Shedding Light on

by Dave Jerrard

Ok, face it... We've all played around with lasers in LightWave 3D at some point in our lives, whether trying to recreate famous space battles, or merely to etch out a shiny logo. It seems the most popular method of creating lasers is by creating a long hollow tube, making it luminous, and using the Polygon Edge transparency to make it look like a glowing beam of light. This will usually work, except when it has to move close to the camera. Then it seems to just shut off due to the Polygon Edge setting kicking in again (figure 1a). Here's another method to try, which avoids the disappearing beam problem mentioned above, and adds a few interesting options in the process (figure 1b).

Figure 1a. The laser ship, firing tubular lasers. Note the problem with edge transparency at sharp angles, making the laser vanish in front of the gun.

Figure 1b. The same scene, but this time using a few variants of the new improved, non-vanishing lasers. Watch your feet!

1:

The first thing to do is to load up Modeler. Start out in the face view by creating box. Select the Box tool from the Objects menu, and drag out a box 10-cm square. Hit the 'ENTER' key to create a polygon. Use the 'Q' key to bring up the Surface panel, and give this a surface name of laser. Center it on the X and Y-axis if it isn't already, just to make life easier later.

2:

Now, select two points that are diagonal from one another and delete them. This will leave a diagonal line. Select the Extrude tool in the Multiply menu and extrude this along the Z-axis. Use the default setting of 1 meter for this. You will now have a 1-meter long panel consisting of two polygons. We only need one, so go to the Polygon menu, and perform a Unify. This is important, as it will avoid any render errors later on.

3:

Select the Mirror tool and center it on the X-axis. Hit Return to activate it. This will give us a simple object that looks like a thin extruded X (figure 2). Save the object as Laser.lwo and that's it! We're done! Well, almost...

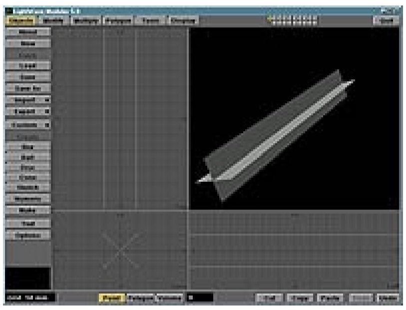

Figure 2. A laser beam's humble beginnings.

4:

Load up Layout. Now before doing anything else, make sure the scene is cleared if it wasn't already. You should have one single light in the center of the universe. Click on the Lights menu to bring up the Lights Panel. Click on the button for Lens Flare to turn it on. The Lens Flare Options will now be active so click on this as well. This will bring up the Lens Flare Options panel.

5:

Turn everything in this panel off, except Central Glow and Red Outer Glow. These are the only two options we need for now. Set the Flare Intensity to 75% and click the Continue button at the bottom.

6:

Bring up the Camera Panel and click on the Custom Size button. Enter a value of 400 for width and height so we get a perfectly square image.

7:

Go to the Record Panel, and set it up to save frames under the name of LaserMap.

Figure 3. The other half of the laser beam, a simple flare.

8:

Click the Render button and leave the options set to Manual Frame Advance. In a second or two, you will have a simple lens flare in the center of the frame, just slightly smaller than the width of the frame itself (figure 3). You may want to locate the frame we just saved and rename it to get rid of the unnecessary frame number.

9:

Clear the scene again and load up the Laser.lwo object we created in Modeler. You will need to move the camera slightly in order to view it since it will load edge-on to the camera.

10:

Go to the Images Panel, and load up the LaserMap image we just created in steps 5 to 8.

11:

Open the Surfaces Panel and select the surface named Laser. From here, we can create a wide variety of laser and energy effects, but to get started, we'll just make a simple, run of the mill laser. First, set the color to black by entering 0 for all three color channels. Now, click the 'T' button next to Surface Color. In the texture panel that opens up, select Planar Image Mapping and set the mapping axis to Z. Select the LaserMap image as the image map, and click on the Automatic Sizing button. Turn the Texture Antialiasing off, then click on Use Texture. Set the Diffuse Level to 0% and raise the Luminosity to 50%. Finally, activate the Additive feature and make this surface Double Sided. Press the 'F9' key for a test render (figure 4).

Figure 4. Instant laser, almost!

What we have is a nice long laser like effect that follows LightWave's lens flare intensity falloff by simply stretching the cross-section of a lens flare along the surface of the polygons. Since we used a pair of perpendicular, intersecting polygons, the laser will be visible and evenly luminous from start to finish, from any direction (except end on, which we'll cover soon). The beam's length can be adjusted simply by stretching it in Layout and creating new keyframes. Likewise, the width of the beam can also be adjusted by merely stretching it on the X and Y-axis, making it look brighter or dimmer. Save this object as GenericLaser.lwo since we'll be using a few times later on. Now, about those harsh edges...

12:

Select the Light as the edit item, and parent it to the laser panel. Keyframe it there and open the Lights Panel. In here, click on the Lens Flare button, and then open the Flare Options. Activate the Fade in Distance button and give a Nominal Distance value of 2 meters. Raise the Flare Intensity to 100% and close the panel again. Move the camera towards the far end, and face it back towards the light. Now, when you do a test render, you'll have a visual source that the laser seems to be coming from (figure 4).

This not only covers the edges, but adds to the effect as well, visually pinning the laser to its source or target. The same can be done for the end that hits the target, as seen in the title image. The object in its current state will be enough for most applications, but let's explore some other possibilities.

We still have a slight problem due to the shape of the laser. It still has an obvious flatness to it, which is very apparent at some angles. We can use LightWave's Motion Blur feature to smooth it out and give it a sense of volume while we're at it.

13:

Open the Motion Graph for the Laser Panel and select the Bank graph. Create a keyframe at frame 1 and give this a value of 180 degrees. Set the End Behavior to repeat and close the panel again.

14:

In the Camera Panel, set the Antialiasing level to low and turn on Motion Blur. Leave the Blur Length set at 50%. Close the panel again hit 'F10' to render and sit back.

In a few moments, you will have a laser bolt, this time with its end smoothed out a bit, giving a slight misty, glowing effect. Also this laser bolt can now be viewed from virtually any angle without any flattening effects occurring like we had earlier. What happened is we've just rendered this object at five different angles as it rotated on its axis. The Blur Length of 50% only covers half of the movement from the current frame (frame 1 in this case) to the previous; thus the laser object only seemed to rotate 90 degrees. The other 90 degrees occurs between frames and is not seen. Since the laser object looks the same from above as it does from the side, we only had to render half of its full rotation to have it end up looking the same as it did when it started rotating. It's also important to remember to render frame 1 and not frame 0 when rendering motion blur. Frame 0 will not calculate the effects of motion blur.

You may notice a slight star like pattern emerging from the way the individual antialiasing passes rendered the panel as it rotated. Higher antialiasing levels will smooth this out even more by filling in these spaces with additional passes, but at a severe cost in render time. If you normally render a scene with Enhanced AA, then this blurring will not add any time to the renders, but upping the AA to medium or high sure will. Luckily, we can reduce this artifacting without adjusting the AA level at all, and at the same time, increase our control over how the final beam looks.

Note: If you use Field Rendering, you'll need to double the amount of rotation again. The amount of motion blur is a percentage of movement going back to the previous frame, or in the case of field rendering, the previous field. With Field Rendering on, a 50% motion blur will only cover half the object's motion in each field, so by doubling the normal rotation, we will have a full blurring from one field to the next. In the example above, we would have to double the 180 degree rotation per frame to 360 degrees if we want to use Field rendering.

15:

Turn off the Antialiasing for now and open the Objects Panel. Load a duplicate of the Laser object and close the Objects Panel.

16:

Parent this second Laser object to the first, then rotate it on its bank by 45 degrees and keyframe it at frame 0. Do a test render and observe what happens.

This time, the laser appears twice as intense as it did when there was only one object due to the fact that the surface is Additive. If we used a luminosity of 100%, this would have looked more like a close-up of a white fluorescent tube. There are three ways we can control the intensity. We can adjust the luminosity, which is the most obvious choice. We can also adjust the texture opacity for the image map we applied. A 50% luminosity and 100% texture opacity will give the same effect as 100% luminosity and 50% texture opacity, as long as the base color is black. The third method is the use of Object Dissolve. This will allow us to animate the intensity of the laser in the same way we would use the Flare Dissolve option for lens flares.

We can also view the laser with less worry about its orientation, making life that much easier for us. If we apply motion blur again, we can smooth out the edges more effectively at lower antialiasing levels. Since we're using a 50% blur length, we'll need to rotate our lasers 90 degrees at frame 1 to cover the 45-degree difference between the two objects. 50% of 90 = 45.

17:

Open up the Motion Graph for the first Laser object again, and change the bank value for frame 1 to 90 degrees. Go to the Camera Panel again, reset Antialiasing to Low, and turn on Motion Blur again. Do another test render of frame 1 (figure 5).

Figure 5. Now, this is looking better.

You'll notice the blurring is much smoother this time because the object was rotating less, placing the AA passes much tighter together. Now, we could go on adding more polygons to smooth this out even more, but multiple layers of transparency have a bad habit of increasing render times. With two copies of our laser object, we only have, at most, four layers of transparency to worry about, which won't impact render times too drastically.

Now that we've covered the basics, let's take a look at some of the endless variations that this method offers. The first obvious variation would be color.

18:

First, clear the scene again, and render a flare that is pure white, with no red outer glow, by following the same procedure as outlined in steps 5 - 8. This one will prove useful for some of the effects we'll explore. Render up a few more lens flares, but vary the light color for each. For these colored lights, raise the flare intensity to 100% as well to compensate for their darker appearance.

19:

Clear the scene and load up your laser object. Experiment by replacing the LaserMap image with some of the colored flares using the Replace Image option in the Image Panel and render off some more tests. You might want to start renaming the surface & saving new copies of this object under different names. I recommend creating a directory to keep all these lasers in one convenient place. You're sure to want to keep a few of these for later.

20:

Now that we've played with color, let's add textures. Clear the scene again, and load up one laser object. This time, we'll surface it differently, and use a fractal noise to define the color. Open the surface panel, and enter the following settings for starters:

```
Surface Color:  255, 255, 10
      Texture:  Fractal Noise
        Texture Size: X: 0.05
                      Y: 0.05
                      Z: 0.01
               Color:  255, 60, 10
         Frequencies: 3
            Contrast:  1

   Luminosity:  0%
     Additive: On
 Texture Type: Planar Image Map
```

Use the white lens flare image as the image map for the luminosity this time, mapped along the Z-axis like we did earlier. Use Automatic Sizing to quickly fit the image to the object and do another quick test render. In a few seconds, you should have a close replica of those familiar energy beams fired by that famous starship (figure 6). All that's left is to add some texture velocity to the fractal noise to give it some added life. Try a value of 0.1 along the Z-axis and 0.005 on the X or Y-axis.

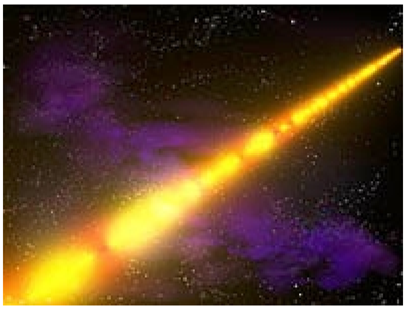

Figure 6. Phasers firing, captain!

Feel free to experiment with various color combinations and texture types. There's an endless variety of possible styles with this simple method alone, but what if you want something that's not always so straight?

21:

Here's where the importance of having the polygons built at 45-degree angles comes into play. Clear the scene and load up the original Laser object again. We'll surface it a bit differently again, but this time, we won't use the lens flare image. First of all, remove all textures and set all the basic texture values to 0%. Next, give this a deep blue color. Click on the color channel's texture button and select the marble texture from the pop-up. Enter the values listed below, paying close attention to the Texture Center value. What this does is position the texture so that one marble vein will run down the exact center of our laser object. Normally, the center of the marble texture is half way between two veins, so we simply used an offset that is half the Vein Spacing amount. Without this offset, the closest veins would be running 0.25 meters to either side of our laser, too far off to be visible.

```
Surface Color:  15, 85, 255
      Texture:  Marble
        Texture Axis:  X-Axis

        Texture Size     Texture Center
          X: 0.05          X: 0.25
          Y: 0.05          Y: 0
          Z: 0.05          Z: 0

       Texture Color: 255, 175, 220
         Frequencies:   6
          Turbulence:   0.025
        Vein Spacing:   0.5
      Vein Sharpness:  25
```

22:

Ok, now that we've set the color, let's light it up. Make sure the luminosity value is 0%, and then click the texture button for this attribute. Again, select the Marble texture, and enter the same values here, with one exception. This time, the Vein Sharpness will only be 15. This will create an identical marble vein that matches the color one above, but will be slightly wider. Since we're working with the luminosity here, a wider vein will lighten not only the colored vein above, but also some of its surrounding color.

```
Luminosity:  0%     Additive:  On
   Texture:  Marble
     Texture Axis:  X-axis

     Texture Size     Texture Center
       X: 0.05           X: 0.25
       Y: 0.05           Y: 0
       Z: 0.05           Z: 0

    Texture Value: 100%
      Frequencies:   6
       Turbulence:   0.025
     Vein Spacing:   0.5
   Vein Sharpness:  15
```

A quick test render will show a bright pink vein (the color texture) with a blue glow around it (the base color), which looks remarkably like a stroke of lightning (figure 7a).

Figure 7a. Playing with electricity has never been safer.

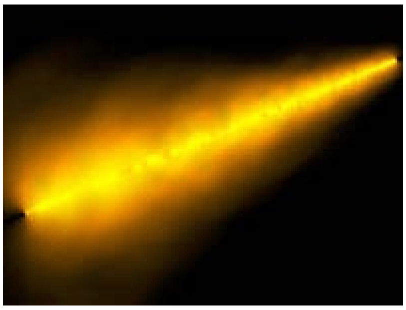

Figure 7b. Another marble texture, this time in orange, gives a foggy look to the effect.

Again, try this technique using various color combinations and texture sizes. Leave the vein spacing alone for now since changing this could cause the whole thing to vanish. Try adding some velocity to the texture. Remember to not only apply velocity on the Z-axis, but also on the X or Y-axis. This will cause the texture to change shape over time as well as seem to move along the length of the object. There is one rule here to follow. Do not apply a velocity to the same axis as the Texture Axis! This would cause the vein to slide sideways and vanish, which is something we just don't want.

A marble texture can be better understood if you picture it as a stack of crinkly paper impaled on a skewer. The skewer would represent the Texture Axis, and each sheet of paper would represent a marble vein. What we see on a marble surface is a cross-section of this stack, where the polygons of the surface would intersect these 'pages'. Each marble vein is actually a wrinkled plane that runs perpendicular to the mapping axis, and parallel to the other two.

This last point is exactly why we built our laser object with the polygons at 45-degree angles. If we were to try mapping a marble vein to a similar object whose polygons were not angled, we would have one polygon, which looked all right, but the other polygon would have the marble vein covering its entire surface. To see this, rotate the laser object 45 degrees on its bank, and activate World Coordinates. A test render now will show a marble vein affecting the entire surface of the vertical polygon (figure 8a).

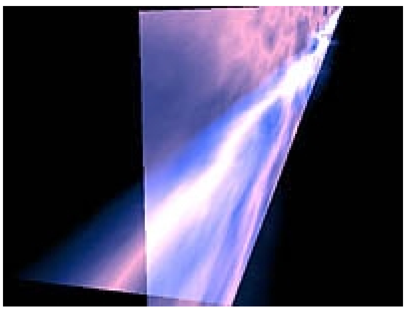

Figure 8a. A marble vein, mapped on the X-axis, looks fine on the

Figure 8b. The same vein, this time, mapped on two angled

horizontal polygon, but it completely covers the vertical one. *polygons.*

Another reason to angle the polygons is for image mapping. Since both polygons are at 45-degree slants, they now have the exact same dimensions, being 0.1 meters tall as well as wide. This is ideal for image mapping purposes, since an image mapped on the X or Y-axis will appear identical on both polygons (figure 8b). This can open up even more possibilities, and here's a favorite:

23:

Clear the scene again, and load up a laser object. Rename the surface to "rings" and click the Surface Color texture button. You'll see the old lens flare image still there, which is fine. Change the mapping axis to the X-axis, which will map the flare sideways onto the object. Change the texture size to X: 0.05, Y: 0.05, Z: 0.2. Click the Texture Center button, and change the texture center to 0.025 on the Y-axis and 0.5 on the Z-axis. Make sure both width and height repeats are turned on for this. While we're here, set the Alpha Image to the flare as well. This will make the flare image look a bit smaller and more intense when rendered. Click the Use Texture button, and then raise the Luminosity to 200%. Make sure you can see the object through the camera, then type 'F9' for a test render (figure 9a).

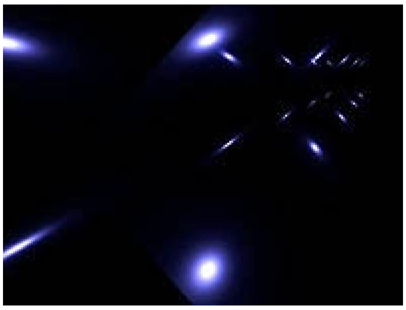

Figure 9a. Very pretty. The result of mapping a repeating flare image on the X-axis, in this case with a blue flare.

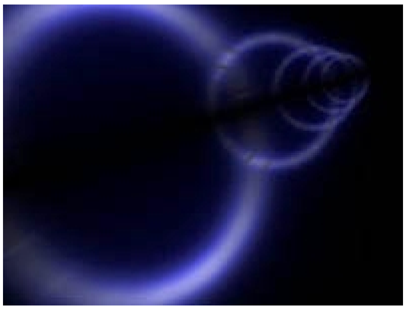

Figure 9b. The same object, this time spinning with motion blur.

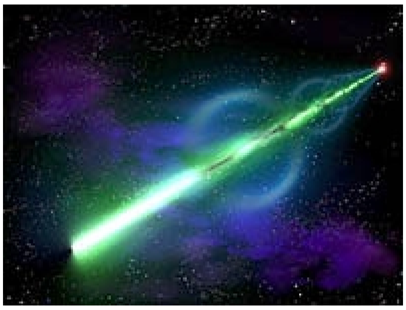

Figure 9c. Rings around a fractal

green beam.

What you'll see here is an array of lens flares, forming two parallel rows on each polygon. Nothing much to look at while it's stationary, but set it spinning like we did earlier, and it's a different story. For best results, add a clone of this object, rotated at 45 degrees to the first, as we did earlier. You'll notice there's a line down the center where the effect is completely transparent (figure 9b). The reason for this is there is no visible color at the center of the object as it is. As each polygon rotates edge on toward the camera, it becomes less visible, and since polygons have no actual thickness to them, they are invisible edge-on. This isn't really a problem, since this effect looks best when combined with one of our earlier lasers (figure 9c).

This is just one example of what effects you can get with image mapping in this way. Other images can provide interesting results as well. Try using a gradient grayscale image as the Luminosity texture, fading out over the length of the object to achieve a flame like effect, similar to that of a blowtorch. Use a Texture Falloff value of 2000 to have the image fade to nothing at the edges, giving a nice tapered look. Now we've opened up a variety of other effects we can achieve with this, like afterburners, torches, spotlight beams, comets, even candle flames! Look closely at the space battle image; the engine flares use this same technique!

We've just touched on the Texture Falloff option, and this is another handy feature that can be exploited. All the effects we've played with so far are best described as steady energy streams. What about those short rapid-fire blaster bolts we've seen so many times in theaters? With the addition of the Texture Falloff, these are just a couple short steps away...

24:

Load original laser object into a fresh scene again. Open the Surface panel and click the Color Texture button. From here, click the Texture Falloff, and enter a value of 200% for the Z-axis (yes, you CAN have a texture falloff on the mapping axis). Close the panel, and position the camera off to the side so you can see the entire object stretching across the screen. Do another quick test render, and you'll have a short laser burst on your screen (figure 10).

Figure 10. The effect of Texture Falloff on the mapping axis.

Note: It's important to remember that the falloff value is the Percentage of falloff PER meter. This object is 0.1 meters tall and wide, so we'll need a value of 2000% to have a texture fade off to nothing at the very edges. Remember we're making the texture falloff from the center, so it's falling off in both directions. This means the falloff distance is half the actual width/height of the object. The same is true for the length. Our laser is only 1 meter long, so you'd expect a value of 100% to work, but this falloff starts out from the texture center. After an Automatic Sizing, our textures are actually centered halfway down the Z-axis, so we only have 0.5 meters on each side for the falloff, thus the 200% value. Again, experiment with different values, as you will find many interesting effects can be achieved.

Now that we can make all kinds of cool looking lasers, we need to incorporate them into our scenes. The easiest way is to set up your scene normally, getting all your starships, characters, and other creations into place first. Once this is done, create a null and parent this to the end of your gun barrels, then load up the laser object of your choice. This is where it's nice to have a collection of pre made effects. Parent the laser object to the null, along with a point light source. Now, you can set the laser object spinning as outlined above, if need be, and even add additional copies, then use the null object to control the size and direction of the laser by keyframing its rotation and size. Scaling the null to zero on the X and Y-axis will effectively turn off the beam, while still letting you see it in Layout, which is great for aiming. Then, just animate the X and Y scales to have it turn on, blow away the enemy, and turn off again.

To fire a short laser bolt, the setup is similar, but this time, don't parent the null to the gun. Instead, keyframe it at the end of the gun it will be fired from. Then, advance a few frames to the point where your bolt will hit its target. Lock the null's movement to the Z-axis by turning off the X and Y buttons under the object edit buttons. Now, holding the CTRL key down, simply move the null along its axis until your bolt has hit the target. Keyframe it here and set the motion type to Linear, under the Spline Controls button. Holding the CTRL key changes the way the mouse moves objects in layout by constraining them to the object's local axis, not the global one. If an object is rotated, and you want it to follow a path that would appear straight from its perspective, just hold that CTRL key down when you move it! It's much easier than trying to position it the old way by switching through multiple views.

The reason we don't parent the null to the gun in this case becomes apparent if your gun is moving. If we did, the bolt would always try to stay in line with the gun, resulting in a laser bolt that wanders around, possibly missing its target completely! This is particularly true if the gun is moving around in a rapid fashion. By the time the bolt would reach its target, the gun might not even be pointed in that direction, meaning the bolt had missed by a long shot!

Well, we've covered quite a few variations on a very simple theme here, which should give you hours of fun and spark those creative juices once again. Now go forth, young warrior, and bloweth thy enemies to tiny pieces!

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