

# Simscape™ Multibody™ Release Notes



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### *Simscape™ Multibody™ Release Notes*

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# R2017a

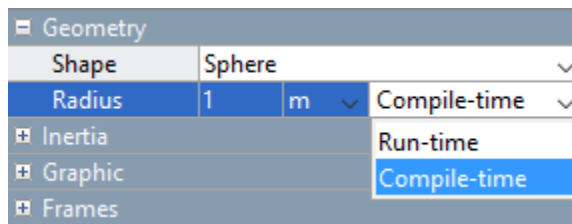
**Version: 5.0**

**New Features**

**Bug Fixes**

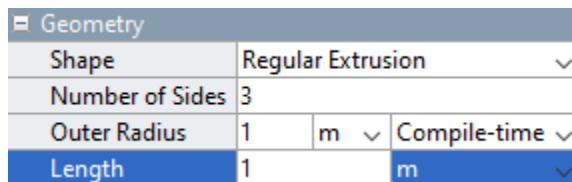
## Run-Time Parameters: Speed up simulation tasks and modify component parameter values without regenerating C code

Simscape™ Multibody™ software now supports run-time parameters. You can configure most numerical block parameters as **Compile-time** (default) or **Run-time** using a drop-down list that appears beside configurable parameters. The figure shows the run-time drop-down list in a Solid block dialog box. All parameters are by default **Compile-time**.



**Compile-time** parameters update in value only when you recompile the model. Use them when performing tasks that rely on inlined parameters such as model optimization. **Run-time** parameters update in value without the need for extra compilations. Use them when tuning parameter values in Fast Restart mode or when simulating models that rely at least in part on generated C code.

To set a parameter as **Run-time** from the block dialog box, you must configure your Simscape preferences. Open the MATLAB® Preferences window, select the **Simscape** node, and check the **Show run-time parameter settings** check box. Parameters without a run-time option or with a run-time option that is inactive (i.e., “grayed out”) cannot be configured. The **Length** parameter in the figure is an example.



For more information about Simscape run-time parameters, see “About Simscape Run-Time Parameters” (Simscape).

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## Onshape CAD Import: Convert an Onshape CAD assembly into a Simscape Multibody model

A new function named `smexportonshape` enables you to export an Onshape<sup>®</sup> CAD assembly model in a format suitable for import into the Simscape Multibody environment.

The `smexportonshape` function generates a multibody description file compliant with the XML schema and a set of STEP geometry files with the geometries of the various bodies. You import the files using the `smimport` function, passing the name of the XML file as a function argument.

For an example showing how to use the new function to export an Onshape model of a humanoid robot, see “Import an Onshape Humanoid Model”.



## URDF Import: Convert a URDF model into a Simscape Multibody model

Import a URDF multibody model into the Simscape Multibody environment using an updated version of the `smimport` function. The function distinguishes between XML and URDF multibody description files via the optional file extension. In the absence of a file extension, the function assumes that the multibody description file conforms to the Simscape Multibody XML schema.

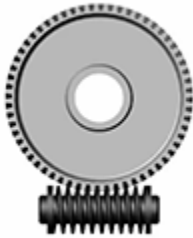
Try importing a URDF model of a humanoid robot as an example. The URDF file and the supporting part geometry files are included in your Simscape Multibody installation. At the MATLAB command prompt, enter the command:

```
smimport('sm_humanoid.urdf');
```

Simscape Multibody software recreates the URDF model as a block diagram that you simulate and build on. To see an example of the imported model with simple motion inputs, at the MATLAB command prompt, enter `sm_import_humanoid_urdf`.

## **Worm and Gear Constraint Block: Model the kinematics of a worm in mesh with a gear**

Model the kinematic constraint between a worm and a gear using the new Worm and Gear Constraint block. The constraint couples the worm and gear so that they rotate at a fixed speed about offset perpendicular axes. The new block imposes assembly requirements that you must satisfy in order to simulate the model. See “Worm and Gear” for a simple assembly example.



### **Worm and Gear Assembly**

## **General Variable Mass Block: Model a point or distributed mass with time-varying inertial properties**

Model the effects of a shifting center of mass and of a time-varying mass and inertia tensor using the new General Variable Mass block. You can specify all three variables as functions of time using physical signal ports. The ports are exposed when the corresponding block parameters—**Mass**, **Center of Mass**, and **Inertia Tensor**—are set to **Time-Varying** in the block dialog box.

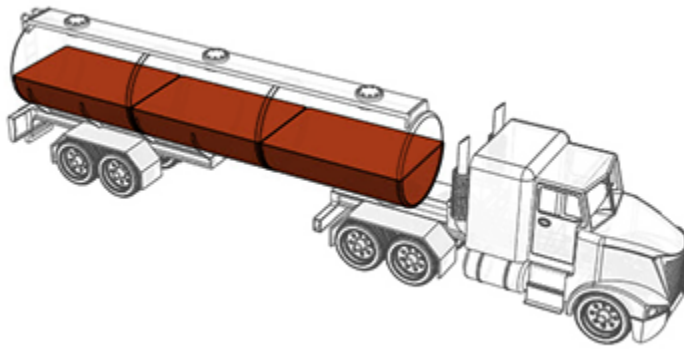
The variable mass can be a point mass or a distributed mass. The **Inertia Tensor** parameter is active only for a distributed mass. To model a distributed mass, set the



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**Inertia > Type** parameter to **Custom**. Inertia ellipsoids provide a means to visualize the time-varying inertial properties.

Use the block in models where the variable mass contents of a system matter, as in a tank truck carrying a sloshing load of fluid.



### **Tank Truck with Variable Fluid Load**

## **New Featured Examples**

The examples library includes two new featured examples. The Independent Suspension System Templates example shows how to model various types of automotive suspensions using Simscape Multibody blocks, including MacPherson, double wishbone, and pushrod types. The Using the Worm and Gear Constraint Block — Solar Tracker example shows how to model a real application using the new Worm and Gear Constraint block.



# R2016b

**Version: 4.9**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## **Tracking Mode for Dynamic Cameras: Track objects during animation playback**

A new **Tracking** mode enables you to define dynamic cameras that follow specific components during simulation. You can fix the position of a dynamic camera to any frame origin in a model. You can aim the camera at any other frame origin in a model or align it with a specific frame axis.

To create or modify a dynamic camera, use the Camera Manager tool in Mechanics Explorer. You can create multiple dynamic cameras in keyframe and tracking modes and select them using the context-sensitive (right-click) menu in the Mechanics Explorer visualization pane.

The **Configuring Dynamic Cameras - Vehicle Slalom** featured example showcases three dynamic cameras defined in **Tracking** mode and compares them with a fourth dynamic camera defined in **Keyframes** mode.

For an overview of global and dynamic cameras, see **Visualization Cameras**. To create a dynamic camera and define its motion in **Keyframes** or **Tracking** mode, see **Create a Dynamic Camera**.

## **smwritevideo Function: Generate videos from the MATLAB command line**

Programmatically configure and create videos of your simulation results from the MATLAB command line using a new function named `smwritevideo`. Use the optional **Name**, **Value** pair arguments to manipulate the video playback speed, frame rate, frame size, and file format.

The function supports several common file formats, including uncompressed AVI and MPEG-4 (MP4). Change the video playback speed to better capture the model dynamics for very fast systems, such as rapidly oscillating beams, or very slow systems, such as the solar system.

## **Video Creator Tool in Mechanics Explorer: Configure video properties such as encoding type, playback speed, frame rate, and frame size**

Interactively configure and create videos of your simulation results using the new Video Creator tool in Mechanics Explorer. Modify the Video Creator parameters to obtain the

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desired video properties, including the video encoding type, playback speed, frame rate, and frame size. Video Creator is the UI equivalent of the new `smwritevideo` function.

## **Animation Resampling for Video Creation: Produce constant-speed videos using any solver settings**

Video playback speed is now independent of Simulink® solver type, step size, and data output options. Create videos with the desired playback speed and frame rate without having to adjust your model configuration parameters. Previously, the video frame rate was fixed at 30 frames per second and the playback speed was constrained to your solver and data export options.

## **Roll Tool in Mechanics Explorer: Rotate the animation view about the line of sight**

Rotate the visualization viewpoint in the plane of your screen about the camera's line of sight. The new tool appears alongside the Rotate, Pan, and Zoom tools in the visualization toolstrips of the Solid block dialog box and Mechanics Explorer. The Roll tool differs from the Rotate tool in that its rotations are strictly 2D.

## **Physical Unit Update: Hertz definition changed from rev/s to 1/s**

The definition of hertz (Hz) has changed from  $\text{Hz} = \text{rev/s}$  to match the standard SI convention  $\text{Hz} = 1/\text{s}$ . The updated definition is the same adopted in the Simscape Foundation library from R2013a onward. This change affects the kilo, mega, and giga SI multiples of hertz (kHz, MHz, GHz).

To discourage the use of hertz, this unit has been replaced with `rev/s` in the block units dropdown lists. You can still manually enter Hz, kHz, MHz, and GHz in the block units fields, but from R2016b onward these map into `1/s`, `1/ms`, `1/μs`, and `1/ns`.

For consistency with the old definition, in older models, Simscape Multibody software automatically replaces Hz, kHz, MHz, and GHz with `rev/s`, `rev/ms`, `rev/μs`, and `rev/ns`. The table shows the old and new mappings between Hz and `rev/s` multiples.

<b>Unit</b>	<b>Old Definition</b>	<b>New Definition</b>
Hz	rev/s	1/s
kHz	rev/ms	1/ms

Unit	Old Definition	New Definition
MHz	rev/ $\mu$ s	1/ $\mu$ s
GHz	rev/ns	1/ns

## New Featured Examples

The examples library includes two new featured examples. The Configuring Dynamic Cameras - Vehicle Slalom example showcases the tracking mode of dynamic cameras. The Hydraulic Interface - Dump Trailer with Hydraulic Cylinder example showcases a cross-domain interface between multibody and hydraulic networks.

# R2016a

**Version: 4.8**

**New Features**

**Bug Fixes**

## SimMechanics renamed to Simscape Multibody

SimMechanics™ software is now named Simscape Multibody. The product library is located in the **Simscape** node of the Simulink library browser under the name **Multibody**. You can open the product library at the MATLAB command prompt using the `sm_lib` command.

The product library structure has been flattened. Sublibraries previously under **SimMechanics Second Generation** now appear directly under **Multibody**. The complete SimMechanics First Generation library is now a **Multibody** sublibrary named **First Generation (1G)**.

## Dynamic camera in Mechanics Explorer: Specify camera location and orientation during simulation using keyframes

Mechanics Explorer adds dynamic cameras with gradually shifting viewpoints during playback. A Camera manager enables you to create cameras and specify camera pose through keyframes—each a viewpoint attached to a playback time. During playback, Mechanics Explorer interpolates between the various keyframes to obtain smooth camera trajectories.

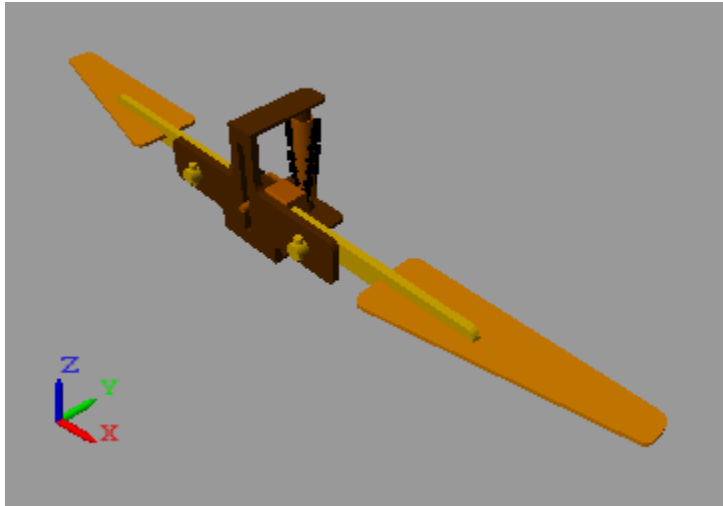
You can create multiple cameras in a model, each with its own set of keyframes. During playback, you can switch between previously created cameras by using the visualization pane context-sensitive (right-click) menu. If you split the visualization pane into tiles, you can assign different cameras to different tiles. For more information, see:

- Global and Dynamic Cameras
- Create a Dynamic Visualization Camera

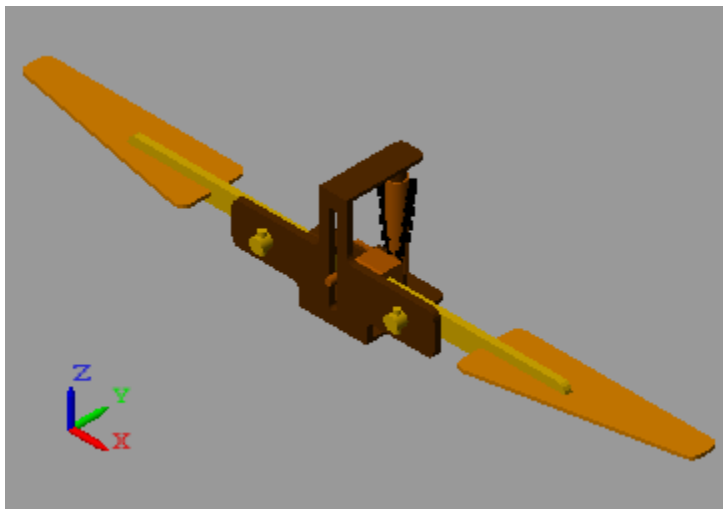
## Perspective view in Mechanics Explorer: Enhance three-dimensional quality of animated simulation results

Dynamic cameras capture your model animation using a perspective view. This view enhances the perception of depth by making bodies appear smaller with increasing distance from the dynamic camera. The perspective view is active only in dynamic cameras. The global camera continues to use an orthographic view. The figures compare the perspective and orthographic views of dynamic and global cameras.





**Perspective View of Dynamic Cameras**



**Orthographic View of Global Camera**

## **Parameterized models from CAD import: Create parameterized model with option to update parameter values only**

Imported models are now parameterized in terms of MATLAB variables defined in a separate data file. The `smimport` function generates the new data file for each model imported and links the two through the model workspace. The data file contains the numerical values of all block parameters, including those parameters left in their default settings.

The `smimport` function provides a new import mode for regenerating data files associated with previously imported models. The new mode provides a limited form of CAD update that updates block parameters but not the block diagram. You specify the new mode by setting the optional `ImportMode Name,Value` pair argument to `dataFile`.

For more information, see:

- CAD Translation
- Model Data File
- Data File Update

## **CAD joint definitions in Simscape Multibody XML schema: Express CAD joints directly in XML files**

The `smimport` function now supports CAD joint definitions in XML import files. To this end, the Simscape Multibody XML schema provides a new `Joints` parameter section. The Simscape Multibody Link CAD plug-in does not support the new joint definitions, but you can create XML import files from the XML schema directly.

# R2015b

**Version: 4.7**

**New Features**

**Bug Fixes**

## Point On Curve Constraint block

Constrain the position of a frame to a specified curve, for example, to model a roller coaster or cam mechanism. You specify a curve using the new Spline block, which you connect to geometry port B. The Point On Curve Constraint block appears in the Constraints library.

The block constrains the attached frame by applying the force needed to keep it on the specified curve. You can sense the constraint force as a three-dimensional vector that the block outputs as a physical signal.

For a tutorial showing how to use the Spline and Point On Curve Constraint blocks, see Model Cam Mechanism.

## Spline block for specifying curved paths

Specify a 2-D or 3-D curve along which to constrain the position of a frame. Connect the Spline block to geometry port B of a Point On Curve Constraint block in order to constrain a frame to the specified curve. The Spline block appears in the new Curves and Surfaces library.

Spline curves can be open or closed and are based on cubic interpolation between the curve points you specify. You can visualize the spline curve in the Spline block UI, for example, to ensure the curve shape is correct. You can also visualize the spline curve in Mechanics Explorer on model update and during simulation.

For a tutorial showing how to use the Spline and Point On Curve Constraint blocks, see Model Cam Mechanism.

## Frame creation via Solid block UI

Interactively add frames to a solid using the frame creation interface in the Solid block dialog box. Use the Frames menu to add or edit any number of frames. You can define the frame origin and orientation based on the solid reference frame axes, the solid center of mass and principal axes, or geometric features such as points, lines, and surfaces.

You can use a geometric feature by selecting the **Based on Geometric Feature** radio button, selecting the desired geometric feature in the visualization pane, and then clicking the **Use Selected Feature** button. To keep your new frame, save the frame definition and select **OK** or **Apply**.

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For a tutorial showing how to use the frame creation interface, see Interactively Create Solid Frames.

## **Mechanics Explorer link to block diagram**

Go to the block corresponding to a node on the tree view pane in Mechanics Explorer. You can select a solid in the visualization pane, right-click the highlighted node in the tree view pane, and then select **Go to Block**. You can also select other node types directly from the tree view pane, such as those corresponding to subsystems, joints and constraints, forces and torques, and other blocks. For more information, see Go to Block from Mechanics Explorer.

## **Rotation Sequence option in Rigid Transform block**

Specify a 3-D rotation as a sequence of three elementary rotations. Such rotation sequences are commonly known as Euler and Tait-Bryan sequences. The rotation sequence parameterization is available in the Rigid Transform block. It is also available in joint blocks with spherical joint primitives, including Spherical Joint, 6-DOF Joint and Telescoping Joint.

## **Featured example**

A new featured example showcases the Point-on-Curve Constraint and Spline blocks:

- `sm_cam_flapping_wing`



# R2015a

**Version: 4.6**

**New Features**

**Bug Fixes**

## Visibility setting to show or hide solids, bodies, and multibody subsystems in Mechanics Explorer

Switch the visibility of a solid, body, or multibody subsystem on or off in Mechanics Explorer. A new context-sensitive menu in the tree-view pane enables you to:

- Show the selected component
- Hide the selected component
- Show only the selected component
- Show all the components in the model

To switch the visibility setting, in the tree-view pane of Mechanics Explorer, right-click the name of a solid, body, or multibody subsystem. Then, select the desired option from the context-sensitive menu. For more information, see [Filtering Model Visualization](#).

## Lead Screw Joint block

The Joints library adds a Lead Screw Joint block. Use this block to convert rotational motion to translational motion and, conversely, translational motion to rotational motion. Lead screw applications include the linear actuators typically used in aircraft flap systems, CNC machines, and 3-D printers. The block is based on a new joint primitive named Lead Screw Primitive (LS).

## Constant Velocity Joint block

The joints library adds a Constant Velocity Joint block. Use this block to model a joint with two rotational degrees of freedom—the bend and azimuth angles—and a kinematic constraint that ensures the base and follower port frames spin at constant velocity relative to each other regardless of their relative angle.

Constant velocity joint applications include automotive driveline systems with power transmission occurring between shafts connected at an angle. The block is based on a new joint primitive named Constant Velocity Primitive (CV).



# R2014b

**Version: 4.5**

**New Features**

**Bug Fixes**

## Constraint force and torque sensing in Constraint blocks

Compute and output the forces and torques that enable a Constraint block to enforce its kinematic constraint. The blocks output one or more physical signals with the variables that you select. These variables can include the constraint force and torque vectors and their signed magnitudes. The blocks resolve the vector quantities in the resolution frame that you specify.

The new blocks with constraint force and torque sensing are Angle Constraint and Distance Constraint. These blocks expand the list of blocks with constraint force and torque sensing. You can also sense constraint forces and torques through Joint blocks.

## Solid 3-D visualization in Solid block dialog box

Visualize the solid you are modeling directly in the Solid block dialog box. The updated block includes a collapsible visualization pane that shows the current state of your 3-D solid. You can use this pane to check the geometry and color of individual solids before updating or simulating the model.

The visualization pane includes a toolbar for controlling the solid view. The toolbar, which provides many of the Mechanics Explorer toolbar buttons, enables you to rotate, pan, and zoom a solid, to select a standard view point, and to visualize the solid reference frame.

## Rotation matrix parameterization in Rigid Transform and Joint blocks

Specify a frame rotation using a 3-D rotation matrix. The new parameterization is available in two block types, Rigid Transform and joint blocks with spherical joint primitives. Use this parameterization in the Rigid Transform block to specify a fixed rotation or in a joint block to specify the position state target of a spherical joint primitive. The joint blocks with the new parameterization are:

- 6-DOF Joint
- Spherical Joint
- Telescoping Joint

## Featured example

A new featured example showcases the constraint force and torque sensing capability of Joint blocks:

- 
- Sensing Composite Forces and Torques in Joints — Potter's Wheel



# R2014a

**Version: 4.4**

**New Features**

**Bug Fixes**

## STEP file import

Load solid geometry directly from a STEP file. This file type enables SimMechanics to automatically compute inertia from solid geometry, an advantage over STL files. You can generate the STEP file that you want to load externally, e.g., using a CAD platform.

## Total and constraint force and torque calculation in joint blocks

Sense the total and constraint forces and torques acting at whole joints. Joint block dialog boxes provide a new expandable parameter list, **Composite Force/Torque Sensing**, in which you can select the whole-joint variables to sense. Select a variable to calculate its time-dependent values during simulation and deliver them through a physical signal output port. Variables that you can sense include:

- Total Force/Torque — Net sum of forces and torques acting at the joint. These variables include contributions from actuation, internal mechanics, and constraint forces and torques.
- Constraint Force/Torque — Forces and torques acting orthogonally to the joint degrees of freedom. In a Revolute Joint block, which provides a single rotational degree of freedom about the Z axis, the constraint forces act along all the Cartesian axes (X, Y, and Z), while the constraint torques act about the X and Y axes.

## Time-varying gravity option in Mechanism Configuration block

Specify the gravitational acceleration vector as a function of time, using the Mechanism Configuration block. To support this task, the **Uniform Gravity** parameter in the block dialog box now provides a **Time-Varying** option. Select that option to expose a physical signal port to which you can connect a time-varying gravity physical signal. The gravitational acceleration vector is strictly uniform in space. It does not vary with position.

## Gravitational Field block

Model the gravitational pull of a point mass on every rigid body in a mechanism. The Gravitational Field block exerts a force that varies with mass and distance according to Newton's law of universal gravitation. Applications include large-scale orbital systems in which gravity changes due to varying distances play an important role—e.g., a solar system model for spacecraft trajectory planning. The block is in the Forces and Torques library.

---

## Animation at arbitrary speed in Mechanics Explorer

Change the base playback speed of a SimMechanics animation by an arbitrary factor. This speed corresponds to the 1x animation slider setting in Mechanics Explorer. It equals the number of seconds in simulation time that play in one second of animation playback time.

You can specify the base playback speed as a numerical input in Mechanics Explorer. This parameter appears in **Tools > Animation Settings**. Change its value to better visualize motion at extreme time scales.

The new parameter is relevant, for example, in a solar system model. At the default value of the base playback speed, planet motion is exceedingly slow. Due to the time scale of such a model, moving the playback speed slider to its maximum value of 256× does not suffice. Planet motion remains nearly imperceptible.

To visualize one Earth revolution in minutes or seconds, you must increase the playback speed by a very large factor. This factor might be seven orders of magnitude larger than the default value—larger than the playback speed slider allows. You specify such a large playback speed using the new base playback speed parameter.

Consider a model of the solar system. You can play animation at a rate of one Earth revolution per second. To play animation at this rate, you specify a base playback speed of

$$365 \frac{\text{days}}{\text{second}} \cdot 24 \frac{\text{hours}}{\text{day}} \cdot 60 \frac{\text{minutes}}{\text{hour}} \cdot 60 \frac{\text{seconds}}{\text{minute}} = 3.15e7.$$

You can then use the playback speed slider to fine-tune the playback speed. The slider multiplies the base playback speed by factors of two between a minimum of 1/256 and a maximum of 256.





# R2013b

**Version: 4.3**

**New Features**

**Bug Fixes**

## **Joint blocks that now permit prescribed motion defined as an input signal**

Joint blocks now accept motion variables—position, velocity, acceleration—as actuation inputs. Use these inputs to specify the time-dependent path of a joint directly.

## **Actuation force and actuation torque calculation for prescribed motion**

Joint blocks can now compute and output actuation force and torque values. Use these outputs to analyze actuation force and torque requirements at a joint, for example, due to prescribed motion.

## **Additional CAD constraints translated during model import**

The import function for second-generation models, `smimport`, supports three additional CAD constraints: parallel, perpendicular, and distance. Imported models represent parallel and perpendicular constraints using Angle Constraint blocks, and distance constraints using Distance Constraint blocks.

## **Bevel Gear Constraint block**

The Gears and Couplings library contains one new block:

- Bevel Gear Constraint — Gear constraint between two frames spinning about arbitrarily oriented axes.

## **Featured examples**

Two new featured examples are available:

- Computing Actuator Torques Using Inverse Dynamics
- 3-Roll Robotic Wrist Mechanism

# R2013a

**Version: 4.2**

**New Features**

**Bug Fixes**

## Common Gear block

SimMechanics provides a new Common Gear Constraint block. You can find this block in the new Gears, Couplings and Drives library.

Block	Description
Common Gear	Gear constraint that you can use to transmit angular motion between two rigid body frames rotating about parallel axes

## Rack and Pinion block

SimMechanics provides a new Rack and Pinion Constraint block. You can find this block in the new Gears, Couplings and Drives library.

Block	Description
Rack and Pinion	Gear constraint that you can use to convert the angular motion of a pinion frame into linear motion of a rack frame and vice-versa

## Pin Slot Joint block

SimMechanics provides a new Pin Slot Joint block. You can find this block in the Joints library.

Block	Description
Pin Slot Joint	Joint with two degrees of freedom, one translational and one rotational, with mutually orthogonal motion axes

## Internal Force block for modeling action and reaction forces

SimMechanics provides a new Internal Force block. You can find this block in the Forces and Torques library.

Block	Description
Internal Force	General force acting between two rigid body frames along the line connecting their origins

## Published XML Schema for model import, enabling users to import mechanical models from external applications such as CAD systems

SimMechanics now provides an XML schema that you can use to generate SimMechanics Import XML files. Use the schema in conjunction with the API of an external application, such as a CAD platform, to generate a valid SimMechanics Import XML file for a multibody model. Then, import this file to automatically generate an equivalent model in SimMechanics Second Generation format.

## Higher Gravity Precision

The gravity vector in the Mechanics Configuration block now has a precision of six significant digits ( $-9.80665 \text{ m/s}^2$ ). Older models with a Mechanism Configuration block retain the older precision level of three significant figures. To apply the higher precision level in these models, you can manually update the gravity vector.

## SimMechanics Generation Comparison

The Gears library adds to SimMechanics Second Generation new complex constraints previously found only in SimMechanics First Generation. For a full comparison between the two SimMechanics generations, see Modeling with SimMechanics First and Second Generations.

## Featured examples

Four new featured examples are available:

- Double-Wishbone Suspension
- Backhoe
- Cardan Gear
- Windshield Wiper



# R2012b

**Version: 4.1**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## Second Generation technology now supporting CAD import from SolidWorks, Inventor, and Pro/ENGINEER

SimMechanics introduces CAD import in SimMechanics second-generation format. Import the SimMechanics Import XML file that represents a CAD assembly, and automatically generate the corresponding SimMechanics second-generation model.

## Second Generation technology now supporting C-code generation with Simulink Coder

SimMechanics Second Generation now supports code generation with Simulink Coder™. Generate C code from a SimMechanics model, and use the code for applications like hardware-in-the-loop (HIL) testing and rapid prototyping.

SimMechanics Second Generation does not support run-time parameters. Model parameters are fixed during code generation, and are not available for edit outside SimMechanics. To update model parameters, you must edit them in SimMechanics and then regenerate the C code for your model.

## Solid of revolution geometry in Solid block

The Solid block adds a **Revolution** geometry. The geometry represents solids that have a constant cross-section about an axis of revolution. Examples include cones, domes, and toroids. Revolutions can be full or partial.

## Changes to inertia specification

The form of the **Products of Inertia** input vector has changed in Solid and Inertia blocks. The new input vector has the form  $[I_{yz}, I_{zx}, I_{xy}]$ . The vector elements correspond to the inertia matrix off-diagonal elements:

$$\begin{pmatrix} & I_{xy} & I_{zx} \\ I_{xy} & & I_{yz} \\ I_{zx} & I_{yz} & \end{pmatrix}$$



---

Previously, the **Products of Inertia** parameter required the negative values  $[-I_{yz}, -I_{zx}, -I_{xy}]$ .

## **Four new examples**

SimMechanics introduces four new examples:

- Radial Piston Engine
- Electrically Operated Bread Slicer
- CAD Import of Stewart Platform
- CAD Import of Four-Bar Mechanism



# R2012a

**Version: 4.0**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## SimMechanics Version 4.0 Software and Second Generation Technology

SimMechanics Version 4.0 introduces Second Generation technology to model, simulate, and analyze two- and three-dimensional multi-body mechanical systems. Second Generation technology provides a more intuitive and powerful block diagram language that lets you easily create reusable parts and libraries. It also adds advanced three-dimensional visualization and animation support.

Version 4.0 provides full support for both First Generation and Second Generation functionality, including block sets and tools. With Version 4.0, you have the option to create and simulate a mechanical model using First or Second Generation technology. Version 4.0 software gives you the two full block libraries, labeled First Generation and Second Generation.

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**Note:** The term *generation* — e.g. “Second Generation” — refers to the SimMechanics technology used. A SimMechanics *version* may contain one or both *generations*.

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## SimMechanics First and Second Generation Technologies

SimMechanics Second Generation technology is a comprehensive advancement of SimMechanics First Generation technology. To ease the transition from First Generation to Second Generation technology, and to support existing First Generation users, SimMechanics Version 4.0 fully supports *both* First Generation and Second Generation features.

This table summarizes First Generation and Second Generation technologies in their native SimMechanics versions.

Technology	Description	Block Library
SimMechanics First Generation	Encompasses the complete SimMechanics behavior through Version 3.2.3 (R2011b). First Generation features are designated by the First Generation library in both the Simulink Library Browser and the Help Browser windows.	To access the block library, at the command line, type <code>mechlib</code> .

Technology	Description	Block Library
SimMechanics Second Generation	Encompasses the new SimMechanics behavior in Version 4.0 (R2012a). Second Generation features are designated by the Second Generation library in both the Simulink Library Browser and the Help Browser windows.	To access the block library, at the command line, type <code>sm_lib</code> .

## Compatibility Considerations

First- and second-generation blocks are based on different languages. To interconnect the two block types, you must use Simulink-PS Converter and PS-Simulink Converter blocks. You can find the converter blocks in the Simscape Utilities library.

## Improvements in SimMechanics Second Generation Technology

The following functionality has been added or improved for SimMechanics Second Generation:

- Multibody modeling paradigm centered on frames, including:
  - Ports and nodes map that directly to frames
  - Frames that are strictly locally-defined
- Mechanics Explorer visualization utility
  - Visualize 3–D models
  - Explore model using tree browser and visualization panes
- Enhanced animation support
  - Control animation speed
  - Replay animation without rerunning simulation
- Inertia calculation and joint state targets
  - Automatically calculate inertia from geometry
  - Specify joint state target values and priority settings

- Improved integration with Simscape.
  - Includes support for physical signals and units.

## Common Functionality in SimMechanics First and Second Generation Technologies

The following functionality is present in both SimMechanics First and Second Generations:

- Rigid body specification
- Joint specification
- Constraint specification
- Force and torque inputs
- Linearization of mechanical models
- Trimming mode of analysis
- Motion outputs

## Functionality Found Only in SimMechanics First Generation Technology

The following functionality is present only in SimMechanics First Generation:

- Code generation support
  - Model reference accelerator mode is absent in the SimMechanics Second Generation sub-library.
- CAD import support
- Motion input in Joint Blocks
- Force outputs in **Joints** and **Constraints** blocks
- Missing **Constraints** blocks:
  - *point-curve*, *gear*, *velocity*, and *projection* constraints are not included in the SimMechanics Second Generation sub-library.
- Missing Force Outputs
  - Applied and reaction force outputs for joints are not available.
- Missing Joints

- 
- *Screw* and *massless connector* joint blocks are not included in the SimMechanics Second Generation sub-library.
  - Variable gravity and mass distribution
  - Visualization features
  - Model reference normal mode is not included in SimMechanics Second Generation technology.





# R2011b

Version: 3.2.3

Bug Fixes



# R2011a

Version: 3.2.2

No New Features or Changes



# **R2010b**

**Version: 3.2.1**

**No New Features or Changes**



# R2010a

Version: 3.2

New Features

## Optional Simplification of Subsystem Hierarchy During Model Import

When you generate SimMechanics models with the `mech_import` command, you can now choose certain automatic simplifications of the imported model's hierarchy:

- Bringing all joints in the generated model to the highest level being imported, either the whole model or a subsystem.
- Grouping all welded bodies at each level of the model hierarchy into new rigid subsystems at the same level.

Without these options, the generated model's hierarchy follows the hierarchy specified in the imported XML file, derived from its original CAD assembly.

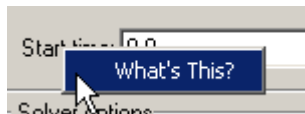
## “What’s This?” Context-Sensitive Help Available for Import Physical Modeling XML Dialog Box

This release introduces “What's This?” context-sensitive help for parameters that appear in the Import Physical Modeling XML dialog opened by entering `mech_import` with no arguments at the command line. This feature provides quick access to a detailed description of the parameters, saving you the time it would take to find the information in the Help browser.

To use the “What's This?” help, do the following:

- 1 Place your cursor over the label of a parameter.
- 2 Right-click. A **What's This?** context menu appears.

For example, the following figure shows the **What's This?** context menu appearing after a right-click on the **Start time** parameter in the **Solver** pane.



- 3 Click **What's This?** A context-sensitive help window appears showing a description of the parameter.



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## Connection Port Block Consolidated to Simscape Library and Documentation

The Connection Port block has been removed from the block libraries of all add-on products dependent on Simscape software. When using these dependent add-on products, look for the Connection Port block in the Simscape Utilities library.

The Connection Port block help for these add-on products now directs you to the Simscape block reference.

## New Demos

Two new demos have been added.

### Model Hierarchy Simplification During Import

You can learn more about how to simplify imported model hierarchy by reviewing the Mechanical Import with Model Simplification featured example.

This demo uses two new Physical Modeling XML files, `SimplificationExample1.xml` and `SimplificationExample2.xml`. Models generated from these XML files also appear as large graphics examples in Nondefault Hierarchy and Organization of Generated Models.

### Reference Coordinate Systems in Imported Physical Modeling XML

With the SimMechanics Link utility, you can export reference coordinate systems that you insert into CAD assemblies. (This feature is not supported on all CAD platforms.) From the exported Physical Modeling XML, you can generate a SimMechanics model with extra Body coordinate systems corresponding to the assembly reference coordinate systems and not associated with CAD constraints and automatically generated Joints.

Using the new `GearAssembly.xml` file, the User-Added Coordinate Systems in an Imported Gear Assembly featured example shows how you can use reference coordinate systems to manually add a Constraint block to a model after import.



# R2009b

Version: 3.1.1

No New Features or Changes



# R2009a

Version: 3.1

New Features

## **Changes to External Virtual Reality Visualization**

The new Simulink 3D Animation software replaces the Virtual Reality Toolbox™ product for visualizing virtual scenes. The documentation section on building and using a virtual reality client to visualize SimMechanics models has been updated to reflect this change.

## **Pro/ENGINEER CAD Translation Case Study**

The CAD translation chapter now contains a case study demonstrating assembly export and re-export, along with model import and update. The study uses SimMechanics and SimMechanics Link software, together with Pro/ENGINEER®, and models a double pendulum, subsequently modified to a triple pendulum. The study illustrates how you can update an existing generated CAD-based model with successive changes to the original CAD assembly.

# R2008b

**Version: 3.0**

**New Features**

**Compatibility Considerations**

## New SimMechanics Visualization and Animation

The visualization has been upgraded with new features and a new interface. It now supports

- Customizable body geometries with STL (stereolithographic) files
- Customizable body colors
- Better dynamic view control
- Better animation speed control

Consult the new *SimMechanics Visualization and Import Guide* for complete information.

For more about creating STL files, see “BodyBuilder for Creating STL Body Geometry Files” on page 18-4.

## Compatibility Considerations

The old SimMechanics visualization allowed you to save visualization settings to a MAT-file associated with a SimMechanics model.

When you open such a model in the new version, the model will attempt to load the MAT-file, as before, and map the old visualization options to the new options as closely as possible. This is a one-time conversion. The MAT-file has to be on the MATLAB path so it can be found when you open the model.

To save these converted visualization settings:

- 1 You must open the visualization window and save these settings to the model.
- 2 Then you must save the model itself.

Use the visualization controls to save the settings to the model. See the *SimMechanics Visualization and Import Guide*.

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**Caution:** To save visualization settings from an old model in the new visualization, you must follow these steps, in this order. Otherwise, you might lose the old settings permanently.

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## **Compressed Animation Recording from New Visualization on Windows Vista and 64-Bit Windows Operating Systems**

To compress a recorded animation of a simulation, you need the Indeo 5 codec. This codec might not be available on the 32-bit Windows Vista™ operating system and the 64-bit Windows® XP and Windows Vista operating systems. If you require compression and the codec is not found, the animation AVI file is still saved, but without compression. A warning appears.

For further details, consult Technical Solution 1-1HTNHW at the MathWorks® web site.

## **New Visualization Window Status Bar Not Available on Intel Mac Operating System**

The status bar of the new visualization window, below the machine display, does not appear at all on the Intel® Mac operating system. On other operating systems, the status bar shows simulation time, as well as Body block and coordinate system names.

## **New Visualization Not Supported on Solaris 64 UNIX Operating System**

The new visualization and animation interface is not available on the Solaris 64 UNIX operating system. SimMechanics software automatically reverts to the old visualization interface.

## **New SimMechanics Link Utility**

The new SimMechanics Link utility provides a bridge from third-party mechanical design and modeling applications to the system and control design features of MATLAB and Simulink. It connects computer-aided design (CAD) platforms to mechanical modeling with SimMechanics software by enabling export of CAD assemblies into the Physical Modeling XML format that allows for automatic generation of SimMechanics models.

Refer to the SimMechanics Link documentation for more information. The SimMechanics Link utility requires MATLAB, but not Simulink, Simscape, or SimMechanics.

## **Upgraded Mechanical Import and Automatic Model Generation**

The new `mech_import` command works with externally defined Physical Modeling XML files to automatically generate SimMechanics models. It supports a new SimMechanics feature, updating models generated previously.

## Compatibility Considerations

Physical Modeling XML files generated by the old CAD-to-SimMechanics translators remain compatible with `mech_import`. Using this command, you can still import old XML files to generate SimMechanics models. Because these models have no associated exported STL body geometry files, they will visualize using the standard (noncustom) body shapes.

The updating feature of `mech_import` works only with Physical Modeling XML files generated by exporting from the SimMechanics Link utility. This feature does not work with Physical Modeling XML files generated from the old CAD-to-SimMechanics translators.

You should replace all existing instances of the `import_physmod` command with the new `mech_import` command. See “Command Being Removed” on page 18-4.

---

**Caution:** Do not attempt to use the `import_physmod` command in older SimMechanics versions with Physical Modeling XML files generated by the new SimMechanics Link exporter.

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## BodyBuilder for Creating STL Body Geometry Files

In addition to generating STL body geometry files automatically from a CAD assembly, you can also create STL files by hand or by using a body geometry editor. BodyBuilder is an application based on MATLAB that provides a graphical means to create STL files for use in SimMechanics body visualization. You can obtain BodyBuilder from MATLAB Central.

## Command Being Removed

Command Name	What Happens When You Use Command?	Use This Instead	Compatibility Considerations
<code>import_physmod</code>	Still runs	<code>mech_import</code>	Replace all existing instances of <code>import_physmod</code> with <code>mech_import</code> .

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## SimMechanics Documentation Reorganized

The SimMechanics documentation is now organized into four books.

<b>Book</b>	<b>Includes Material from Old Chapters</b>
SimMechanics Getting Started Guide	1, 2, and 3
SimMechanics User's Guide	4, 5, 8, and 9
SimMechanics Visualization and Import Guide	6 and 7
SimMechanics Reference	10, 11, 12, and 13



# R2008a

Version: 2.7.1

New Features

## “What’s This?” Context-Sensitive Help Available for Simulink Configuration Parameters Dialog

R2008a introduces “What's This?” context-sensitive help for parameters that appear in the Simulink Configuration Parameters dialog. This feature provides quick access to a detailed description of the parameters, saving you the time it would take to find the information in the Help browser.

To use the “What's This?” help, do the following:

- 1 Place your cursor over the label of a parameter.
- 2 Right-click. A **What's This?** context menu appears.

For example, the following figure shows the **What's This?** context menu appearing after a right-click on the **Start time** parameter in the **Solver** pane.



- 3 Click **What's This?** A context-sensitive help window appears showing a description of the parameter.

# R2007b

Version: 2.7

New Features

## Interfacing with One-Dimensional Simscape Domains

The Prismatic-Translational Interface and Revolute-Rotational Interface blocks of the new Interface Elements library allow you to connect a SimMechanics Prismatic or Revolute joint primitive to a Physical Networks line connected to Simscape blocks. The Prismatic-Translational Interface and Revolute-Rotational Interface blocks transfer mechanical velocities and forces/torques as Physical Networks cross- and through-variables, respectively, without energy loss, along or around axes that you can define.

Several new demos illustrate the use of the Interface Elements blocks. See [New Demos](#).

## SimMechanics State Names Now Available to Simulink and Real-Time Workshop

You can access the names of the mechanical states of your SimMechanics models through the `mech_stateVectorMgr` command. The names of these states and the SimMechanics blocks that define them are now available to Simulink and appear in the outputs of model simulations. They also appear in simulations based on code generated with Real-Time Workshop.

See the Simulink and Real-Time Workshop documentation for further details about states.

## Controlling Redundant Constraint Analysis with New Tolerance Setting

You can now adjust the sensitivity of the SimMechanics redundant constraint analysis in the **Constraints** tab of the Machine Environment block, which allows you to choose between automatic constraint redundancy analysis or specifying a constraint redundancy tolerance explicitly.

Certain mechanical configurations are sensitive to the constraint redundancy tolerance and can spuriously lose or gain degrees of freedom if this tolerance is adjusted incorrectly.

## New Demos

Nine new demos have been added.



---

## Interface Blocks

These demos illustrate how to use the new Interface Elements blocks. See *Interfacing with One-Dimensional Simscape Domains*.

- mech\_interface\_crate\_transfer
- mech\_interface\_dspring\_damper
- mech\_interface\_hyd\_cylinder
- mech\_interface\_hyd\_slidercrank
- mech\_interface\_rot\_spr\_damper
- mech\_interface\_trans\_spr\_damper

## Car Modeling

These new demos provide examples of sophisticated automotive modeling.

- mech\_car\_handling
- mech\_car\_kinematics

These demos shipped in the Version 2.6 (R2007a) SimMechanics product.

## Code Generation Documentation Consolidated to Simscape User's Guide

Documentation of code generation features common to all Physical Modeling add-on products based on Simscape software has been consolidated to the *Simscape User's Guide*. The *SimMechanics User's Guide* continues to document uniquely SimMechanics features related to code generation.



# **R2007a**

**Version: 2.6**

**New Features**

**Compatibility Considerations**

## SimMechanics Software Now Requires Simscape Product

SimMechanics software now depends on and requires Simscape software, the foundation for Physical Modeling products. Simscape software includes common Physical Modeling utilities and block libraries.

## Sharing Models Using Simscape Editing Modes

SimMechanics software now features a selection of two Simscape editing modes that allow full or restricted editing of models.

- The Restricted mode requires SimMechanics product to be installed, but does not require a license. It allows you to change a limited set of model parameters, but not the blocks or connections, in a SimMechanics model.
- The Full mode requires both Simscape and SimMechanics products to be installed. It allows you to change anything in a SimMechanics model.

## Block Library Links Must Be Resolved

All SimMechanics blocks in your models must now have resolved block library links. You can neither disable nor break these library links. This is a global Simscape requirement. Consult the Simscape documentation for further details.

## Compatibility Considerations

If you have an existing SimMechanics model with disabled or broken links from SimMechanics blocks to the SimMechanics block library, you must restore all the broken block library links for your model to be valid.

If you have disabled or broken the SimMechanics library link for blocks that you have customized and want to keep these modified blocks in your model, you must move these modified blocks to your own custom library or libraries, then copy the block instances that you need to your model.

You must still restore the block link to its parent library, whether that parent is the SimMechanics block library or your own.

## Two Blocks Now with Tunable Parameters

These SimMechanics parameters are now tunable from their respective block dialogs:

- 
- The **Gravity vector** field of the Machine Environment block.
  - All three parameter fields of the Body Spring & Damper block.

## **Demos Expanded**

Five new demos have been added.

### **Angular Motion Equivalence**

The `mech_gimbal_transform` demo shows the equivalence of a body's angular motion as measured by Joint Sensors and as measured by Body Sensors.

### **Joint Limits**

Two demos illustrate how to model limits or clearance on joint motion:

- `mech_jointlimit_prismatic`
- `mech_jointlimit_revolute`

The first illustrates limits on translational motion; the second, limits on rotational motion.

### **Stochastic Oscillator and Controller**

Two demos simulate a mixture of deterministic and random forces with a model of a micromechanical damped linear oscillator:

- `mech_brownian_osc`
- `mech_brownian_osc_control`

The first model has no controller; the second, a control force in addition to the damped spring and white noise forces.

## **Modeling Constraints with SimMechanics Software**

A new MATLAB Digest article explains how to model mechanical constraints with SimMechanics blocks. The article uses a set of four existing SimMechanics demos as illustrations.



# R2006b

**Version: 2.5**

**New Features**

**Compatibility Considerations**

## Computer-Aided Design Translator for Pro/ENGINEER Available via the Web

A new computer-aided design (CAD) Pro/ENGINEER-to-SimMechanics translator is available. You install and use this translator with Pro/ENGINEER. It is independent of MATLAB.

The translator converts a Pro/ENGINEER CAD machine assembly into an XML file in the Physical Modeling format. The XML file represents the assembly in a form that you can use to generate a SimMechanics block diagram model dynamically equivalent to the original CAD assembly. To generate models, use the `import_physmod` command.

### Installing the Pro/ENGINEER-to-SimMechanicsTranslator

Obtain and use the installer executable by locating and downloading its archive at [www.mathworks.com/products/simmechanics/](http://www.mathworks.com/products/simmechanics/). A README page is provided that describes installation and configuration details.

### Translator Documentation

Help files accompany the Pro/ENGINEER-to-SimMechanics translator. They include two HTML pages and a PDF book. These files are independent of the MATLAB help system.

### Translator Examples

Some examples of Pro/ENGINEER CAD assemblies are included with the Pro/ENGINEER-to-SimMechanics translator.

One of the examples is a robot arm assembly. The corresponding XML file in Physical Modeling format, `robot.xml`, is located in the `toolbox/physmod/mech/mechdemos/` folder, relative to your MATLAB root.

## Compatibility Considerations

Versions of Pro/ENGINEER compatible with the Pro/ENGINEER-to-SimMechanics translator are listed at the MathWorks Web site. The translator is available only for the Microsoft Windows (32-bit) operating system.



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## **SolidWorks-to-SimMechanics Translator Now Available Only via the Web**

The existing SolidWorks®-to-SimMechanics translator for the SolidWorks CAD platform continues to be available via the Web, at [www.mathworks.com/products/simmechanics/](http://www.mathworks.com/products/simmechanics/). However, it no longer ships with the SimMechanics product.

### **Compatibility Considerations**

Versions of SolidWorks compatible with the SolidWorks-to-SimMechanics translator are listed at the MathWorks Web site.

The SolidWorks CAD platform and the SolidWorks-to-SimMechanics translator are available only for the Microsoft Windows (32-bit) operating system.

### **New Demo**

This version of SimMechanics software includes one new demo model, `mech_brownian_osc`, a stochastic linear harmonic oscillator based on micro- and biomechanics.

### **Modeling Flexible Bodies with SimMechanics Software**

A new MATLAB Digest article and related technical paper explain how to simulate flexible bodies with SimMechanics models and third-party finite element analysis applications. A set of models accompanies the technical paper in a compressed zip archive available from MATLAB Central.



# R2006a

Version: 2.4

New Features

## New Block Dialogs and the Simulink Model Explorer

Most of the SimMechanics block dialogs have been upgraded and are now compatible with the Simulink Model Explorer. See the Simulink documentation for more about Model Explorer.

### Block Dialogs Not Rendered in Model Explorer

Model Explorer cannot render the dialogs of these blocks:

- Shared Environment
- Point-Curve Constraint

## Joint Spring & Damper Adds Extra Simulink State When Connected to a Revolute

Each Joint Spring & Damper block connected to a revolute primitive now adds a Simulink state to your model. These states are in addition to other normal Simulink states, such as those associated with Integrator and Transfer Fcn blocks. See the Simulink documentation for more about Simulink model states.

This new feature does not change the mechanical states of your model, those associated with SimMechanics joint blocks. See the `mech_stateVectorMgr` command reference for more about mechanical states.

## Improved SolidWorks CAD Translation

The SolidWorks-to-SimMechanics translator and Physical Modeling XML import command have been improved. See Importing Mechanical Models and the `import_physmod` command reference in the SimMechanics User's Guide.

- Mates in a CAD assembly (restrictions on the free motion of CAD parts) are now translated into Joint blocks that reflect a particular combination of joint primitives, such as Prismatic, Revolute, Spherical, Bushing, etc. Previously, all degrees of freedom in a CAD assembly were translated into appropriately configured Custom Joint blocks. Rigid connections between parts continue to be translated into Welds.
- Blocks in SimMechanics models generated from Physical Modeling XML files are now, by default, labeled with shorter names. You can change the naming convention in the `import_physmod` command options.

# R14SP3

**Version: 2.3**

**New Features**

## New Shared Environment Block

The new Shared Environment block allows you to link two separate SimMechanics block diagrams with a nonphysical connection. The block enforces the same machine environment settings on both machines but adds no mechanical components (bodies or degrees of freedom) to either. Two machines so connected require exactly one Machine Environment block, rather than two.

See the Shared Environment block reference for further details.

## Updated Body Spring & Damper Block

The Body Spring & Damper block no longer contains any degrees of freedom.

Previous versions of the Body Spring & Damper block contained six degrees of freedom (DoFs) represented by a Joint. This Joint had to be taken into account when counting DoFs and loops in your model.

The new Body Spring & Damper block instead uses a Shared Environment block to connect the two sides and contains no DoFs. See their respective block references for more information.

## Normalizing Rotations

The Body dialog accepts various rotational forms (Euler angles, rotation matrix, quaternion). The Body block now interprets these rotational forms in a slightly different way, so that the standard normalization conditions on rotation matrices and quaternions are consistently enforced. As a result, you might now see slightly different simulation results from earlier versions.

## New State Vector Commands

Four new SimMechanics commands allow you to manipulate the mechanical states of your models. See the command references for more.

- `mech_get_states`
- `mech_runtime_states`
- `mech_set_states`
- `mech_transfer_states`

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## New import\_physmod Dialog

The `import_physmod` command generates SimMechanics models from Physical Modeling XML files. In addition to importing Physical Modeling XML through the command line, you can now set up the command through a dialog.

See the `import_physmod` command reference for further information.

## Demos Expanded

Two new demos have been added:

- `mech_flexible_four_bar` models a flexible four bar machine.
- `mech_pole_vault` models a rigid pole vaulter, with a discrete event.

The second demo has an associated MAT-file.

## Documentation Enhancements

The *SimMechanics User's Guide* has been enhanced.

- The review on representing motion has been revised.
- The analyzing motion has been revised.
- The computer-aided design (CAD) documentation (also available as a separate book) has been significantly revised. See the CAD chapter.
- A new chapter of case studies, based on the Stewart platform, has been added. The studies apply advanced methods and tasks to this system. SimMechanics software includes a related set of demo model and library files.
  - Degrees of freedom, states, closed topology, and constraints
  - Trimming and linearization
  - Designing controllers for the platform
  - Generating code versions of the model
  - Implementing code on dedicated hardware (hardware in the loop)





# R14SP2

**Version: 2.2.2**

**New Features**

## Demos Expanded

Two new demos have been added:

- mech\_sticky\_box
- mech\_sticky\_screw

Each demo has an associated MAT-file.

These demos illustrate static friction (stiction) implemented with the Joint Stiction Actuator.

## Documentation Enhancements

The online SimMechanics Help has been enhanced with links to four new Web-based AVI animation files (one of them new in this release) that record SimMechanics simulations.

You can access these links most easily by using the Examples index in the Help browser, under **Prerecorded Animations**.