AV4676-V - Integrating Water Elements and Fountains into Architectural Renderings Using Particle Flow

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Many architectural structures incorporate a water feature as a prominent visual component of the structure. This exciting class explains how to implement 3ds Max Particle Flow for architectural use. This class takes you through the creating water fountains, waterfalls, and other water features architects like to use. We will cover creating particle flow networks to simulate water flow and using space warps to affect the motion of the particles. We will also cover the point cache and particle rendering.

Learning Objectives
At the end of this class, you will be able to:

- Create particle flows to simulate fountains and other water features
- Use space warps to create custom effects with particle flows
- Add point cache to effectively work with large numbers of particles
- Apply materials and render particle systems using the mental ray® renderer

About the Speaker

Steven is a graduate of the R.I.T. film/animation program and recently, the AB Tech Entrepreneurship program. He started Spectralight Images in 1989 delivering 3D software training and computer animation. He moved to Orlando, Florida from New York in 1990 to pursue a future in the computer graphics field. In 1995, he was vice president of Computer Animators Plus, and began teaching 3D animation at several local schools including Seminole Community College. His love of art brought him to open Gallery 611 in 1997, and helped to form the Orlando Visual Artists League (OVAL) in 2000, serving as president until 2004. Steven became a Kinetix/Discreet®/Autodesk® training specialist in 1998, and has contributed to the development of Autodesk certified training material for nine releases of 3ds Max®, the Autodesk Certified Instructor Program, the Autodesk 3ds Max® fundamental standards (MEIS) Documents, and CAD Learning's 3ds Max and Maya training programs. In 2007, he took Spectralight Images, LLC full-time, sharing with others his love of teaching and computer graphics.

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Introduction
As an architect or designer Autodesk’s software to create buildable fountain designs for anything from simple water pools to highly complex articulated multi water jet fountains. There are many times when it is helpful to see a design animated in order to see how the water features will look when assembled and functioning. While you can create the static model of the water streams that shoot from the jets, in order to visualize the actual fountain the water jets can be animated using particles. Particle Flow is a tool that can be used for creating a visual simulation of water jets and other water features in a fountain. 3ds Max Design is the ideal environment for creating animated versions of fountain designs. Whether the model is built within 3ds Max Design or imported from another program, such as Autodesk Revit, You can create the animation for the water using the Particle Flow particle system built into 3ds Max Design. You are also able to add collisions as well as realistic water materials. All this can be used to create what appears to be a complex animated fountain system.

Controlling the animation or the particles that make up the water flows is what makes Particle Flow in 3ds Max a better solution than simply using a standard particle system. While a single particle system can portray the motion of water spraying from a jet and colliding with another surface, presenting a compelling animation involves being able to coordinate the animation of multiple particle streams within the same scene. Once the particle flow is complete you need have the ability to output both a preview animation and a fully rendered sequence.

In many cases, animated sequences rendered to a video file that can be played back at full speed. The level of quality of final rendering will usually be based on certain requirements. If you’re running a test to see if the animation looks the way you want it to, you can save a preview rendering of the view port. When it comes time to creating a final high quality rendering, rendering with mental ray can create a high quality realistic rendered animation.

This class will discuss and outline the steps you would take to create the water features in an architectural fountain and then render the animation to a fully rendered sequence using 3ds Max Design.

Adding Spacewarps
The scene being used in this lesson is an architectural fountain that contains two water spouts in the pool area, and one water spout shooting out of the top of the a hemispherical stone located in the middle of the fountain. When determining what needs to happen in this scene, the water is to shoot out of the two jets that are in the pool, and bounce off of the hemispherical stone in the center. The water must arc and bounce off of the stone in the center. The water should not just completely bounce away; some of the water should run down the hemispherical stone. The same thing needs to happen with the water shooting of the top of the hemispherical stone. In order to accomplish this several different space warps will need to be added into the scene.

Gravity
If gravity is not added into the scene, the water shooting out of the jets in the pool and the top of the stone will continue moving infinitely in the same direction. Adding a gravity space warp will cause the particles to respond to gravitational forces like they would in the real world.
Deflectors
The next thing that needs to be thought about is the bounce of the water off of the stone hemisphere and into the pool below. This requires two different deflector space warps, these deflectors will be used to deflect the particles. If you’re wondering why! There will be a spherical deflector that is used for the hemisphere in the pool; and a universal deflector, that will be used for the water in the pool.

The Udeflector, will be used to make the particles disappear from the scene as soon as they hit the water’s surface. By setting the water surface and the deflector object, if a particle collides with the water surface object it will test as true. It’s easiest to make changes to the deflectors as the spacewarps are added to the scene.

Configuring collisions
There are several parameters that deflector’s contain; however, there are two primary parameters that dramatically affect how particles interact with deflector’s surfaces. The first is the bounce amount,
which determines the percentage of bounciness for the particle when it collides with space warp. A high value makes the deflector more bouncy, whereas a low value will cause particles to hit the surface and not bounce as dramatically. By lowering the bounce amount, you can obtain a realistic affect of water bouncing off the stone surface.

The second parameter is friction, which determines how quickly or slowly the particles move along the surface of the deflector. A deflector with a higher friction value will cause particles to stick to the surface; a lower value will cause particles to slide more easily along the surface.

Creating a Particle Flow

The particle flow particle system built into 3ds Max Design is a highly capable particle animation system. With particle flow, you can create particle animations ranging from simple water drops; to highly complex animated systems that create elements like helicopter rotor wash over water. Unlike other particle systems that only allow you to create one particle event, such as the rain falling down or spray from a garden hose, Particle flow allows you to create multiple events. Particle flow is significantly different from single particle systems, it is what is known as an event driven particle system.

Event driven particles allow you to work with multiple events in the same particle system. For example, you can still have the rain falling down, or the water coming of the garden hose; but we can add an event that occurs once the water hits an object. For example, the water coming of the garden hose hits a wall and splashes off, with the initial splash both bouncing off of the wall, and dripping down the wall.

A particle flow is created using three different types of actions within the Particle View dialog box. The first type is an operator, a basic element of a particle system. By combining operators into events, you create the particles characteristics for a given period of time. There are two types of operators available within the particle flow particle system. The first is a series of operators that affect the particle behavior directly, and the second, provide more of the utility function. A test is used to figure out if a particle satisfies a specific condition. When you use a test, for example a collision test, you can create a branch to a new event if the test for the collision is true. Flows allow you to create different kinds of initial particle flows. For example a preset flow gives you the ability to merge in particle flow's that are available in the preset directory. By using a combination of flows, operators and tests, you can build an unlimited variety of particle systems.
Add a PFlow object

Once the scene is setup, it’s time to create the Particle Flow particle system. The first step is to add a particle flow source object into the scene, once added particle view needs to be opened in order to begin creating the particle flow.

In order to add a particle flow into the scene you need to access the create panel, choose the geometry category, select particle systems and then choose the PF source option. Once selected, you can create a Particle Flow object in the scene. Since this particle flow will not be using the particle flow source as an emitter for the particles, it can be place where ever it is convenient to be placed.
Event setup
When creating particle flows, one important option that you should look at is the Quantity Multiplier for the viewport and the renderer. When working with particles in 3ds Max Design, you can quickly create a large number of particles. In order to keep the viewport display from becoming slow and unusable the Viewport Quantity Multiplier option can be reduced to a level that shows only a fraction of the total particles. In this scene, the Viewport percentage can be reduced to about 50% in order to both see the result and still be able to work in the view.

The Rendering Quality Multiplier determines the quantity of particles that will be used for rendering the Particle Flow animation. The render quantity multiplier provides a way of increasing the quality of certain types of particle animation. In this case, the ability to increase the value to 500% provides for 5 times the number of particles when the Particle Flow is evaluated at render time.

Editing events
Once a particle flow is created, you need to begin by editing the events that are part of the flow. One of the first operators to modify is the birth operator. By clicking on the operator in the event you can edit the parameters of the operator. The Birth event parameters allow you to change when the particles are emitted and how many particles are emitted.

In this flow the emit stop will be the last frame of the current active time segment, frame 500. The rate can be set to a value of 500; this sets the particle system to emit at a rate of 500 particles per second.

Adding Operators
Now you need change the position of the particles when they are emitted. The position defaults to the “position icon” operator, which tells the particles to emit from the icon that was created in the viewport. In order to have particles emitted from objects in the scene, click in drag a “position object”
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operator from the depot on top of the position icon operator that’s currently in the first event. A red line going through the position icon operator, when I release the mouse button I will overwrite that operator.

Once the Position Object operator is added, it can be configured to emit particles from the water pipe geometry in the scene. More specifically, the particles will be emitted from the selected faces of the geometry.

From this point, the speed of the particles must be set. By adding a “Speed by Surface” operator the particles can be made to spray out of the surface they are created on. By setting the speed of the particles you can set the particles to spray a certain distance. In this case a speed of 33 feet per second will cause the particle stream to hit the stone in the center of the fountain. However, until the gravity is added the spray will just shoot out of the water pipes at 33 FPS in a straight line forever. In order to create an arc in the water stream, the gravity needs to be added to the event. This is done by adding a force and assigning the gravity to it.

**Incorporating Tests**

Once the operators are added and configured, the next step is to create the collision and the splash of the water off the stone. A collision is a test, which will allow you to create a branch to another event, in this case the splash, if a particle tests true. By adding a Collision test and setting the SDeflector at the deflector in the test, if a particle collides with the deflector it registers at true for the test. To make the splash a new event needs to be created.

To create a new event you can simply drag a new operator into an open space in the work area, in this case a Speed by Surface operator. Then, by adding the stone geosphere as the surface object, and
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connecting the output of the test to the input of the new event, the particles will shoot away from the stone. To cause the particles to react to gravity in the second event, you can copy and paste the force operator from the first event into the second event.

In order to delete the particles when they collide with the water (UDeflector), you need to test for the collisions. By adding a new collision test to the bottom of the second event, you can use the UDeflector as the test collision object. Dragging a Delete operator into an open area will automatically create a third event. And, by connecting the output of the water surface collision test and the delete event, the particles will be deleted from the scene when they hit the water. This way the particles do not continuously get added to the scene and slow the calculation of the particle flow.

A Second Particle Flow

In order to create the water shooting out of the stone hemisphere in the center of the fountain a second birth event is needed. This even is very similar to the first event that shoots particles out of the pipes in the water. By making a copy of the first event, you can make some minor changes to the Position Object and Speed by Surface operators to use the Stone geosphere instead of the water pipes. This will cause a water jet to shoot out of the top of the stone in the center of the fountain.

The first collision test, the SDeflector, works just the way it need to with the particles in the event. To delete the particles when they hit the water, copy and paste the second collision test
Applying materials

There are several ways to apply materials to particle systems in particle flow. For this fountain you are looking to create realistic water from a simple material. When applying the material you can use the material type is known as a static material. Because it’s a static material, use the material static operator in order to apply it to the particle geometry.

One important part of applying materials in particle flow is where the material operator is placed. If you want a particular event to use a certain material, place the material within that event. For the purposes of this lesson, all of the particles in this entire particle flow should be the same water material. To easily do this, the material static operator needs to go into the PF source event.

Creating and assigning a water material

To create the water material, click and drag the material static operator into the PF Source event just below the geometry operator. This will apply the same material to all the events with in this particle flow. To choose the material, click the assign material button on the parameters panel. This will open the material/map browser. From the material map browser, in the mental ray material rollout choose the Autodesk water material.

In order to edit the material itself, the slate material editor needs to be open. By dragging the material from the Material Static operator into the slate material editor and choosing instance, any changes
made will affect the look of the particles. To make the material more appropriate for the water spray, set the wave height to 0.0.

**Caching particles**

As particle systems generate more particles, the computer needs to spend more time calculating how those particles are going to move and interact. This can cause particle systems to be evaluated slower and slower as your frames progress in the viewport, and during rendering as well. One way to make a particle systems operate more efficiently is to save a particle cache down to the hard drive. This cache precalculates the particles in the particle system, allowing you to scrub through the timeline more smoothly and reduces processing time when you go to render the animation.

**Using point cache**

Now it’s time to add a cache operator to the particle flow for the fountain. From the depot area, choose the cache operator and drag the cache operator to the bottom of the PF source event. In the cache operator parameters, set the “use at” option to “viewport”. This needs to be set because a different number of particles will be used in the viewport then at render time.

The sampling options can be set to “Every Nth Frame” in order set the number of frames between each cache sample. Use three frames for the N value, giving a particle sample every three frames during the animation. Make sure that I cache the test results, and save the cache with the file are checked. This will make the file larger, but will automatically reload the particle cash when the scene opens again. Clicking update will evaluate the particle flow and capture every third frame into the cache. Once this is complete you can see the particle animation as you move through the frames both forward and reverse.
Rendering the Fountain

Now that the particle system has been completed, you’re ready to render the particle system. First, to save time create a viewport preview of the particle system so you can see the particle system as it will look in real time. This is a much faster way to preview your particle animation than any other kind of test rendering. Once the particle flow has been setup to meet your needs, you can move on to a low quality test render using Mental Ray to provide a more Photoreal look at the fountain.

Creating a preview

Creating a preview rendering is a straightforward process. Right click in the camera viewport to make it the active view port. In the tools menu, Grab Viewport option, select the “Create Animated Sequence” option to open the Make Preview dialog box.

In the make preview dialog, keep the active time segment the selected preview range, and leave everything else at the defaults. In the output section click on the choose codec button. From the video compression dialog that pops up, use the Microsoft video one codec and click OK. You can choose a different CoDec if desired, depending on what is installed on your particular computer. Make sure the render viewport is the camera view and click the create button. 3ds Max will take a little while, and you’ll see the time slider progressing through the frames while the preview is created.

Once the preview is complete 3ds Max will open a media player associated with the AVI file. Playing the animation back in real-time allows you to see what the particle animation will look like and how the particle flow is being evaluated over time. Once you like the way the particle flow is setup, you can precede with setting up mental ray as the render.
Rendering with Mental Ray

Setting Motion Blur
When rendering particles particularly water, you may want to use motion blur on the particles to make them look more visually realistic. To setup motion blur, the particle flow object needs to be selected, if it’s not selected you can select it in the top viewport, or from the select by name dialog. Then, right click on the particle system, and choose object properties from the right click menu. Down at the bottom right of the object properties dialog, set the motion blur to be “by object”. This will override the layer settings and use the objects motion blur options. To use the motion blur, make sure the “enabled” check box is checked, and the “object motion blur” option is chosen, and then click OK to close the dialog.

Render a Low Resolution Animation
Now that the Particle Flow is configured, the material is applied and the motion Blur is active, it is time to prepare a first pass, low resolution test render of the final animation. This is going to be test render that will give you a good idea of what the particle system and animation will look like.

Mental ray is already the current renderer so there is no need to select it. Then, in the time output section of the Common panel, set the active time segment to be the output time frame. The output size is already configured for HDTV at a resolution of 480 by 270; a small animation but a good preview size.

In order to set the file location, in the render output section click on the “files” button. This opens directly into the render output directory of the current project folder. In the file name, type in “fountain.png”, and then click save. In the PNG Configuration dialog, set the colors to RGB 24 bit, and since there will be no need to render with an Alpha channel, uncheck the Alpha channel option and click OK. That now sets the file name and path for the files that will be saved to the hard drive once rendering begins.

After setting the image size and file parameters, switch over to the renderer tab to adjust the sampling and motion blur settings. With the samples per pixel set to a minimum of one 16th, and the spatial contrast set the value of 0.2 for all the channels, the current render setting in the file reflect a lower sampling quality. This lower sampling will reduce the time it takes to render the scene.
Other option that will make this scene render the way we want is to ensure that the motion blur option is enabled in the Camera Effects rollout. Change the number of motion segments to 3. This will increase the accuracy of the motion blur at render time. Keep in mind that higher values will increase rendering time.

Make sure the Camera002 viewport is the current render view and click the render button. For the first several frames you won’t see very much happening because the particles start emitting at frame zero and you won’t see too much for at least a few frames. When the animation is finished rendering, you can play back the image sequence using the ram player, or bring the sequence into your favorite video editing or compositing program.