15-394 Final Project

Ultrasonic Liquid Diffuser

The Aqualux

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1 Introduction

Life can get busy sometimes; especially at CMU. When life gets busy, your dorm is going to be a mess. You stumble on a roomful of your own stinky shoes and leftover pizzas. And of course, it smells bad overtime. So every time I go back to my dorm, this amalgam of stinky smells inspired me to design a prototype that refreshes the air. Wouldn't that be nice if adding a few drops of oil would solve the problem? A diffuser came to my mind. After some research on how common diffusers work, I decided to apply the knowledge I learned in 15-394 to prototype a diffuser that brings aesthetic pleasure as well as aroma to my room. **Aqualux** can turn this into reality! It turns liquids into tiny droplets that get diffused in the surrounding air while bringing gorgeous lighting effects that shines through the mist of vapor. The functionality is realized by using an ultrasonic atomizer and the design is accomplished using SolidWorks, Rhinoceros, GrassHopper and AutoDesk softwares, etc. The exterior container is manufactured using laser cutters. Because it's also a decorative luminary that has the best visual effect in the dark, I decided to call it the **Aqualux**. [-Aqua: water, -lux: light]

Figure 1: Ultrasonic Liquid Diffuser — The Aqulux

2 Design Details

For the technology part of **Aqualux**, I adopted a 24V ultrasonic atomizer. So I connected that with an AC adaptor that takes 100V-240V, 50/60Hz voltage input and outputs a 24V, 1000mA DC current. Ultrasonic atomizer is created using high frequency sound vibrations, which are converted to mechanical vibrations. As liquid is fed onto the surface of the atomizer, it is subjected to these mechanical vibrations, which continuously breaks liquid into smaller droplets until they are small enough to be suspended in air.

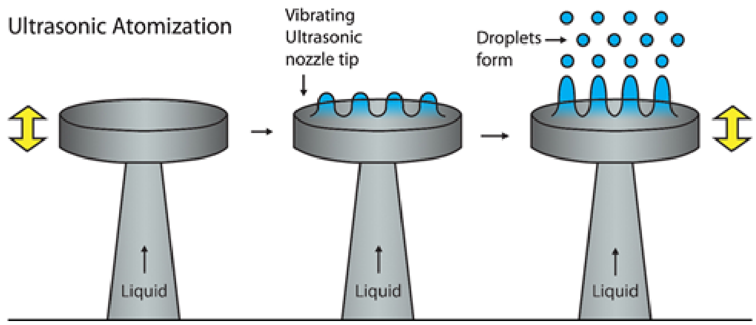

Figure 2: Mechanism of an ultrasonic atomizer[1].

For the decorative aspect of the **Aqualux**, I designed an complex, intricate interlock sliced shape.I started off with some sketches in Solidworks. After some iterations, I decided to go with an icicle matrix that can be produced by slicing algorithms. The way to do that is to reverse engineer a hollow cylindrical shape with a smaller inner radius r for the front surface as shown in **Figure 3**. Where r is also the radius of the ultrasonic diffuser from measurement.

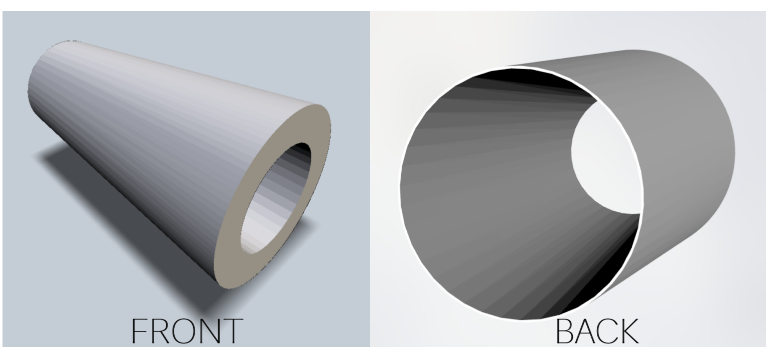

Figure 3: Basic Cylindrical Prototype. Front with $R = 1.5r$ and back with $R \approx r$

Since the glowing LED lights can change colors, the expected visual effect would be the following. When warmer colors, like red/orange light is glowing, the icicle matrix will appear to be a volcano; whereas when cooler colors, like blue is glowing, the icicles might give you a shiver even just by looking at it. Then, in order to have gorgeous icicle slices, I adopted both Grasshopper[2] and AutoDesk Slicer[3] for the slicing algorithms options. However, it was really hard to get a perfect division parameter for my slices. But finally, my reverse engineered cylinder was sliced successfully. As shown in **Figure 4**, the slices are interlocked with pointy vertices on one end, which meets my design expectation perfectly.

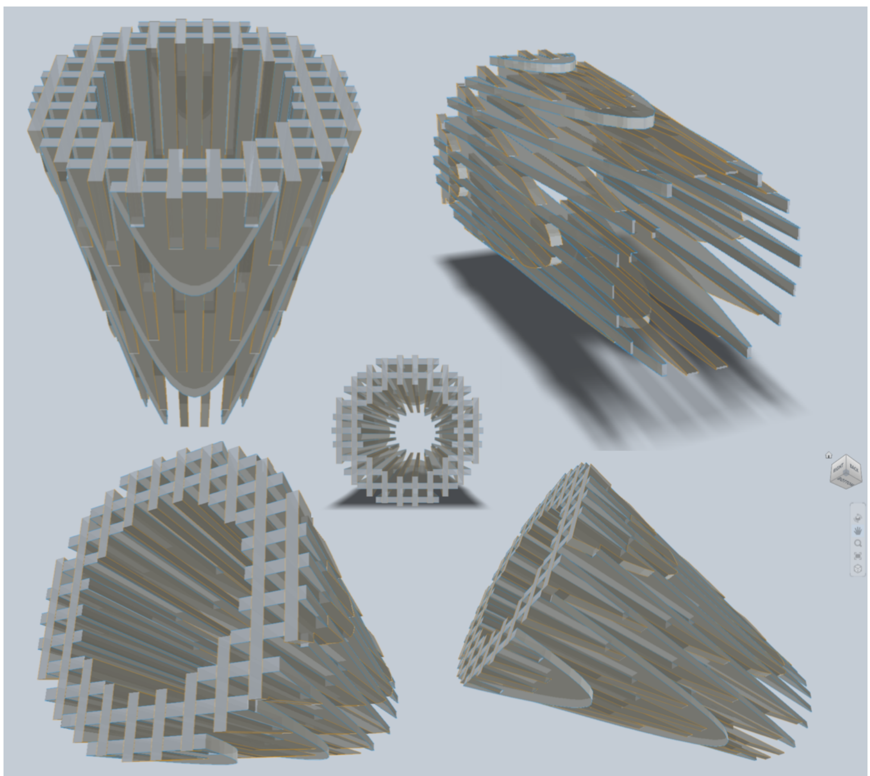

Figure 4: Icicle Matrix slices renders

Then I started thinking the material I should use for the **Aqualux**. And no doubt, using 1/8 in acrylic was the way to go because it's water proof and transparent. So I arranged a dxf that can be used most economically to prepare for the laser cuts. Because the icicle matrix is going to be working with water and vapors, I applied minimal hot glue at the junction of each icicle pieces to ensure the fastness.

After laser cutting the parts, I realized I need a non-slip bottom for a nice finish. Since I need to let the water vapor out of the diffuser, the top is left open. For the bottom, I chose cork for its nice surface feeling and it adds a little bit more friction to the bottom. Inside of it, there's a part from a plastic water bottle that serves as the water tank and keep the liquid from leaking. Thanks to professor Touretzky's advice for a viable idea to resolve the non-closed-surface-water-containing impasse. The final product look like this.

Figure 5: The Aqualux.

The way to use the **Aqualux** is still in a straightforward way. Plug in the power and add water to the water container. It works best if you have a pipette so you can direct the water to the white circular center of the atomizer. Now, say goodbye to stinky smells in the room and enjoy the brilliant lights with aroma while studying for your finals.

3 Iteration Process

At the very beginning, I was set on using the slicing algorithm I learned in 15-394 to produce a complicated shape to assemble. However, the final product will not be a closed surface after slicing. In particular, the **Aqualux** is a prototype that is supposed to have the ability to contain liquids. So I started thinking a few ways for a non-closed surface to be able to contain water. What came to my mind first was actually a vase-shaped container (as shown in **Figure 6**), which took me a long time to design and polish. But unfortunately, but no matter what I tried, it failed to slice. So I aborted the design with sorrow.

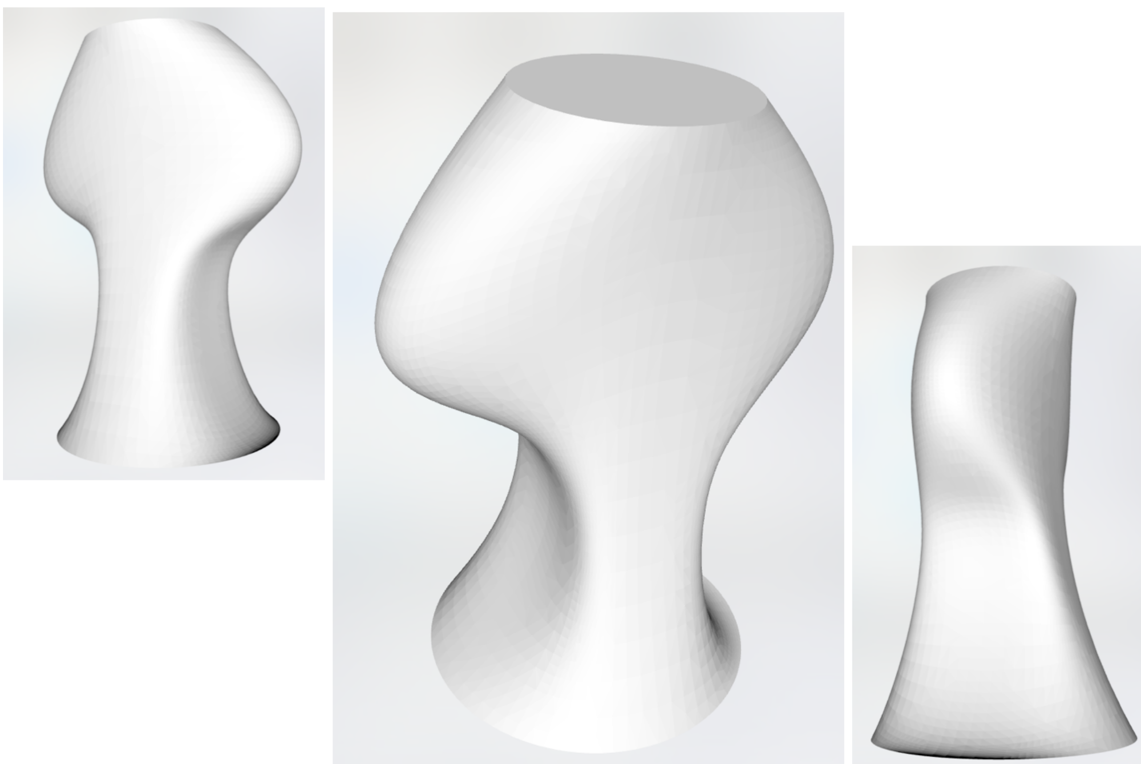

Figure 6: The vase-shaped prototype.

The shape uses 4 guide-curves on 2 different planes, which produced an elegant beautiful shape that was impossible to slice after all means of attempts.

4 Demo Photos

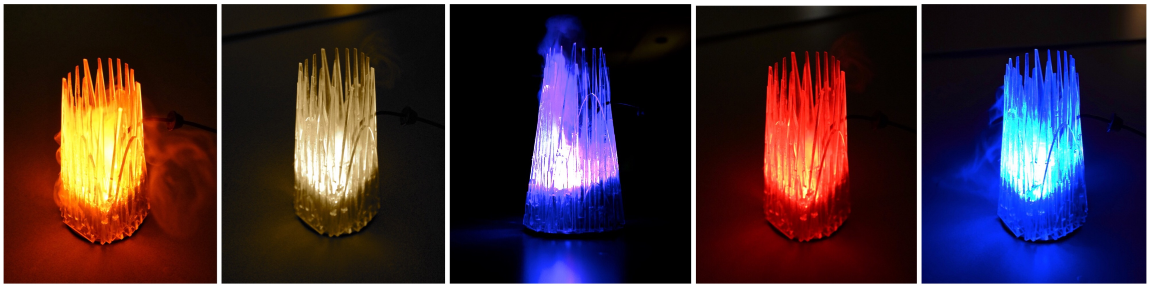

Figure 7: The Aqualux

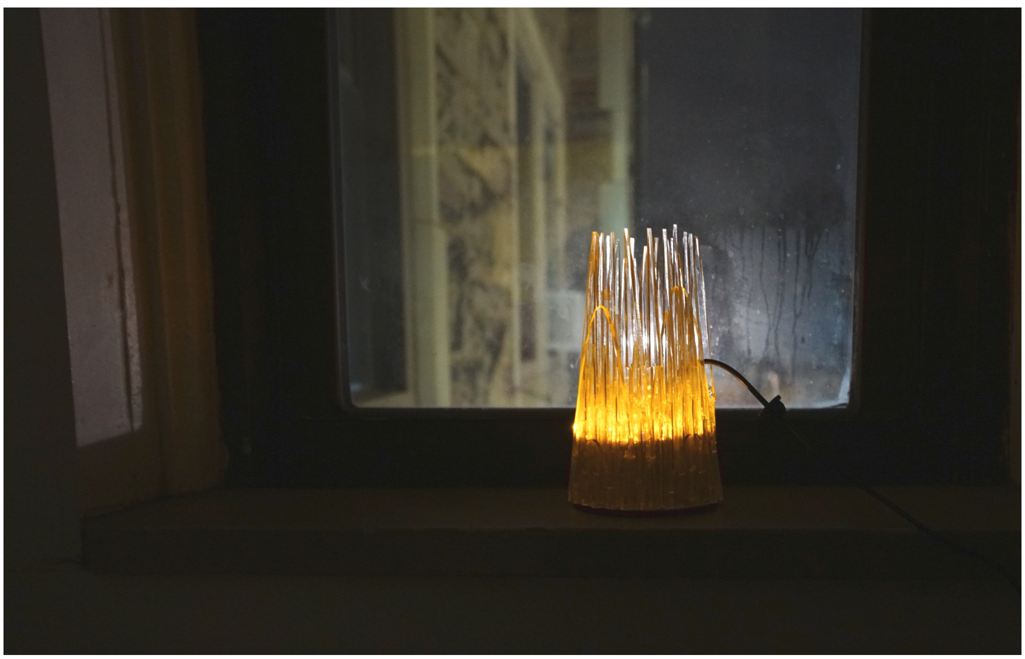

Figure 8: The Aqualux

- Be sure to check out videos of the **Aqualux** working in action:
  https://drive.google.com/open?id=1VM4eIYwdBQJHUZZlX70ejyXHi92Empq-

References

[1] SonoTek: How does an ultrasonic diffuser work?
`http://www.sono-tek.com/ultrasonic-glass-coating-equipment/`

[2] 15-394 Course Website: Grasshopper and Rhino Lecture
`http://www.cs.cmu.edu/afs/cs/academic/class/15394h-f17/lectures/gh2/gh2.html`
`http://www.cs.cmu.edu/afs/cs/academic/class/15394h-f17/assignments/slicer/slicer-assignment-v2.gh`

[3] 15-394 Course Website: Making 3D Models Lecture (last lecture)
`http://www.cs.cmu.edu/afs/cs/academic/class/99353-f16/day4/models.pdf`