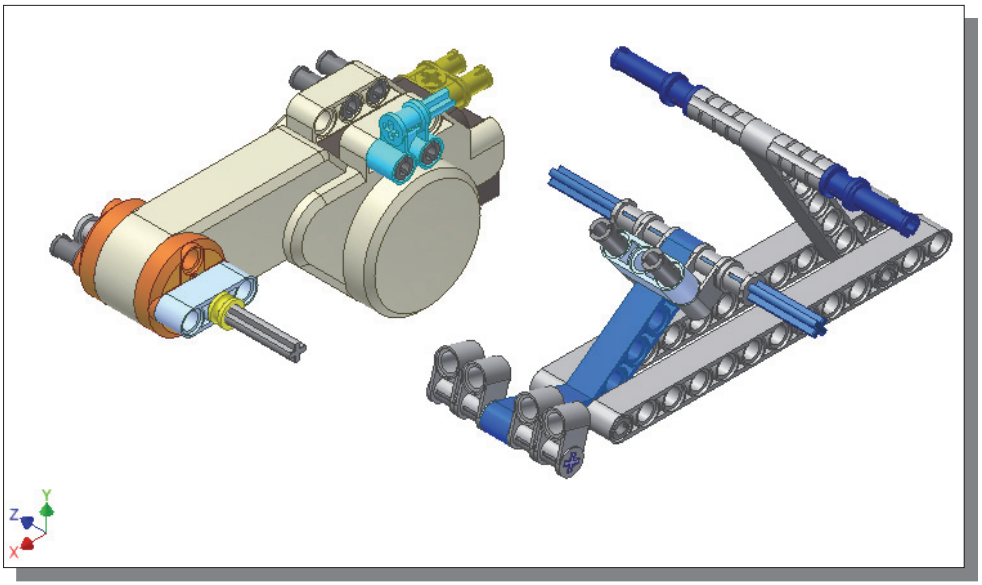


1. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.

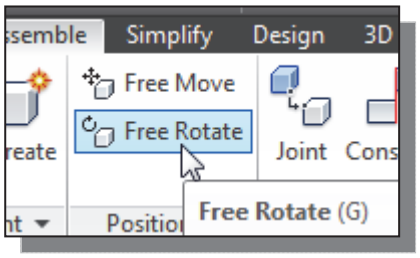
2. Select the ***Motor-Left*** assembly in the list window. Click on the **Open** button to retrieve the model.



3. Place a copy of the ***Motor-Left*** assembly to the left side of graphics area.

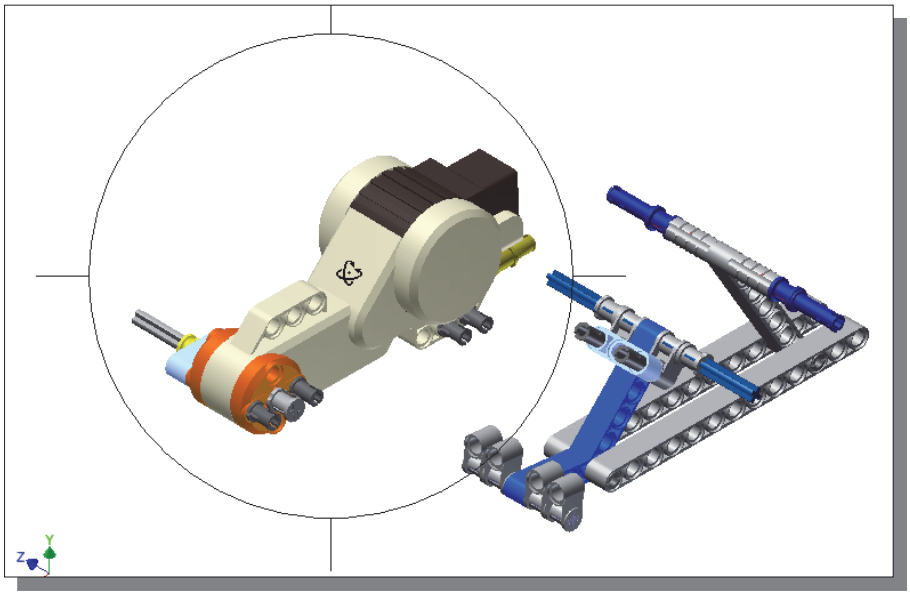


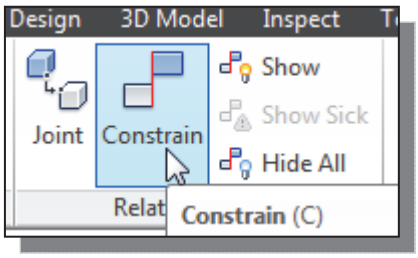
4. Inside the graphics window, right-mouse-click once to bring up the option menu and select **Done** to end the Place Component command.



5. Select the **Free Rotate** command by left-mouse-clicking once on the icon.

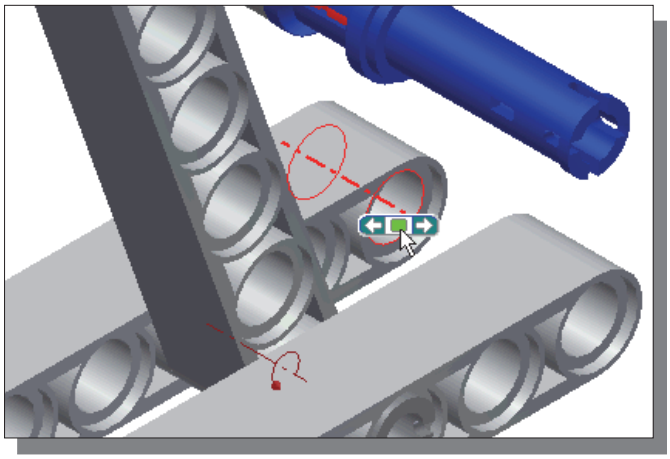
6. On your own, use the left-mouse-button and rotate the *Motor* to the orientation as shown.

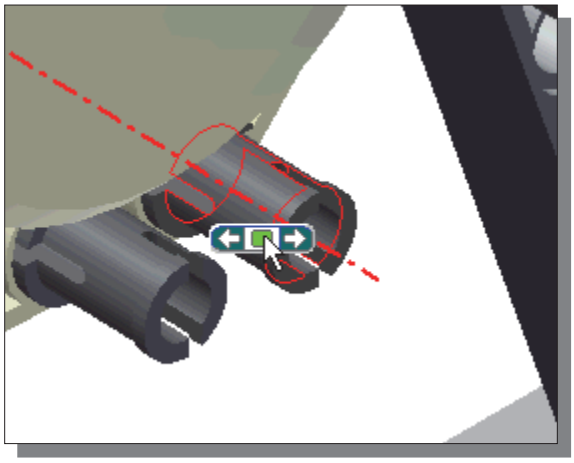




7. In the *Assembly* panel, select the **Constrain** command by left-mouse-clicking once on the icon.

8. Select the last hole feature, on the inside cylindrical surface, of the left ***Beam 13-module*** as shown.

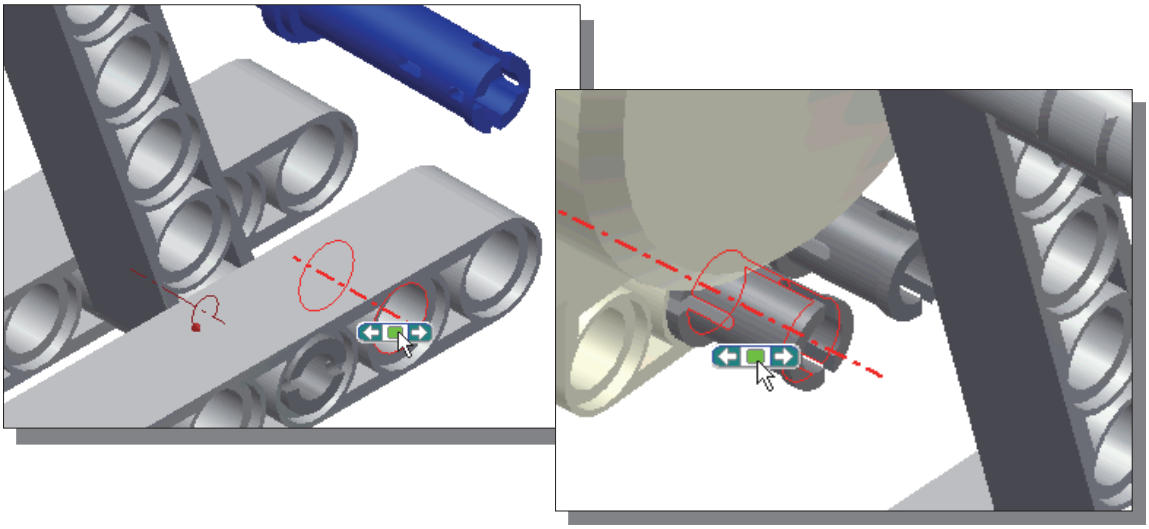




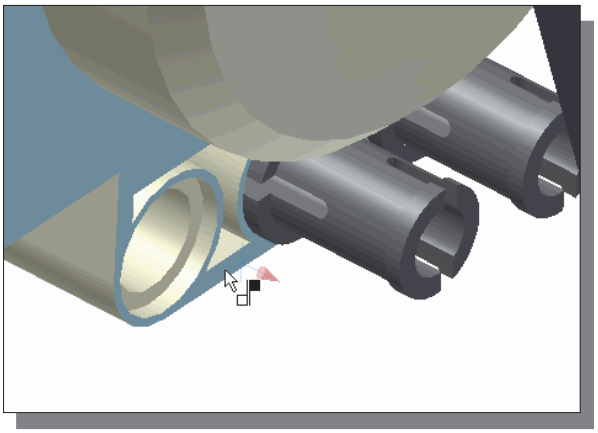
9. Select the circular face of the back ***Peg*** part of the ***Motor-Left*** assembly as the 2nd item for the Constrain command.

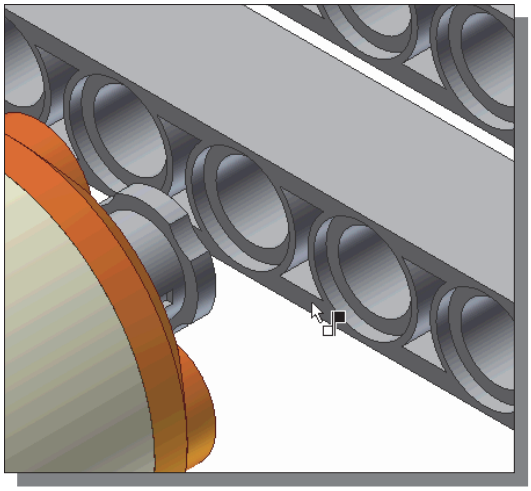
10. Click on the **Apply** button to accept the selection and apply the Mate constraint.

11. On your own, repeat the above steps and align the other ***Peg*** as shown.

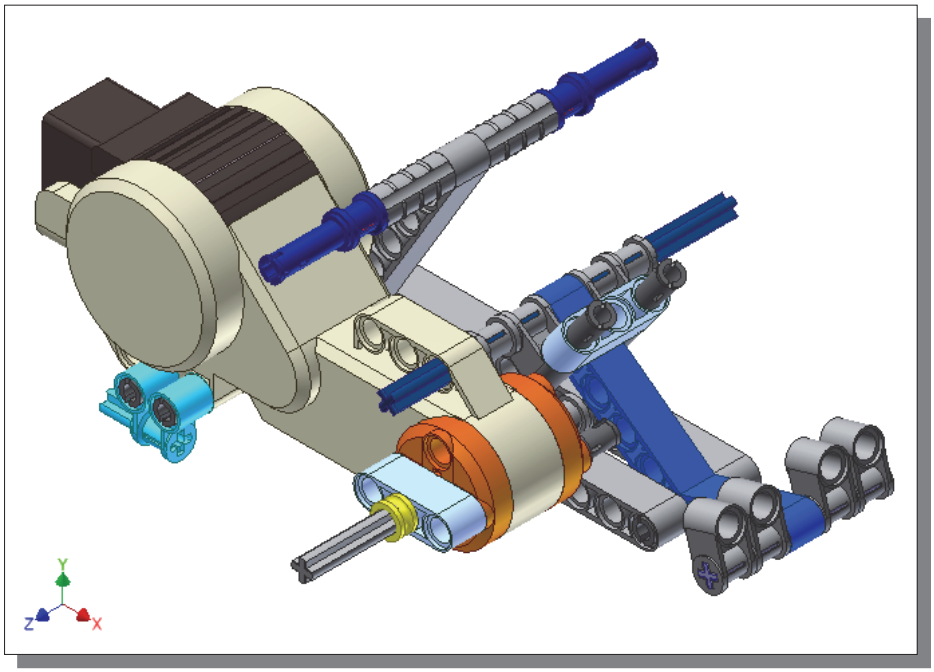


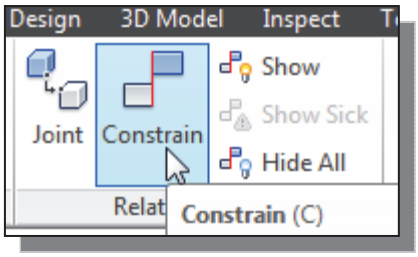
12. Also apply a **Mate** constraint to align the inside surface of the *Motor* subassembly as shown.





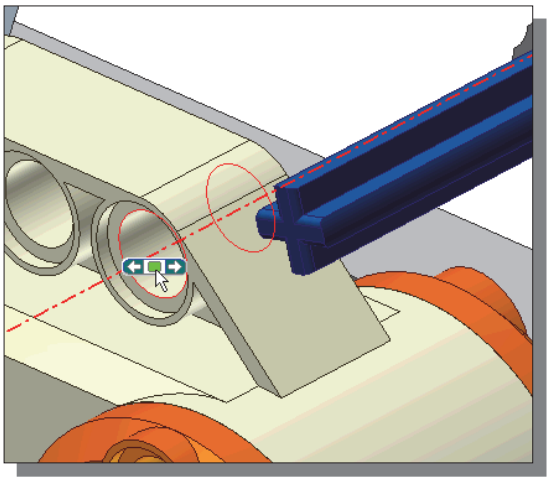
13. Adjust the positions of the ***Frame-Center*** and ***Frame-Front*** subassemblies by drag-and-drop with the left-mouse-button.

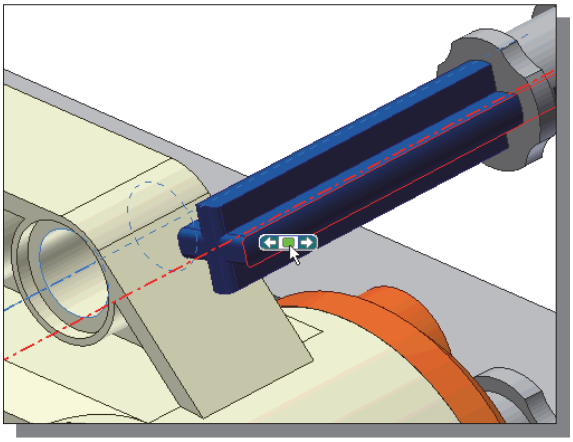




14. In the *Assembly* panel, select the **Constrain** command by left-mouse-clicking once on the icon.

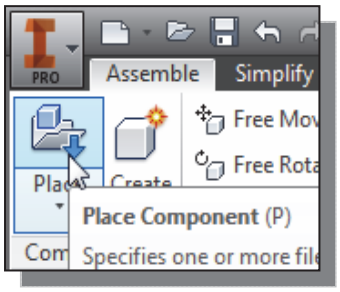
15. Select the last hole feature, on the inside cylindrical surface, of the ***Motor-Base*** part as shown.





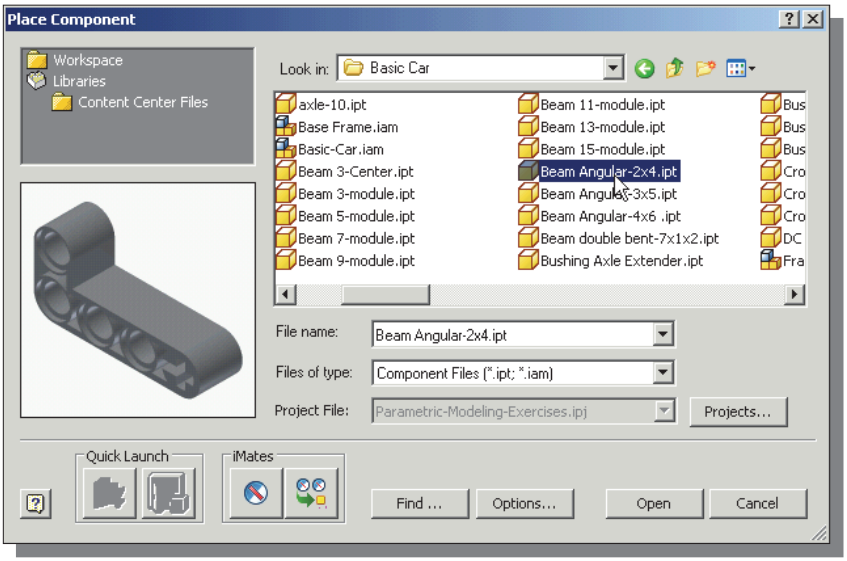
16. Select the curved surface of the ***Axle*** part of the ***Frame-Front*** assembly as the 2nd item for the Constrain command.

17. Click on the **Apply** button to accept the selection and apply the Mate constraint.



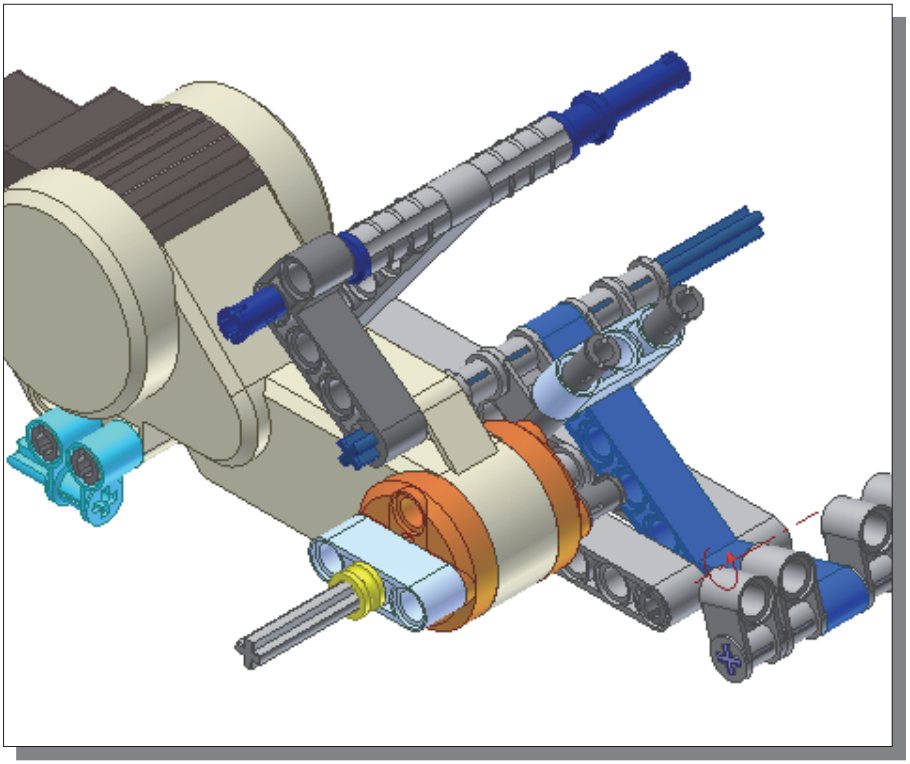
18. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.

19. Select the ***Beam Angular-2x4*** part in the list window. Click on the **Open** button to retrieve the model.

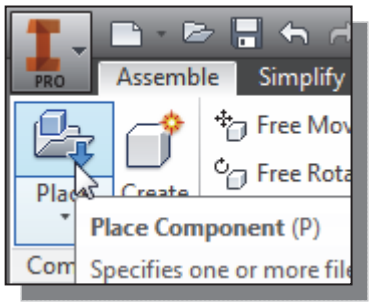


20. Place one copy of the part toward the left side of the graphics window.

21. On your own, assemble the ***Beam Angular*** part to lock the ***Frame-Center*** and ***Frame-Front*** in place as shown.

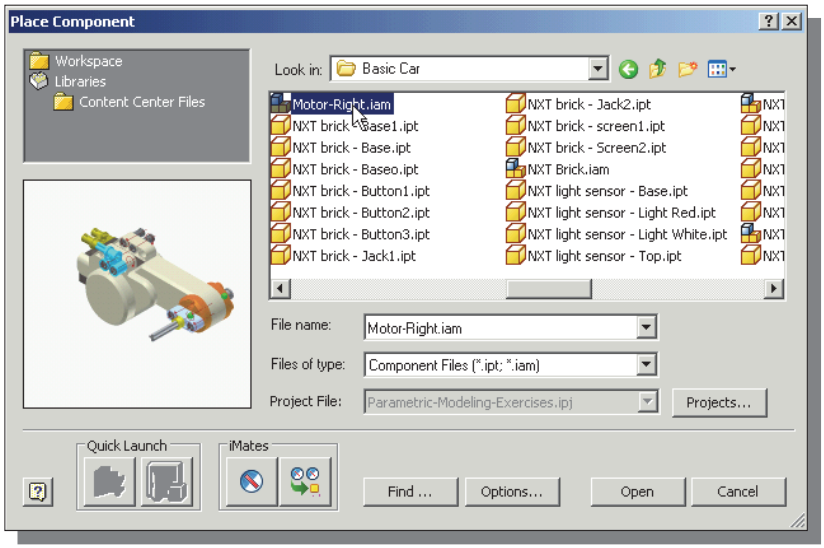


Adding the *Motor-Right* Subassembly to the Main Assembly



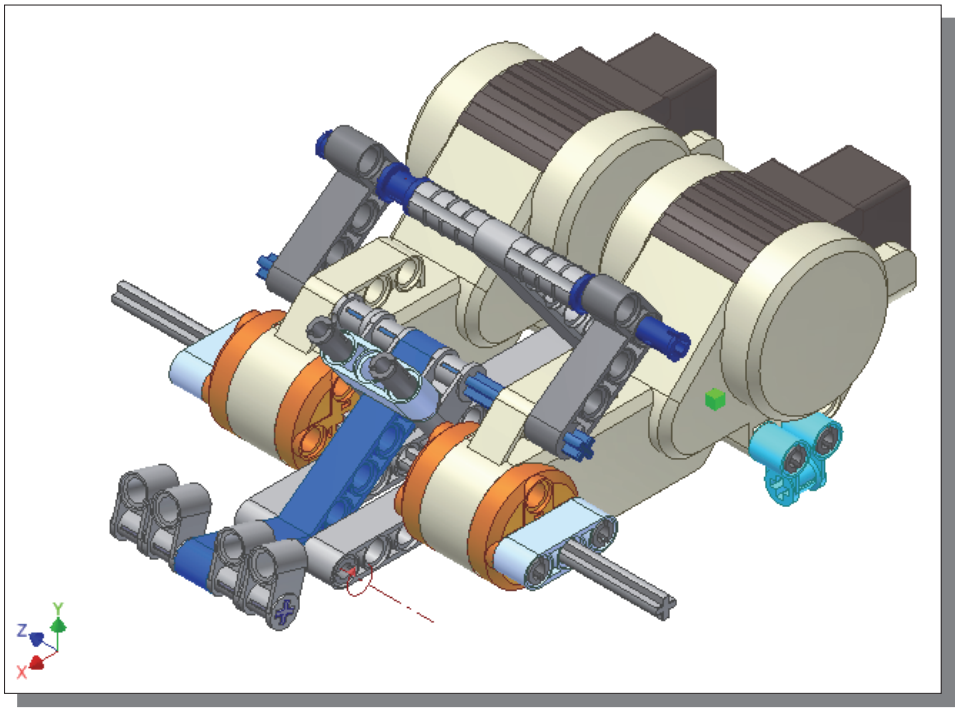
1. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.

2. Select the ***Motor-Right*** assembly in the list window. Click on the **Open** button to retrieve the model.

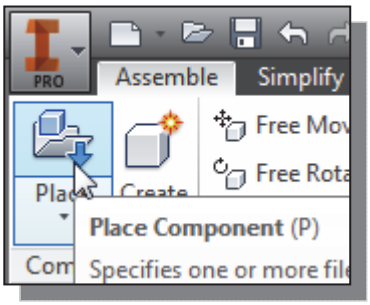


3. Place one copy of the assembly toward the right side of the graphics window.

4. On your own, repeat the same procedure to assemble the ***Motor-Right*** assembly and a copy of the ***Beam Angular-2x4*** part as shown.

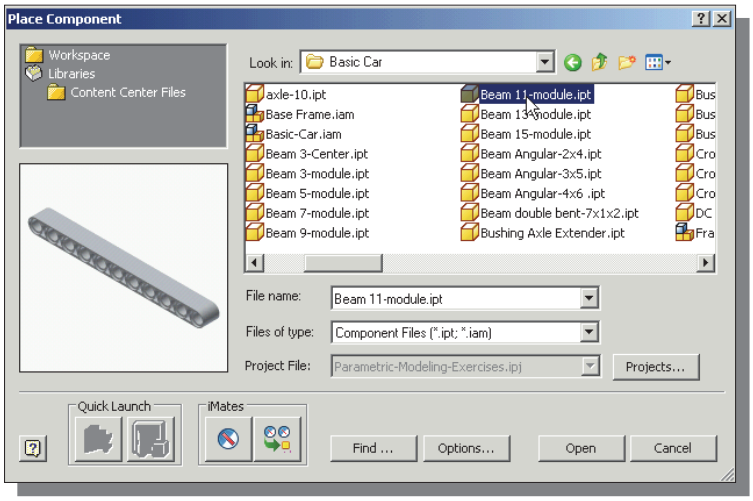


Assemble the Rear Swivel Assembly and Wheels



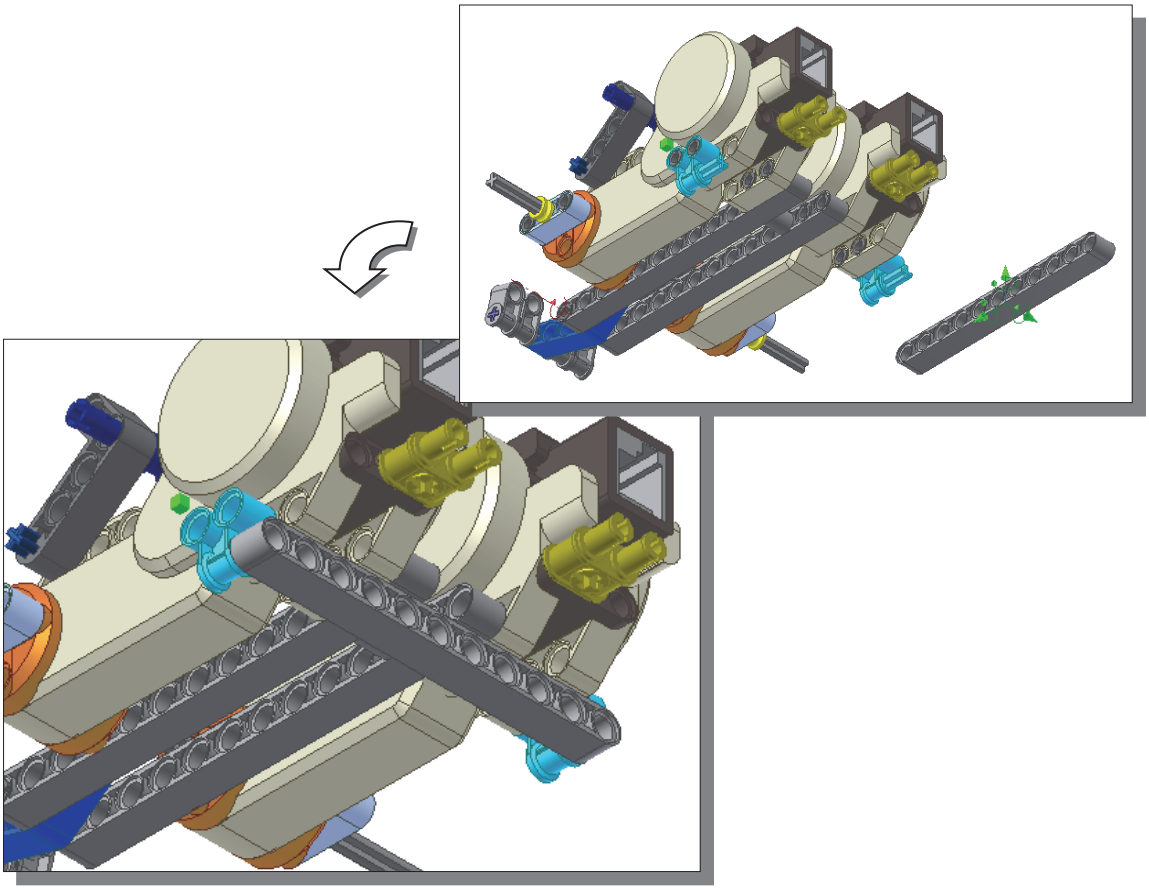
1. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.

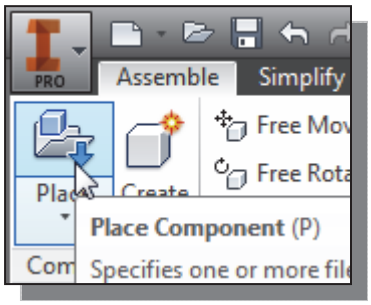
2. Select the ***Beam 11-module*** part in the list window. Click on the **Open** button to retrieve the model.



3. Place one copy of the part toward the right side of the graphics window.

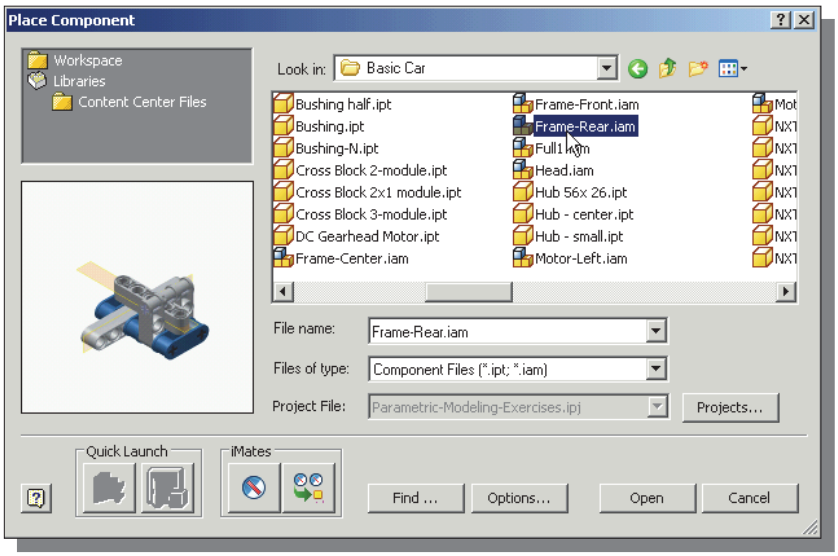
4. On your own, assemble the part as shown.



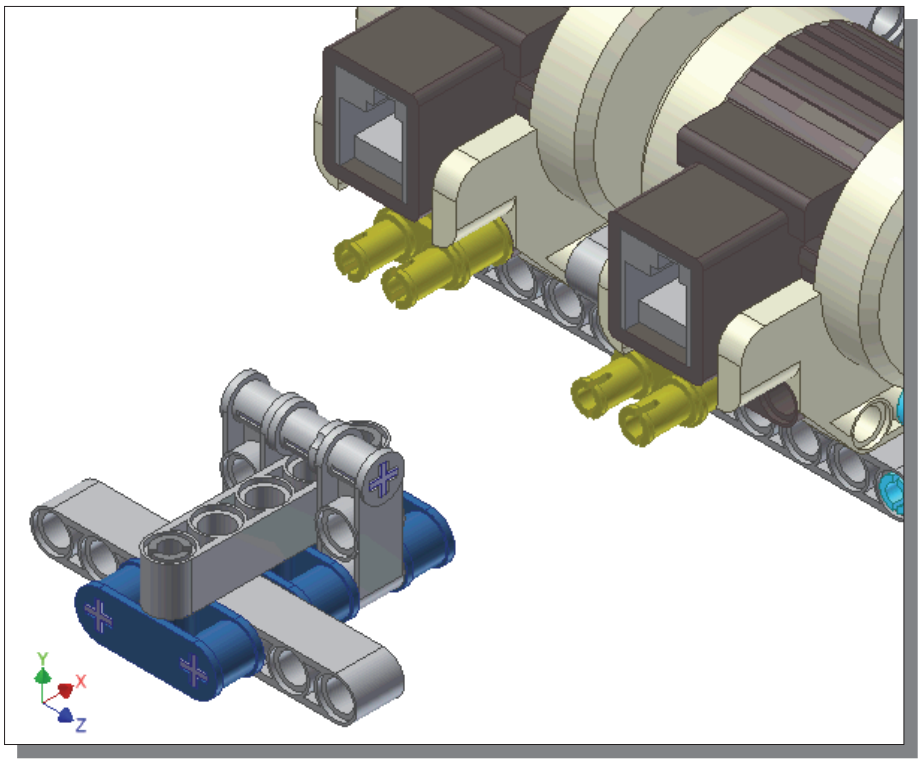


5. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.

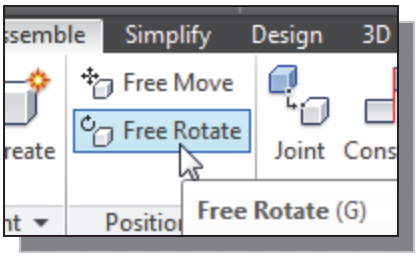
6. Select the ***Frame-Rear*** assembly in the list window. Click on the **Open** button to retrieve the model.



7. Place one copy of the ***Frame-Rear*** assembly next to the assembly.

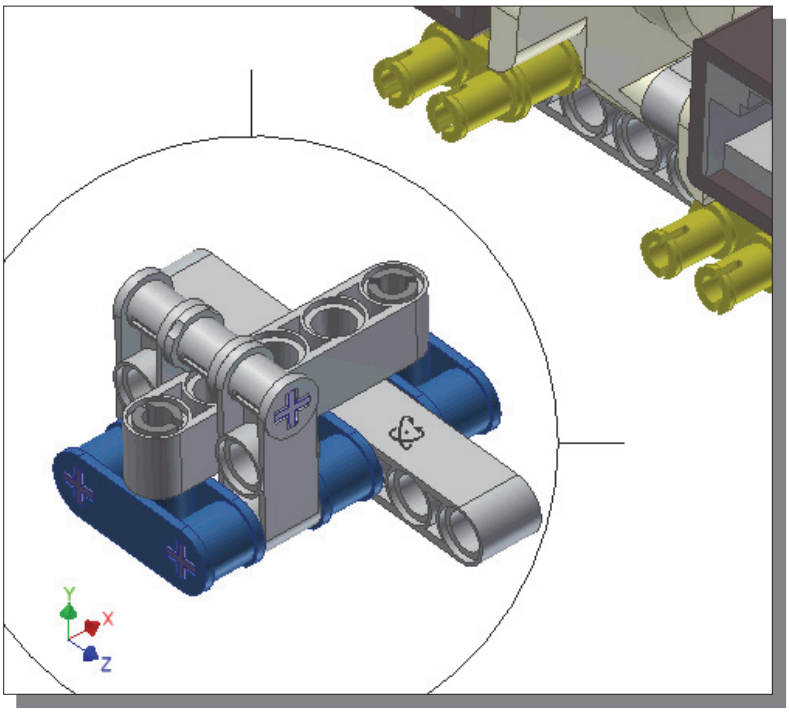


8. Inside the graphics window, right-mouse-click once to bring up the option menu and select **Done** to end the Place Component command.

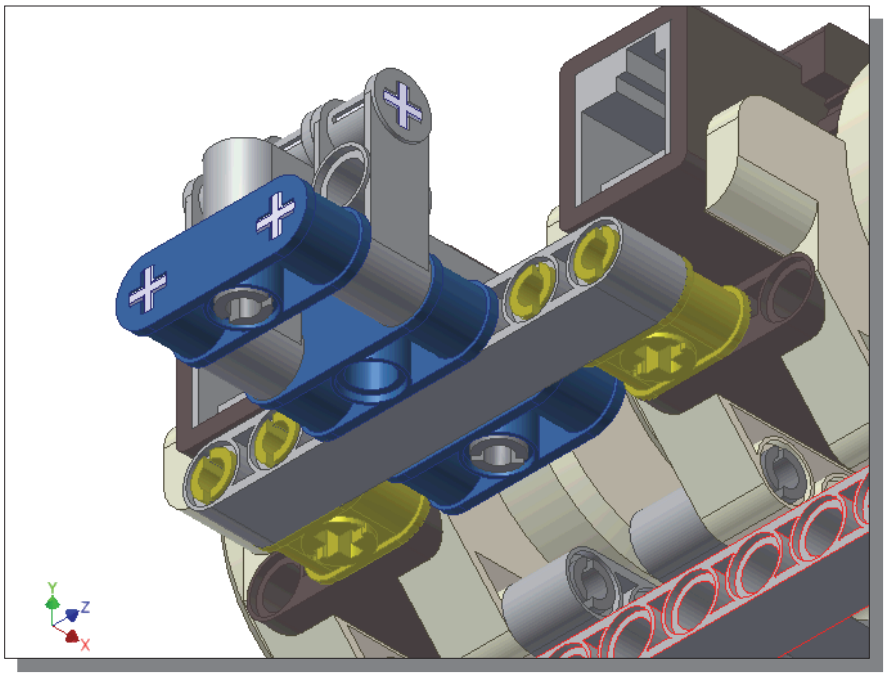


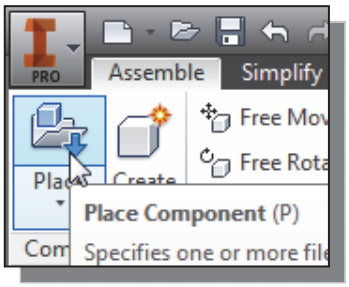
9. Select the **Rotate Component** command by left-mouse-clicking once on the icon.

10. On your own, use the left-mouse-button and rotate the subassembly to the orientation as shown.



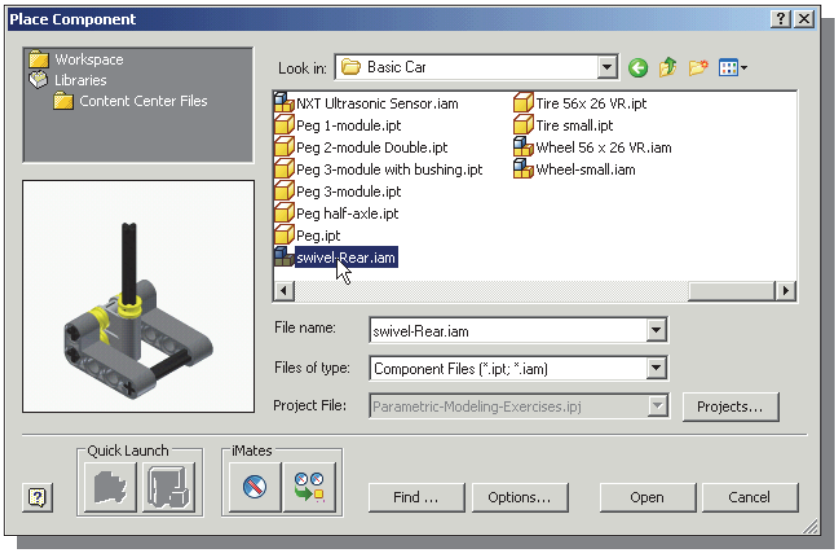
11. On your own, apply the necessary constraints to align the subassembly to the two ***Peg 2-module Double*** parts as shown.





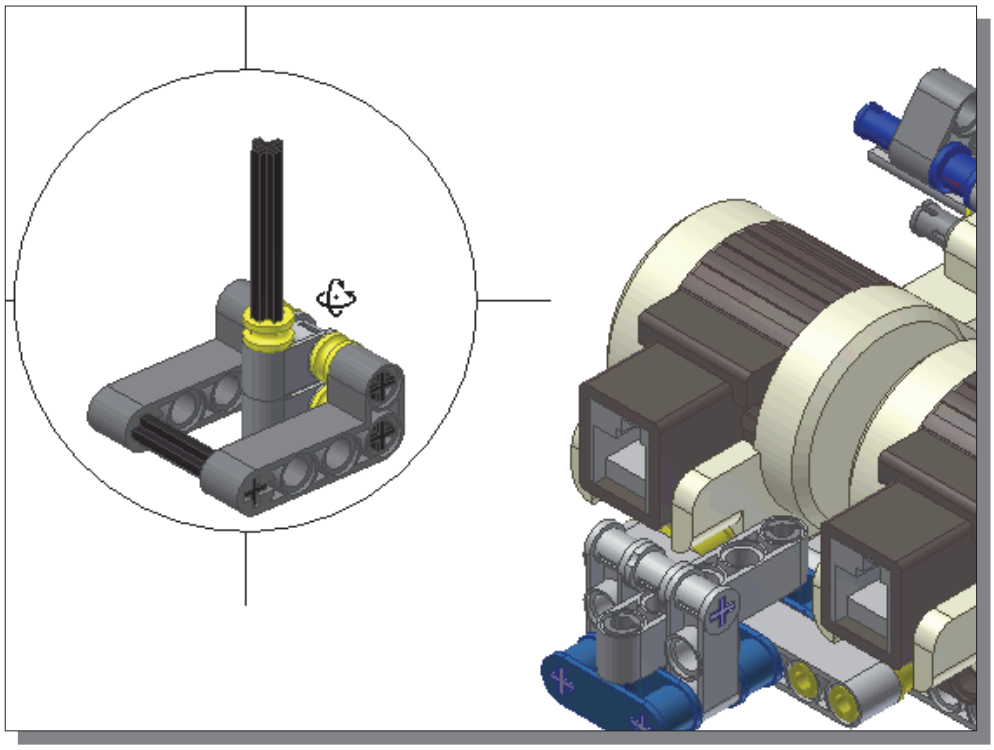
12. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.

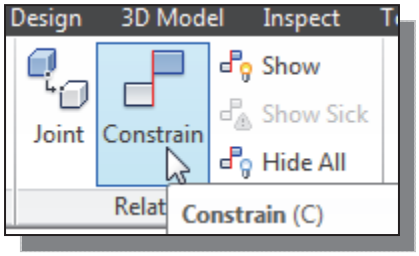
13. Select the ***Swivel-Rear*** assembly in the list window. Click on the **Open** button to retrieve the model.



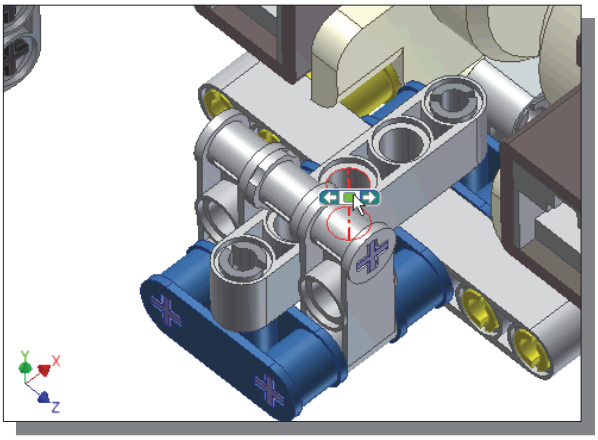
14. Place one copy of the ***Swivel-Rear*** assembly next to the assembly.

15. On your own, rotate the assembly to the orientation shown.

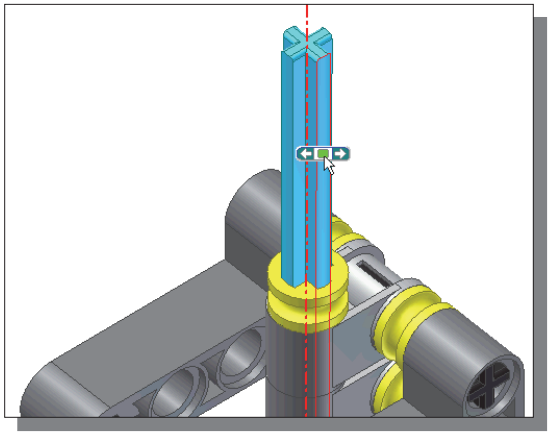




16. In the *Assembly* panel, select the **Constrain** command by left-mouse-clicking once on the icon.

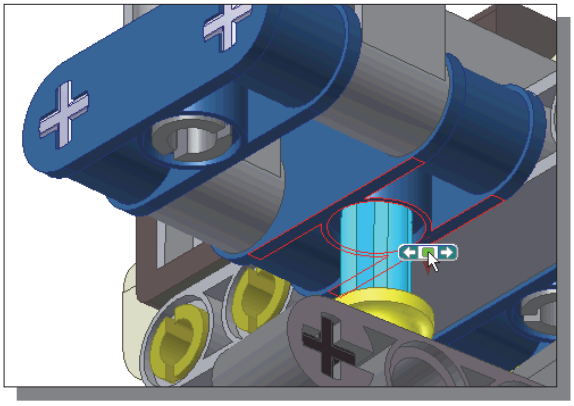


17. Select the center hole feature, on the inside cylindrical surface, of the ***Peg 5-Module*** part as shown.

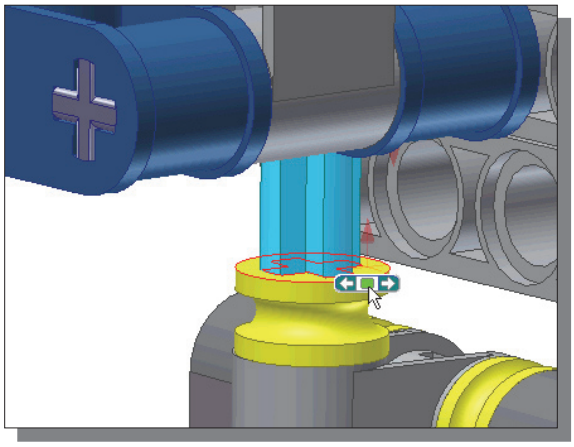


18. Select the curved surface of the ***Axle*** part of the ***Rear-Swivel*** assembly as the 2nd item for the Constrain command.

19. Click on the **Apply** button to accept the selection and apply the Mate constraint.



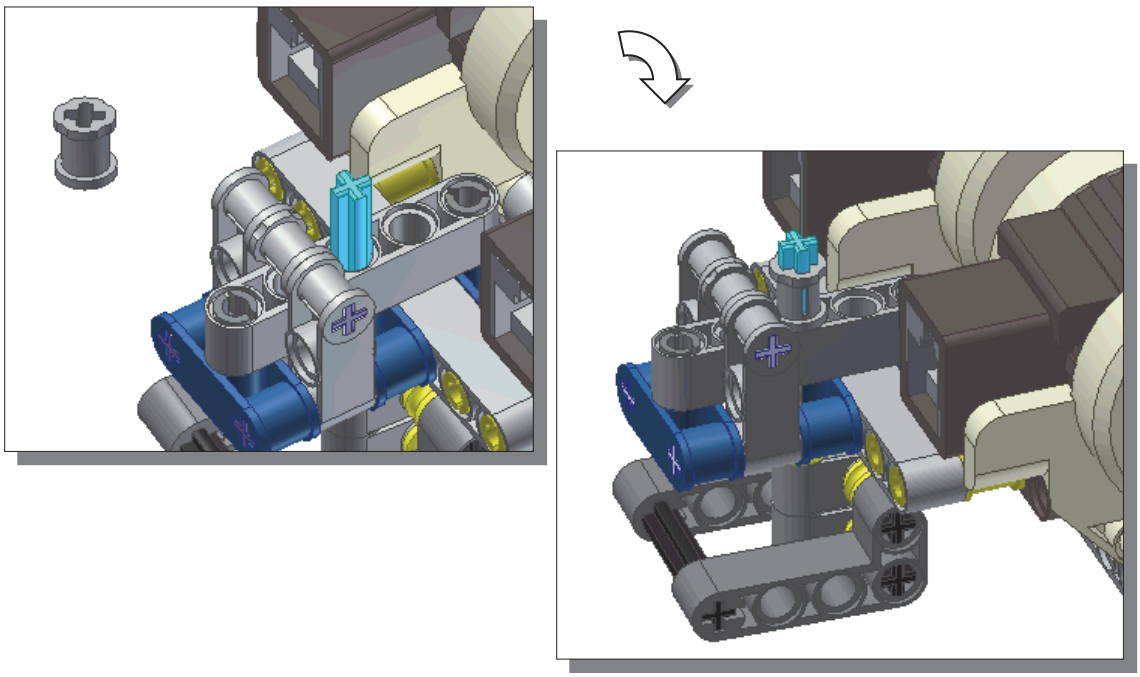
20. Select the bottom surface of the ***Beam 3-Center*** part as shown.



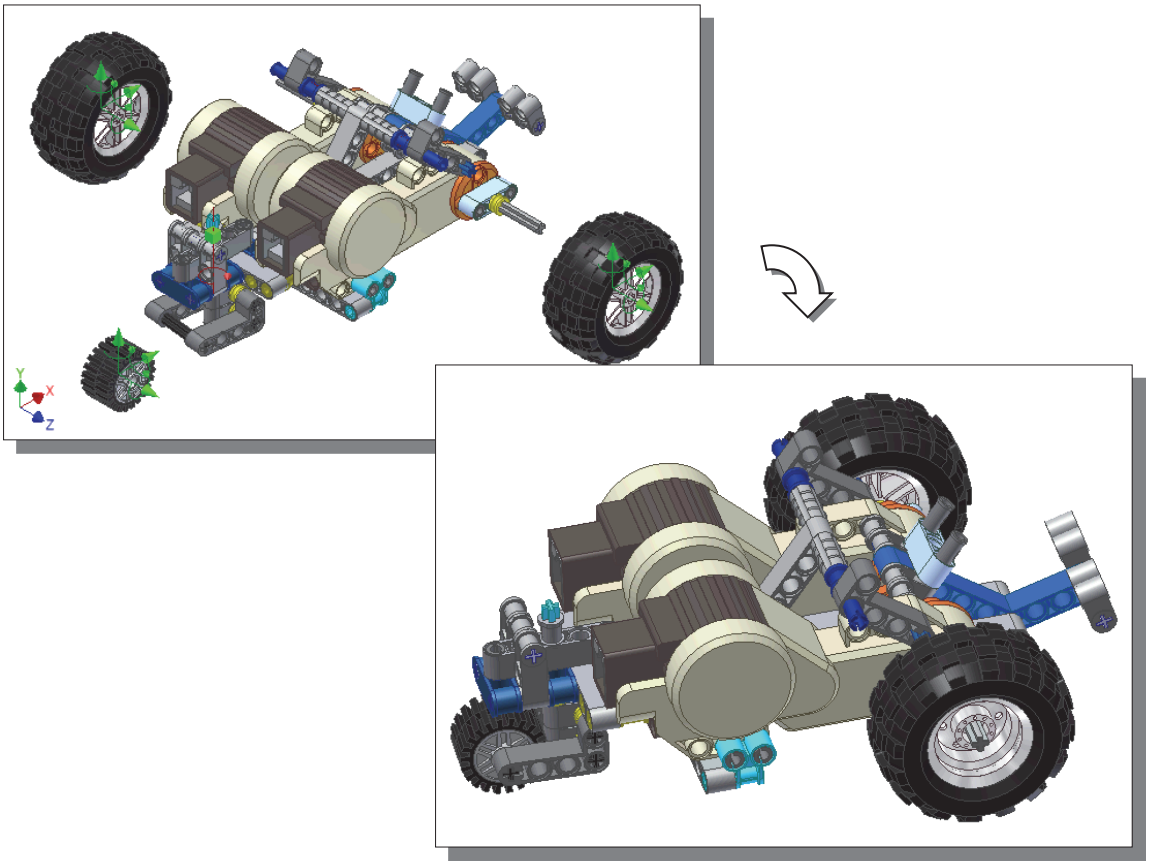
21. Select the top surface of the ***Bushing*** part of the **Rear-Swivel** assembly as the 2nd item for the Constrain command.

22. Click on the **Apply** button to accept the selection and apply the Mate constraint.

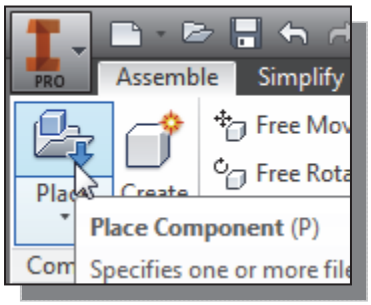
23. On your own, assemble a copy of the **Bushing** to the **Axle** of the ***Rear-Swivel*** assembly as shown.



24. On your own, assemble a ***Wheel-Small*** assembly and two copies of the ***Wheel 56x26 VR*** assembly as shown.

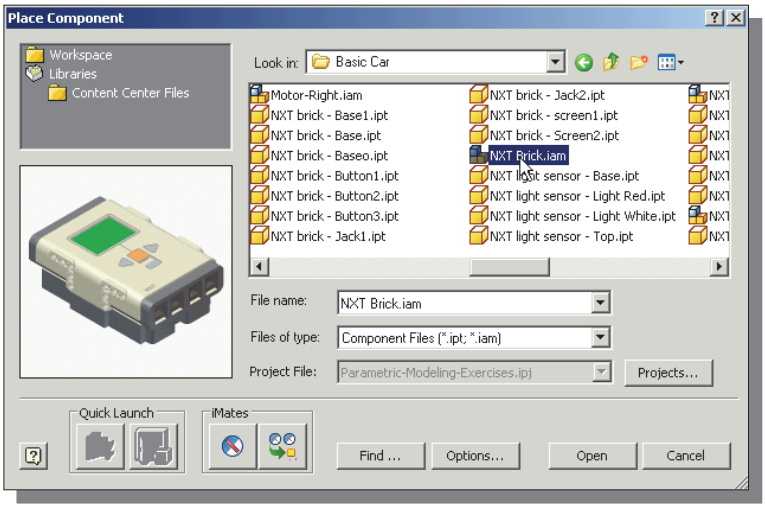


Assemble the NXT Micro-controller



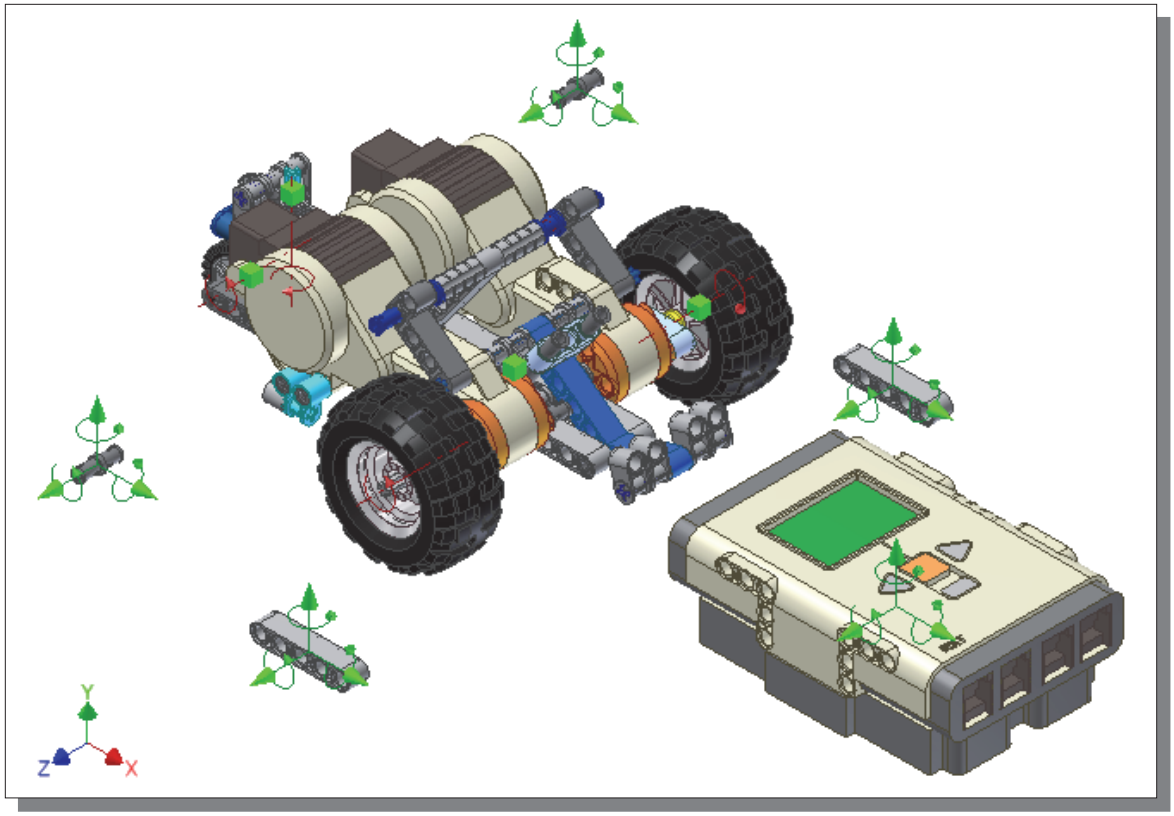
1. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.

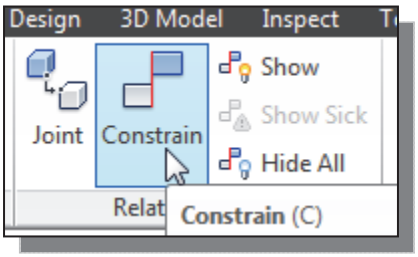
2. Select the ***NXT-Brick*** assembly in the list window. Click on the **Open** button to retrieve the model.



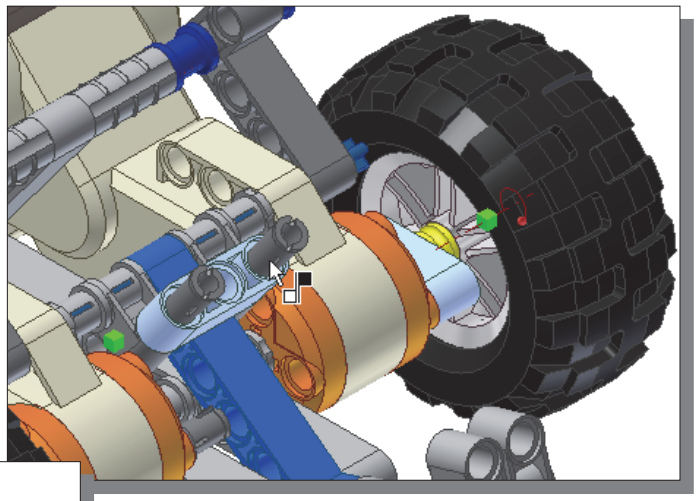
3. Place one copy of the assembly toward the right side of the graphics window.

4. On your own, also place two copies of ***Peg 1-Module*** and ***Beam 5-Module*** into the assembly as shown.

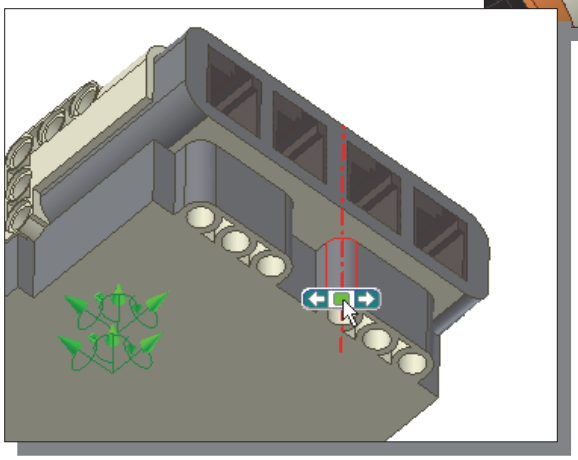




5. In the *Assembly* panel, select the **Constrain** command by left-mouse-clicking once on the icon.

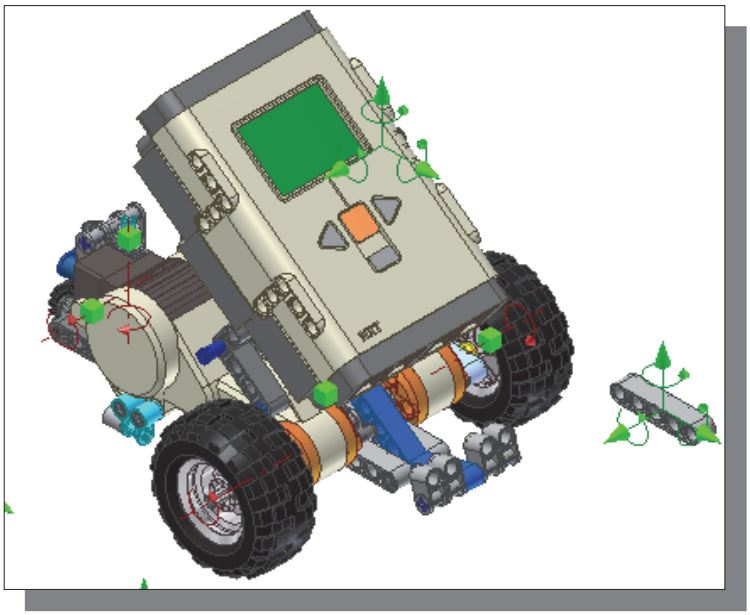


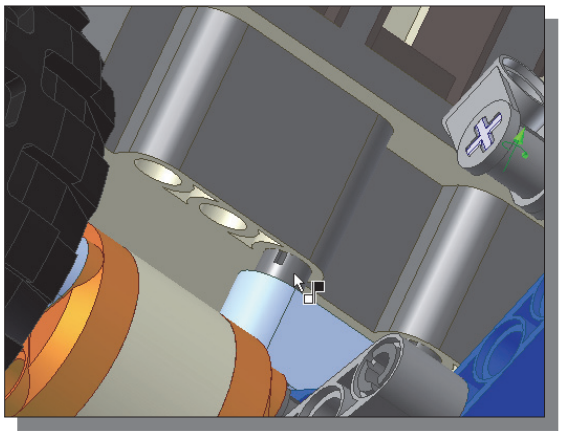
6. We will first align the bottom of the ***NXT-Brick*** to the *Frame-Front* assembly. Select the outside cylindrical surface of the right ***Peg 1-Module*** part of the *Frame-Front* assembly as shown.



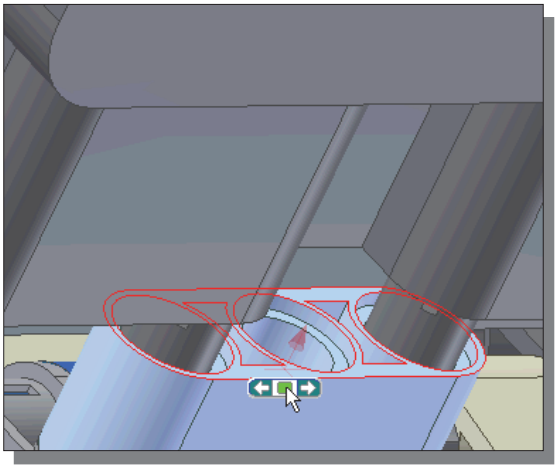
7. Select the center axis of the first hole feature on the bottom right of the ***NXT-Brick*** assembly as shown.

8. Click on the **Apply** button to accept the selection and apply the Mate constraint.





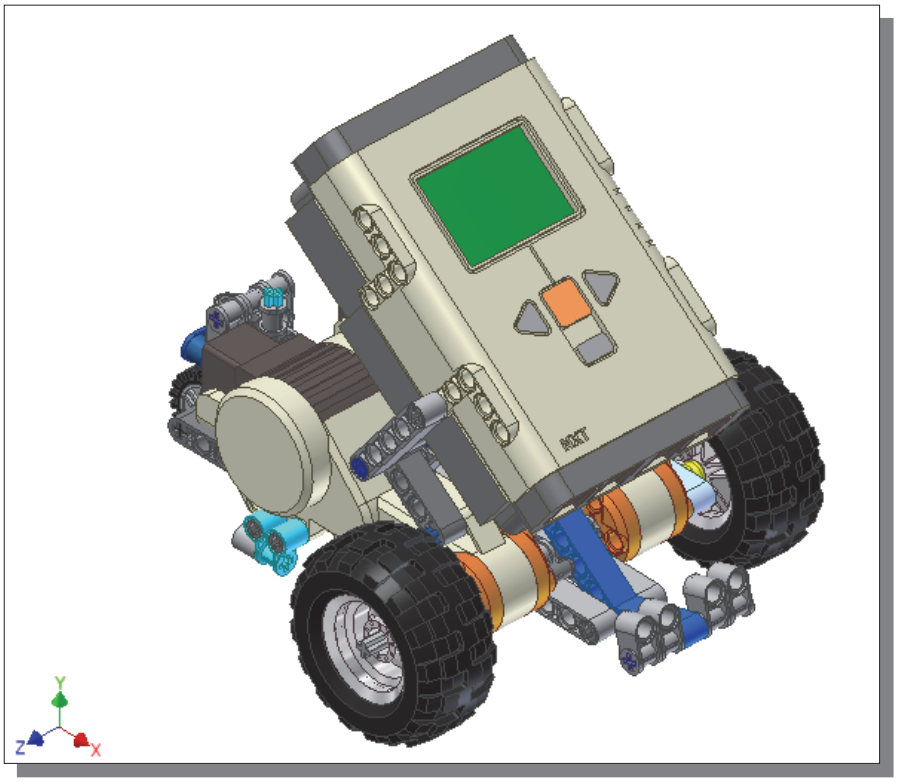
9. Select the outside cylindrical surface of the left ***Peg 1-Module*** part of the *Frame-Front* assembly as shown.



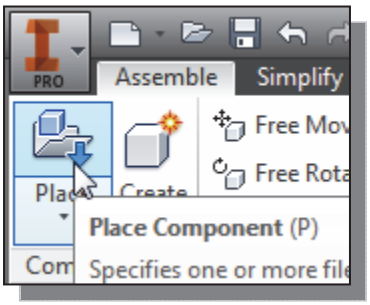
10. Select the center axis of the first hole feature on the bottom left of the ***NXT-Brick*** assembly as shown.

11. Click on the **Apply** button to accept the selection and apply the Mate constraint.

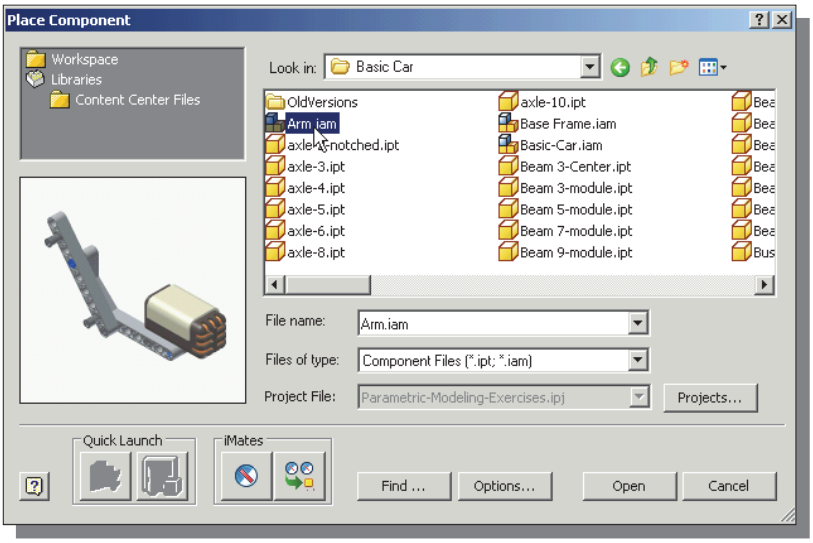
12. On your own, assemble the two sets of ***Peg 1-Module*** and ***Beam 5-Module*** parts as shown.



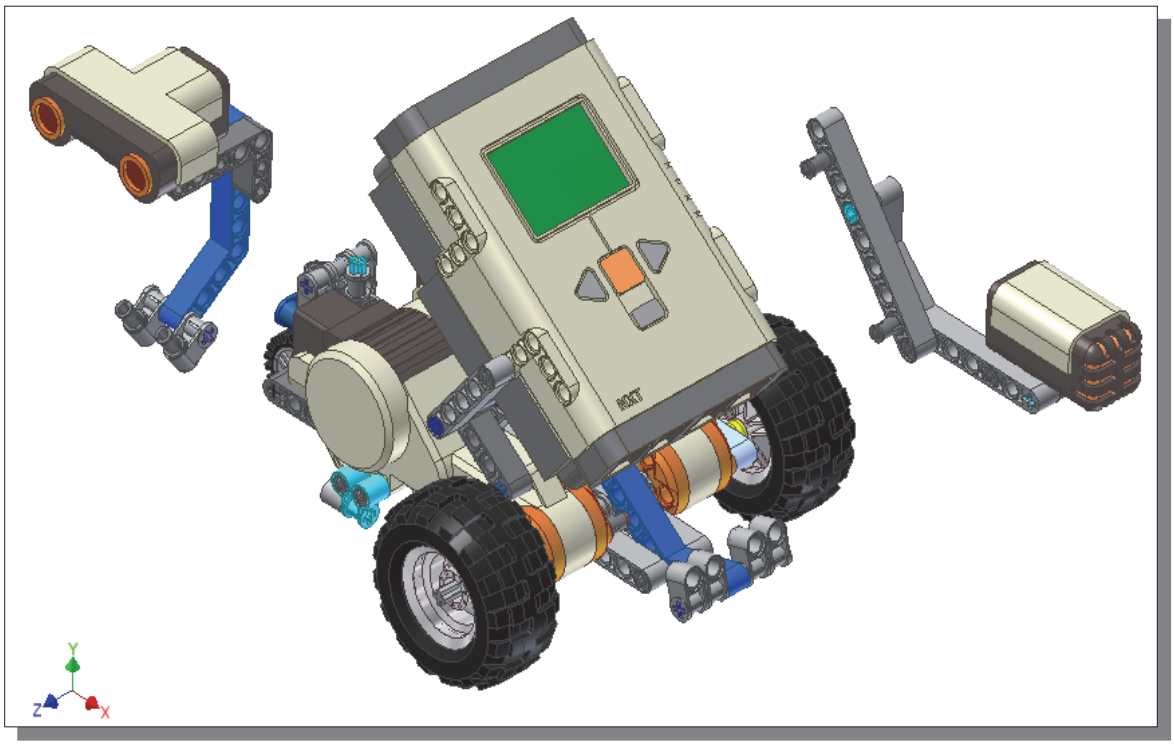
Assemble the Sensors

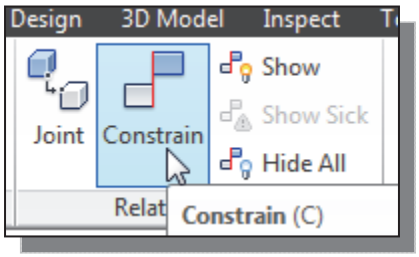


1. In the *Assembly* panel, select the **Place Component** command by left-mouse-clicking the icon.
2. Select the ***Arm*** assembly in the list window. Click on the **Open** button to retrieve the model.

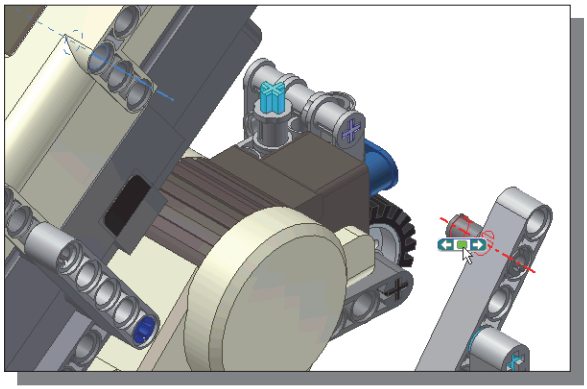


3. Place one copy of the assembly toward the right side of the graphics window.
4. On your own, also place a copy of the ***Head*** assembly into the current assembly as shown.

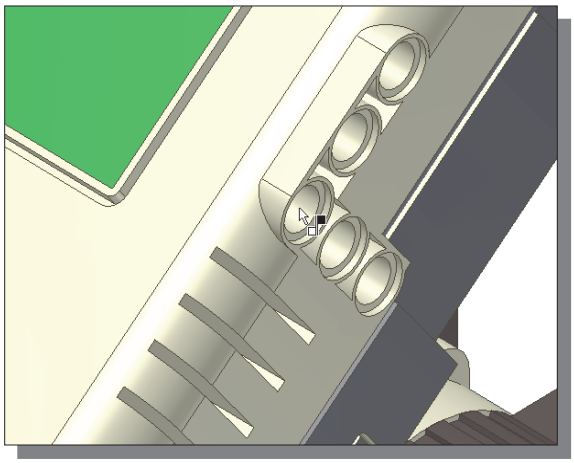




5. In the *Assembly* panel, select the **Constrain** command by left-mouse-clicking once on the icon.

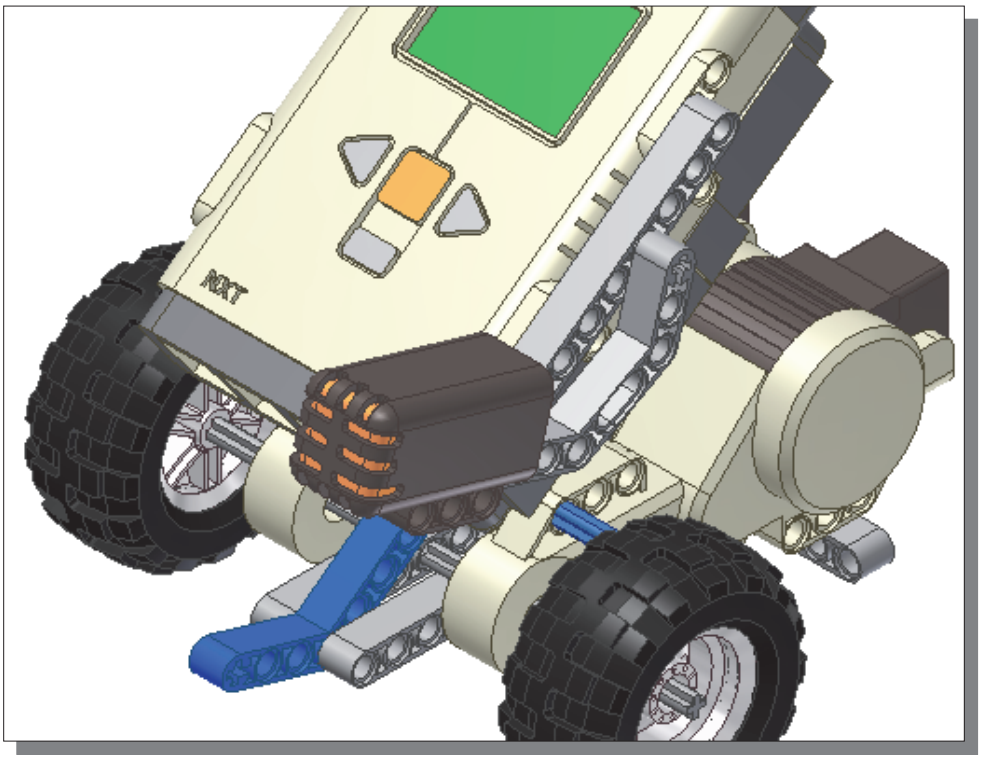


6. Align the center axes of the upper ***Peg*** on the ***Arm*** assembly to the corresponding hole feature on the ***NXT-Brick*** assembly as shown in the two figures.

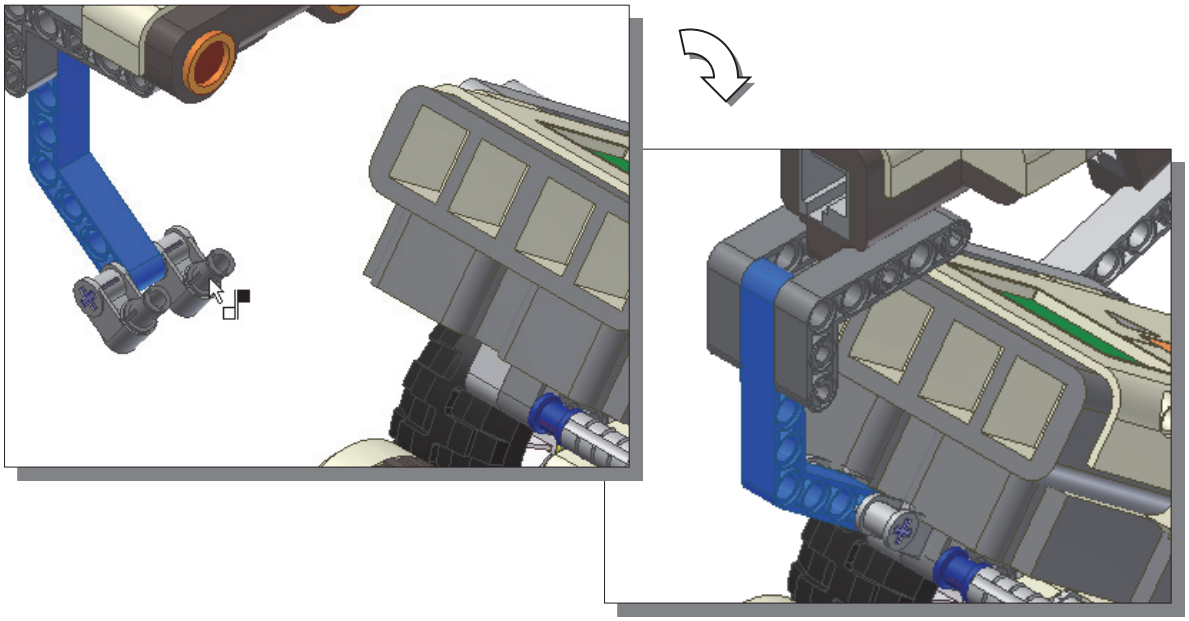


7. On your own, align the center axes of the lower ***Peg*** on the ***Arm*** assembly to the corresponding hole feature on the ***NXT-Brick*** assembly. (The top of the *Beam 9-module* part on the *Arm* assembly is parallel to the top of the *NXT-Brick*.)

8. Apply another **Mate** constraint to complete assembling the ***Arm*** as shown.



9. Align the two ***Pegs*** on the ***Head*** assembly to the bottom of the ***NXT-Brick*** assembly as shown.



10. Complete the assembly by adding another **Mate** constraint to align the ***Head*** assembly as shown.