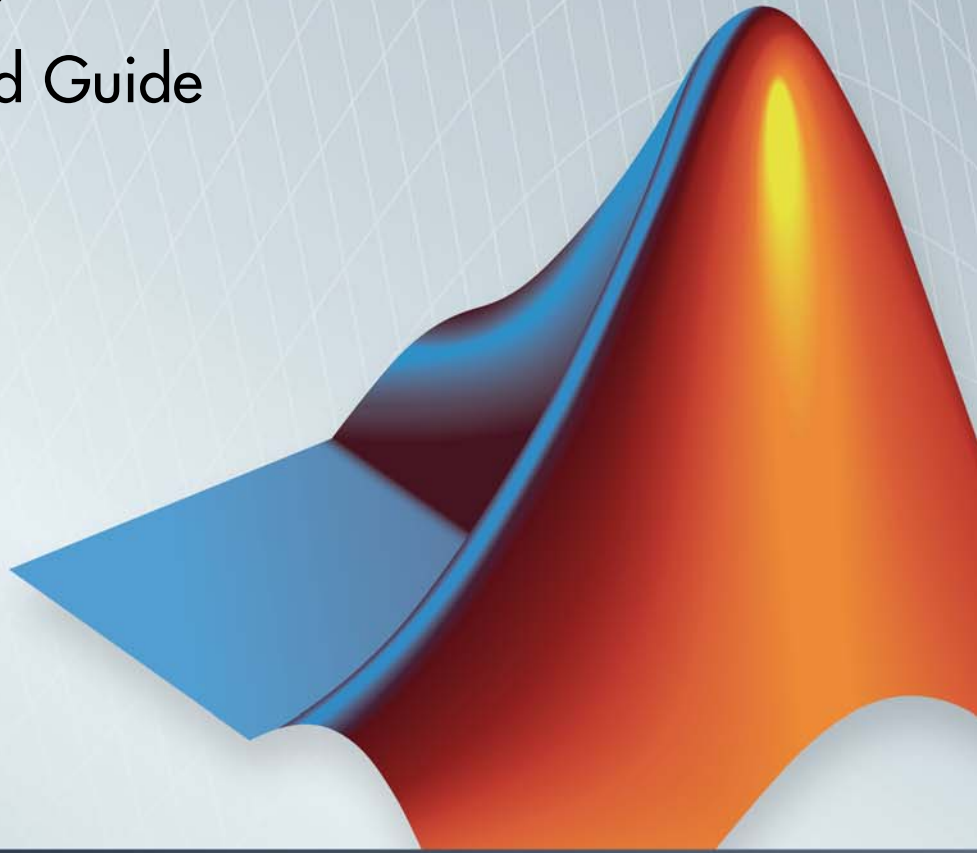


# SimMechanics™

## Getting Started Guide

**R2013a**



**MATLAB® & SIMULINK®**



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The MathWorks, Inc.  
3 Apple Hill Drive  
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*SimMechanics™ Getting Started Guide*

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March 2012	Online only	New for Version 4.0 (Release R2012a)
September 2012	Online only	Revised for Version 4.1 (Release R2012b)
March 2013	Online only	Revised for Version 4.2 (Release R2013a)

## Introduction to SimMechanics Software

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# Introduction to SimMechanics Software

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## Product Description

### **Model and simulate multibody mechanical systems**

SimMechanics™ provides a multibody simulation environment for 3D mechanical systems, such as robots, vehicle suspensions, construction equipment, and aircraft landing gear. You model the multibody system using blocks representing bodies, joints, constraints, and force elements, and then SimMechanics formulates and solves the equations of motion for the complete mechanical system. Models from CAD systems, including mass, inertia, joint, constraint, and 3D geometry, can be imported into SimMechanics. An automatically generated 3D animation lets you visualize the system dynamics.

You can parameterize your models using MATLAB® variables and expressions, and design control systems for your multibody system in Simulink®. You can add electrical, hydraulic, pneumatic, and other components to your mechanical model using Simscape™ and test them all in a single simulation environment. To deploy your models to other simulation environments, including hardware-in-the-loop (HIL) systems, SimMechanics supports C-code generation (with Simulink Coder™).

### **Key Features**

- Blocks and modeling constructs for simulating and analyzing 3D mechanical systems in Simulink
- Rigid body definition using standard geometry and custom extrusions defined in MATLAB
- Automatic calculation of mass and inertia tensor
- Simulation modes for analyzing motion and calculating forces
- Visualization and animation of multibody system dynamics with 3D geometry
- SimMechanics Link utility, providing an interface to Pro/ENGINEER®, SolidWorks®, and Autodesk Inventor, and an API for interfacing with other CAD platforms
- Support for C-code generation (with Simulink Coder)

## Required and Related Products

In this section...
“Required Products” on page 1-3
“Related Products” on page 1-4

### Required Products

To use SimMechanics software, you must have installed current versions of the following products:

- MATLAB
- Simulink
- Simscape

### SimMechanics Visualization Requirements

SimMechanics visualization requires Silicon Graphics OpenGL® graphics support on your system to display and animate SimMechanics models.

You can improve your speed and graphics resolution by adding a graphics accelerator hardware card to your system. Animation of simulations is sensitive to central processor and graphics card speed and memory. Experiment with graphics hardware and system settings to find a reasonable compromise between quality and speed for your system.

### Support for Recorded Animations

You can record simulation animations in Microsoft Audio Video Interleave® (AVI) format using SimMechanics visualization. Animations are recorded as compressed AVI files with the default Motion JPEG codec. This codec is available on most operating systems.

To play back AVI files, you need an AVI-compatible media application. MATLAB has an internal movie player compatible with AVI. You can also use an external AVI-compatible player.

---

**Note** SimMechanics visualization does not support uncompressed AVI recording.

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## Related Products

You can extend the capability of SimMechanics using other physical modeling products found in the Simscape family. Each physical modeling product gives you a set of block libraries with which you can model common components found in industry and academia: rigid bodies, gears, valves, solenoids, etc.

With the physical modeling products, you can model not only mechanical systems, but also electrical, hydraulic, and power systems. You can model each system separately, and then integrate the systems into a single multiphysics model where you can analyze combined system performance.

## Physical Modeling Product Family

The physical modeling family includes five products:

- SimDriveline™, for modeling and simulating drivetrain systems
- SimElectronics®, for modeling and simulating electronic systems
- SimHydraulics®, for modeling and simulating hydraulic systems
- SimMechanics, for modeling and simulating three-dimensional mechanical systems
- SimPowerSystems™, for modeling and simulating electrical power systems

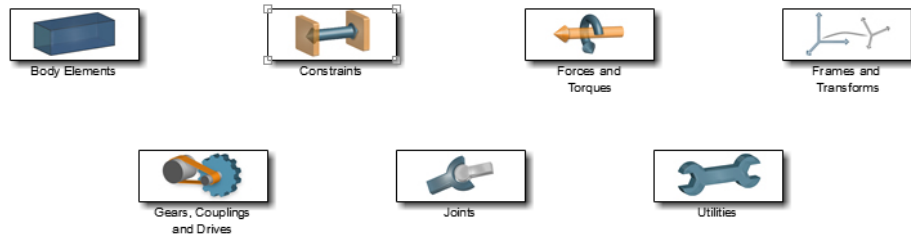


## Representing Machines with SimMechanics Blocks

To model a 3-D multibody system, you use the SimMechanics block library. This library contains seven sublibraries that you represent the different model components with. Components that you can represent include rigid bodies, joints, gear and general kinematic constraints, forces and torques, and motion sensors.

### Open the Library

To open the SimMechanics block library, at the MATLAB command line enter `sm_lib`. The SimMechanics block library opens in a new window. The figure shows the library that opens.



### SimMechanics™ Product Library

#### Explore the Library

The table provides an overview of the SimMechanics sublibraries. Open each sublibrary to explore its blocks. For detailed information about a block, see its reference page. You can do this by double-clicking the block, then clicking **Help** in the block dialog box.

Sublibrary	Description
Body Elements	Represent the solid properties of a rigid body
Constraints	Constrain the relative motion between two rigid body frames

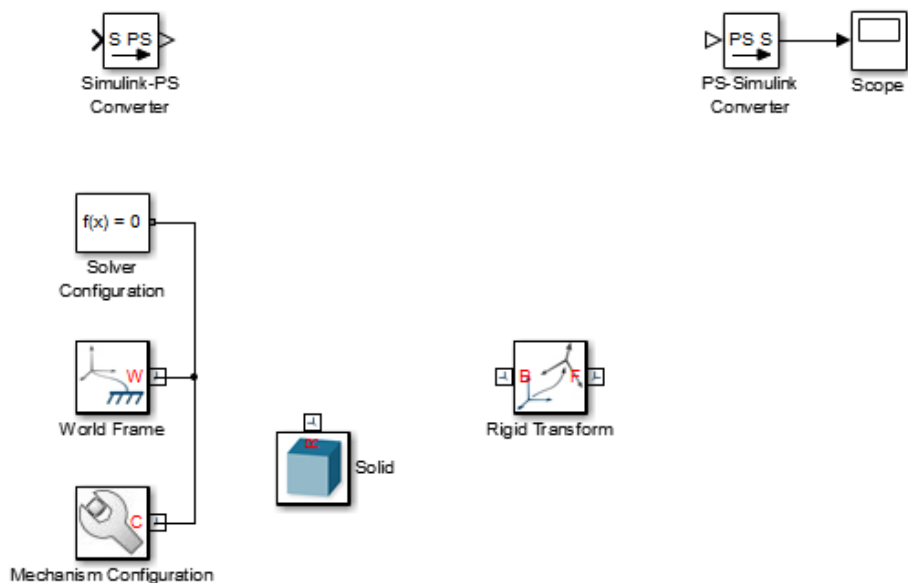
<b>Sublibrary</b>	<b>Description</b>
Forces and Torques	Apply internal and external forces and torques on or between rigid body frames
Gears, Couplings and Drives	Couple the motion of two rigid body frames
Joints	Represent the mechanical degrees of freedom between two rigid body frames
Utilities	Represent the external environment of a multibody system

**Related Examples**

- “Start New Multibody Model” on page 1-7

## Start New Multibody Model

You can start a new multibody model from the MATLAB command line. To do this, enter `smnew`. A new model window opens with commonly used blocks. The SimMechanics block library also opens. The figure shows the new model window that you see. Drag blocks from the library into the model window to begin modeling a new multibody system.



### Concepts

- “Representing Machines with SimMechanics Blocks” on page 1-5

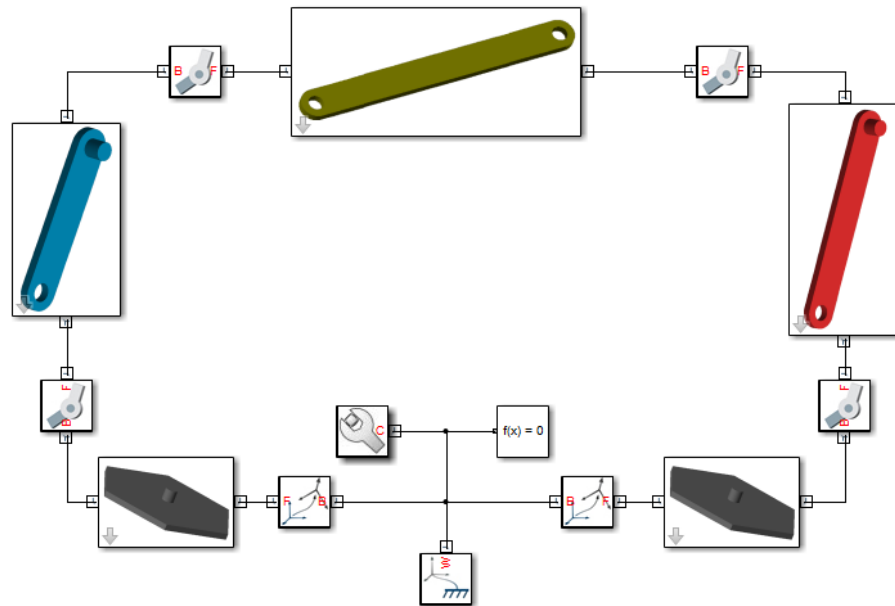
## Multibody Model Anatomy

In this section...
“Basic Model Components” on page 1-8
“Applying Forces and Torques” on page 1-11
“Sensing Motion” on page 1-13
“See Also” on page 1-15

With SimMechanics, you represent a multibody system using blocks. Like all physical modeling products, each block represents a physical component or an abstract entity fundamental to physical modeling—e.g. frames and frame transforms. By connecting the blocks with connection lines, you define the relationships that connect the physical components. In a basic model, these physical components include rigid bodies and joints. In more advanced models, you can find forces and torques, motion sensors, and kinematic constraints.

### Basic Model Components

The figure shows the block diagram of a multibody system—the four-bar linkage. This model contains subsystem blocks to represent the links and pivot mounts. These represent the rigid bodies of the model. The model contains also four Revolute Joint blocks. These represent the joints in the model. Combined, these blocks form the foundation of this model.

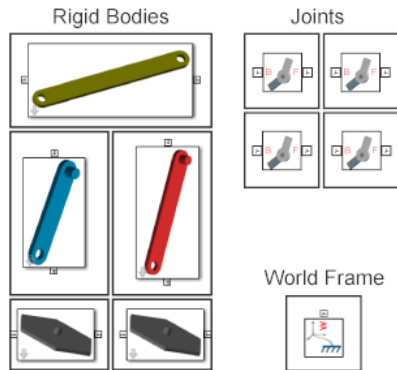


While important, rigid body subsystem and joint blocks are not sufficient to represent the four-bar linkage. Other blocks serve important purposes. These include World Frame, Rigid Transform, Mechanism Configuration, and Solver Configuration blocks. The table summarizes their purpose in a multibody model.

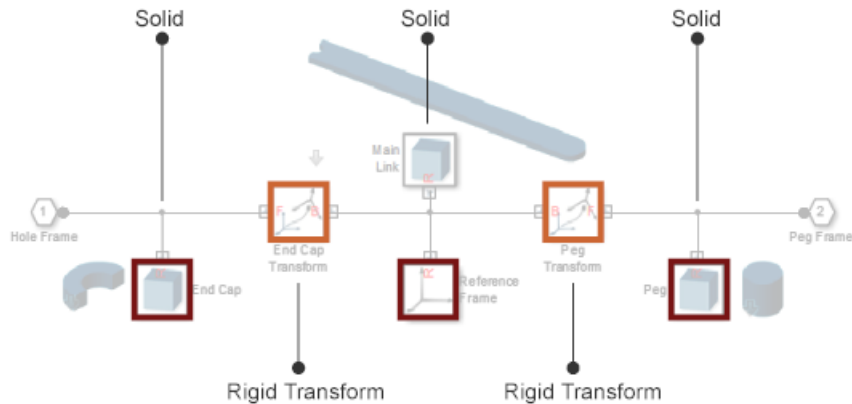
Block	Purpose
World Frame	Provides the ultimate reference frame in a model. All remaining frames are defined with respect to this frame. It is inertial and it defines absolute rest.
Rigid Transform	Apply a fixed spatial relationship between frames. This block defines the offset distance and angle between two frames.

Block	Purpose
Mechanism Configuration	Identifies the gravity vector in a model.
Solver Configuration	Provides essential simulation parameters required to simulate the model.

The figure breaks the four-bar model into its logical components. These are the physical components and abstract entities that you need in order to represent this system.



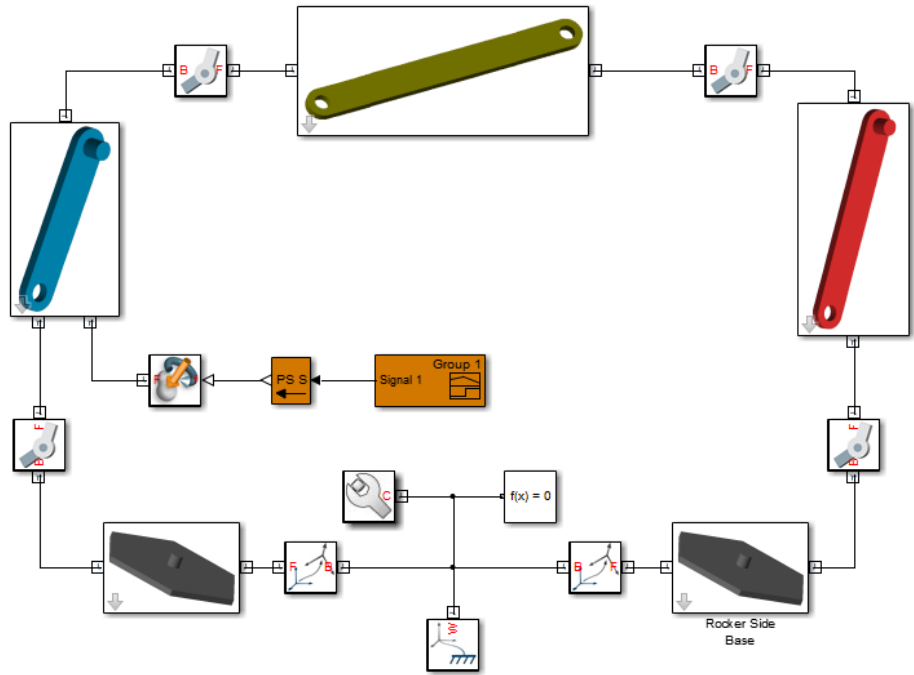
Each rigid body subsystem contains SimMechanics blocks that represent solids and their spatial relationships. The blocks are Solid and Rigid Transform. The figure shows the blocks that model one of the binary links. Three Solid blocks represent the three solid sections of this rigid body—main, peg, and hole sections. Two Rigid Transform blocks represent the fixed spatial relationships between the three solids. You use them to position the peg and hole sections at the ends of the main section.



## Applying Forces and Torques

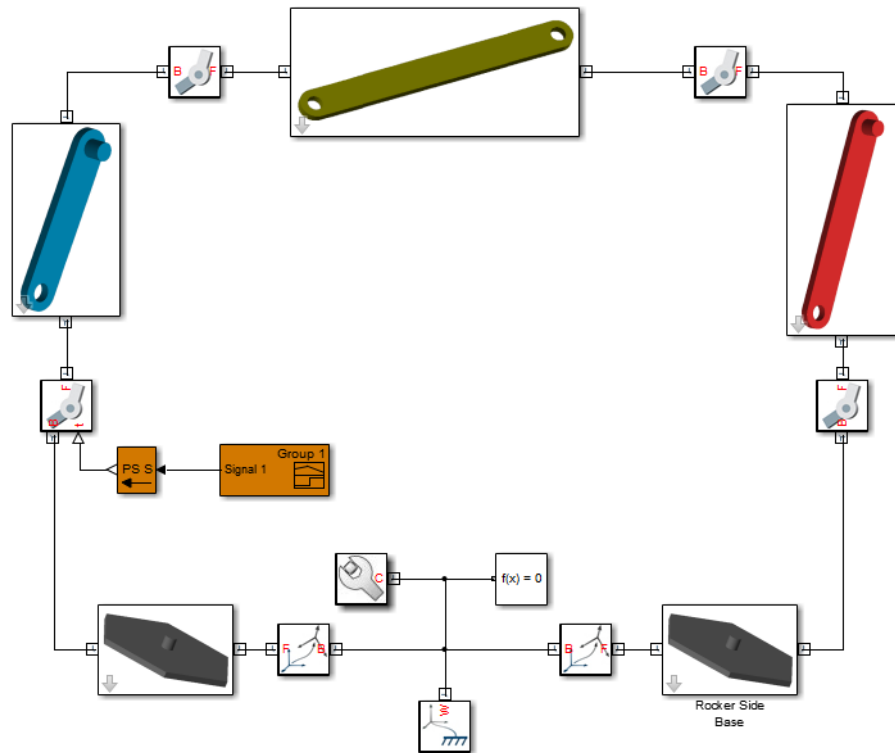
You can actuate a model by applying a force or torque to a rigid body or to a joint. To represent forces and torques acting on a rigid body, SimMechanics provides a Forces and Torques library. Drag a block from this library and connect it to the rigid body frame(s) that you want to apply the force or torque to.

One block represents an external force or torque—External Force and Torque. The other blocks represent internal forces between two rigid body frames. You can represent a general internal force, using the Internal Force block, or a specific internal force type, using Spring and Damper Force and Inverse Square Law Force blocks. The figure shows how you can use the External Force block to actuate the crank link of the four-bar model.



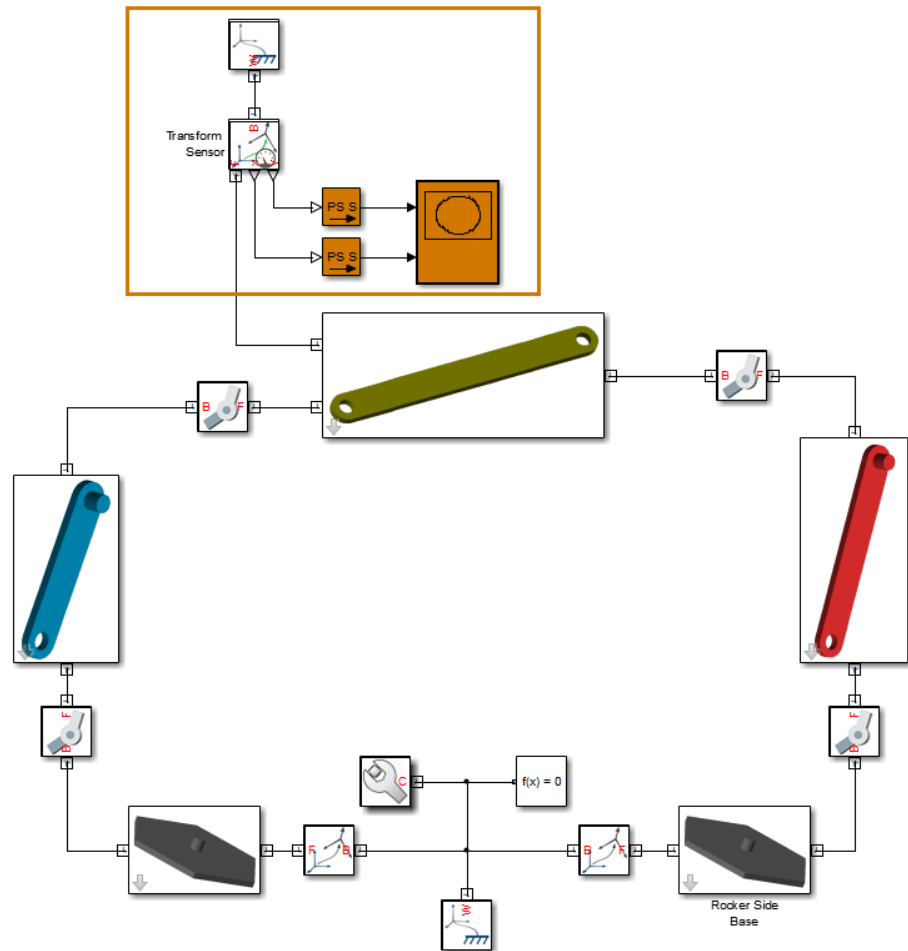
To represent forces and torques acting at a joint, SimMechanics provides a selection of actuation inputs in each Joint block. Each joint primitive—the basic component of a joint block—provides a selection of actuation inputs that you can select. You can represent a torque acting on a revolute or spherical joint primitive, or a force acting on a prismatic joint primitive. The figure shows how you can use the base-crank revolute joint block to actuate the joint directly.



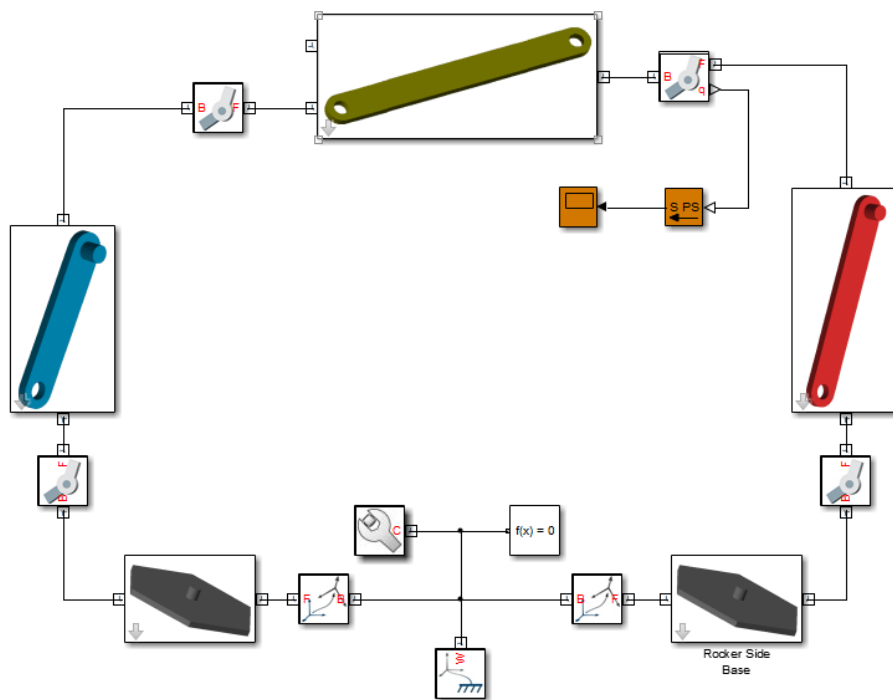


## Sensing Motion

You can sense motion between two arbitrary rigid body frames. For this task, SimMechanics provides the Transform Sensor block, which you find in the Frames and Transforms library. This block provides the broadest motion sensing capability in SimMechanics. With it, you can sense position, velocity, and acceleration, both rotational and translational, between any two frames in a model. The figure shows how you can use the Transform Sensor block to sense the position coordinates of the coupler link reference frame with respect to the World frame.



To sense motion directly between two rigid body frames connected at a joint, SimMechanics provides a selection of sensing outputs in each joint block. Each joint primitive provides a selection of sensing outputs that you can select. You can sense rotational position, velocity, and acceleration using revolute and spherical joint primitives. You can also sense translational position, velocity, and acceleration using prismatic joint primitives. The figure shows how you can sense the angular position of the coupler-rocker revolute joint directly from the joint block.



## See Also

For more information, see:

- “Model Aiming Mechanism” on page 1-30

## Multibody Modeling Workflow

### In this section...

“Model Rigid Bodies” on page 1-16

“Assemble Multibody Model” on page 1-20

“Add Forces, Torques, and Motion Sensors” on page 1-23

“Simulate and Analyze model” on page 1-27

The multibody modeling process contains a set of well-defined, sequential steps. Before you begin, define the intent of the model. Then, select a modeling approach and define the model requirements.

SimMechanics supports two modeling approaches:

- Manually build model — most common modeling approach. The following sections outline the manual approach.
- Automatically generate model from CAD assembly — for users wishing to simulate a CAD assembly in a physical modeling environment. Approach requires access to supported CAD software and assembly files. See “CAD Translation”.

### Model Rigid Bodies

Rigid bodies are the building blocks of a multibody system. Before you can connect rigid bodies with joints and constraints, you must model the rigid bodies. You can create two types of rigid bodies:

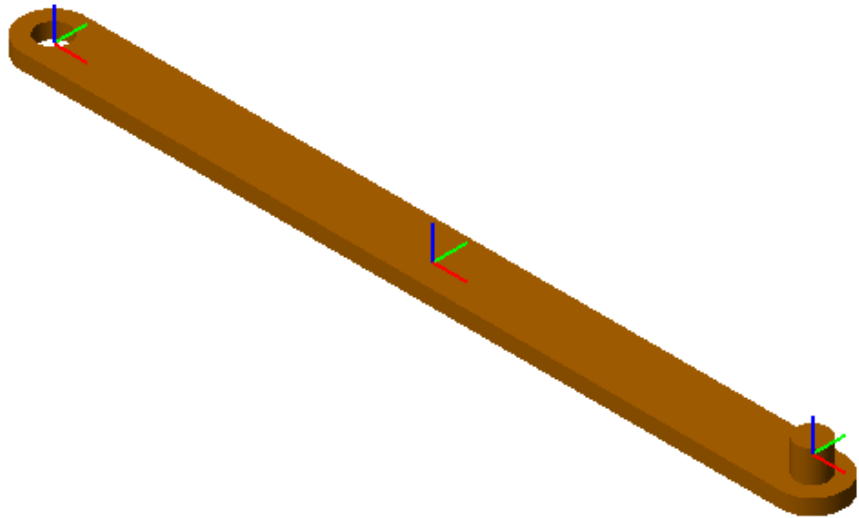
- Simple — Use a single Solid block to model the rigid body. Simple rigid bodies are quicker to model. Use simple rigid bodies to quickly produce proof-of-concept models, before you create more detailed rigid body subsystems.

A simple cylinder is a simple rigid body.



- Compound — Rigidly connect multiple Solid blocks to model the rigid body. Compound rigid bodies require more time to model, but provide the most accurate representation of a rigid body that you can manually build.

A detailed binary link is a compound rigid body.



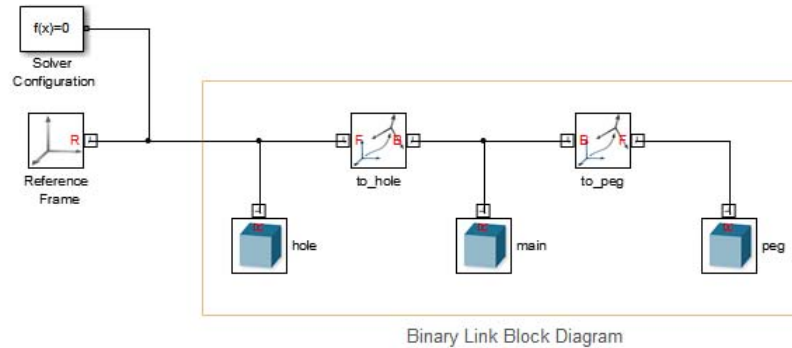
A complete rigid body subsystem contains the following:

- Frames — Construct with position and orientation in space.
- Physical properties — Geometry, inertia, and graphic parameters of a solid.

### **Add Frames**

To add frames to a rigid body subsystem, you use the Rigid Transform block. The block rotates and/or translates a base frame to obtain a follower frame. A chain of Rigid Transform blocks represents a chain of frames. Connect the reference frame port of a Solid block to a frame port or line to give the frame a position and orientation in space. See “Representing Frames”.

The binary link subsystem contains three Solid blocks rigidly connected with two Rigid Transform blocks. Each Rigid Transform block translates a local reference frame, located at the center of the link, by an amount equal to half the link length along the length axis. The two end frames serve as joint connection frames.



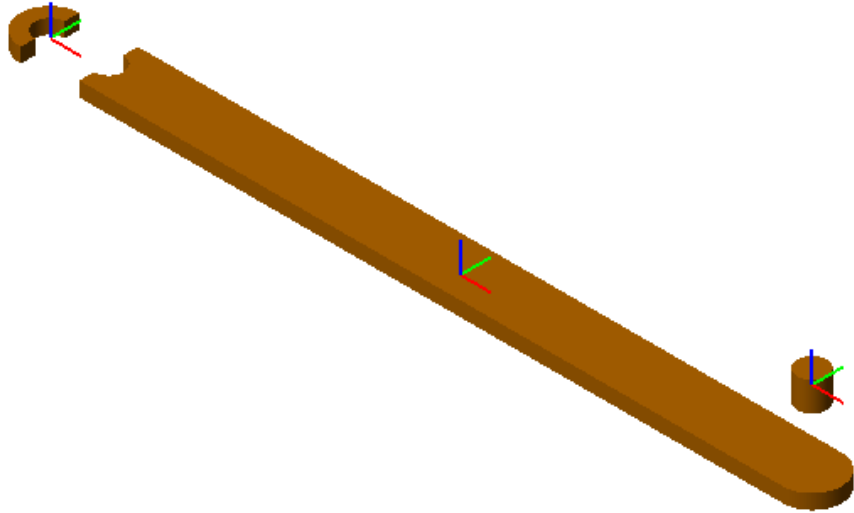
### Add Geometry, Inertia, and Graphic Properties

To add geometry, inertia, and graphic properties to a rigid body, you use the Solid block. In the dialog box of the block, you can specify the numerical values for each parameter set:

- Geometry — 3-D shape of the rigid body. Required for assembly, visualization and simulation.
- Inertia — Mass or density and inertia tensor. Required for simulation.
- Graphic — Color of the rigid body. Required for visualization.

In the binary link subsystem, three Solid blocks provide the physical properties of three elementary pieces:

- Peg — Cylinder shape
- Main body — General Extrusion shape
- Hole Section — general Extrusion shape



In the Inertia menu of the Solid dialog box, you can specify the density if the link material — e.g.  $2.70 \text{ g/cm}^3$  for Aluminum. SimMechanics provides the option to automatically calculate the moments and products of inertia from geometry. To provide a uniform density to the binary link, the three Solid block contain the same value in the **Density** field.

In the Graphic menu of the Solid dialog box, you can specify the color of the link material. In this example, the color is orange with RGB vector  $[0.8 \ 0.45 \ 0]$ . To provide a single color to the binary link, the three Solid blocks contain the same RGB vector in the **Color** parameter.

## Assemble Multibody Model

Once you have created the rigid body subsystems, you can assemble the subsystems into a mechanism or machine. In a mechanism or machine, joints and constraints provide well-defined degrees of freedom that constrain rigid body motion. Two types of motion are possible:



- Rotation about one or more axes
- Translation along one or more axes

## Connect Joints

To assemble rigid body subsystems into complete multibody systems, connect the with joints. SimMechanics provides a library with fourteen joint blocks. Each block provides a different number and/or type of mechanical degrees of freedom. Exactly two rigid body frames connect to each joint, with each frame belonging to a different rigid body.

Joints are composed of joint primitives — elementary joints that you can combine to create more complex joints. SimMechanics contains three joint primitives:

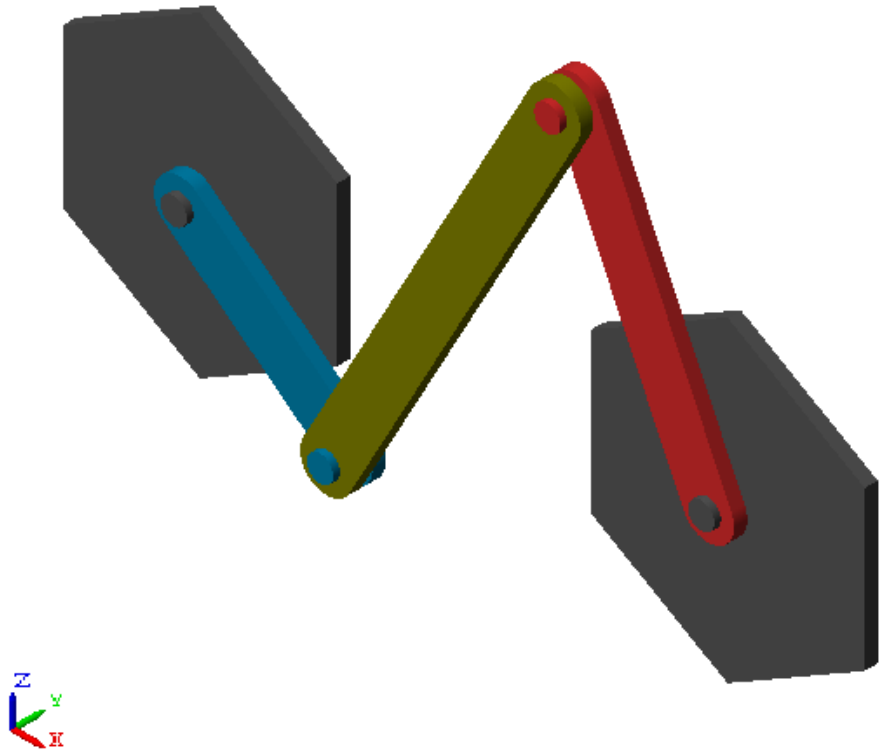
- Prismatic — one translational degree of freedom along an axis
- Revolute — one rotational degree of freedom about an axis
- Spherical — three concurrent degrees of freedom about three axes

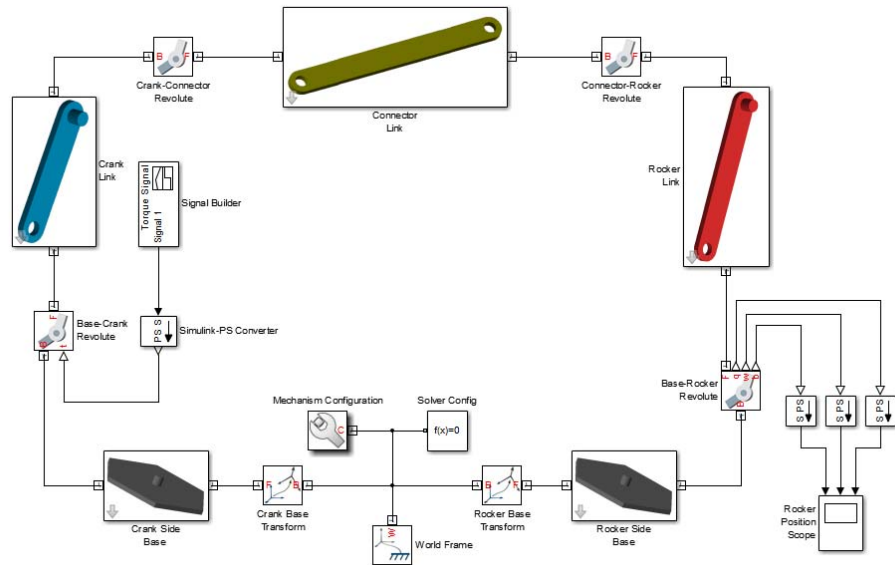
The following table identifies the joint primitives associated with each joint.

		Prismatic Primitives			
		0	1	2	3
<b>Revolute Primitives</b>	0	Weld Joint	Prismatic Joint	Rectangular Joint	Cartesian Joint
	1	Revolute Joint	Cylindrical Joint	Planar Joint	—
	2	Universal Joint	—	—	—
	3	Gimbal Joint	Bearing Joint	—	6-DOF Joint
<b>Spherical Primitives</b>	1	Spherical Joint	Telescoping Joint	—	Bushing Joint

The four-bar system contains four rigid bodies connected with four revolute joints. The block diagram for this model contains four rigid body subsystems

connected with four Revolute Joint blocks. The following figures show the Mechanics Explorer display of a four-bar model and the associated block diagram.





## Specify Joint State Targets

To specify the initial configuration of a multibody assembly, use the **State Targets** menu of the joint dialog box. You can specify values for the initial joint position and velocity, and assign different priorities for the state targets. SimMechanics attempts to meet the state target. If the state targets make assembly impossible, SimMechanics tries to use an approximate value that allows assembly.

## Add Forces, Torques, and Motion Sensors

You can add force and torques to, or between, rigid body frames. The following table summarizes the force/torque types that you can add to a model. The **Procedure** column identifies the steps required to add each force/torque type to a model.

<b>Force/Torque Type</b>	<b>Description</b>	<b>Procedure</b>
Joint actuation	Force or torque between base and follower frames along or about joint primitive axis	<ol style="list-style-type: none"> <li><b>1</b> In the <b>Actuation</b> menu of the joint dialog box, select the desired actuation mode.</li> <li><b>2</b> Connect a physical signal line to each exposed physical signal port.</li> </ol>
Joint internal mechanics	Spring and damper force or torque between base and follower frames along or about joint primitive axis	<ol style="list-style-type: none"> <li><b>1</b> In the <b>Internal Mechanics</b> menu of joint dialog box, enter the spring and damper parameters for the joint.</li> </ol>
Rigid body actuation	Force or torque acting on a rigid body frame not connected to a joint	<ol style="list-style-type: none"> <li><b>1</b> Connect an External Force and Torque block to the rigid body frame you wish to actuate.</li> <li><b>2</b> In the dialog box of the block, select the force and torque components you wish to specify and the frame in which you wish to resolve the components.</li> <li><b>3</b> Connect a physical signal line to each</li> </ol>

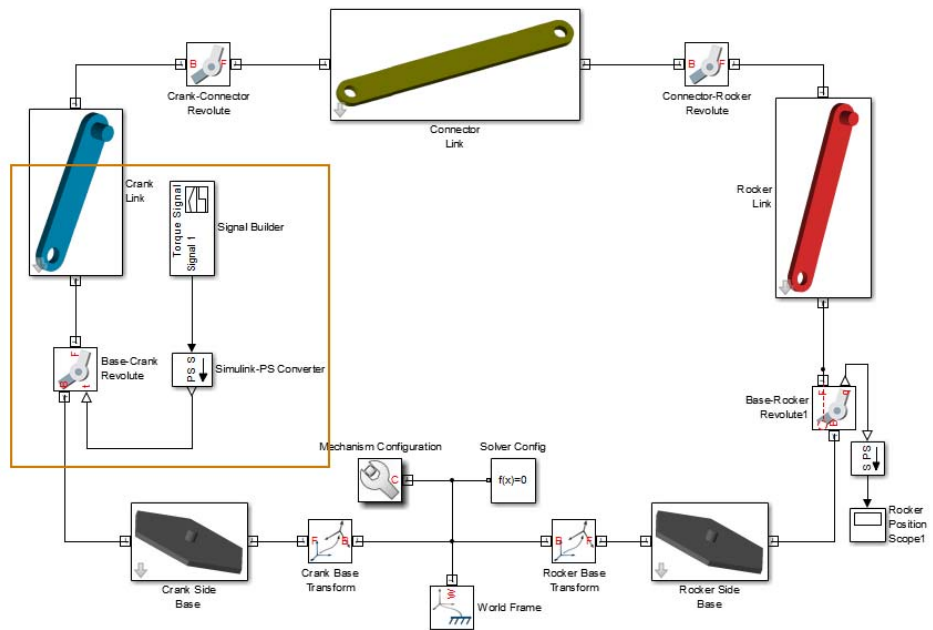
Force/Torque Type	Description	Procedure
		exposed physical signal port.
Rigid Body Internal Forces	Force acting between two rigid body frames, one frame per rigid body	<ol style="list-style-type: none"> <li>1 Connect the Inverse Square Law Force or Spring and Damper Force block between the two rigid body frames.</li> <li>2 In the dialog box of the block, enter the force constants.</li> </ol>

You can also add mechanical sensing between frames. Force sensing is limited Inverse Square Law Force or Spring and Damper Force blocks. The following table summarizes the types of motion and force sensing you can add to a model. The **Procedure** column identifies the steps required to add each sensing type to a model.

Sensing	Description	Procedure
Joint Motion	Sensing of position, velocity, and acceleration parameters of joint follower frame with respect to base frame	<ol style="list-style-type: none"> <li>1 In the <b>Sensing</b> menu of the joint dialog box, select the desired motion parameter.</li> <li>2 Connect a physical signal to each exposed physical signal port.</li> </ol>
Rigid Body Motion	Sensing of position, velocity, and acceleration parameters of one rigid body frame with	<ol style="list-style-type: none"> <li>1 Connect the Transform Sensor block to two rigid body frames.</li> </ol>

Sensing	Description	Procedure
	respect to any other frame in a model	<p><b>2</b> In the dialog box of the Transform Sensor block, select the motion parameters you wish to sense.</p> <p><b>3</b> Connect a physical signal to each exposed physical signal port.</p>
Force Input	Sensing of force magnitude in Inverse Square Law Force and Spring and Damper Force blocks	<p><b>1</b> In the dialog box of the force block, select <b>Sense Force</b>.</p> <p><b>2</b> Connect physical signal to the exposed <b>fm</b> physical signal port.</p>

The following figure shows an application of joint actuation inputs. The Base-Crank joint of a four-bar model receives a torque input indirectly from the Simulink block Signal Builder. The Simulink-PS Converter block converts the Simulink signal into a physical signal compatible with SimMechanics blocks.

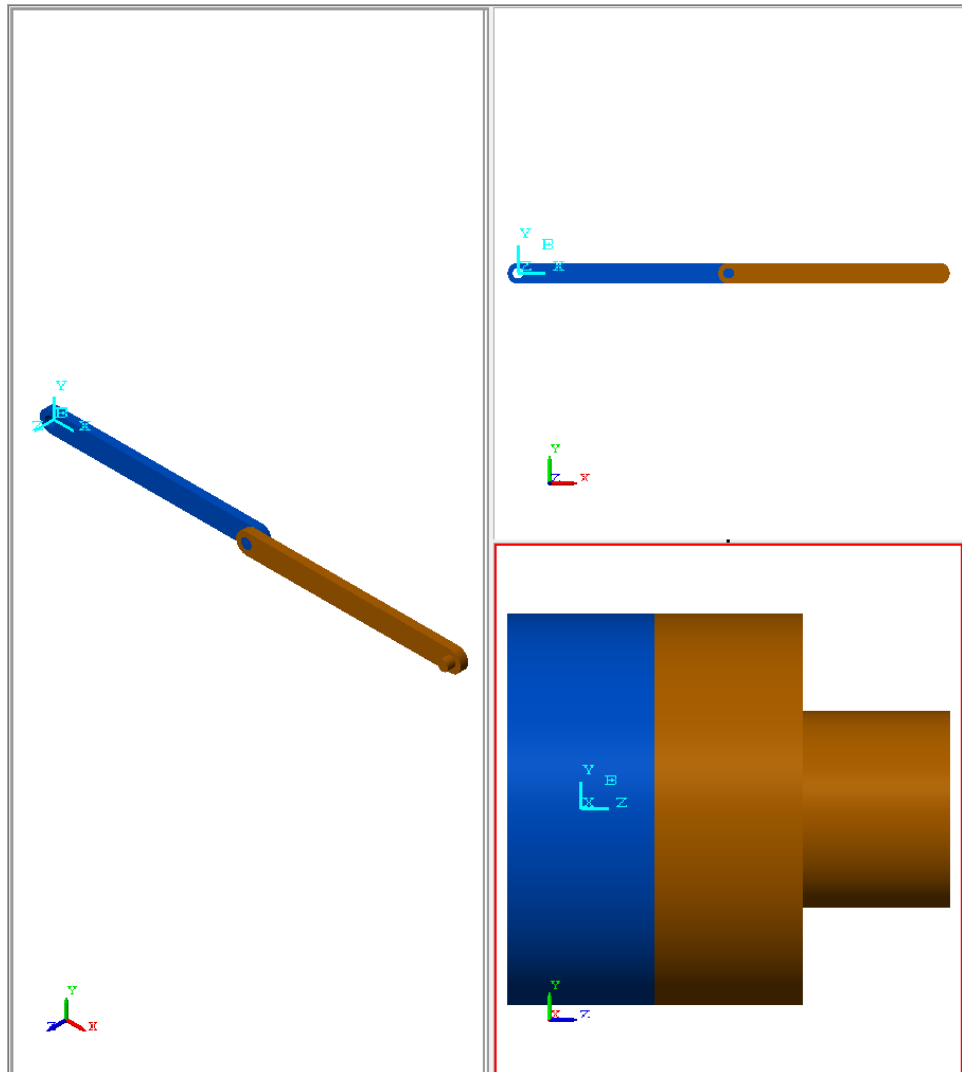


## Simulate and Analyze model

Run the simulation to examine the dynamic behavior of the model. Simulink provides a set of model simulation options that you can adjust for your application. Before running simulation:

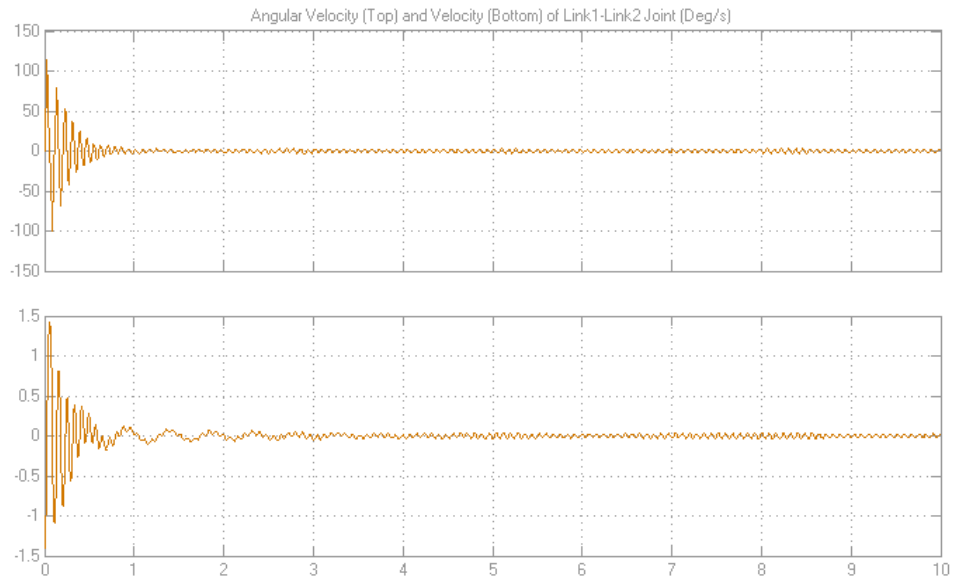
- Check the choice of solver. SimMechanics models require a continuous solver. Variable-step solvers provide the best performance. Use `ode45` (Dormand-Prince) as a first try for most models.
- Check the solver step sizes and tolerances. Smaller values for both parameters produce more accurate results at the cost of increased simulation time.
- Check the simulation time span. To let a simulation run indefinitely, specify `inf` in the **Stop time** field.

The Mechanics Explorer utility provides 3-D visualization for SimMechanics models. By default, the utility opens the first time you update a model, and refreshes for all subsequent model updates. The following figure shows the Mechanics Explorer display of a double-pendulum model.





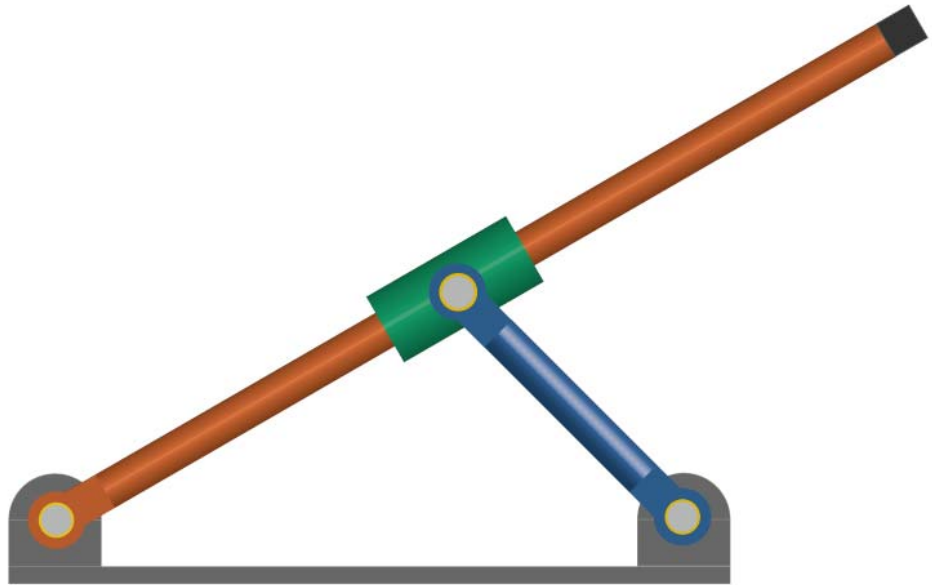
During simulation, you can open any scope blocks in the model to examine the dynamic behavior of the model. The following figure shows the angular position and velocity of the bottom frame of a damped double-pendulum model as functions of time.



## Model Aiming Mechanism

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This example provides an overview of the modeling process for a double-crank aiming mechanism. The basis of this example is the `sm_dcrankaim_assembly_with_error` model present in your SimMechanics installation. The model contains an intentional assembly error, which you troubleshoot using the Model Report tool of Mechanics Explorer.

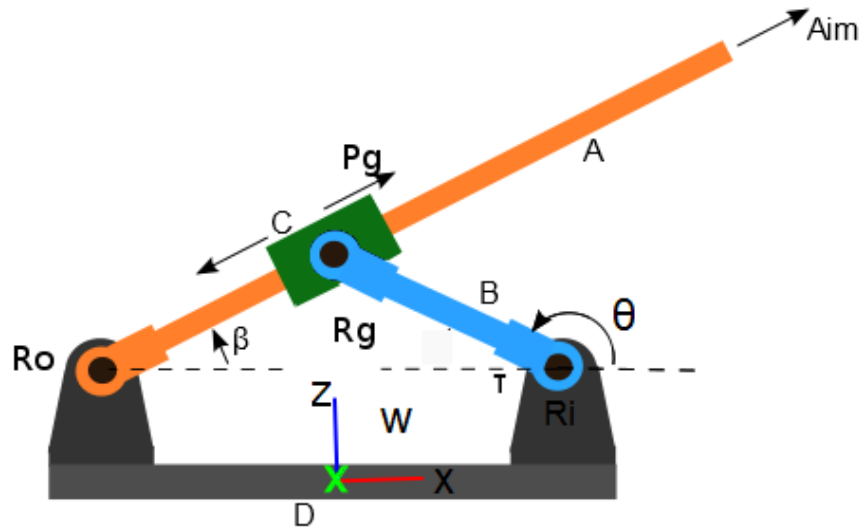


## Open Model

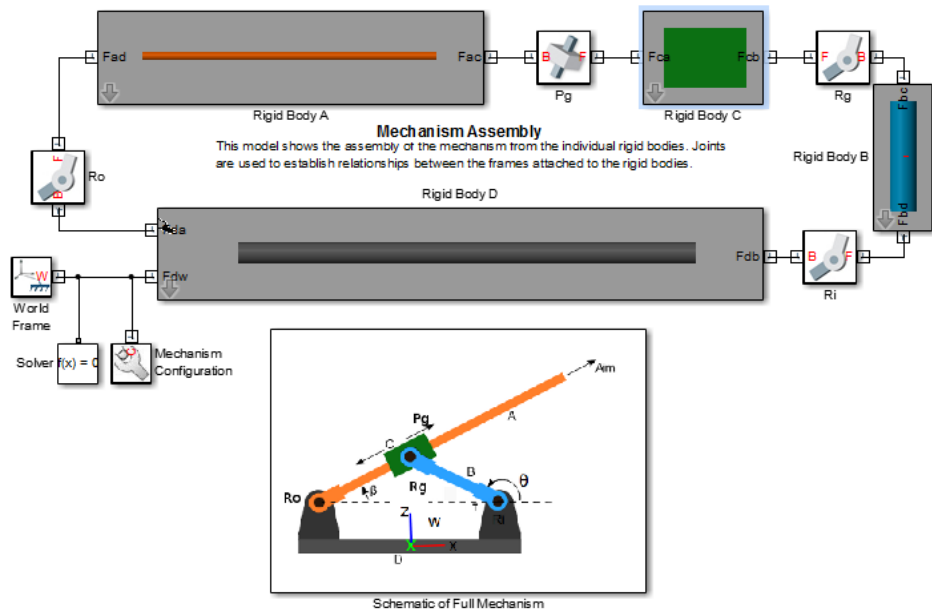
To open the model, at the MATLAB command line, enter `sm_dcrankaim_assembly_with_error`. The model opens in a new window.

## Explore Model

The figure shows a schematic of the system that the model represents. This system contains four rigid bodies, labeled A-D. These rigid bodies connect in a closed loop via four joints, labeled Ri, Ro, Rg, and Pg. When connected to each other, these components form a system with one degree of freedom.

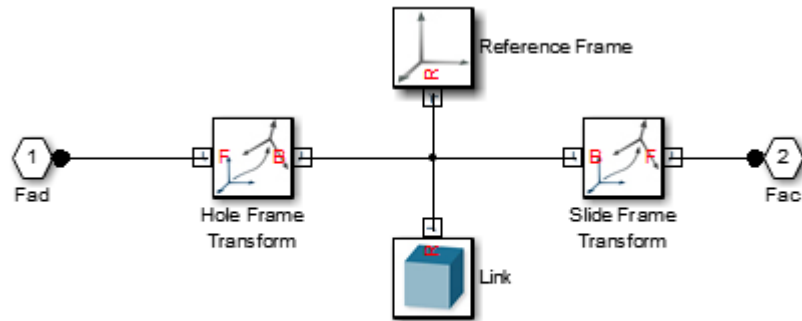


The model represents the components of this system using blocks. Each block represents a physical component. A World Frame block provides the ultimate reference frame in the model. The figure shows the block diagram that the model uses to represent the double-crank aiming mechanism.



To represent the rigid bodies, the model contains four subsystem blocks, labeled Rigid Body A-D. Each subsystem contains one Solid block and multiple Rigid Transform blocks. The Solid block provides geometry, inertia, and color to the rigid body subsystem. The Rigid Transform blocks provide the frames that you connect the joints to. A Reference Frame block identifies the ultimate reference frame in the subsystem block.

The model labels the rigid body subsystem blocks Rigid Body A-D. To examine the block diagram for a rigid body subsystem, right-click the subsystem block and select **Mask > Look Under Mask**. The figure shows the block diagram for Rigid Body A.



Components that make up rigid body A

To represent the joints, the model contains four joint blocks. Three joints provide one rotational degree of freedom between a pair of rigid bodies. You represent each of these joints with a Revolute Joint block. A fourth joint provides one translational degree of freedom between a pair of rigid bodies. You represent this joint with a Prismatic Joint block. The model labels the revolute joint blocks Ro, Rg, and Ri, and the prismatic joint block Pg.

## Update Model

As the model name suggests, this model contains an error. The error prevents the model from assembling successfully, which causes simulation to fail. To update the model and investigate the assembly error:

- On the Simulink menu bar, select **Simulation > Update Diagram**.

Mechanics Explorer opens with a static display of your model in its initial state. Because the model contains an assembly error, SimMechanics issues an error message. Ignore that message for now.

## Troubleshoot Assembly Error

The Mechanics Explorer utility contains a Model Report tool which identifies the status of joints and constraints. Use the Model Report utility to determine if joints and constraints have successfully assembled. The report also provides information on the configuration of joints and constraints. To see the report:

- On the Mechanics Explorer menu bar, select **Tools > Model Report**.

The model report opens in a new window. The top section of this window identifies the assembly status of the model as a whole. Because assembly failed, the assembly status for this model is “Unassembled”. Because the source of the assembly error is a joint block, the assembly status for joints is “Unable to assembly all joints”.

The screenshot shows a window titled "Model Report - sm\_dcrankaim\_assembly\_with\_error". At the top, it indicates the assembly status is "Unassembled" (red square) and "Unable to assemble all Joints" (red square). Below this, there are tabs for "Joints", "Constraints", and "Statistics". The "Joints" tab is active, displaying a table with columns for Joint, Assembled, Primitive, Position (Actual, Specified, Unit, Priority), and Velocity (Actual, Specified, Units, Priority, Status).

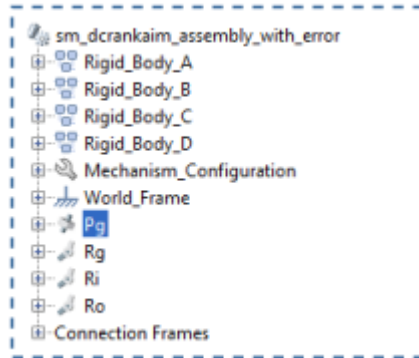
Joint	Assembled	Primitive	Position				Velocity						
			Actual	Specified	Unit	Priority	Status	Actual	Specified	Units	Priority	Status	
Pg	■	Pz	N/A		m				N/A		m/s		
Rg	●	Rz	-0.00442103		deg				+0		deg/s		
Ri	●	Rz	+0.00773987		deg				+0		deg/s		
Ro	●	Rz	+0.00331709		deg				+0		deg/s		

To identify the joint block that caused assembly fail, examine the model report **Joints** tab. A red square identifies the problematic joint—Pg. This joint did not assemble, and the model report provides neither position nor velocity information for that joint.

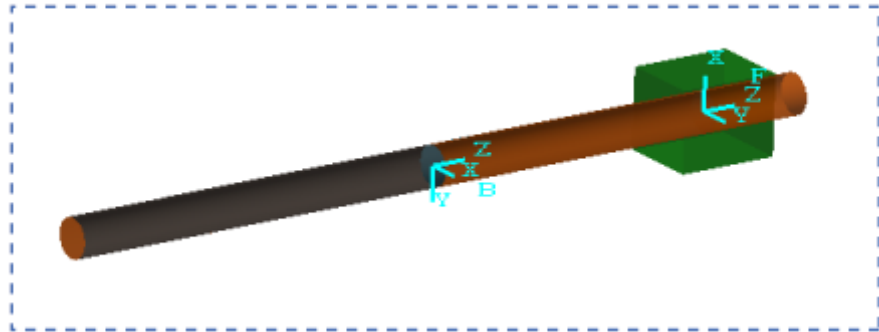
## Identifying Error Root Cause

The error message that SimMechanics issued during model update identifies position violation as the root cause of assembly failure. This suggests that the frames which joint Pg connects to are improperly aligned. To confirm this hypothesis, check the orientation of these frames in Mechanics Explorer.

- 1 In the Mechanics Explorer tree view pane, click joint Pg.



- 2 In the Mechanics Explorer visualization pane, examine the position and orientation of the highlighted frames. These are the frames that appear in turquoise blue.



The two frames are offset along the Z axis. Because joint Pg provides a translational degree of freedom along the Z axis, this offset is valid. However, the follower frame has a different orientation than the base frame. It contains a rotation angle of 90 degrees about the common Z axis with respect to the base frame. Because joint Pg provides no rotational degrees of freedom, this rotation angle is invalid. This angle prevents the two joint frames from aligning correctly, causing assembly to fail.



## Correcting Assembly Error

To correct the assembly error, you must change the orientation of either base or follower joint frames. In this example, you change the orientation of the follower frame so that the model can assemble successfully. To change the orientation of this frame:

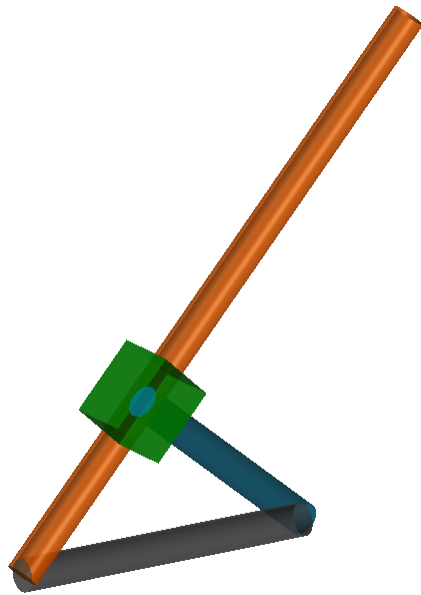
- 1 Right-click the Rigid Body C subsystem block and select **Mask > Look Under Mask**.
- 2 Double-click the **Slide Frame Transform** block and select the new parameter values that the table provides.

Parameter	New Value
Rotation > Pair 2 > Follower	+X
Rotation > Pair 2 > Base	+Y

- 3 Click **OK**.

## Simulate Model

You can now simulate the model. On the Simulink menu bar, select **Simulation > Run**. Mechanics Explorer opens with a dynamic display of your model. The figure shows this display. Rotate, pan, and zoom to explore.



You can use the Model Report tool to verify the assembly status. To do this, on the Mechanics Explorer menu bar, select **Tools > Model Report**. The model report opens in a new window. Check that the assembly status icon for the model and its joints is a green square. The green square indicates that assembly has been successful.

Model Report - sm\_dcrankaim\_assembly\_with\_error

Assembly status:

Joints:

Constraints:

Joints | Constraints | Statistics

Joint	Assembled	Primitive	Position					Velocity				
			Actual	Specified	Unit	Priority	Status	Actual	Specified	Units	Priority	Status
Pg	<input checked="" type="radio"/>	Pz	+0.3		m			+0		m/s		
Rg	<input checked="" type="radio"/>	Rz	+0		deg			+0		deg/s		
Ri	<input checked="" type="radio"/>	Rz	+0		deg			+0		deg/s		
Ro	<input checked="" type="radio"/>	Rz	+0		deg			+0		deg/s		

OK

## See Also

For more information, see:

- “Identifying Assembly Issues”
- “Model Double Pendulum”
- “Model Four-Bar Linkage”

## Modeling with SimMechanics First and Second Generations

SimMechanics software contains two technologies: First Generation and Second Generation. First-generation technology includes the block library and visualization utility found in SimMechanics releases prior to R2012a. Second-generation technology introduces a simpler modeling paradigm with a new block library, a powerful computational engine, an advanced visualization utility based on OpenGL computer graphics, and tighter integration with Simscape products.

SimMechanics first- and second-generation technologies have different sets of capabilities. Which technology to use depends on the effects you need to model. Use first-generation technology for models requiring variable gravity, certain complex constraints, motion actuation, or to measure reaction or constraint forces. In nearly all other cases, use second-generation technology.

The table provides a detailed comparison between first- and second-generation technologies.

<b>Feature</b>	<b>SimMechanics First Generation</b>	<b>SimMechanics Second-Generation</b>
Mass/Inertia Calculation	Manual only	Automatic or manual
Solid Geometry	No	Yes
Animation Replay	No	Yes
3-D Model Exploration	Limited	Yes
Initial State Targets	Limited	Yes
Simscape Logging	No	Yes
Code Generation	Yes	Yes
CAD Import	Yes	Yes <sup>2</sup>
Motion Actuation	Yes	No
Force Sensing	Yes	No
Complex Constraints <sup>1</sup>	Yes	Gears only
Variable Mass/Gravity	Yes	No

<sup>1</sup>Point-curve, Gear, Velocity, and Screw constraints

<sup>2</sup>CAD update supported only in first-generation

SimMechanics continues to support first-generation technology. You can maintain and simulate legacy models built with first-generation blocks. You can also create a new first-generation model using the SimMechanics First Generation block library. For more on modeling with first-generation technology, see “What You Can Do with SimMechanics Software”