Carrara Studio 3 Tutorial:

Fun with Physics

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The Continuous Cannon

If you have ever wanted a virtual cannon for your computer, but didn't have the disk space for all of its ammunition, then this recycling model is the one for you. The animation shown above was made using the Physics engine in Carrara, and it's the focus of this month's foray into the digital domain.

We will start with an overview of the Physics Engine and some tips on keeping it running smoothly. We will then outline the strategy used for this project before putting together the animation.

An Overview of the Physics Engine

The Physics engine in Carrara allows you to take any object, give it an initial push and/or spin, then animate the object's resulting behavior over time, with or without the effects of gravity. All of the forces are applied at the start of the animation, and the Physics engine does not work with Keyframes. However, once the effects of Physics have been calculated for the animation, the object's motion may be converted from Physics to Explicit to generate Keyframes if desired.

You can also mix the motion modes for a group of objects in an animation. For example, one object could be using Explicit Keyframe motion, another object could be controlled entirely by the Physics engine, and a third object could be following a user defined motion path.

For this tutorial, we'll be using a Directional force to simulate the effects of gravity. Other forces available in Carrara include Torque, Point, Damping, and Flow.

Tips for Smooth Running with the Physics Engine

Keep the Save Tweeners box checked to store the output of the Physics engine. This will prevent the recalculation of the physics unless something has been changed since the last pass.

Once you have run the Physics engine through to the end of the animation, uncheck the Physics Enabled box for the scene. This will allow you to fine tune the arrangement of objects in your scene without having to recalculate the physics every time something was moved. Only turn Physics back on and rerun it if you made a change to an object with Physics applied or anything else that object might interact with.

Rewind your animation to the first frame before moving any objects to avoid inserting unwanted Keyframes.

Physics calculations are slow, but can be sped up by using low Effects Fidelity and Surface Fidelity when getting the scene set up. Be aware though, that this can have an effect on the accuracy of the object interactions. For example, objects may bounce off each other before they actually make contact. Generally, use the low fidelity settings to rough in an animation, and the high fidelity settings to fine tune it and make the final renders.

Turn on Collision Detection, which may be found under the View menu. This will help prevent objects from falling through each other. It is also helpful to keep Physics driven objects a tiny distance from the object they are interacting with. For example, if you are going to animate a sphere rolling across a plane, then start your animation with the sphere

a very small distance above the plain. If the surface of the sphere and plane occupy the same space, they can be interpreted as already intersecting which will cause the sphere to obey gravity and drop down through the plane. You will also have better results using a regular plane of limited size instead of the infinite plane.

Strategy for a Continuous Cannon

(1) Setup the scene with the stationary and moving objects, apply Physics to the objects that will need it, and add a Directional Force to simulate gravity.

(2) Check the alignment by moving any stationary objects blocking the path of the moving objects so you will be able to get a clear view of the moving objects' trajectories during a test run of the animation. This is particularly necessary in this case because the Physics driven object is starting the animation inside another object.

(3) Check the interaction by returning the stationary objects to their original positions and rerunning the animation..

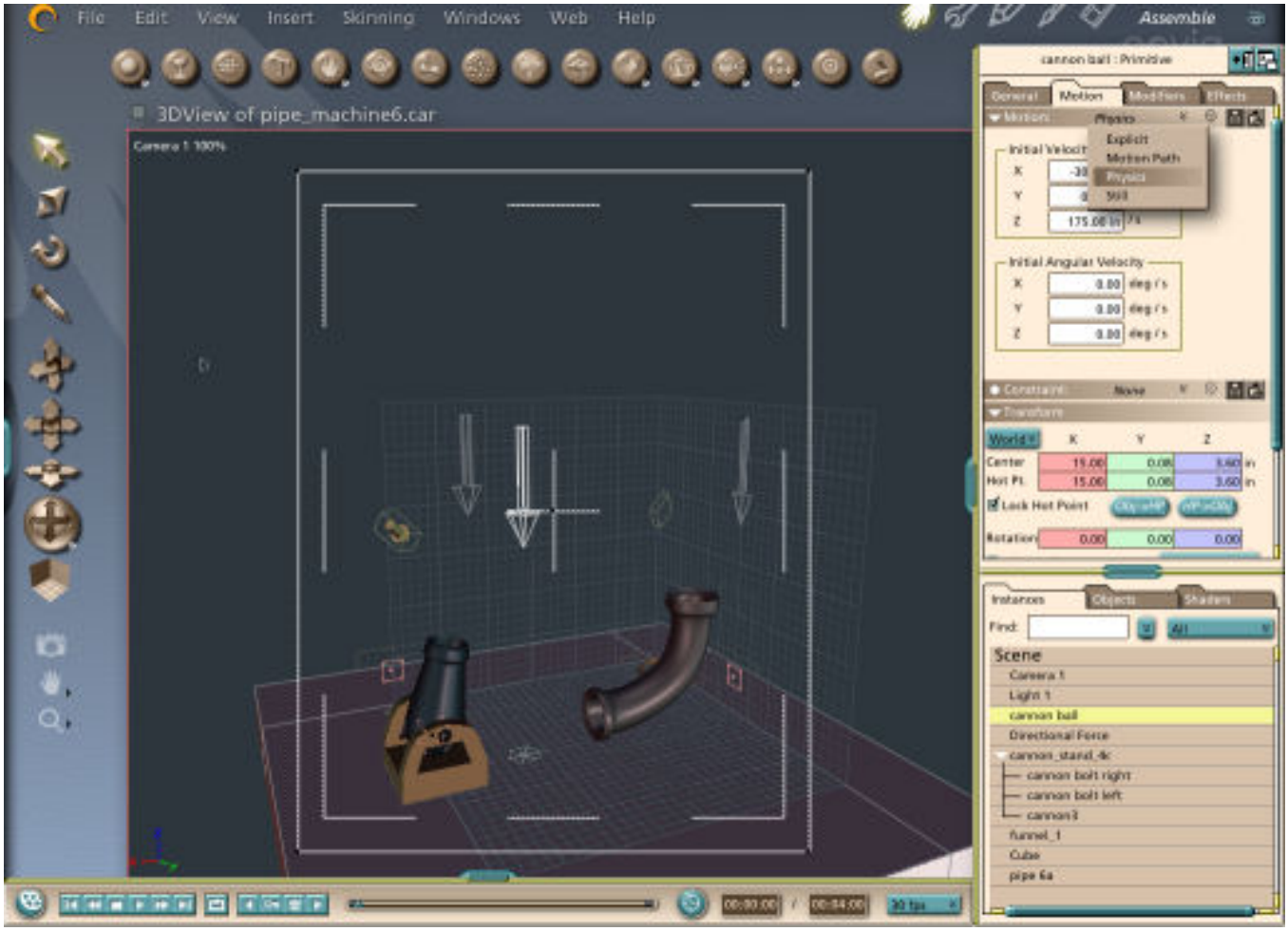
(4) When everything is satisfactory, render the animation.

Setting the Scene

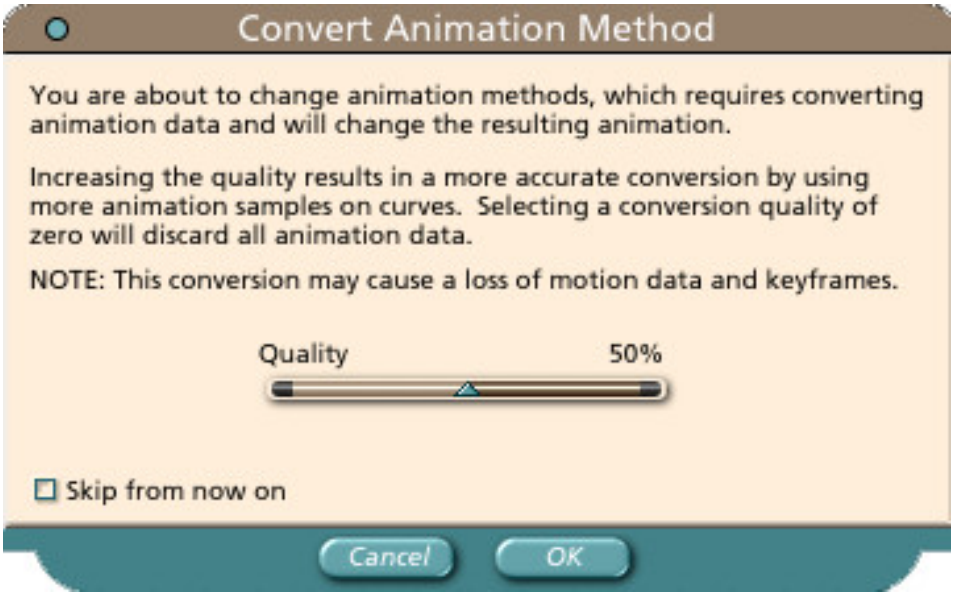
We are setting up an animation where a cannon fires a cannonball which travels in an arc in the XZ plane. The cannonball starts the animation inside of the cannon, is propelled out the barrel, then passes through a curved pipe which redirects it back to the base of the cannon. The animation is then looped, giving it the appearance of a perpetual motion machine.

For reference purposes, the Carrara scene file I created for this project may be downloaded from the Related Links section at the end of this tutorial. This file is complete and ready to run. The following instructions cover the procedures used to build this scene and may be used to build up a similar scene from scratch.

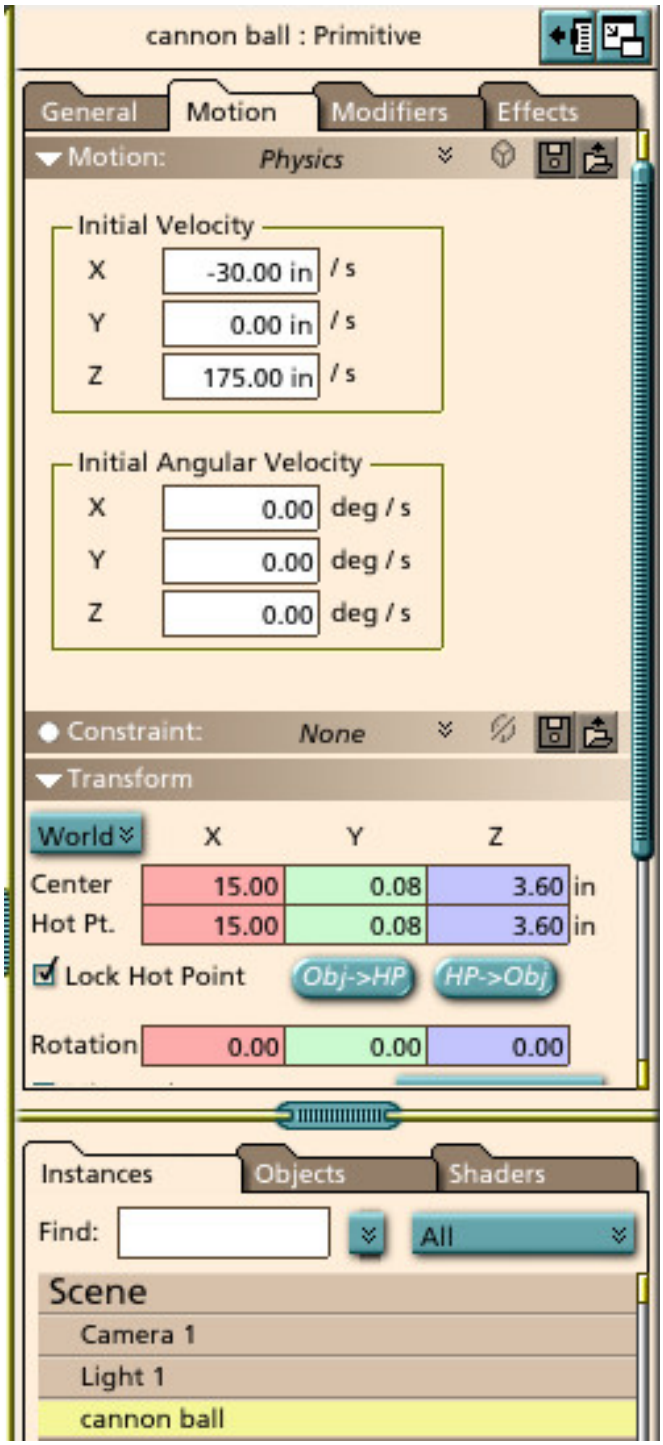
Whether you design and build your own models for this project, or you download and use the reference file, when your scene is set up, your Assembly room window should look similar to the image below. Though the cannonball is selected, it is not plainly visible since it is sitting inside the cannon, ready for firing. Click on the image to see a larger version in a new window. If it does not open to full size, click on the magnification button that appears in the lower right of the image..



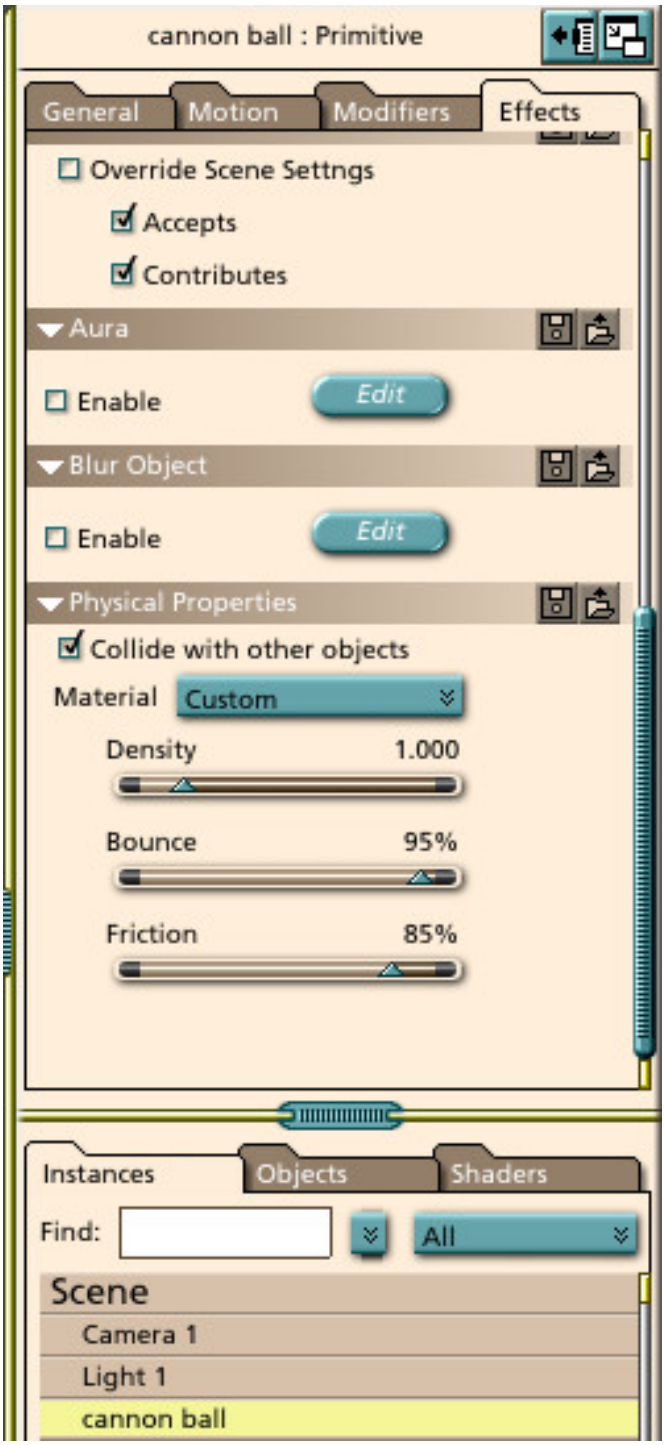
Once the scene is constructed, select the cannonball and click on the Motion tab on the Properties tray. Change the cannonball's motion type from Explicit to Physics, as shown above. The popup window shown below will open. Click on OK to accept the defaults.



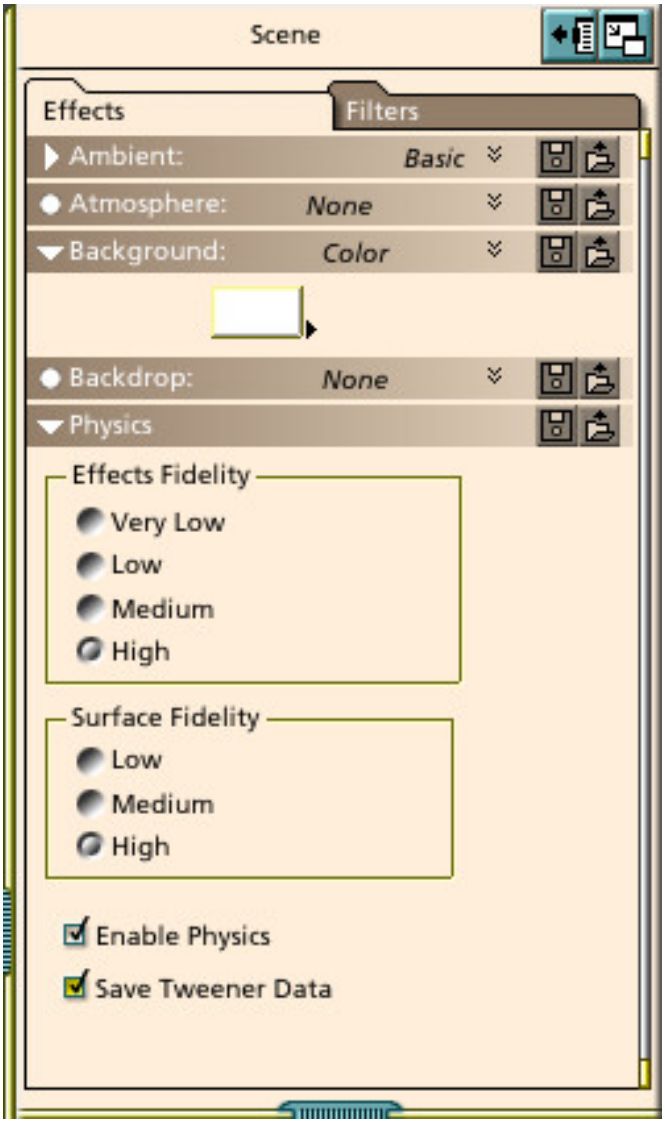
Set the Initial Velocity for the cannonball under the Motion tab as shown below. This will cause the cannonball to fire up at an angle in the XZ plane before gravity causes it to fall back to earth.



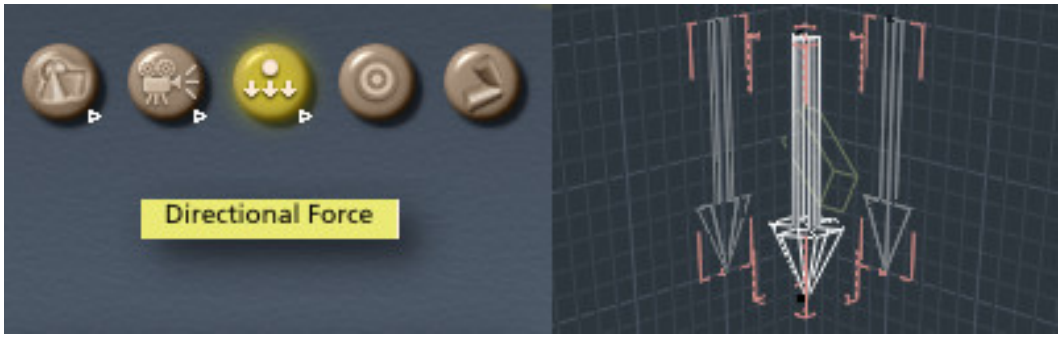
The Physical Properties of the cannonball are set under the Effects tab as shown below.



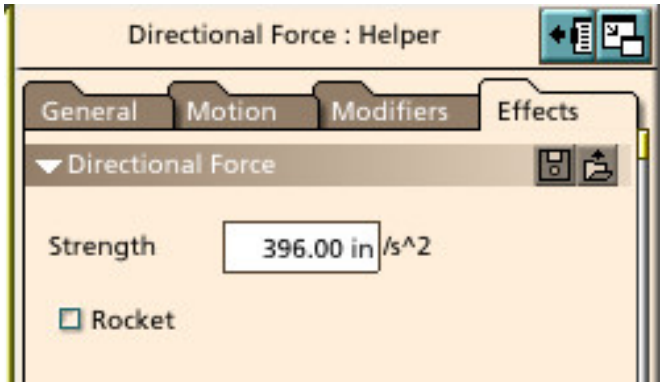
Select the Scene and check the Enable Physics and Save Tweener Data boxes. You could speed up the Physics calculation by setting the Effects and Surface Fidelity to Low, but you'll get better results with these parameters set high as shown below.



Now it's time to add some gravity to our simulation. Click on the Directional Force icon (shown highlighted below left), and drag it into the scene. You should see the Directional Force helper object shown below right.



With the Directional Force selected, go to the Effects tab of the Properties tray and change the value for the Strength from 78.74 inches per second squared to 396.0 inches per second squared as shown below. This will put you close to the value needed to simulate the acceleration due to gravity.



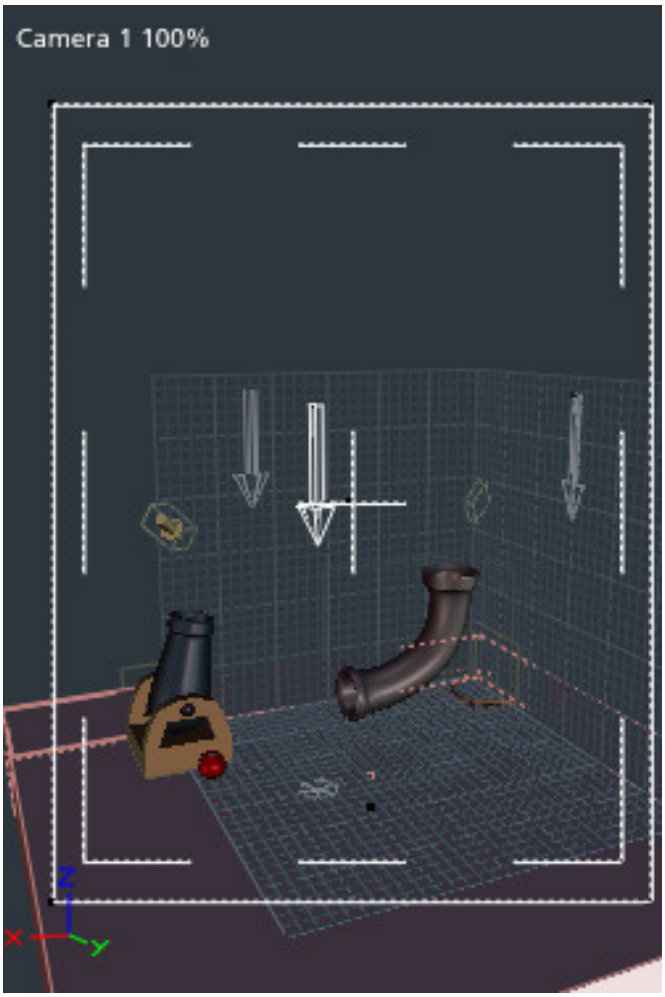
Check the Alignment

Now that the initial scene is set up, we are going to move any stationary objects blocking the path of the moving objects. In this case, the cannon and the pipe are moved 10 units in the -Y direction as shown below left. By viewing the animation with an Isometric camera, we will be able to align the stationary objects with the moving object's trajectory in the XZ plane.

With the Scene selected, make sure the Enable Physics and the Save Tweener Data boxes are checked in the Properties Tray. Now run the animation and observe the trajectory of the cannonball in the isometric front view. You will probably need to adjust the angle of the cannon and the X position of the pipe to get the objects lined up with the trajectories. Uncheck the Enable Physics box before moving anything else in the scene. This will let you replay the animation repeatedly without having to recalculate the Physics. To avoid introducing unwanted Keyframes, it is also important to rewind the animation to the first frame before making any adjustments. When the scene is properly aligned, it should look like the animated isometric view shown below right.

Perspective View

Alignment Check



Isometric View

Alignment Check

Check the Interaction

Once the scene is properly aligned in the XZ plane, we need to restore the cannon and the tube to their original position on the Y axis as shown below left. Note that the cannonball is no longer visible since it is now sitting inside the cannon waiting to be fired. Enable Physics and try rerunning the animation. If everything works, the cannonball should exit the cannon without hitting anything on the way out, it should enter the pipe at the center of the top opening, and it should exit the pipe and roll to the base of the cannon as shown below right.

Perspective View

Interaction Check

Isometric View

Interaction Check

If things do not work quite right, then disable Physics and check the animation from different viewpoints, adjusting the position of objects if needed. Also, make sure the Effects Fidelity and Surface Fidelity are both at the highest setting. Imported models that are grouped with parent-child hierarchies can give problems. The models made for this project in Amapi had to be ungrouped, using only the mesh, before things would work correctly. The friction and bounce of the tube also had to be decreased before the cannonball would pass through it smoothly.

Rendering the Animation

Enter the rendering room and open the Properties tray. Set your preferences under the Rendering tab, select Movie under the Output tab, pick the output file format you want, then render away.

The Rest of the Show

The models of the cannon and the curved pipe were built in Amapi Designer 7. The finished animations in this tutorial used shaders from the Elite Metal Collection available from Shaders3D, although these shaders are not present in the downloadable Carrara scene file.

Good luck with this project, and try not to hit anything with it, or you'll have to model another cannonball.

Related Links

Download the source file for this project

Eovia, home of Carrara and Amapi

Shaders3D for Carrara

[RETURN TO TUTORIALS]