<table>
<thead>
<tr>
<th>Using Physical Dynamics</th>
<th><strong>Physical Dynamics</strong> is a method for visualizing assembly motion in a more realistic way. Expanding on the capabilities of dynamic collision detection, <strong>Physical Dynamics</strong> lets one object act upon another. When two objects collide, one will move the other according to the available degrees of freedom. <strong>Physical Dynamics</strong> propagates throughout the assembly. The dragged component can push aside a component, which then moves into and pushes aside another component, and so on.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note</td>
<td>Do not confuse <strong>Physical Dynamics</strong> with a kinematic analysis application. With <strong>Physical Dynamics</strong>, characteristics such as momentum, friction, or whether a collision is elastic or inelastic are not considered.</td>
</tr>
</tbody>
</table>
On the Move Component PropertyManager, click Physical Dynamics.

When you drag a component with Physical Dynamics enabled, a small symbol appears on the component. This represents the center of mass. Physical Dynamics uses mass properties to compute how the forces acting on a component will make it behave as it collides with other components. Dragging a component by its center of mass exhibits different motion than dragging by a point on the component.

In the Physical Dynamics folder are some examples. They are illustrated in the chart below.

<table>
<thead>
<tr>
<th>Simulation Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nested Slides</td>
<td>As you drag the innermost slide, the next slide is contacted and pulled out as far as possible.</td>
</tr>
<tr>
<td>Clock</td>
<td>As you drag the minute hand, the hour hand moves.</td>
</tr>
<tr>
<td>Geneva Wheel</td>
<td>As you turn the input wheel, the pin engages and disengages the slots in the output wheel.</td>
</tr>
<tr>
<td>Simulation Element</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Limit Mechanism</td>
<td>Rotate the cam wheel counterclockwise and the Y-shaped actuating lever oscillates back and forth.</td>
</tr>
<tr>
<td>Bevel Gears</td>
<td>Turn the handle on one gear, and the other gear rotates.</td>
</tr>
<tr>
<td>Rolling Balls</td>
<td>Drag the individual balls so they collide with each other.</td>
</tr>
</tbody>
</table>

Tips for Working With Physical Dynamics

1. **Physical Dynamics** depends on collision detection. It will not work if the assembly contains interferences. If the item you are dragging interferes with another component, the source of the interference is made transparent. Use Tools, Interference Detection to find and eliminate interferences before using Physical Dynamics.

2. Use the appropriate mates to define the assembly. Highly unconstrained assemblies are less likely to be successful. Do not depend on Physical Dynamics to solve everything. For example, in the Nested Slides assembly, the appropriate mates were used to mate slide1 and slide2 so they each had only one
degree of freedom. Then **Physical Dynamics** was used to handle the interaction of the pins and the slots.

3. **Physical Dynamics** does not work on assemblies that have symmetry mates. For more information about symmetry mates, see the advanced course *Advanced Assembly Modeling*.

4. **Physical Dynamics** can be computationally intensive. Limit the scope by selecting components in the **Selected Items** box, and then clicking **Resume Drag**. Items that are not in the list are ignored.

**Physical Simulation**

**Physical Simulation** allows you to simulate the effects of motors, springs, and gravity on your assemblies. **Physical Simulation** combines simulation elements with SolidWorks tools such as mates and Physical Dynamics to move components around your assembly. Use an assembly that has the mates to support the simulation effects.

**Note**

Do not confuse **Physical Simulation** with a kinematic analysis application. With **Physical Simulation**, characteristics such as momentum, friction, or whether a collision is elastic or inelastic are not considered.

**Simulation Toolbar**

The commands for **Physical Simulation** are located on the Simulation toolbar. The individual tools will be explained later in this lesson.

**Where to Find It**

- Click **Simulation Toolbar** on the Assembly toolbar.
- Or, click **View, Toolbars** and select **Simulation**.

**Toolbar Options**

There are several options for creating the simulation:

- Stop Record or Playback
- Calculate Simulation
- Reset Components
- Replay Simulation

**Simulation Elements**

There are several simulation elements that move components around in the assembly.

<table>
<thead>
<tr>
<th>Simulation Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Linear Motor]</td>
<td>Linear Motors move components along a straight line path.</td>
</tr>
<tr>
<td>![Rotary Motor]</td>
<td>Rotary Motors move components about a selected axis, but they are not forces. Motor strength does not vary based on component size or mass. For example, a small component moves at the same speed as a large component if the <strong>Velocity</strong> slider is set to an equal value. You should not add more than one motor of the same type to the same component.</td>
</tr>
<tr>
<td>Simulation Element</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| ![Linear Spring](image) **Linear Spring** | Springs apply a force to a component. A spring with a higher spring constant will move a component faster than a spring with a lower spring constant. Also, a component with a smaller mass will move faster than a component with a larger mass if acted upon by springs of equal strength.  
Motion due to a spring stops when the spring reaches its free length.  
Motion due to motors supersedes motion due to springs. If you have a motor moving a component to the left and a spring pulling a component to the right, the component moves to the left. |
| ![Gravity](image) **Gravity** | You can define only one gravity simulation element per assembly.  
All components move at the same speed under the effect of gravity regardless of their mass.  
Motion due to motors supersedes motion due to gravity. If you have a motor moving a component up and gravity pulling a component down, the component moves up without any downward pull. |

**Animation Controller**

The Animation Controller is invoked by the **Replay Simulation** button on the Simulation toolbar.

![Animation Controller](image)

**Playback Options**

There are several options for replaying the simulation:

- **Start**
- **Rewind**
- **Play**
- **Pause**
- **Fast Forward**
- **End**
- **Normal**
- **Stop**
- **Save as AVI**
- **Reciprocate**
- **Slow Play**
- **Loop**
- **Fast Play**

**FeatureManager Design Tree**

When you add simulation elements to an assembly, a Simulation feature is added to the FeatureManager. If you right-click on the Simulation feature, you can:

- Delete the Simulation feature, including all the simulation elements.
Delete the replay of the simulation. This leaves the simulation elements intact.

Reset the components to their positions prior to the simulation.

1 **Add a rotary motor.**

Click the **Rotary Motor** and select the circular edge of the **crank-shaft** as the **Direction** of the motor.

2 **Simulation folder.**

When the Rotary Motor is added, a new **Simulation** folder is added to hold it.

3 **Calculate the simulation.**

Click **Calculate Simulation** on the Simulation toolbar. Record approximately two complete revolutions of the **crank-assy**.

**Note**

When you record a simulation, the components actually move within their degrees of freedom according to the simulation elements. The degrees of freedom are determined by the mates on the components and collisions with other components.

4 **Stop recording.**

Click **Stop Record or Playback** on the Simulation toolbar.

5 **Play the simulation.**

Click **Replay Simulation** on the Simulation toolbar to access the Animation Controller. Use any of the controller options to speed up, slow down, loop or reciprocate the playback.

6 **Save and close.**

Another Example

The following section is another example of Physical Simulation where the motor is applied to one component and that motion affects several others.
1 Open an assembly.
Open the assembly
machine.sldasm located
in the Sarrus Mechanism
folder.

2 Hide Component.
Switch to the Back Iso view
and hide the Mount
component.
This will make it easier to add
a rotary motor to the shaft of
the Wheel.

3 Rotary Motor.
Click Rotary Motor on
the Simulation toolbar.
Select the cylindrical face of
the shaft of the Wheel.
Click Reverse Direction and
then click OK.

4 Show Component.
Switch back to the My Iso
view, and show the Mount
component. Record, stop and
play the simulation in the
same fashion as the previous
one.

Other Examples
You can use any of the assemblies in the Physical Dynamics
folder to experiment with Physical Simulation.