



Cloth

Version 6.5



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Maya®, Version 6.5

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Graph Layout Toolkit

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Introducing Cloth

About

Cloth overview

With Cloth, you can create realistic animated cloth within the Maya environment. Cloth gives you the ability to model garments for any animated 3D figure, apply dynamic effects, and simulate the cloth behavior.



Stuart Little image courtesy of Sony Pictures Imageworks. Columbia/TriStar. All rights reserved.

In addition to clothing characters, you can create many other types of cloth animation, including sheets, bedding, drapery, flags, and fabric goods of all kinds.

To help you learn how to create clothing, we've included lessons in Chapter 3, Cloth, of Getting Started with Maya Unlimited. We recommend that you do this tutorial before starting to work with Cloth.

Related topics

- ❖ "Load Cloth"
- ❖ "Creating cloth"

1 | Introducing Cloth

How do I? > Load Cloth

How do I? Load Cloth

When you start Maya, Cloth is automatically loaded. You can also load and unload Cloth using the Plug-in Manager.

Note If you exit Maya using the *quit -force* command, temporary files may be left in the directory specified by the TMPDIR environment variable. If that variable is unset, any files are left in your /tmp directory.

To turn off Cloth autoload

- 1 Select Windows > Settings/Preferences > Plug-in Manager.
- 2 In the Plug-in Manager window, turn off the auto load checkbox for CpClothPlugin.so (IRIX and Linux) or CpClothPlugin.mll (Windows).
Now, when you start Maya, Cloth is not automatically loaded.

To turn on Cloth autoload

- 1 Select Windows > Settings/Preferences > Plug-in Manager.
- 2 In the Plug-in Manager window, turn on the auto load checkbox for CpClothPlugin.so (IRIX and Linux) or CpClothPlugin.mll (Windows).
Now, when you start Maya, Cloth is automatically loaded.

To unload Cloth

- 1 Select Windows > Settings/Preferences > Plug-in Manager.
- 2 In the Plug-in Manager window, click the loaded checkbox for CpClothPlugin.so (IRIX and Linux) or CpClothPlugin.mll (Windows).
Maya unloads Cloth.

To load Cloth

- 1 Start Maya.
- 2 Select Windows > Settings/Preferences > Plug-in Manager.
- 3 In the Plug-in Manager window, click the loaded checkbox for CpClothPlugin.so (IRIX and Linux) or CpClothPlugin.mll (Windows).
Maya loads Cloth and adds the Cloth menu set.
You can access Cloth's features from the Cloth menu set, or from the Hotbox.

1 | Introducing Cloth

How do I? > Load Cloth

To select the cloth menu set

Click the menu selector in the status line and select Cloth from the pull-down menu.

The Cloth menu set is displayed in the menu bar.

1 | Introducing Cloth

How do I? > Load Cloth

2

Creating Cloth

About

Creating cloth

With Cloth, you can create a simple piece of cloth, such as a tablecloth or flag, or a complicated article of clothing that is fitted on a model.



There are two ways to create clothing:

- “Create a garment”
- or for a simple piece of cloth, like a tablecloth, you can “Create a cloth object”

Related topics

- ❖ “Differences between a garment and a cloth object”

How do I?

Create a garment

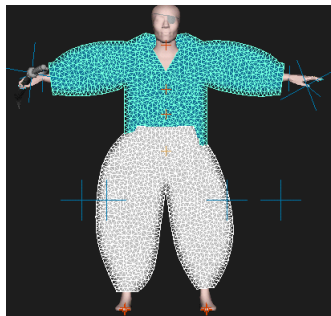
The basic workflow for constructing a garment is similar to the way a tailor makes clothing.

2 | Creating Cloth

How do I? > Model the character

- You create cloth panels by drawing a closed region of curves on a 2D plane.
- You sew individual panels together by specifying seams on the panel.
- You specify material properties and resolution values for each panel.
- When the garment is constructed, you simulate it using the cloth solver.

The final product is a 3D fabric triangle mesh consisting of 2D panels sewn together.



Model the character

When you model the character that will wear the garments you are creating, you need to anticipate your solver scale. You set the solver scale to take into account the size of your models. The solver scale makes cloth behave as though it were a different size, so if you have a small character, the cloth behaves as though it were real-world size.

Understand solver scale

When you drape a garment onto a model, the cloth solver runs the simulation that drapes the garment. By default, the cloth solver works in terms of real-world units. To change how the cloth solver interprets the size of the model and the cloth, you change the solver scale.

The solver scale is 1 by default. When the solver scale is 1, you should model your character in real-world sizes. For example, a human being is about 160 centimeters tall and the typical length of a shirt is 60 to 70 centimeters. You would therefore build a model of a human character to be about 160 centimeters tall and the character's shirt to be about 60 to 70 centimeters in length.

If you do not create the model in real-world units, you can change the solver scale to compensate. You can increase the solver scale to make the cloth behave as though it were larger. For example, if you build a model

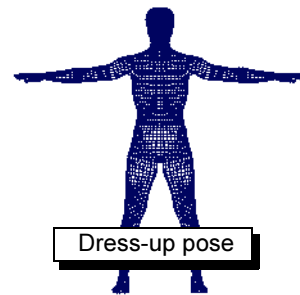
16 centimeters tall and increase the solver scale to 10, you get the same cloth draping solution as if your character was 160 centimeters tall and the solver scale was set to 1.

For information on changing the scale of the solver, see “Scale the solver” on page 54.

Pose the character

You use the actual skin geometry as a mannequin to make the panels and fit the garment. You pose the mannequin in a dress-up pose.

The dress-up pose places the body in a position that eliminates any self-collision and minimizes wrinkling in the initial fitting of the garment.



Build a pattern for the garment

The pattern for a garment consists of one or more panels that are sewn together. The panel is the basic building block of any fabric model.

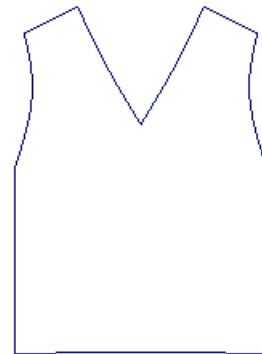
Create curves

To create your garment, you first create some curves. The curves define the outline for the panels. The panels are seamed together to make a garment.

To make a panel, you draw a closed region consisting of two or more NURBS curves. The curves must satisfy the following requirements:

- The curves must form a closed region. In other words, the last control vertex of one curve must be in the same position as the first control vertex of the next curve.
- They also must be coplanar, which means the curves are all drawn in a plane.

You can create curves using either the CV Curve Tool or the EP Curve Tool. These are modeling tools available from the shared menu sets. We've provided a brief description of how to use these tools to create panel curves. For more detailed information on using these modeling tools, see the *NURBS Modeling* guide.



2 | Creating Cloth

How do I? > Build a pattern for the garment

Tip

You can use the Cut Curve tool to subdivide intersecting curves, which can save you time when modeling complex garments. See the *NURBS Modeling* guide for information on using Cut Curve.

Use the CV Curve Tool

The CV Curve Tool creates free-form curves. Use this tool when you want to create curved seams. When constructing curves using the CV Curve Tool, you must place several points to complete the curve, depending on the curve degree setting in the CV Curve Tool options window.

The default setting for curve degree is 3. You need one point more than the curve degree, so you have to place at least four points to construct the curve using the tool's default settings.

Use the EP Curve Tool

When constructing curves with the EP Curve Tool, only two edit points are required to create the initial curve segment.

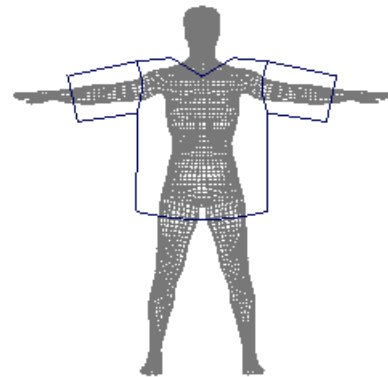
To create curves for a garment

- 1 Load your character model and display it in an orthogonal view.

Drawing your curves in an orthogonal view helps make sure the curves are drawn coplanar.

- 2 Select the model, then right-click and select Actions > Template.

This makes the model a template. Templates are objects that you can see but cannot select. By making the model a template, you won't accidentally select the model or modify it.



- 3 In the main toolbar, click  to turn on Snap to Curves.

This snaps to curves and polygon edges. You can also press the c key to turn on Snap to Curves.

Tip

Hide any other polygons in your scene so you don't accidentally snap to the wrong curve.

2 | Creating Cloth

How do I? > Build a pattern for the garment

- 4 Set the curve tool options, if you want.
- 5 Select the curve tool you want to use: Create > CV Curve Tool or Create > EP Curve Tool.

Remember

If you construct a curve using the CV Curve Tool, you must place several points to complete the curve, depending on the curve degree setting in the CV Curve Tool options window.

- 6 Position the pointer where you want the curve to begin.
- 7 Using the character model as a guide, click to place the first CV or edit point.
- 8 Click where you want to place the second CV or edit point.
- 9 Keep clicking to add CVs or edit points and continue the curve
Remember, you need at least four clicks to create a CV curve.
- 10 When the curve is complete, press the y key.
This finishes the curve and keeps you in the curve tool
- 11 Continue making more curves. You need at least two curves to create a panel.
Remember, each curve must touch the end of the previous curve.

Tip

You can use Snap to Curve to verify that your curves are attached exactly at their endpoints (see the next section).

To verify that the curves are attached at the endpoint

- 1 When you place the first CV or edit point in a curve you want to snap, drag it along the adjacent curve.
If the CV or edit point is snapped to the curve, it will follow the path of the curve.
- 2 Drag the CV or edit point to the end of the adjacent curve and release the mouse button.

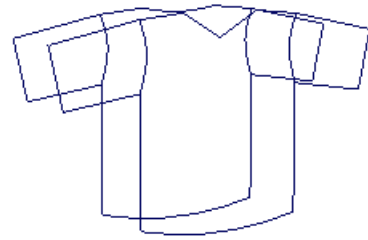
2 | Creating Cloth

How do I? > Build a pattern for the garment

Duplicate curves

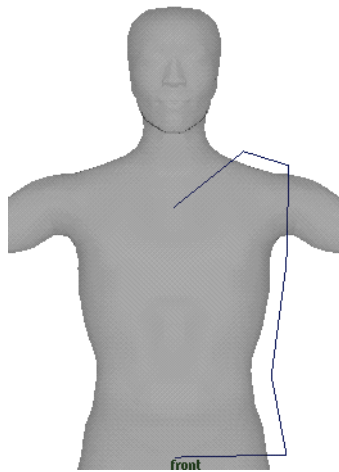
It is helpful to keep your patterns symmetrical. One way to do this is to create the curves for one side of the pattern, then duplicate the curves to create the other side.

You can also duplicate the curves with instancing turned on. This way, if you adjust a CV on one side of the pattern, the same adjustment is made to the instanced CV on the other side of the panel.



To duplicate curves

- 1 Draw the curves for the right half of the garment.



Make sure you snap the curve end points to the center grid.

- 2 Select the curves and select Edit > Duplicate.

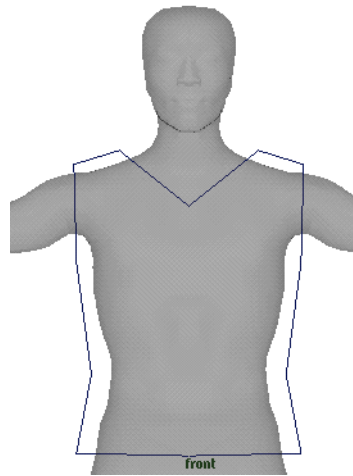
Tip

To make sure your curve end points snap to the center grid, turn on the snap to grid button or press the x key to snap to grid.


- 3 Select the curves and select Edit > Duplicate.
- 4 In the Channel Box, set the X Scale value to -1.
The curves are duplicated and moved to the left side of the model.

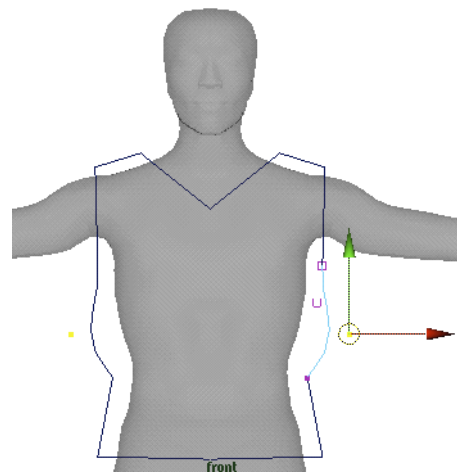
2 | Creating Cloth

How do I? > Build a pattern for the garment



To instance the control vertices

- 1 Draw the curves for the right half of the garment.
Make sure you snap the curves to the center grid.
- 2 Select the curves and select Edit > Duplicate > .
- 3 In the Duplicate Options window, turn on Instance.
- 4 Click Duplicate.
- 5 In the Channel Box, set the X Scale value to -1.
- 6 To adjust the curve, select a curve. Position the pointer over the curve, press the right mouse button and select Control Vertex.
- 7 Select one of the control vertices and use the move tool to move it.



The instanced control vertex moves in conjunction with the selected control vertex.

Group curves

Grouping your curves is a handy way to organize your pattern. For example, if you are making a shirt, you might want to group all the curves that comprise the front of the shirt into one group and name it *shirtFront*.

2 | Creating Cloth

How do I? > Build a pattern for the garment

Then group all the curves that comprise the back of a the shirt into a group named *shirtBack*. You can then group the two groups into one group named *Pattern*.

To create a group of curves

- 1 Select the curves.
- 2 Press Ctrl-g to create a group.
- 3 In the Outliner, name the group.
- 4 Select Modify > Center Pivot.

This centers the pivot on the group so you can move the group more easily.

Position curves

Generally, you want to position your curves as close as possible to the body without intersecting the body. With realistic models, this is simply a matter of positioning the curves in front of and in back of the model. With exaggerated body shapes, you may need to pivot the curve group to place the curves as close as possible to the body.

To position curves on a realistic figure

- 1 Select the curves that will comprise a panel.
- 2 Press Ctrl-g to create a group.
You can name the group using the Outliner.
- 3 Select Modify > Center Pivot.
This centers the pivot on the group so you can move the group more easily.
- 4 Make sure the group transform is selected. Use the Move tool to position the group of curves as close to the body as possible without intersecting the body.



2 | Creating Cloth

How do I? > Create panels

To position curves on an exaggerated figure

- 1 Select the curves that will comprise a panel.
Press Ctrl-g to create a group.
You can name the group using the Outliner.
- 2 Select Modify > Center Pivot.
This centers the pivot on the group so you can move the group more easily.
- 3 Make sure the group transform is selected. Use the Rotate tool to rotate the group of curves as so they more closely follow the general shape of the body.

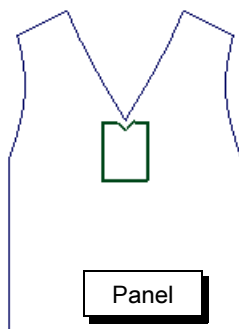


Create panels

Once you've created all the curves for your garment, you can create panels out of the curves. A *panel* is defined as a closed set of planar NURBS curves. The curves must be planar and closed. Two panels can share curves.

Note If you delete a curve that makes up a panel, the panel becomes invalid.

To create panels



- 1 Select the curves that represent the portion of the garment you want to designate a panel (selection order is unimportant).
- 2 Select Cloth > Create Panel.
A panel node is created.

2 | Creating Cloth

How do I? > Create panels

Tip

If your curves are grouped according to panel, you can select a single curve and press the up arrow key to select the group. Then select Cloth > Create Panel.

What if you get error messages?

In order to create a panel or a garment, your curve must be planar, and they must make a closed loop. If not, you'll get an error message. Here are some tips to help if you get an error message when you try to create a panel.

Curves must form a closed loop

If you get the message *Error:Curves must form a closed loop* when you try to create a panel, it means that the position of the last control vertex of one curve does not match the position of the first control vertex of the next curve.

You can avoid this by turning on Snap to Curve or Snap to Grid when drawing the curves. To correct this, you can use the Move tool to snap a CV to another curve.

Tip

You can also get this error message if you have selected curves that are on top of each other. This can happen if you have duplicated an extra curve. Check the Outliner to make sure you don't have extra curves.

To make your curves a closed loop

- 1 Zoom in on your curve intersections to identify control vertices that don't touch.
- 2 When you find two curves that look like they are not touching, select one of the curves. With the pointer over the curve, press the right mouse button and select Control Vertex.
- 3 Select the control vertex that is not touching the adjacent curve's control vertex.
- 4 Select the Move tool.
- 5 Turn on Snap to Curve.
- 6 With the middle mouse button, click and drag on the curve you want to snap to.
The selected CV will snap to the curve.
- 7 Drag the CV to the end of the curve.

2 | Creating Cloth

How do I? > Seam the garment

Curves must be coplanar

If you get the message *Error: Curves must be coplanar* when you try to create a panel, it means that the curves are not on the same 2D plane.

You can avoid this error by drawing your curves in an orthogonal view and turning on snap to view plane. Make sure you don't accidentally rotate your curves.

To check for rotated curves

- 1 Select a curve.
- 2 In the Channel Box, make sure the values for Translate X, Y, and Z, and Rotate X, Y, and Z are set to zero.
- 3 Keep selecting and curves and checking the Translate and Rotate values in the Channel Box until they are all set to zero.

Seam the garment

Once you've created the panels, you can seam the garment. Remember, a *garment* is a collection of *seamed panels*.

Create the initial garment

You designate one of your panels as the initial garment. This triangulates the panel and creates the Stitcher, which lets you seam panels to the garment.

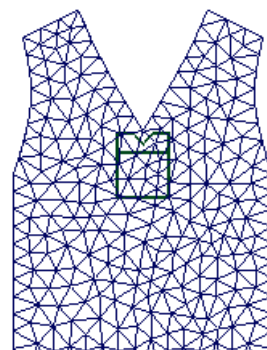
To create the initial garment

- 1 Select a panel and select Cloth > Create Garment.

This tessellates the panel and creates a polymesh. A cloth node and cpStitcher node are created. You use cpStitcher to set the resolution of the garment (see "Set resolution" on page 31).

You can also create the initial garment by selecting the curves and selecting Cloth > Create Garment directly instead of first creating the panel.

- 2 You can rename the garment using the Outliner.



2 | Creating Cloth

How do I? > Seam the garment


Tip

If you change to shaded mode, you'll see the garment more clearly.

Seam the panels

You add other panels to the initial garment by seaming them together. When the new panel is added to the garment, the mesh is retessellated.

To seam the panels

- 1 Click  to turn off the Surfaces pick mask.

This makes it easier to select the curves for seaming.

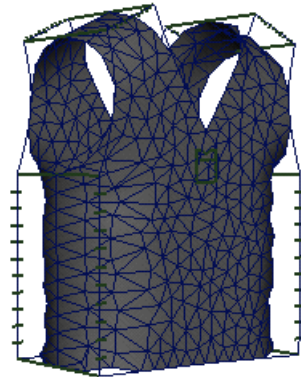
- 2 Select a curve from the garment and Shift-Ctrl-click a curve from the panel that you want to seam to the garment.

One panel must be part of a garment.

- 3 Select Cloth > Create Seam to create a seam between these two panels.

This tessellates the new panel and seams the two panels together.

- 4 Continue creating seams as desired.



Note

The cpSeam MEL command now allows you to query the stiffness. In the Command Line or Script Editor, type:

```
cpSeam -query -stiffness;
```

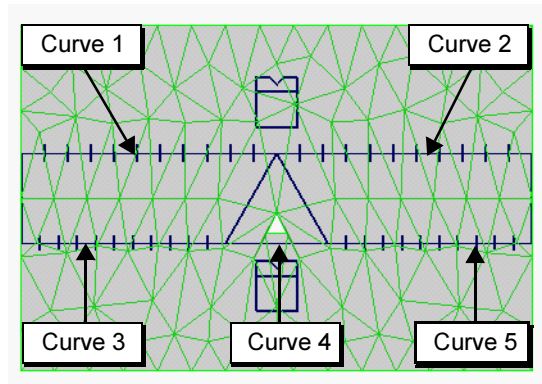
Tips for seaming panels

If you are seaming a continuous boundary of panels that consists of several curves, the curves you seam must be contiguous.

For example, in the figure below the top panel's edge is made up of two curves and the bottom panel's edge is made up of three curves.

2 | Creating Cloth

How do I? > Tailor with darts



- Curve 1 and Curve 3 are seamed together
- Curve 2 and Curve 5 are seamed together
- Curve 4 is not seamed

This is an invalid seaming operation and can cause errors when you change the resolution of the panel.

To correct this

- 1 Do one of the following:
 - Seam contiguous curves. For example, seam Curve 1 to Curve 3, and seam Curve 2 to Curve 4
 - Remake your curves so the number of seams match. For example, delete curve 4, and extend curve 3 and curve 5 so they meet.

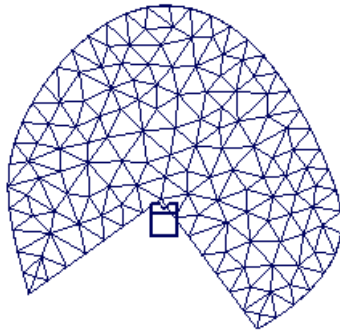
Tailor with darts

A dart transitions a garment from a part of the body that is larger to one that is smaller. For example, from the bust to the waist or from the hips to the waist are areas that commonly use darts. Pleats and gatherings can also perform this same function.

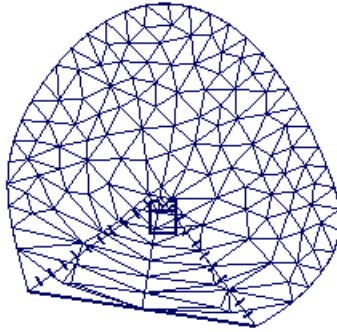
You can seam together curves from the same panel to create darts in clothing. You shape the panel so the area that would be overlapping in a real garment with a dart is not included in the panel. You can use the Cut Curve modeling tool to help create darts.

2 | Creating Cloth

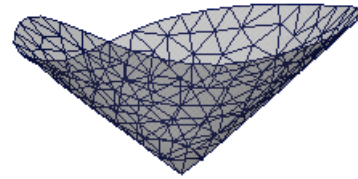
How do I? > Tailor with darts



Create a panel allowing space for the dart



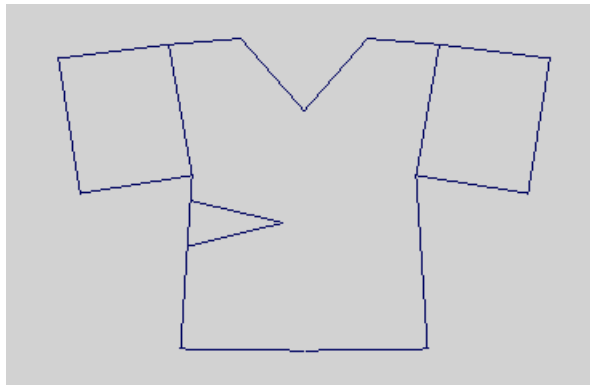
Seam the edges of the panel



Simulate the cloth to create the shape of a garment with a dart

To create darts with the Cut Curve tool

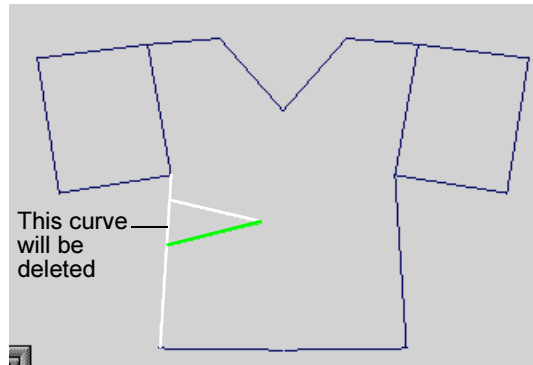
- 1 Draw the curves for your garment.
- 2 Draw the curves representing the dart seam.



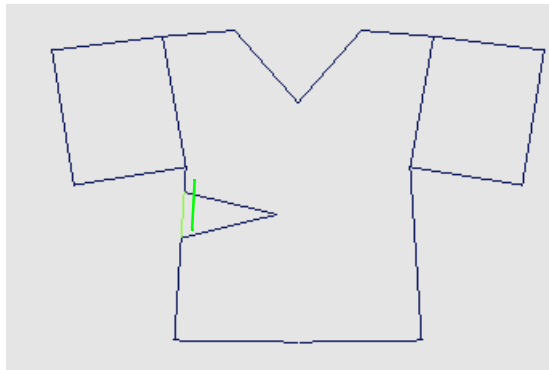
- 3 Select the curves attached to the curve you want to delete to create the cut for the dart.

2 | Creating Cloth

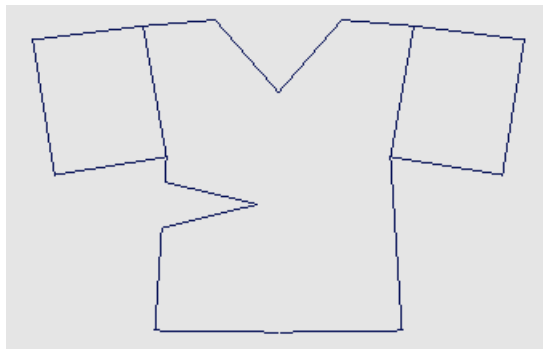
How do I? > Tailor with darts



- 4 From the Modeling menu set, select Edit Curves > Cut Curves > ☐.
- 5 In the Cut Curves options window, make sure All Curve Segments is turned on.
- 6 Click Cut.
- 7 Select the curve you want to delete.



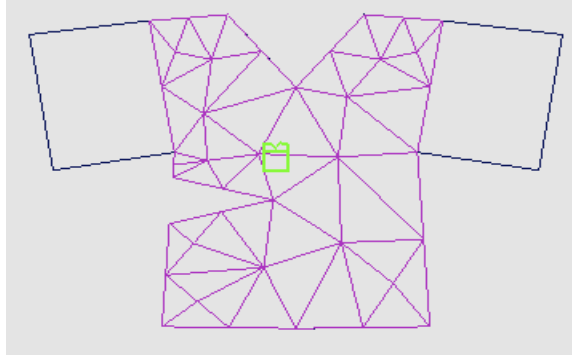
- 8 Press Backspace to delete the curve.



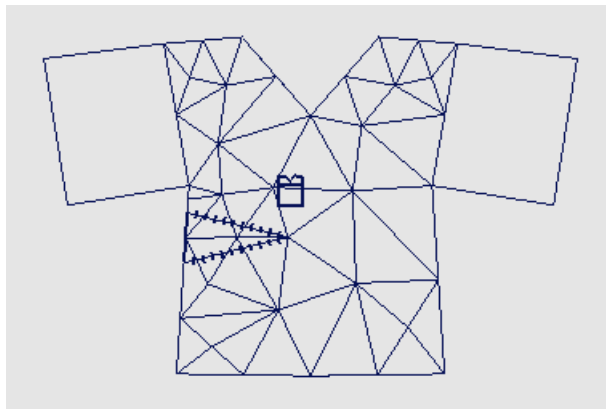
2 | Creating Cloth

How do I? > Adjust the garment

- 9 Make the curves a panel or garment.



- 10 Select the two seams for the dart and select Cloth > Create Seam.



When you simulate the cloth, the seam will be drawn together to form a dart.

Adjust the garment

This section describes changing the shape of a garment before simulating. If you want to change the shape of a garment after you have simulated, see "Modify the panel after simulating" on page 51.

Change the shape of a panel

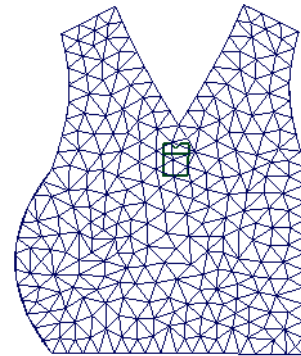
You can change the shape of a panel in a garment and the panel will retessellate.

2 | Creating Cloth

How do I? > Move the garment

To change the shape of a panel

- 1 Select Simulation > Disable Solver.
Disabling the solver is not required but it makes it easier to adjust the curve.
- 2 With the pointer over the curve, press the right mouse button and select Control Vertex.
- 3 Select CVs on the curve and use the Move tool to move them as needed.
- 4 Select Simulation > Enable Solver.



Tip

You can change the shape of two seams at once if you instance the seams. See "Duplicate curves" on page 20 for information on instancing curves.

Move the garment

You can move the garment after you've created and seamed it by either moving the curves or moving the cloth.

To move a garment using curves

- 1 Select Simulation > Disable Solver.
This disables the solver and makes it easier to move the curve.
- 2 Select the curves that comprise the garment (don't select the cloth).
- 3 Move the curves to the desired location.
- 4 Select Simulation > Enable Solver.

To move a garment using the cloth

- 1 Select the cloth mesh only (don't select the curves).
- 2 Move the cloth to the desired location.
- 3 Select Simulation > Save as Initial Cloth State.

Set resolution

You generally want to set your resolution as low as possible when you are creating and simulating a garment. You can substitute higher resolutions later after you fit the garment. (See "Modify the panel after simulating" on page 51.)

2 | Creating Cloth

How do I? > Adjust the seams

There are two ways to set the resolution of your cloth: for the entire garment or on a per-panel basis. If you sew together panels with dissimilar resolution, the lower resolution panel is further tessellated along the seam to match the resolution of the higher resolution panel.

To set the resolution of the entire garment

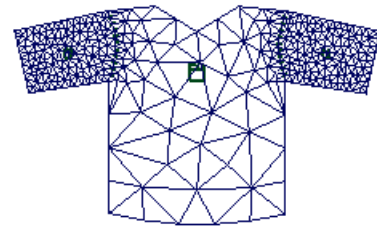
- 1 Select your cloth.
- 2 Do one of the following:
 - Display the Attribute Editor and click the cpStitcher tab.
 - In the Channel Box, click cpStitcher.
- 3 Enter a value for Base Resolution.
This represents the number of triangles in one meter of cloth.
- 4 To stop the retessellation of your cloth, press the Esc key.



Setting garment resolution

To set the resolution per-panel

- 1 Select the panel.
- 2 Do one of the following:
 - Display the Attribute Editor and click the panelShape tab.
 - In the Channel Box, locate panelShape.
- 3 Enter a value for Resolution Factor.
This is a multiplier for the Base Resolution. If you set it to 2, this panel will have twice the resolution of the Base Resolution.
- 4 To stop the retessellation of your cloth, press the Esc key.



Setting panel resolution

Adjust the seams

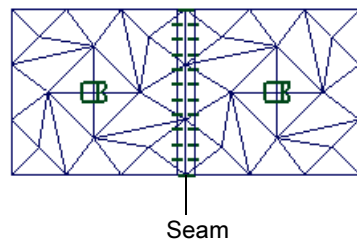
You can adjust several attributes that crease or round your seams.

To select a seam

- 1 You can turn off the Surfaces and Curves pick masks to make selecting the seam easier.
- 2 Click the seam to select it.

2 | Creating Cloth

How do I? > Adjust the seams



Crease seams

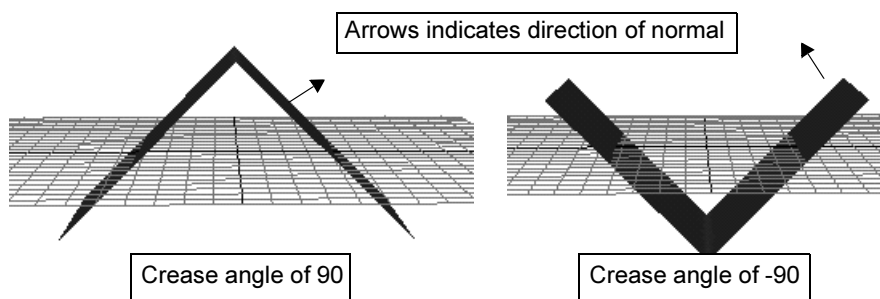
If you want to have more control over your seams, you can specify a crease angle on a particular seam. This lets you have more control over things like lapels on jackets.

To change crease angle and stiffness

- 1 Select a seam.
- 2 In the Attribute Editor or the Channel Box, enter values for the following:

Crease Angle

Specify a value between -180 and 180. A value of 0 creates no crease and gives you a flat seam. A value of 180 folds the cloth flat. Negative values fold in the direction of the normals.



Crease Stiffness

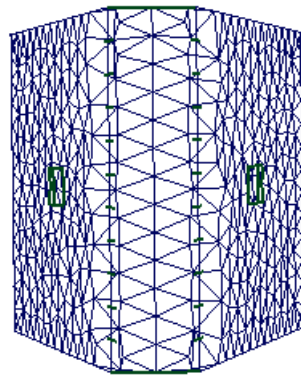
Lets you specify how much the crease should resist being pulled flat. The value you enter is a multiplier on the Bend Resistance attribute of the property. See "Applying properties to Cloth" on page 63 for information on the Bend Resistance attribute.

2 | Creating Cloth

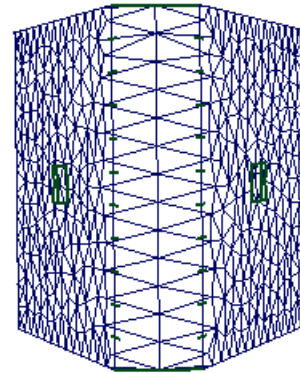
How do I? > Model parts of a garment

Round seams

The Round Seams attribute tells the Stitcher to smoothly round the panels that are being seamed. If you turn Round Seams off, only the seam vertices are stretched. Round Seams is turned on by default.



Round Seams on



Round Seams off

The Round Seams attribute does not affect how the seam behaves during the simulation. It helps distribute the amount of stretch of the mesh triangles along the seam that extends to neighboring triangles. This helps decrease the amount of time required to relax the garment around the character (see "Simulate cloth" on page 49).

To turn off round seams

- 1 Select your cloth and display the Attribute Editor.
- 2 Click the cpStitcher tab.
- 3 Click Round Seams to turn round seaming off.

If you change the Round Seams attribute after you have simulated, you must resimulate.

Model parts of a garment

If you are creating a garment that has a collar or other complicated subassembly, you can model and simulate a separate garment for the subassembly and merge it with the main garment.

For example, you can drape and fit a shirt around a character while independently building and simulating a collar as a separate garment. You position the collar near the shirt and seam it to the shirt.

2 | Creating Cloth

How do I? > Set display options

The two garments that are merged are called the *source* garment and the *target* garment. The first curve you select becomes the source garment and the second curve you select becomes the target garment. After seaming, the source garment's Stitcher and cloth node are deleted and the source garment becomes part of the target garment.

The garments must be in the same solver when you merge them. If you create them using different solvers, you can transfer them to the same solver. (See "Use multiple solvers in a scene" on page 120.)

To attach two garments

- 1** Create and simulate the main garment (target) and the subassembly garment (source) you want to attach.
- 2** If the target and source garments are in different solvers, transfer them to the same solver (see "Use multiple solvers in a scene" on page 120).
- 3** Select the garment that you want to be the target garment and display the Attribute Editor.
- 4** Click the cpStitcher tab and turn on Fit To Surface.
- 5** If you need to move the subassembly mesh closer to the main garment, select the subassembly and use the Move tool to position the subassembly where you want it in relation to the main garment. With the subassembly selected, choose Simulation > Save as Initial Cloth State.
- 6** Select the curve on the subassembly that you want to seam to the main garment.
This is considered the source garment.
- 7** Shift-Ctrl-click the corresponding curve to seam on the main garment.
This is considered the target garment.
- 8** Select Cloth > Create Seam.
The source cloth node and its Stitcher are deleted and the source garment is seamed to the target garment.

Set display options

You can set your display options to hide or show cloth panels, panel curves, and seams.

To hide cloth panels, curves, or seams

- Select Display > Hide > Hide Cloth, and select All, Panel Curves, Panels, or Seams.

2 | Creating Cloth

How do I? > Create a cloth object

To show cloth panels, curves, or seams

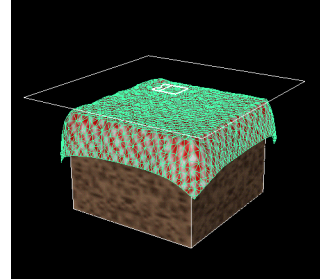
- Select Display > Show > Show Cloth, and select All, Panel Curves, Panels, or Seams.

Create a cloth object

If you are creating a simple piece of cloth like a sheet or tablecloth, you can either:

- create a polymesh or NURBS shape and make it a *cloth object*
- create curves that make a pattern for the cloth and create a *garment*

You can then add dynamic forces, add a collision object for the cloth to drape over, and run the simulation.



Differences between a garment and a cloth object

A *cloth object* is a piece of geometry simulated as cloth. If you select a NURBS shape and make it a cloth object, Cloth first converts the NURBS to a polygonal object.

A *garment* is one or more panels that are seamed together to form a cloth. (A panel is made up of two or more NURBS curves that are on the same plane and form a closed region.)

Garments

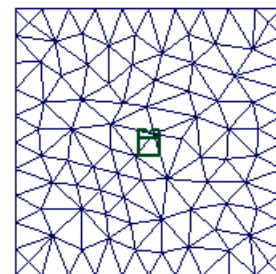
When you create a garment from curves, Cloth creates a mesh with varying sizes of triangles that are randomly distributed. The mesh has no regularity or stress lines. This creates more natural folds.

In addition, if you change the resolution of a garment after simulating, Cloth can update the geometry without resimulating. However, you need to simulate for the cloth to move with the new resolution.

All the constraints in Cloth apply to garments.

Cloth objects

You create cloth objects from polygonal shapes or NURBS shapes. The original shape is hidden and the tessellated cloth shape is displayed. The original shape and the cloth shape are grouped under the object's transform.



Garment tessellation

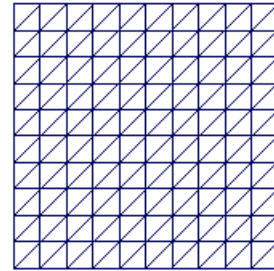
2 | Creating Cloth

How do I? > Create a cloth object

With NURBS objects and certain procedurally-generated polygonal objects, you can get artificial stress lines caused by the regular tessellation.

If you change the topology of the polygonal object after simulating, you have to resimulate.

Only the transform, field, and mesh constraints work on cloth objects. If you change resolution, you must reattach these constraints.



Cloth object tessellation of a plane

Important Cloth objects originating from NURBS surfaces are inherently unstable in stressful environments due to their regular tessellation. Regular tessellations contain unnatural biases for bending, which can cause the surface to collapse when bent in those directions. We recommend that you use a cloth garment instead of a cloth object if the cloth will be put under stress, such as folding or significant stretching.

To create a cloth object

- 1 Select a polygonal or NURBS object.
- 2 Select Cloth > Create Cloth Object.

To change the resolution of procedurally-generated polygonal objects

Polygonal primitives are examples of procedurally generated polygonal objects.

- 1 Select the cloth mesh object.
- 2 In the Channel Box, select the history node.
- 3 Enter values for the subdivisions.

To change the resolution of a NURBS object

- 1 Select the cloth mesh object.
- 2 In the Channel Box, select the nurbsTessellate node.
- 3 Enter values for the U Number and V Number attributes.

2 | Creating Cloth

Reference > cpStitcher node

Reference cpStitcher node

These are descriptions of the attributes in the cpStitcher node. For more information, see "Seam the garment" on page 25, "Set resolution" on page 31, "Adjust the seams" on page 32 and "Model parts of a garment" on page 34.

Base Resolution

This represents the number of triangles in one meter of cloth.

Round Seams

When this is on, the Stitcher smoothly rounds the panels that are being seamed. If Round Seams is turned off, only the seam vertices are stretched.

Fit To Surface

If after playing the cloth simulation you change the resolution of the garment, turn on Fit To Surface on to maintain the current shape. If Fit To Surface is turned off, the cloth will pop back to its previous shape.

cpSolver node

These are descriptions of the attributes in the cpSolver node.

Solver Attributes

These are the attributes in the Solver Attributes section.

Solver Enabled

Turns the current solver on or off.

Cloth Collisions

Turns cloth-to-cloth collisions on or off. This affects cloth collisions in all the garments connected to this solver. To disable cloth-to-cloth collisions on a per-vertex basis, you use collision constraints (see "Create collision constraints" on page 88).

Output Statistics

Turn this on to output statistics to the Script Editor. Time to calculate each frame and the total calculation time is displayed.

Velocity Cutoff Min

Specifies a cutoff velocity for cloth vertices. If a cloth vertex is moving slower than this velocity (in distance per second), the solver sets the velocity to zero. The default value of Velocity Cutoff Min is 0, which means no velocity cutoff. You can use this to control cloth motion, see "Control cloth motion" on page 53.

Velocity Cutoff Max

Specifies a second range of velocity cutoff. If the velocity of a cloth vertex is greater than the Velocity Cutoff Min and less than the Velocity Cutoff Max, then the velocity is damped toward zero. If velocity of a cloth vertex is greater than Velocity Cutoff Max, the vertex is not damped. You can use this attribute to control cloth motion, see "Control cloth motion" on page 53.

Velocity Cutoff Damping

Defines the amount of damping if a cloth vertex has a velocity value between the Velocity Cutoff Min value and the Velocity Cutoff Max value.

Damping of 0 is equivalent to multiplying velocity by $1/2$ for each time step. The solver may take many time steps between frames as it adaptively determines a solution for the cloth.

Damping of N is equivalent to multiplying velocity by $1/(N+2)$ for each time step.

You can use this attribute to control cloth motion, see "Control cloth motion" on page 53.

Start Frame

Specifies at what frame the solver starts calculating.

Frame Samples

Specifies the number of times the solver samples the time interval between successive frames. Frame Samples and Time Step Size work together. See "Set frame samples and time step size" on page 54.

Time Step Size

Specifies the maximum time, in seconds, that the internal dynamic solution advances. Frame Samples and Time Step Size work together. See "Set frame samples and time step size" on page 54.

Solver Scale

Specifies the scale of the internal coordinate system of the solver. See "Scale the solver" on page 54.

Time Scale

Determines the relative time Cloth is running with respect to the Dependency Graph time. For example, if you want the cloth to run through the simulation twice as fast, the Time Scale value should be set to 2. The longer the Cloth's simulation time is, the more force has

2 | Creating Cloth

Reference > cpSolver node

an effect on the Cloth. For example, if the force is gravity, the Cloth will appear to be heavier as the Time Scale increases. The default value is 1.

Relax Frame Length

Specifies the number of frames that a rubbery “relax material” is applied to a garment and the garment does not react to gravity. After the specified number of frames, the normal material is applied and the cloth reacts to gravity.

If you are creating a cloth object that does not need to be relaxed, such as a tablecloth, set the Relax Frame Length to zero.

If you are creating a cloth object that is really stretched out, you can increase this value.

Gravity

Specifies the value for gravity. If you want to disable gravity, set this to 0, 0, 0. The default is 0, -980, 0.

Cache Enabled

Turn this on to cache your simulation results to a file. For more information on caching, see “Manage cache files” on page 98.

Cache Name

Specifies the name of the current cache. You can save cache files to different names and play them back. See “Save and load cache files” on page 103 for more information.

Save Cache

The Save Cache button is beside the Cache Name attribute. Click this button to save the cache when you want to, ensuring that successful simulations are retained.

Cache Save Interval

Cloth simulation is often processing intensive and sometimes time consuming. By saving simulations in small increments this can often overcome situations where an entire simulation is lost. You can set the Cache Save Interval to any value. For example, if you set it to 10, caches will be saved every 10 frames during simulation. The default value is 0.

Clear Simulation Timer

Click the Clear Simulation Timer button to reset the internal timer of the solver. Timing statistics are printed to the script editor when Output Statistics is turned on.

If you change your simulation and want to know if this speeds up or slows down your simulation, you can reset the timer before starting the new simulation and compare simulation times.

Adaptation Control

This controls what steps the solver can take when it reacts to a situation where it is having difficulty solving a simulation. Select an option from the drop-down list.

Adapt Frame Samples

And Time Step This gives the solver full control over reaction. The solver will adjust frame samples and time step as it sees necessary to try to resolve the problem.

Adapt Time Step This limits the solver's reaction to adjusting the time step variable.

Stop Solver This tells the solver to halt and release control to the user. A MEL script is executed if it is defined by the user.

No Action This tells the solver not to react.

monitorScript

Specify the monitor control script, also known as the MEL callback script. If a script is defined and the solver has not been able to resolve a failing simulation, or Stop Solver is specified for Adaptation Control, then the script assigned to this string will be executed. For more information, see "Monitor script parameters" on page 117.

Collision Object Debug

These are the attributes in the Collision Object Debug section. For more information, see "Debug cloth collisions" on page 58.

Show All, Hide All

Shows or hides all meshes.

First, Last, Previous, and Next

Use any of these to view the appropriate group of meshes and hide the previously viewed group (if any). First select Hide All (of the meshes) and then use these buttons to step through the subframes.

Deprecated Attributes

The Deprecated Attributes section contains attributes that are no longer used, but are kept around for backwards compatibility purposes. When old scenes are loaded into Maya, Maya checks for these old attributes and copies them to new attributes/nodes.

2 | Creating Cloth

Reference > Cloth > Create Panel

Cloth > Create Panel

Use this to create a cloth panel from the selected curves. For more information, see "Create panels" on page 23.

Cloth > Create Garment

Use this to create a cloth garment from the selected panel or curves. For more information, see "Create a garment" on page 15.

Cloth > Create Seam

Use this to create a cloth seam from the selected curve(s). For more information, see "Seam the garment" on page 25.

Cloth > Create Cloth Object

Use this to create a cloth object from the selected polygon. For more information, see "Create a cloth object" on page 36.

3 Draping and fitting Cloth

About

Draping and fitting

After you create the garment, you drape it and fit it to the character. To drape the garment on the model, you specify the model as a collision object and use the cloth solver to drape the garment over the model.



Fitting involves modifying the original garment to accommodate peculiarities of the character on which it is draped. You can influence how the cloth settles on the character using constraints and dynamic fields. For example, you can pull out wrinkles or pin portions of the garment to specific places on the character. You can assign different properties to the panels and set various attributes of the cloth to change the physical behavior of the cloth.

Once the garment has settled, you can save this initial position of the garment and begin animating.

Tip

If you have a complicated scene, you can segment the cloth simulations into multiple independent simulations that are solved separately. You do this by using multiple solvers. This chapter covers draping and fitting using a single solver. To use multiple solvers, see "Use multiple solvers in a scene" on page 120.

How do I?

Create cloth collision objects

In order for your cloth to drape over your model or an object, you need to make it a collision object. When you make an object a cloth collision object, Maya connects it to the cloth solver and adds collision object attributes.

3 | Draping and fitting Cloth

How do I? > Adjust the cloth collision object

Polygonal objects, NURBS, and subdivision surfaces can all be used as collision objects. If your model is a NURBS object or a subdivision surface, Maya automatically converts it to polygons when you make it a collision object.

Tip

This section covers using collision objects with a *single* solver. For information on using collision objects with *multiple* solvers, see "Use collision objects with multiple solvers" on page 122.

To create a cloth collision object

- 1 Select the object you want to be a collision object.
If you have templated your model, select the model from the Outliner.
- 2 With the model or object still selected, select Cloth > Create Collision Object.
The object is made a collision object and connected to the current solver. Collision object attributes are added (see "Adjust the cloth collision object" on page 44).
Now, when your cloth evaluates, it will collide with the collision object.

Remove collision objects

You can remove a collision object from the solver. However, the collision object attributes remain. That way, you can temporarily remove a collision object from the solver and add it back without losing the collision object attribute settings.

To remove a cloth collision object

- 1 Select the collision object.
- 2 Select Cloth > Remove Collision Object.

Adjust the cloth collision object

The collision object attributes help determine how the cloth collides with the collision object.

To adjust the collision object attributes

- 1 Select the collision object.
- 2 Do one of the following:

3 | Draping and fitting Cloth

How do I? > Adjust the cloth collision object

- Display the Attribute Editor, click the *nameShape* tab, and open the Extra Attributes section.
- In the Channel Box, locate the collision attributes.

3 Enter values for the following:

Collision Offset

Specifies the distance the cloth stays from the collision object. The default is 1. If your character is small, for example 10 cm high, you might want to decrease this value.

Collision Offset is measured in centimeters and is not affected by the solver scale. If you specify a value of 2, the cloth stays 2 centimeters from the collision object.

Collision Depth

Specifies the distance the cloth can penetrate the collision object and still be repelled. Once the cloth is past this threshold, the collision object won't try to repel the cloth. This value should not be greater than half the distance from one side of the collision object to the opposite side of the object. In this case, the cloth may be pulled through the object. The depth is measured in centimeters and is not affected by the solver scale.

Collision Depth is applied to an entire collision object, which may not be appropriate for complex objects such as human bodies. If finer control of the collision depth is desired, then turn on the Depth Map Enable checkbox on the collision object for a single frame in the first few frames of the cloth simulation. This will generate a depth map based on the shape of the collision object. If you still want finer control, you can paint offsets to the generated depth map using the **Cloth > Paint Collision Properties Tool**.

Note

Depth Map Enable and Depth Map Offset (Paint Collision Properties Tool) should only be used if a simulation is incorrect and vertices are sticking inside the collision object. These options cannot be used to adjust the simulation results.

Important!

Make sure the surface normals of the collision object face the outside of the object. If the normals face to the inside of the object, intersecting cloth will be pulled into the object.

3 | Draping and fitting Cloth

How do I? > Adjust the cloth collision object

Tip

Neither Collision Offset nor Collision Depth is affected by the Solver Scale. For example, if Collision Offset is set to 1 and Solver Scale is set to 10, the cloth will still be offset 1 unit above the surface of the model.

Collision Priority

Collision Priority controls how pinched cloth vertices are handled during collisions. If you want a collision object to take priority over another collision object, you set the Collision Priority attribute.

A lower value takes priority over a higher value. The default value is 1. You can set values to positive or negative short integers. We recommend you use values of 1, 2, or 3. In most cases, you only need to use values of 1 and 2.

For more information, see the next section, “Control pinched cloth.”

Depth Map Enable

When turned on, this scans the collision object and calculates the ideal collision depth for each face on the object. A new depth map is generated for each frame so this can be expensive to use. This attribute is located in the Extra Attributes section of the collision object’s shape node in the Attribute Editor.

Depth Map Weight

This value is multiplied by the depth map value for each face, resulting in the depth map actually used by Maya. Generally the depth map weight should be left at its default value of 0.3. Raising this above 0.3 will result in a deeper depth map, but increase the possibility of erratic or unstable simulations. Lowering this value will result in a more shallow depth map that may increase the chance of cloth vertices getting stuck in the cloth object. This attribute is located in the Extra Attributes section of the collision object’s shape node in the Attribute Editor.

Collision Display

This drop-down list only appears if you selected **Cloth > Create Collision Offset/Depth Mesh** for the collision object. Use this drop-down list to control which collision object attributes are displayed as a mesh: Depth, Offset, Depth and Offset, or None.

3 | Draping and fitting Cloth

How do I? > Paint cloth collision objects

Control pinched cloth

Sometimes, cloth garments become pinched between two collision objects. For example, if you have a skirted character who sits down on a chair, you define the chair and the character skin as collision objects. If the chair and skin intersect, how is the cloth solved? Or if cloth gets caught under the arm and in between the elbows, how does the software handle the collisions?

The collision object triangle that is closer to the cloth in each time step takes precedence. The other collision object triangle is ignored by the cloth for that time step and is reconsidered the next time step. However, in some cases the proximity of the collision objects switches quickly. This can cause instability in the solution.

To help solve this problem, you can set the Collision Priority attribute so one collision object takes priority over another collision object during collisions. A lower value takes priority over a higher value. For example, in the case of the chair and the skirt, you could set the collision priority of the chair to 1, and collision priority of the character skin to 2. This would cause the vertices that are pinched to ignore the skin for those frames where both the skin and the chair were in contact.

Paint cloth collision objects

Use the Paint Collision Properties Tool to paint collision properties of cloth objects. Specifically, the collision priority for collision objects is paintable as well as the collision depth map offset and collision offset map. These attributes are per-vertex maps and therefore cannot be painted on NURBS surfaces.

To make it easier to see the effects of your painting, you can also use **Cloth > Create Collision Offset/Depth Mesh**. The following are a couple of suggested workflows for using these features:

- "To paint Cloth collision attributes" on page 47
- "To tweak a Cloth collision simulation" on page 48

To paint Cloth collision attributes

- 1 Select the Cloth collision object to be painted.
- 2 In the Cloth menu set, select **Cloth > Create Collision Offset/Depth Mesh**.

A mesh appears around the collision object representing the Collision Offset value. To change the mesh display to Collision Depth, go to the Attribute Editor of the object's shape node and in the Extra Attributes section, select *depth* from the Display Collision drop-down list.

3 | Draping and fitting Cloth

How do I? > Visualize cloth collision object attributes

For more information, see "Visualize cloth collision object attributes" on page 48.

- 3 Select **Cloth > Paint Collision Properties Tool** > .

The Paint Cloth Collision Properties Tool settings window appears.

- 4 Select the attribute you want to paint from the Paint Attribute drop-down list and then select a Value to paint. For descriptions of these attributes, see "Cloth > Paint Collision Properties Tool" on page 60.

Tips

Paint in Smooth Shaded display mode.

If painting Collision Depth, the mesh appears on the inside of the collision object. To make it easier to paint, go to the Attribute Editor of the collision object's shape node, in the Extra Attributes section and adjust the overall Collision Depth value, for example, to -3. Once you've finished painting, reset the Collision Depth value.

- 5 Set the rest of the painting attributes. See "**Common Artisan Brush Tool Settings**" in the *Paint Effects, Artisan, and 3D Paint* guide.
- 6 Drag to paint the collision object and see the effects on the Offset/Depth mesh.

To tweak a Cloth collision simulation

If a Cloth collision simulation is incorrect and vertices are sticking inside the collision object, you can use the following workflow to adjust the simulation results.

- 1 Play the Cloth simulation.
- 2 Follow the steps in "To paint Cloth collision attributes" on page 47 to paint Collision Depth or Collision Offset values in the problem areas.
- 3 To clear the Cloth cache, select Simulation > Delete Cache.
- 4 Replay the Cloth simulation.
- 5 Repeat steps 2 to 4 until the Cloth collision simulation is corrected.

Visualize cloth collision object attributes

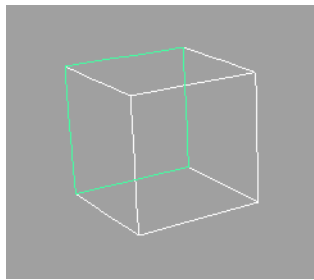
You can visualize and animate a cloth object's collision depth and offset attributes. This helps to better control the collision parameters.

3 | Draping and fitting Cloth

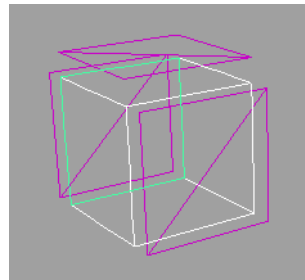
How do I? > Simulate cloth

To show the collision object's offset or depth mesh

- 1 Select the collision object whose collision attributes you want to visualize.
- 2 Select **Cloth > Create Collision Offset/Depth Mesh**.
A mesh appears around the collision object. Also, a Collision Display drop-down list is added to the collision object attributes. Use this drop-down list to control which collision attribute is displayed: Depth, Offset, Depth and Offset, or None. For more information about collision attributes, see "Adjust the cloth collision object" on page 44.



Collision object without mesh



Collision object with mesh

To hide the collision object's offset or depth mesh

- 1 Select the collision object whose collision mesh you want to hide.
- 2 Select **Cloth > Remove Collision Offset/Depth Mesh**.
The mesh is removed from the collision object.

Simulate cloth

Once you have your cloth ready to drape over your character, you can start the simulation. The simulation is performed by the cloth solver, which assembles information on all the garments, cloth objects, the bodies they interact with, and any fields or constraints applied to the cloth.

You can use multiple solvers in your scene to segment the cloth simulations into multiple independent simulations that are solved separately (see "Use multiple solvers in a scene" on page 120).

What happens when cloth solves?

When you start the cloth simulation, a rubbery material is applied to the garment and it is not affected by gravity for the first few frames. This period is called the *relax frame length*. You can specify how long the relax frame length lasts (see "Relax Frame Length" on page 40).

3 | Draping and fitting Cloth

How do I? > Use the cloth solver

This lets the simulation proceed more quickly to get past the state in which the cloth is stretched beyond its natural state and reach the point where it can solve more naturally. After a few frames, gravity affects the cloth and its normal material is applied.

Once you've done the initial draping, you can save the initial state and set the relax frame length to 0.

Use the cloth solver

There are two ways for the cloth to solve:

- Play through the time slider
- Start a local simulation

For the draping phase, you get the same results using either method of cloth solving.

Important!

In interactive mode (GUI or non-batch mode), cloth simulation is triggered by refresh events, which can occur only when the 3D view is visible on the screen. If the Maya main window is iconified or if a screen saver is active, the simulation will stop. For background simulation done non-interactively, we recommend you use batch mode.

Play through the time slider

When you play through the time slider, the cloth evaluates each time a frame advances. As time changes, the cloth's motion is saved in a cache file so you can scrub in the time slider.

To simulate by playing through the time slider

- 1 Make sure your start frame in the time slider is frame 1.
- 2 In your Animation preferences, make sure Playback Speed is set to Play every frame and Playback by is set to 1.
- 3 Click the play button.
After a few seconds, your cloth should begin to drape over your character.
- 4 To stop the simulation, press the Esc key or click the stop playback button.

3 | Draping and fitting Cloth

How do I? > Use the cloth solver

To undo a simulation created by playing through the time slider

- 1 Select Simulation > Delete Cache.
For more information on caching, see "Manage cache files" on page 98.
- 2 Click the Rewind button.

Start a local simulation

When you start a local simulation, the cloth solves but time does not advance and no cache is created.

If you have an animated character, you can run a local simulation to drape the cloth without the character moving. You also use local simulation when using the drag control (see "Use the Drag control" on page 55).

To run a local simulation

- 1 Select Simulation > Start Local Simulation.
- 2 To stop the simulation, press the Esc key or select Simulation > Stop Local Simulation.

Tip

You can tear off the Simulation menu so it is easier to select menu items.

To undo a local simulation

- Select Edit > Undo.
This returns you to the previous state of the cloth.

Modify the panel after simulating

You can change the resolution of a cloth garment, modify the shape of a panel, or add seams after you have run the simulation using the Fit to Surface option. The geometry is updated without having to start the simulation from the beginning.

When you use Fit to Surface, the cache is deleted and a new initial state is saved.

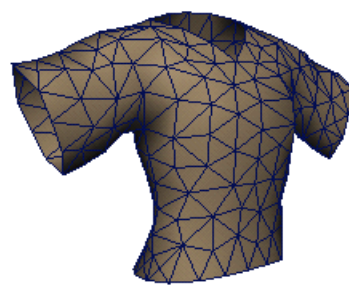
To modify the resolution

- 1 Select the cloth garment and display the cpStitcher attributes in the Attribute Editor.
- 2 Turn on Fit to Surface.

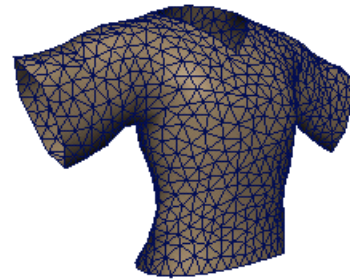
3 | Draping and fitting Cloth

How do I? > Use the cloth solver

- 3 Enter a new value for Base Resolution.
The cloth garment updates to the new resolution.
- 4 To stop the retessellation of your cloth, press the Esc key.



Low-resolution cloth



High-resolution cloth

To modify the panel shape

- 1 Select Simulation > Disable Solver.
- 2 Select the cloth garment and display the cpStitcher attributes in the Attribute Editor.
- 3 Turn on Fit to Surface.

Important

Use caution when moving control points to make sure that all of the control points of the panel remain in a plane and that the curves of the panel continue to form a closed, non-intersecting loop.

- 4 Select some CVs and drag the curve to modify the panel shape.
- 5 Select Simulation > Enable Solver.
The new topology is mapped onto the surface.
- 6 Select Simulation > Start Local Simulation to run a local simulation.
You should see the modifications take shape.

To add a seam

- 1 Select the cloth garment and display the cpStitcher attributes in the Attribute Editor.
- 2 Turn on Fit to Surface.
- 3 Add the seam.

Tip You can seam panels from a different garment. See “Model parts of a garment” on page 34.

Save initial state of the cloth

Once you have the cloth in the position you like, you save its initial state. This tells the cloth solver to use the current position as its start position.

To save the initial state

- 1 Select the cloth.
- 2 Select Simulation > Save as Initial Cloth State.
- 3 Select Simulation > Delete Cache.

Adjust the cloth solver

The cloth solver attributes affect how cloth solves in general.

To adjust the solver attributes

- 1 Select the cloth and display the Attribute Editor.
- 2 Click the cpSolver tab and set the desired attributes. For descriptions of these attributes, see “cpSolver node” on page 38.
See also “Advanced solver performance tools” on page 117.

Solver hang detection

The solver can detect instances where it is having difficulties solving a simulation. To control how a solver reacts to situations where there is a probability of it hanging, use the following attributes to the cpSolver node: “Adaptation Control” and “monitorScript” in “cpSolver node” on page 38.

Control cloth motion

You can use the velocity attributes to inhibit cloth motion when a garment is draped on a character that is stationary or barely moving. The velocity attributes control the velocity of cloth vertices when the velocity is close to zero.

Tips for setting velocity cutoff

Stopping cloth motion when a moving character stops

Set velocityCutoffMin to 1, velocityCutoffMax to 10, and velocityCutoffDamping to 4.

3 | Draping and fitting Cloth

How do I? > Adjust the cloth solver

With these velocity settings and a film frame rate of 1/24 fps, if your cloth vertices are moving less than 0.04 units per frame, the velocity will be set to zero. If the cloth vertices are moving between 0.04 and 0.4, the velocity will be multiplied by 1/6.

Reducing small popping of cloth vertices

Keyframe the Velocity Cutoff Min attribute from 0 to 2 during the frames where popping needs to be reduced. This helps correct popping without affecting the rest of the cloth animation.

Set frame samples and time step size

If your animation is moving fast and you notice that your cloth is penetrating the collision object or that the cloth motion is jerky, you can adjust the Frame Samples and Time Step Size.

Frame Samples and Time Step Size work together to control how the solver works. Frame Samples is the number of times the solver samples the collision object geometry between successive frames. Time Step Size divided by Frame Samples is the maximum time, in seconds, that the internal dynamic solution advances.

If you notice jerky motion or penetration, first try increasing the Frame Samples value. If that doesn't fix the problem, decrease the Time Step in small increments.

Scale the solver

If you are working in units smaller than real-world units, you can increase the Solver Scale attribute. This attribute lets you control the scale of the internal coordinate system of the solver.

When Solver Scale is set to 1.0 (the default), the solver coordinate system is the same as that used by Maya. When Solver Scale is set to 2.0, the solver coordinate system is two times larger than the one used by Maya.

For example, if your 3D character is 6 inches tall in the Maya workspace but you want the clothes to look and behave as if your character is 5 feet (60 inches) tall, you can set the solver scale to 10.

$$\text{solver scale} = \text{desired size} / \text{Maya size}$$

$$10 = 60'' / 6''$$

The solver scale doesn't change the actual size of the cloth, it just makes the cloth behave as though it were a different size. To physically change the actual size of the cloth, you can change the U Scale and V Scale attributes of the property assigned to the panel (see "U/V Scale" on page 74).

Manipulate your cloth

You can manipulate your cloth several ways:

- You can manually move points on the cloth.
- You can use the Drag control to adjust areas of your cloth before you start animating. You can also use the Drag control as an animation tool.
- You can use constraints to attach objects to cloth or constrain cloth to a body (see "Use cloth constraints" on page 79).
- You can apply dynamic forces to move the cloth (see "Connect dynamic fields to your cloth" on page 91).



Manually move cloth points

Sometimes you need to move points around on your cloth to make it the exact shape you want. However, the solver doesn't understand how to calculate the forces when you simply grab a point and move it. You need to re-evaluate the cloth in its modified position and calculate the appropriate forces.

To manually move cloth points

- 1** Click the right mouse button over the cloth and select Vertex.
- 2** Select some points on the cloth.
- 3** Move the points to the desired location.

Tip

You may want to use the proportional modification tool (Modify > Transformation Tools > Proportional Modification) because if the points move too far from each other, the cloth can become unstable.

- 4** Select the cloth you just modified.
- 5** Select Simulation > Update Cloth State.

This gives the new cloth positions to the solver. It doesn't delete the cache.

Use the Drag control

Sometimes you want to fix certain areas of your cloth before you start your animation. You can do this using a manipulator called a *Drag control*. You can also use the Drag control to roll up your character's sleeves, pull a towel through a towel rack, or wrap a scarf around your character's neck.

3 | Draping and fitting Cloth

How do I? > Manipulate your cloth

The Drag control takes points on your cloth and moves them along a path towards a destination.

When you use the Drag control to fix certain areas of your cloth before starting your animation, you use a local simulation. When you use a local simulation, time does not advance in the time slider.

When you use the Drag manipulator as part of your animation, such as rolling up your character's sleeves, you need to keyframe the Drag control.

To use the drag control

- 1** Click over the cloth poly mesh with the right mouse button and select Vertex.
- 2** Select a few vertices on the cloth.
- 3** Select Simulation > Manipulators > Drag Control.
A cloth manipulator is created, and the locator at the end of the path is selected.
- 4** To manipulate the path, simply rotate or move the locator.
- 5** To start simulating, select Simulation > Start Local Simulation.
- 6** To stop the local simulation either press the Esc key or select Simulation > Stop Local Simulation.

To undo the effect of the drag control

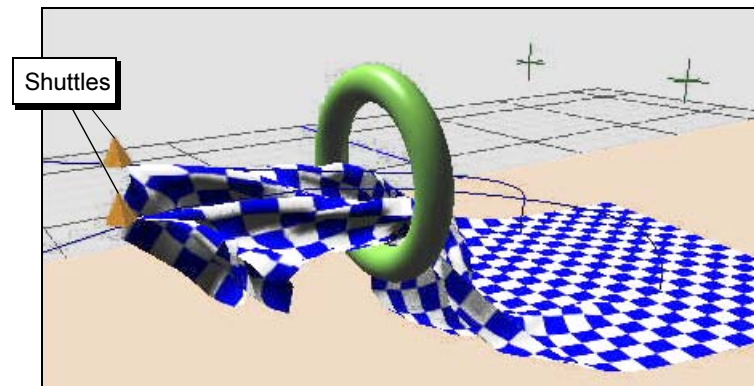
Select Edit > Undo.

To keyframe the Drag control

- 1** Select the shuttle (small pyramid shape).
- 2** In the Channel Box, click shuttleShape and keyframe the U Value attribute.

3 | Draping and fitting Cloth

How do I? > Fix interpenetration problems



Drag control pulling cloth through ring

To set the drag control attributes

- 1 Select the shuttle.
- 2 In the Channel Box or Attribute Editor, enter values for the following:

U Value

Controls the position of the shuttle along the motion path. A value of 0 is the start point and a value of 1 is the end point.

Rate

Controls the speed of the shuttle during local simulation. Typical values are 0.03 - 0.1.

To delete the drag control

In the Outliner, display the hierarchy of your cloth object. Select DragControl and delete it.

Fix interpenetration problems

Sometimes you may see interpenetration between cloth and collision objects. Use the following tips to correct interpenetration.

- Keep the cloth mesh size reasonably small compared to the other objects for the final rendered simulation.

The cloth solver operates on the vertices of a cloth mesh, not the triangle edges. Because of this, if the size of the objects with which the cloth intersects is small compared to the size of the triangles of the cloth, the cloth edges may pass through those objects. Try increasing the resolution of the cloth.

- Avoid setting the initial state of the simulation with cloth bodies penetrating other objects in the simulation.

3 | Draping and fitting Cloth

How do I? > Debug cloth collisions

The cloth solver tries to avoid any interpenetration between cloth bodies and other cloth and rigid bodies.

- Raise the Frame Samples rate of the cloth solver.

This helps prevent collision objects from passing through the cloth. It also stabilizes high-speed cloth collisions with collision objects.

See "Set frame samples and time step size" on page 54 for more information.

- Lower the Time Step attribute of the cloth solver.

This helps prevent collision objects from passing through the cloth. It also stabilizes high-speed cloth collisions with collision objects.

See "Set frame samples and time step size" on page 54 for more information.

- Check the Collision Offset attribute of the collision object.

The Collision Offset specifies the distance the cloth stays from the collision object. See "Applying properties to Cloth" on page 63 for more information.

Debug cloth collisions

Complex Cloth simulations that generate collision objects through the use of deformers or custom nodes can cause problems with the Cloth simulation when the object moves through the scene in an erratic or jumpy manner. If erratic motion occurs at the subframe level, you can use the Cloth Collision Debug feature to troubleshoot. See "To debug a Cloth collision simulation" on page 59.

When you turn on Cloth Collision Debug and run the Cloth simulation, each collision object that was selected for debugging is displayed with a mesh. All of the generated meshes are parented under a common transform node called `CollisionObjectDebug_solvername`. Under this transform node, transforms are created for each subframe being evaluated. These nodes are named `frame_frame_subframe`. Under these transforms, the actual meshes are created and named after the original collision object that they are based on.

The Frame Samples attribute in the `cpSolver` node determines how many meshes are created for each frame of the simulation.

3 | Draping and fitting Cloth

How do I? > Debug cloth collisions

Note When using the Cloth Collision Debug feature, groups are created each time the Cloth solver samples the shape of a collision object. This may result in additional groups being created that are slightly beyond the playback range. If the collision geometry is not animated beyond the last frame of the playback, these additional groups will be in the same position as the last frame. This is expected behavior. However as a workaround you can delete the groups you don't want.

Large amounts of meshes may be created using this feature. Collision Object Debug Enable is keyable and you are encouraged to only turn it on for problematic areas.

Once the simulation is run and the meshes are generated, they are visible, which may be confusing. To assist with visualizing all the meshes, there are control buttons in the cpSolver node in the Collision Object Debug section:

Show All, Hide All

Shows or hides all meshes.

First, Last, Previous, and Next

Use any of these to view the appropriate group of meshes and hide the previously viewed group (if any). First select Hide All (of the meshes) and then use these buttons to step through the subframes.

To debug a Cloth collision simulation

- 1 Open the Cloth scene.
- 2 Select the Cloth collision objects that seem to be causing the problem and then, in the Cloth menu set, select Cloth > Collision Object Debug > Add Selected Objects.
- 3 In the cpSolver node, go to the Collision Object Debug section and turn on the Collision Obj Debug Enable attribute.
- 4 Do one of the following:
 - Select Simulation > Start Local Simulation to run the simulation.
 - Use the Collision Object Debug controls that are available in the cpSolver node to visualize the results.

The selected collision objects will be echoed as the solver evaluates them during simulation.

3 | Draping and fitting Cloth

Reference > Cloth > Create Collision Object

Reference Cloth > Create Collision Object

Sets the selected object as a collision object. For more information, see “Create cloth collision objects” on page 43.

Cloth > Remove Collision Object

Removes the selected collision object from the solver. For more information, see “Remove collision objects” on page 44.

Cloth > Create Collision Offset/Depth Mesh

Displays a collision mesh for the selected collision objects. See “Visualize cloth collision object attributes” on page 48.

Cloth > Remove Collision Offset/Depth Mesh

Removes the collision mesh from the selected collision objects. See “Visualize cloth collision object attributes” on page 48.

Cloth > Paint Collision Properties Tool

Lets you use the Paint Collision Properties Tool to paint collision properties of cloth objects. For more information, see “Paint cloth collision objects” on page 47. See also “How Artisan brush tools work” in the *Paint Effects, Artisan, and 3D Paint* guide.

Cloth > Paint Collision Properties Tool > □

Lets you specify the settings for the Paint Collision Properties Tool in the Tool Settings editor and then paint the selected Cloth collision object. In the Paint section there are some attributes unique to the Paint Collision Properties Tool. These unique attributes are described below. For descriptions of other attributes in the Paint section and attributes in all other sections, see “Common Artisan Brush Tool Settings” and also “Artisan Brush Tool Settings” in the *Paint Effects, Artisan, and 3D Paint* guide.

Paint section

These are attributes in the Paint section that are unique to the Paint Collision Properties Tool.

3 | Draping and fitting Cloth

Reference > Simulation > Start Local Simulation

Select Attribute

Be sure to first select a Cloth collision object in the scene view, then select a cloth attribute from the drop-down list (see attribute descriptions below). When you paint, you paint values for that attribute.

Priority Map This is a per-vertex value [0,1]. These values are averaged over a face and added to Collision Priority. The resulting per-face values are used to resolve collisions on a per-face level in the same way that Collision Priority was used on the per-object level.

Depth Map Offset This is a per-vertex value [-1,1]. These values are averaged over a face and then used as a percentage offset applied to the calculated depth at that face. This is used to adjust for situations where the depth map calculation method does not produce perfect results. The effective depth can be painted up or down as needed.

If Depth Map Offset exists and Depth Map Enable is not turned on, Depth Map Offset is instead applied to Collision Depth. This allows the depth map to be completely manually painted if that is desirable.

Collision Offset Map This is a per-vertex value [-1,1]. These values are averaged over a face and then used as a percentage offset applied to the calculated offset at that face. This is used to adjust for situations where the depth offset calculation method does not produce perfect results. The effective offset can be painted up or down as needed.

Delete Attribute

If you've painted an attribute and want to undo the painting, select this attribute from the Delete Attribute drop-down list.

Simulation > Start Local Simulation

This starts the Cloth simulation. For more information, see "Simulate cloth" on page 49 and "Start a local simulation" on page 51.

Simulation > Stop Local Simulation

This stops the simulation that's running. For more information, see "Start a local simulation" on page 51.

3 | Draping and fitting Cloth

Reference > Simulation > Save as Initial Cloth State

Simulation > Save as Initial Cloth State

Use this to tell the cloth solver to use the current position as its start position. For more information, see "Save initial state of the cloth" on page 53.

Simulation > Update Cloth State

Use this to give the new cloth positions to the solver, but it doesn't delete the cache. For more information, see "Manually move cloth points" on page 55.

Simulation > Manipulators > Drag Control

Activates the Drag Control Cloth manipulator and the locator at the end of the path is selected. For more information, see "Manipulate your cloth" on page 55 and "Use the Drag control" on page 55.

4 Applying properties to Cloth

About

Applying properties to cloth



Cloth properties work much like shaders. However, instead of assigning a color or texture like a shader, cloth properties specify the physical properties of the cloth. These properties affect how the cloth behaves when it moves. For example, you could create a property that makes your cloth behave like denim. See "Apply properties to panels" on page 63.

You can create new materials and save them in your own material library.

You can also paint properties on portions of the cloth panel instead of the entire panel. See "Paint properties on cloth" on page 64.

How do I?

Apply properties to panels

By default, each panel is connected to a property called *cpDefaultProperty*. However, you can add as many properties as you want and connect any panel to any property.

To create a new property

- Select Simulation > Properties > Create Cloth Property.
This creates a new property. If you have any panels selected, the property is automatically connected to the panels.


4 | Applying properties to Cloth

How do I? > Remove Cloth properties

To assign a property to a panel

- 1 Select the panel.
- 2 Select Simulation > Properties > cpProperty $number$.
The property is assigned to the selected panels.

To change attributes of the property

- 1 Do one of the following:
 - Select Simulation > Properties > cpProperty $number$ >  to display the Attribute Editor.
 - Select the panel and look in the Channel Box for the attributes.
- 2 Enter values for the attributes in the Property Attributes section. For descriptions of these attributes, see "cpProperty node" on page 73.

Remove Cloth properties

Use Remove Cloth Property to sever the connection between the cloth and the solver. The Cloth Property node remains in the Properties submenu.

To remove a cloth property

- 1 In the Cloth menu set select Simulation > Properties > *PropertyName*, where *PropertyName* is the name of the desired property.
- 2 Select Simulation > Properties > Remove Cloth Property. This removes the selected cloth property.

Paint properties on cloth

You can use the Paint Cloth Properties Tool to paint properties, such as wrinkling effects across the entire surface of a garment or cloth object, and tessellation of garments and panels. This lets you apply properties to portions of the cloth instead of the entire panel or object. You could also use the Paint Cloth Properties Tool to apply properties such as stiffness to isolated parts of the garment rather than to whole panels, much like spraying starch on a collar.

When you select a property attribute to paint, a paint attribute is dynamically added to the cloth. The paint attribute is used as a multiplier or "weight." The property attribute value is multiplied by the paint attribute value.

To paint properties on cloth

- 1 Select Shading > Smooth Shade Selected Items.
- 2 Select the cloth you want to paint property attribute values on.

4 | Applying properties to Cloth

How do I? > Paint properties on cloth

- 3 From the Cloth menu set, select Simulation > Properties > Paint Cloth Properties Tool > .

The Tool Settings window opens. For information about these settings, see "Simulation > Properties > Paint Cloth Properties Tool" on page 73.

- 4 From the Paint Attribute drop-down menu, select the property attribute you want to paint values for. If you want to paint wrinkles, select the *bendAngle* attribute. (See "Attribute for painting wrinkles" on page 65.) If you want to paint tessellation, paint the *tessellation* attribute. (See "Attribute for painting tessellation on garments and panels" on page 67.)

For information on the property attributes see "Apply properties to panels" on page 63.

- 5 Define the Paint Cloth Properties Tool settings, if required.

For each property attribute, the initial value is set to 1.0. For information on defining settings, see "Simulation > Properties > Paint Cloth Properties Tool" on page 73.

- 6 Move the pointer over the cloth.

The pointer becomes a paintbrush.

- 7 Paint over the triangle edges.

The value of the property attribute in the painted area is modified according to the settings of the Paint Cloth Properties Tool. Look in the Script Editor to see the values.

Painting U/V attributes

For attributes with U and V settings, such as U Scale, V Scale, U BendRate and V BendRate, the U and V share one paint attribute.

For example, if you select the Scale property from the Paint Attribute pulldown, U Scale and V Scale are both affected by the Scale weight. The formula is:

```
the final uscale = uscale * scaleWeight  
the final vscale = vscale * scaleWeight
```

Attribute for painting wrinkles

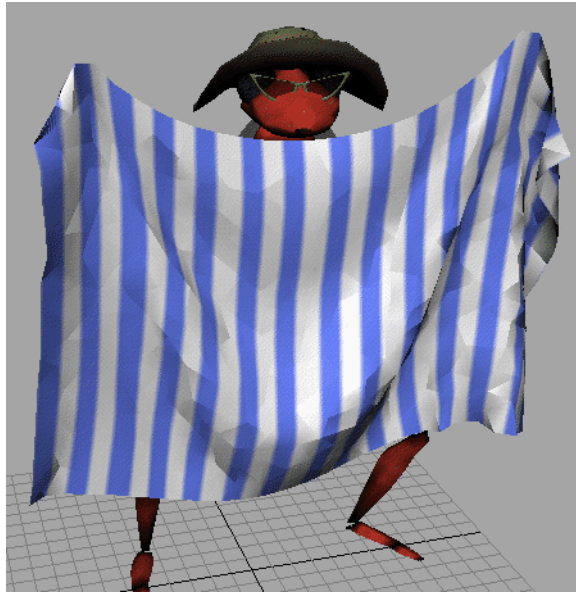
Cloth has an attribute—*bendAngle*—to make it easy to paint wrinkles on your cloth. The *bendAngle* attribute is dynamically added to the cloth when you choose *bendAngle* from the Paint Cloth Properties Tool.

4 | Applying properties to Cloth

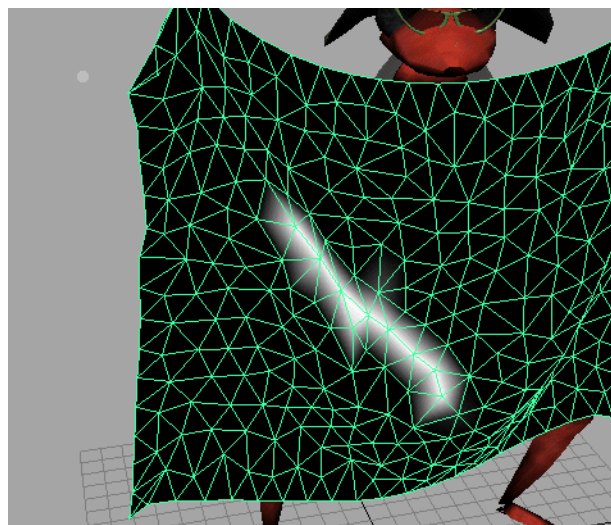
How do I? > Paint properties on cloth

The `bendAngle` attribute specifies the resting angle of the cloth. Initially, the resting angle value for each edge of each triangle of the cloth mesh is zero. The cloth solver uses the `bendAngle` to bend the cloth mesh about the each triangle edge. When painting, you can see the final values for each vertex in the Script Editor.

For example, in the image below notice the wrinkles on the cloth sheet.



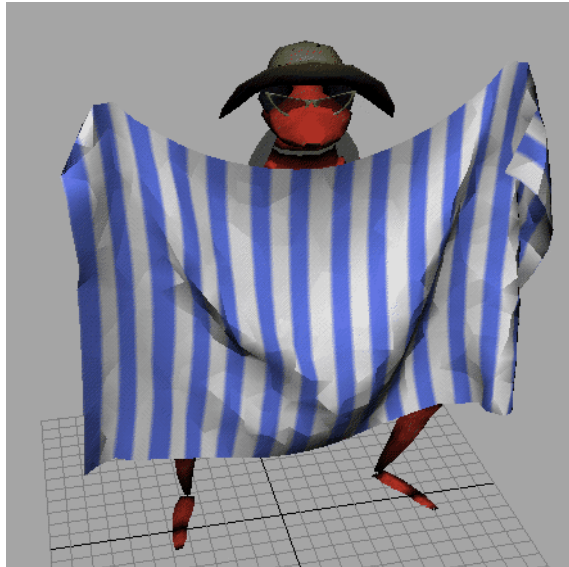
If you want to see a larger wrinkle propagated along the diagonal, you can use the Paint Cloth Properties Tool to paint a `bendAngle` value on this area.



4 | Applying properties to Cloth

How do I? > Paint properties on cloth

After the area is touched up, you simulate the cloth. The `bendAngle` attribute causes the cloth to bend or wrinkle in this region during the simulation.



Attribute for painting tessellation on garments and panels

Using the paintable attribute, *tessellation*, you can control the number of triangles on Cloth garments and panels. This does not work for Cloth objects.

In production, the Cloth tessellation is bumped to very fine to catch details in certain areas, allowing the tessellation to be very coarse in areas where you don't care or expect these details. The total number of triangles can be reduced to several times less and the overall performance and memory consumption also improve accordingly. Once *tessellation* is selected, click the Apply Tessellation button to get the new tessellation result.

Tessellation ranges in $[0,1]$ as other paintable attributes and it's used to reduce the tessellation. In general, you would set the max tessellation in the panel node or stitch node, and then use *tessellation* to reduce the tessellation.

Change the Cloth Properties Paint Tools settings

You can change the Cloth Properties Paint Tool settings to create different effects. Again, these are the same as the Artisan brush tool settings. See the following topics in the *Paint Effects, Artisan, and 3D Paint* guide:

4 | Applying properties to Cloth

How do I? > Vertex level cloth properties

- ❖ [How Artisan brush tools work](#)
- ❖ [Artisan Brush Tool Settings](#)
- ❖ [Common Artisan Brush Tool Settings](#)

Set cloth per-vertex properties without using Artisan tools

You can set cloth properties on a per vertex basis without using Artisan tools. To do this you must first add the attribute, as follows:

```
addAttr -ln attribute_name -dt doubleArray
```

Then you can set the value of the attribute using the setAttr command. For example:

- 1 You should add an attribute to Shape node, such as:

```
select -r clothShape1
addAttr -ln (/attribute_name/ + "Weights") -dt
doubleArray;
```
- 2 You will have to suffix "Weights" with the attribute name.
- 3 Build a double array of the size of Cloth and use setAttr on it.

More specifically:

```
select -r clothShape1
addAttr -ln "bendResistanceWeights" -dt doubleArray;
setAttr clothShape1.bendResistanceWeights -type doubleArray
10 0 1 0 1 0 1 0 1 0 1;
```

Vertex level cloth properties

You can assign cloth properties to sets of vertices on a cloth object. Keep the following things in mind when assigning cloth properties to sets of vertices:

- This works for cloth objects only, therefore you can't add vertex property sets to panels.
- You can't assign vertices to a property that is already assigned to the entire cloth object. Instead, first remove the property from the cloth object and then reassign it as a set.

To create a cloth property for a set of vertices

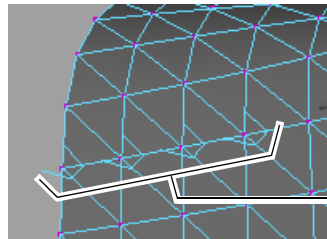
- 1 Select the desired vertices.
- 2 In the Cloth menu set, select **Simulation > Properties > Create Cloth Property**.

4 | Applying properties to Cloth

How do I? > Use the material library

The selected vertices are automatically assigned to the new property and the cpProperty node is displayed in the Attribute Editor. For more information about cpProperty attributes, see "cpProperty node" on page 73.

- 3 Optionally, you can change the Orientation value. The Orientation attribute controls the direction the indicator is facing that's displayed on each vertex that's part of the Cloth Property. This is to help distinguish between vertex property sets.



Indicators displayed on each vertex in the Cloth Property

To add vertices to an existing property

- 1 Select the vertices on the cloth object you want to add.
- 2 Do one of the following:
 - Select Simulation > Properties > *PropertyName*, where *PropertyName* is the name of the desired property.
 - Go to the cpProperty node and in the Set List section, click the *Add selected vertices to set* button.

The vertices are added to the set.

To remove vertices from a property

- 1 Select the vertices on the cloth object you want to remove.
- 2 Go to the cpProperty node and in the Set List section, click the *Remove selected vertices from set* button.

To replace all vertices in a property

- 1 Select the vertices on the cloth object you want to be in the set.
- 2 Go to the cpProperty node and in the Set List section, click the *Replace set with selected vertices* button.

Use the material library

You can create new materials and save them in your own material library. You can also rename or delete materials from the library.

A material is defined by the settings of the property attributes. The material library is stored in your userPrefs.mel file.

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How do I? > Use the material library

The materials are used as presets. You assign a material to a property and the property values are set to the presets defined by that material. You can then assign that property to a panel.

The library also comes with pre-made materials. You cannot modify or remove a pre-made material, but you can copy one and modify the copy as you wish.

Tip

You can share materials in your material library with others by assigning the material to a property node and exporting the property node. See "To export a material from the material library" on page 71.

To create a material and save it in the material library

- 1 Select Simulation > Properties > Create Cloth Property.
This creates a new property node. If you have any panels selected, the property is automatically connected to the panel.
- 2 Select Simulation > Properties > cpProperty $number$ > ☐.
The property node attributes are displayed in the Attribute Editor.
- 3 Set the values of the property attributes.
- 4 Scroll down and display the Material Library section of the Attribute Editor.
- 5 Click the Save As button and enter a name for the material in the dialog box. Click OK to save the material.
The material is saved in your userPrefs.mel file.

To assign a material from the library


- 1 Load a property node into the Attribute Editor by selecting Simulation > Properties > cpProperty $number$ > ☐.
You can either use an existing Property node or create a new property node.
- 2 Scroll down and display the Material Library section of the Attribute Editor.
- 3 Click the folder button next to the Material Name box.
- 4 From the list, select the material you want to use.
- 5 Click OK.
- 6 Select the panel or panels that you want to assign the material to.

4 | Applying properties to Cloth


How do I? > Use the material library

- 7 Assign the Property node to the panel by selecting Simulation > Properties > *cpPropertynumber* (selecting the property node to which you assigned the material).


To edit a material in the library

- 1 Load a property node into the Attribute Editor by selecting Simulation > Properties > *cpPropertynumber* > .
- 2 Scroll down and display the Material Library section of the Attribute Editor.
- 3 Click the folder button next to the Material Name box.
- 4 From the list, select the material you want to edit and click OK.
- 5 Modify the property attributes and click Update.


To rename a material in the library

- 1 Load a property node into the Attribute Editor by selecting Simulation > Properties > *cpPropertynumber* > .
- 2 Scroll down and display the Material Library section of the Attribute Editor.
- 3 Click the folder button next to the Material Name box.
- 4 From the list, select the material you want to rename and click OK.
- 5 Click the Rename button in the Attribute Editor.
- 6 Enter a new name in the dialog box and click OK.

To remove a material from the library

- 1 Load a property node into the Attribute Editor by selecting Simulation > Properties > *cpPropertynumber* > .
- 2 Scroll down and display the Material Library section of the Attribute Editor.
- 3 Click the Remove button.
- 4 From the list, select the material you want to remove and click Remove.

To export a material from the material library

- 1 Select Simulation > Properties > New.
This creates a new property node.
- 2 Load the new property node into the Attribute Editor by selecting Simulation > Properties > *cpPropertynumber* > .
- 3 Scroll down and display the Material Library section of the Attribute Editor.

4 | Applying properties to Cloth

Reference > Sample properties for cloth

- 4 Click the folder button next to the Material Name box.
- 5 From the list, select the material you want to export and click OK.
- 6 With the new property node selected, select File > Export Selection.
- 7 Assign a name to the scene with the exported property node.
Other users can now import the scene and save the material to their *userPrefs.mel* file.

To import a material into your material library

- 1 Import the scene that has the material.
- 2 Select the property node that has the material assigned to it.
- 3 Display the Attribute Editor and open the Material Library section.
- 4 Click Save As.
- 5 Enter a name and click OK.
The material is now part of your Material Library and will be saved to your *userPrefs.mel* file. You can delete the imported property node, if you want.

Sample properties for cloth

We've included some scenes with sample properties to help you in creating properties for your garments. The extras/cloth/properties directory provides a web page with examples of various cloth property settings and scenes that show example properties.

Reference [Simulation > Properties > Create Cloth Property](#)

Use this to create a new property (attached to the selected panels). For more information, see "Apply properties to panels" on page 63.

[Simulation > Properties > Remove Cloth Property](#)

Use this to sever the connection between the cloth and the solver. The Cloth Property node remains in the Properties submenu. For more information, see "Remove Cloth properties" on page 64.

4 | Applying properties to Cloth

Reference > Simulation > Properties > Paint Cloth Properties Tool

Simulation > Properties > Paint Cloth Properties Tool

Lets you use the Paint Cloth Properties Tool to paint properties and wrinkling effects across the entire surface of a garment. For more information, see ["Paint properties on cloth" on page 64](#). See also ["Using Artisan brush tools"](#) in the *Paint Effects, Artisan, and 3D Paint* guide.

Simulation > Properties > Paint Cloth Properties Tool >

Lets you specify the settings for the Paint Cloth Properties Tool in the Tool Settings editor. In the Paint section there are some attributes unique to the Paint Cloth Properties Tool. These unique attributes are described below. For descriptions of other attributes in the Paint section and attributes in all other sections, see ["Common Artisan Brush Tool Settings"](#) and also ["Artisan Brush Tool Settings"](#) in the *Paint Effects, Artisan, and 3D Paint* guide.

Paint section

These are attributes in the Paint section that are unique to the Paint Cloth Properties Tool.

Select Attribute

Select a cloth attribute from the drop-down list. When you paint, you paint values for that attribute.


Apply Tessellation

Click this button if you've painted the *tessellation* attribute and want to see the new tessellation.

Delete Attribute

If you've painted an attribute and want to undo the painting, select this attribute from the Delete Attribute drop-down list.

cpProperty node

These are the attributes in the cpProperty node.(Simulation > Properties > cpProperty > ) For more information, see ["Apply properties to panels"](#) on page 63 and ["Vertex level cloth properties"](#) on page 68.

Property Attributes

These are the attributes in the Property Attributes section of the cpProperty node.

4 | Applying properties to Cloth

Reference > cpProperty node

The slider ranges for the Property Attributes represent values for realistic cloth. To enter values that exceed the default slider range (and create unrealistic cloth effects), type them in the boxes or Ctrl-drag in the boxes to use the virtual sliders.

U/V Bend Resistance

Controls how much the cloth resists bending in the U and V directions. The greater the U/V Bend Resistance value, the stiffer the cloth. Lower values create very flexible cloth. The default is 10.

U/V Bend Rate

The U/V Bend Resistance may increase non-linearly as the cloth triangles are folded from 0 degrees to 180 degrees. The U/V Bend Rate attribute controls the exponent of how much the U/V Bend Resistance increases from 0 to 180 degrees.

A U/V Bend Rate of 0 means a constant resistance. A U/V Bend Rate of 1 means that at 180 degrees, the bending resistance is so high that it will not bend without a huge amount of force. The default is 0.

U/V Stretch Resistance

Controls how much the cloth resists stretching in the U and V directions. The greater the value, the more the cloth resists stretching. A value of 100 is very stiff cloth and a value of 1 is very stretchy. The default is 50. A value greater than 0 is recommended.

Shear Resistance

Controls how much individual triangles resist moving in an opposite but parallel sliding motion. The higher the number, the less the triangles can shear. The default is 45. A value greater than 0 is recommended.

U/V Scale

Controls the scale of the cloth in the U and V directions.

Values of 2 in the U and V Scale make the cloth object twice its actual size. Values of 0.5 in the U and V Scale make the panel half its actual the size. The default is 1.

Density

Controls the mass per unit area of the cloth. The greater the value, the more mass per unit area of the cloth. A value of 0.1 creates a very heavy cloth; a value of 0.01 creates a light cloth. The default is 0.01.

4 | Applying properties to Cloth

Reference > cpProperty node

Thickness

Controls the depth dimension of the cloth. The value specifies the collision offset of the cloth when it collides with itself and with other cloth bodies. The amount of offset may vary depending on the Thickness Force attribute. The default is 0.2. The recommended range for thickness is between 0.1 and 0.7.

Thickness is measured in centimeters and scaled by the solver scale attribute. If you increase the Solver Scale value, Thickness is decreased. For example, if solver scale is 10 and thickness is 0.2, then the actual thickness resulting will be 0.02 centimeters for your cloth mesh. If you choose thickness values beyond the recommended range, the simulation results are unpredictable.

When you have two cloth bodies colliding, the Thickness attribute is not additive. The solver uses the greater value as the Thickness. For example, if one cloth body has a Thickness of 0.5 and the other has a Thickness of 0.2, the distance maintained between them when they collide is 0.5, not 0.7.

Thickness Force

Controls the force used to maintain the collision offset specified by the Thickness attribute during cloth-to-cloth collisions. If a heavy piece of cloth gets closer to another piece of cloth than the distance specified by the Thickness attribute, you can increase this value to keep the heavier cloth at the proper distance. The default is 1.0.

In scenes with many cloth-to-cloth collisions, the recommended range for thickness force is between 30 and 75. A value of 50 for some animations is ideal.

Cloth Friction

Controls friction between the cloth and other cloth bodies. You can enter values between 0 and 1. Smaller values create less friction. The default is 0.3.

Cloth Damping

Specifies how strongly the overall motion of the cloth is diminished. The default is 0.2, which adds stability to the system. A value greater than 0 is recommended.

Air Damping

Specifies how strongly the motion of the cloth is diminished by the physical properties of the air. Air damping provides air resistance to triangles that are normal to the direction of travel. If the triangles on the cloth are parallel to the direction of travel, Air Damping has no effect. The default is 0.1.

4 | Applying properties to Cloth

Reference > cpProperty node

Static Friction

Determines the friction between cloth and collision objects that are at rest and in contact. Static friction must be overcome for the cloth object to move against collision objects.

A value of 0 lets the cloth move freely against a collision object. A value of 1 restricts the movement between cloth and collision objects. The default is 0.6.

Dynamic Friction

Sets the amount of resistance to the motion of a moving cloth object against collision objects. A value of 0 lets the cloth move freely against a collision object. A value of 1 restricts the movement between cloth and collision objects. The default is 0.1.

Blend Weights

In the Blend Weights section, use the slider to set a blend weight value for vertices that overlap with other sets. The blend weight value can be between 0 and 1, and zero means the set has no weight, and 1 means the set has full weight. For example, if two overlapping sets both had a blend weight of 1, then the sets property values would be averaged together. But if set A had a blend weight of 0.5 and set B had a blend weight of 1.0, then set A would get half the weight of set B.

Set List

If the property contains a set of vertices the following buttons are available in the Set List section of the cpProperty node.

Select set vertices

This selects the vertices on the cloth object.

Add selected vertices to set

This adds the selected vertices to the set of vertices in the cloth property.

Replace set with selected vertices

This replaces the set of vertices in the cloth property with the currently selected vertices.

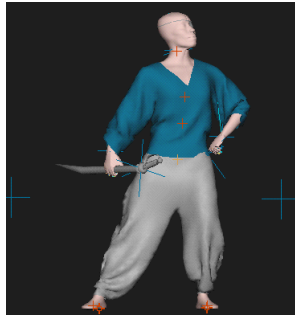
Remove selected vertices from set

This removes the selected vertices from the set of vertices in the cloth property.

5 Animating Cloth

About

Animating cloth



When you animate your character, the cloth solver calculates the collisions and motion of the cloth. Before you begin animating your character, you need to move the character from the dress-up pose to the animation start pose. If you want to drape the garment about the character in a particular way, you can use the drag control to adjust the garment (see "Use the Drag control" on page 55).

To modify the movement of the cloth during the animation, you can add constraints or fields from Maya Dynamics.

Related topics

- ❖ "Create the animation start pose for cloth" on page 77
- ❖ "Use cloth constraints" on page 79
- ❖ "Connect dynamic fields to your cloth" on page 91
- ❖ "Constraint Shape node" on page 92
- ❖ "Collision Shape node" on page 93
- ❖ "Point Assigner node" on page 94

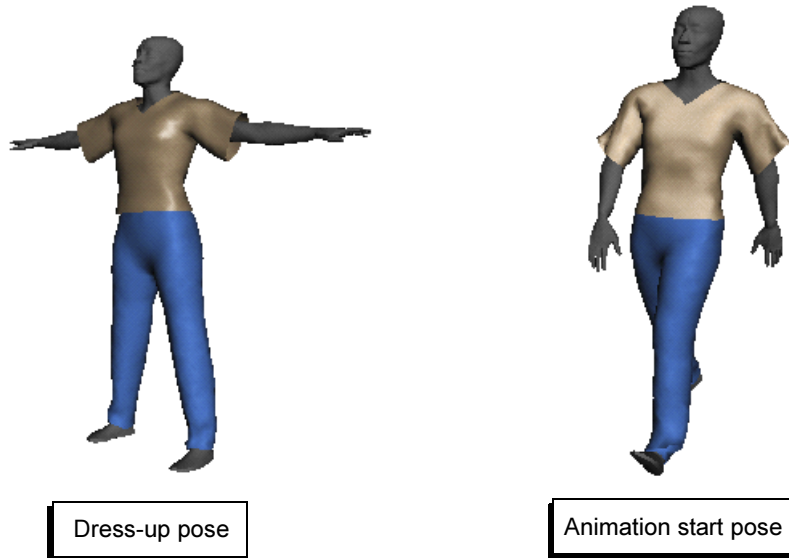
How do I?

Create the animation start pose for cloth

To create the animation start pose, you move your character from the dress-up pose to the position it will be in at the start of the animation. You may want to add some frames to the start of your scene to accommodate this transition.

5 | Animating Cloth

How do I? > Create the animation start pose for cloth



To create the animation start pose

- 1** Place your character in the dress-up pose at a frame that precedes your animation.
- 2** Save a keyframe.
For example, if your animation starts at frame 1, place your character in the dress-up pose at frame -20.
- 3** Go to the first frame of your animation.
- 4** Position your character in its animation start pose.
- 5** Save a keyframe.

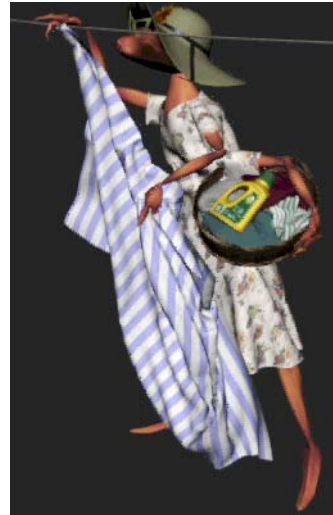
Use cloth constraints

Creating clothes for character animation involves more than creating panels and seaming them together. Sometimes you may want to constrain certain parts of your clothing to your character so it doesn't fall off. You can do this using constraints. For example, you can use constraints to make sure the pants of your character stay on, or to keep straps in a dress attached to the shoulders.

In addition, you can use constraints to pin clothing together or attach items such as buttons or pockets.

Cloth includes the following constraint types:

- transform constraints
- mesh constraints
- cloth constraints
- button constraints
- collision constraints
- field constraints



Constrain points or curves

You can attach constraints to points on the cloth or to a panel curve. When you constrain points, Cloth creates a point assigner, which determines the actual set of vertices that are constrained as the resolution of the cloth changes. See "Edit the point assigner" on page 89.

When you constrain a panel curve, Cloth creates a curve assigner, which lets you determine the start and end vertices that are constrained along the curve. See "Edit the curve assigner" on page 90.

Create transform constraints

One way of manipulating your cloth during an animation is to use a transform constraint. A transform constraint constrains the cloth to the object at a certain distance, as though it were welded. If the object moves, the points on the cloth that are constrained also move.

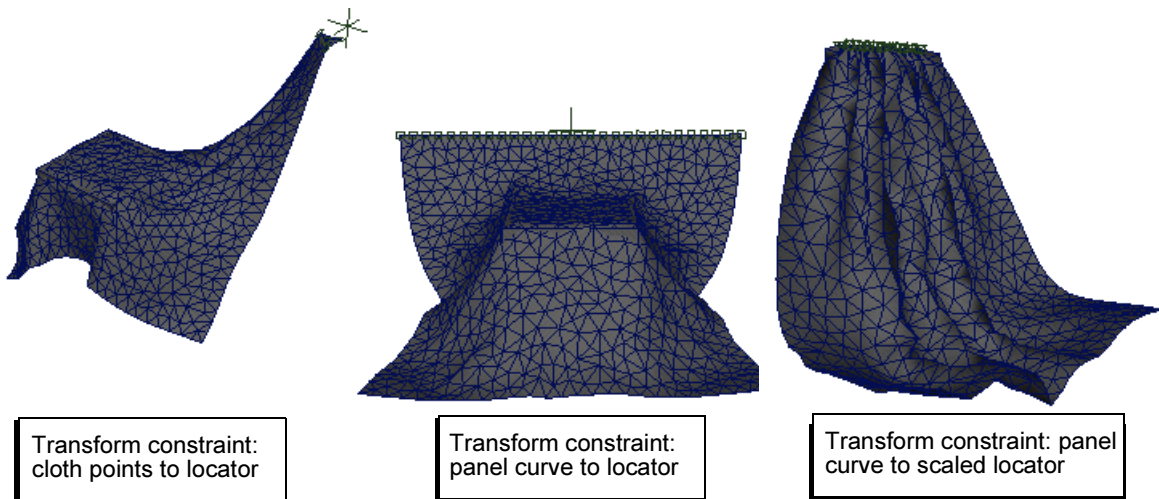
You can constrain the cloth to a locator or to anything with a transform. In Maya, a transform can be the parent of a shape, a joint, or a parent of other transforms.

5 | Animating Cloth

How do I? > Use cloth constraints

If you scale or rotate the transform, the transform constraint scales or rotates the constrained points. This is a quick way to deform a set of cloth points.

You constrain cloth by selecting either cloth points or panel curves.



To create a transform constraint

- 1 Select Create > Create Locator or create the object to which you want to constrain the cloth.
- 2 Position the locator or object near your cloth where you want to use the Transform Constraint. Keep it selected.

The distance you place the locator or object from the cloth vertices will be maintained by the constraint during the simulation.

- 3 Do one of the following:
 - If you are constraining cloth points, click the right mouse button over the cloth mesh and select Vertex. Shift-Ctrl-click the vertex points you want to constrain.
 - If you are constraining a panel curve, Shift-Ctrl-click the curve you want to constrain.

Tip

If the cloth has already been simulated, the panel curve may not be located near the cloth edge to which it belongs.

When you move the locator or object, these vertex points or the curve will move with it exactly during the simulation (this includes rotating and scaling the locator).

5 | Animating Cloth

How do I? > Use cloth constraints

- 4 With the vertex points and the locator or object transform selected, choose Constraints > Transform.

The points do not snap to the constraint; they remain at a fixed distance from the target and at a fixed orientation relative to the target.

- 5 Now you can animate the locator and the vertex points will move with it.

To adjust transform constraint attributes

- 1 Select the constraint.
- 2 In the Attribute Editor or Channel Box, set the desired attributes in the ConstraintShape tab. For descriptions of these attributes, see "Constraint Shape node" on page 92.

To delete the transform constraint

- 1 Do one of the following:
 - Select the constraint in the view and delete it.
 - In the Outliner, open the cloth transform so you can see the shapes below them. Select transformConstraint and delete it.

Create mesh constraints

Sometimes you may want to constrain certain parts of your clothing to your character so the clothing doesn't fall away. This can be useful to make sure the pants of your character stay on, or to keep straps in a dress attached to the shoulders. A mesh constraint constrains cloth to a collision object.

The Is Soft attribute, when turned on, constrains cloth to a collision object via springs. The amount of elasticity of the springs is controlled by the Stiffness and Damping attributes, which are also paintable per-vertex.

To add mesh constraints to a character constructed from multiple collision objects, see "Use mesh constraints with multiple collision objects" on page 82.

To create a mesh constraint

- 1 Do one of the following:
 - To constrain cloth vertices to a collision object, click the right mouse button over the cloth and select Vertex. Select the vertices in the cloth you want to constrain.
 - To constrain a panel curve to a collision object, select the curve.

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How do I? > Use cloth constraints

- 2 Shift-Ctrl-click the collision object to which you want to constrain the cloth.
- 3 Select Constraints > Mesh.

To adjust mesh constraint attributes

- 1 Select the constraint.
- 2 In the Attribute Editor or Channel Box, set the attributes Constraint Weight and Size in the MeshConstraintShape tab. For descriptions of these attributes, see "Constraint Shape node" on page 92.

To delete the mesh constraint

- 1 Do one of the following:
 - Select the constraint in the view and delete it.
 - In the Outliner, open the cloth transform so you can see the shapes below it. Select meshConstraint and delete it.

Use mesh constraints with multiple collision objects

If your character is constructed from multiple collision objects, you can save time by selecting a group of collision objects to use with mesh constraints.

To create a mesh constraint with multiple collision objects

- 1 Select the collision objects for the character. Select Edit > Group to group the collision objects under one transform.
- 2 Right-click over the cloth and select Vertex from the popup menu.
- 3 Select the cloth vertices you want to constrain.
- 4 Do one of the following:
 - Shift-select one of the collision objects in the group. Press the up arrow to select the group's transform.
 - In the Outliner, Ctrl-click the group transform.
- 5 Select Constraints > Mesh.

Each selected cloth vertex is constrained to the closest collision object. One or more mesh constraints is created.

Create cloth constraints

A cloth constraint binds cloth vertices to cloth. When you create a cloth constraint, the vertices on the *source* cloth are bound to triangles on the *target* cloth. Even as the target cloth is deforming and moving, the vertex holds its position relative to that assigned triangle.

5 | Animating Cloth

How do I? > Use cloth constraints

You do not need to select the individual triangles. The cloth constraint detects the location of the source and target, finds the closest triangle, and binds them together.

You can use a cloth constraint to lay one cloth on top of another cloth. For example, you can design a pocket as a small separate piece of cloth and constrain it to a shirt using a cloth constraint. You use the Offset attribute to control which side of the cloth the pocket is constrained to and how far the source cloth lies from the target cloth.



You can create a pocket using a cloth constraint

If you position the source cloth near the target cloth and the offset is 0, when the constraint is simulated, it pulls the source cloth into the target cloth.

You can also animate stiffness and damping attributes. The cloth constraint use springs internally to keep the cloth sewn together. You can use a high stiffness value to keep the cloth adjacent.

When the Stitch attribute is turned on, the Offset, Damping and Stiffness attributes are all disabled so they have no effect. In “Stitch mode” constrained cloth vertices are kept very close (0.1 mm away) to the closest point on the target. This has the same effect that a user setting the offset to 0 would desire; however, an offset of zero will still result in a gap between the cloth vertices and the target because the solver considers the cloth to have thickness. This is useful for doing things like attaching a collar to a shirt when modeling clothing with cloth objects.

You can make cloth constraints only with cloth made from panels, not with cloth objects made from polygonal geometry.

To create a cloth constraint between garments

- 1 Do one of the following:
 - To constrain the vertices of one cloth garment to another cloth garment, right-click over the source cloth and select Vertex. Select the vertices in the cloth you want to constrain.
 - To constrain a panel curve to a cloth, select the curve.
- 2 Shift-Ctrl-click the target cloth.
- 3 Select Constraints > Cloth.

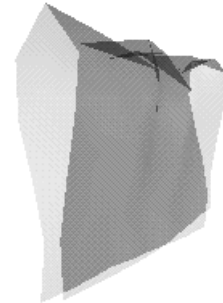
5 | Animating Cloth

How do I? > Use cloth constraints

Constrain cloth to itself

In addition to creating cloth constraints between separate pieces of cloth, you can constrain a piece of cloth to itself. For example, you can create a vest with a left front panel and a right front panel and constrain the left front to the right front.

When you constrain one piece of cloth to another piece of cloth, you specify the cloth points or curve to be constrained, and the target object. When you constrain cloth to itself, you specify the points or curves on the cloth to be constrained. The software determines the closest target points on the cloth.



Cloth constrained to itself

To create a cloth constraint within a garment

- 1 Select the cloth points or curve you want to constrain.
- 2 Select Constraints > Cloth.

Cloth determines the target for the constraint. The software looks for the closest points that are greater than three edge lengths away from the selected points. When you play the simulation, the points or curve you selected will be constrained to that target.

To adjust cloth constraint attributes

- 1 Select the constraint.
- 2 In the Attribute Editor or Channel Box, set the attributes in the ClothConstraint Shape tab. For descriptions of these attributes, see "Constraint Shape node" on page 92.

To delete the cloth constraint

- 1 Do one of the following:
 - Select the constraint in the view and delete it.
 - Select the cloth and in the Outliner, turn on Show > Shapes. Open the cloth transform so you can see the shapes below it. Select clothConstraint and delete it.

Create button constraints

A button constraint follows the cloth, like a tracking device. It can be positioned anywhere on the cloth—on a vertex or in the middle of a triangle.

5 | Animating Cloth

How do I? > Use cloth constraints

When you create a button constraint, a transform is created and updated every frame, which tracks the position and orientation of the cloth. You can parent an object to the transform and it will follow cloth like a button does.

The button transforms are parented under the cloth's transform.



Types of button constraints

You can create a button constraint three ways:

- You can position the button exactly where you want it to be, even if it is offset from the cloth.
- You can snap the button to the surface of the cloth.

If you want to move the button, you can select it and translate, rotate, or scale it. Even if you snap to the surface of the cloth, you can later make the button offset or rotated from the cloth.


- You can rotate the button 90 degrees in the X axis when you create it. Because most buttons are modeled in object space with the Y axis pointed up, this method rotates the button so that the Y axis is in line with the Z axis of the cloth.

Tip You can select multiple objects and make them into buttons.

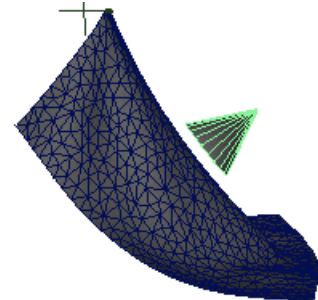
5 | Animating Cloth

How do I? > Use cloth constraints

To create a button constraint and preserve its position


- 1 Create the geometry for the button.
- 2 Position the geometry exactly where you want the button to be on the cloth.
- 3 With the button geometry still selected, Shift-Ctrl-click the cloth.
- 4 Select Constraints > Button > .
- 5 In the Button Constraint Options window, turn on Preserve Translation and Preserve Rotation.

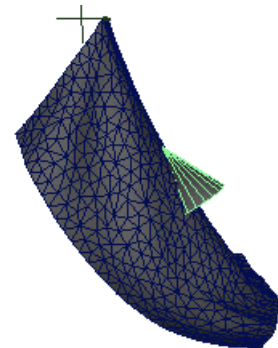
This preserves the position and offset of the button in world space. The button does not move after the constraint is created.



Button constraint with original position preserved

To create a button constraint and snap it to cloth

- 1 Create the geometry for the button.
- 2 Position the geometry approximately above the surface of the cloth.
You do not need to orient it exactly. The constraint will re-orient it.
- 3 With the button geometry still selected, Shift-Ctrl-click the cloth.
- 4 Select Constraints > Button > .
- 5 In the Button Constraint Options window, turn off Preserve Translation and Preserve Rotation.
- 6 Set Translate x, y, z and Rotate x, y, z to 0, 0, 0.




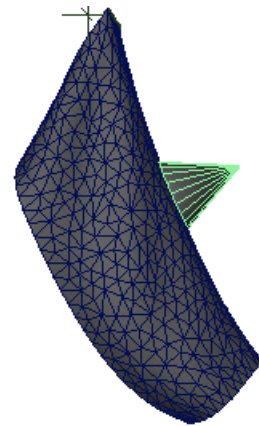
Button constraint snapped to cloth

5 | Animating Cloth

How do I? > Use cloth constraints

To create a button constraint and rotate it 90°

- 1 Create the geometry for the button.
- 2 Position the geometry or locator approximately above the surface of the cloth. You do not need to orient it exactly. The constraint will re-orient it.
- 3 With the button geometry still selected, Shift-Ctrl-click the cloth.
- 4 Select Constraints > Button > .
- 5 In the Button Constraint Options window, turn off Preserve Translation and Preserve Rotation.
- 6 Set Rotate x, y, z to 90, 0, 0.



Button constraint snapped to cloth and rotated 90°

To select a button constraint

- 1 Do one of the following:
 - Select the button and press the up arrow key to select the button constraint.
 - In the Outliner, open the cloth transform that the button is attached to so you can see the transforms below it. Select cpButton.

To move a button constraint

- 1 Select the button constraint.
- 2 In the Channel Box, click the U Coord or V Coord label.
- 3 Move the pointer into the view and middle-mouse-drag to move the button.

To delete a button and button constraint

- 1 Select the button geometry in the view.
- 2 Press the up arrow key.
The cpButton*number* object is selected.
- 3 Press the Backspace key to delete the button and the button constraint.

To delete a button constraint without deleting the button

- 1 Select the button geometry in the view.
- 2 In the Outliner, press the right mouse button and select Show selected.

5 | Animating Cloth

How do I? > Use cloth constraints

- 3 In the Outliner, use the middle mouse to drag the highlighted shape and drop it so it is unparented.
- 4 In the Outliner, select `cpButtonnumber` and press the Backspace key to delete the button constraint.

Create collision constraints

Collision constraints let you control collisions on a per-vertex basis and animate the control over time.

When you create a collision constraint, you can select cloth vertices or panel curves and disable the cloth-to-cloth collisions and cloth-to-collision object collisions on those vertices. This can help untangle cloth in many cases.


To create a collision constraint

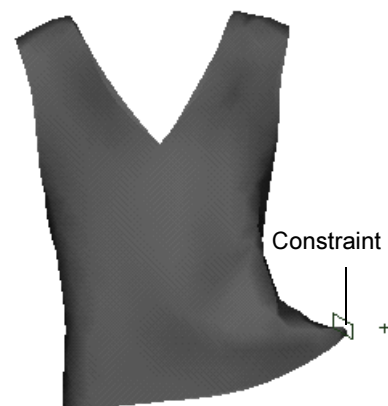
- 1 Do one of the following:
 - To constrain cloth vertices, click the right mouse button over the cloth and select Vertex. Select the vertices in the cloth you want to constrain.
 - To constrain a panel curve, select the curve.
- 2 Select Constraints > Collision.
A collision constraint is created.
- 3 You can set the attributes in the Channel Box or Attribute Editor in the CollisionShape tab. For descriptions of these attributes, see "Collision Shape node" on page 93.

Tips for displaying and selecting constraints

Each point that is currently constrained or affected by the constraint is displayed as a square. You can increase the Size attribute to make it easier to select the constraint.

To select a constraint

- 1 Do one of the following:
 - Select the constraint. If you have selected the constraint and the cloth mesh, hold down the CTRL key and click the cloth mesh.
This deselects the cloth mesh so just the constraint is selected.
 - Click  to turn off the Surfaces pick mask and select the constraint.



5 | Animating Cloth

How do I? > Use cloth constraints

To change the size of the constraint

- 1 Select the constraint.
- 2 In the Channel Box, increase the Size value.

Edit constraints

You can edit membership of Cloth constraints using the Edit Constraint Membership Tool.

To edit the set membership of a Cloth constraint

- 1 Select the Cloth constraint (in Outliner).
- 2 In the Cloth menu set, select **Constraints > Edit Cloth Constraints Membership**.
- 3 Do the following:
 - Shift+click to add items (for example, vertices, points).
 - Ctrl+click to remove items (for example, vertices, points).

Edit the point assigner

The point assigner is created when you constrain cloth vertices. It determines the actual set of vertices that are constrained as the resolution of the cloth changes.

Set the resolution method

The resolution method attribute of the point assigner lets you choose the method of vertex assignment.

To set the resolution method

- 1 Select the constraint.
- 2 Do one of the following:
 - In the Channel box, click pointAssigner.
 - Display the Attribute Editor and click the pointAssigner tab.
- 3 From the Resolution Method pulldown menu, select one of the following: One-to-one or Boundary. For descriptions of these attributes, see "Point Assigner node" on page 94.
- 4 If you select the Boundary resolution method, you can set the following two attributes in the Attribute Editor: Use Radius and Boundary Radius. For descriptions of these attributes, see "Point Assigner node" on page 94.

5 | Animating Cloth

How do I? > Use cloth constraints

Edit the curve assigner

The curve assigner is created when you constrain a panel curve. It lets you determine the start and end vertices that are constrained along the curve.

Set the start and end of a constrained curve

You can constrain the entire panel curve or a percentage of the curve by setting the Start curve param and End curve param.

To set the start and end of the constrained curves

- 1** Select the constraint.
- 2** Do one of the following:
 - In the Channel box, click curveAssigner.
 - Display the Attribute Editor and click the curve Assigner tab.
- 3** Enter a value between 0 and 1 for the Start curve param and End curve param.

To constrain the entire curve, set the Start curve param to 0 and the End curve param to 1. To constrain the starting half of the curve, set the Start curve param to 0 and the End curve param to 0.5. To constrain the ending half of the curve, set the Start curve param to 0.5 and the End curve param to 1.

Animate the start and end of a constrained curve

You can animate the Start curve param and End curve param over simulation time to create a tearing cloth effect. The following procedure animates the cloth constraint opening.

To animate the start and end of the constrained curves

- 1** At the starting frame, set the Start curve param to 0 and the End curve param to 1.

This constrains the entire curve.
- 2** Set keys for these attributes.
- 3** At the end of the animation, set the Start curve param to 0 and the End curve param to 1. Set keys for the attributes.
- 4** You can animate the cloth moving apart using transform constraints.

Connect dynamic fields to your cloth

Because Cloth is fully integrated with Maya, you can use Maya's dynamic fields to affect the motion of your cloth. You create the field the same way you create a field in Maya. You connect the field to cloth using a type of constraint known as a *field constraint*. You can connect field constraints to cloth vertices or panel curves.



To connect a dynamic field to cloth

- 1 To create the field you want to use, from the Dynamics menu set, select Fields > Create > *fieldname*.

Tip

When you create the actual field, make sure you don't have your cloth selected.

- 2 Do one of the following:
 - If you are constraining cloth points, click the right mouse button over the cloth mesh and select Vertex. Select the vertex points you want to constrain.
 - If you are constraining a panel curve, select the curve you want to constrain.
- 3 Shift-Ctrl-click the field.
- 4 From the Cloth menu set, select Constraints > Field.

Tips

The magnitude of your field may be too low for the cloth animation. If you don't see the field's effect, increase the magnitude by a factor of 100.

Also, make sure the cloth is within the range specified by the Max Distance attribute of the field, and that Attenuation value is not so great that the cloth is not affected.

To adjust field constraint attributes

- 1 Select the constraint.

5 | Animating Cloth

Reference > Constraint Shape node

- 2 In the Attribute Editor or Channel Box, set the attributes Constraint Weight and Size in the fieldConstraint Shape tab. For descriptions of these attributes, see "Constraint Shape node" on page 92.

To delete field constraints

- 1 Do one of the following:
 - Select the constraint in the view and delete it.
 - Select the cloth. In the Outliner, open the cloth transform so you can see the transforms below it. Select the fieldConstraint and delete it.

Reference Constraint Shape node

These are the attributes in the ConstraintShape node. For more information, see "Use cloth constraints" on page 79.

Constraint Weight

Specifies whether the constraint is on or off. A value of 0 turns off the constraint. Any value greater than 0 turns on the constraint.

Size

Specifies the size the constraint is displayed on the screen. When the constraint is created, the size is based on the edge length of the triangle, which is determined by the resolution. The greater the resolution, the smaller the edge length and the smaller the constraint size.

Is Soft

(Transform constraint only) Specifies whether the constraint behaves like it's rigid or soft. If you turn off Is Soft, the constraint behaves like a rigid bar is holding the cloth to the object to which it is constrained.

If you turn on Is Soft, the constraint behaves like a spring. The rest length of the spring is its initial distance from the transform. The amount of elasticity is controlled by the Stiffness and Damping attributes.

Stiffness

Applies only if Is Soft is turned on. Specifies the amount of springiness of the constraint. The default value of 100 creates a constraint that is similar in springiness to a rubber band. You should increase this value by a factor of 10 to see different results. A value of 100,000 creates a constraint similar to a steel rod.

Damping

Applies only if Is Soft is turned on. Specifies how strongly the motion of the constraint is diminished by the physical properties of the constraint. Generally, the Damping value should be about 1/10 of the Stiffness value.

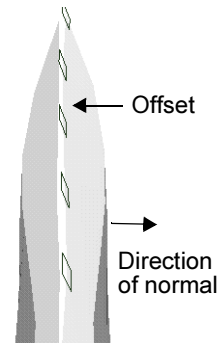
The higher the Damping value, the less the constraint jiggles back and forth. A high Damping value creates an effect similar to pulling a spring through maple syrup as opposed to air. It does not affect the magnitude of the initial force, which is specified by the Stiffness attribute.

Offset

(Cloth constraint only) Specifies the distance the constraint maintains between the source and target cloth.

You use the Offset attribute to control which side of the cloth the pocket is constrained to, and how far the source cloth lies from the target cloth. A positive value offsets the cloth in the direction of the cloth's normal. A negative value offsets in the opposite direction.

If you position the source cloth near the target cloth and the Offset is 0, the constraint pulls the source cloth into the target cloth when it is simulated.



Collision Shape node

These are the attributes in the CollisionShape node. For more information, see "Create collision constraints" on page 88.

Collision Constraint

These are the attributes in the Collision Constraint section of the CollisionShape node.

Size

Specifies the size of the square icon drawn for each vertex.

Cloth Collisions

Set the Cloth Collisions attribute to on or off to enable or disable cloth-to-cloth collisions for the selected vertices. Setting the cloth collisions to off can effectively untangle cloth in many cases. The default is off.

5 | Animating Cloth

Reference > Point Assigner node

Rigid Collisions

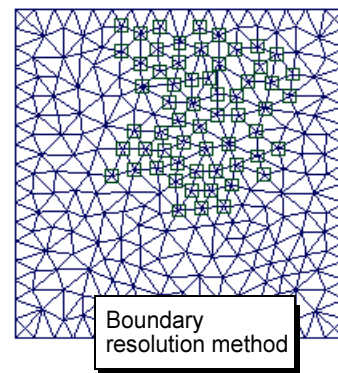
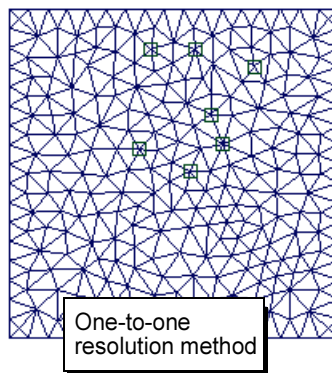
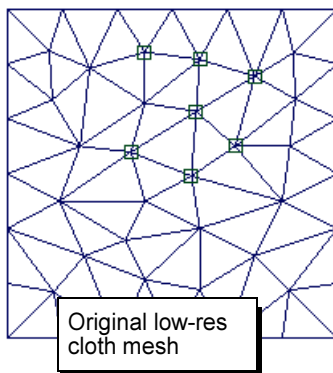
Set the Rigid Collisions attribute to on or off to enable or disable cloth-to-collisions object collisions for the selected vertices. The default is off.

Point Assigner node

These are the attributes in the PointAssigner node for constraints. For more information, see "Edit the point assigner" on page 89.

Resolution Method

- | | |
|------------|---|
| One-to-one | Preserves the exact number of points that are constrained when you increase the resolution of the cloth mesh. |
| Boundary | Preserves the boundary of the area specified by the selected points when you increase the resolution of the cloth mesh. |



Use Radius

Specifies whether the boundary calculation is done automatically or whether you control the points in the boundary by specifying a boundary radius.

If you turn off Use Radius, the radius is calculated for you, creating a continuous boundary of constrained cloth vertices.

If you turn on Use Radius, you must specify a value for the Boundary Radius.

Boundary Radius

For each selected cloth vertex, Cloth uses an imaginary circle to determine which points are constrained at a higher resolution. If the cloth vertex falls inside the circle of the radius specified, then it is constrained.

Constraints > Edit Constraint Membership Tool

Use this to add or remove points, vertices, etc. from the set of a Cloth constraint. For more information, see "Edit constraints" on page 89.

Constraints > Transform

Use this to create a transform constraint that constrains the cloth to the object at a certain distance, as though it were welded. If the object moves, the points on the cloth that are constrained also move. For more information, see "Create transform constraints" on page 79.

Constraints > Mesh

Use a mesh constraint to constrain cloth to a collision object. For more information, see "Create mesh constraints" on page 81.

Constraints > Cloth

Use a cloth constraint to bind cloth vertices to cloth. For more information, see "Create cloth constraints" on page 82.

Constraints > Field

Use this to connect a dynamic field to cloth. For more information, see "Connect dynamic fields to your cloth" on page 91.

Constraints > Collision

Use a collision constraint to let you control collisions on a per-vertex basis and animate the control over time. For more information, see "Create collision constraints" on page 88.

5 | Animating Cloth

Reference > Constraints > Button

Constraints > Button

This creates a button constraint. When it is created a transform is created and updated every frame, which tracks the position and orientation of the cloth. You can parent an object to the transform and it will follow cloth like a button does. For more information, see "Create button constraints" on page 84.

Constraints > Button >

These are the options in the Button Constraint Options window.

Button Name

Enter a name for the button.

Preserve Translation

This preserves the position of the button in world space. The button does not move after the constraint is created

Translate

When Preserve Translation is turned off, you can set the translate X, Y, Z values.

Preserve Rotation

This preserves the offset of the button in world space. The button does not move after the constraint is created

Rotate

When Preserve Rotation is turned off, you can set the rotate X, Y, Z values.

.

6

Playing back Cloth simulations

About

Playing back Cloth simulations



When you run your simulation, you can cache the results for quick playback. You can save different cache files for the same scene to compare. You can speed up playback by disabling the solver or the collision objects.

Related topics

- ❖ "Visualize stress on cloth" on page 97
- ❖ "Manage cache files" on page 98
- ❖ "Speed up playback" on page 104
- ❖ "Fix playback and simulation problems" on page 104

How do I?

Visualize stress on cloth

You can get visual feedback on areas of the cloth where there's stress, as defined by the cloth solver. The cloth solver monitors the energy of the cloth on a per-vertex basis. With the Stress Visualizer you can see the stress areas reported by the solver.

Once you know the problem area of the cloth, you can frequently prevent the problem by increasing cloth resolution in that area, adding collision constraints, or modifying the collision geometry.

To show cloth stress

- 1 Select the cloth object or garment.

6 | Playing back Cloth simulations

How do I? > Manage cache files

- 2 In the Cloth menu set select **Simulation > Show Cloth Stress**.

Make sure the display is in shaded mode (press 5) and the locator nodes are showing (Show > Locators).

- 3 Play the simulation.

At the zero frame there will be no stress because this is the initial state of the cloth. Once you start the simulation you will notice the cloth mesh displaying shaded areas; by default, white represents areas of high stress and black represents areas of low stress.

For descriptions of the attributes in the cpClothStress node, see "cpClothStress node" on page 108.



The lighter shading represents areas of high stress on the table cloth.

To hide cloth stress

- 1 Select the cloth object or garment.
- 2 In the Cloth menu set select **Simulation > Hide Cloth Stress**.

Manage cache files

When you simulate cloth by playing through the time slider, Cloth creates a cache file to store all the positions of the vertices of the cloth. The cache lets you quickly preview the results of the cloth simulation without having to render to a flipbook. This offers many benefits, including scrubbing back and forth in the time slider and re-using a cache so you don't have to solve at render time.

If caching is enabled, the solver writes the cache file to a temporary file. When you save the file, the temporary cache file is renamed to the cache filename and saved with the file. Cloth cache files have the mcc file extension.

6 | Playing back Cloth simulations

How do I? > Manage cache files

You can have more than one cache per solver and switch between caches dynamically. You can examine different simulations without having to load new caches to view them. Plus you can copy, blend, and interpolate caches over a range of frames.

All Cloth cache information is stored in the cpCache node. The default cache is attached to the cpSolver node.

- ❖ "Create a cache" on page 99
- ❖ "Switch between caches" on page 99
- ❖ "Delete and truncate the cache" on page 100
- ❖ "Compress the cache" on page 100
- ❖ "Interpolate the cache" on page 101
- ❖ "Use the Cache Editor" on page 101
- ❖ "Save and load cache files" on page 103

Create a cache

To create a cache

- 1 To make sure caching is enabled, go to the cpCache node (Simulation > Caches > cpCache) in the Attribute Editor and make sure Cache Enabled is turned on.
- 2 Make sure your start frame in the time slider is frame 1.
- 3 In your Animation preferences, make sure Playback Speed is set to Free and Playback by is set to 1.
- 4 Press the play button to run the simulation by playing through the time slider.

To create a new cache

Select Simulation > Caches > Create Cache.

A new, empty cache is created and it becomes the current cache. You need to put data into the cache either by running a simulation or editing the cache.

Switch between caches

Each solver can have multiple caches, but solvers cannot share caches.

To switch between caches in a solver

Select Simulation > Caches and then select the desired cache.

6 | Playing back Cloth simulations

How do I? > Manage cache files

Delete and truncate the cache

If you want to re-evaluate a part of your scene, you need to delete the cache on your cloth. To do this, you can use one of two methods: *Delete Cache* or *Truncate Cache*. Delete Cache deletes the entire cache for the cloth object; Truncate Cache deletes the cache from the current frame forward.

To delete a cache

- 1 If you have more than one solver in the scene, select the cloth belonging to the solver whose cache you want to delete.
- 2 Select Simulation > Delete Cache.
The entire cache for the cloth object is deleted.

To truncate a cache

- 1 If you have more than one solver in the scene, select the cloth belonging to the solver whose cache you want to truncate.
- 2 Select Simulation > Truncate Cache.
The cache from the current frame forward is deleted.

Compress the cache

The cache file can become quite large for scenes with many cloth bodies or highly tessellated cloth bodies, especially for longer animations. If you are satisfied with the simulation stored in the cache, you can reduce its cache file size by compressing the cache.

A cache file stores position and velocity data for all cloth objects associated with a particular cloth solver. When you compress a cloth cache file, you remove all velocity data from the cache except for the last frame in the cache. This final set of velocities is required to restart the simulation from the end of the cache. As newly simulated frames are appended to the end of a compressed cache, both their position and velocity values are saved. So caches may be not completely compressed.

You can play back a compressed cache and continue a simulation from the end of a compressed cache. But you can't truncate a compressed cache and restart the simulation from a frame that has been compressed. Compressing the cache does not slow down playback performance.

To compress the cache

- 1 If you have more than one solver in the scene, select the cloth belonging to the solver whose cache you want to compress.
- 2 Select Simulation > Compress Cache.

6 | Playing back Cloth simulations

How do I? > Manage cache files

Interpolate the cache

Use this to smooth the cloth's position at the frame(s) in the selected time range.

To interpolate cache data

- 1 Select the cloth and then select the time range (shift-drag in the Time Slider).
- 2 Select **Simulation > Interpolate Cache**. This interpolates the current cache between the selected time range.

Note

You can also interpolate cache data using the Cache Editor. With the Cache Editor you can specify the type of interpolation as either linear or sine. See "Use the Cache Editor."

Use the Cache Editor

Using the Cache Editor you can interpolate, blend or copy cache frames from different simulations in the same solver. This reduces the number of simulations needed to produce a good cloth simulation.

To edit a cache you need the following:

- an edit operation (copy, blend, interpolate)
- a collection of source cache segments
- a target cache segment

An edit operation takes a series of source cache segments and produces a result in the target cache segment. A cache segment is made up of a cache node, range, and, optionally, a weight. Cache segments indicate what part of a cache to manipulate in the operation. The weight specifies how much of the cache segment you want to keep. In an operation all of the cache segments are normalized so their sum equals one.

The operation acts on the cache segments and combines the results into a target cache segment, which again specifies a cache node and a range, but not a weight.

Cache segments can start at different frames, but cannot be different in length (duration). In non-linear editing this is known as scaling and is not currently supported.

If a target cache segment is not specified then the default target is the same as the first source cache segment.

6 | Playing back Cloth simulations

How do I? > Manage cache files

To open the Cache Editor

Select **Simulation > Cache Editor**.

The Cache Editor window appears. For descriptions of the options in the Cache Editor window, see "Simulation > Cache Editor" on page 106.

To interpolate caches using the Cache Editor

- 1 Select **Simulation > Cache Editor**. The Cache Editor window appears.
- 2 Click the Add Cache Segment button. This adds a panel in the Cache Editor window for you to set the options for the source cache segment. You can only have one source cache segment when interpolating.
- 3 Set the options for the source cache segment.
- 4 Select a Target Cache from the drop-down list.
- 5 Specify a Target Range of frames.
- 6 Select *interpolate* from the Operation drop-down list.
- 7 Select an Interpolation Type from the drop-down list.

Linear

Specifies linear interpolation from the start of a cache segment range to the end.

Sine

Favors values close to the start and end of the cache segment range and follows a more linear interpolation in the middle.

- 8 Click Apply or Apply and Close.

To blend caches using the Cache Editor

- 1 Select **Simulation > Cache Editor**. The Cache Editor window appears.
- 2 Click the Add Cache Segment button. This adds a panel in the Cache Editor window for you to set the options for the source cache segment. Add as many source cache segments as you need.
- 3 Set the options for each source cache segment, including the blend weight. Each range must be the same duration.
- 4 Select a Target Cache from the drop-down list.
- 5 Specify a Target Range of frames. The range must be the same duration as the source cache segments.
- 6 Select blend from the Operation drop-down list.
- 7 Click Apply or Apply and Close.

6 | Playing back Cloth simulations

How do I? > Manage cache files

To copy frames between caches using the Cache Editor

- 1 Select **Simulation > Cache Editor**. The Cache Editor window appears.
- 2 Click the Add Cache Segment button. This adds a panel in the Cache Editor window for you to set the options for the source cache segment. You can only copy one segment at a time.
- 3 Set the options for the source cache segment.
- 4 Select a Target Cache from the drop-down list.
- 5 Specify a Target Range of frames. The range must be the same duration as the source cache segment.
- 6 Select copy from the Operation drop-down list.
- 7 Click Apply or Apply and Close.

Save and load cache files

You can save different cache files for the same scene. For example, if you are experimenting with different property values, you can save the cache using one set of values, change the values, re-run the simulation, and save the cache under a new name. You can then load a cache file that has already been created.

To name and save a cache file

- 1 In the cpCache tab of the Attribute Editor, enter a name for the cache in the Cache Name box.

Cloth cache files have .mcc extensions. If you don't enter a name, *scenefilename.mcc* is used.
- 2 Play the simulation.
- 3 Save the file.

To rename a cache file

- 1 In the cpCache tab of the Attribute Editor, enter a new name for the cache.
- 2 Save the file.

To load a cache file

- 1 In the cpCache tab of the Attribute Editor, click the folder button next to the Cache Name box.
- 2 In the browser, select the *cachefile.mcc* you want to load.
- 3 Click the Open button.

The cache file is loaded into the scene.

6 | Playing back Cloth simulations

How do I? > Speed up playback

Note

The cache file will not open if the geometry in the cache file does not match the geometry in the scene file.

Speed up playback

Disable/enable the solver

Sometimes you may want to disable the solver so you can keep animating other parts of your scene without the solver trying to evaluate.

To disable/enable the solver

- 1 Select Simulation > Disable Solver.
Now you can animate without solving for cloth.
- 2 Select Simulation > Enable Solver to turn the solver back on.

Disable cloth collisions

You can disable cloth-to-cloth collisions to speed up playback.

To disable cloth-to-cloth collisions

- 1 Select Simulation > Solvers > *cpSolvernumber* > ☐.
- 2 Turn off Cloth Collisions.

Fix playback and simulation problems

- "Use cloth with very fast motion" on page 104
- "Cloth not solving" on page 105
- "Cloth animation stops moving" on page 105

See also "Advanced solver performance tools" on page 117.

Use cloth with very fast motion

When you run a cloth simulation, the vertex positions of the collision objects that the cloth collides with are sampled once per frame. If you have very fast motion, you may want to increase the frequency of the sampling.

You can animate the frame sampling value, setting a higher value for the specific frame range in which the rigid bodies are moving quickly.

6 | Playing back Cloth simulations

How do I? > Fix playback and simulation problems

To increase the frame sampling rate

- 1 Select the cloth.
- 2 In the Channel Box, select cpSolver and display the Attribute Editor.
- 3 In the Frame Samples box, enter a value greater than 1.

The number you enter determines the number of times per frame that the solver samples the vertex positions of the rigid body. This attribute has a large impact on performance. Typical values are in the range of 1 to 4.

Cloth not solving

If you play or render an animation and do not start at the first frame of the animation, cloth will not solve because the cloth solver does not handle run-up.

The following warning message displays when this situation occurs:

```
// Warning: Cloth cannot solve because run-up is not supported: please restart playback or rendering from the first frame of the animation.//
```

The solution

- 1 Do one of the following:
 - Rewind and play from the start.
 - When rendering, re-render from the start of the animation.

Cloth animation stops moving

If frames are skipped when solving, the solver will stop, with the effect that your cloth animates for a few frames and then stops moving. This can occur during playback if your playback mode allows frames to be skipped or when rendering when the frame increment is something other than one.

The following warning message is displayed when this situation occurs:

```
// Warning: Cloth cannot solve because increment between frames is not one: ensure playback mode or rendering increment does not skip frames.//
```

The solution

- 1 Do one of the following:
 - Click the Animation Preferences button and set the Playback Speed to Play every frame;
 - When rendering, set your rendering frame increment to one.

6 | Playing back Cloth simulations

Reference > Simulation > Caches > Create Cache

Reference Simulation > Caches > Create Cache

Use this to create a cache. For more information, see "Create a cache" on page 99.

Simulation > Delete Cache

Use this to delete a cache. For more information, see "Delete and truncate the cache" on page 100.

Simulation > Truncate Cache

Use this to truncate a cache. For more information, see "Delete and truncate the cache" on page 100.

Simulation > Compress Cache

Use this to compress a cache. For more information, see "Compress the cache" on page 100.

Simulation > Interpolate Cache

Use this to interpolate the specified time range of a cache. For more information, see "Interpolate the cache" on page 101

Simulation > Cache Editor

This opens the Cache Editor window. Use this to blend, interpolate, or copy frame ranges from different caches into a target cache. For more information see "Use the Cache Editor." The following are descriptions of the options in the Cache Editor window.

Add Cache Segment

Click this button each time you want to add a source cache segment. Then set the source cache segment's options.

Cache	Select the cache for the source cache segment.
Range	Specify a range of frames for the source cache segment.
Weight	Specify a weight if you are blending cache segments.

Target Cache

Select a target cache from the drop-down list.

6 | Playing back Cloth simulations

Reference > Simulation > Disable Solver

Target Range

Specify the start and end frame in the target cache. The duration of this frame range must be the same as the source range(s). For example, the source range could be frames 1 to 5 and the target range could be frames 21 to 25.

Operation

Select an editing operation from the drop-down list.

Interpolate	Removes the cloth particle's position at the frame(s) as specified in the Source Cache and Source Range and uses the previous and following positions of the particle(s) to calculate a new position. The interpolation type determines how the values are calculated. Interpolation only works with a single Source Cache.
Blend	<p>Based on a specified blend weight, combines specified equal duration frame ranges from different simulations into the target cache segment at the specified range. Set the blend weight in the source cache segment options. Weighting values are normalized so the sum of cache segment weights equals 1.0. The source and target ranges can be in different caches.</p> <p>For example, combine frames 1 to 5 of one simulation and frames 6 to 10 of another simulation into frames 21 to 25 of the target simulation.</p>
Copy	Copies the specified frame range in the source cache segment to the specified frame range (of equal duration) in the target cache segment.

Interpolation Type

If you select interpolate as your editing operation, you'll need to select a type of interpolation.

Linear	Specifies linear interpolation from the start of a cache segment range to the end.
Sine	Favors values close to the start and end of the cache segment range and follows a more linear interpolation in the middle.

Simulation > Disable Solver

Use this to turn off the solver. For more information, see "Disable/enable the solver" on page 104.

6 | Playing back Cloth simulations

Reference > Simulation > Enable Solver

Simulation > Enable Solver

Use this to turn on the solver. For more information, see "Disable/enable the solver" on page 104.

Simulation > Show Cloth Stress

Use this to turn on the display of stress feedback on the cloth. For more information, see "Visualize stress on cloth" on page 97.

Simulation > Hide Cloth Stress

Use this to turn off the display of stress feedback on the cloth. For more information, see "Visualize stress on cloth" on page 97.

cpClothStress node

These are the attributes in the Cloth Stress Visualization section of the cpClothStress node. For more information, see "Visualize stress on cloth" on page 97.

High Stress Color

This color in the Stress Visualizer represents areas of high stress. The default color is white.

Low Stress Color

This color in the Stress Visualizer represents areas of low stress. The default color is black.

Draw Type

This defines how the stress will be displayed on the cloth object or garment. The drop-down list includes: Default, Shaded, and Numeral.

Default	If you are in Wireframe mode, stress is displayed as Numeral by default; if you are in Shaded mode, stress is displayed as Shaded by default.
Shaded	This applies only when you are in Shaded (as opposed to Wireframe) mode. Areas of stress are represented by colors, as defined by the High Stress Color and Low Stress Color attributes.
Numeral	Areas of stress are annotated with values representing the level of stress. These values are the normalized values from the solver; high areas are close to 1.0 and low areas are close to 0.0.

6 | Playing back Cloth simulations

Reference > cpClothStress node

Disable Cutoff

This is available only when the Numeral Draw Type is selected. By default this checkbox is turned off. When it is turned on the Cut Off value is disregarded and all stress values are displayed in the Stress Visualizer. This can result in a cluttered display.

Cut Off

This value is a lower limit on what numerals are displayed in the Stress Visualizer. The default value is 0.5; in this case only stress values of 0.5 and higher are displayed.

Stress Scale Factor

In large cloth objects or garments, the normalization of stress values can hide stress. With Stress Scale Factor you can increase or decrease the stress factors to better see the stress. The default is 1.

$$\text{actual} = \text{Stress_Scale_Factor} * \text{normalized_stress_value}$$

Mesh Draw Offset

This is only for the Shaded Draw Type. Use this to better see the stress. The cloth object or garment is drawn n-units closer to or farther from the user in the viewing direction. For example, if the Mesh Draw Offset was 1, but then increased to 2, the cloth would be drawn 1 unit closer in the user's viewing direction. The default is 0.05.

6 | Playing back Cloth simulations

Reference > cpClothStress node

7

Adding texture and shaders to Cloth

About

Adding texture and shaders

Textures and shaders add lifelike realism to your cloth. You use the standard Maya tools to add texture and shaders to your cloth just like you add them to any object in Maya. Find out more about shaders and textures that are unique to cloth:

- "Create non-overlapping texture coordinates" on page 111
- "Adjust texture coordinates" on page 113
- "Use double-sided shaders" on page 114
- "Use patterns" on page 114



How do I?

Create non-overlapping texture coordinates

In Cloth, UV texture coordinates are generated by taking a bounding box of all the panels that form the garment and normalizing their values between 0 and 1 using a uniform scale. The UV texture coordinates will not be squashed or stretched relative to each other as they are scaled into the 0 to 1 range. Either the height or width of the garment, whichever is greater, defines the scale of the texture.


To create non-overlapping UV texture coordinates

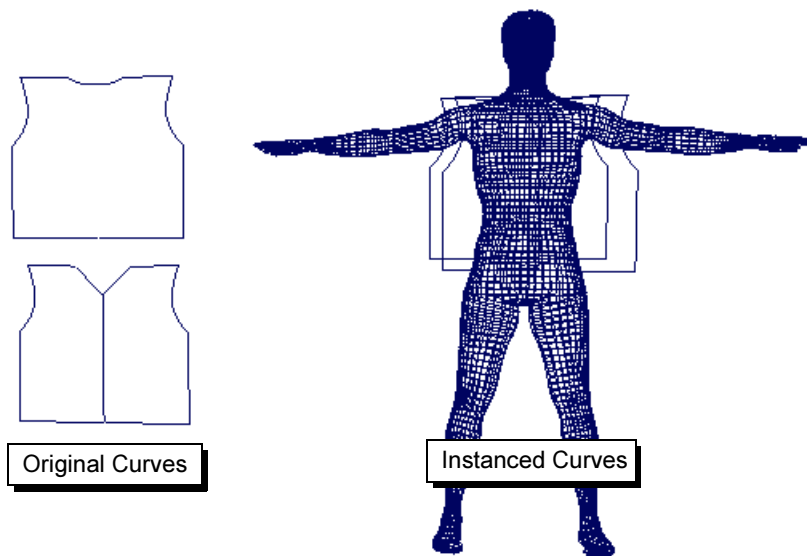
- 1 Create your curves, all under one hierarchy.

7 | Adding texture and shaders to Cloth

How do I? > Create non-overlapping texture coordinates

For example, create the curves either all under one group or under the world.

- 2** Select the curves. Select Edit > Duplicate > .
- 3** In the Duplicate Options window, turn on Instance and click Duplicate.
- 4** Group the curves as needed to organize your garment.
For example, group the original curves and the instanced curves.
- 5** Position the instanced curves around the character.



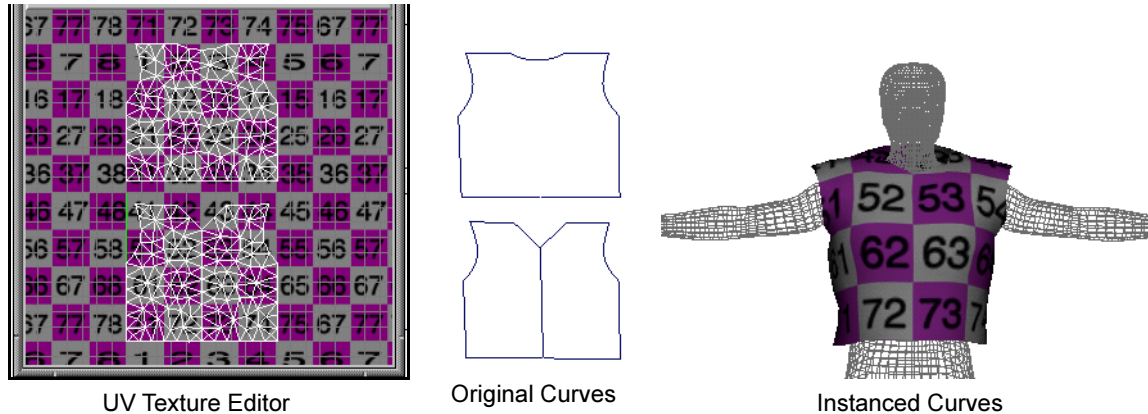
- 6** Create your cloth panels and seam the garment.
- 7** Assign a shader to the cloth.

To view the texture coordinates

- 1** Select the cloth garment.
- 2** From the Modeling menu set, select Window > UV Texture Editor.

7 | Adding texture and shaders to Cloth

How do I? > Adjust texture coordinates



3 To tailor the garment, you can do the following:

- To move the curves and modify the UV texture coordinates, select the vertices of either the original curves or the instanced curves in the scene view and move them.
- To move your curves without modifying the UV texture coordinates, select the groups of the instanced curves and move them.

Adjust texture coordinates

You can move selected UV texture coordinates (UV points) to modify selected parts of your texture map. You use the UV Texture Editor to do this.

Note If you manipulate texture coordinates downstream from the solver, these coordinates will be incorrect if you change the cloth resolution. Make sure your cloth is at its final resolution.

As you adjust the UV points, the way the image is mapped onto the object changes accordingly. You manipulate UV points of the model in the UV Texture Editor without actually changing the UV points of the object in the 3D view. The idea is to stretch and squeeze parts of the 2D object so that they match up with the equivalent parts of the 3D object. The 3D view reflects your changes as you make them in the UV Texture Editor.

For information on moving texture coordinates using the UV Texture Editor, see the *Polygonal Modeling* guide.

7 | Adding texture and shaders to Cloth

How do I? > Use patterns

Use patterns

Cloth looks best when you use a texture with a repeatable pattern. For a pattern to be repeatable, you must be able to tile it without it appearing to obviously repeat. The texture should have no edge lines and no obvious indications of a repeating texture that make it look like a small texture that has been copied and duplicated.

If you have a pattern that is non-repeating, you need to make it repeatable. That usually entails taking it into a paint package and adjusting it so it doesn't look obviously "tiled."

Use double-sided shaders

You can create double sided shaders to apply a different shader to each side of a two-sided garment. For example, you could use a double-sided shader to apply satin lining to a tweed vest.

For information on creating double-sided shaders, see "[Use double-sided shaders](#)" on [page 114](#) in the *Shading* guide.



8 Managing Cloth scenes

About

Managing Cloth scenes

You can use these techniques to manage your cloth simulation scenes:

- "Export and import garments" on page 115
- "Advanced solver performance tools" on page 117
- "Use multiple solvers in a scene" on page 120
- "Simulate cloth in batch mode" on page 123



How do I? Export and import garments

You can export a garment with or without its solver. You can also export a garment with or without its collision object.

If you export a garment *without* the solver, you get the polygonal mesh of the cloth after it has been simulated. The cloth can no longer be simulated. For example, you could simulate a tablecloth and export it without the solver to use it in a restaurant scene where the tablecloth doesn't have to simulate.

If you export a garment *with* the solver, you get the solver and all the garments that are connected to the solver. For example, if you create a shirt and pants connected to the same solver, then you export the shirt with the solver, the pants are also exported. If you don't need the pants, you can delete them when you import the garment. Alternatively, you can transfer the garment you want to export to a separate solver (see "Use multiple solvers in a scene" on page 120).

8 | Managing Cloth scenes

How do I? > Export and import garments

To export a garment with the solver

- 1 Select the garments you want to export.
The garments will be disconnected from their collision objects during export.
- 2 Select File > Export Selection > ☐.
- 3 In the Export options box, turn on the History checkbox.
- 4 Click the Export Selection button.
- 5 Enter a name for the new scene.
The scene will contain the exported items.

To export a garment without the solver

- 1 Select the garments you want to export.
The garments will be disconnected from their collision objects during export.
- 2 Select File > Export Selection > ☐.
- 3 In the Export options box, turn off the History checkbox.
- 4 Click the Export Selection button.
- 5 Enter a name for the new scene.
The scene will contain the exported items.

To export a garment and its collision object

- 1 Select the garment and the collision object.
- 2 If you want to export the solver also, select File > Export Selection > ☐ and turn on the History checkbox.
- 3 Click the Export Selection button.
- 4 Enter a name for the new scene.
The scene will contain the exported items.

To import a garment

- 1 Select File > Import.
- 2 Navigate to the file that contains the garment you want to import.
- 3 Click Import.

Reset initial position

If you want to import a garment that was modeled at the origin and place it on a character that is *not* at the origin, use Save as Initial Cloth State.

To reset initial position

- 1 Import the garment.
The garment must have been exported with History turned on.
- 2 Select the cloth mesh and position the garment on the character.
You can drag the cloth using the Move tool, or you can copy the transformation values of the character and enter the values in the Channel Box.
- 3 Make sure the cloth is still selected. Select Simulation > Save as Initial Cloth State.
The current cloth vertex positions are saved in the solver, and the cloth transform is reset to the origin.

Advanced solver performance tools

- "Monitor script parameters" on page 117
- "Reasons for solver failure" on page 118
- "Solver diagnostics" on page 119

Monitor script parameters

To take advantage of the MEL callback, your MEL routine must have the following parameters:

- string \$solverName - This tells the callback the name of the solver that called it.
- int \$failureReason - This tells the callback the reason of failure. See "Reasons for solver failure" on page 118.
- string \$optionString - This string is reserved for future parameters.

These arguments must be the last three arguments of your MEL callback. You can have additional parameters, but they must occur before the above parameters.

Here is a sample callback:

```
global proc myReact( int $stepsBack, string $solverName, int
$reason, string $optionVar )
{
    print ("User defined script called" + $i + "\n");
    print ("solverNode = " + $solverNode + "\n");
    print ("reason = " + $reason + "\n");
    print ("option = " + $option + "\n");

    float $by = `playbackOptions -query -by`;
    float $curr = `currentTime -query`;
    float $min = `playbackOptions -query -min`;
```

8 | Managing Cloth scenes

How do I? > Advanced solver performance tools

```
float $max = `playbackOptions -query -max`;

float $theStep = $stepsBack * $by;

if (($curr != $min) &&
    (($curr - $theStep) >= $min) && (($curr - $theStep) < $max))
{
    currentTime -edit ($curr - $theStep);
}

// Truncate the cache at the current time.
//
cpSolver -e -deleteRestOfCache;

// Set frame samples to be 1.
//
string $plug1 = ($solverNode + ".frameSamples");
setattr $plug1 1;

// Play forward
play;
}
```

monitorString attribute would equal myReact x where x would equal the number of frames you would want to step back.

Reasons for solver failure

There can be a few reasons for failure. These reasons equate to the internal fail detector in the solver node.

- 1** Bad Cutoff - The cutoff value is a double precision value that represents, approximately, the amount of stress in the cloth. Very large cutoff values are usually an indication of a bad cloth configuration. When the cutoff value exceeds the internal threshold, the fail detector reports the problem and a response is taken. When \$failReason equals 1 this implies a large cutoff value occurred and the detector requested that the solver stop.
- 2** Bad Adaptive Step - To solve a single frame the solver makes several steps within that frame to get a solution. Internally the solver has a mechanism for determining how large, or small, of a step it should take to get a solution. This is known as adaptive stepping. If the adaptive step size becomes too small, then the frame may not complete in a reasonable amount of time. The detector looks for cases where the adaptive size is very small and reports this. When \$failReason equals 2 this implies a very small adaptive step was encountered.

Solver diagnostics

The solver node monitors solver performance through a series of solver callbacks. These callbacks indicate how well the solver is performing. There are three types of callbacks that represent performance.

- Adaptive Step Notification

In midstep the solver may decide that it would be appropriate to restart the current step at a smaller time increment (recall that solver takes several steps between frames to compute the output mesh for a given frame). When the solver makes this internal adjustment it notifies the solver node. The solver node records this for analysis. Very small steps are indication the solver is having difficulty finding a solution for the frame.

- Collision Detection Notification

This callback indicates that collision detection is being performed. The solver tells the solver node the maximum amount of penetration found from a collision.

- Linear Solution Notification

The solver uses a linear solver to determine the output mesh. This callback is invoked several times during this solution process. Encoded in the callback information is a cutoff value. This value roughly indicates the amount of stress in the simulation. Large values indicate poor cloth configuration. These values are recorded by the solver node and used for diagnostic purposes.

Extracting and interpreting the diagnostic data

You can extract the recorded callback information after a simulation has stopped, either from the completion of playback or from fail detection. To extract information use the following command:

```
cpSolver -wsh "/path/fileName"
```

The solver command extracts the data from the solver node and stores it in the file you specify. A .cbd extension will be added to the name of that file.

The output .cbd file contains four columns.

- The first column is the time instance that the callback data was sampled from. The time corresponds to the current time units.
- The second column is the cutoff parameter returned from the linear solution callback.
- The third column is the maximum penetration value returned from the collision callback.
- The final parameter is the array of adaptive step notifications.

8 | Managing Cloth scenes

How do I? > Use multiple solvers in a scene

Use multiple solvers in a scene

It can be computationally expensive to simulate several clothed characters at the same time. To reduce this problem, you can segment the cloth simulations into multiple independent simulations that are solved separately. You do this by using multiple solvers.



If two garments will not be colliding with each other, you can place them in separate solvers. You can turn a solver on or off independently of the other solvers. This lets you work on the simulation of one garment without having to wait for other simulations to solve.

In addition, caching is performed on a per-solver basis. This means you can build your animation in stages by solving simulations one at a time. You can view the previously solved simulations with the one you are currently working on.

Create multiple solvers

To create a new solver

1 Do one of the following:

- Select Simulation > Solvers > Create Solver.
- Select Simulation > Solvers > Create Solver > , modify the settings in the Cloth Solver Options window, and then click Create. For information about these options, see "Simulation > Solvers > Create Solver > " on page 124.

A new cloth solver is created and added to the list of solvers in the Cloth Solver menu. This new solver becomes the current solver. You can rename the solver in the Channel Box.

Select the solver

You specify which simulation you want to work on by making its solver the current solver. All subsequent construction operations are applied to that simulation.

To make a solver current

- Select Simulation > Solvers > *cpSolvername*.

The solver you select becomes the current solver. Any garments, cloth objects, and collision objects you create while this solver is current are controlled by this solver.

Edit multiple solvers

To change the solver's attributes

- 1 Select Simulation > Solvers > *cpSolvername* > ☐.
The solver attributes are displayed in the Attribute Editor.
- 2 Enter values for the attributes (see "Adjust the cloth solver" on page 53 for information on the solver attributes).

Turn multiple solvers on or off

To disable a solver

- 1 Do one of the following:
 - Select Simulation > Solvers > *cpSolvername* > ☐. Turn off Solver Enabled in the options window.
 - Select the cloth belonging to the solver you want to disable. Select Simulation > Disable Solver.

To enable a solver

- 1 Do one of the following:
 - Select Simulation > Solvers > *cpSolvername* > ☐. Turn on Solver Enabled in the options window.
 - Select the cloth belonging to the solver you want to enable. Select Simulation > Enable Solver.

Transfer garments between solvers

To transfer a garment from one solver to another

- 1 Make the solver you want to transfer the garment to current by selecting Simulation > Solvers > *cpSolvername*.
The solver you select becomes the current solver.
- 2 Select the garment you want to transfer to the current solver.
- 3 Select Simulation > Transfer Garment.
The garment is connected to the current solver.

Important!

When you transfer garments from one solver to another, the cache files of both solvers become invalid. You must resimulate using each solver to create new cache files.

8 | Managing Cloth scenes

How do I? > Use multiple solvers in a scene

Delete cache with multiple solvers

To delete the cache in scenes with multiple solvers

- 1 Select the cloth.
- 2 Select Simulation > Delete Cache.
Cloth ignores the current solver, finds the solver for the selected cloth, and deletes the cache.

Use collision objects with multiple solvers

A collision object can be connected to more than one solver. Before creating or removing collision objects, you must select the solver that the collision object is connected to.

The collision object attribute settings apply to all the solvers that the collision object is connected to.

To create a cloth collision object

- 1 Select Simulation > Solvers > *cpSolvername*
where *cpSolvername* is the name of the solver to which you want to add the collision object.
This makes it the current solver.
- 2 Select the object you want to be a collision object.
- 3 With the object still selected, select Cloth > Create Collision Object.
The object is made a collision object and connected to the current solver.

To remove a cloth collision object

- 1 Select Simulation > Solvers > *cpSolvername*
where *cpSolvername* is the name of the solver from which you want to remove the collision object.
This makes it the current solver.
- 2 Select the collision object.
- 3 Select Cloth > Remove Collision Object.

To transfer a collision object from one solver to another

- 1 Select Simulation > Solvers > *cpSolvername*
where *cpSolvername* is the name of the solver from which you want to remove the collision object.
This makes it the current solver.

8 | Managing Cloth scenes

How do I? > Simulate cloth in batch mode

- 2 Select the collision object.
- 3 Select Cloth > Remove Collision Object.
The object is no longer a collision object of the first solver.
- 4 Make the new solver current by selecting Simulation > Solvers > *cpSolvername*
where *cpSolvername* is the name of the solver that you want to add the collision object to.
This makes it the current solver.
- 5 Select the object and select Cloth > Create Collision Object.
The object becomes a collision object connected to the new solver.

Simulate cloth in batch mode

We've included a script, *cpRunBatch.mel*, which lets you solve a cloth animation in batch mode. You can use this script to create the cache file without having to run Maya graphically.

Simulate cloth in batch mode with a floating license

When simulating cloth in batch mode, Maya acquires the simulation license when it reaches the first frame that requires cloth simulation. In a floating license installation, the license acquisition during batch mode can fail if another user starts a Maya Unlimited interactive session on another machine and exhausts the supply of licenses before the cloth content is reached. To prevent this, we've included the environment variable `MAYA_CLOTH_SIMULATE`.

If you set this variable before you start the batch simulation, Maya loads the simulation license at the start of the batch mode, which ensures that a simulation license is reserved by the time the cloth frame is reached.

To set the `MAYA_CLOTH_SIMULATE` environment variable

- 1 Do one of the following:
 - (IRIX and Linux) Type the following in a shell:

```
setenv MAYA_CLOTH_SIMULATE
```
 - (Windows) Set the `MAYA_CLOTH_SIMULATE` environment variable in the `Maya.env` file. See ["Setting environment variables using Maya.env"](#) in the *Environment Variables* guide.

To simulate cloth in batch mode

- 1 Do one of the following:
 - (IRIX and Linux) Type the following in a shell:

8 | Managing Cloth scenes

Reference > Simulation > Solvers > Create Solver

```
maya -batch -file filename -command "cpRunBatch  
startframe endframe"
```

- (Windows) Type the following in a DOS shell:

```
mayabatch.exe -batch -file filename -command  
"cpRunBatch startframe endframe"
```

Simulate cloth in batch mode with a node-locked license

To simulate cloth in batch mode when you have a node-locked license, you need to use the node-locked license.

To simulate cloth in batch mode (IRIX and Linux)

- Type the following in a shell:

```
maya -batch -lic=unlimited -file filename -command  
"cpRunBatch startframe endframe"
```

To simulate cloth in batch mode (Windows)

Create a batch file that sets the environment variable MAYA_LICENSE to unlimited, then use that batch file to create the cloth cache file.

- 1 Create a file called createCache.bat with the following lines.

```
set MAYA_LICENSE=unlimited  
  
mayabatch.exe -batch -file "%1" -command  
"cpRunBatch %2 %3"
```

- 2 Then run the batch file, by typing:

```
createCache filename startframe endframe
```

Reference [Simulation > Solvers > Create Solver](#)

Lets you create a solver so you can segment cloth simulations into multiple independent simulations that are solved separately. For more information, see "Use multiple solvers in a scene" on page 120.

Simulation > Solvers > Create Solver > □

Lets you specify the settings for the solver in the Cloth Solver Options window.

Name

Enter a name for the solver.

Start Frame

Specify at what frame the solver starts calculating.

Frame Samples

Specify the number of times the solver samples the time interval between successive frames. Frame Samples and Time Step Size work together.

Time Step Size

Specifies the maximum time, in seconds, that the internal dynamic solution advances. Frame Samples and Time Step Size work together.

Solver Scale

Specifies the scale of the internal coordinate system of the solver.

Gravity

Specifies the value for gravity. If you want to disable gravity, set this to 0, 0, 0. The default is 0, -980, 0.

Relax Frame Length

Specifies the number of frames that a rubbery “relax material” is applied to a garment and the garment does not react to gravity. After the specified number of frames, the normal material is applied and the cloth reacts to gravity.

If you are creating a cloth object that does not need to be relaxed, such as a tablecloth, set the Relax Frame Length to zero.

If you are creating a cloth object that is really stretched out, you can increase this value.

Simulation > Transfer Garment

Use this to connect the garment to the current solver. For more information, see “Transfer garments between solvers” on page 121.

8 | Managing Cloth scenes

Reference > Simulation > Transfer Garment

A Cloth cache format

About

Cloth cache format

A cache file stores position and velocity data for all cloth objects associated with a particular cloth solver. The Cloth cache file is in binary Big-Endian format for IRIX, Linux and Windows. All integers are represented as 8-byte integer data.

The file consists of a header, followed by the body of the cache. The body contains position and velocity values of each cloth object connected to the associated solver for each frame that has been simulated. The header stores a magic number, so there is no restriction on cache filenames. In addition, the header stores a version number to allow the format to evolve over time.

Compressed caches

You can compress caches, which removes some or all of the velocity data. The Compress Cache operation removes all velocity data from the cache except for the last frame in the cache. This final set of velocities is required to restart the simulation from the end of the cache. As newly simulated frames are appended to the end of a compressed cache, both their position and velocity values are saved. So caches may be not completely compressed. The header contains the number of compressed frames so it is possible to calculate the position of any frame in the cache. Compressing the cache does not slow down playback performance.

Warning

When truncating a cache, it is not valid to truncate the cache to a frame that has been compressed. The format contains no delimiters between frames of data, so a poorly truncated frame uses the next frame's positions as its velocities when being restarted by a solver.

Header format

The header starts with five 8-byte integers in the following order:

- magic number
- version number
- total number of frames
- number of compressed frames

A | Cloth cache format

About > Body format

- number of cloth objects

The magic number is **5463728** and will not change. The version number for Version 2 is 2. The total number of frames includes both compressed and uncompressed frames. The number of cloth objects must equal the number of cloth objects connected to the solver that use this cache. This includes both cloth objects that have been created from panels and cloth objects that have been created from existing polygonal meshes and NURBS surfaces.

Following these five integers is a set of 8-byte integers, one for each cloth object. These integers specify the number of vertices in each cloth object.

Warning

The number of integers must be equal to the number of cloth objects specified. There is no delimiter between these integers and the body of the cache. An incorrect number of integers results in either header data being used in the body or vice versa.

The correspondence between the cloth objects represented in the cache and the cloth objects simulated in the solver is by the connection order of the cloth objects into the solver. The cloth solver node defines an input attribute called `clothBody`. This attribute is an array whose elements contain the connections from the cloth objects that will be used by the solver.

The connections can be viewed using Maya's Hypergraph or Connection Editor. The array can be sparse, so the first cloth object in the cache corresponds to the connection with the lowest array index. The next cached cloth object corresponds to the connection with the next lowest array index, and so forth.

The solver verifies that all of the data in the header matches the information in the solver, and that the magic number is correct and the solver recognizes the version of the cache. If any of this information is invalid, the cache will not be used by the solver.

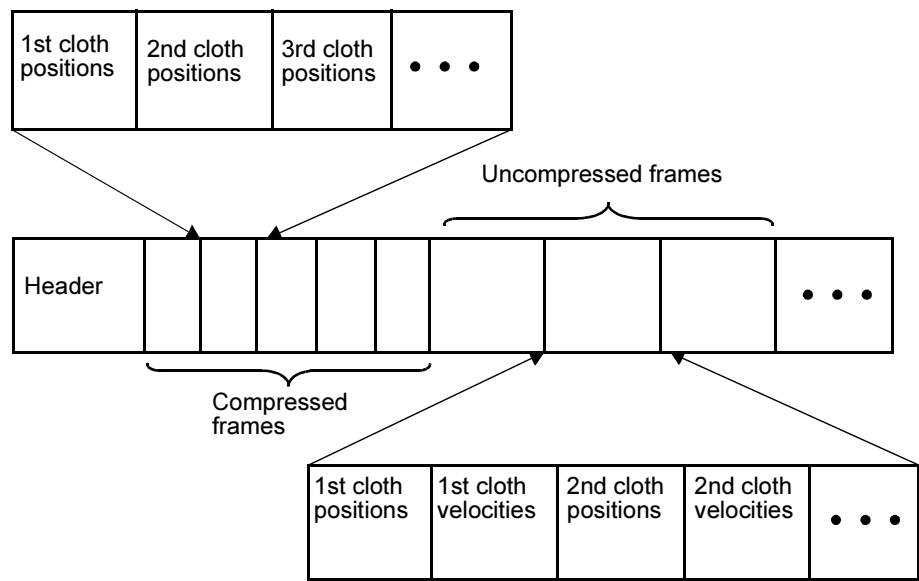
Body format

Following the header is the body of the cache. The body stores the position and velocity data for each cloth object for each simulated frame.

The figure below shows the organization of the data. All the data for a frame is grouped together. The order of the bodies is the same as the order specified in the header. The ordering of the positions and velocities is the same order as the vertex ordering of the shape as specified in Maya.

A | Cloth cache format
About > Body format

The frames are stored sequentially with the first frame after the header being the first frame simulated. The initial position of the cloth objects are not stored in the cache file. There must be at least one uncompressed frame. All position and velocity values are stored as 4-byte floating point data. There are no delimiters between any group of data.



A | Cloth cache format

About > Body format

B

Cloth licenses

About

Cloth licenses

Each copy of Maya Unlimited comes with one edit license, one simulation license, and additional licenses for batch rendering. The edit license lets you use all the Cloth features, the simulation license lets you simulate cloth, and the licenses for batch rendering let you render cloth scenes in batch mode.

The simulation license

The simulation license is used for:

- In interactive mode, the simulation license is acquired as soon as the Cloth plug-in is loaded. Therefore, when an interactive session of Cloth is running, you cannot render a cloth scene that requires cloth to be simulated. (This applies when floating licenses exist and all edit licenses are in use.)
- In batch mode, prompt mode, or when rendering, a simulation license is acquired only when cloth needs to be simulated.

The Cloth plug-in does not release any of the licenses it acquires until you exit Maya. Unloading the Cloth plug-in does not release the licenses.

Cloth licenses and rendering

The simulation license is used as follows for rendering:

- you can simulate while rendering (This requires a simulation license.)
- you can render a cloth scene that has already been simulated and has a cache file (This does not require a simulation license.)

B | Cloth licenses

About > Cloth licenses and rendering

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