MAKING A **REALISTIC NUCLEAR EXPLOSION** IN MAYA

- Using dynamic 3D Fluids -

tutorial by:
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Introduction

I decided to write this tutorial, because of the lack of real good Maya tutorials in this topic. This tutorial might not be *real good* too, but I think it will be a good start. And this is my main purpose: to give you a starting point, to flash the opportunities of this technic.

In the end of this tutorial we'll have a neat little mushroom cloud and the skill to make better and better neat little mushroom clouds in the future.

I've searched over and over the net after Maya tutorials of making nuclear explosions, but I almost find nothing. Oh, actually, I found a weird one: in that the mushroom cloud was made of solid objects, then textured with some sort of cloud texture. *Oh, God, why do you do this to me....* :) Man, but I want to make *mushroom cloud*, not MUSHROOM! So we can forget that one.

Then one day I found the keyword on a forum: **fluids.** And this is the solution, because I've messed a lot with Particles and Fields and that haven't put me in the right way.

Ok, so I will guide you step by step and meantime we will learn:
- the basics of Fluid Effects:
- basics of 3D Fluid Containers
- basics of Fluid Emitters

What you will need to complete this tutorial:
- Alias WaveFront Maya Unlimited (I use version 5.0)
- basic skills of using Maya (creating objects; knowing option boxes; knowing Hypershade, Visor, Outliner, Attribute Editor etc.)


Now it's time to work, so let's go!

STEP 1 - Creating the Fluid Container

Start Maya and find **Create 3D Container** option. Now press its option box and you get the window called **Create 3D Container Options**. Here you can adjust some settings before the creation. Set these values like on the picture. We'll talk about the resolution later, now, just set it like this.

X Resolution = 20
Y Resolution = 30
Z Resolution = 20

X Size = 10.000
Y Size = 30.000
Z Size = 10.000
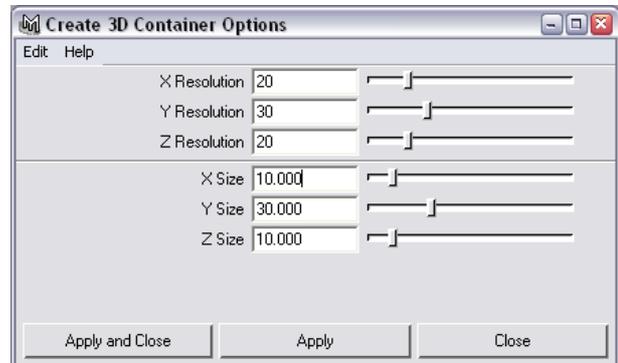
Push **Apply and Close**. You got a green prism. This is the container. As its name says, this will contain the fluid particles.

It's important: the fluid must have a container, you can't put fluids in your scene without a container. The container will determine the fluid's spreading range, the fluid can't spread out from the container. So it's important to choose the right size when you create the container.
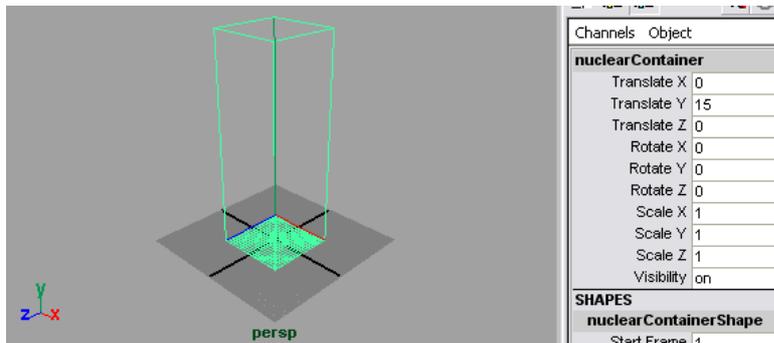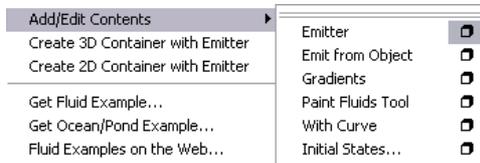
Ok, now rename the container to **nuclearContainer** and change it's **Translation Y** value to **15** so it's standing on the ground or on the grid now. But it's not crucial, you can hide the grid, we don't need it now.

It seems STEP 1 is completed. We have a nice 3D Container. Move on to next STEP.

STEP 2 – Creating the Fluid Emitter

Select the nuclearContainer if it's not selected. And go to **Fluid Effects > Add/Edit Contents > Emitter**. Push its option box. In the option window change the Emitter Type to 'Volume' and the **Volume Shape** to **'Sphere'**. Click Apply and Close.


You see a green sphere appeared in the center of the container. While the emitter is selected, rename it to **nuclearEmitterMain**. Later we'll make another emitter in the same container so that's why the 'Main' there.

Ok, let's make some translatings and scalings with our new emitter.

Set these values:

Translate X = 0
Translate Y = -13.895
Translate Z = 0

Scale X = 1.358
**Scale Y = 0.521**
Scale Z = 1.358
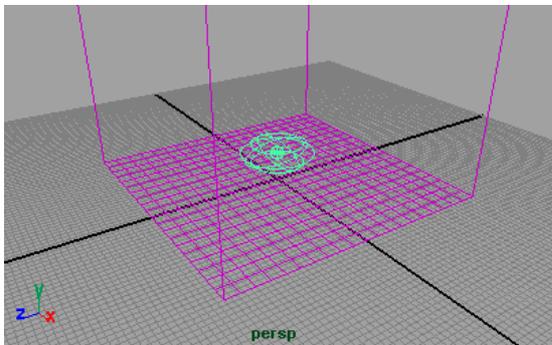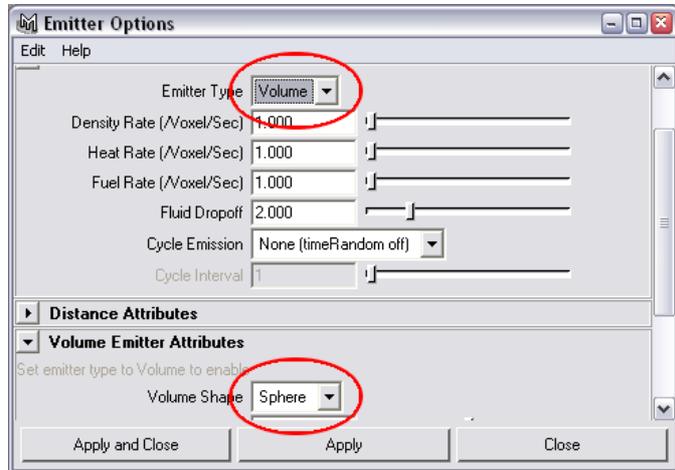
We got now a flat sphere in the bottom of the container.

Let's make some more spectacular thing now. On the **Time Slider** set the **Start Time** to **'0'**, the **Playback Start Time** to **'0'**, the **Playback End Time** to **'240'** and the **End Time** to **'240'** too. Next we will push the **Play** button, but before you do this, push **'6'** to switch to hardware textured mode.

You can push the Play button now, buddy!

If everything is ok, you see a white fog-like material emerges from the emitter and heads upward in a faster and faster manner. Then, at the top of the box it turns back, and slowly fills up the container. Yep, this is the fluid:) Now, it doesn't look like a mushroom cloud yet, but it will after some changes.
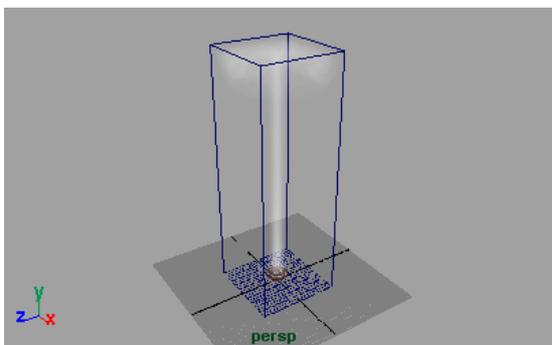
But first we made another important step. So let's move.

STEP 3 - Creating Cache

I don't know how was it with you, but when I first played the animation, it played only every third or fourth frame of the time slider. Maybe it is because my computer is not the newest power-plant on the market. It's a problem, because you don't see your fluid's behaviour in full detail. Even if your playback was smooth, it's a big relief to create a fluid cache file.

The cache file means that Maya creates a file that contains all the data of the rendering. When you start the playback, the CPU render the image from frame to frame. Say, if your current frame is 50 and you click on the 125th frame, the CPU have to compute the fluid's actual state on the 125th frame. It can be a real time-eater, you believe!

The cache file contains the fluid's states on every frame you set in the **Create Cache Options** window. The cache file size depends on how much frame it contains. But when you have a cache file, Maya reads out the actual render data from this file and thus the CPU has much less work to make the same data in real time.

I hope you understood this.

The cache file is not the final solution for the smoother playbacks. You have to delete it and recreate it time to time, because some changes needs to be re-rendered to show up properly so the cache file needs to be rewritten.

Ok, so let's create our first cache file.

Select you **nuclearContainer**. Now go to **Fluid Effects > Create Cache** and press option box. Reset settings there so the **Cache Time Range** is set to **'Time Slider'**. Click Create and wait until the Time Slider's pointer finishes its way along the Time Slider:)

Now, you have a cache file! Click on any time-position and see how fast you get the rendered image of the fluid. Maybe you can't see any changes, but that's because your CPU can handle the rendering in no time. Significant changes will be visible when you have your Fluid Container loaded up full of different attributes like color, texture, etc.
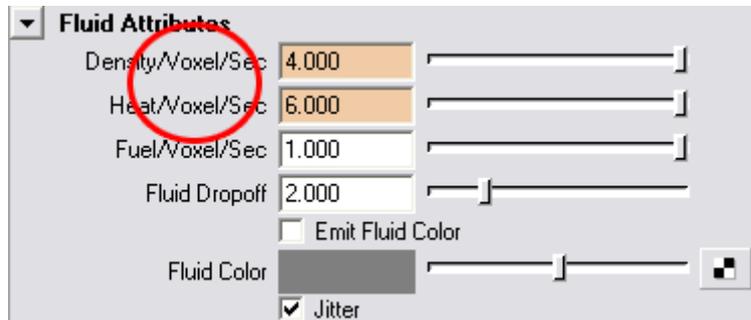
Ok, next STEP!

STEP 4 - Adding attributes to Fluid Emitter

Select your **nuclearEmitterMain**. If you can't click on it, without selecting the container too, open up the **Outliner** and use it. It will be very easy we change just two attributes.

Open up **Attribute Editor** and find this: **Fluid Attributes**.

We'll set keys for the **Density/Voxel/Sec** and the **Heat/Voxel/Sec**.

Here are the **Density** Keys:

	Time	Value	InTan Type	OutTan Type
0	0	4	clamped	clamped
1	10	2	clamped	clamped
2	30	1	clamped	clamped

And the **Heat** Keys:

	Time	Value	InTan Type	OutTan Type
0	0	6	clamped	clamped
1	5	9	clamped	clamped
2	20	0.01	clamped	clamped

I think you can set the keyframes with no problem, it's basic Maya and 3D skill.

If you look closer, you'll notice what we just made: the emitter emits a hot and dense wave of clouds at the beginning of the explosion, then the emission slowly cools down, and becomes thinner.

We're done with the main emitter, so we can leave it alone now.

STEP 5 – Adding attributes to Fluid Container

This is the most important STEP of this tutorial. In this, we make the mushroom cloud itself with adding and changing attributes of the **nuclearContainer**. This part is the whole thing's essence.

So, select the **nuclearContainer** and open Attribute Editor. Or you can use the **Tool Settings** window in the beginning, because it's much more faster to change the following settings. I'll not comment each and every setting. If you want a description, search for it in the Maya Docs.

SHAPES	
nuclearContainerShape	
Start Frame	1
Do Fields	on
Do Emission	on
Inherit Factor	0
Slices	2
Voxel Quality	Faster
Opacity Preview	0.5
Hardware Self S	on
Grid Interpolator	linear
Solver	Navier-Stoke
Boundary X	None
Boundary Y	-Y side
Boundary Z	None
Mass Conversio	1

I'll use the Tool Settings first. Here are the settings we change, and the related values.

Boundary X = None
Boundary Y = -Y side
Boundary Z = None

Boundary XYZ means, that what kind of 'wall' do you want for the container. The container is like a paperbox. Boundary X and Z is set to 'None', so there are no walls in those directions. It doesn't mean that the fluid vortexes (particles) will spread out of the box. As I said before, fluid is linked to its container, it can't exist out of that. The fluid won't spread out, but won't reflect from the walls either. The vortexes will simply disappear and the disappearing is controlled by the **Edge Dropoff** setting. I'll talk about it later.

Boundary Y was set to '-Y side'. This means, that the negative Y directon from the center of the container aka the bottom of the container behaves az a solid wall. We don't want the fluid to disappear at the bottom of the container.

Next settings:

Velocity Scale X = 3
**Velocity Scale Y = 0.5**
Velocity Scale Z = 3

Here we set the spreading directions and velocity of the fluid. The fluid will spread more in horizontal directions, than in vertical.

Before you set the following Temperature settings, you must enable the **Temperature** at **Contents Method** in the Attribute Editor. So open up the **nuclearContainer**'s Attribute Editor, find **Contents Method > Temperature,** then set it to **'Dynamic Grid'**. Now you can set these:

Temperature Scale = 2
Temperature Dissipation = 0.2
Temperature Diffusion = 0.1
Temperature Turbulence = 0
Buoyancy = 0

I think it's pretty simple and understandable. Earlier, we set the **nuclearEmitterMain**'s heat emission, now we control this emission with the **'Temperature'** settings.

We arrived to a point where we have to use the Attribute Editor. So open up it, and find the **Shading** menu. Set the Transparency like in the picture.
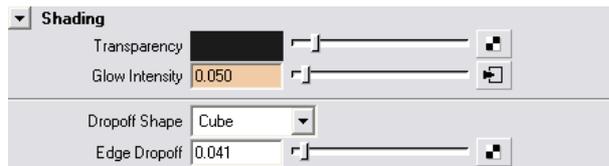
Now add Keyframes to the **Glow Intensity** like this:

| Keys		Time	Value	InTan Type	OutTan Type
0		0	0.1	clamped	clamped
1		50	0.1	clamped	clamped
2		70	0.05	clamped	clamped

If it's ok, then set **Dropoff Shape** to **'Cube'** and the **Edge Dropoff** to **'0.041'**. I mentioned the Edge Dropoff earlier. this function controls the disappearance of the fluid vortexes near the container's walls. So the greater the Edge Dropoff value, the smoother the fluid's edges near the walls. We want a rather sharper edges, because a nuclear mushroom cloud more denser than an average cloud.

Next we add color, incandescence, opacity and texture to our explosion.

Color gradient:

Add 3 control points to the color gradient then set:

**1. Selected Position = 0.479
   Selected Color: H=10.28 S=0.475 V=0.064**

**2. Selected Position = 0.636
   Selected Color: H=23.15 S=0.486 V=0.179**

**3. Selected Position = 0.771
   Selected Color: H=10.28 S=0.475 V=0.064**
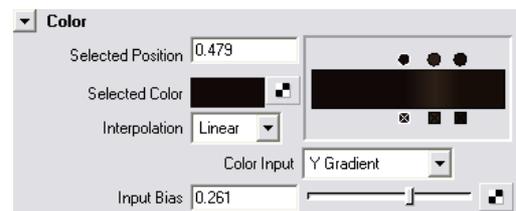
**Interpolation = 'Linear'
Color Input = 'Y Gradient'
Input Bias = 0.261**

Chect out the screenshot.

Incandescence gradient:

5 control points.

**1. Selected Position = 0.000
   Selected Color: H=235.89 S=0.076 V=0.688**

**2. Selected Position = 0.243
   Selected Color: H=218.10 S=0.240 V=0.611**

**3. Selected Position = 0.464
   Selected Color: H=25.51 S=0.091 V=0.300**

**4. Selected Position = 0.579
   Selected Color: H=14.28 S=1.000 V=1.000**

**5. Selected Position = 0.786
   Selected Color: H=40.00 S=0.714 V=1.500**
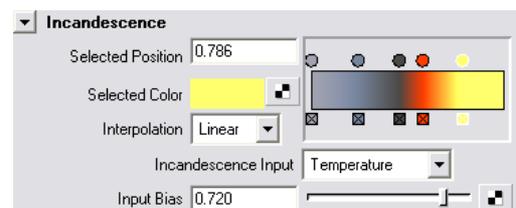
Interpolation = 'Linear'
Incandescence Input = 'Temperature'
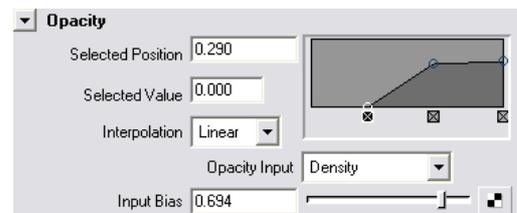**Input Bias = 0.720**

Chect out the screenshot.

Opacity:

3 control points.

1. Selected Position = 0.290
   Selected Value = 0.000

2. Selected Position = 0.636
   Selected Value = 0.640

3. Selected Position = 1.000
   Selected Value = 0.680

Interpolation = 'Linear'
Opacity Input = 'Density'
Input Bias = 0.694

Chect out the screenshot.

We're almost done. Find **Textures** menu and open it.

Enable the **Texture Color,** the **Texture Incandescence,** and **Texture Opacity**. All 3 of them.

Texture Type = 'SpaceTime'
Coordinate Method = 'Fixed'

Color Tex Gain = 0.298
Incand Tex Gain = 1.000
Opacity Tex Gain = 0.975

Treshold = 0.000
Amplitude = 1.000
Ratio = 0.265
Frequency Ratio = 10.000
Depth Max = 1

Invert Texture = off
Inflection = on

Texture Time:
We add some script to our texture time, so right mouse click on the text: **Texture Time** and choose
'Create New Expression...'. There comes the **Expression Editor** window. At the bottom, there's a
text field. Write it there: **textureTime = time * .2**
Click **'Create'**, then **'Close'**.
This script will animate our texture constantly, we don't need to set Keyframes.

Frequency = 5.000
Texture Scale = 1.000 / 1.000 / 1.000
**Texture Origin = 0.000 / 0.000 / 0.000**

Implode = 0.000
Implode Center = 0.000 / 0.000 / 0.000

**Size Rand = 0.5**
Randomness = 3

Ok, it's done! Time to see the result! Before we start the playback on the Time Slider, we make another cache.

Choose **Fluid Effects > Delete Cache** with the **nuclearContainer** still selected. We can't make new cache until we delete the old one.

Now click on **Fluid Effects > Create Cache** and wait 'till it's finished. During the cache creation process you can already see, what will be the animation like.
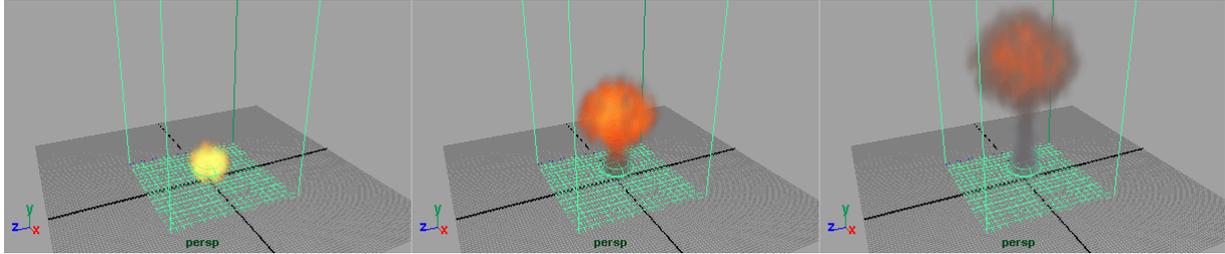
As you see, we got pretty neat mushroom shape here. At last! The hard work is done. Let's make a render to see how it really looks like.
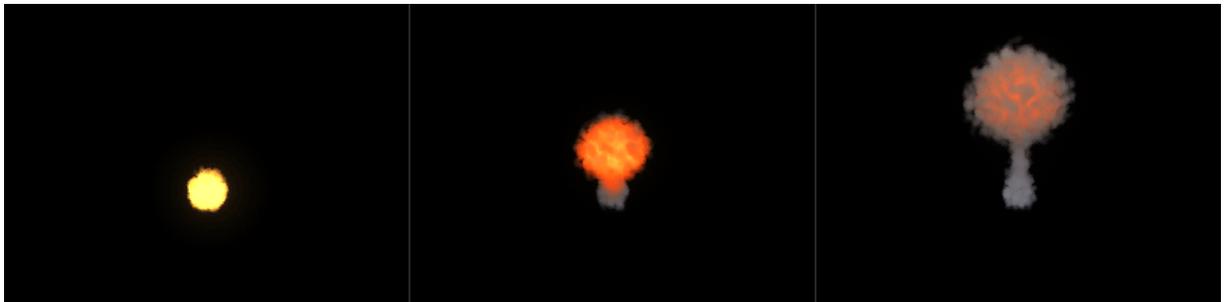
I think it's pretty much ok, just the lighting is little bit homogenic, but we fix it later. And the bottom of the smoke is more like a tree than an explosion, because there are no smoke spreading along the ground.

Let's move to the next STEPs where we make some more clouds to simulate ground blast effect.

STEP 6 – Adding a second emitter to the same container (Ground Blast 1)

By now you know, how to create emitters. In this STEP we make one to our existing **nuclearContainer** and place it to the bottom to simulate a wave of cloud that spreads along the ground.

Select **nuclearContainer** and click on **Fluid Effects > Add/Edit Contents > Emitter**. Make sure you set **Emitter Type** to **'Volume'** and **Volume Shape** to **'Sphere'**. Oh, and name it: **nuclearEmitterSub**.

And the other settings:

Translate Y = -14.599
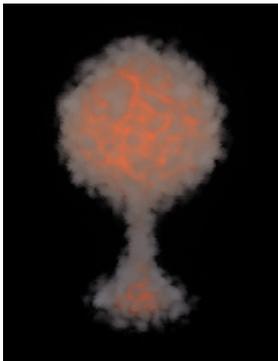
Scale X = 4.821
Scale Y = 0.356
Scale Z = 4.821

Fluid Heat Emission = 0.05

We don't need to set up other attributes now, because this emitter will use the **nuclearContainer**'s settings (Color, Texture etc.)

Ok, let's **Create Cache**! Then make a render too.

The bottom is now ok. The whole thing's a little fluffy, but never mind :)

Next STEP and another ground blast!

STEP 7 – Adding a second 3D Fluid Container with Emitter (Ground Blast 2)

Fluid Effects > Create 3D Container > Option Box.

Resolution X = 20
Resolution Y = 20
Resolution Z = 20

Scale X = 10
Scale Y = 10
Scale Z = 10

Name it: **groundBlast**

Ok, now add an emitter. **Fluid Effects > Add/Edit Contents > Emitter > Option Box**.

Emitter Name = 'groundBlastEmitter'

Emitter Type = 'Volume'

Volume Shape = 'Torus'

Click Apply and Close then set:

Scale X = 2.685
Scale Y = 0.954
Scale Z = 2.685

Emitter done! Time to set the **groundBlast** attributes.

Select **groundBlast**. Open Attribute Editor. Set:

Boundary XYZ all set to 'Both Sides'

Density = 'Dynamic Grid'
Velocity = 'Dynamic Grid'
Temperature = 'Off(zero)'
Fuel = 'Off(zero)'

Velocity Scale X = 3
Velocity Scale Y = 3
Velocity Scale Z = 3

Velocity Damp = 0.6

Set Keyframes to **Transparency** like on the screenshot:

Keys

	Time	Value	InTan Type	OutTan Type
0	0	0.29752	clamped	clamped
1	5	0.29752	clamped	clamped
2	200	0.42976	clamped	clamped
3	240	0.42976	clamped	clamped

Glow Intensity = 0.000
Dropoff Shape = 'Cube'
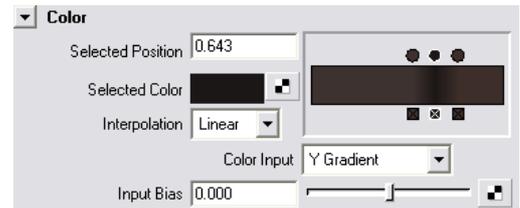**Edge Dropoff = 0.198**

Color gradient:

3 control points

1. Selected Position = 0.529
   Selected Color: H=11.69 S=0.228 V=0.242

2. Selected Position = 0.643
   Selected Color: H=11.69 S=0.185 V=0.109

3. Selected Position = 0.764
   Selected Color: H=11.69 S=0.228 V=0.242

Interpolation = 'Linear'
Color Input = 'Y Gradient'
Input Bias = 0.000

Chect out the screenshot.

Incandescence gradient:
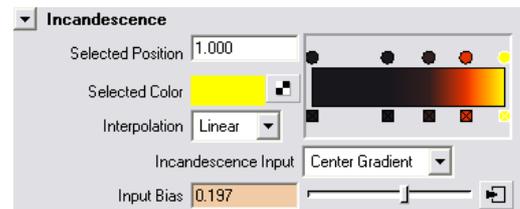
5 control points.

1. Selected Position = 0.000
   Selected Color: H=240.00 S=0.107 V=0.110

2. Selected Position = 0.393
   Selected Color: H=250.00 S=0.207 V=0.114

3. Selected Position = 0.607
   Selected Color: H=359.27 S=0.388 V=0.198

4. Selected Position = 0.800
   Selected Color: H=13.33 S=1.000 V=0.900

5. Selected Position = 1.000
   Selected Color: H=40.00 S=1.000 V=1.500

Interpolation = 'Linear'
Incandescence Input = 'Center Gradient'

And for the **Input Bias** we add some Keyframes:

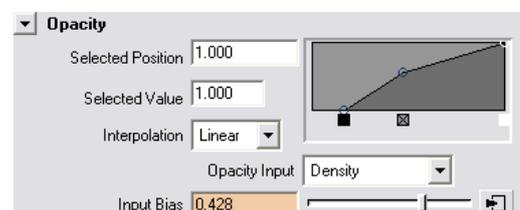|	Time	Value	InTan Type	OutTan Type
0	0	0.009	clamped	clamped
1	5	0.009	clamped	clamped
2	100	0.26132	clamped	clamped
3	240	-0.5	clamped	clamped

Chect out the screenshots.

Opacity:

3 control points.

1. Selected Position = 0.164
   Selected Value = 0.000

2. Selected Position = 0.471
   Selected Value = 0.560

3. Selected Position = 1.000
   Selected Value = 1.000

Interpolation = 'Linear'
Density Input = 'Density'

And for the **Input Bias** we add some Keyframes:

Keys	Time	Value	InTan Type	OutTan Type
0	0	0.42344	clamped	clamped
1	5	0.42344	clamped	clamped
2	180	0.35132	clamped	clamped
3	240	-0.09904	clamped	clamped

Texture:

Texture Color = on
Texture Incandescence = on
Texture Opacity = on

Texture Type = 'SpaceTime'
Coordinate Method = 'Fixed'

Color Tex Gain = 0.215
Incand Tex Gain = 0.579
Opacity Tex Gain = 1.000

Treshold = 0.000
Amplitude = 0.471
Ratio = 0.707
Frequency Ratio = 1.298
Depth Max = 2

Invert Texture = off
Inflection = on

Texture Time: again, create expression with this command: **textureTime = time * .2**
Frequency = 5.000
Texture Scale = 1.000 / 1.000 / 1.000
Texture Origin = 0.000 / 0.000 / 0.000

Implode = 0.207
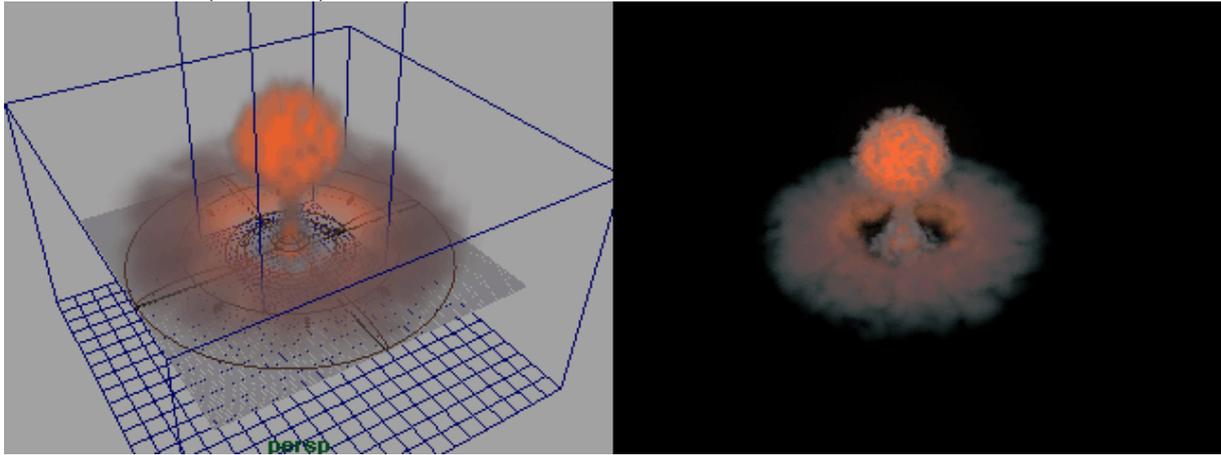**Implode Center = 0.000 / 0.000 / 0.000**

We're done with the attributes, now animate the **groundBlast** container. Set Keyframes to **Scale XYZ** settings:

Scale X		Scale Y		Scale Z	
Frame	**Value**	**Frame**	**Value**	**Frame**	**Value**
0	0.189	0	0.16	0	0.189
5	0.189	5	0.16	5	0.189
240	6	240	3.8	240	6

Oh, and set **Scale Y** to **0.144**

Cache file creation comes!

And the result is (tadaaam):

Woa! We got a fairly realistic nuclear explosion here! :)

Adding some details and the thing is ready. We'll do this in the STEP, where we create the great white flash at the start of the explosion, add some lighting and a camera. Go ahead!

STEP 8 – Adding the details

Ok, so let's start with the flash.
Create a **Point Light**, and name it **Flash.**

First set Keyframes for the **Y position**.

Translate Y	
Frame	**Value**
0	1.384
10	1.384
40	2.806
80	4.785

Then set the **Light Color: H=13.55 S=0. 729 V=1.000**

And Keyframes again. This time for the **Intensity**.

Keys

	Time	Value	InTan Type	OutTan Type
0	1	0	clamped	clamped
1	3	5.5	clamped	clamped
2	20	0.93	clamped	clamped
3	60	0	clamped	clamped

Open **Light Effects** panel in the Attribute Editor and add **Light Glow**.
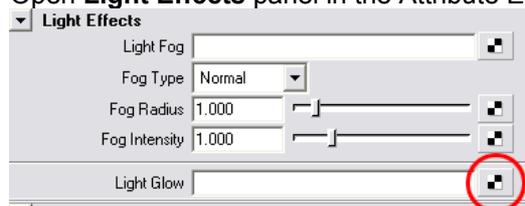
On the appearing **Optical FX** window set these values:

Active = on

Glow Type = 'Exponential'
Halo Type = 'Linear'

Glow Color: H=82.29 S=0.805 V=1.000

Glow Intensity is keyframed:

Keys

	Time	Value	InTan Type	OutTan Type
0	1	2.5	clamped	clamped
1	20	0	clamped	clamped

Glow Spread = 1.241
Glow Radial Noise = 0.380
Glow Star Level = 0.331

Halo Color: H=356.41 S=0.459 V=1.000

Halo Intensity is keyframed:

Keys

	Time	Value	InTan Type	OutTan Type
0	1	0.19	clamped	clamped
1	40	0	clamped	clamped

Halo Spread is keyframed too:

	Time	Value	InTan Type	OutTan Type
0	1	5	clamped	clamped
1	60	1.13	clamped	clamped

We're done with the **Flash**. Try it out and make a render at about frame 10:

It looks really cool in animation :)

Now we set the lighting. Create a **Area Light**, and set the values:

Translate X = -13.617
Translate Y = 32.688
Translate Z = -8.267

Rotate X = -214.515
Rotate Y = -49.8
Rotate Z = 175.951

Scale X = 7.595
Scale Y = 7.595
Scale Z = 7.595

Intensity = 4.38

Select **nuclearContainer** and in the Attribute Editor find the **Lighting** menu. There enable the **Self Shadow**, the **Hardware Shadow** and the **Real Lights** options. Then set the **Shadow Opacity** to **10.000**.

Do the same with the **groundBlast**, just leave the **Shadow Opacity** at **0.500** and **disable Real Lights**.
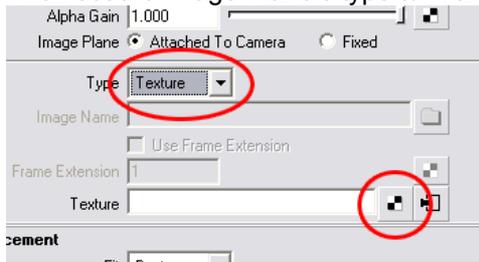
Create a **Camera**, set the values:

Translate X = -7.389
Translate Y = 2.548
Translate Z = 20.115
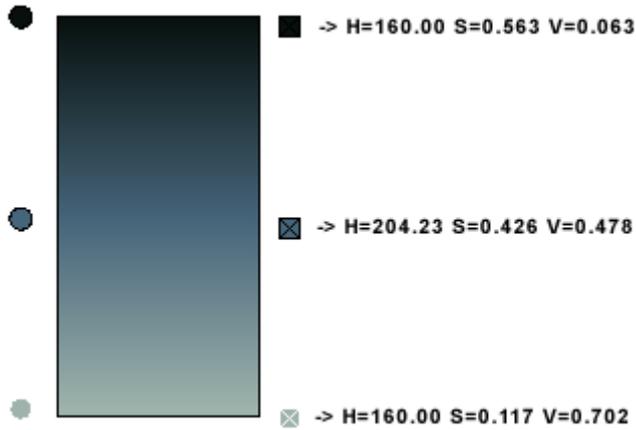
Rotate X = 16.199
Rotate Y = -10

At the **Environment** menu create an **Image Plane**.

Then set the Image Plane's type to **'Texture'**. And select a **Ramp** texture.

Change the Ramp's gradient to look like this:

-> H=160.00 S=0.563 V=0.063

-> H=204.23 S=0.426 V=0.478

-> H=160.00 S=0.117 V=0.702

Ok, we have a nice sky texture now. Let's see it in action!

One little detail and we're ready for sure. We make a shockwave.

Create a **NURBS Sphere**, name it **shockWave**. Set keys for the **Scale XYZ** attributes:

Scale XYZ	
Frame	Value
0	1
10	1
60	97

Add a **Ramp Shader** material to the **shockWave** and call it **shockWaveRamp**.

Here are the attributes of the **shockWaveRamp**:

You figure it out, I'm sure of it. Try to experiment with it.

Here is the result of our shockwave (image rendered at frame 23):

I think we finished!

In the final STEP I talk a little bit about the opportunities.

Beyond this tutorial

Time, time time... You'll need it. You'll need a lot of it to perfect your newly created mushroom cloud. Time to experiment, time to render, time to think.

My nuclear explosion isn't perfect or fully realistic: maybe the cloud should be more flat, or its material should be less fluffy. But as I said in the Introduction, I want to give you an *idea*, how to make a realistic nuclear explosion. The whole tutorial is just the first step of a journey. It's up to you to finish it with lots of experiments.

Play around with the settings, this is the key. It won't be easy, I can say. I've been playing around with it for some time myself and still haven't reach to make a perfect-perfect photorealistic nuclear explosion.

It won't be easy, because there are thousands of variation of the different settings. What if you give a larger number to the fluid emitter's heat emission option, and what if you set the fluid container's temerature scale to a larger value? What's the difference? Try it, try it, try it!

Here's a little example of how the frequency values affect the final look of the fluid:
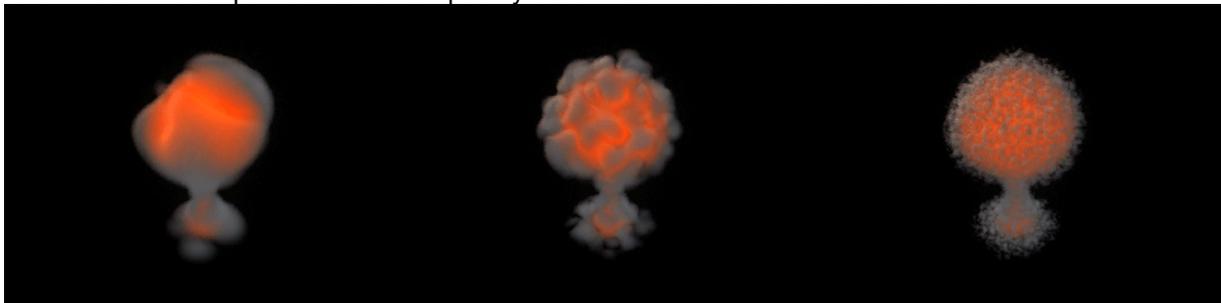
Frequency = 1.000   **Frequency = 3.000**   **Frequency = 5.000**

Try out everything! If you confused of the lot of settings, make screenshots and notes of the results and try to figure out what would fit you the best!

Play with the Turbulence, the Temeprature, the Density, the Frequency, and the velocity modifiers: Velocity Swirl, Velocity Damp, Velocity Scale XYZ. Try to animate the emitter. For example: set its scaling to a higher value at the start, then make it smaller and smaller.

Play with the colors, the incandescense, the opacity! Try Input Bias!

Incand Input Bias = 0.900   **Incand Input Bias = 0.650**   **Incand Input Bias = 0.200**

I think you get the idea now. Hope my tutorial was useful.
And as they say: **now the rest is up to you!** :)

Good work!

Please send me any feedback to cloud00@freemail.hu!

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