FORMULA SAE: EXHAUST

COMPONENT DESIGN

As a member of the powertrain team, I worked to create a flange and flange spacer to mount the exhaust manifold to the motor on Viking 59. The previous design worked but had a few known issues. The V58 flanges were .25” thick steel. While strong it was deemed unnecessary by the powertrain team. I designed the new flange to be water-jetted out of thinner .1875” steel, I also created a few cutouts in order to remove additional weight. During this project I learned that sharp corners are stress risers and can lead to failures, especially in high heat applications such as exhaust components. I worked around this by eliminating the sharp corners of the cutouts and instead using semicircles. I modified the outside shape of the flange, creating a silhouette closer to an oval to remove material in places where structural integrity is not compromised.

An issue with the previous V58 flange spacer is that the exhaust port on the CBR600RR motor is 1.3” and the internal diameter of the exhaust tubing is 1.25”. I consulted several texts on exhaust design and concluded this step in diameter is poor for flow and can cause turbulence in the exhaust stream. To combat this I designed the new spacer with a chamfered inner diameter to match the exhaust port size. The exhaust runner slips in up to the base of the chamfer and will be chamfered at the same angle. This will ensure a smooth continuous transition to 1.25” in order to mitigate turbulence.
Formula SAE has many rules and design requirements that components must conform to. The rule book states that “The final drivetrain shield must cover the chain from the drive sprocket to the driven sprocket. The final drivetrain shield must start and end parallel to the lowest point of the sprocket” (bottom right). Not only is it important to conform to the rules as performance in the overall competition depends on it, but the chain guard is an important safety feature to protect the driver and bystanders, as well as prevent catastrophic failure that can occur by a broken chain puncturing the engine crank case. I designed the chain guard to be made of .105” steel as the rules require, and to the minimum required width dimensions so that no more weight is added than absolutely necessary. The chain guard hoops will be bolted into brackets on the differential box to have a solid foundation should the chain fail.
LONGBOARDS: MOLD CREATION AND VACUUM BAGGING

Longboarding started out as a hobby for me, and as my skill increased I developed ideas of what I wanted in a board. I started to design and create my own. This is one of my favorite creations, a “drop deck” which means the standing platform is lower than the truck mounts. I started this project by drawing the shape to scale on a large sheet of paper. I then transferred the drawing onto a sheet of 1.5” extruded polystyrene insulation foam that I shaped with an orbital sander. This material works well for molds because it is cheap, easy to shape, and has a high crush resistance that can stand up to the pressure of the vacuum bag. For drop deck longboards you must glue the mold to a rigid plywood backbone to ensure the trucks will be on the same plane (pictured above).

Longboards do not have bindings like snowboards so in order to maintain grip while turning, various concaves are pressed in. The various bends help to “cup” the heels and balls of your feet and also serve as reference points so that you may shift your feet on the standing platform without looking. I constructed this particular board out of 9 plies of 1/16” Canadian Maple to provide a rigid “chassis” and minimize flex, which can lead to instability at high speeds. I’ve found that Titebond III is a great glue for this because of its long wet-time and strong adhesion. The first two layers are glued together and pressed overnight, and in cases with extreme bends such as this, it works best to add on one ply per layup after the initial lamination is cured. Once all the plies are added, I then transfer the center line from the mold onto the wood “blank” to use as a reference to place the trucks. Pictured in the bottom right is a template I designed on Rhinoceros and laser cut from acrylic to ensure accurate drilling and proper truck alignment.
After the blank is marked with a center line I then trace the design onto it. Initial shaping is done with a band saw or jig saw and intricate final shaping is done with a belt sander. The finish is important since wood will degrade with exposure to moisture, leading to de-laminations and compromised rigidity. I finished this particular board with a waterproof clear coat to let the natural wood grain show and applied 24 grit grip tape to the standing platform. While I made this board to keep for myself, I made a few to sell. The board pictured to the right with integrated handles and recessed truck mounting is an example of one.
As a project, I purchased a motorcycle that had a variety of issues. I have been diagnosing, troubleshooting and fixing these issues since I acquired it. The bike had been spray painted with no preparation work; the finish was patchy and most of the paint had flaked off. I installed new plastics which completely transformed the look of the bike. The headlight that the bike came with had a very dim 30 watt bulb which only worked intermittently. After researching I found that the stator could keep power in the battery with a much brighter headlight. I replaced and completely rewired the light with an updated after-market unit which has a much brighter 70 watt high beam. When I purchased this bike it was missing a lock washer on the engine sprocket, which I wasn’t aware of at the time. This led to the sprocket nut coming loose and draining most of the engine oil onto the chain and ground, coating the rear tire. Fortunately, I noticed before making any turns and possibly losing control. Because the sprocket seal was damaged during the ordeal, I replaced it. Looking at part diagrams, I determined that the lock washer was missing. I installed one to prevent a repeat failure.

My car, an Infiniti G35, has been a great learning experience. I have completed modifications to achieve better appearance as well as improved handling characteristics. Most notably I have installed coil-over suspension, as well as after-market control arms to bring the alignment back to factory specifications at it’s lower ride height. I also purchased wider wheels and tires to increase grip. In addition to modifications, I have done all of the routine maintenance myself to gain a better understanding of my car and vehicle systems as a whole.