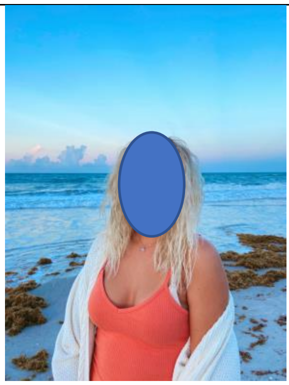
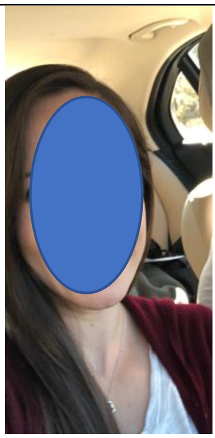
AEE 1201: Introduction to Aerospace Engineering
Students Teaching Engineering- Final Report (Part 2)
Group #3: The Space Jammers
The Venturi Nozzle

Due: November 17th, 2020

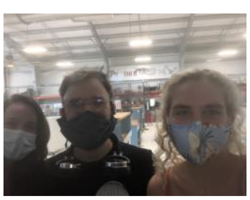
 K P	 T F
 S B	 S W

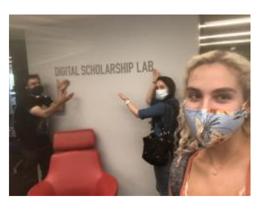
“Making Facilities” at Florida Tech (K.P.)

To begin, my group and I went to visit the Harris Student Design Center (HSDC), Machine Shop, and Evans Library Digital Scholarship Center (DSL). The HSDC has many resources that can be helpful for our design project. A huge workshop area is provided to work on projects where you can build, design, and create. This center has lots of materials available for students to use. This huge open warehouse allows students to work comfortably and efficiently. With the HSDC being very open and large, it could be a very resourceful place to work on the Aerospace Design Project. This is where my team decided to print out our nozzle. We sent over our design, where it was in a queue waiting to be printed. When we send the design over, HSDC representatives assisted us in choosing which printer was the best for our nozzle’s dimensions. There are three different printer types at the HSDC including: FORM 2 SLA Printer, Direct to Fabric Printer, and the Large format poster printer. Our design was printed using the FORM 2 SLA Printer. My team also visited the machine shop. This is where students can safely work on projects and labs that support the development of research and design applications. This center is right next to the HSDC, which is very convenient. Lastly, our team went and visited the Digital Scholarship Center. This center has multiple resources that could be helpful for us during this project. They have a 3-D printer right next to the DSL, which is accessible to students. In the DSL, there are computers, workshop rooms, and seating areas for groups of people. This center has many software applications and studios that can be helpful when doing the modeling/design part of this project. The DSL can also be helpful when it comes to working together on the visual aid part of the project. The room is set up so you can safely work together on the project as a team. Overall, the Harris Student Design Center (HSDC), Machine Shop, and Evans Library Digital Scholarship Center (DSL) are very resourceful.

Harris Student Design Center: https://www.fit.edu/engineering-and-science/about/facilities/harris-student-design-center/
Machine Shop Info: https://www.fit.edu/machine-shop/
Digital Scholarship Library: https://lib.fit.edu/dsl/

*Students who want to work in the HSDC, Makerspace, and Machine Shop should complete "Hand and Power Tools –Electric" training which can be found at: https://support.fit.edu/vividlms/





A Venturi tube is a classic model used to represent the constriction of fluid flow between two objects. The tube itself is often portrayed as an hourglass shape, which forces the fluid into a confined space for a brief period of time as it flows through the application. Giovanni B. Venturi, Italian scientist, derived this principle from the work of Daniel Bernoulli, author of Bernoulli's Principle:

Bernoulli's Principle

Theory - Equation

$$P_1 + \frac{1}{2}\rho V_1{}^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho V_2{}^2 + \rho g h_2$$

Where (in SI units)

P= static pressure of fluid at the cross section
ρ= density of the flowing fluid
g= acceleration due to gravity;
v= mean velocity of fluid flow at the cross section
h= elevation head of the center of the cross section with respect to a datum.

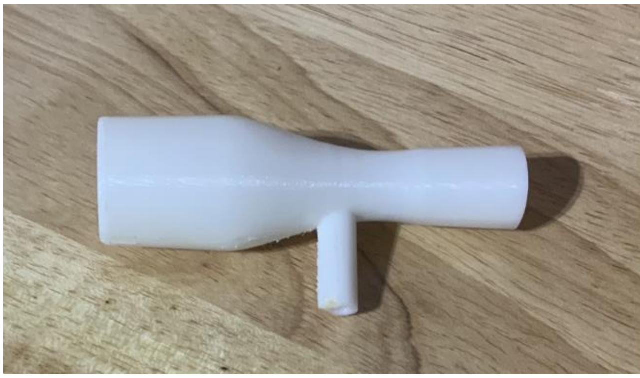
"Bernoulli's Principle." *Quizlet*, https://quizlet.com/ca/397552082/bernoullis-equation-flash-cards/

In summary, Bernoulli's principle can be described as the inverse relationship between velocity and pressure of a fluid or gas. As fluid flow increases, the pressure decreases and vice versa. This means that as the velocity of fluid flow increases in the hourglass model, the pressure significantly decreases at the midpoint. As this occurs, a partial vacuum is created due to the extreme vector conditions of the fluid. This concept is clearly visible in our model, as the hourglass pinches off toward the center, creating a confined environment.

The Venturi Principle is important in many engineering applications, as it is an ideal model for fluids and gases in streamline flow. For example, a large-scale Venturi application can be used to remove liquids from reservoirs and atomize them. To accomplish this, the respective fluid is sucked in by the Venturi system, forming a negative pressure gradient upon arrival at the decreased cross-sectional area. Because the total pressure is negative, the fluid is pulled through the midpoint outlet valve where it moves on to the next leg of the system. Additional applications that utilize this system include carburetors, pneumatic maintenance units, wine decanters, jet pumps, and fuel injectors.

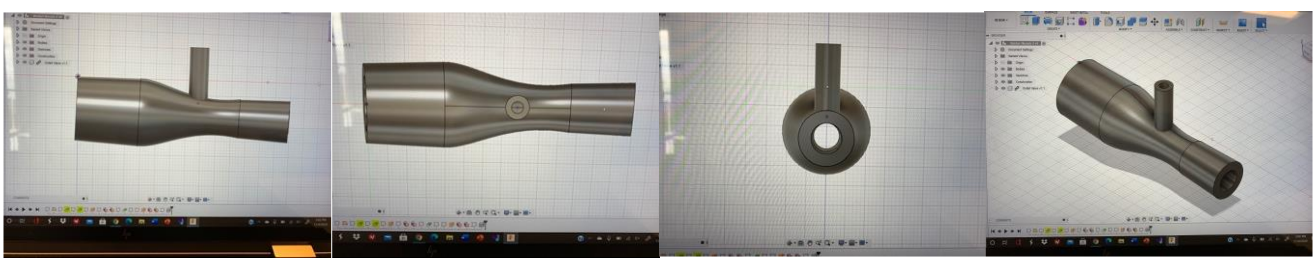
4. The Visual Aid and how you made it. (S.B.)

Our visual aid started with the 3D nozzle Shayla had printed on campus. I put together a water rig at my house to demonstrate its properties. The rig starts with the water inlet of a standard hose connection for convenience. Next, is the adapter connecting the hose connection to the pipe. The pipe has another adaptor on the other end connecting it to the nozzle. The nozzle will be the outlet as well as where the vacuum is created. A small flexible hose is connected to the tapered section of the nozzle. This is so it can connect and reach whatever variable is to be moved. Luckily, the entire rig only needed a little Plumber's tape and pipe glue. The sections were secure enough to ensure water tightness for the given pressure. The nozzle itself did require a little sanding. A garden nose was connected and the suction tubing was placed in a glass of water to demonstrate the result.



5. Related CAD Model (S.W.)

Using Autodesk Fusion 360, I developed a small-scale Venturi nozzle that was implemented in our visual aid. I 3D-printed the part after drafting a few different versions of the model. In order to construct the nozzle, I first drew a center line in the front plane; I built the exterior around that. I used a spline in the middle to construct the pinched cross-sectional area and then revolved the object around the center line after I set my reference points in the appropriate locations. After the main body of the nozzle had been completed, I built a separate component for the outlet valve. I then merged the parts and saved the STL file for slicing at the HSDC.



6. Teaching someone using the visual aid (T.F.)

The Venturi nozzle is a fantastic example to teach someone about the physics of Bernoulli's principle, the Venturi effect, and even the principle mass of continuity. Once the visual aid was constructed, we scheduled a time to hook it up and teach someone. Since the rig was fabricated and put together at S.B.'s house, she "volunteered" her significant other to be our guinea pig. I was able to teach this concept via Zoom while having C.S. physically operate the rig. First, we hooked up the rig to a standard water hose and put the suction hose in a glass of water. He was instructed to turn it on when ready and warned about the possibility of getting wet. I took the time to describe the rig and how it worked as well as the physics behind it. Luckily, Chris is smart and understood all the concepts which made it very easy for me. Once we were done, we took our photo with the new full glass of water and turned the water pressure down to illustrate the concept rather than the effective, yet fun, jet stream we had created across the yard. We had a lot of fun putting together and teaching this concept while maintaining social distancing.

7. Lessons Learned (K.B.)

A big lesson learned from working on this project is how important teamwork and collaboration is. This project required everyone to contribute and do their part in helping make this design come to life. Working together allowed the team to draw from each other's experiences and knowledge, efficiently designing a Venturi nozzle. This skill is very important when it comes to engineering and will be very useful in the work force. Time management is also a lesson our team has progressed on. With the virus happening, getting the whole team together proved to be difficult. Nonetheless, our team worked through it and scheduled Zoom and In-person meetings. In addition, another pivotal lesson learned was being responsible. Our project was split up into different parts, with each team member having a section to complete. All team members learned the importance of making sure their work was finished on time. This relates to the engineering field greatly, for engineers must perform timely tasks to the standard of professional behavior that requires adherence to the highest principles of ethical conduct. Furthermore, the team learned how to use Autodesk Fusion 360 CAD drafting software. When creating our valve design, we learned how to merge parts (the main body and outlet valve) and slice the model for the 3D printer. This software is very common and vastly helpful for engineers. Becoming familiar with CAD software is beneficial for the team as we continue in our engineering degrees.

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