



Sparrowhawk3D

The Cloth Deformer

for CARRARA 5, 6 & 7

BETA Version 0.03

The Cloth Deformer is a plugin which can be used to perform limited cloth simulations in Carrara. The Cloth Deformer is not recommended for use with detailed draping or full costumes but instead for dynamic elements of cloth. With the right application the plugin can be used to animate loose clothing, the hems of a skirt or dress, the body and length of polygon hair, a trailing cape, hanging cloth or curtain.

To install the plugin extract the contents of the compressed zip package into the Carrara\Extensions sub-folder. The plugin must also be installed into the ..\Extensions folder of all render nodes. To remove the Cloth Deformer users must delete the cloth.mcx, cloth.dat and cloth.txt files.

Once installed, apply the Cloth Deformer plugin by selecting a suitable model, opening out the Properties tray and then on the Modifiers card hit the + icon and choose Cloth from the list of modifiers. If other Sparrowhawk3D modifiers are installed then the deformer can be found under a sub-menu.

The Beta is still very much under development, check back at Sparrowhawk3D.com for updates...

New For Beta 0.03

- Added selection list to allow for the use of multiple collision objects during simulations
- Improved collision *Surface Offset* to automatically add thickness to objects and proxy figures during simulation
- Removed *Smoothing Force* and replaced with *Crease Resistance* for better simulation results
- Added *Octaves* to wind force turbulence and improved wind noise algorithm
- Improved draping accuracy and secondary collisions so that cloth will slide over surfaces
- Fixed simultaneous and layered cloth object on cloth object during draping and collisions
- Added bounding sphere collision optimization for slightly increased simulation speeds (by approx 10%)
- Disabled redundant *Edge to Polygon Collisions* mode
- Added some safety features to prevent user changes to critical parameters during simulation
- Included surface normal checks versus collision object surface to make the simulation faster and recover from poke throughs
- Modified the algorithm to reduce stretchiness of cloth and give more accurate simulations

Known Issues

- Carrara 7.0 users will encounter an error when first trying to save a scene using the Cloth Deformer if no weight map has been loaded. Load any image file as the weight map and uncheck the *Use Weight Map* box to get around this. The issue is resolved with the Carrara 7.1.1 update.
- Weight Maps applied onto polymesh grids may need to check the *Seamlessly* box in the texture map UI to prevent uv values from wrapping around 0 to 1. Some uv layouts need adjustment.
- Files saved with earlier beta versions will need to have collision objects reselected in the new list
- Changing the cloth mesh or adding deformer and modifiers during animation (when Progress is not 0%) will crash the plugin.
- Demanding and complex collisions and interactions of the cloth will fail to produce accurate results, especially when the collisions objects are twisting and rotating.
- There is an increased chance of poke through problems and spikes forming in falloff transition zone areas

Limitations & Restrictions

- Objects suitable for use with the Cloth Deformer must have no more than 8 edges connected to any single vertex.
- The default triangulated mesh source mode setting is for use with all suitable source objects. Conforming figures must use triangles.
- Vertex primitives with only a single polymesh, made up of only square polygons, will be recognized by the deformer, unless in triangle mode.
- Both the cloth object and collision object must not use any other deformers that change the number of facets of the geometry, for example the bend and twist deformer.
- The surface normals of collision objects must point consistently outwards to correctly describe the surface, imported objects or those duplicated with symmetry may give unexpected results
- Cloth draping has higher surface accuracy but polygon to polygon collisions are not well detected for moving objects, resulting in lower surface accuracy.
- Cloth does not perform edge or polygon to polygon self-collision checks and thus will collapse under its own weight and may penetrate itself.
- Painted weight maps required unique per-vertex texture co-ordinates. Polymeshes with multiple shading domains are not supported with falloff weighing.
- Cloth simulations are not stored or saved but calculated during playback in the preview window or during render time.
- Simulations on full costumes will perform slowly and poorly, particularly on sleeves at the shoulder or with figures sitting down.
- Vertex primitives can be modified after the cloth is applied, but changes will not be detected by the deformer unless the sequencer time is changed or a value toggled when progress is zero %
- The Cloth Deformer is not compatible with Carrara hair simulations. Hair may be added to objects using the deformer but the hair physics simulations are not compatible.
- Layered Simulations using cloth object to cloth object interactions may produce unexpected results

General Recommendations

- Do not attempt to use the Cloth Deformer Beta in large projects or designs until its limitations are understood and work within them.
- The cloth mesh should be smaller and denser than the collision object to get accurate collision results.
- Use a hidden proxy (stand-in/substitute) for the real collision object with a much lower polygon count for faster simulations.
- When using a proxy figure or prop as the collision object make sure that it has a clear offset from the real figure to prevent 'poke throughs' in the final result.
- There is no 'drape now' feature so figures with dynamic cloth elements must be 'zeroed' at the start of the simulation and then move into action after a dozen or so frames.
- Test the cloth behaviour first without collisions on to adjust the gravity, flexibility, crease resistance and dampening properties of the cloth.
- Set the option in the sequencer to Play Every Frame for a proper preview of the simulation in the Assemble room.
- Cloth simulations may take a long time to run. Reduce the simulation step count to 5 and reduce secondary collisions to gain fast results over accuracy.
- The resulting mesh from a cloth simulation can be exported, imported back into Carrara and then smoothed and subdivided for better draping results.
- Disable the plugin at time 0 while painting weight maps onto the cloth object and while setting up the rest of the animation for a smoother workflow.
- If a simulation is taking too long during a preview or render press the [Esc] button to immediately abort. Press the stop button in the sequencer to finish the simulation at the end of the frame.

The Cloth Deformer User Interface & Features

<Params>

The *Progress* value must be set to 0% at the start of the animation and to 100% at the end, otherwise the deformer will not be called. The source geometry for the cloth is sampled and converted when the progress value is 0%. If the simulation needs to be run for a longer time do not forget to adjust the key frame of the *Progress* in the sequencer tray.

By default the *Use Triangles* option is checked for use with most types of objects. Uncheck this option only when working with a vertex primitive, with one polymesh, made up of only squares. Conforming figures must use triangles. Vertex primitives with one polymesh made up of only squares give better simulation results.

The *Gravity* value dictates how heavy the cloth will be. Most real cloth will take about 1 second to fall a metre or to hang loose when released and held. The density of the mesh will not determine the correct setting of the gravity value. Run a test animation with collisions disabled to make sure the cloth falls at the correct rate.

Flexibility adjusts how much the cloth can stretch or be compressed. Very low values in the range 1%-10% give the best results for most cloth. Use a higher flexibility for rubber, silk or lycra. When the flexibility is set to 100% the existing edges of the cloth mesh will stretch up to twice or compress up to half their initial length before being pulled back together. If the flexibility is set to 10% then when a 10x10 square of cloth is draped it will stretch out to an 11x11 sheet of cloth. The cloth is not allowed to tear and will stretch indefinitely under external forces pushing or pulling from both ends.

Crease Resistance can be adjusted to control the smoothness of the folds that form in the cloth. When the value is set toward 0% the cloth will form heavy creases along existing edges and be more likely to fold in upon itself. When the value is set close to 100% the cloth will resist folding and bending along existing edges but may expand after being draped. Values in the range of 50-90% should give the best results for most soft cloth.

The *Dampening* value adjusts how quickly the cloth will stop moving and come to rest. At 100% dampening the cloth will only move when acted upon by weight or movement and will not accelerate when dropped. When the forces acting upon the cloth are below the *Threshold* value the vertices will come to rest. Any small movement of the cloth below the threshold value is ignored.

The *Simulation Steps* value is very important. Every frame of the animation is broken into a number of smaller movements for greater accuracy. For a slower but more accurate simulation set the count to 10-20 steps. For faster results when testing before a final simulation drop the step count to 2 or 3. When too low a number of steps is used the cloth will tend to stretch and warp, the extra steps are needed to hold it together.

The *Tighten-Loosen* setting should normally be 100%. When the source mesh is turned into cloth a 50% value will pull all of the vertices of the mesh together to about 1/2 their original size once the simulation begins. Values greater than 100% will cause the cloth to expand. This may be useful in getting some costumes to fit.

The *Disable Simulation* box can be checked to speed up work flow when doing any animation work and previews during which cloth simulation, particularly with collisions, will be slow. When changing the vertices of the cloth mesh the deformer should be disabled. This value can be key framed.

<Collisions>

Hit the [Select Object(s)] button to invoke the object selection dialog box and select one or more objects, other than the cloth itself, to collide with or drape over. Cloth simulations can be layered and collide with each other but the outer layer of cloth must come first in the scene hierarchy.

The *Surface Offset* value is used during collisions to give the appearance of thickness in the cloth and to keep it clear from the mesh of the drape object or figure. Set a higher *Surface Offset* value when using a proxy figure in costume to help prevent poke throughs in the final result. If a value of 1cm is used and a small cloth is draped over a large table then the cloth will be seen floating 1cm above the table surface. The effect on the collision mesh objects during the simulation is the same as if they had been given an offset surface command in the vertex modeler.

Uncheck the *Do Collisions* box or deselect the collision object to disable collisions. This is particularly useful when adjusting the dynamic properties for fast feedback of the results in a preview.

Increasing the number of *Secondary Collisions* will result in a more accurate but much slower simulation. Once a collision of a cloth vertex with an object polygon is detected the cloth vertices will drag over the surface. 1-2 secondary collisions should be enough for most simulations involving simple and regular collision surfaces. Setting a value of 0 will prevent cloth from being able to slide down a slope or over an edge.

~~Check the *Edge to Polygon Collisions* option for a more accurate but slower simulation. This currently applies only when the cloth is draped over an object and not for objects that push the cloth.~~

Check the *Polygon to Polygon Collisions* option for an even more accurate but much slower simulation. This greatly improves the results in draping simulations and prevents the cloth from passing through sharp corners. Simulations with smoothed collision objects and a large enough surface offset can perform well enough without using polygon to polygon collisions.

Check the *Cloth to Cloth Collisions* option to include cloth vertex to cloth polygon collision checks. This will help to prevent the cloth from entering upon itself but slow down the simulation.

When running a simulation that drapes one cloth object over another, place the outermost cloth object lower down in the scene hierarchy. Be sure to set a suitable *Surface Offset* so that the cloth appears to have a thickness.

<Falloff>

Texture maps are used to control the falloff of the cloth, in order to pin parts of the cloth up or conform them to a figure. A loaded texture map image can be greyscale, but currently only the red channel is actually used. Where the image is black the vertices will not move in response to the dynamics. Where the image is white the vertices will move freely. For greyscale values in-between, the vertices will be pulled back to their originally modeled, posed or positioned location. The lighter the grey the weaker the force. When used with dynamic polygon hair the falloff effect will work to return the hair to its original style. Run a test animation with collisions disabled to test the falloff behaviour of the cloth in response other forces.

The *Conform* value can be used with or in place of a weighing map to force a costume to keep its posed shape. When set to 100% a costume will not drape but it can be pushed. At 0% conform the dynamics are not affected. The texture map *Brightness* value can be used to reduce the intensity of the weight map and therefore affect the dynamics.

Uncheck the *Use Weight Map* value when the loaded texture map is not required.

Some objects may require the texture map *Seamlessly* option to be checked to fix problems where the texture map wraps around at the edges of the cloth.

<Wind>

The wind *Direction* value relates to a top view of the scene where at 0° it blows from +Y. At 90° the wind blows in the direction of +X.

The wind *Force* value determines how far and how fast a vertex of the cloth will be blown.

Set a positive or negative *Updraft* in addition to the force of the Z component of the wind.

Check the *Enable* option to apply turbulence or noise in localized pockets and over the scene for more realistic wind effects.

The *Scale* specifies the size of the pockets of wind. If the scale dimension is the same as the width of a hanging cloth then only a little turbulence will be noticed, in the middle of the cloth or at the edges. If the scale is much smaller than the width of the cloth then the shape of the cloth will be very messed up.

Adjust the *Limits* to change how much the wind force varies due to the turbulence. Using a 0-100% range of values will create the greatest variance in turbulence. Using a 90-100% set of limits will generate low turbulence. Dropping the upper limit value will reduce the maximum force of the wind accordingly.

Use a different *Seed* value to change the overall turbulence between animations.

When the number of *Octaves* is increased then larger pockets of turbulence and localized gusts can be added to the wind force. When there are 2 octaves a second pocket twice as large as the specified *Scale* will be generated in the wind. As more octaves are added each is double the size of the previous and has double the effect on the noise in that area.

Most of the wind force parameters can be animated. Use a noise tweener between the key frames for better wind effects. To create gusts of wind set variable direction, wind force and updraft values in the time line. Use a noise tweener for variation and the turbulence for localized noise.

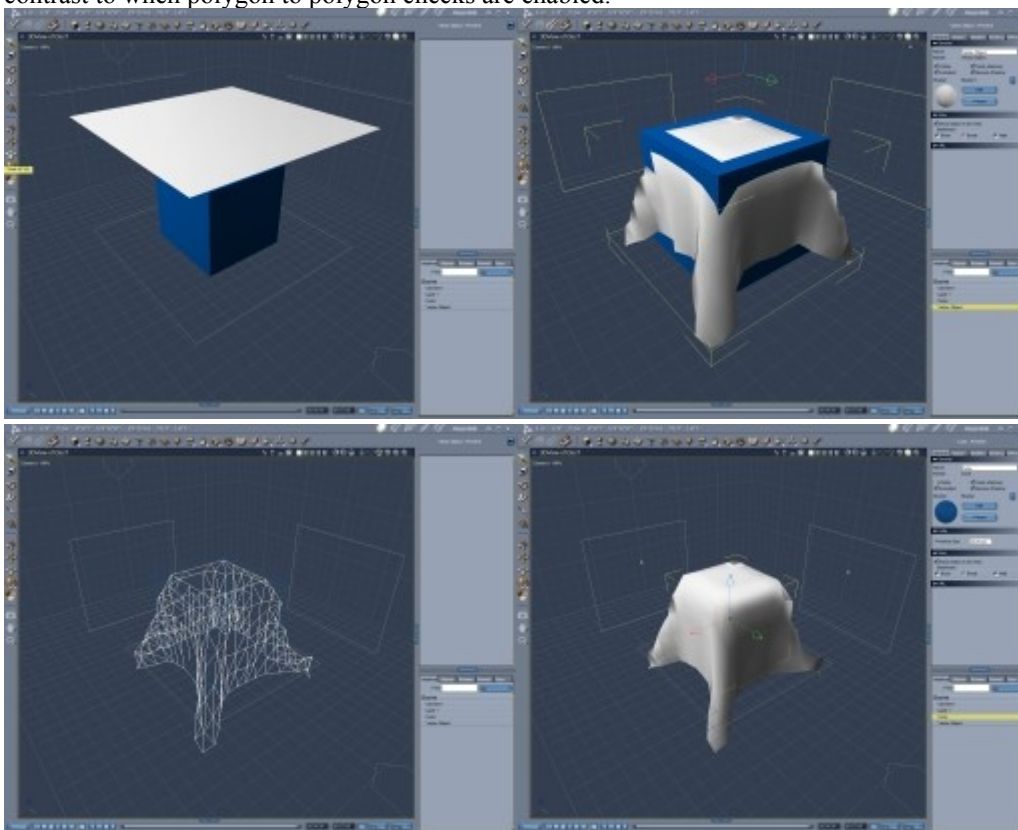
Using the Cloth Deformer

Test out the Cloth Deformer first with some simple examples. Adjust the various parameters and replay the simulations to gain a better understanding of how they work with simple cloth objects and with basic collisions objects. Use a cube or sphere made in a vertex primitive with reduced geometry for faster tests, the geometric scene primitives can have a large number of polygons.

Carrara 6 and 7 users will need to set the Play Every Frame mode when running a simulation preview in the Assemble room. If frames are skipped then the cloth simulation will not perform well since the ? mode skips frames to give a smooth real-time preview.

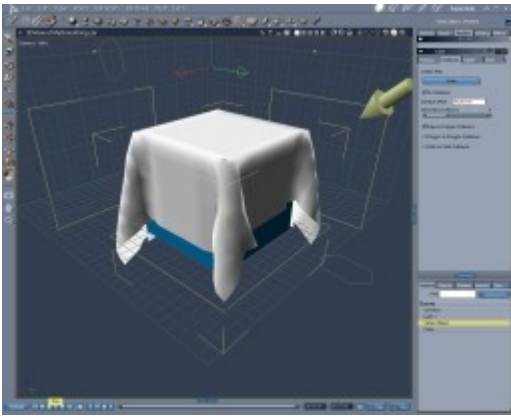
Draping

Insert a Vertex Object into a scene. This will be the cloth. Inside the Model room insert a Grid, or from the menu choose Construction | Insert 3D | Grid... setting the Perpendicular to Z. Use the +/- arrows to increase the density and tessellation or choose Model | Tessellate | Mid-Edge to Center. Return to the Assemble room then insert a Cube primitive into the scene. Raise the Vertex Object above the cube, scale and position it so that the cloth will drop onto the cube. With the Vertex Object selected switch to the <Modifiers> tab in the Properties tray. Apply Cloth from the list of modifiers - it may be found under the Sparrowhawk3D submenu. Hit the Fast Forward button in the sequencer tray and adjust the *Progress* value to 100%. Rewind time back to 0%. Switch to the <Collisions> tab, hit the [Collide With] button and select the Cube. Hit the play button in the preview and the cloth will fall onto the cube. Take note of the rate at which it falls and adjust the *Gravity* value. The limitation of vertex to polygon only collision checks shows where the cloth intersects with the sharp edges of the cube - in contrast to when polygon to polygon checks are enabled.



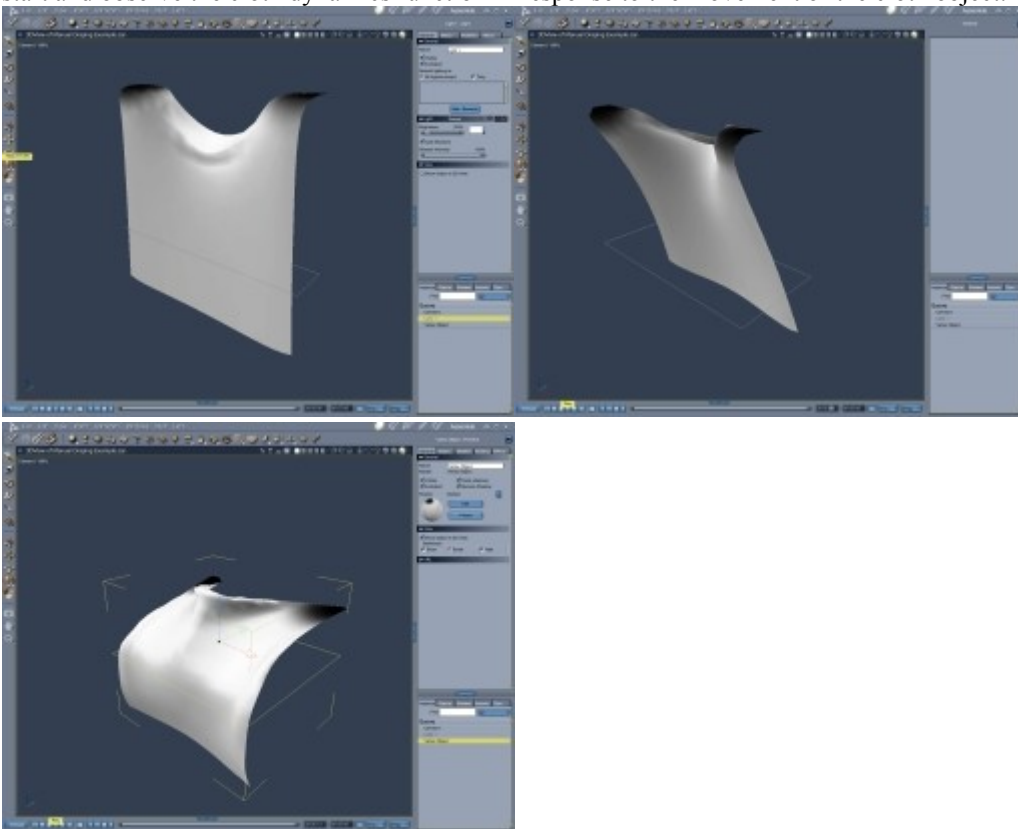
Using the same simple test, switch to the <Collisions> tab and check the *Edge to Polygon Collisions* then press play or render to run the simulation again. The simulation will be slower but the cloth will no longer penetrates through the sharp edges of the cube underneath.

Cloth simulations using edge to polygon collisions will still be penetrated by sharp corners though. Switch to the <Collisions> tab and check the *Polygon to Polygon Collisions* option instead of the *Edge to Polygon Collisions* for a slower but more accurate draping simulation.



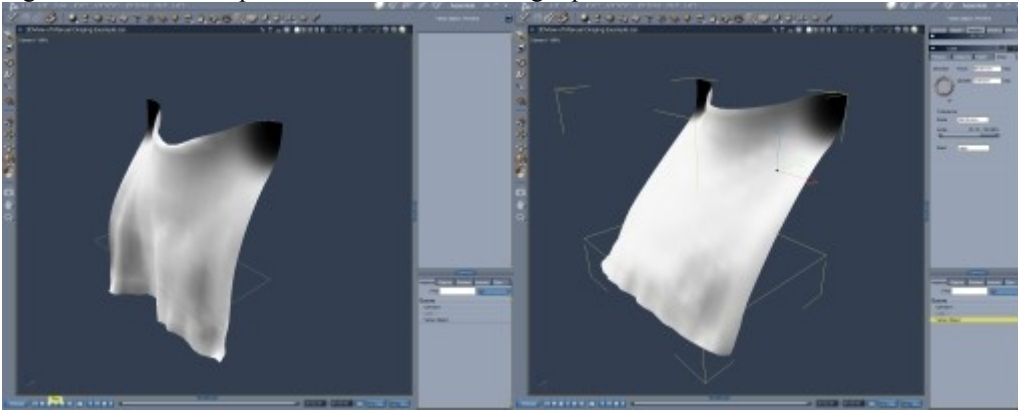
Hangings

Insert a vertex object into a scene. Inside the Model room insert a Grid onto the xz plane and adjust the tessellation. Use the UV editor to apply a planar projection onto the grid or apply box face mapping. Use your favourite 2D painting application and create an image with a sharp colour gradient from black to white, or with some areas of black in the corners or a black line along the top. Apply the Cloth Deformer to the vertex object. Never forget to set the *Progress* value to 0% at the start of the simulation and to 100% at the end. Switch to the <Falloff> tab and load the image to be used as a weight map. Make sure the *Use Weight Map* box is checked. Hit the play button and observe how parts of the cloth remain held in place while others fall. Create some key frame positions and move the cloth object around the scene over time. Replay the simulation from the start and observe the cloth dynamics function in response to the movement of the cloth object.



Wind

Create a simulation using a hanging cloth with a grid, planar mapped texture coordinates and a weight map to hold it in place along the top edge or in the corners. Apply the Cloth Deformer and adjust the *Gravity* and other parameters so the cloth hangs naturally. Switch to the <Wind> tab. When the *Direction* is set to 0° then the wind will blow from the direction of the +Y axis and blow the cloth in a -Y direction. Set the wind *Force* to be about half that of the *Gravity* and use an even smaller *Updraft* force value. These values are all set in scene units and specify how far a vertex of the cloth will move or lift in 1 second of play during the simulation, the greater the force, the stronger the wind. Play the simulation and watch the cloth moved steadily by the wind. Next check the *Enable* option the Turbulence section for a more realistic result. The turbulence *Scale* must be adjusted to give the desired size of the pockets of disturbance. Using a scale size that is much smaller than the cloth mesh will result in ripple like disturbances all over the cloth. Using a scale that is much larger than the cloth will have the effect of wind gusts with the cloth hardly moving at all or it being fully blown. Adjust the *Limits* value range to 0-100% for maximum effect of the turbulence. Set the turbulence *Scale* to be about $\frac{1}{4}$ the width of the mesh then increase the number of *Octaves* to 3 or higher to create small pockets of turbulence in larger pockets.



Real World Materials

The Cloth Deformer is a simple simulator but there is enough variation in the settings to attempt to model different types of material. The mesh fidelity or density has a great effect on the visual quality of the simulation - and its speed. Finer cloth will require a finer mesh and heavy fabrics can be modelled with a low resolution mesh.

Using Dynamic Clothing with Figures

The Cloth Deformer is designed to achieve dynamic animation on *parts* of costumed figures. For good results always use a hidden, low polygon conforming 'proxy', stand-in or dummy figure. Some proxy figures are provided for use with the deformer. Use an appropriate proxy with a minimal polygon count only where it is really needed to greatly speed up the simulation. Import a proxy figure into the scene then conform it to the real figure. Don't forget to hide the proxy figure when running the simulation during a render of the animation.

The Cloth Deformer does not have a 'drape now' feature to hang the cloth over the figure in a smooth transition from their reset pose into a pose at the first frame. The figure must be reset to their zero pose at the start of the simulation or the cloth manually adjust to be clear of the posed figure. During most practical simulations it is sensible to have the figure move into action off camera.

The Cloth Deformer works well when using polygon to polygon collisions and when draping, but not when the collision objects push the cloth. The proxy figure should have a clear offset from the real figure to avoid 'poke throughs' and use only simple vertex to polygon collisions for fast simulations. Problems may occur if the proxy figure does not bend correctly with the real figure. If the proxy figure is not sufficiently offset from the surface of the real figure then skin or conforming clothing underneath the cloth will poke through. For real world scaled figures the proxy's offset should be about 1-2cm and this can be easily adjusted using the Surface Offset value or by applying a surface offset to the figure in the vertex modeler.

Costumes should be modeled and morphed to fit the figure where they are worn close and will conform tightly, but must start clear of the figure where the proxy will be used. The costume must be clear of the collision proxy at the start of the simulation. If a collision object mesh penetrates the cloth before the simulation begins or during the simulation it may result in a visible poke through, but the cloth should recover and pass back out of the figure again. Use the available tools in the vertex modeler, such as displacement painting, if the cloth needs adjusting. In Carrara 7 it is much easier to check if the costume is clear from the proxy figure where it needs to be by using the vertex modeler in the Assemble room. In early versions increase the size of the preview window at the bottom of the properties tray and make small adjustments while waiting for visual feedback.

Dynamic Polygon Hair

Many suitably modeled hair objects can be animated by using a painted falloff map. The roots and hair draped over the crown need to remain fixed in place and only the length of the hair should be allowed to move. When painting the falloff map the roots must be black and the tips should be white. Typically hair below the ears can be allowed to move, unless the style features spikes or bangs. As with costumes the hair must start out at the beginning of the simulation clearly offset from any proxy figure used with collision. For short or medium length hair a proxy figure or prop with only the polygons for the head should be sufficient.

Suitable hair objects must have one texture map layout and one polymesh. If the hair prop includes a scalp (or 'skull cap') this is best selected and removed and made into a separate object. Duplicate the hair mesh then select and delete the scalp in one new master, keeping the length of the hair, and the invert the selection and keep the scalp in the other. If the hair has multiple polymeshes try exporting it in OBJ file format and then import it back into Carrara as a single vertex primitive with one polymesh.

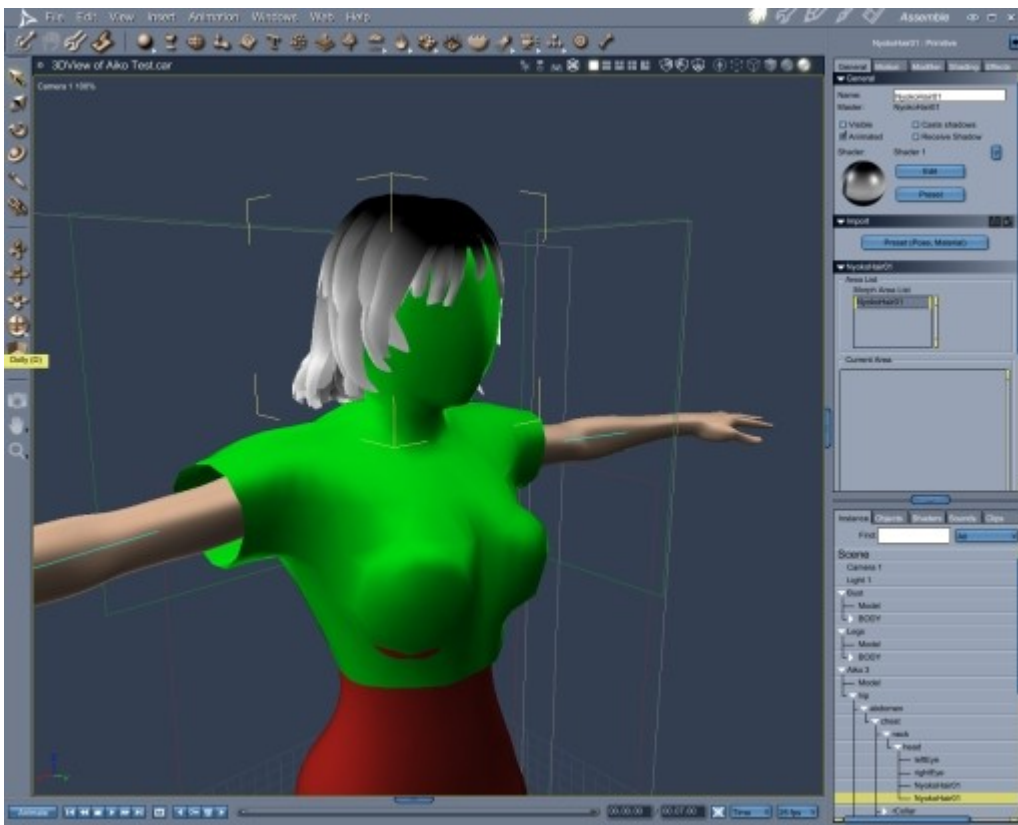
Set a low *Gravity* value when using hair so that it keeps its body. Raise the *Conform* value in the <Falloff> tab to reduce dynamics and force the hair to maintain its style, rather than becoming a mess. The *Brightness* value of the texture map can also be reduced to effect the dynamics.

Test the hair first to get the dynamic properties right without a collision object selected, or disable collisions. By nature polygon hair will not give realistic results when the figure is hanging upside-down or performing intense actions, but the results in most cases can be more appealing and faster than using strand based dynamic hair.

This example shows a painted falloff map applied to a hair prop.

The hair is black at the roots and white at the tips.

The proxy figure is coloured green, conforming to the real figure but showing a clear offset from the surface.



Dynamic Costumes

Conforming dresses are especially difficult to animate or pose without the legs being able to push the cloth as they move. The Cloth Deformer can be used to animate and also help to pose many costumes for stills. The plugin is best applied to costumes with conforming and dynamic elements and clothing needs to be designed or modified with the dynamics in mind. The painted falloff maps are used to control which parts of the costume conform and which obey dynamic forces. Costumes with detailed hems, belt loops, buttons, pockets etc all modeled with polygons, rather than with textures, will not be suitable for use with the deformer. Highly detailed meshes and conforming figures may take a very long time to simulate. Costumes that have multiple shading domains with different texture map layouts are not compatible with the Cloth Deformer.

When modeling a costume be aware that it will fall and drape over the figure, but that a tight fit is needed around the waist or the rest of the figure where it will conform. Some costumes can be modified for use with dynamics by changing the bone influence or groups. Remove any 'body handles' and move all of the dynamic parts of a dress into the hip in a suitable figure editor.

Parts of the figure will poke through the costume where the cloth mesh is too large compared to the proxy figure and when the collision object or proxy figure is not sufficiently offset from the surface of the real figure. This is more likely to occur with the shins and forearms.

Costumes need to be practical if they are expected to perform reasonably. A full length dress will not work well in action scenes but might perform perfectly for a walking figure. Although impressive, a large cloak or long hair will get in the way or be tangled up during a fight. Work within the limits of the simulator.

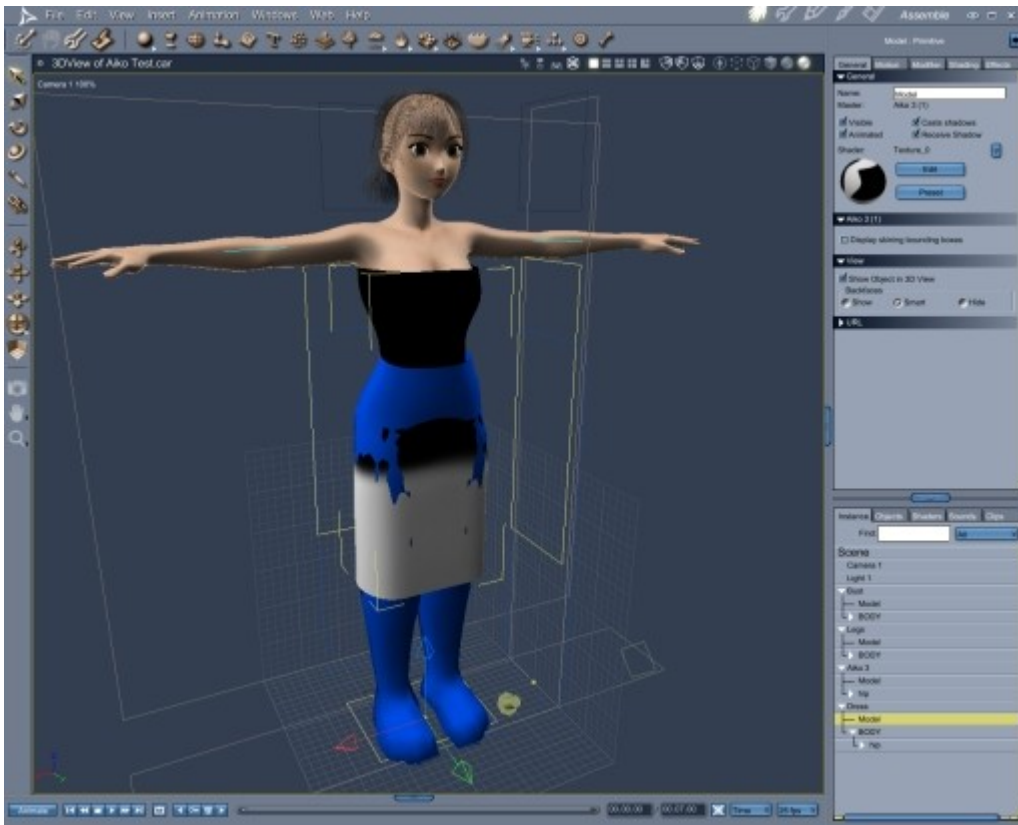
Set the simulation to use a very low step count and disable collisions when testing and adjusting the dynamics parameters. If the *Gravity* value is set too high then the costume will appear to be wet or too heavy.

In this example the dress has been imported and conformed to the figure. The bones above the waist will conform to the figure and the rest of the dress mesh is in the hip body part.

The painted weight map shows as black where the dress will conform to the torso and white below the hips where it will be dynamic.

The proxy figure, larger than the real figure is coloured blue.

In the area of transition from the conforming parts of the dress to the dynamic, this costume must be altered in the vertex modeler to be clear of the blue proxy figure before the simulation is run.



If the figure's body pushes areas of the cloth that have a falloff, from the full simulation effects, then poke through problems are more likely to occur. In this example the girls thighs will probably penetrate the dress if she raises her knees up toward her abdomen.

Planned Improvements

- Implement optimizations to speed up simulations so that they do not require low detail proxy figures and props
- To fully implement and improve polygon to polygon collision checks, including in object collisions and in self collisions
- Add simple internal softbody force to maintain a closed object's volume
- To add a list of inclusion zones for the setting of falloff weighing as an alternative to painted maps
- To allow for a separate list of selected zones that grab hold of and drag or pull cloth vertices
- To add air resistance and sliding friction values for cloth
- Possibly to allow cloth to tear apart when overstretched
- More realistic and controllable wind turbulence and possible link to global master wind object
- Weight painted flexibility and implementation with multiple or specific shading domains
- Allow for multiple polymeshes to be recognized from a vertex modeler square mesh source
- Additional painted weighing properties, such as flexibility and creasing, may be added into separate colour channels of weight maps
- Raise a warning box when the source mesh is deemed unsuitable for use with the cloth deformer
- Add extensive tool tips into the final user interface
- Option to process and save simulation results in memory or to an external file for playback using the deformer

Support

Sparrowhawke3D is an amateur project so I can't make any promises regarding support, however I'm keen to improve my simple practical plugins and share them with the Carrara community.

The Cloth Deformer plugin for Carrara is free, you can use it in any project, commercial or otherwise. You may not repackage, bundle, redistribute or sell the Cloth Deformer.

For comments, feedback and suggestions email me, Jeremy@Sparrowhawke3D.com.