

Team 1Cat

Sruthi Anil Raygan Bingham
 Ruben Bonilla Grayson Briles

Vehicle Impact Attenuation

Problem Statement

Approximately 2,500 crashes occurs between vehicles and fire trucks parked as blockers on highways and busy roads each year. First responders responding to vehicle collisions oftentimes park their trucks as blockers to help protect the crash-site and individuals on the scene. This set up leaves responders susceptible to additional highway crashes. These accidents cost departments millions of dollars in repair costs, leaves drivers and responders severely injured or killed, and emergency vehicles out of commission.

Lab Time: 12:30 PM, Tuesday & Thursday

Lab Coordinator: Cristiano Miguel Cabrera

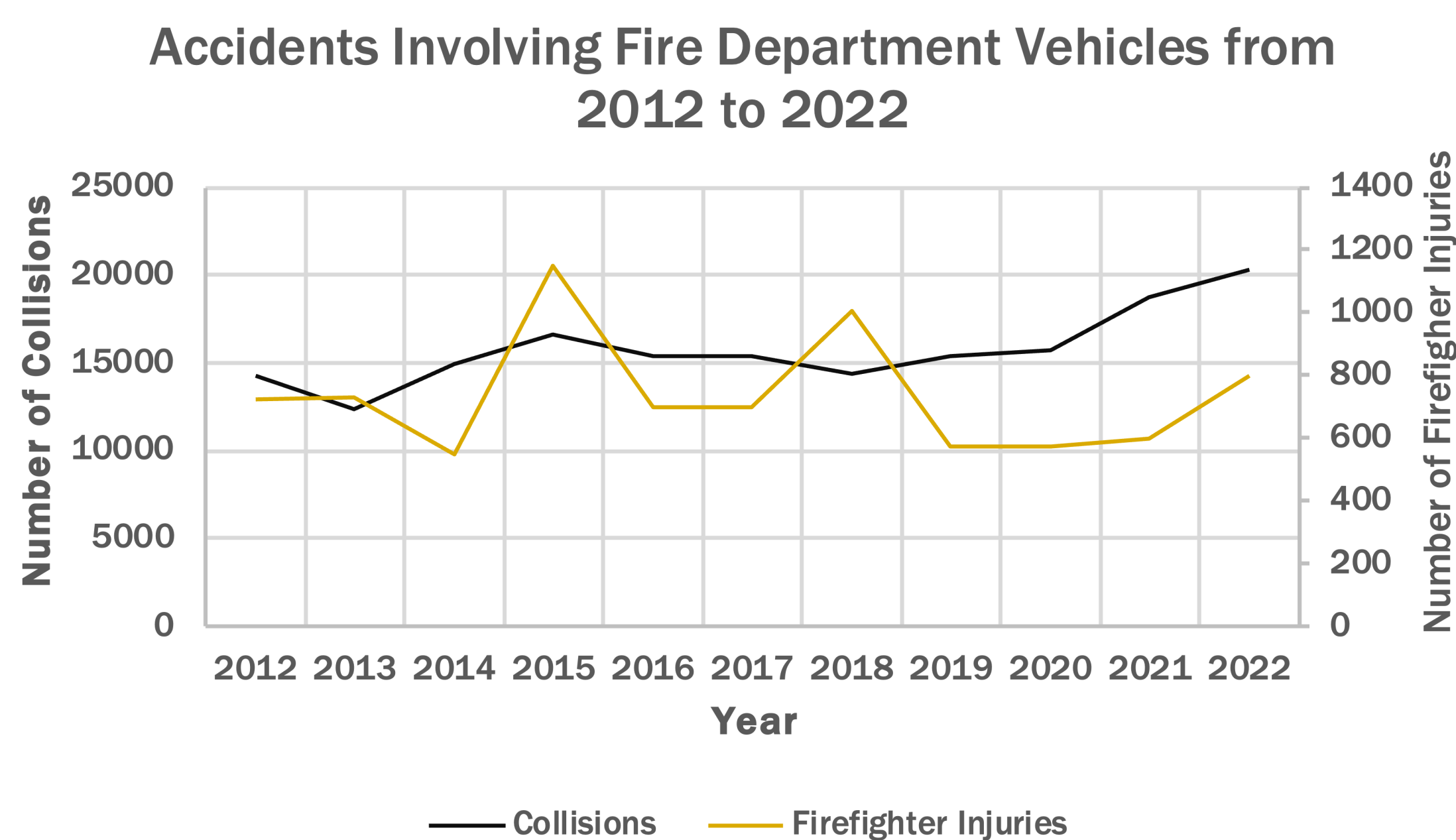


Figure 1: Accidents involving fire departments from 2012 to 2022

Primary Requirements

The primary goals of this apparatus are to improve upon the ease of use, risk negation, financial viability, and visibility of current market solutions. Associated with each of these goals, the product must be easy to maneuver, be capable of blocking multiple lanes completely, withstand multiple high velocity crashes, be quick to set up at the scene, and effectively warn roadway users of its presence, all at a practical price point.

To meet the ease-of-use requirement, the product must make turns easily, have a reasonable stopping distance, and require no special licensing to drive. To effectively protect crash sites, the apparatus must be able to both block one lane and multiple lanes with equal effectiveness, all while mitigating risk of injury to first responders as much as possible. Additionally, the product must withstand regular collisions without requiring intense repair. In order to accomplish this, the apparatus was designed to have shielding to all vulnerable components, as well as multiple layers of redundancy in the event of all types of collisions.

As previously mentioned, it is also important that it does not pose an increased risk to first responders in the event of a "worst case collision," chosen to be a tractor-trailer at approximately 40mph, and is of low production cost (less than \$500,000) and low repair time (less than a month for small repairs, less than two months for more intense repairs.).

Primary Concept Description

In order to gain useful feedback from potential end-users, interviews and in-person discussions of current market solutions were conducted with multiple fire departments. This yielded further insights and resulted in multiple design choices that allow for the new design, the Vehicle Impact Attenuator Apparatus (VIAA), to have an edge over the few market solutions available now. These modifications are seen in Figure 3, which shows the most recent design, and some of them are discussed below:

- The internal cabin is equipped with numerous integrated technologies, such as displays for cameras providing a full 360-degree view of the vehicle, communications equipment for accident response logistics, and controls of lighting systems on the vehicle. The cabin also utilizes bench seating and provides ample room for drivers and passengers to enter and exit from both sides of the vehicle.
- Impact absorbing materials are used on all potentially exposed sides of the vehicle, which include honeycomb-like Negative Stiffness repeating structures on the sides and the use of an adjustable-angle Scorpion impact attenuator for the rear.
- In the case of higher energy collisions, a robust steel frame and thick steel external paneling allows for little to no damage to the chassis or any sensitive components, such as the cabin, wheels and axles, drivetrain, and electronics.
- A large overhead lightboard with flashing arrows can redirect traffic and alert roadway users of the accident from great distances. As well, the use of easily replaceable warning lights along the length of the vehicle warns any vehicles closer, and the use of standard emergency lights and sirens provides all of the same benefits as any other emergency vehicle.

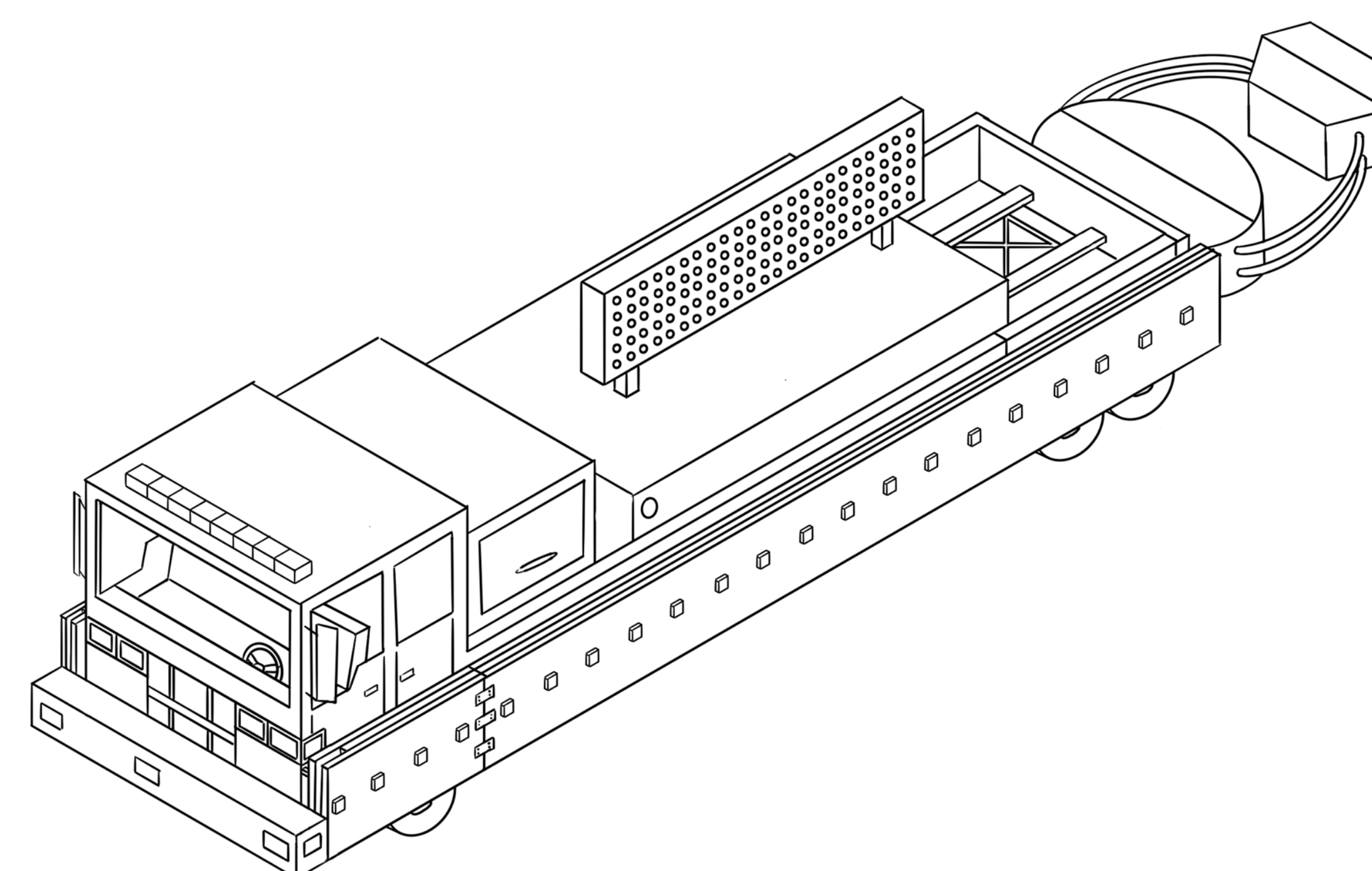


Figure 2: Current iteration of the VIAA

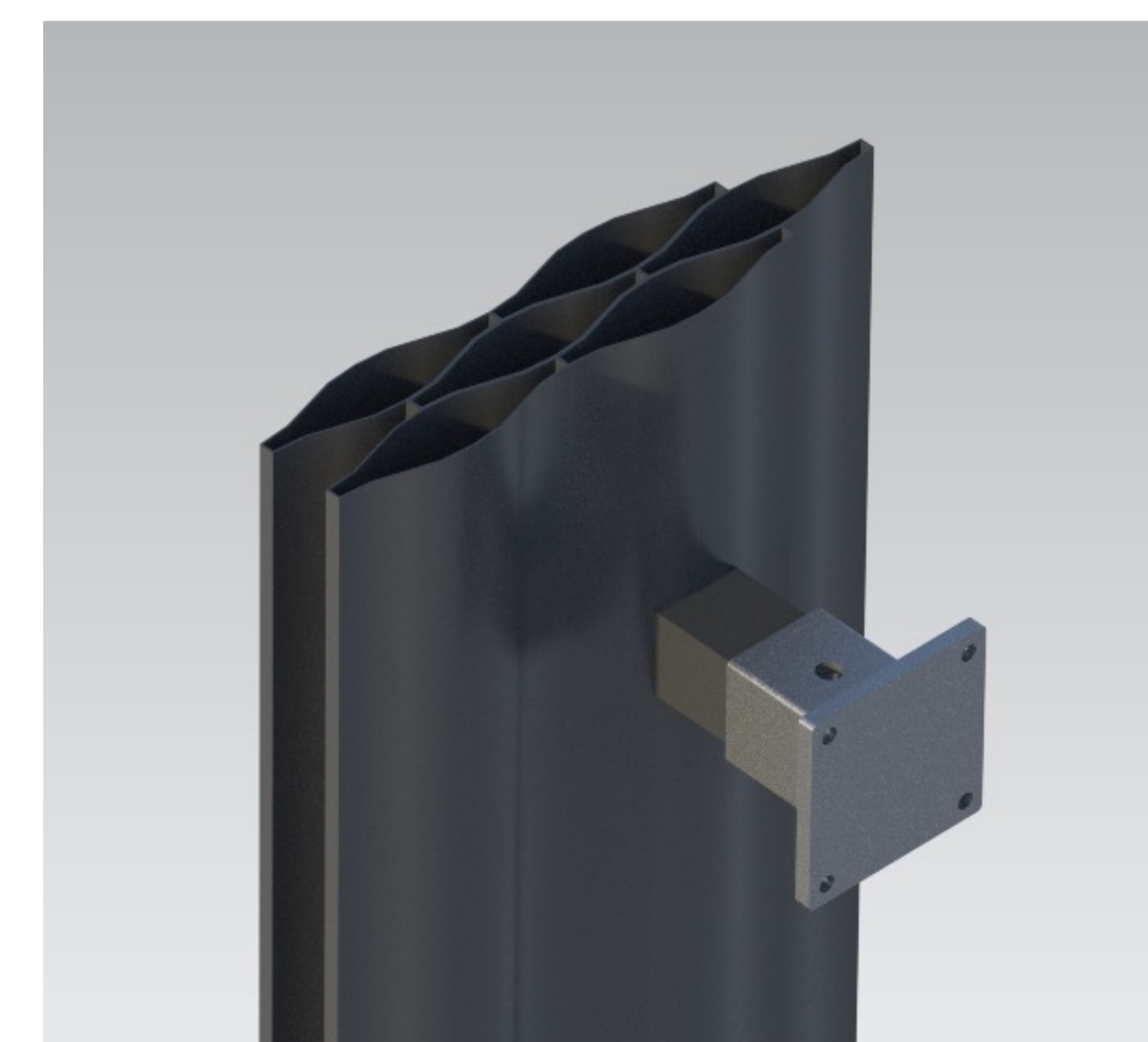


Figure 3: NS Honeycomb Material

Comparison to Benchmarks

Consumer Requirements	Vehicle Impact Attenuator Apparatus	Blocking Trailer	Retired Engine Retrofit
Procurement Cost	0	-2	2
EMS Safety	0	1	1
Driver Safety	0	1	-2
Visibility to Drivers	0	-1	-1
Ease of Use	0	-3	0
Blocking Capability	0	0	-3
Mechanical Reliability	0	0	-3
Total	0	-4	-6

Figure 4: Comparison to current market benchmarks with current design set as a datum.

Implementations

When first responders arrive at accident sites, one of the most important steps is to block the site from oncoming traffic to ensure no more lives are endangered in the process of providing medical care, fire suppression, and more. If only one lane needs to be shut down, which is often the case, a responding vehicle is parked "upstream" from the accident and is often more than capable of providing all of the protection needed for that situation. However, when multiple lanes need to be blocked and a blocking apparatus is not available, a fire truck is often parked at a 45 degree angle, allowing for traffic to "flow" around it and leave a protected space "downstream." Both of these approaches would be utilized in the case of the Vehicle Impact Attenuator Apparatus, however, the implementation of the Scorpion TMA device provides top-of-the-line rear impact protection, while the impact absorbing materials, sturdy construction, and high relative weight provides excellent side impact resistance. All of this is visible in the prototype on display, which shows an accident scene with responding vehicles in a proper configurations for multiple potential implementations.