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1 Introduction

I like watching the playful antics of arches (“sprites”, “leapers”, or whatever you want to call them) during faster moving songs, but I also like the slow, graceful look of fans to complement slower moving songs. Since they are basically the same shape, why not combine them? I decided to try some multi-purpose “ArchFans” for Christmas 2009.



ArchFans: as Arches, as Fans, or as something else (ie, Eyes)

I discovered that the Arch + Fan combination is actually much more versatile than either prop was separately - I was able to use a number of interesting effects that I have not seen used elsewhere. You can find these in the eShepherds of Light Christmas 2009 videos on YouTube and Vimeo. My favorite effect was the “eyes”, which appear in a couple of the videos, but the other effects were also fun to sequence. Here are some videos showing the various effects:

- <http://www.vimeo.com/8845012> eyes
- <http://www.vimeo.com/8844290> eyes, wheels
- <http://www.youtube.com/watch?v=8eOTiSZQJgs> fans, arches
- <http://www.youtube.com/watch?v=NUus6T3nSXo> fans, arches
- http://www.youtube.com/watch?v=8zMieO_liGU rolling stone, clapping hands
- <http://www.vimeo.com/8845549> piano
- <http://www.youtube.com/watch?v=18a68Ut3Cel> ping pong, steeple chase

The 2 examples labeled “fans, arches” above illustrate how fans can fit in with slower parts of a song, while the arches fit well with faster moving parts of the same song.

Since these props might be of interest to other DIYC members, this article will describe how I built the ArchFans. This is mostly just a combination of ideas found elsewhere. There are probably better ways to do it, but this will at least give the general idea of what I did. Unless otherwise noted, all measurements are in U.S. units (feet, inches, etc).

2 Parts/Planning

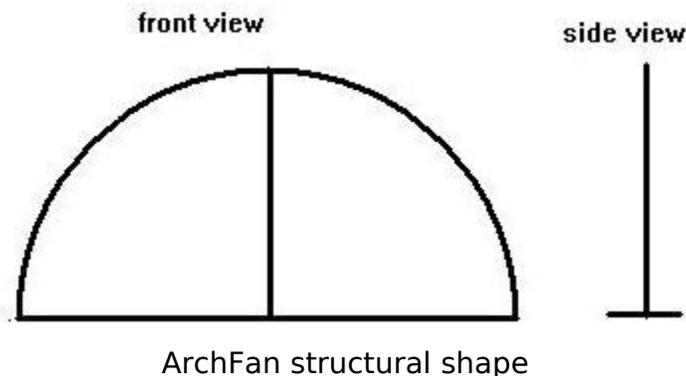
The cost of materials for the ArchFans was minimal – something like \$5 each excluding the mini-lights, which were also very inexpensive at after-Christmas prices (but they can still add up, due to the quantities). I used 16 strings of 100 ct. mini-lights for each ArchFan, so the channels add up quickly.

Obviously you can make these any size you want, but the materials that I used for each ArchFan were as follows:

- two 10' sections of Schedule 120 PVC
- two T joints
- two L joints
- 2 end caps (temporary, shared)
- a 1' piece of stiff wire, such as ceiling hanger wire
- a 1' piece of plastic tubing to fit over the stiff wire (optional)

I wanted to use precise measurements (to avoid needing to rewind the arches), but very simple geometry, so I used a full semi-circular shape (as opposed to the somewhat “flattened” appearance sometimes used with arches). PVC commonly comes in 10' lengths, and a semi-circle with perimeter of 10' has a radius of $10/\pi \approx 3.2'$. With a height of a little over 3' and width of about 7', the arches seemed like they would fit well with the rest of the display - large enough to stand out, but small enough to not dwarf other props. Later I discovered that this shape also seems to allow a greater variety of effects (as listed earlier).

Since the arches would also serve as the outer edges of the fans, they needed to hold their shape both during construction and after setup. This ruled out the spring-like construction that is often used with arches (stakes in the ground, holding the PVC in an arch shape under tension). So I permanently bent the arches, and added supports in an upside-down “T” arrangement using a structure as follows:



A short test showed that I would get about 6 turns per inch if the mini-light strings were pushed together tightly around the arches. With a PVC outer diameter of $3/4''$, each linear inch of arch (6 turns) would take about $6 \times 2\frac{1}{4}'' = 15''$ of mini-light string. My mini-light strings were about $23\frac{1}{2}'$ lighted, so each would give about $18''$ of linear arch length, which was a little longer than I wanted for each arch segment. I suppose I could have sub-divided each string into two 50 ct strings, but then this would have been shorter than I wanted ($9''$), so instead I just chose to use larger PVC. With an outer diameter of $1''$, each linear inch of arch (6 turns) would then take $\approx 6 \times 3\frac{1}{4}'' \approx 18''$ of mini-light string, for an arch segment length of about $15''$. This length worked nicely for the size of arches I wanted to use ($8 \times 15''$ segment = $10'$ arch length).

I wasn't too concerned about odd vs. even number of segments because I wasn't sure which sequence effects I would end up using, but I wanted to use around 7 - 9 segments per arch. I settled on 8 segments when the 1" outer diameter PVC worked out nicely to 8 segments using the calculations shown above. Actually, 7 segments would have been better with my SSRs, which were multiples of 7 channels since I use all 8 wires in the cat5 to carry data to the SSRs.

To accommodate the bulky wire build-up at the centers of the fans and to account for the T and L joints, I added a few inches on to the ArchFan radius. I ended up with an actual radius of about 39", which could still be cut from one 10' piece of PVC.

Previous attempts to bend Schedule 40 PVC did not work well for me, but Schedule 120 did, so I decided to use Schedule 120 again for this project. Structural strength was not an issue due to the relatively light weigh of the ArchFans.

3 Construction

3.1 Building the Frames

For each ArchFan, I started with two 10' pieces of PVC. I discovered that the lengths were not exact, but they were never less than the advertised length:



Schedule 120 PVC

In order to make several ArchFans with the correct shape easily, I made a jig for the curved sections. I drew an arc with the correct radius on plywood (using a loop of string as a compass) and then added rows of nails along the inside and outside of the curve:



Plywood-and-nails jig

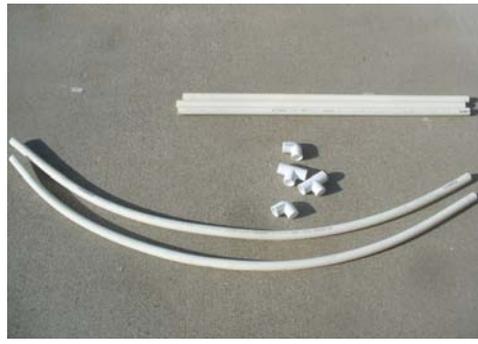
Then for each ArchFan I cut 1 piece of PVC into two 5' sections, then bent them into shape. I capped one end, poured near-boiling water into it, then capped the other end and slipped it into

the jig to let it sit for a few minutes. Then I removed one of the end caps, poured out the water and waited for it to cool. When removed from the jig, the PVC held its shape:



Bending PVC with hot water and jig

I cut the other piece of PVC for each ArchFan into three 39" sections, then laid them out in groups and started assembling them:



ArchFan parts: 2 curved sections, 3 straight sections, 2 Ts, and 2 Ls

First I glued the 2 T joints to the ends of the upright (one of the straight 39" pieces), then added the other 2 cross pieces, with L joints at each end, and then the 2 curved sections:



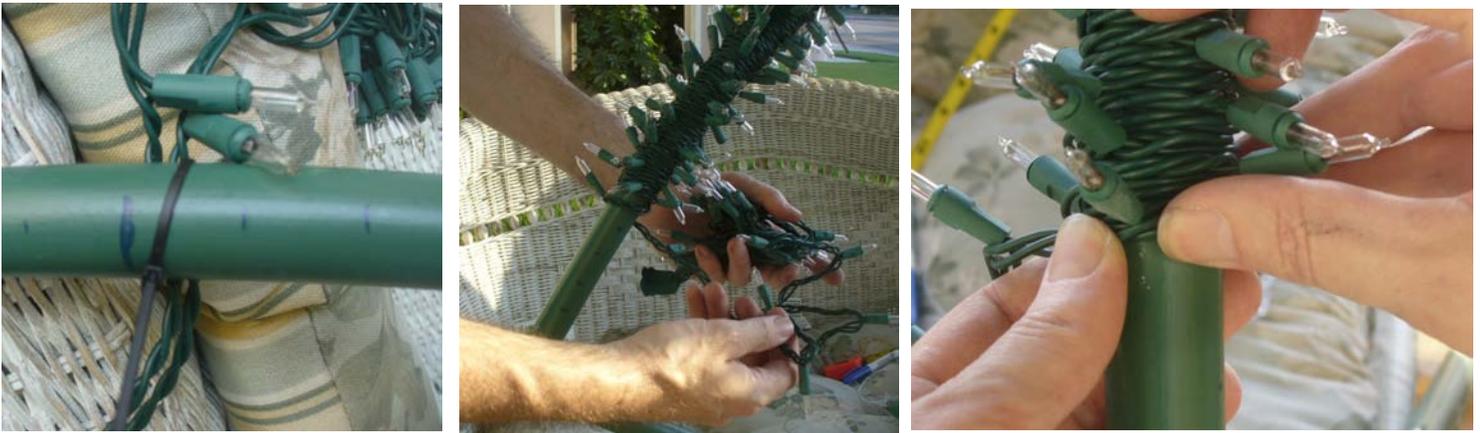
Assembling cross-members and curves

Since the upright and cross members would be visible (not wrapped with lights), I painted the ArchFan frames with dark green Latex paint. For uniformity, I also painted the curved sections even though those parts would be completely covered. Later I discovered that this was actually helpful for creating a soft "friction layer" to help hold the wrapped lights in place.

3.2 Adding the Lights - Arches

I wrapped the arches first because they were denser and had a lot more turns than the fans. Since the arches were already curved, I could not use the spinning PVC technique that others have used to wrap the lights. So, I just wrapped them by hand. This actually was not too tedious once I got the hang of it.

I started by placing evenly spaced marks on the arches, so that I could tell if I was wrapping according to "budget". I used a zip-tie to anchor one end of the string, then wound the string around the PVC by hand. I found it helpful to not uncoil the mini-lights more than needed, in order to avoid tangles. Occasionally I would stop to adjust the lights by squishing them closer together if I was using up too much space based on the number of lights to go vs. the number of marks left for this segment:



Anchoring and wrapping the lights

I found that I did not need any zip-ties mid-way within the segments - any slightly loose wrapping tended to be held in place by the Latex "friction layer", and by using the marks I was able to wrap the lights fairly uniformly. I alternated the plugs on each segment, so that 2 female ends or 2 male ends were together - this would consolidate the feeder wires, which I planned to run over to the center upright, rather than trying to hide them along the arches themselves (because I planned to put the SSRs behind the ArchFans, in the middle).

I often cut off the female plugs if they are not needed, but I left them on for the arches because they weren't really in the way. At the end of each string, I used a twist-tie to temporarily hold the end in place until I wrapped the next segment. Then I could use one zip-tie to hold the ends of 2 segments in place:



Wrapping the arches

I worked from one end of the arch to the other. Since each string took about 15", I ended up with 8 segments on each 10' arch.

3.3 Adding the Lights - Fans

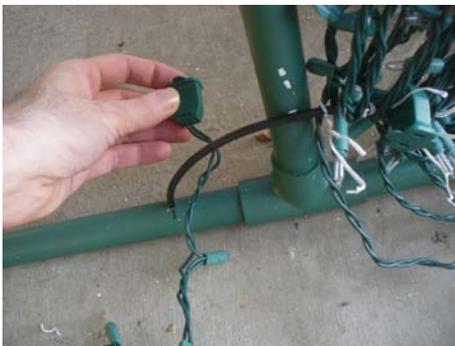
The fans were designed to be less dense than the arches, to give them a more delicate look and so that other props would show through. The idea was to loop the mini-light strings back and forth between the center T and the outer arch - with 23.5' long mini-light strings, this would give 4 loops per string (3' radius back and forth x 4 loops \approx 24').

I needed a way to hold the loops in place at the center, so I made a half retainer ring by bending a 1' length of ceiling hanger wire into a $\sim 7''$ diameter semi-circle, using a round object as a bending guide. I slipped some plastic tubing over the ceiling hanger wire to make it a little wider and softer (leaving $\sim 1\frac{1}{2}''$ bare at each end), and possibly for insulation purposes. I drilled a hole in each of the cross members near the T, slipped the end of the retainer loop into it, and bent it over to keep it in place:



Retainer ring in center

Stringing the lights for the fans went fairly quickly, since there were only 4 loops per fan segment. To string the loops, I threaded the first half of a mini-light string thru the retainer loop until I reached the middle of the string, then starting looping it around the arch and back:



Mini-light string threaded mid-way through retainer loop, then out to arch

As I returned to the center again, I wrapped the returning string once or twice around the outbound string in order to make the string a little sturdier (probably not necessary), then threaded it through the retainer ring again for the next loop:



Wrapped string along loop

I stretched each string out around the arch and back to the center again, and temporarily tied off the end using a twist-tie. I didn't want to use a zip-tie just yet in case I needed to adjust the spacing (the other half of the string might under- or over-shoot the center):



Tie off one end at center

Then I strung the other half of the mini-light string out to the arch and back (twice), and again tied off the end at (or, in some cases, near) the center. The strings didn't need to end up exactly at the center, since the bulbs near the center are closer and other bulbs would fill in any empty space.



String and tie off other end at center (more or less)

After the first fan segment, I continued on with other fan segments, working toward the center of the ArchFan until all segments were in place:



Stringing one fan segment at a time

Even though the ArchFans have a fixed shape and cannot be stretched out lengthwise like arches that are held under tension, they really don't take up too much storage space. I store 4 ArchFans standing upright, in a space about 3½' high and 7' wide, by about 14" deep:



ArchFans can be stored upright

4 Placement and Hookup

Initially I was unsure how to place the ArchFans within the display layout, due to various trade-offs. If they are to be a focal point, they should be “up front”, closer to the audience. OTOH, if they are just used to provide a little background effect for other props, then they should be more towards the back of the display, so that other props can take the focus.

Nativity figures are the main focal point of our display, since that helps to remind viewers of the true meaning of Christmas. So I ended up placing the ArchFans right behind the Nativity figures and in front of the midi tree, basically forming 2 “layers” in the display. This actually worked quite well, because all of the props are “transparent” and allow any objects behind them to be seen.



“Layered” display props, ArchFans behind, other props in front

After deciding on the placement, the ArchFans were actually very easy to set up and adjust as necessary. They can be free-standing in the yard, with guy wires or feet to hold them up, but they can also be moved fairly easily. Since they were “pre-bent”, there were no ground stakes or rebar posts to move around, and the curved shape was not held under tension like a spring.

I placed the SSRs right behind the ArchFans, to minimize cords. The plugs from the fan light strings were all located in the bottom center of the ArchFan, so they could be plugged into the SSR directly. Some of the arch light strings also reached, but I had to use extension cords on a few of them in order to reach to the SSRs:



SSRs located directly behind the ArchFans, a few extension cords needed

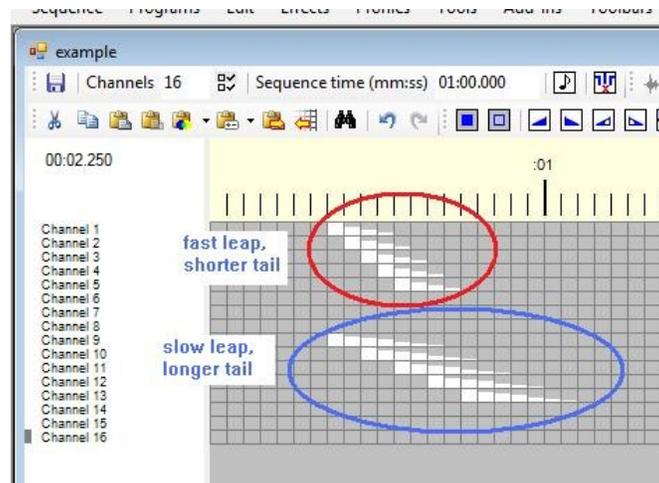
I had made some 1' extension cords using the female ends cut off of other light strings and then added a male plug, but I ran out of those so I just used regular extensions cords. This was okay since they were behind the ArchFans and not visible anyway.

5 Sequencing

As far as sequencing in Vixen is concerned, when the ArchFans are used as regular arches or fans they just acted like groups of 8 channels, so they could use regular ramps and fades, chase patterns, etc. However, as Virtus pointed out in the following DIYC forum thread, it is important for the start and end of the chase to align correctly with the beats in the song:

<http://www.doityourselfchristmas.com/forums/showthread.php?t=8751>

As with regular chase patterns, the speed of the arches or fans can be adjusted by using different numbers of intervals between each step. Adjusting the length of the tail can also reinforce the illusion of fast or slow motion. In extreme cases, it might also be necessary to turn on more than one segment at a time for very fast-moving songs.



Adjusting the speed of the arches or fans

When the arch and the fan portions were used together as a single prop, the ArchFans generally did not follow these rules, because there was typically a non-standard effect being used. There are too many variations to discuss here, so I will leave it as an exercise for anyone who is interested to just look at the sequences for yourself. The Vixen sequences to all of the eShepherds of Light sequences are posted in the DIYC File Library (under Vixen 2.1, but they can be easily converted to Vixen 2.5), in case anyone would like to look at how they were done or use them as a jump-start. I'm not an expert on arch or fan effects in general, but I can at least answer questions or provide more details about the specific effects that I used.

Here is a short demo of a couple of the effects, but the videos listed earlier provide better examples of the effects as they are used within the actual songs:

http://www.youtube.com/watch?v=_WwRarX2AEk

6 More Information

If you have any questions or comments for improvement of this article, please send an email to techguy@eShepherdsOfLight.com.

Revision History

Revision	Date	Description
1.0	02/13/10	Initial write-up

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