The Spring Primitive

for CARRARA 4,5 & 6

Version 0.42

The Spring Primitive correctly models and animates the geometry for a variety of helical springs. While springs can be made using the spline or vertex modelers, they are hard to edit and do not animate accurately using the object's scale.

To install the plugin extract the contents of the compressed zip package into the Carrara\Extensions sub-folder. The primitive must also be installed into the ..\Extensions folder of all render nodes. To remove the Spring primitive Carrara 4 users must delete the Spring.mcx and Spring.dta files from the ..\Extensions\ folder. Carrara 5/6 users must delete the Spring.mcx,Spring.dat and Spring.txt files.

Macintosh users should open the Carrara installation folder (typically /Applications/Carrara). Right-click on the Carrara or Carrara Pro application and then choose "Show Package Content". Navigate to "Contents/MacOS/Extensions" then copy the Spring.mcx, Spring.dat and Spring.txt files into that folder.

Once installed add a Spring to the scene by selecting the spring icon from the toolbar and drag and drop it into the 3D view of the scene or into the scene list. Avoid clicking and dragging to scale the spring in the assemble room for best results. Switch to the modeler room to edit the spring parameters or double click on the spring.

Basic Parameters

The basic parameters used to describe the spring are simple. Note that the *Coil Radius* is the length from the centre of the spring to the centre of the wire.
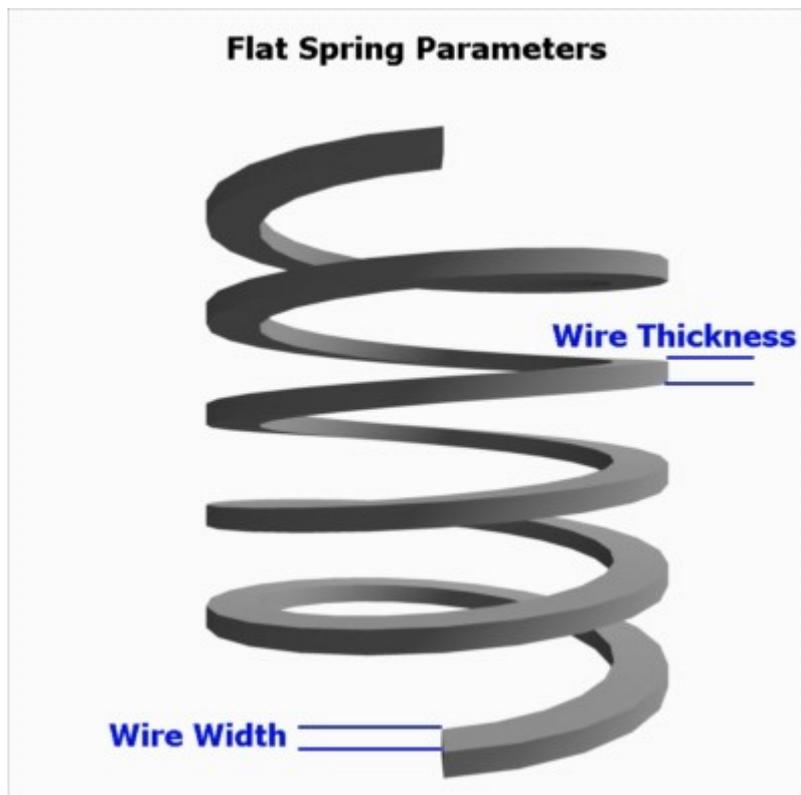
When the *Flat Coil* option is checked the *Wire Thickness* box becomes available which sets the height of the flat wire. The *Wire Radius* box changes to give the *Wire Width* instead.

When the option to *Grind Ends* is checked the first and last turns of the spring are created so they present a flat surface.

Check the *Left Hand Helix* box to change the spring from a standard right hand wound coil. To understand the term point the thumb of your right hand in the up or down direction of the spring and curl your fingers round - they should follow the winding of the coils.

Unchecking the *Cap Ends* option will not close the geometry at the end sections of the spring. This might be useful for creating a hollow pipe or tube.

Adjust the *Coil Detail* and *Wire Detail* values to set the number of points used in the Spring geometry. Using a higher level of detail will improve the surface quality but may slow down the preview window. Optionally turn the detail levels down and adjust them to maximum when rendering.


When the Conical spring option is enabled the *Coil Radius 2* sets the radius for the upper most coil of the spring. When a non-zero *From Height:* is set the spring coils keep the main radius until that height is reached. *Currently a From Height > 0 does*

Inactive Coils

Some springs have sections at the top and/or the bottom that do not flex when the spring is stretched or compressed. The *Total Turns* count includes any inactive coils. Inactive coils do not move or animate.
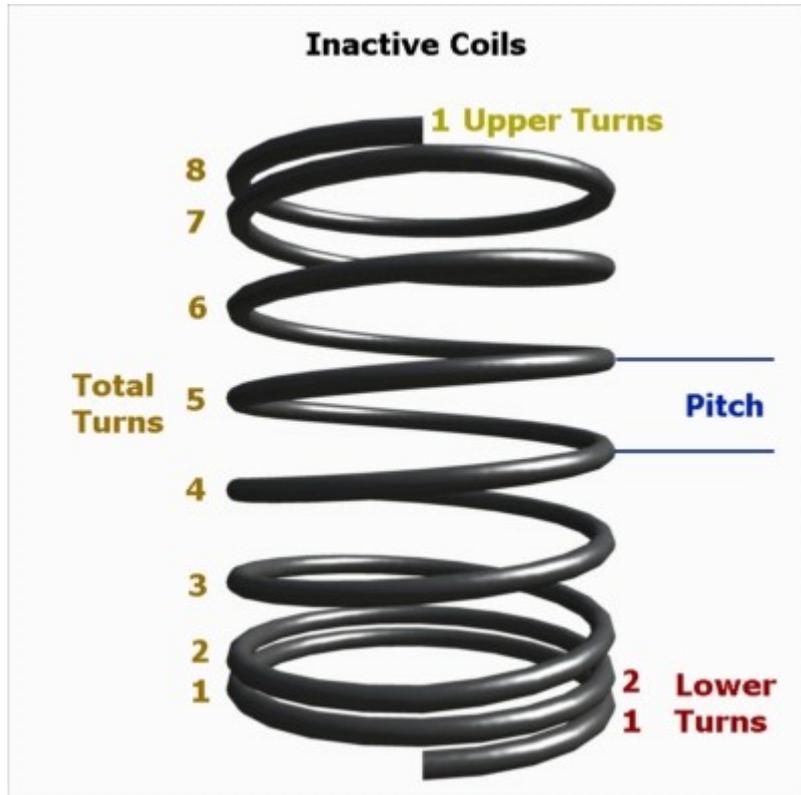
Specify the fixed *Pitch*, which is the height from the centre of one coil to the next after a single turn and the number of *Turns* the inactive coils make. The pitch should always be greater than or equal to the diameter or height of the spring wire.

Keep the *Prevent Compression* option checked for accurate animation of the spring. When the height is set incorrectly the inactive coils will still remain in place and correct the overall height of the mesh but not the entered value.

Animating the Spring

The *Spring Height* is in scene units. Simply change this value over time to animate the spring. Most of the parameters of the Spring Primitive can be animated, such as the total turns (for unusual effects) but typically these should not be altered past the first key frame at time = 0; *Some parameters may be protected from animation in the final version to reduce user error.*

The *Prevent Over Compression* in the *Animation* section is checked by default. Whether animating or not this ensures that the spring coils do not enter in upon each other when the spring is compressed. The compression of conical springs is processed differently and if the parameters are entered correctly a concial spring can be collapsed down to its wire height or against the lower coils depending on how tightly wound they are. *This feature may work unexpectedly with complicated conical springs combined with inactive coils.*

The Spring Primitive can be animated automatically between any two selected (or named) target points. When the *Work Between Hot Points of* option is enabled any height set for the spring is ignored but the pitch of inactive coils is kept. The absolute distance between the target points is used so they are best setup as part of a machine or with the second target point parented to the first and using a Z slider constraint. Use a Track modifier on the spring to keep it attached to the first lower target point or parent it to that point. Group the points and the spring together and freely move them round the scene as a closed system or attach them to a machine. If the target points are moved too close together and the spring is set to prevent over compression this will not stop the points from moving. Set the slider constraint to sensible limits.

In this example two plates were created using cube primitives. The first was lowered so that its upper surface was at Z=0 then the hot point was unlocked and moved to Z=0. A second plate was duplicated from the first then the hot point adjusted so that it was at the bottom surface of the plate. Both the upper plate and the spring were parented to the bottom plate and then a slider constraint applied to the upper plate. Moving the upper plate up and down over time flattened and stretched the spring.

Any scaling applied to the spring system will prevent it from working properly between target points.

Note that the spring will not change in the preview after moving a target point until the stop button is hit or the time scrubber is moved. The spring will always animate correctly when rendered.

Texture and Shading

The Spring Primitive geometry is built with uv texture co-ordinates and intended for use with simple shaders and shiny reflective metals. Fractal and other 3D patterned shaders will not work correctly with animated springs because the geometry changes. When texturing a greasy or rusty spring it is recommended that you bake the texture or export the spring from the scene and convert any procedural shader into a texture map.

One entire 'v' texture range (from 0 to 1) runs up length of the spring from bottom to top. One 'u' texture range wraps around the diameter of round wire and once in proportion for a flat coil section. The ends of the spring have a separate shading domain and share the flat or round uv space projected in proportion to a full 1 unit square. That is for a round section the uv co-ordinates draw a circle inside the square of a texture map. For a flat coil section the base is always at the bottom of the texture map then filled depending on which proportion of width or height is greater.

Troubleshooting

- If the spring does not animate correctly between target points check in the properties tray on the <motion> card that there is no scaling % on the spring - it must be at 100% overall size at least in the Z axis. Check that the target points are in line with the spring's Z axis. Make sure that the hot point of the spring has not been moved from the base of the spring.

Tips and Tricks

- Springs dont have to make an exact number of turns and any partial turns are added to the top of the spring.
- Try using the spring to model the thread for a screw, set the taper for the right height and the wire detail to 3
- If the spring needs a hook to be added to its end model this in a vertex modeler. Insert an oval with the same UV size as the wire diameter and perpendicular to Y. Set the number of sides equal to the wire detail setting for the spring. The spring mesh always places its first vertex at 3 o'clock which makes it consistent with ovals used in the vertex modeler. Translate the oval in X by the coil radius of the spring. Extude the oval into the shape required or sweep it along a polyline. Set the spring's hot point in the scene to the origin then move the hook it into place with its hot point at the spring height-½ wire diameter for the top or at ½ wire diameter for the bottom. Target the spring to animate with any hooks by moving them.

Planned Improvements

- 3 different tapering groups or radii; upper, middle, lower
- tapering % to work consistently with inactive coils
- curved springs that follow an arc and animate properly between two points (ie a slinky)
- correctly modelled and animating spiral springs
- get springs to animate between points when the system is scaled in the scene

Support

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

Special thanks to Untoldwind for the Carrara 6 builds for the Macintosh.

The Spring Primitive plugin is absolutely free, you can use it in any project, commercial or otherwise. You may not repackage and sell the Spring Primitive.

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