ENGR 101
Energy Chimney
Final Report
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1 PROBLEM DEFINITION

We will be working with an energy chimney and modifying it so that it meets our sponsors criteria.

1.1 Problem Statement

Modify the energy chimney so that it has an adjustable seal on top to control when air comes out of the chimney as well as the speed. Also make the chimney out of better material so that it is more stable.

1.2 System Description

Our team is designing a new, more stable and practical chimney for a system that uses a pump, water, and short/long wave radiation to create clean energy. The system uses radiant heating and cooling, which exchanges heat by both convection and radiation with the environments they are designed to heat/cool. An example of this system is seen on the Loyola campus as radiant ceiling panels. The airflow of the system in the flex lab is so small that it is difficult to measure the velocity of the air, so that is why a cardboard chimney was designed; it streamlines the air to the top, which creates a smaller space for the air to pass through, creating a readable velocity.

Our job is to replace the current cardboard chimney that has been used and beat up for several years, and we also want to make a few adjustments. Our first goal is to make it much sturdier than cardboard so it can be used many times. The second goal is to create an airflow adjustment mechanism at the top of the chimney that can control the amount of air that is being pushed out of the chimney at a certain time. We not only want to make a more functional chimney than before, but a more aesthetically pleasing one, without going over the monetary constraints.

1.3 Realistic Constraints

a. Valve at the top to restrict surface area at the exit
b. Not too steep of a curve to the exit; must have minimal back pressure
c. Total budget of $100 to build the chimney
d. Must be stable even with holes cut into it since there will be holes to insert tubes in the back of the chimney

1.4 Measurable Requirements

The requirements are listed below:

a. Cone attachment area vary by a factor of 2 (base 10in^2, 5in^2 , 2.5in^2)
b. Length 48in, width 5 5/8in, and height of 11.8in with a tolerance of 0.1in

2 SYSTEM DEFINITION

Here we will talk about our two best designs and we will discuss the pros and cons of each design.

2.1 Materials and Budget

Project materials and the corresponding budget are given in Table 1 and Table 2:

Table 1. Variable cone chimney design

Part	Size (Only taking the surface area since the inside is hollow, sizes are estimates)	Cost (Determined by the fact that a sheet of acrylic with a thickness of 3/8in cost \$1 per 11.755in^2)
Base of chimney	632.775in^2	\$53.83
Curve of the chimney leading up to the exit	316.388in^2	\$26.92
Original cone	10in^2	\$0.85
Second cone	5in^2	\$0.43
Third cone	2.5in^2	\$0.21
Total	966.663in^2	\$82.23

Table 2. Rotating circle cover design

Part	Size (Only taking the surface area since the inside is hollow, sizes are estimates)	Cost (Determined by the fact that a sheet of acrylic with a thickness of 3/8in cost \$1 per 11.755in^2)
Base of chimney	632.775in^2	\$53.83
Curve of the chimney leading up to the exit	316.388in^2	\$26.92
Original cone	10in^2	\$0.85
Rotating circle cover+Clip	10in^2	\$0.85+\$1.31
Total	969.163in^2	\$83.76

2.2 Experimental Measurements and Analysis

Through our testing and design analysis we concluded that while the rotating circle cover design was simple for the user and would be an effective solution, the simple design of the cone attachments means less complexity with the parts and should lead to a device that can be used for a long time and do its job well with a little less configuration as the downside. Also, our measurements (shown in the tables above), indicate that the cost of the two designs is approximately the same, so we decided that we will probably go with the simpler design of the two seeing as cost won't have a big influence in the usability of our designs.

2.3 Feasibility of Proposed Solutions

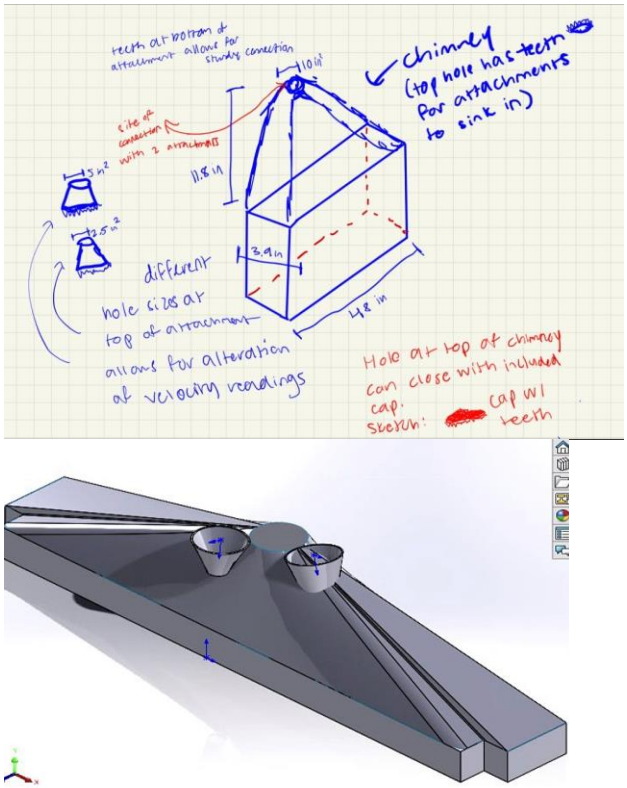


Figure 1: Variable cone chimney

Pictured above is our first attempt at creating a fully functional, sturdy, and simple chimney. Problems with this design will be gone into more detail in the testing section, but it would have been a great solution if not for printing issues due to the large size of the chimney. We knew that creating attachments in a way where they could just be placed on would be cost-effective, as well as simple to design and print. An important design feature we added is a lip that could be seen on the top right picture, which we incorporated into our second and final design.

For this design we thought that it would be a good idea to change the size of the cone that sits on top of the chimney. With this method we can change the air flow of the chimney with ease by simply taking off the cone and putting a different sized cone in its place. We will have three cones one that is $10in^2$, the other is $5in^2$, and the last one is $2.5in^2$; these sizes were requested by Dr.Sivandran. The benefits of this design are that it is simple and efficient, we can print and acquire the different sized cones easily and because the cone sizes are relatively small, and they cost very little to make. It is also efficient because you just switch the cone when you want to change the airflow. The only drawback to this design is that we will not be able to specifically adjust the system, so that so we get the amount of air that we want coming out. Also, we only have three different airflow options which is not a lot, but Dr.Sivandran said it is sufficient. All the

parts including the chimney will be made of acrylic plexiglass and does not surpass our budget of $100.

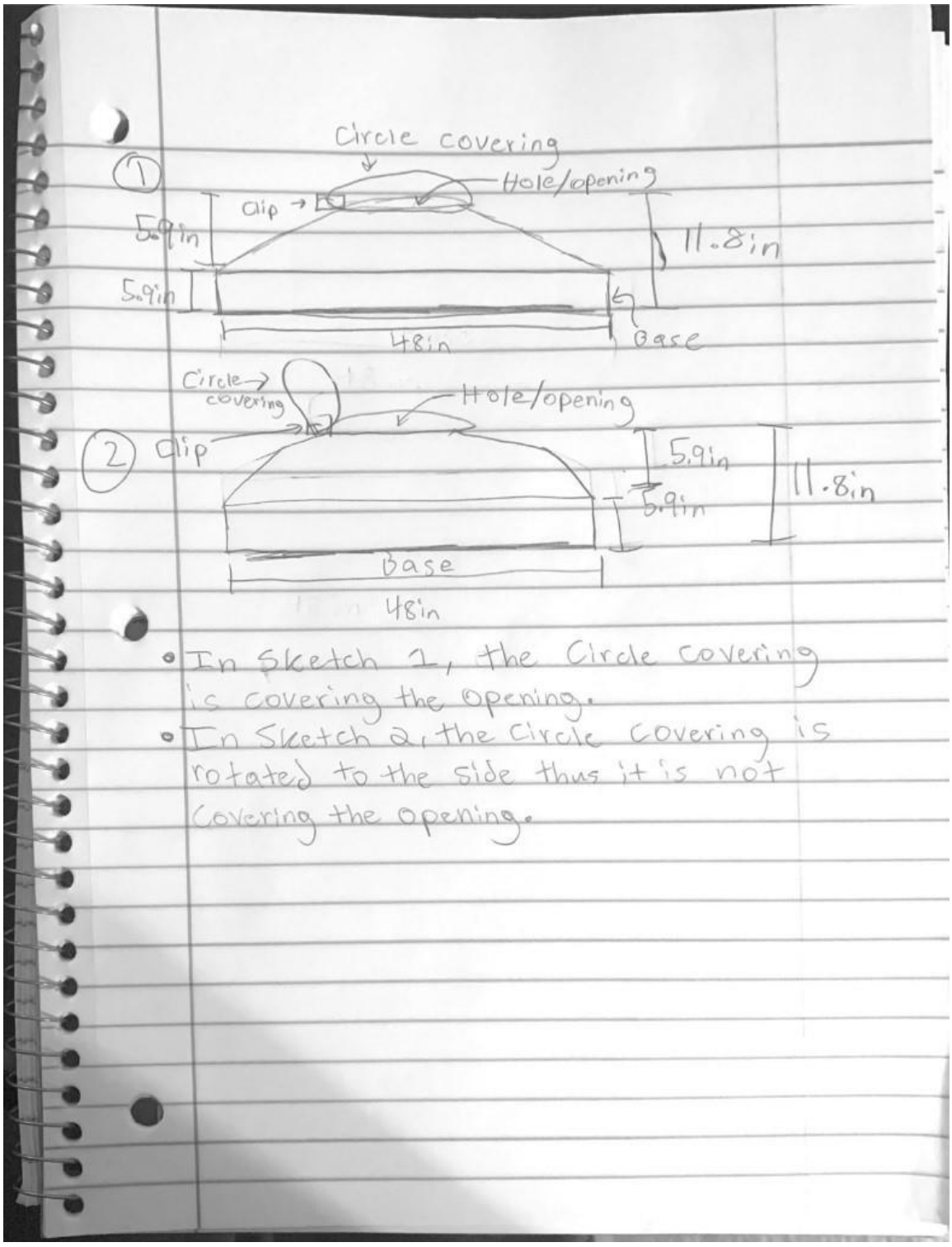


Figure 2: The rotating circle cover

For this design we decided to have a clip at the very top of the chimney where the opening is and have a circle covering attached so that we can rotate it left and right. With this circle covering, we can move it to the left which would allow all the air to come out of the opening, or we could move it to the right, covering the opening and stopping the airflow of the chimney completely. The benefit of this simple design is you can rotate the circle towards the opening to cover a certain portion of the opening. Another benefit is we have more control over the airflow adjustment. The negatives to this design are that the clip must be sturdy to hold the circle covering; otherwise, the circle covering will fall off. The other negative is that the design is a little more complicated than the first design. We must make sure that we are able to put the clip in the appropriate spot on the chimney to work as intended. The circle covering and the chimney will all be made of acrylic plexiglass, and the does not surpass our budget of $100.

3 RECOMMENDED SOLUTION

You will only have to add new Sections 3, 4, and 5 to your Final Report. But please fix any issues that were identified with text/Figures/Tables/formatting in the Progress Report. Have a short intro sentence here, as a Level 1 heading should be followed by text.

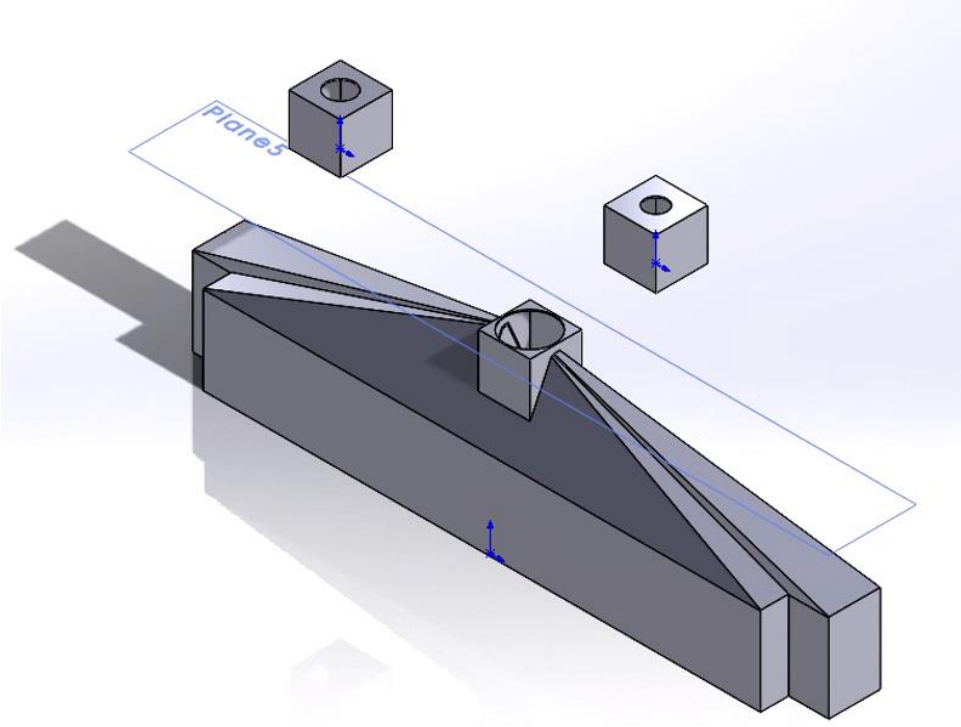
3.1 Solution Justification

Both designs are simple and easy to make for the most part. The designs are also good because they don't surpass our budget which is very important. The material we chose, acrylic plexiglass is also good because it is way more stable than the cardboard that the current chimney is made of and we chose a thickness of 3/8in to make sure that the chimney is sturdy enough to be placed on the system otherwise it would fall apart. The idea/ mechanic of both designs is simple, so anyone is essentially able to change the airflow of the chimney and they can do it with ease. So, looking at both designs considering these things, our designs are very doable, and they meet our sponsors criteria of being able to control airflow and being sturdy, and we should have no problem designing and making/building them for them to be used. Out of the two designs we still however prefer the multiple cone chimney design because it is easier to make and the idea of it so much simpler and our sponsor Dr.Sivandran thought it was a much better choice.

3.2 Solution Testing

For our testing, we decided to have a zoom meeting with Dr. Streeter; he gave us valuable insight on how to change our chimney design so that it will be able to print. The problem we faced was that the chimney would be too big to be printed in a 3d printer, so acrylic sheets would have to be used. Dr. Streeter explained that since we will be laser cutting sheets of acrylic, the original design that has curves on the hood of the chimney

will not work. He stated that the original design is practical and would work if we were not constrained by the printer. The whole chimney would have to use geometrically flat pieces that would be compliant with a laser cutter. Knowing this, the chimney was redesigned to have a rectangular top instead of a circular one, so that the chimney would not have to be curved to have everything fall into place using the loft feature. Shown below is our final chimney design, which should have no issues being manufactured with acrylic sheets and laser cutting. We also decided to scale the chimney up a tiny bit so that it would fit snugly over the system. We kept the lip on the bottom from the original design, and we also used the original design for inspiration for the improved design, except we streamlined it and made the features more "box-like" so that it will be compliant with the laser cutter.



Final Chimney Design (post testing)

4 CONCLUSION

The real goal behind this project was to create a more durable and longer lasting replacement to the old cardboard chimney used to funnel air from the radiant heating and cooling system while also adding the ability to have a variable airflow volume. The rotating circle cover was our first idea but that would’ve been very complex, so we instead opted for the simpler version with fixed airflow rates. By adding cone attachments, you can have differing levels of airflow and velocities. By using flat edges for this design, the build process is very simple, and the device should prove durable

enough and easy to use for years to come. Most of our process revolved around designing and not researching, so our process involved mainly sketching and modeling based on the measurements that Dr. Sivandran gave us.