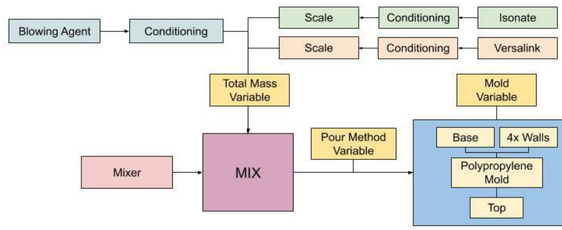
Impact Mitigating Foam

Experimental Mechanics Laboratory

Team Foam Busters

Sponsored by: Dr. George Youssef



System Level Diagram

Everyday we take impacts to our body. Whether it is simply running or taking hits in football, impacts are a part of our lives. One of the most common ways to mitigate impact is through foam. Foam is primarily used because it has a high energy dissipation to weight ratio. As a team we focused on optimizing lightweight foam samples created using a patented manufacturing process. This foam must mitigate high peak forces and increase the amount of time to reach such forces.

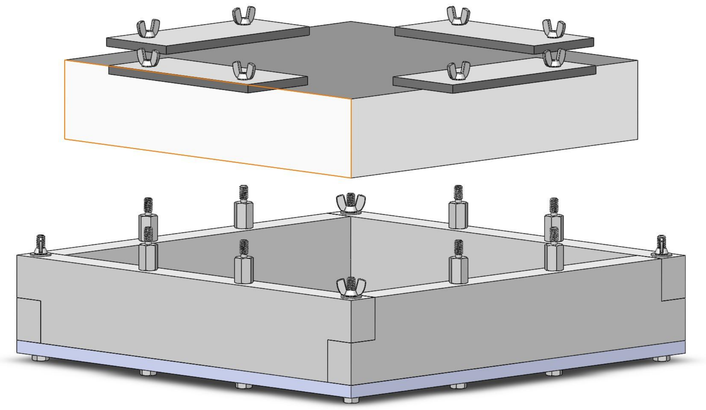
These characteristics will be beneficial to many future prospective applications. The National Football League (NFL) had a record high of 281 head injuries during the 2017 season. Due to this, the NFL has begun to recommend advanced helmets, leading to the NFL's HeadHealth TECH Challenge. This competition challenges participants to develop helmet technologies that will effectively reduce impact forces, therefore reducing head injuries.

Our sponsor, Dr. Youssef, is participating in this challenge and tasked us to help him improve upon his patented foam manufacturing process. The current patented foam has a density of 120 kg/m^3 . Our goal is to reduce this density to 80 kg/m^3 . This density will not only reduce the weight of the foam, but also allow for a higher impact mitigation.

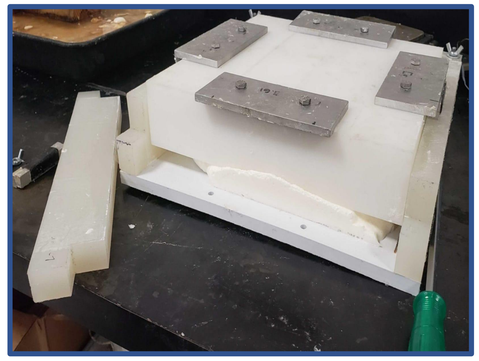
Meet The Team

Jonathan Ethridge
Brandon Winsatt
Christopher Khoury
Antonio Maldonado

Polypropylene Mold



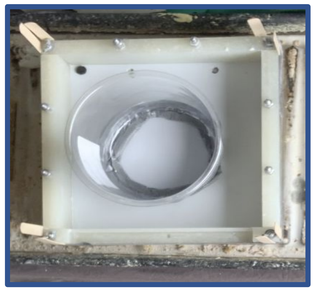
- **Polypropylene allows for enhanced cleanability**
- **Spacer design allows for variable foam heights**

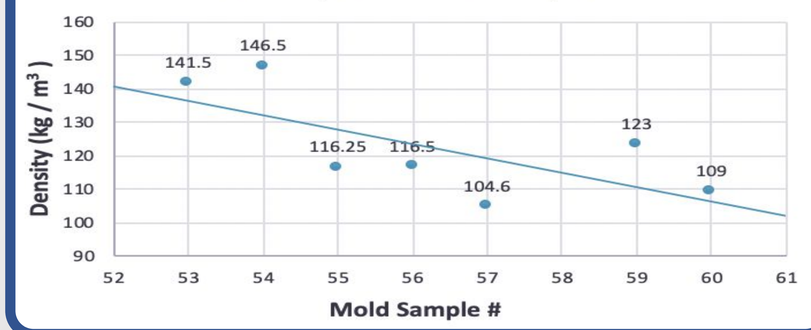


Manufacturing Variables

- **Gravity After Pour**
- **Optimizing Pour Patterns**
- **Draining**
- **Spreading w/ Spatula**
- **Compress/Raise Top**
- **Pouring on a Tilt**
- **Absorption**
- **Pour with Funnel**

Closed-loop system removes variability by eliminating pour method and allowing for a better spread of slurry, resulting in a higher percent volumization. Mixing, pouring, and curing are all in the same location. Drainage holes were added to remove unwanted material.

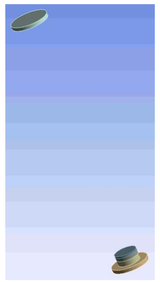




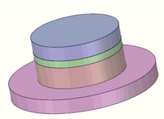
Impact Drop Test - ANSYS Simulation

→ **Simulated 36 configurations analyzing peak force and rise time. Samples with the lowest peak force and high rise time are ideal.**

ANSYS Simulation Impact Drop Test



Layered Foam Sample



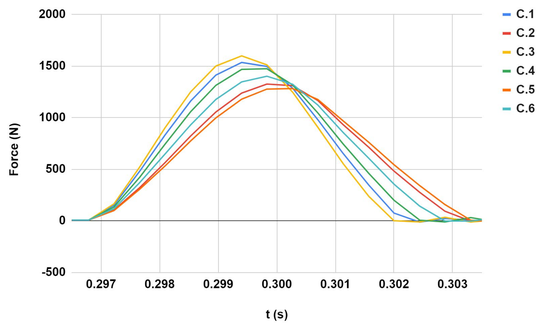


***Figure 1:** Force-time relationship at first impact of six different thickness configurations retaining a modulus of elasticity of E = 5.0 E7 Pa, E = 2.7 E7 Pa, and E = 1.0 E7 Pa, corresponding to a three layered polyurea foam, respectively, at a total thickness of 0.75 inches, simulated by ANSYS.*

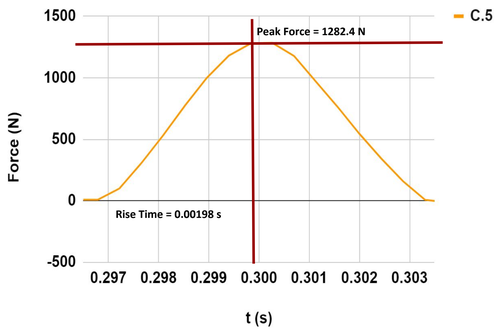


***Figure 2:** Force-time relationship at first impact of the C.5 configuration retaining a modulus of elasticity of E = 5.0 E7 Pa, E = 2.7 E7 Pa, and E = 1.0 E7 Pa, and a thickness of t = 0.125, t = 0.25, and t = 0.325, respectively.*

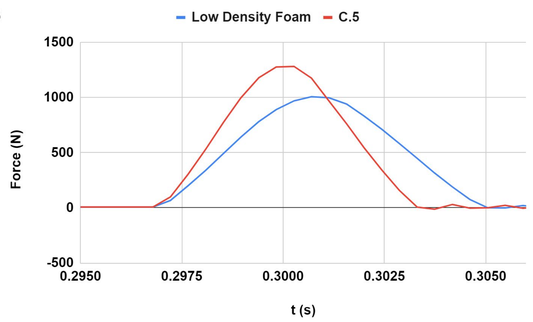


***Figure 3:** Comparison of the C.5 configuration and a theoretical low density foam that will retain the lowest impactive force and high rise time.*

Spring 2020, Project 24