

## The Curve Deform function

### - HOW TO MAKE A WINCH OR A WINDER -

I'm not experienced in making tutorials, and english is not my native language. This is more an example than a tutorial, so please be indulgent. I hope that it will be understandable and usefull. If not, please let me know !

I have made this tutorial after spending a long time playing with curves to get a nice path without this annoying problem of flipping that is cause of the well known ugly twist at 180° on beveled objects. I couldn't avoid completely the twist, but in most cases it doesn't appear until you do a very complex path. There are little tricks that you can use to hide the twist. On fig Q, there are two twists, but the twist on the right is hidden under the rope itself. A twist often appear where you put a pulley. Placing the camera with a good view point, you can use the pulley to hide the twist.

I will not use beveled objects here, but a modeled one.

This animation uses the Curve Deform feature that is proposed when you want to make an object child of a curve (CTRL+P).

After many trials using NURBS, I have noticed that Bezier curves were less sensitive to the twist problem. I hadn't used them first, because they were supposed to be more difficult to control. The experiment in this particular case seems to demonstrate the opposite.

This example is built around a winch (or a winder). For one of my projects I needed one. I wanted it realistic and detailed in order to allow sights in close up.

The rope had to be flexible and easy to animate with hooks, AVK or RVK, for wind, winding and tension effects, and allowing the use of pulleys. Later, I could have to break the rope too. So I needed a modeled object, a true mesh. The Curve Deform function allows the deformation of the mesh by deformations applied to the curve. This means that all kind of deformations are available using this feature !

We can start now!

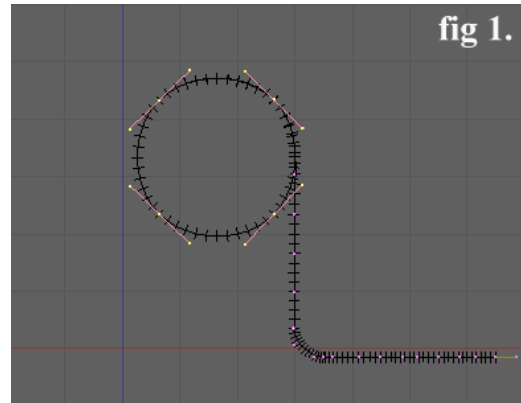
Always display the axis of your objects, this will help you a lot.

The first important thing is the drawing of the Path.

Add - Curve - Bezier Curve.

This is done in Front View (PAV NUM 1).

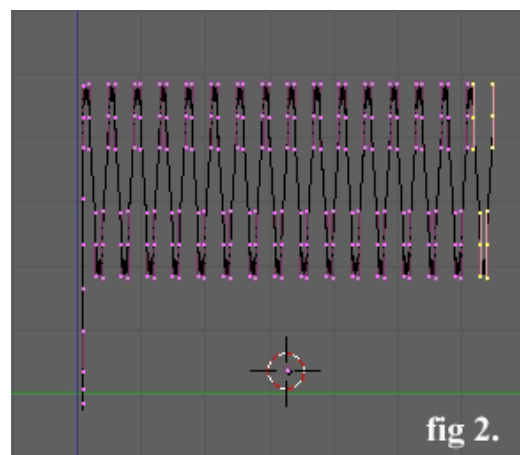
Make first a circle, placing 4 points in a square shape as shown on fig 1.



Each new point of the curve is extruded from the previous one.

When the first circle is done, select all the points and duplicate the circle. Type N to show the Transform Properties panel and work now in Side View (PAV NUM 3). Select the points one by one and shift them along the Y axis. The shift between each point depends of the thickness of the rope that you will make.

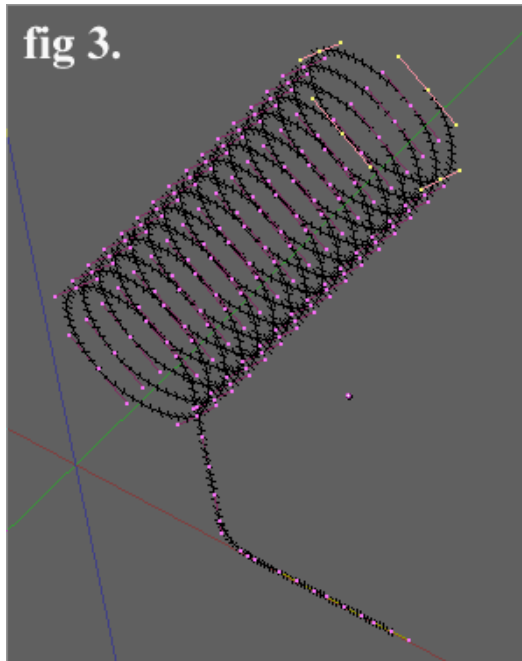
When the first turn is ready, duplicate it and shift it, in order to merge it with the previous one (fig 2).



For this, you will have to remove the first point of the last duplicated turn. Select the first remaining point, and the last one of the previous turn, and type F to join them.

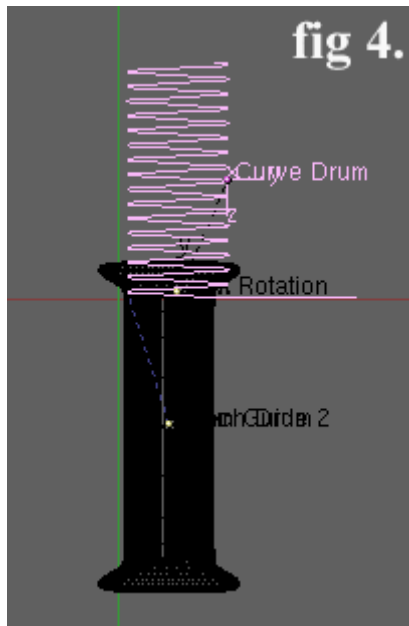
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Use the same method for the other turns, until you have the complete coil (fig 3).



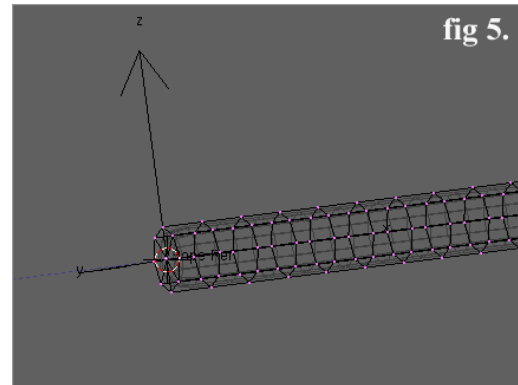
This curve is named Curve Drum. It is placed on layer 2.

The drum itself will be modeled later. It is one of the less important things (fig 4).

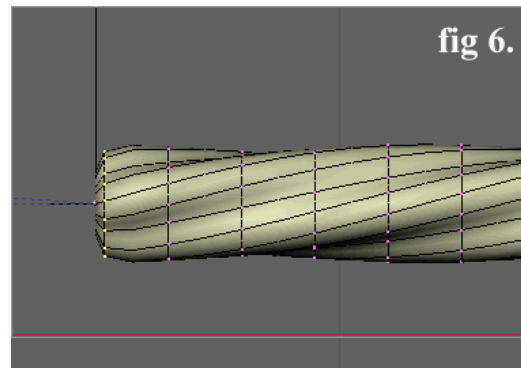


You will notice that the tilt plane is parallel to the screen plane (Z local axis pointing toward you).

Now, the second important thing is to model your rope. For the trials, or if you are going to texture your rope and apply Nor mapping, you can model a simple cylinder, using Extrude Dup in the Mesh tools panel (fig 5).



I prefer to model a twisted one to get more realism, but the principle is the same (fig 6).



I have extruded 9 times a short section, rotating the new vertices layer with a value of  $20^\circ$ . The piece of rope is duplicated and shifted, added to the previously made, and Remove doubles is applied. Apply CTRL+N too, in order to recalculate normals. Apply CTRL+A to apply size and rotation.

Make a long rope. If you make it too short, you may have to remake it later !

NOTA: you will notice that some objects are named Rope Ref 2, Rope Follower 2 and Drum Guide 2 on the pictures instead of Rope Ref , Rope Follower and Drum Guide. It is because I had made two ropes : a cylindrical one, and a twisted one. The names ending by 2 are related to the twisted one. In the original Blend file, the two ropes were put in different layers. So do not pay attention to the number 2 and read for example Rope Ref 2 like if it was Rope Ref.

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You will need an Empty as the «head» of the rope. Select the first layer of vertices and place the cursor on this selection with SHIFT+S (fig 7).

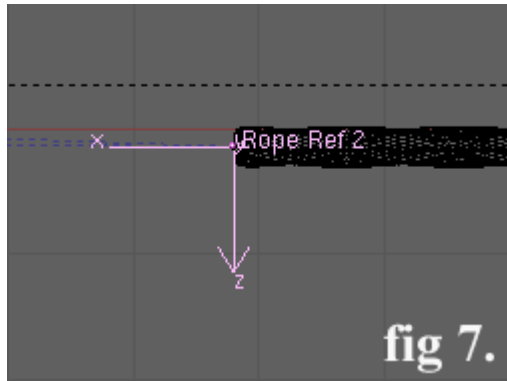


fig 7.

Do not pay attention to the axis of this empty on the picture, it has not a great importance.

Get out of Edit mode and in Top view (PAV NUM 7), Add an Empty and name it Rope Ref.

When you will add the drum, the drum will have a Track constraint pointing at this Empty (fig 8).

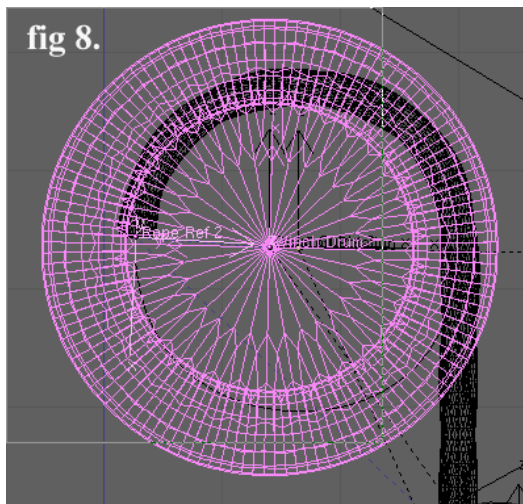


fig 8.

Select the rope and select the first layer of vertices again. Apply CTRL+P to make the Empty Rope Ref the child of these vertices (Vertex parent). Now, the «head» of the rope has an empty attached to it. You can do the same thing for the end of the rope, but is not usefull now. Do not forget that you may have to cut the rope later. This «tail» empty will be used to make an object child of the end of the rope. This allows you to hang an object at the tip of the rope.

Now Make a copy of the Empty Rope Ref, and name it Rope Follower (fig 9).

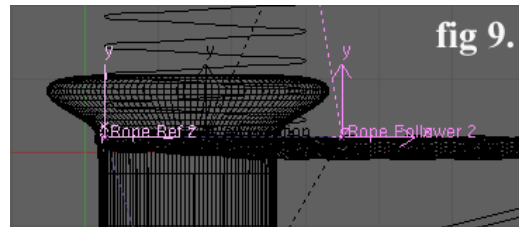


fig 9.

Make it child of Curve Drum. This will be usefull at the end, because you will be able to move all the objects when moving only this curve. This Empty has a copy location constraint pointing at Empty Rope Ref (Y axis). Constraint settings are shown on fig 10.



fig 10.

The Rope Follower Empty is the parent of an other Empty named Drum Guide which is used to create an Offset in Y direction for the Drum.

Now, model the Drum. It may be a simple cylinder for now. Place it at the beginning of the Curve as shown fig 4.

Place the Empty named Drum Guide at the center of the Drum mesh (fig 11).

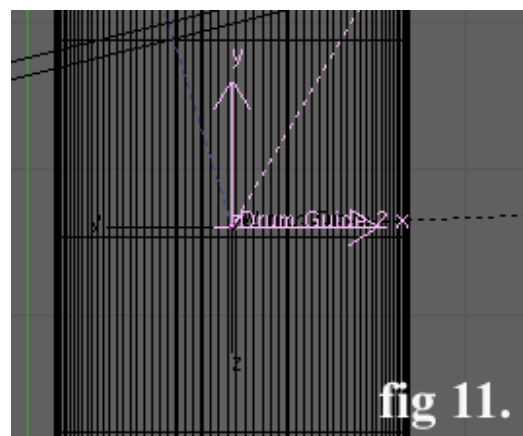


fig 11.

For the Drum, set a copy location constraint that point to the Empty named Drum Guide (Drum Guide 2), and toggle XYZ axis. Add an other constraint Tracking the Rope Ref (Rope Ref 2)Empty.

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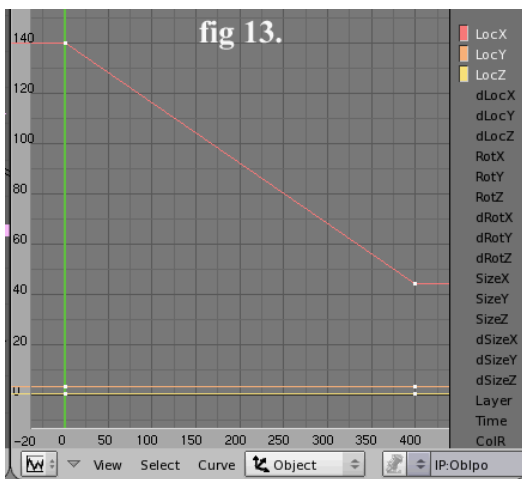
This will give the rotation to the Drum. Constraints settings are shown fig 12.



The empty Drum Guide will allow the fine placing of the Drum.

You must understand that in our virtual world, it is not the Drum that wind the rope, but the rope that turns around the curve and gives the rotation to the Drum !

The rope itself must be animated by an Ipo curve that makes it moving along the X axis. This Ipo curve is shown on fig 13.

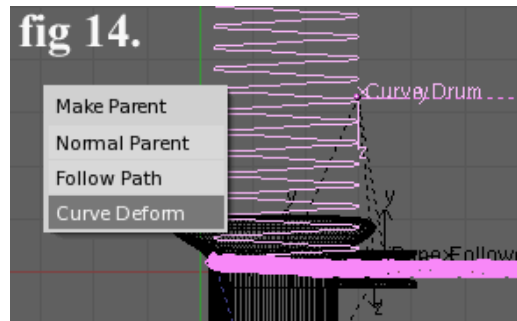


You will add this Ipo curve at the end. If you make it now, you will have some difficulties when moving the rope by hand, because of the Ipo.

Now, almost all the important objects are made.

Place your rope in front of the entry point of the curve.

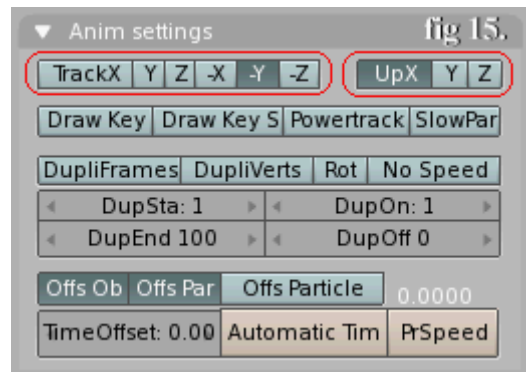
Now, you have to make the curve the parent of your rope. Choose Curve Deform (fig 14).



Your rope may be like aspirated by the curve. Now move your rope, until you get a nice coil of rope.

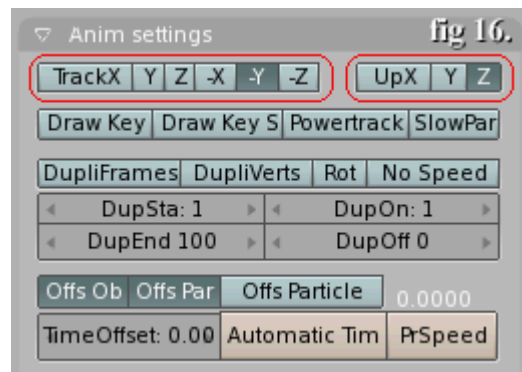
At this point, you may have a bad surprise : your rope may be strongly distorted or displaced. Do not Panic !

The most difficult thing is for now : you have to toggle the good buttons in the Anim Settings panel (fig 15).



First select the curve. You can see that the X axis is pointing vertically, so toggle UPX in the Anim Settings panel. In my case, X is pointing down, but it is the same thing ! The important thing is the axis, not the direction.

For the Track direction (pointing to the rope), choose Y or -Y. Do in the same way for the rope (Z axis UP, fig 16).

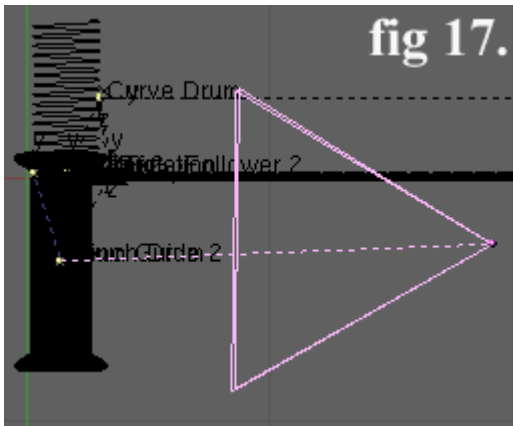


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You may have to tweak the Track Axis and the Up axis to find the setting convenient for your scene. This is the most difficult point.

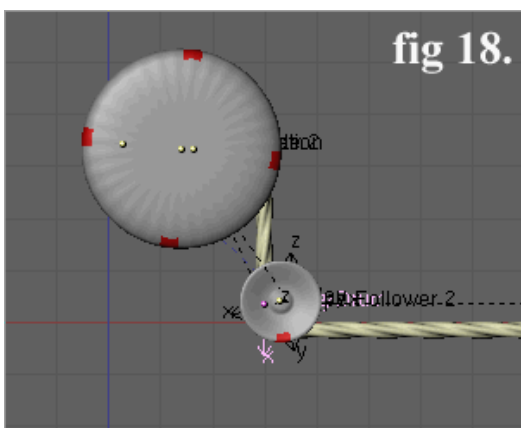
If all the objects are correctly linked, you will be able to move all of them by displacing only the curve.

You will notice that the rope is steady in Y axis, and that the Drum is moving along the same axis. If you want to render a sequence without this weird effect, you must make the camera the child of the Empty Drum Guide (fig 17).



If you have a lot of objects and if you don't want to make the whole objects of the scene childs of the Empty Drum Guide, you can add an Ipo curve moving it in the opposite direction, and use this empty as a parent for the objects that mustn't move (not yet tested).

The final touch is the pulley (fig 18).

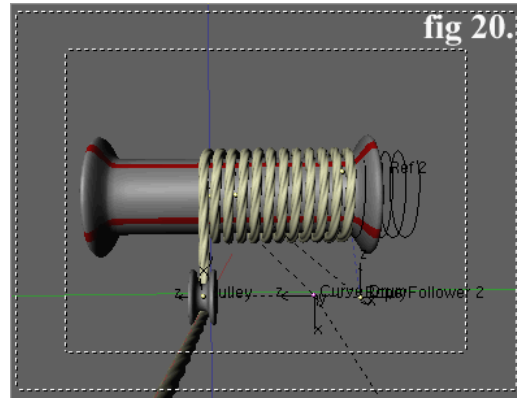


It is moved by a short script (it is almost all I am able to do with Python !) that convert the linear moving of the rope in a rotation for the pulley (fig 19). You may have to change the multiplication factor to calibrate the speed rotation.

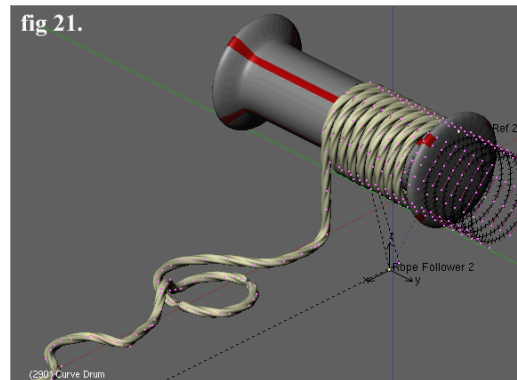
```
import Blender
ropet = Blender.Object.Get("Rope 2")
pulley = Blender.Object.Get("Pulley")
pulley.RotY = - 2 * ropet.LocX
Blender.Redraw()
```

fig 19.

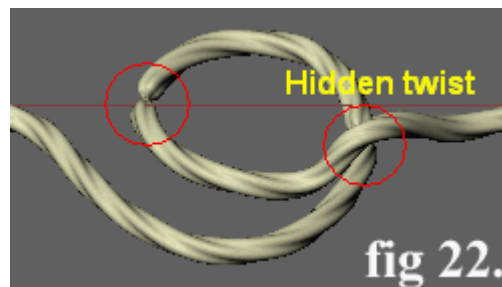
The final result is shown on fig 20.



As said at the beginning of this tutorial, I couldn't avoid completely the twist, but in most cases it doesn't appear until you do a very complex path (fig 21).



There are little tricks that you can use to hide the twist. On fig 22, there are two twists, but the twist on the right is hidden under the rope itself. A twist often appear where you put a pulley. Placing the camera with a good view point, you can use the pulley to hide the twist.



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NOTA : When running the animation in 3D View with ALT+A, you may notice a jitter in the position of the rope. This is caused by the script. It has no effect on the rendering, and can be avoided disabling the script, if you don't want to use the pulley.

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