Pro/ENGINEER®

Design Animation Concepts Guide

Wildfire 2.0 Release

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Introduction

Design Animation is a tool for creating animation sequences using Pro/ENGINEER® parts, assemblies, and mechanisms previously created in Mechanism Design.

Read the following topics for an introduction to Design Animation and information on how to get started:

Introducing Design Animation

The Design Animation module enables you to animate mechanisms previously created in Mechanism Design or any assembly from Pro/ENGINEER®. It differs from Pro/MECHANICA MOTION™ and Mechanism Design in that you can create animation sequences by linking a series of "snapshots", without being required to create joints or servo motors.

Design Animation is meant for both casual and expert CAD or Pro/ENGINEER users. Any designer or engineer can use Design Animation to:

- generate high-quality animations for sales and marketing presentations, management meetings, or design reviews
- animate assembly, disassembly, and maintenance sequences
- create complex, composite animations

The components of an animation can be controlled through the Design Animation timeline. The timeline appears below the Pro/ENGINEER graphics window. You can display, edit, move, and synchronize the components of the animation on the timeline.

Design Animation enables you to define key frame sequences, describing the position and orientation of parts and assemblies at specific times during the animation. Design Animation interpolates between the frames in the sequence to produce a smooth animation. You can include a sequence of key frames in an animation multiple times.

You can also control animation sequences by identifying key events during the animation to trigger subanimations (copies of animations inserted into the timeline) or other effects such as view orientation, transparency, and magnification. These view changes enable you to emphasize the most important aspects of your animation by focusing attention on the parts of the model that are changing during your animation.

You can define servo motors and specify a time in the animation when they will be active.

Another feature that adds to the versatility of Design Animation is multiple-body locking. You designate a lead body and one or more follower bodies, and specify a time during the animation when the body lock is active. During that time in the animation, the follower bodies will follow the lead body in the same relative position as when the lock took effect, as if they were glued together.

You can define an animation for a subassembly, and the animation can be used when the subassembly is included with the parent assembly. This makes it easy to define animations for small subsets of a large assembly, and bring them together for a combined presentation.

Accessing Design Animation

You access Design Animation from the Pro/ENGINEER Applications menu. This allows you to:

- work within the Pro/ENGINEER user interface
- operate on the Pro/ENGINEER geometry model
- use Pro/ENGINEER visualization, file manipulation, graphics, and printing tools

Servo motors, snapshots, bodies, and connection definitions created in Mechanism Design are inherited by Design Animation.

Note: If you have not used Mechanism Design to build your assembly, you cannot use the connection status or joint axis-based servo motor functionality in Design Animation.

Learning Design Animation Basics

Before using Design Animation, you should become familiar with some terminology and windows. Read the following topics to learn the basics of working with Design Animation:

Terminology

The following list describes terms and their definitions or common uses:

Item	Definition
animation time domain	the time period, number of intervals, or time step for the current animation
body	a combination of parts that move together as one unit, similar to a body in Mechanism Design
connection	a set of constraints that ties two bodies together and restricts the relative motion of the bodies in some or all directions
connection status	defines the state (**Enable**, **Disable**, **Locked**, **Unlocked**) of a connection at a given time during an animation
display at time	a specification that describes how every component in an assembly is displayed at a given time (**Blank**, **Wireframe**, **Hidden Line**, **No Hidden**, or **Shaded**)
event	a named point in time. It serves as a reference for other animation components or events. You can create your own events or use system-defined events.

Item	Definition
geometric constraints	constraints between geometric entities on two bodies applied while using the dragging functionality
key frame sequence	a set of snapshots that establish the location of certain bodies at specific times
key frame sequence instance	a copy of a key frame sequence included on the timeline
multi-body locking	a temporary rigid attachment of follower bodies to a lead body for a specified period of time
servo motor	a component that specifies relative motion of two bodies on geometric entities or about a Mechanism Design joint connection
servo motor instance	a copy of a servo motor applied to the timeline for a specific time period
snapshot	a picture of the model with the bodies in a particular orientation and position
subanimation	an animation included as a component in the current animation. It may originate with a subassembly of the parent assembly. It appears on the timeline as a line, without any of its components shown. To see the features of the subanimation, click on the circle at the beginning or ending of the line.
system-defined events	default events defined by the system for each component of the animation. These can include start and end times for each component.
transparency at time	a specification that describes the degree of transparency or opacity for a selected assembly component at a given time during an animation
view at time	a view saved within Pro/ENGINEER (for example: FRONT) that defines the orientation and magnification from which a model is viewed at a given time during an animation

Design Animation Interface

You can use Design Animation through Pro/ENGINEER menu commands, or by clicking buttons on a toolbar, or by moving elements in the timeline. Following are examples of the Design Animation toolbar and the timeline.

Toolbar

The toolbar buttons represent Design Animation commands and act as a quick way to get to the appropriate dialog box. You can customize the toolbar to include only those commands you use regularly.

Button	Action/Name
	Create a new animation
	Control icon visibility
	Define bodies
	Drag model
	Create key frame sequence
	Create body-body locking
	Start running the animation
	Play back the animation
	Export the animation to a frame file
	Create a servo motor
	Change the connection status
	Create an event
	Include a subanimation
	Create a new transparency at time
	Create a new view at time

Button	Action/Name
	Define component display at time
	Define the interpolation settings
	Create a new transparency at time
	Edit the selected entity in the timeline
	Undo
	Redo
	Remove the selected entity from the animation timeline
	Zoom in on the time scale
	Zoom out on the time scale
	Zoom to refit the time scale
	Change the animation time domain
	Change the assembly tolerance

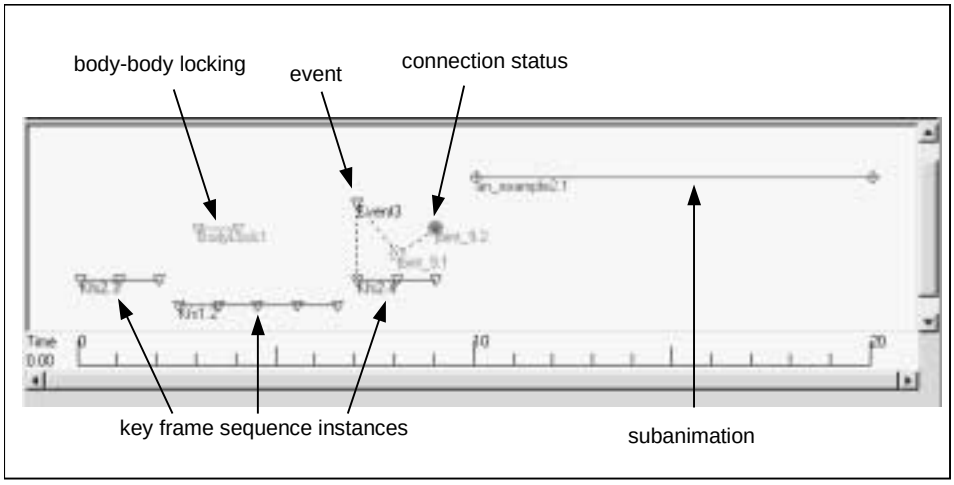
Timeline

The Design Animation timeline is a graphical interface that appears below the Pro/ENGINEER window when you start Design Animation. The timeline displays the items that make up your animation on a line drawing associated to a time scale. The components that make up the animation—including key frame sequence instances, servo motor instances, and connection status—are represented by triangles, diamonds, or circles connected by a line.

You add components to the timeline or edit existing components by using the menu commands or the Design Animation toolbar buttons. You can also easily edit an existing animation by right-clicking on components in the timeline. A right-click brings up pop-up menus that let you edit, copy, or remove the selected component from the timeline. Clicking the middle mouse button moves objects vertically, so you can view them more easily.

The timeline is not only a convenient way to represent your animation; you can also use it when you want to change your animation's time parameters. You can change the time when a specific event occurs by dragging the event's symbol to a different location on the timeline. For example, you can change the time when an animation or key frame sequence begins or ends by left-clicking on the desired sequence and dragging the line connecting the separate components to a new location with respect to the time scale. You can also position the key frame sequence for convenient viewing.

The following is an example of a Design Animation timeline:



As the animation time progresses, the components in the timeline become enabled at the appropriate time and move associated bodies to their desired positions. Multiple components may be enabled at any given time.

In addition to the components shown in the illustration, an animation can contain information on enabling and disabling servo motors, information on viewing the animation from different orientations, information on blanking or unblanking your assembly components, and information on making your assembly components transparent or opaque.

Limitations

Following are the limitations associated with Design Animation:

- Any definition (body, joint, servo motor) created in integrated Motion is not available in Design Animation. It is available if created in Mechanism Design.
- You cannot transfer data from Design Animation to Motion, but you can use snapshots and servo motors in Mechanism Design.
- Pro/ENGINEER constraints are not honored in Design Animation, but they are used in the initial body definition.
- If you export your animation to a frame file (extension .fra), it does not save the view orientation.
- Constraints and locked bodies (to ground) are saved with a snapshot. However, they are not enforced during a key frame sequence animation. You may need to define body locks and connections within Design Animation to get the desired animation.
- View interpolation settings must be set for the entire animation. These settings are not honored in subanimations.
- Opening a simplified rep may cause animation components to be deleted. If you then save the animation and open the master rep, you may lose information. To retain the master rep animation, do not save the simplified rep. This is also true for suppressed components.

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Creating an Animation

Using the Design Animation timeline and toolbar, you can create an animation for your assembly. Read the following topics for an introduction to the components of an animation.

Overview

You can create an animation to do many different things. Depending on your objective, you may use different steps to create your animation.

Following are the typical steps you might take to create an animation:

1. Open an assembly in Pro/ENGINEER and start Design Animation.
2. Create a new animation and give it a meaningful name using the **Rename** command.
3. Check your body definitions:
   - For a Pro/ENGINEER assembly, you probably want to select **One Part per Body** and then edit the body to put the parts into the appropriate moving groups.

     One Part per Body will empty the ground body of parts. You should edit the body named ground and reassign ground parts to it.
   - For a Mechanism Design assembly, you should check that the body definitions are as desired.
4. Define animation components that create movement.
   - To specify general movement, create key frame sequences. To create key frame sequences, take snapshots of your assembly at specific positions, using the drag functionality to move bodies to new positions. Design Animation will interpolate between these key frames to produce a smooth animation.
   - To create specific movement between bodies connected by joints or between geometric entities, define servo motors on joints or geometric entities.
5. If not already on the timeline, include the servo motors and key frame sequences on the timeline. Any components included on the timeline form the basis for your animation. You can edit the timeline length and increments, as well as the length of the servo motor or key frame sequence in the animation.
6. Optional: If you have not already included body locking, events, or connection status in the timeline, you can add them now.
   - If you want a group of bodies to be fixed relative to each other for a part of the animation, you may want to set up body locking for that time period.
   - Changing the connection status is useful for assembling and disassembling your model. If you are working with key frame sequences, you have probably changed the connection status while dragging bodies to position them in snapshots. If you are working with servo motors, you want to use the **Animation > Connection Status** command, or click  on the toolbar.
   - If you need to have animation components sequenced in a particular order, you can specify a system-defined or user-defined event as a reference, or you can group them together in a subanimation.
7. Run your animation.

8. If you have problems, try one of the following:
   - Make sure your mechanism is not overconstrained. For example, check that a servo motor and key frame sequence do not require conflicting positions.
   - Increase the number of time steps (**Tools > Time Domain** or click ).
   - Try changing the tolerance (**Tools > Animation Settings** or click ).
9. Use the **Playback** dialog box to rerun the animation. If desired, check for interference and other results.
10. Define views along your animation to view the orientation and magnification of your model. Also, choose an interpolation method for your views.
11. Specify component displays along the animation for your assembly components.
12. Rerun the animation and view results.
13. Save your animation and results. You save your results using the **Save** button on the **Playbacks** dialog box. Design Animation saves your playback results to a .pba file. To save the animation to disk, you must save the entire assembly using **File > Save**. Design Animation saves your animation to the .asm file with your model. You can also export to a .fra file, or you can save the animation as a graphic file.

See the following sections for more information about bodies, snapshots, key frame sequences, servo motors, events, connection status, and body locking.

Using Bodies

A body is a group of parts that move as a unit. There is no relative motion of parts within the group. You can define a group of parts as a body in Design Animation, or you can add components to a body that was defined in Mechanism Design.

Body definition is important because you can define movement and create body locking only between distinct bodies.

Following are the rules for body definitions:

1. By default, bodies in Design Animation are created using the Mechanism Design body rule. The Mechanism Design body rule is that parts with a Pro/ENGINEER constraint (not a connection constraint) are placed in a single body.
2. Once you modify a body definition in Design Animation, the modified body definition holds. Any new parts subsequently added to the assembly are placed in bodies following the Mechanism Design body rule. **One Part per Body** is considered a body modification operation.
3. Bodies defined in a subassembly cannot be modified in the parent assembly. For example, you cannot add or delete a part to a body redefined in a subassembly.

   Note: Neither the **One Part per Body** nor the **Default Bodies** operations on the **Bodies** dialog box will override the body definitions contained in a subassembly.

When you add parts to a body, they are deleted from any other bodies that previously contained them. If you delete a body, all of its parts are moved into the Ground body.

Editing body definitions may cause connections, servo motors, and other animation components to become invalid. Invalid components are permanently deleted from the animation timeline.

Note: Any change you make to a body definition in Design Animation will only be valid while you are in Design Animation. You cannot transfer the body definition to Mechanism Design.

Taking Snapshots

You use dragging to place bodies in their desired position for a snapshot. You can drag a point or body. You can choose free-form movement, or movement along a coordinate system axis. Design Animation attempts to position the selected entity as close as possible to the current cursor location. The **Drag** dialog box displays the coordinates of the drag point with respect to a selected coordinate system and updates the coordinates as you move the model. You can use this display to place your component more precisely, or to recall a previous position. When the desired orientation is reached, you click the snapshot button to capture the current position and orientation of each body in the model.

You can choose to have connections between bodies remain connected during the dragging process, or you can disable the connection. You can also apply two types of temporary geometric constraints to the model—**Align** and **Mate**. The constraints are in effect only during the dragging operation. You can select points, lines, or planes on the model for alignment. When you align two planes or surfaces, they become coplanar and face the same direction. When you align lines they become coaxial. You can mate only planar surfaces. When you mate planes, they face each other. You can also orient two planes to be parallel, and specify the distance separating them.

You can constrain the relative position of the bodies connected by a joint by entering a value for the joint axis position.

You can specify that one or more bodies remain stationary relative to ground during a dragging operation by locking them. You can also lock or disable a connection, so it does not move or is ignored, respectively. Design Animation saves the body locking and connection status information with the snapshot, so if you edit a snapshot those features will be active.

If you are creating a new key frame sequence or editing an existing key frame sequence, the snapshots you take are automatically added to the key frame sequence. However, if you click the button on the Design Animation toolbar to create snapshots with the **Drag** dialog box, Design Animation will not automatically add the snapshots to any key frame sequence instance in the animation.

Defining a Key Frame Sequence

A key frame sequence is a series of snapshots that show the change in position and orientation of parts or assemblies over a period of time. You define the body locations relative to ground or to another body. You decide whether each body's position is required, desired, or unspecified. Design Animation will interpolate between these key frames to produce a smooth animation.

A key frame sequence definition includes the following items:

- name
- bodies controlled by the sequence
- ground or other reference body
- time of each key frame (snapshot)
- locations of the bodies

You make a key frame by moving the model into the desired orientation and taking a snapshot. After a group of snapshots is prepared, you place them in the desired order in the key frame sequence. After you prepare and save snapshots, you can reorder them in later key frame sequences.

While creating or editing a key frame sequence, you can preview existing snapshots, change the order of the snapshots, make new snapshots, and add snapshots to the key frame sequence. When you include the key frame sequence as an instance in an animation, it appears in the timeline window. Each key frame is represented by a triangle, and a line connects the triangles. You can drag a triangle on the timeline to a different time and the associated key frame will update automatically.

When creating the sequence, you control the importance of each body's location by specifying whether its status is **Required**, **Desired**, or **Unspecified**. Any body that has its status set to **Unspecified** is not controlled by the sequence. You also select a reference body, which can be ground, for the entire sequence. All bodies whose status is required or desired in that sequence will be placed in the appropriate position, as defined by the snapshot, relative to the reference body at each time in the sequence.

If the reference body moves, all of the controlled bodies in the sequence will then move with it.

When you run your animation, if the bodies do not move to the correct position, especially at key frames, you should try using the **Required** status. In general, however, you should use **Desired**, because **Required** may over-constrain your assembly.

The entire key frame sequence can be reversed. This is useful, for example, in illustrating the assembly of a mechanism. If you remove the parts of your assembly one by one in a key frame sequence, reversing that key frame sequence produces an animation illustrating the assembly of the model.

Working with Servo Motors

You use servo motors to impose a particular motion on your mechanism without regard to what forces are required to cause the motion. Servo motors force a specific type of motion to occur between two bodies. You can place servo motors on joint axes or between geometric entities such as points and planes on different bodies.

Design Animation offers several types of servo motors. When you define a servo motor, you first specify how you want the motion to change with respect to time—either by position, velocity, or acceleration—and whether you want the motion to be translational or rotational. Within these broad categories, Design Animation provides several profiles you can use, including ramp, parabolic, and polynomial. In addition, you can define your own servo motor function, either with a table, or with a mathematical expression. You can define, edit, or copy servo motors in both Design Animation and Mechanism Design, and the servo motor definition will be valid in both applications.

Once you define your servo motor, you can include an instance of the servo motor for a specified length of time. You can include the servo motor multiple times in the animation and specify that each servo motor instance is applied at a different time during the animation. For each instance, the servo motor function will be evaluated using relative time from the start of the instance.

Body Locking

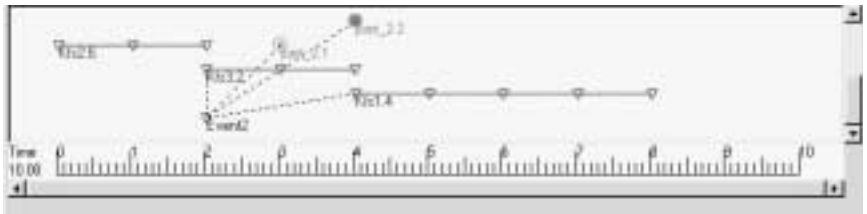
You can use the multi-body locking functionality to lock bodies to a lead body. Design Animation determines the relative position and orientation of the follower bodies with regard to the lead body at the time the body locking becomes active in the animation and keeps them in this same orientation while the lead body moves according to the animation's definition. When body locking ends in the animation, the bodies are allowed to move independently again.

Working with an Event

Events are used to synchronize animation components relative to one another. The beginning of the animation is a default event named "start." As you include components in an animation, you can set them to start or stop at some time relative to the beginning or end of other components. This means that you can associate components so that their relationship in time is maintained through subsequent changes. You can rearrange the order of your components to draw attention to the most important part.

For example, you can define an animation that includes several components. In the following figure, the animation includes two key frame sequences, Kfs3.2 starting at time 0 and Kfs1.4 at time 2 seconds. In addition, there are two connection status events. A joint is disabled at time 1 second (noted by a hollow circle) and enabled at time 2 second (noted by a filled-in circle). All four of these components are defined with respect to Event2, which in turn is defined as beginning at the start of the animation.

Suppose you decide to insert a third key frame sequence, Kfs2.6, in front of this sequence of events. Define the Start time for Kfs2.6 as the start of the animation, then change the start time for Event2 to 2 seconds after *Start*. The other events that are linked to Event2 are automatically shifted ahead in time without changing their relationship to each other.



Connection Status

You can change the status of a connection during an animation. Using this functionality, you can disable a connection so a servo motor can move a body, then enable the connection so the body moves with its connected body. Changing the connection status is useful when assembling and disassembling a mechanism during an animation.

Working with the Animation Appearance

After you are satisfied with the way your assembly moves during the animation, you can adjust the appearance to emphasize certain portions of the animation.

- You can move smoothly from one orientation of your model to another during the animation by using the view-at-time functionality. For example, you might want to begin the animation by viewing the assembly from the top, and then zoom in on a portion that is moving.
- You can define different display states, in which you make the less important parts of the assembly invisible, with the parts that you want to emphasize shaded.
- You can use the transparency-at-time functionality to make one of the assembly's components completely opaque at one point during the animation, then smoothly make its surfaces transparent, so that the components hidden beneath it gradually become visible.

Design Animation Tips

Following is some helpful information you should know when using Design Animation:

- By default, a key frame sequence controls locations of all of the bodies during an animation. If you want the bodies to be able to move more freely—for example, if a servo motor needs to move them—you should specify that the body definition is **Unspecified** instead of **Desired** when defining a key frame sequence.
- When creating constraints during drag, multiple planar constraints can easily lock up an assembly if the constraints close a loop. It is very difficult to keep plane normals aligned. Try to avoid closing loops or using other constraint types.
- When adding a constraint to a long chain of connected bodies, try to add the constraints to bodies that are "near" each other.

- Dynamic spinning works best when you use the screen center option on the **Orientation** dialog box. You can access this dialog box using Pro/ENGINEER's **View > Orientation > Reorient** command. Select **Dynamic orient** in the **Type** pull-down menu. When this is done, try to get the spin center icon to be over a physical part. This makes dynamic spinning behave much better.
- Key frame sequences have a lot of freedom to move parts around. When parts move unexpectedly, try tying things down using body locking and constraints.
- If you are using an assembly created in Mechanism Design, you should use **Lock Bodies** to regroup parts into groups if you are animating after an assembly sequence.

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