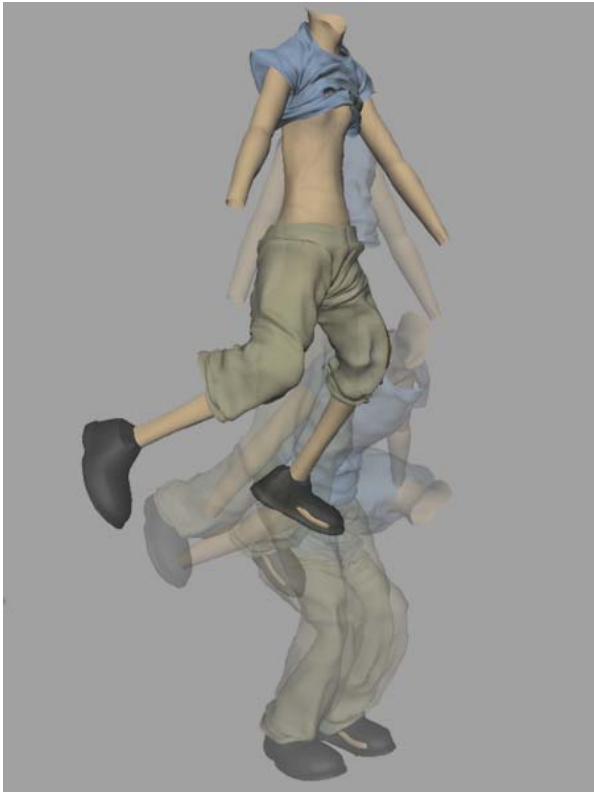


# **nCloth advanced techniques**

**6**

## Overview



The nCloth advanced techniques tutorial demonstrates a workflow that allows you to simulate high resolution clothing mesh using nCloth. In the tutorial, two lower resolution versions of a high resolution mesh clothing are converted to nCloth and then simulated. Using a wrap deformer, the nCloth objects become influence objects for the high resolution mesh clothing, which then behaves the same as the simulated nCloth. Using this workflow, you can quickly create animated behaviors unique to simulated cloth using high resolution meshes.

The tutorial describes methods for identifying problem areas in your nCloth simulations and explains how to resolve simulation issues, such as inaccurate collisions and self collisions, which often lead to occurrences of interpenetrations between colliding objects. Inaccurate collisions are at play when the components participating in collisions do not accurately detect the

presence of other participating components. This can happen when simulating models with complex geometry. It also explains the importance of setting key Nucleus solver attributes early in the simulation process to ensure better results in more complex nCloth simulations. When simulating complex models, the default solver settings often need to be adjusted to optimize your nCloth.

Use of any data from *The Spine* in this tutorial is courtesy of the National Film Board of Canada.

### **When is this workflow useful?**

This workflow is useful for, but not limited to the following scenarios:

- Simulating highly detailed polygon meshes.
- Simulate clothing from various mesh resolutions, which can then be used for characters in the background, mid ground, and foreground of your scene.
- Simulate the same clothing for multiple characters in scene that have similar scale and shape.

### **Why is the workflow useful?**

- Reduces the amount of simulation time and computing resources, allowing you to spend more time testing and adjusting nCloth attribute settings.
- Shorter simulation and caching durations provide quick feedback on how specific attribute adjustments affect nCloth behavior.
- Allows you to better develop an understanding of how your nCloth is behaving and responding to your nCloth attribute settings.
- Allows you troubleshoot simulation problems using a low resolution proxy mesh, and then apply the solutions to high resolution mesh nCloth objects.

The nCloth Advanced Techniques tutorials assume that you have a familiarity with nCloth in your Maya scenes, and have completed the nCloth tutorials from the Getting Started with Maya Unlimited sections of Maya Help. This chapter includes the following lessons:

- [Lesson 1: Converting the pants to nCloth and setting up the simulation](#) on page 135
- [Lesson 2: Simulating the pants in a static stance](#) on page 142

- Lesson 3: Wrapping the high resolution mesh and simulating the pants during animation on page 147
- Lesson 4: Simulating the low resolution shirt on page 166
- Lesson 5: Simulating medium resolution meshes using custom nCloth attribute presets on page 177

## Preparing for the lessons

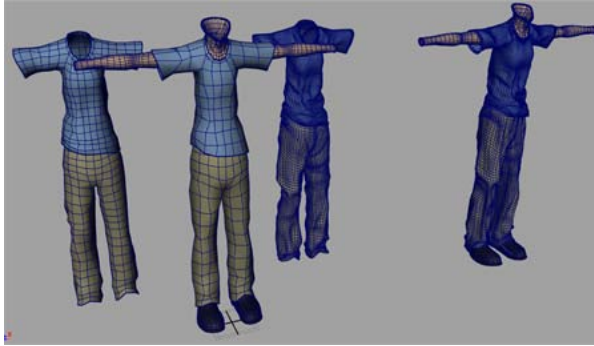
To ensure the lessons work as described, do these steps before beginning.

- 1 Make sure you understand the basic concepts of polygon modeling, animation, and nCloth.
- 2 If you have not already done so, copy the nCloth Advanced Techniques folder from the following location:  
<http://www.autodesk.com/maya-advancedtechniques>. Then, set the `AdvancedTechniques` directory as your Maya project.
- 3 Select the nDynamics menu set. Unless otherwise noted, the directions in this chapter for making menu selections assume you've already selected the nDynamics menu set.

## About the tutorial assets

Throughout this tutorial, you use and refer to four variations of the character's polygon mesh clothing: a low resolution, medium resolution, high resolution, and reference character version. To view the tutorial assets, open `Character_Multiple_Resolution.mb` in Maya. The following sections describe each asset.

Use of any data from *The Spine* in this tutorial is courtesy of the National Film Board of Canada.



Throughout this tutorial, you use and refer to four variations of the character's polygon mesh clothing: a low resolution, medium resolution, high resolution, and reference character version. To view the tutorial assets, open `Character_Multiple_Resolution.mb` in Maya. The following sections describe each asset.

### **Low resolution polygon meshes**

The low resolution shirt (`Shirt_LowRes`) and pants (`Pants_LowRes`) objects are the low resolution meshes that you convert to nCloth and simulate. Most lessons in the tutorial focus on optimizing the simulation of these low resolution objects. The low resolution shirt pants are used as the wrap influence objects for the wrap deformer. The `Shirt_LowRes` object consists of 180 faces and the `Pants_LowRes` object consists of 244 faces.

### **High resolution polygon meshes**

The high resolution shirt (`Shirt_HighRes`) and pants (`Pants_HighRes`) objects are the high resolutions meshes used as the deform objects for the wrap deformer. At various stages of the tutorial, you show these meshes in the scene view to observe how the wrap deformer meshes behave when influenced by the low resolution nCloth shirt and pants. The `Shirt_HighRes` object consists of 6510 faces and the `Pants_HighRes` object consists of 5712 faces.

### **Medium resolution polygon meshes**

In the final lesson of the tutorial, you apply a custom nCloth attribute preset to the medium shirt (`Shirt_MedRes`) and pants (`Pants_MedRes`) objects. The nCloth preset is created from the attribute values used for the low resolution nCloth simulation. Like the low resolution shirt and pants, the medium

resolution objects are also used as the wrap influence objects for the wrap deformer.

## Reference Character

The reference character (`Reference_Character`) is a high resolution version of the character and clothing (shirt and pants), which is animated using a cached simulation. It represents the final high resolution mesh that you want to emulate when simulating the low resolution meshes with the wrap deformer. At various stages of the tutorial, you can display the reference character object in the scene view to compare with your current low resolution nCloth simulation.

In the tutorial scene files, the reference character appears hidden in the Layer editor. To display the object, turn on Visible in the Layer Display editor.

For information about the Layer Editor, see Display Layer editor in the *Basics* guide.

## General modeling considerations

In this tutorial, the terms low, medium, and high resolution are used to distinguish each mesh. The terminology is not intended to define the composition of a low, medium, or high resolution mesh, but rather it only describes the meshes general characteristics. When modeling geometry for nCloth, consider the following guidelines:

- High resolution meshes typically look better in a scene than low or medium resolution meshes; however, they take considerably more time to simulate. It is important to establish where in the scene the character wearing the nCloth is to appear. The character's placement helps determine the level of detail its clothing mesh. For example, if the nCloth is used for a character in the foreground of your scene you will want to use a high or medium resolution mesh. If the character is a stand-in or in the background of scene, lower resolution meshes may be sufficient.
- This tutorial assumes that no original low polygonal meshes were created, as all models are derived from the high-resolution meshes. The low and medium resolution meshes have been modeled based on the original high resolution mesh by superimposing the lower resolution meshes on top of the high resolution mesh. Modeling the lower resolution mesh on top of the original high resolution mesh allows you to use the high resolution mesh to quickly identify problem areas in your simulation, such as the crotch and knees in nCloth pants.

- You can use Smooth Polygon Preview mode to see what your low resolution mesh looks like with a higher polygon count. Be aware, that when the mesh is converted to nCloth, it uses the base mesh and not the preview subdivided mesh.
- When modeling your low resolution meshes, try to superimpose them close as possible to the high resolution mesh. Doing this minimizes offsets between the meshes during the simulation, which can cause interpenetrations between the character's body and the high resolution mesh. These interpenetrations may not appear in the static frames (initial set up) of your simulation, but may appear in frames in which the character is animated. Be aware that interpenetrations are easier to resolve in the initial frames of your simulation.
- It is a best practice to model your mesh using equal sized quads, as this directly impacts how your nCloth behave in the simulation. nCloth created from input meshes with similar sized polygons tend to produce more accurate collisions than nCloth meshes with varied size of polygons. Typically, meshes created from uniform quads provide better result in other character creation tasks, such UV layout, skinning, and deformation. For more information, see [Optimizing geometry for nCloth conversion](#) on page 32.

## Lesson 1: Converting the pants to nCloth and setting up the simulation

Before setting up the simulation environment, you need to convert the low resolution pants mesh (Pants\_LowRes) to an nCloth object. When the nCloth object is created, an nClothShape and a Nucleus node are created. You can then begin to set up the simulation environment.

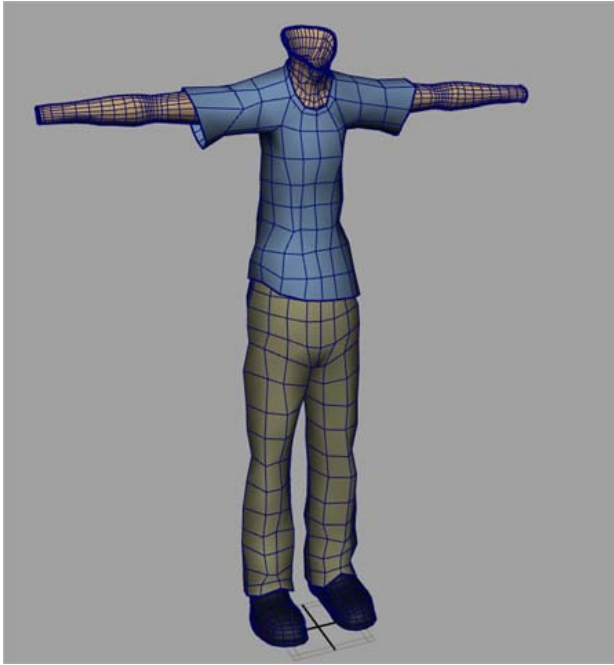
In this lesson, you will:

- Convert the Pants\_LowRes object to an nCloth object.
- Convert the Body and Shoe objects to passive collision objects.
- Set Nucleus solver properties, such as Time Attributes and Scale Attributes.

## Converting the pants to nCloth

To convert the pants to nCloth

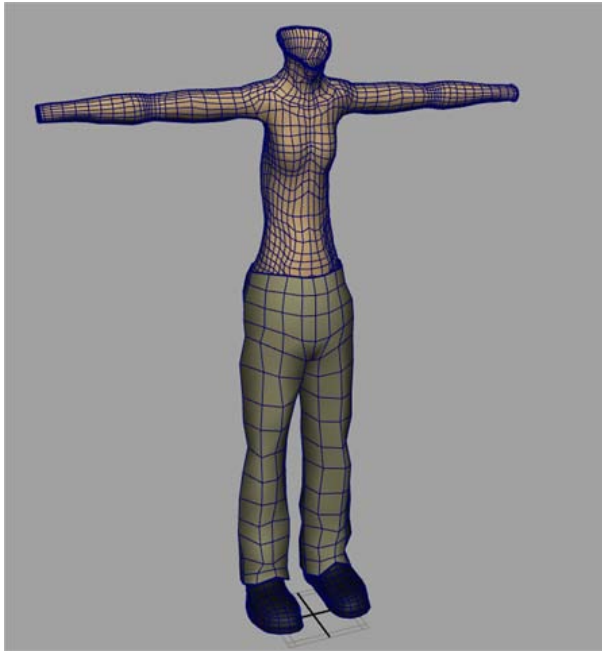
- 1 Open `Character_LowRes_1.mb` in Maya.




- 2 Make sure that only the low resolution pants (`Pants_LowRes`), Body, and Shoes are displayed in the scene view.

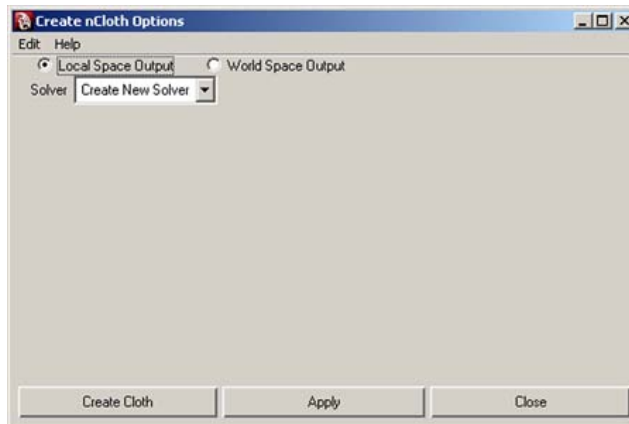
If other objects are displayed, hide them now by selecting each object in the Outliner, and selecting `Display > Hide > Hide Selection`.





- 3 Select the Pants\_LowRes object and select **nMesh > Create nCloth** > 

The Create nCloth Options window appears.



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**NOTE** If the nCloth menu set appears in the Maya interface do not use it. You must use the nDynamics menu set to create and control nCloth. See [nCloth menu set appears in Maya](#) on page 381 for information about removing the nCloth menu set from Maya.

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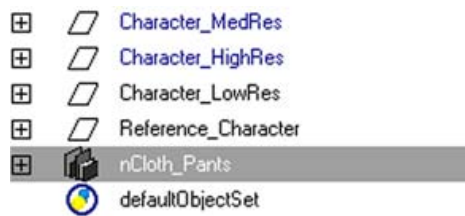
4 Select Edit > Reset Settings.

5 Click Create Cloth.

The low resolution pants are converted to an nCloth object, and its Maya Nucleus solver is created.

6 To ensure that all nCloth objects that you will create in tutorial are easy to identify in your scene, rename your pants nCloth object. To do this, in the Outliner, double-click *nCloth1*, and type *nCloth\_Pants*.

7 Press Enter.



8 Play back your simulation.

When you playback the simulation, you notice that the nCloth is not responding to the Nucleus forces, meaning it is not being simulated. In the step, you adjust the scene's start frame so that your nCloth is simulated.

## Setting up the simulation

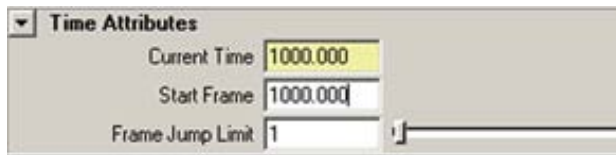
Before you begin simulating nCloth, it is important to adjust the Nucleus solver properties to suite your simulation. The Maya Nucleus solver properties control internal forces that affect all of the nodes that are members of a particular solver system. One of the most important Nucleus solver attributes to be aware of is Space Scale. When Space Scale is set to its default value of 1, the Nucleus solver applies Gravity and Wind to objects as if the objects were scaled in meters. In some production pipelines, the geometry that is used in nCloth simulation is modeled as life size or in large scale, and therefore Space Scale needs to be adjusted to compensate for the difference in scale. For more information, see [Space Scale](#) on page 361.

## Setting Nucleus solver attributes

For this tutorial, the Time Slider settings specify the Playback time of the scene to start at frame 1000 and end at frame 1150. By default, the Nucleus solver starts simulations at frame 1. To begin simulating the scene, set the Start Frame of the simulation to frame 1000.

### To set the simulation Start Frame

- 1 In the Attribute Editor, select the nucleus1 tab.
- 2 In the Time Attributes section, set the Start Frame to 1000.

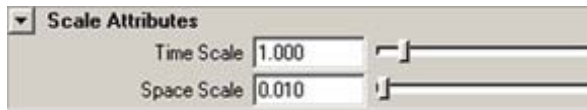


- 3 Go to frame 1 and play back your simulation.

When you play back the simulation, you notice that, the nCloth pants are falling under the influence of gravity generated by the Nucleus solver. However, they fall too slowly to be realistic. This occurs when the scale of the objects in your scene do not match the scale of the Nucleus solver system. Since the Nucleus solver simulates as if centimeters were meters, you need to adjust the Space Scale of the Maya Nucleus solver. In this scene, the character and clothing meshes have been modeled using centimeters as the Maya scene units. Therefore, to simulate your nCloth objects (which were modeled lifesize), you need to set Space Scale to 0.01.

### To edit Space Scale

- 1 In the Nucleus node Attribute Editor, in the Scale Attributes section, set the Space Scale to 0.01.



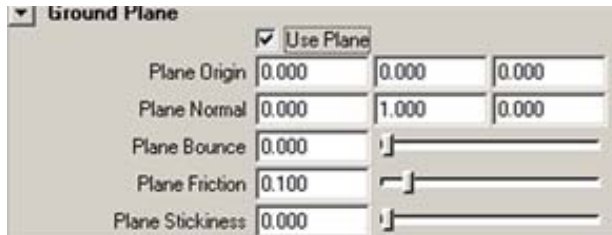
By reducing the Space Scale attribute, Maya evaluated the pants as if it was a much smaller object. This result is a visibly increased gravitational affect on the nCloth pants object.

- 2 Play back your simulation.

When you playback the simulation, you notice that the nCloth pants now falls from its start position at a realistic speed, however it is falling out of the scene. To stop the pants from falling out of the scene view, turn on the Nucleus Ground Plane. See [Ground Plane](#) on page 359.

### To turn on the Nucleus Ground Plane

- 1 In the Nucleus node Attribute Editor, in the Ground Plane section, turn on Use Plane.



- 2 Play back the simulation.

When you play back the simulation, you notice that the pants are not colliding with the body and shoe objects. This is because the body and shoe meshes are not yet part of the nCloth's Nucleus system. In the next step, you convert these objects to passive collision objects.

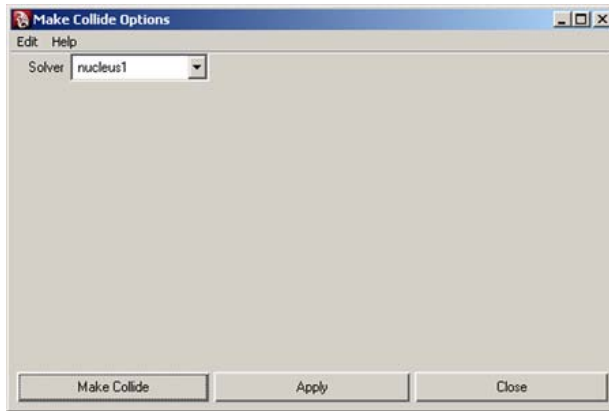


### Converting the body and shoes to passive collision objects

The last step in setting up the simulation is to convert the body and shoe meshes to passive collision objects. As passive collision objects, the body and shoe meshes will collide with the nCloth pants object.

#### To convert the body and shoe meshes to collision objects

- 1 In the scene view, Shift-select the body and shoe meshes, and select [nMesh > Create Passive Collider](#) > ☐ .  
The Make Collide Options window appears.



- 2 From the Solver drop-down list, select nucleus1.
- 3 Click Make Collide.  
Two nRigidShape nodes (nRigidShape1 and nRigidShape2) appear in the Attribute Editor.
- 4 Rename the body and shoe nRigidShape nodes, in the Outliner, double-click *nRigidShape1* and *nRigidShape2*, and type *nRigid\_Body* and *nRigid\_Shoes* respectively.



## Lesson 2: Simulating the pants in a static stance

Before simulating nCloth on an animated character, it is important to ensure that your nCloth simulates correctly while the character is at rest or in a static stance. By allowing the nCloth to settle, it is easier to identify problems in

the simulation and apply the proper adjustments before your simulation becomes too complex and hard to diagnose.

In this lesson, you will:

- Create a Point to Surface constraint to constrain the pants to the nRigid\_Body object.
- Edit Stretch Resistance and Compression Resistance.
- Edit Damp to decrease the amount of time required for your simulated nCloth to reach rest state.

### **Constrain the pants to the body**

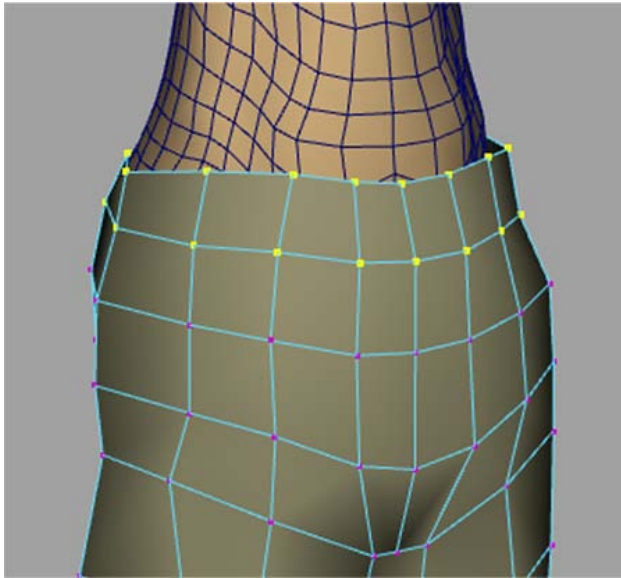
You'll notice that, if you play back the simulation, the nCloth pants are now colliding with the body and shoe objects, but they are falling off the character's body. To keep the pants from falling, create a Point to Surface constraint to constrain the nCloth pants object to the nRigid\_Body object's waist area. For more information about nConstraints, see [Constraining Nucleus objects](#) on page 12.



### To constrain the pants to the character's body object

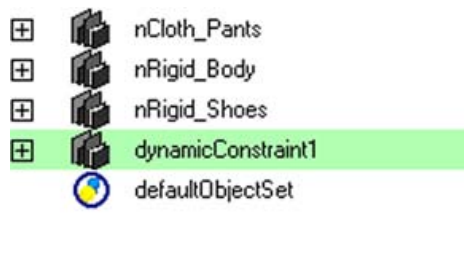
- 1 Open the scene file named `Character_LowRes_2.mb`.  
This file can be found in the `AdvancedTechniques` directory that you set as your Maya project.
- 2 In the scene view, select the nCloth pants object.
- 3 Right-click the nCloth and select Vertex from the context-sensitive menu that appears.
- 4 Select the first two rows of vertices at the top of the nCloth pants.  
Dolly and tumble the camera to ensure that only those vertices in the first two rows are selected.





- 5 Shift-select the nRigid\_Body object and select **nConstraint > Point to Surface**.

For this lesson, leave the dynamicConstraintShape attributes at their default values.



### Edit the pants' Dynamic Properties attributes

When you play back the simulation, you notice the following:

- The nCloth pants simulate using the default Dynamic Properties settings. However, its behavior might not resemble the type of materials that is suitable for the character's clothing.

- The nCloth pants come to rest state after 40 frames of the simulation (frame 1040).

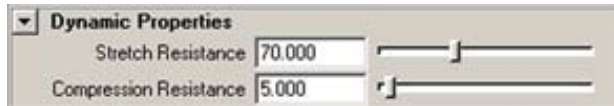
When simulating nCloth on a character that is standing still, edits to the nCloth's Dynamic Properties attributes may only produce subtle changes to the cloth's behavior since gravity and wind are the only forces working on the nCloth. When the nCloth is simulated on an animated character, changes to the cloth's behavior will be more noticeable as these forces begin to generate velocity, collisions, and self collisions, causing your nCloth to deform in different areas and in different directions. Therefore, to simplify your simulation set up, you can give your nCloth some of its unique characteristics by editing some Dynamic Properties attributes using a static simulation.

Stretch Resistance and Compression Resistance are important attributes in determining the nature of your cloth. For example, to create nCloth that behaves like heavy denim, burlap, or thick leather, higher Stretch Resistance values are required, while lighter materials, such as silk or cotton, use lower Stretch Resistance. Stretch Resistance and Compression Resistance iterate resistance on the links and cross links on each quad of the nCloth mesh. Stretch Resistance works to stabilize the pulling or stretching effect which results from the Nucleus forces, such as gravity and wind. Compression Resistance works to stabilize the compressing or squeezing effects on the links as a result of Nucleus forces. Therefore, the higher you set these two attributes, the more the nCloth resists deformation, although they tend to increase simulation time. For more information about Stretch Resistance and Compression Resistance, see [Stretch Resistance](#) on page 328 and [Compression Resistance](#) on page 328.

Be aware that adjusting one Dynamic Properties attribute can affect other attributes. For example, increasing your nCloth's Mass makes it heavier, which may require an increase in Stretch Resistance to compensate. A useful method for editing your nCloth's Dynamic Properties attributes is to set one attribute at a time, and then playback the simulation to observe how the adjustment affected your nCloth.

### **To edit Stretch Resistance and Compression Resistance**

- 1 In the Attribute Editor, select the nCloth\_PantsShape tab.
- 2 In the Dynamic Properties section, set Stretch Resistance to 70.
- 3 Set Compression Resistance to 5.

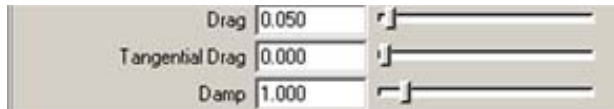


- 4 Play back the simulation.

When play back the simulation, you notice that the nCloth pants come to rest state after 40 frames of simulation. Increasing Damp can bring your simulated nCloth to rest sooner as it dissipates the energy generated from your nCloth Stretch Resistance working against the pull of the Nucleus Gravity. You can also use the Stretch Damp to dissipate this energy.

#### To edit Damp

- 1 In the Attribute Editor, select the nCloth\_PantsShape tab.
- 2 In the Dynamic Properties section, set Damp to 1.



- 3 Play back the simulation.

#### Other attribute settings to consider

Before proceeding with your simulation, consider adjusting the collision Thickness attribute for each nCloth and passive collision object to optimize the collision detection between them. However, when using a workflow that includes a wrap deformer, ensure that the nCloth collision volume (Thickness) allows room for the wrapped mesh without causing interpenetrations with the nRigid\_Body and nRigid\_Shoes objects.

## Lesson 3:Wrapping the high resolution mesh and simulating the pants during animation

In this lesson you will:

- Create a wrap deformer to influence the behavior of the high resolution mesh (Pants\_HighRes).

- Import geometry caches to animate the body (nRigid\_Body) and shoe (nRigid\_Shoes) meshes.
- Create an nCache for the simulated nCloth pants object.
- Identify problem areas in the simulation, such as poorly deformed polygons and interpenetrations caused by inaccurate collision detection between the nCloth and passive collision objects, as well as self collisions within the nCloth itself.
- Edit Nucleus solver Substeps to improve overall quality of the simulation.
- Set keyframes to increase Substeps at specific problem frames in the simulation.
- Resolve interpenetrations.

## Lesson Setup

To ensure the lesson works as described, do these steps before beginning:

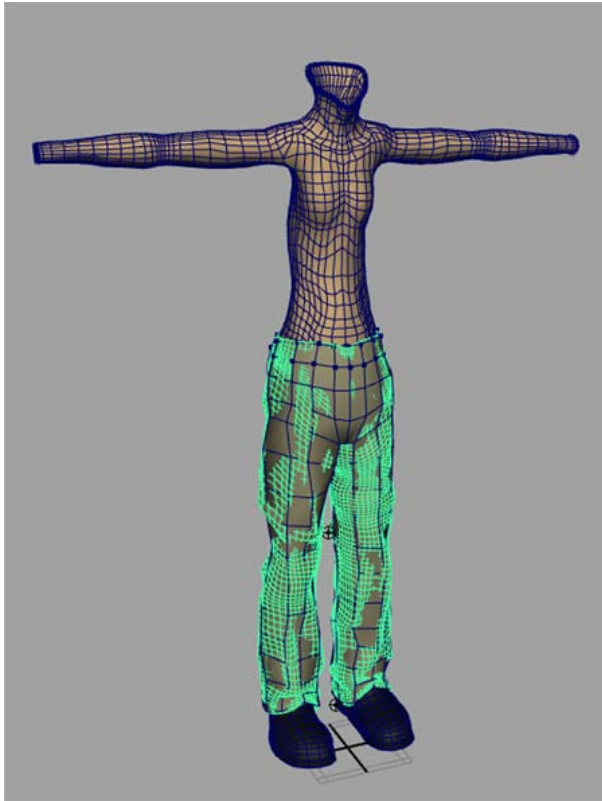
- 1 If you have not already done so, copy the nCloth Advanced Tutorial folder from the following location:  
<http://www.autodesk.com/maya-advancedtechniques>. Then, set the nCloth AdvancedTechniques directory as your Maya project.  
 For this lesson, you need to access Maya geometry cache files in addition to the lesson scene file.
- 2 Open the scene file named `Character_LowRes_3.mb`.  
 This file can be found in the AdvancedTechniques directory that you set as your Maya project.

## Wrapping the high resolution mesh

In this section of the lesson, you use a wrap deformer to create an influence object that causes the high resolution to behave like the simulated low resolution mesh. For more information, see *What are deformers?* in the *Rigging* guide.

### To wrap the high resolution mesh

- 1 In the scene view, show the *Pants\_HighRes* object by selecting it in the Outliner, and then selecting **Display > Show > Show Selection**.



- 2 Shift-select the nCloth pants.
- 3 From the Animation menu set, select Create Deformers > Wrap.  
A wrap node appears in the Attribute Editor, and a *Pants\_LowResBase* object appears in the Outliner.



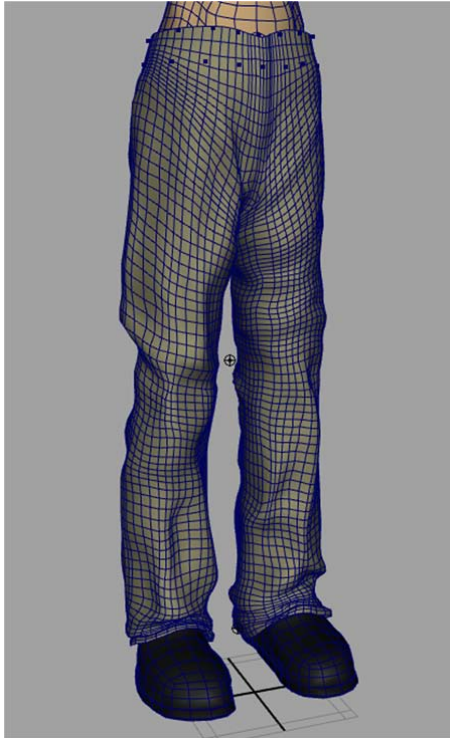
- 4 In the Attribute Editor, click the wrap1 tab.
- 5 In the Wrap Attributes section, turn on Exclusive Bind.



With this turned on, each surface point (vertex) on the Pants\_HighRes object is constrained or affected by the Pants\_LowRes object vertices. This ensures that the Pants\_HighRes object inherits the properties of the simulated nCloth pants.

- 6 Hide the Pants\_LowRes object, and play back the simulation.

When you play back the simulation, you notice the following:



- The *Pants\_HighRes* object appears to be simulating as if it were an nCloth object.
- The speed of the resolution is not reduced or affected by the *Pants\_HighRes* object.

With the high polygon count of the *Pants\_HighRes* object, one would expect to see the simulation slow down. However, this is not the case, since the Nucleus solver is not simulating any data associated with the *Pants\_HighRes* object. All Nucleus calculations involved in the simulation are still performed on the low resolution nCloth pants. The behavior of the *Pants\_HighRes* object is being influenced by a new instance of the simulated nCloth pants, the *Pants\_LowResBase* object. In the Outliner, you can see that the *Pants\_LowResBase* object has been added to the *Character\_LowRes* group.

The *Pants\_LowResBase* object is the base shape for the deformation of the *Pants\_HighRes* object, which is the wrap influence object. Like all wrap deformers, any difference in position, orientation, or shape between the base

shape and the wrap influence object results in a deformation of the surface being influenced by the wrap deformer.

### **Simulating the nCloth pants on an animated character**

In this section of the lesson, you import geometry caches for the nRigid body and nRigid shoe objects, and begin simulating the nCloth pants object while the body and shoes are animated.

#### **Lesson setup**

To ensure that this section of the lesson works as described, do these steps before beginning:

- 1 If the `Pants_HighRes` object is visible in the scene view, hide it now, by selecting `Pants_HighRes` in the Outliner, and selecting `Display > Hide > Hide selection`.
- 2 If the `Pants_LowRes` object is not visible in the scene, show it now, by selecting `Pants_LowRes` in the Outliner, and selecting `Display > Show > Show Selection`.


#### **To import the geometry caches to animate the body and shoe meshes**

- 1 In the scene view, select the `nRigid_Body` object.
- 2 From the Animation menu set, select `Geometry Cache > Import Cache`.
- 3 In the Import window that appears, browse to your Maya projects folder and select `Body_Animation.mc`.
- 4 In the scene view, select the `nRigid_Shoes` object.
- 5 From the Animation menu set, select `Geometry Cache > Import Cache`.
- 6 In the Import window that appears, browse to your Maya projects folder and select `Shoe_Animation.mc`.

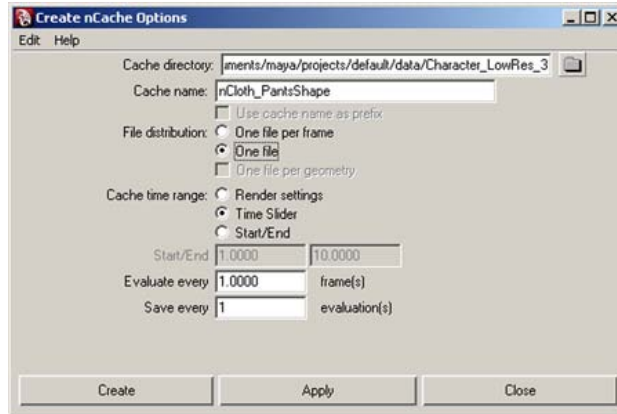
You can play back the simulation to see how your nCloth pants behave when they are simulated with the animated character. However, it is difficult to closely inspect the simulation without being able to scrub the Timeline. To make it easier to identify problems in the simulation, create a cache for the nCloth pants object. For information about nCaches, see [nCaching overview](#) on page 245.



## To cache the nCloth pants simulation

- 1 In the scene view, select the nCloth pants.
- 2 From the nDynamics menu set, select **nCache > Create New Cache >** 

The Create nCache Options window appears.

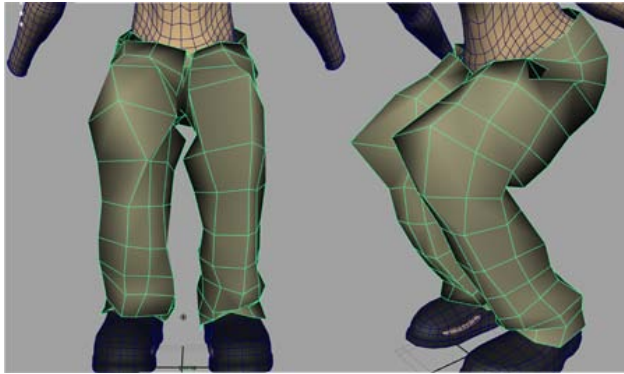


- 3 In the Create nCache Options window, do the following:
  - Set the Cache directory to the folder to which you want your caches saved.
  - Set the Cache Name to nCloth\_PantsShape.
  - Beside File distribution, select One File.
  - Click Create.
- 4 Play back the simulation.

## Identifying problem areas in the simulated nCloth

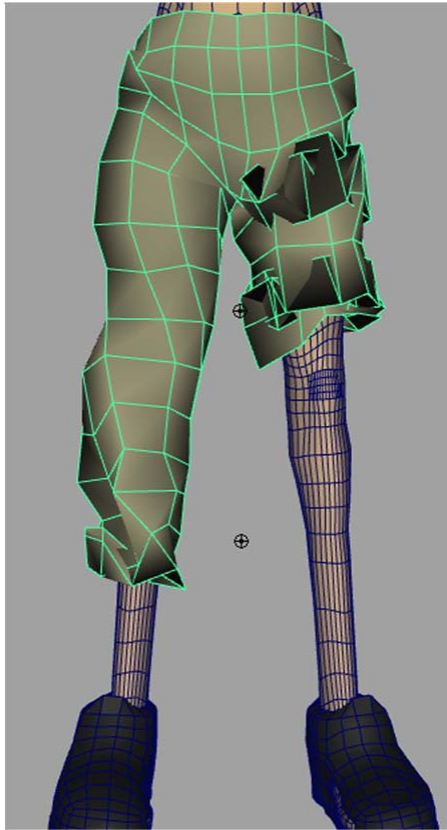
When you play back the simulation, you notice the following problems with the nCloth pants object:

- Between frames 1025 and 1035, the polygon faces around the waist and crotch area of the pants are exhibiting poor self collisions, resulting in interpenetrations. Also, the polygon faces in the front and back of the knees are poorly formed, with some polygons protruding outward making the cloth look heavy and stiff.



- At frame 1037, the polygon faces around the ankle area are folding over each other and are being trapped.
- Between frames 1040 and 1045, self collision issues continue at the waist, knees, and cuff of the pants.





Dolly and tumble the scene while scrubbing the Timeline so that you can closely observe each problem area.

### **Editing Substeps**

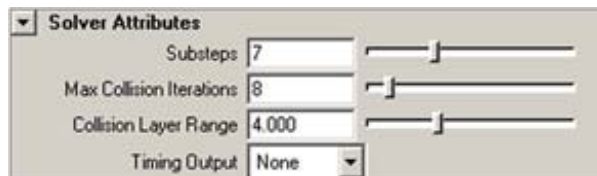
A useful first step to fixing simulation issues is to increase the number of Nucleus solver Substeps and Max Collision Iterations. Substeps specify the number of times per frame that the Maya Nucleus solver calculates everything involved in the simulation, from the collision detection between nCloth and passive collision objects, to the effects of Dynamic Properties attributes and the dynamic constraints. Adjusting Substeps allows you to control how the simulation time is broken up into calculation segments. Simulation quality and collision accuracy generally improve with increasing substeps values. Max Collision Iterations specify the maximum number of collision iterations per

frame for this Maya Nucleus solver. A high number of Substeps or Max Collision Iterations may result in a slower solve.

Depending on the complexity of your scene, the default values of 3 Substeps and 4 Max Collision Iterations may work well when simulating a static scene in which only gravity and wind are affecting the nCloth objects. When the nCloth begins to move and self collide, higher Substeps values are required to ensure accurate collision detection, especially on fast-moving objects. Increasing Max Collision Iterations becomes important when the number of nCloth collisions increases, and when dynamic constraints are added to your object. For more information, see [Substeps](#) on page 360 and [Max Collision Iterations](#) on page 360.

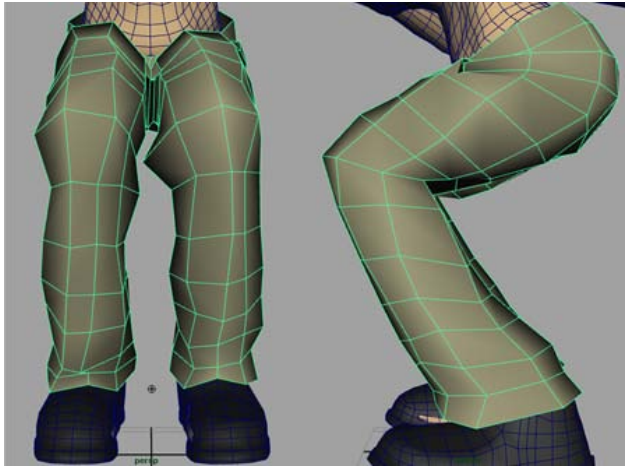
### To edit Substeps and Max Collision Iterations

- 1 In the Attribute Editor, click the nucleus1 tab.
- 2 In the Solver Attributes do the following:
  - Set Substeps to 7.
  - Set Max Collision Iterations to 8.



- 3 Before playing back the simulation to see the results of these new settings, delete the simulation's previous nCache, otherwise, your changes will not appear in the simulation. To delete the previous nCloth cache, select your nCloth object, and then select [nCache > Delete Cache](#) on page 307.
- 4 Cache, and then play back the simulation.

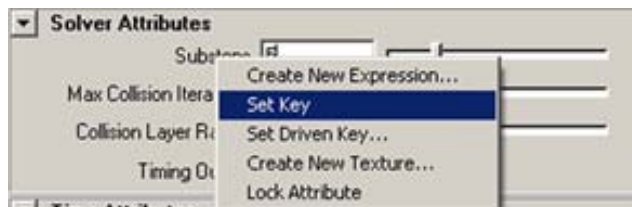
When you play back the simulation, you notice that, starting at frame 1030, the polygon faces in the area of the knees look more realistic. The cloth deformation is now spread over more faces, making it look more realistic. However not all of the simulation problems were resolved. Higher Substeps and Max Collision Iterations may be required.



Because increasing Substeps and Max Collision Iterations cause the Nucleus solver to perform more calculations each simulated step, it slows down the simulation. To develop a balance between simulation quality and performance, it is useful to identify the specific areas or frames in the simulation that require higher Substeps and Max Collision Iterations. You can then animate the Substeps and Max Collision Iteration values over the duration of the simulation by setting keyframes.

### To set keyframes for Substeps and Max Collision Iterations

- 1 In the Timeline, go to frame 1000.
- 2 In the Attribute Editor, select the nucleus1 tab.
- 3 In the Solver Attributes section, do the following:
  - Set Substeps to 5.
  - Right-click the Substeps attribute field, and select Set Key from the context-sensitive menu.



- Set Max Collision Iterations to 6

- Right-click the Max Collision Iterations attribute field, and select Set Key from the context-sensitive menu.

4 Continue setting keyframes in your simulation using values from the following table:

Frame	Substeps	Max Collision Iterations
1019	5	6
1020	7	8
1022	9	12
1025	15	20
1060	9	12

5 Cache your simulation and the play it back.

### Fine tuning nCloth attributes

When you play back the cache, you notice that the overall quality of the simulation has improved. However, problem areas, most notably in the waist and in the crotch, can still be observed. For example, at frame 1030, poor self collisions in the area of the crotch are resulting in undesirable polygon deformations. To improve the quality your simulation, you can to start fine tune the Dynamic Properties attributes.



When fine adjusting nCloth attributes, such as Dynamic Properties attributes, it is useful to create a duplicate of the nCloth mesh at different frames of your simulation. When you play back the simulation, you can then compare your currently simulated nCloth against the duplicate mesh and evaluate:

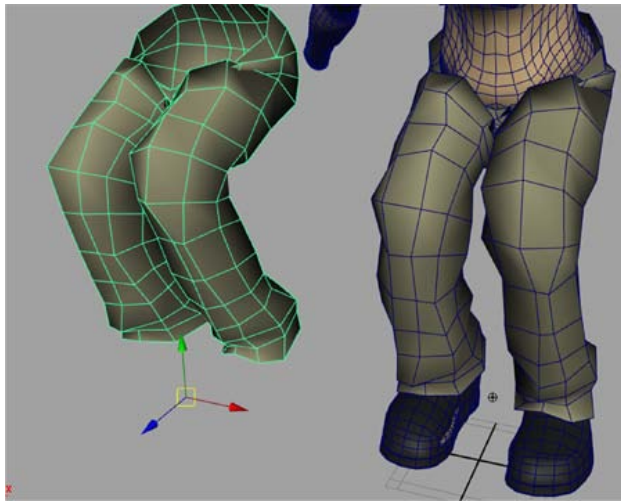
- If you have correctly identified the attribute that requires adjustment.
- How the adjustment affects the nCloth behavior.

To help solve the problems in the crotch area, you can increase Bend Resistance so that the edges of the polygons better retain their shape. For more information, see [Bend Resistance](#) on page 329.

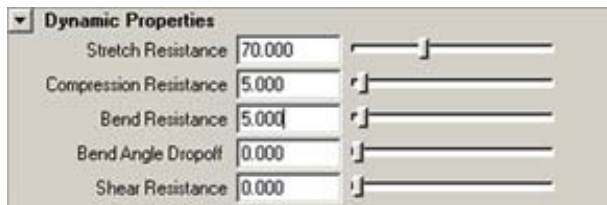
#### **To create a duplicate mesh and edit Bend Resistance**

- 1 In the Timeline, go to frame 1030.
- 2 In the scene view, select the nCloth pants and select Edit > Duplicate.

- 3 In the Outliner, select `Pants_LowRes1` and in the scene view, move the mesh object to the right of your character.



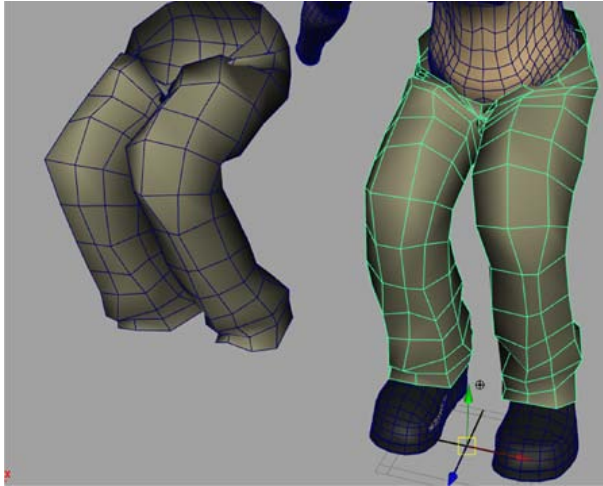
- 4 In the Attribute Editor, click the `nCloth_PantsShape` tab.
- 5 In the Dynamics Properties section, set Bend Resistance to 5.



- 6 Cache simulation and play it back.

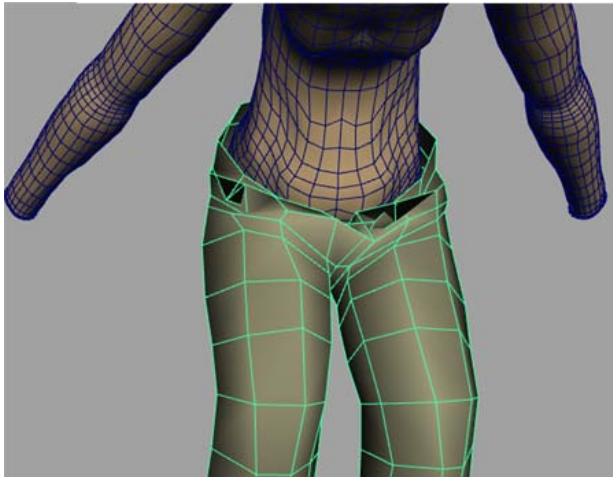
When you play back the simulation, you notice that the cloth is bending more realistically in the crotch area. In the Timeline go to frame 1030, and compare your simulated nCloth to the duplicate mesh. Dolly and tumble the scene so that you can closely observe the problem area.





### Editing Quality Settings and resolving interpenetrations

When you play back the simulation and compare the problem areas with duplicate meshes, you notice that the problem areas between frame 1030 and 1035 still persist.

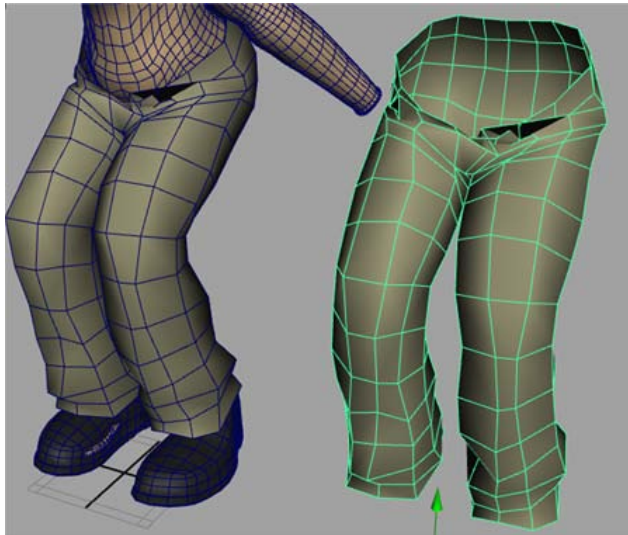


Another way to improve simulation quality is to edit the Self Collision Flag and Quality Settings attributes, which affect the nCloth components' collisions and self collisions. By default, Self Collision Flag is set to VertexFace, which means that the nCloth object's vertices and faces collide with each other. Setting Self Collision Flag to Full Surface sets all of the object components

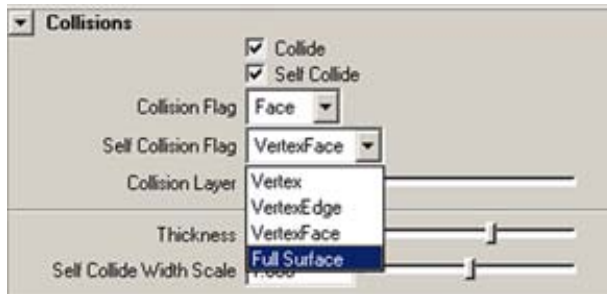
(vertices, edges, and faces) to participate in self collisions. When simulating a low resolution mesh, increasing the number of potential self collision areas of the nCloth object is important because of the mesh's low vertex, edge, and face count. Setting Self Collision Flag to Full Surface on high resolution nCloth meshes increases simulation time. This is less of an issue with low resolution meshes, which makes this alternative much more appealing for iterative simulation tests. For more information, see [Collisions](#) on page 321.

#### To edit the Self Collision Flag attribute

- 1 In the Timeline, go to frame 1033.
- 2 In the scene view, select the nCloth pants and select Edit > Duplicate.
- 3 In the Outliner, select Pants\_LowRes2 and in the scene view, move the mesh object to the left of your character.



- 4 In the Attribute Editor, click the nCloth\_PantsShape tab.
- 5 In the Collisions section, set Self Collision Flag to Full Surface.



After initial fine adjustments to Self Collision attribute, you edit the Quality Settings to improve collisions and self collisions in the simulation. This will resolve any remaining interpenetrations between the nCloth pants object and the nRigid shoes. You can also increase Thickness or create a Thickness Map to improve collision detection.

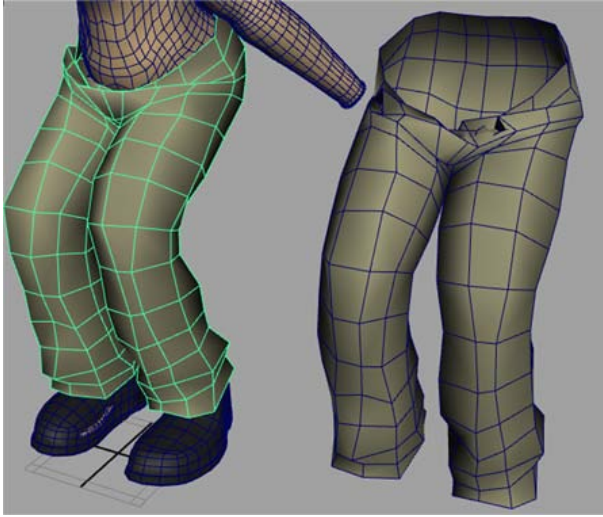
### To edit the Quality Settings

- 1 In the Attribute Editor, select the nCloth\_PantsShape tab.
- 2 In the Quality Settings section, do the following:
  - Make sure Max Iterations is set to 10000.
  - Turn on Trapped Check.
  - Turn on Self Trapped Check.



- 3 Cache the simulation and then play it back.

In the Timeline, go to frame 1033, and compare your simulated nCloth to the duplicate mesh. Dolly and tumble the scene so that you can closely observe the problem area.



### **Comparing the wrapped nCloth simulation with the simulated high resolution mesh**

To complete the attribute adjustments of the nCloth pants object, you compare the wrapped nCloth simulation to the reference character object (the original simulated high resolution mesh).

#### **To compare the low and high resolution nCloth meshes**

- 1 Hide the Pants\_LowRes object, selecting it in the Outliner, and then selecting Display > Hide > Hide Selection.
- 2 Show the Pants\_HighRes object by selecting it in the Outliner, and then selecting Display > Show > Show Selection.
- 3 Using the Displays Layers Editor, turn on Visible to display the Reference\_Character object in the scene view.
- 4 Scrub through the Timeline to compare how nCloth meshes behave in the animation. Dolly and tumble the scene so that you can closely observe the problem area.



### Observations

When you play back or scrub the simulation, you notice the following:

- Overall, the wrapped nCloth pants and reference character objects behave in the same way.
- Between frames 1040 and 1047, the pant legs on nCloth pants object are falling a little faster than the pant legs on the reference character object.

To force the pant legs of the nCloth pants to simulate in the same way as the pants legs on the reference character object, adjust the Friction attribute.

## Lesson 4: Simulating the low resolution shirt

In this lesson, you simulate the character's shirt using the workflow described in Lesson 3. Although there are some variations in attributes and their respective values, the principles are the same.

In this lesson you will:

- Convert the Shirt\_LowRes object to nCloth.
- Create a wrap deformer to influence the behavior of the high resolution mesh (Shirt\_HighRes).
- Apply the nCloth tshirt preset to the nCloth shirt.
- Edit the nCloth shirt Collisions and Dynamic Properties attributes.
- Create an nCache for the nCloth shirt.
- Identify problem areas in the simulation, such as poorly deformed polygons and occurrences of interpenetrations.
- Edit the nCloth shirt Quality Settings.
- Resolve interpenetrations.


### Lesson Setup

To ensure the lesson works as described, do these steps before beginning:

- 1 If you have not already done so, copy the nCloth Advanced Tutorial folder from the following location:  
*<http://www.autodesk.com/maya-advancedtechniques>*. Then, set the nCloth AdvancedTechniques directory as your Maya project.  
For this lesson, you need to access Maya geometry cache files in addition to the lesson scene file.
- 2 Open the scene file named `Character_LowRes_4.mb`.  
This file can be found in the AdvancedTechniques directory that you set as your Maya project.
- 3 If you use a Maya scene file from a previous lesson, ensure that you:
  - Turn off the visibility for the Reference\_Character object in the Animation Layers Editor.
  - Hide the Pants\_HighRes object.

## Converting the shirt to nCloth

### To convert the shirt to nCloth

- 1 Show the Shirt\_LowRes object by selecting it in the Outliner, and then selecting Display > Show > Show Selection.
- 2 Select the low resolution shirt object (Shirt\_LowRes) and select **nMesh > Create nCloth** > .

The Create nCloth Options window appears.

---

**NOTE** If the nCloth menu set appears in the Maya interface do not use it. You must use the nDynamics menu set to create and control nCloth. See [nCloth menu set appears in Maya](#) on page 381 for information about removing the nCloth menu set from Maya.

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- 3 From the Solver drop down list, select nucleus1.
- 4 Click Create Cloth.  
The low resolution shirt is converted to an nCloth object, and has been added to the existing May Nucleus solver.
- 5 To ensure that low resolution nCloth shirt is easy to identify in your scene, rename it. To to this, in the Outliner, double-click *nCloth1*, and type *nCloth\_Shirt*.
- 6 Press Enter.

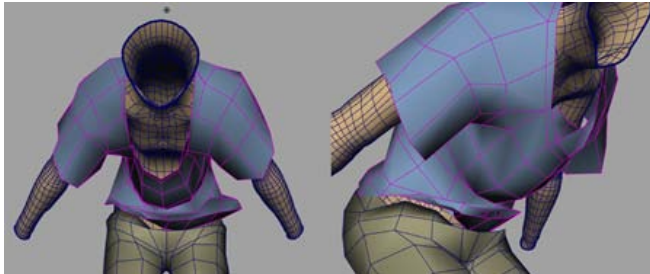


- 7 Cache your simulation and then play it back.

## Applying a nCloth preset to the shirt

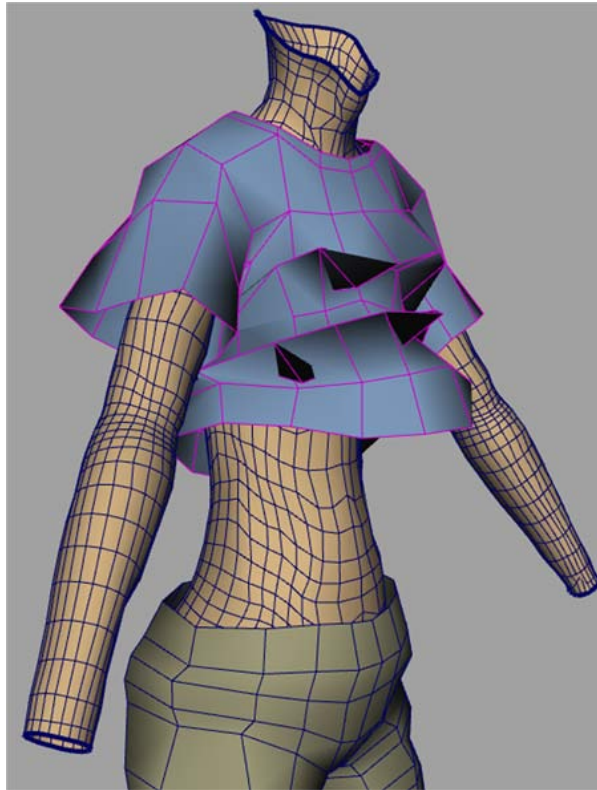
When you play back the simulation, you notice the following:

- Around frame 1033, the shirt collar is stretching too much to resemble the fabric it's trying to emulate.
- At frame 1033, some of the shirt's vertices are self trapped within the object, and interpenetrations between the shirt and pants appear around the characters waist. This is caused by inaccurate collisions between the nCloth shirt and nCloth pants objects.



- At frame 1037, the shirt is riding too high on the character's body and the polygon faces in the front of the shirt are deforming poorly.
- Between frames 1040 and 1098, some of the shirt's vertices are becoming trapped within the object, and there are interpenetrations.





A useful way to solve a number of these simulation problems simultaneously is to apply an nCloth attribute preset to the nCloth shirt object.

#### **To apply an nCloth preset to the shirt**

- 1 In the scene view, select the nCloth shirt.
- 2 In the Attribute Editor, select the nCloth\_ShirtShape tab.
- 3 Click-hold the Presets button.
- 4 Select the tshirt preset, and then Replace (tshirt > Replace).

Some important attributes adjustments made by the t-shirt preset are the following:

- Stretch Resistance is adjusted from 20 to 35.

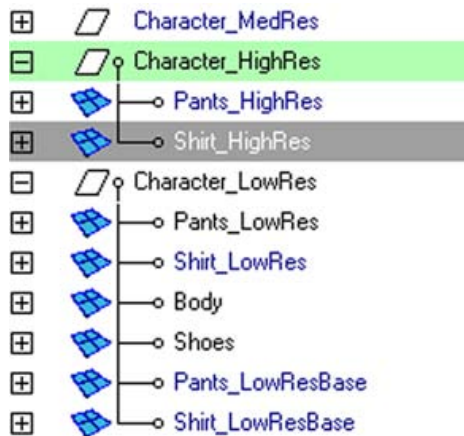
- Bend Angle Dropoff is adjusted from 0 to 0.4  
Bend Angle Dropoff adds resistance to bending forces in response to the strength of the bending force. In the simulation, Bend Angle Dropoff effectiveness in reducing the nCloth tendency to bend can be observed when the nCloth shirt is beginning to bundle up at frame 1032.
- Mass is adjusted from 1.0 to 0.6.  
The reduction in Mass reflects the light to medium weight material of a cotton t-shirt.
- Damp is adjusted from 0.0 to 0.8.

## Wrapping the high resolution mesh

In this section of the lesson, you use a wrap deformer to create an influence object for the high resolution shirt.

### To wrap the high resolution mesh

- 1 In the scene view, show the Shirt\_HighRes object by selecting it in the Outliner, and then selecting Display > Show > Show Selection.
- 2 Shift-select the nCloth shirt object.
- 3 From the Animation menu set, select Create Deformers > Wrap.  
A wrap node appears in the Attribute Editor, and a Shirt\_LowResBase object appears in the Outliner.



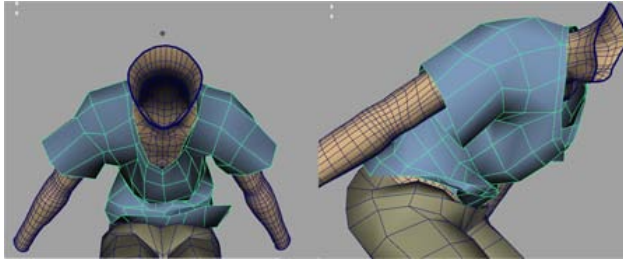
- 4 In the Attribute Editor, click the wrap2 tab.

- 5 In the Wrap Attributes section, turn on Exclusive Bind.
- 6 Hide the Shirt\_HighRes object, and play back the simulation.

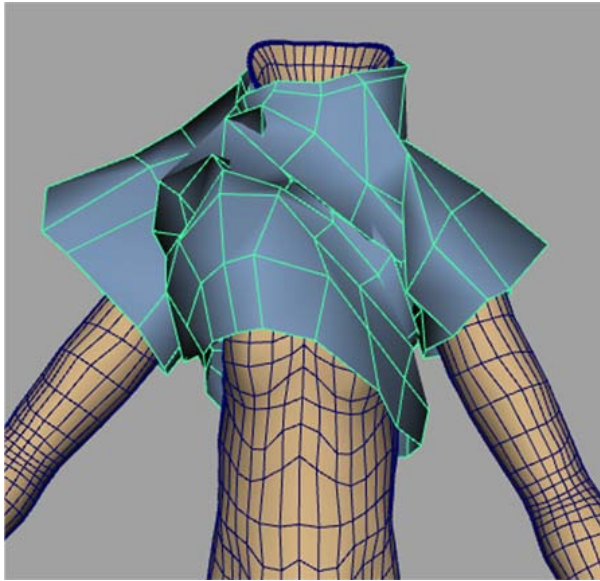
### Identifying problem areas in the simulated nCloth

When you play back the simulation, you notice the following:

- At frame 1032, the excessive stretching around the shirt's collar is reduced. However, this area of the nCloth is still stretching too much.



- At frame 1033, in the waist area, some previous instances of self trapped vertices have been resolved, however some interpenetrations still remain.
- Between frames 1039 and 1049, in the chest area, the shirt deformations have improved, but the polygon faces still protrude too far outward to resemble the realistic behavior of a t-shirt.

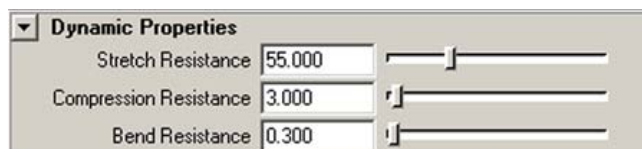


The nCloth t-shirt preset has improved many of the simulation issues, however some Dynamic Properties attributes need further adjustment.

When editing the Dynamic Properties attributes, cache your simulation and then play it back between attribute adjustments to see how your new settings affect the nCloth shirt's behavior. For comparison purposes, you can also display the reference character in the scene. To do this, in the Display Layer Editor, turn on Visible.

### To edit the shirt's Dynamic Properties

- 1 In the Attribute Editor, click then nCloth\_ShirtShape tab.
- 2 In the Dynamic Properties section, make the following settings:
  - Stretch Resistance: 55
  - Compression Resistance: 3
  - Bend Resistance: 0.3

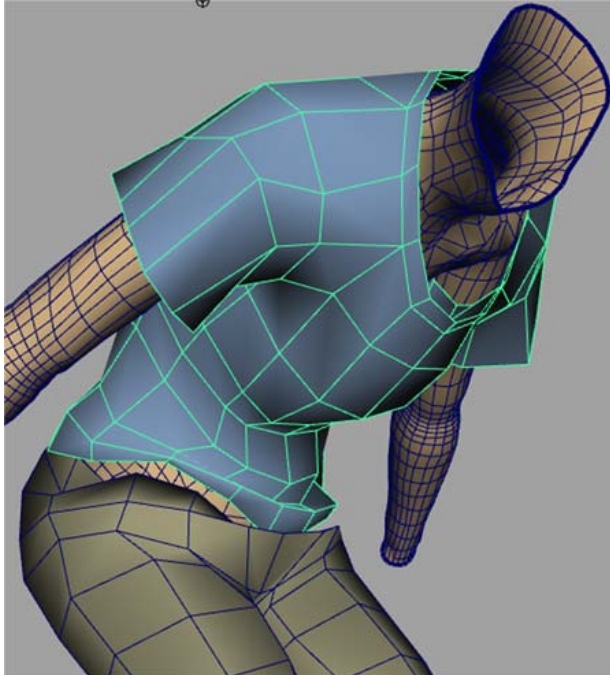


- 3 Cache your simulation, and play it back.

### Editing the Quality Settings and resolving interpenetrations

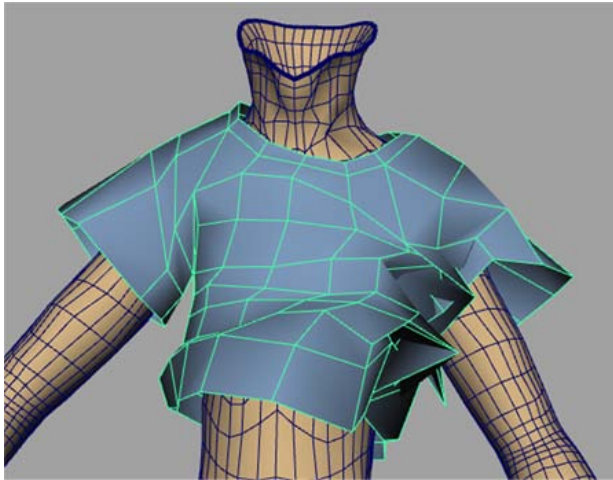
When you play back the simulation, you notice the following:

- Between frames 1028 and 1034, around the character's waist, there are areas where the pants and shirt no longer overlap. This exposes the nRigid\_Body object, which might be a desired result.



The offset between the nCloth object occurs because the collision Thickness is currently set to accommodate the high resolution wrap deformer. Reducing Thickness may solve this issue, but be aware that interpenetrations can result from such an adjustment. For the purposes of this tutorial, Thickness is left at its present value.

- At frame 1042, there are still too many quads bunching up in the shirt at the character's chest, causing interpenetrations. Although this behavior can be considered realistic, reducing interpenetrations in this area would make the shirt's more realistic.



To smooth the mesh and reduce instances of interpenetrations, edit the Collisions and Quality Settings.

#### To edit the Collisions and Quality Settings

- 1 In the Attribute Editor, select the nCloth\_ShirtShape tab.
- 2 In the Collisions section, set the Self Collision Flag to Full Surface.
- 3 In the Quality Settings section, set the following:
  - Max Iterations: 12000.
  - Max Self Collision Iterations: 8.
  - Turn on Trapped Check.
  - Turn on Self Trapped Check.



- 4 Cache the simulation and then play it back.



### **Fine tuning the simulation**

To further improve the quality of the simulation and reduce the instances of interpenetration in problem areas, such as the bunching of the shirt in the chest area (see frame 1040) you can set Push Out and Push Out Radius. Try setting the attributes values between the following ranges:

- Push Out: 0.1—20
- Push Out Radius: 10—50

Experiment with your settings by creating duplicates of the meshes at specific frames of the simulation. For example, create mesh duplicates at frames 1040 and 1043. Cache the simulation, and then scrub through the Timeline and compare your simulation with your duplicate mesh to see the results of your attribute edits.

## Comparing the final low resolution simulation with the simulated reference character mesh

In the section of the lesson, you compare the final simulation result of the nCloth shirt and nCloth pants objects with the simulated reference character object (the original simulated high resolution mesh).

### To compare the simulations

- 1 Hide the Shirt\_LowRes and Pants\_LowRes objects, selecting by selecting them in the Outliner, and then selecting Display > Hide > Hide Selection.
- 2 Show the Shirt\_HighRes and the Pants\_HighRes objects by selecting them in the Outliner, and then selecting Display > Show > Show Selection.
- 3 If you have not done so already, using the Displays Layers Editor, turn on Visible to display the Reference\_Character object in the scene view.
- 4 In the Shading menu, turn off Wireframe on Shaded.
- 5 Scrub through the Timeline, to compare how nCloth meshes behave in the animation. Dolly and tumble the scene so that you can closely observe the problem area.







There are subtle differences between the way both the high resolution and reference character objects simulate, but overall the nCloth behaves in similar ways. Considering the amount of time saved of repeatedly working through the simulation workflow of caching the simulation and adjusting attributes on the low resolution mesh, the low resolution mesh workflow provides good results. Although the reference character object can be improved by optimizing the simulation, however, the higher resolution mesh would slow down caching and simulation time and might require more attribute adjustments.

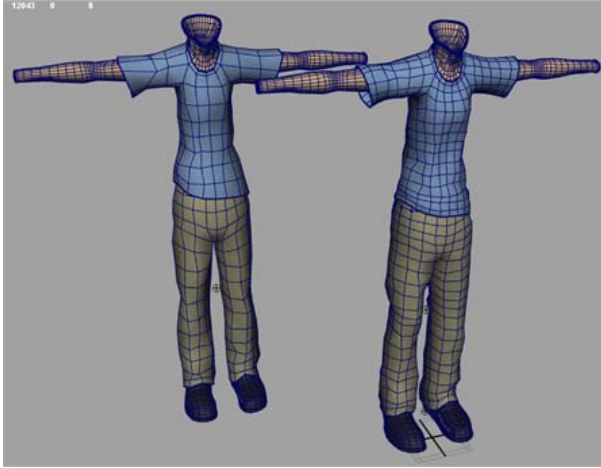
## Lesson 5: Simulating medium resolution meshes using custom nCloth attribute presets

Now that you used the workflow described in Lessons 3 and 4 to realistically solve the low resolution nCloth meshes, you can use them to quickly prepare a medium resolution version of the nCloth pants and shirt for simulation.

In this lesson, you will:

- Save the nCloth attributes for both Shirt\_LowRes and Pants\_LowRes objects as custom nCloth presets.
- Change the Scaling Relation attribute and observe its impact on the nCloth simulated meshes.

## Lesson Setup



Open the scene file named `Character_MedRes.mb`. The medium resolution shirt and pant meshes that you use in the lesson have already been converted to nCloth objects, and named `nCloth_Shirt_MedResShape` and `nCloth_Pants_MedResShape`. A Point to Surface constraint has already been applied to the pants to constrain them to the character's waist. The medium resolution shirt and pants have already been wrapped, using a wrap deformer, with a new, duplicated high resolution shirt and pants mesh. The low resolution shirt and pants nCloth shirt and nCloth pants objects have been cached and are positioned next to the medium resolution meshes for reference.

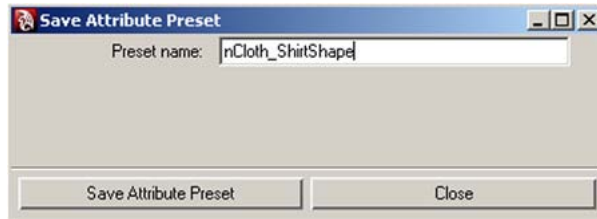
### Save the nCloth attributes as custom presets

By the end of the Lesson 3 and 4, you generated optimized simulations of your character's shirt and pants. A number of steps were involved in obtaining the attribute values that drive your the behavior of these nCloth objects, and so you may want to save these optimized attribute values. Using Maya attribute presets, you can save the attribute values of the low resolution nCloth shirt (`nCloth_ShirtShape`) and nCloth pants (`nCloth_PantsShape`) objects as custom nCloth presets. Your new nCloth presets can then be applied to other versions of the meshes, including the medium resolution shirt and pants. This workflow allows you to quickly prepare other simulations with geometry that has similar topology to your original objects.

#### To save the nCloth shirt object's attributes as a custom nCloth preset

- 1 In the scene view, select the nCloth shirt.

- 2 In the Attribute Editor, click the `nCloth_ShirtShape` tab.
- 3 Click-hold the Presets button.  
The `nCloth` attribute Presets pop-up menu appears.
- 4 Select Save `nCloth` Preset.  
The Save Attribute Preset window appears.

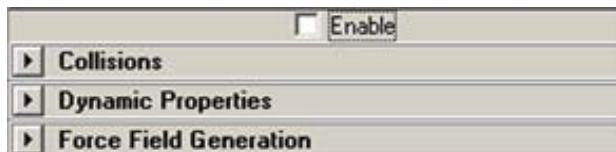


- 5 In the Preset name field type `nCloth_ShirtShape` for the name of the custom attribute preset you want to create, and then click Save Attribute Preset.
- 6 Repeat steps 1 to 5 to save the `nCloth` pants as a custom `nCloth` attribute preset `nCloth_PantsShape`.

Since you no longer need to simulate the low resolution `nCloth` shirt and pants, you can disable them from the Nucleus solver. Doing this will increase the simulation speed of your medium resolution `nCloth` shirt and pants.

#### To disable the `nCloth` shirt from the Nucleus solver

- 1 In the scene view, select the `nCloth` shirt.
- 2 In the Attribute Editor, click the `nCloth_ShirtShape` tab.
- 3 Turn off Enable.



- 4 Repeat steps 1 to 3 for the `nCloth` pants object.

## **Applying the custom nCloth attribute preset to the medium resolution shirt and pants**

In this section of the lesson, you apply your custom nCloth attribute presets to the medium resolution versions of the nCloth shirt and pants (nCloth\_Shirt\_MedResShape and nCloth\_Pants\_MedResShape). After the attribute presets are applied, you can fine tune the simulation by adjusting your objects' Collisions, Dynamic Properties, and Quality Setting attributes.

### **To apply your custom nCloth attribute preset to the medium resolution nCloth**

- 1 Hide the Shirt\_LowRes, and Pants\_LowRes objects by selecting them in the Outliner, and then selecting Display > Hide > Hide Selection.
- 2 Show the Shirt\_MedRes and Pants\_MedRes objects by selecting them in the Outliner, and then selecting Display > Show > Show Selection.
- 3 In the scene view, select the nCloth medium resolution shirt.
- 4 In the Attribute Editor, click the nCloth\_Shirt\_MedResShape tab.
- 5 Click-hold the Presets button.
- 6 Select the nCloth\_ShirtShape preset, and then select Replace.
- 7 In the scene view, select the medium resolution nCloth pants.
- 8 In the Attribute Editor, click the nCloth\_Pants\_MedResShape tab.
- 9 Click-hold the Presets button.
- 10 Select the nCloth\_PantsShape preset, and then Replace.
- 11 Shift-select the nCloth\_Shirt\_MedResShape and nCloth\_Pants\_MedResShape objects, cache your simulation, and then play it back.

In the final section of this lesson, you compare the behavior of the medium resolution nCloth shirt and pant objects with the low resolution nCloth simulation from lessons 3 and 4.

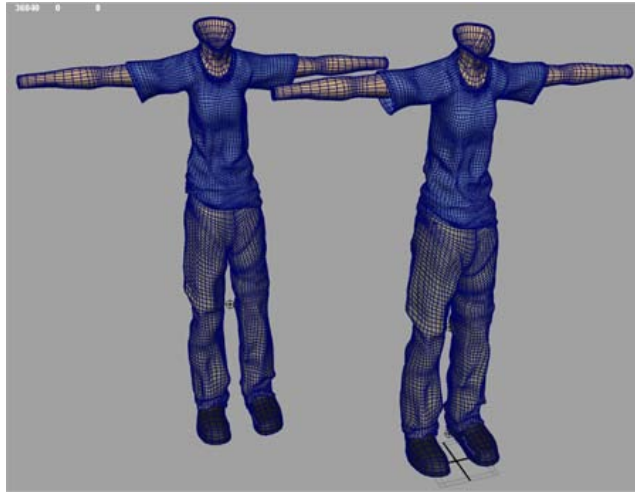
### **Comparing the final simulations**

In final sections of the lesson, you compare your final nCloth simulations. First, you compare the behavior of your medium resolution nCloth shirt and pant objects with your final low resolution shirt and pants simulations. In the last section, you compare all three simulation versions of nCloth (the original high resolution, medium resolution, and low resolution meshes).

### To compare your medium and low resolution simulations

- 1 Hide the `nCloth_ShirtMedRes` and `nCloth_PantsMedRes` objects by selecting them in the Outliner, and then selecting `Display > Hide > Hide Selection`.
- 2 Show all the objects in the `Character_HighRes` group by selecting `Pants_HighRes` and `Shirt_HighRes` in the Outliner, and then selecting `Display > Show > Show Selection`.

The medium resolution and low resolution nCloth meshes, each wrapped by the same high resolution shirt and pants, now appear in the scene view.

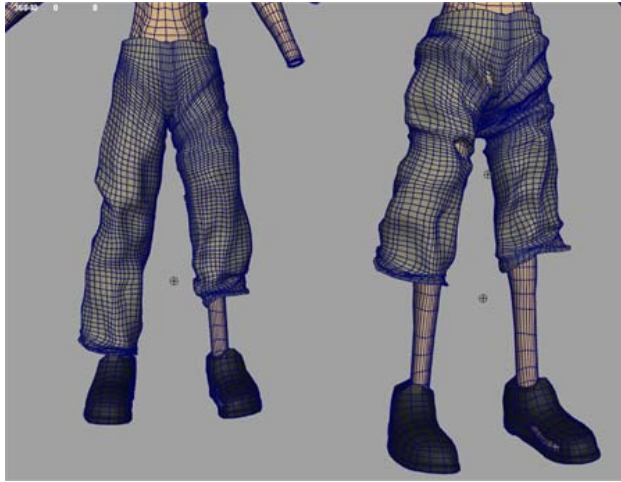


- 3 Play back the scene.

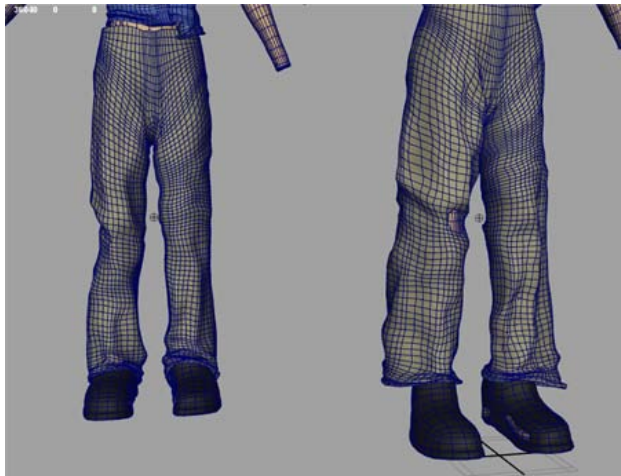
Dolly and tumble the scene while scrubbing the Timeline so that you can closely observe any differences in the behavior of each nCloth object.

When you play back the simulations, you notice the following:

- The low and medium resolution shirts are behaving in the same way.
- The medium resolution pants are taking more time than the low resolution pants to settle in the first frames of the simulation.
- Between frame 1040 and 1045, the medium resolution pants ride further up on the character legs than the low resolution pants.



- At frame 1047, the cuffs of the medium resolution pants are further apart than the cuffs of the low resolution pants.



- The medium resolution pants appear to have more bounce during specific areas of the simulation.

If you are not satisfied with the behavior your medium resolution nCloth shirt and pants, use the same attribute optimizing workflow described in lessons 3 and 4 to adjust the objects' Collisions, Dynamic Properties, and Quality Settings attributes.

You can remove some of the bounce from the medium resolution nCloth pants by editing the Scaling Relation attribute. When Scaling Relation is set to Link, the nCloth's dynamic attributes, such as Bend Resistance and Stretch Resistance are calculated relative to the mesh's scale. When Scaling Relation is set to Object, the dynamic attribute calculations are automatically scaled based the meshes resolution. Low resolution meshes tend to stretch more when Scaling Relation is set to Object, than if Scaling Relation is set Link. High resolution meshes tend to stretch less when Scaling Relation is set to Object, than if Scaling Relation is set Link. For more information, see

### To edit Scaling Relation

- 1 In the scene view, select the medium resolution nCloth pants.
- 2 In the Attribute Editor, click the nCloth\_Pants\_MedResShape tab.
- 3 In the Dynamics Properties section, set Scaling Relation to Object Space.



- 4 Cache the simulation ([nCache > Create New Cache](#)), and play it back.

### Compare all three versions of nCloth

#### To compare all three versions of nCloth

- 1 Ensure that:
  - The *Shirt\_LowRes*, *Pants\_LowRes*, *nCloth\_ShirtMedRes*, and *nCloth\_PantsMedRes* objects are hidden.
  - All objects in the *Character\_HighRes* group are appear in the scene.
- 2 Using the Displays Layers Editor, turn on Visible to display the *Reference\_Character* object in the scene view.
- 3 Scrub through the Timeline to compare how nCloth meshes behave in the animation. Dolly and tumble the scene so that you can closely observe any subtle differences in the nCloth.



When you compare the three versions of nCloth in the scene, you have to look closely to notice the subtle differences in behavior of each set of objects. Considering the amount of time saved optimizing a low resolution mesh resolution, this workflow provides a viable alternative to simulating highly detailed character clothing. By wrapping your highly detailed mesh on to a lower resolution nCloth instead of simulating it, you can still model details into mesh without worrying about how it simulates.

By saving the low resolution nCloth attributes as a custom preset, you add value to the time invested in optimizing the nCloth simulation. After applying the preset to the medium resolution nCloth, only minimal adjustment was required to obtain a simulation with good results.