Executive Summary

Sponsored by Fred Hamud, the purpose of this project was to develop a universal vehicle equipment rack that could accommodate various types of equipment by attaching to the hitch of sprinter vans. Conventional vehicle racks in today's market are designed to accommodate a single type of equipment like bikes or surfboards, requiring constant attaching and detaching of different racks for each equipment type. This makes it difficult and tiring for users to efficiently pack all the necessary gear for outdoor activities. The motivation for this project was to design and manufacture a modular universal rack that was: versatile with the types of equipment it can rack, accessible for ordinary users to customize, durable to withstand a maximum load of 500 lbs, and cost efficient to be less than current competitors.

To reduce the cost of the rack while optimizing its structural integrity, the modular rack was composed of 1018 cold rolled steel and was structured after a hollow u-channel with tapered ribs to minimize the displacement experienced at the ends of the rack to 0.12 mm. Vibrational forces from driving were also minimized by selecting 1018 steel, with a young's modulus of 200 GPa as opposed to aluminum with a young's modulus of 68 GPa. The universal rack was designed with 4 square openings to support modular vertical attachments for surfboards, skis, and lockers. These vertical components were designed to slot into any of the 4 openings of the rack and then be secured into place with a sliding locking mechanism integrated into the internals of the u-channel. The surfboard mount was the only vertical component manufactured due to time constraints and was prioritized by request of the sponsor. With the component's strength-to-weight ratio in mind, the surfboard mount was manufactured using both 1018 steel and 6063 aluminum and features a tray lined with neoprene to seat the boards and adjustable rotating arms to prevent the equipment from moving in the horizontal direction. To test the rack, FEA analysis was performed on the structural design of the rack after each iteration and was theoretically determined to withstand a load of 500lbs while experiencing a maximum displacement of 24mm at the ends proving strong enough to hold multiple pieces of equipment. By giving users the flexibility to customize modular equipment attachments and optimize space in their cars, the Hamud Universal Rack saves users time and money during their trips and outdoor excursions.