E28 Technical Binder
2018

Roster

Leadership

President - Lawson Sumner

VP/Shop Manager - Matthew Foster

Lead Engineer - Alex Gray

Sponsorship Chair - Soniya Bhagat

Secretary - Milad Mozayyani

Treasurer - Sunny Chen

Press Secretary - Jordan Rich

General Members

Alexander Olsen
Alexander Wilson
Anderson Duong
Benjamin Engelman
Bryan Borgerding
Casey Todeki
Daniel Kotten
Dennis Henderson
Derek Nixon
Evan Shellow
Harry Scott
Hiten Bhatewara
Jacob Skovran
James Cipolletti
James Lewis
Jeremy Ping
Jeremy Walker
Jiajie Wen
Josh Bredbenner
Joshua Donegal
Lorin Achey
Luke Marino
Luke Teverino
Madison Watts
Max Hertlein
Maxwell Beaver
Minh Hoang
Nolan Knox
Oliver Junnila
Rebekah Travis
Robert Bowden
Ryan Kilgore
Salim Ben Ghorbel
Sam Gilmer
Sam Pendergast
Samuel Choi
Sebastian Lopez
Stephen Zacks
Taekyu Kim
Tanner Liu
Thomas Barone
William Tran
Wyatt Maher

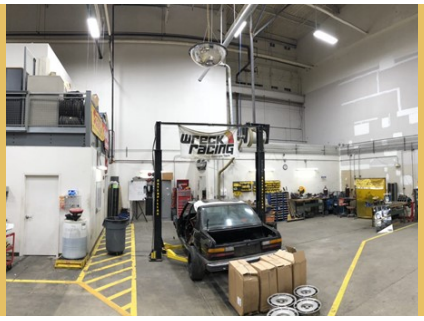
Table of Contents

Goals

Our goal for the GRM $2018 Challenge was to build a focused drag car that could run a 10 second quarter mile time, switching gears from our past focus on autocross performance. With a target weight of 2400 pounds and a power goal of 500 horsepower, our car would put us well above the performance metrics of most $100k cars.

Summary

Our 2018 challenge car is the legendary 80's BMW E28 fitted with the iconic 5.3 liter Chevrolet LS engine and TH400 automatic transmission. It features a custom front and rear suspension biased towards the drag challenge, but still built with handling characteristics in mind. The front was adapted to fit an E36 subframe and coilovers requiring custom control arms to utilize rack and pinion steering as well as provide better geometry for the car. The back contains a solid rear axle with 3 link and coilover suspension.



The E28

The fully operational 1986 BWM E28 was purchased in Savannah, Georgia in February 2017 for $400.

The E28 was chosen because it is a relatively light car and contained a large engine bay that would provide us with the opportunity to utilize as large of an engine that we desired.

First drive into the shop.

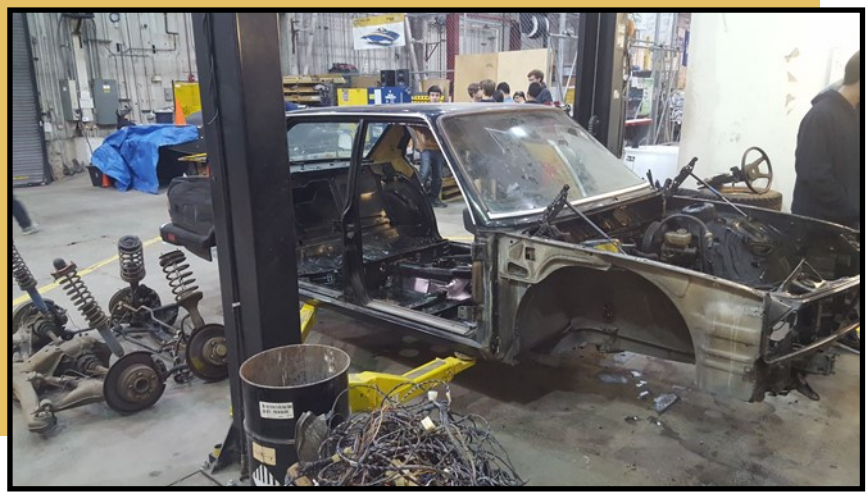
Original interior.

Measuring the size of the trunk.

Just after purchasing the E28.

Preparation

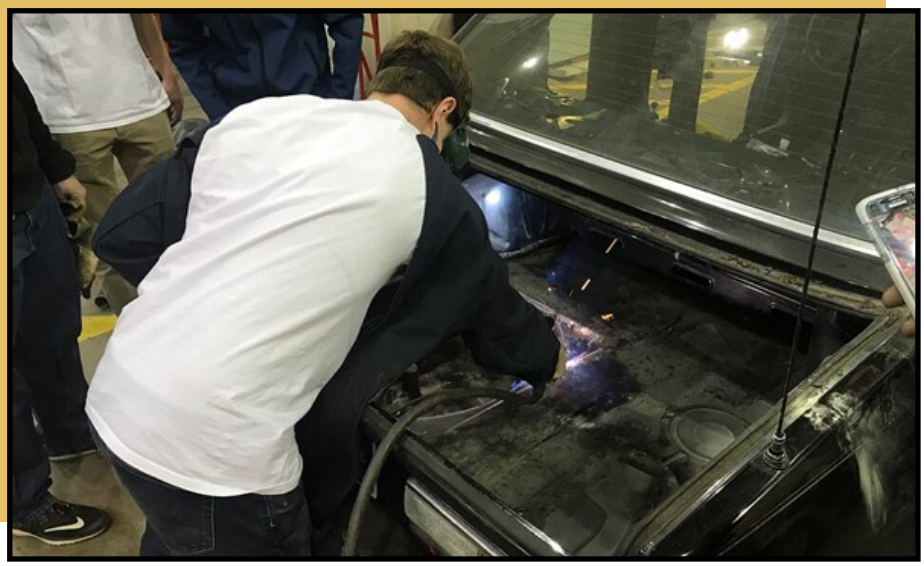
Luxurious interior….



….to just a shell.

The BMW ready for modification with our 2017 GRM challenge Honda Insight relaxing in the background

After trying to figure out how to transport the frame outside without wheels, we realized that we could just carry it as a group.



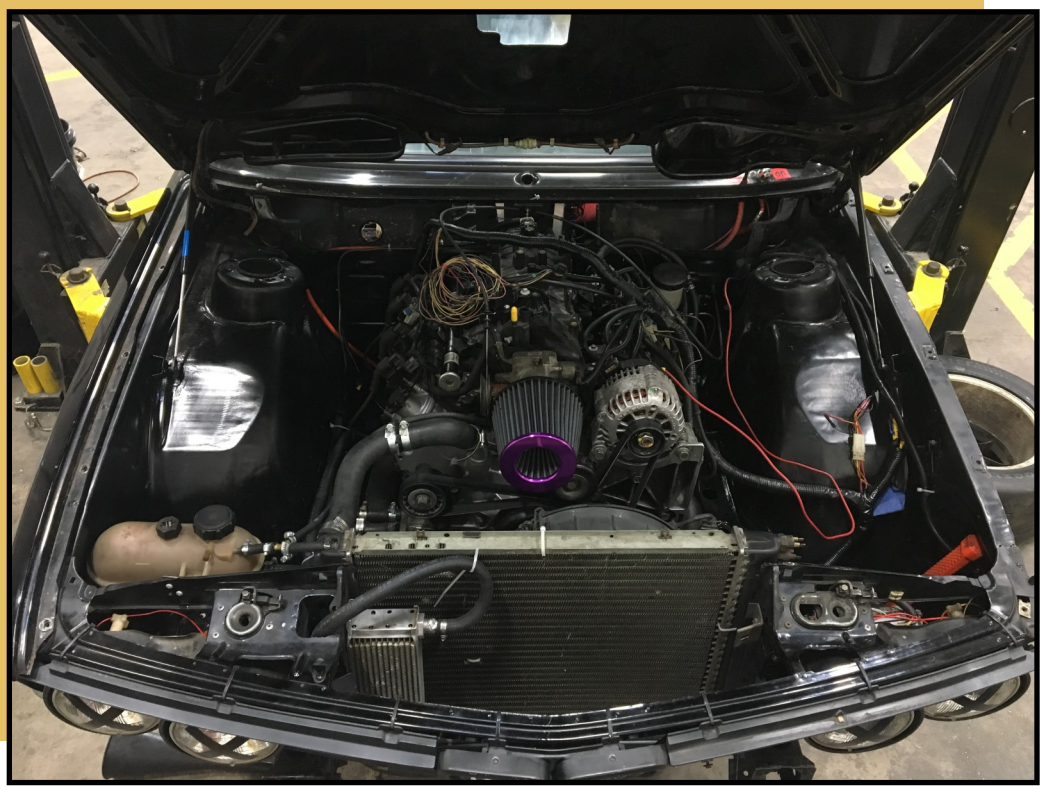
Cutting out the trunk with a plasma cutter in order to prepare for the rear suspension… it was going well until the trunk caught on fire!

Finding Parts

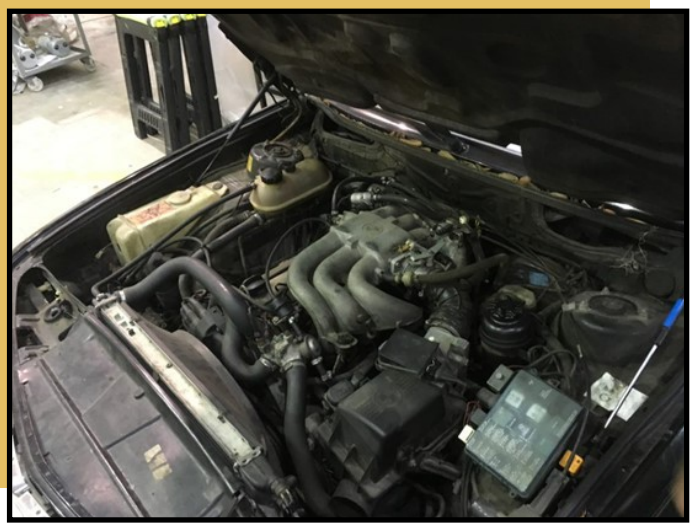
We spent many hours finding various parts for the car including a rear axle from a Ford Explorer, drive shaft from a GMC Envoy, front coilovers and subframe from a BWM E36, and motors from GM trucks.

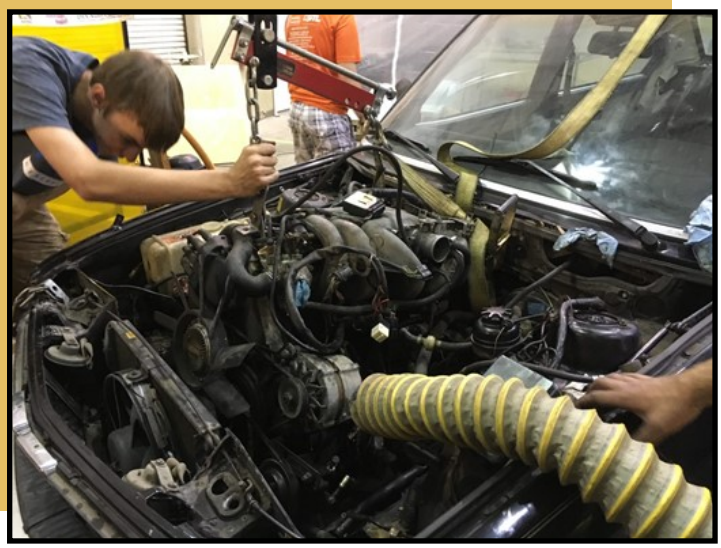
Engine

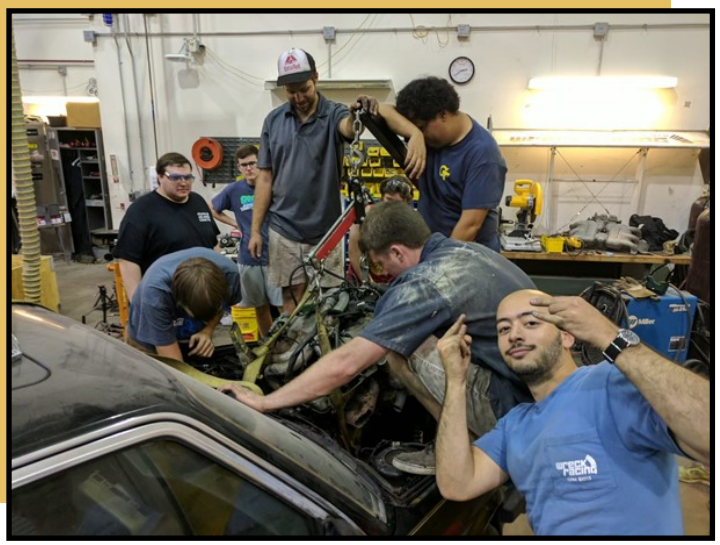
An LS engine was chosen in order to get as much horsepower as could fit in our engine bay. The LS is a cheap, accessible option that bolts to various transmissions and has cheap and easy to find parts.



Out with the old...



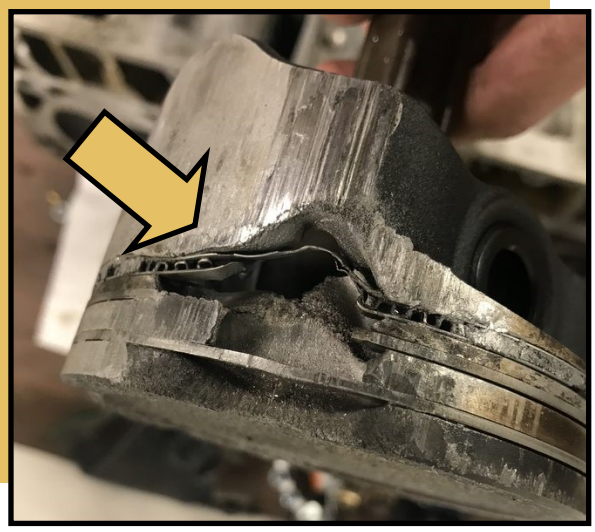




5.3 vs 6.0

Both a Chevrolet LS 5.3 liter and 6.0 liter engine were purchased. However, upon inspection it was found that one of the pistons of the 6.0 liter had a large hole in it which resulted in damage to the cylinder. Therefore the 5.3 liter engine is used in the final product as it was in proper working order after inspection and minor repairs.

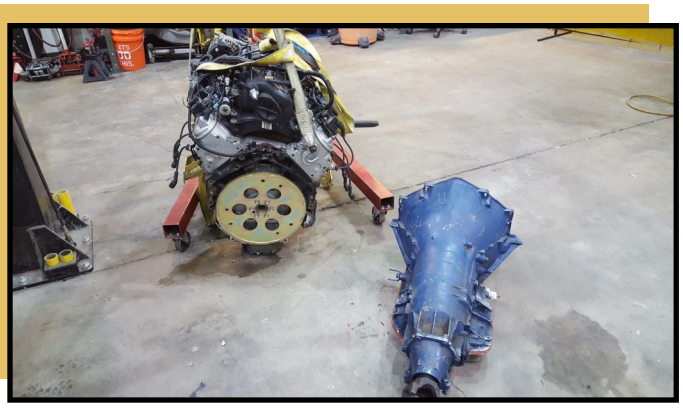
Bringing the engines home.

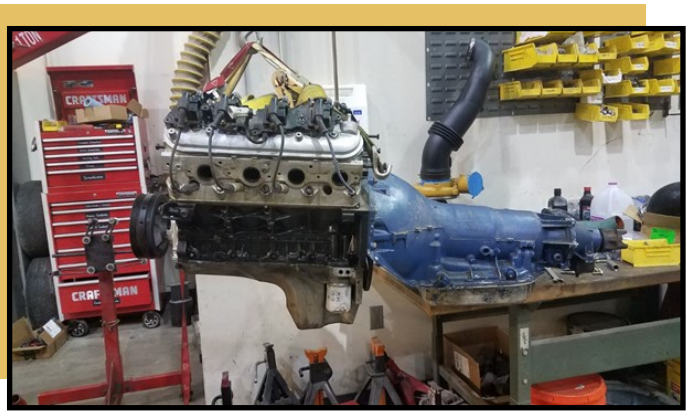


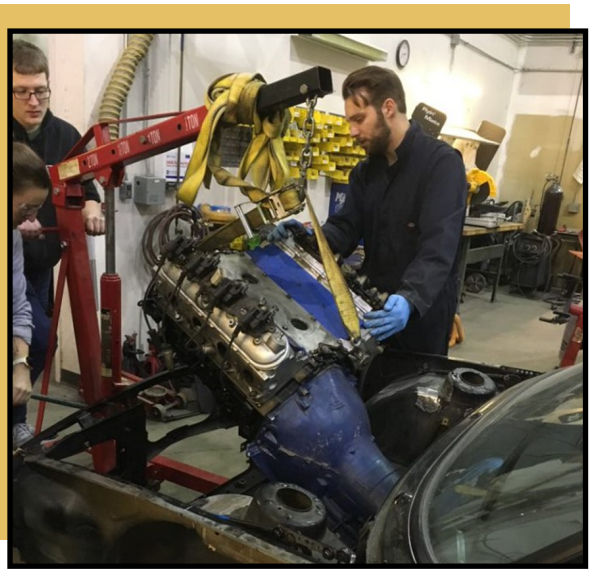
A hole in one of the 6.0 liter engine pistons.

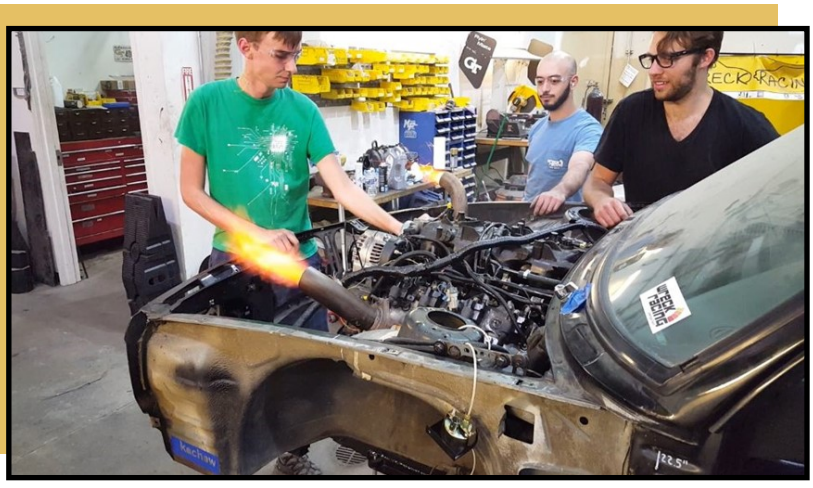
Inspecting the engines.

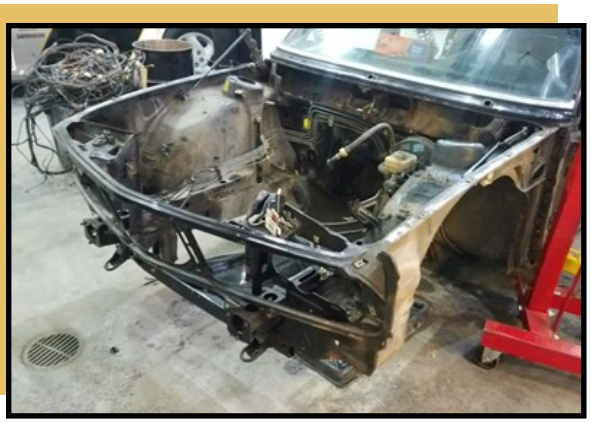
...in with the new

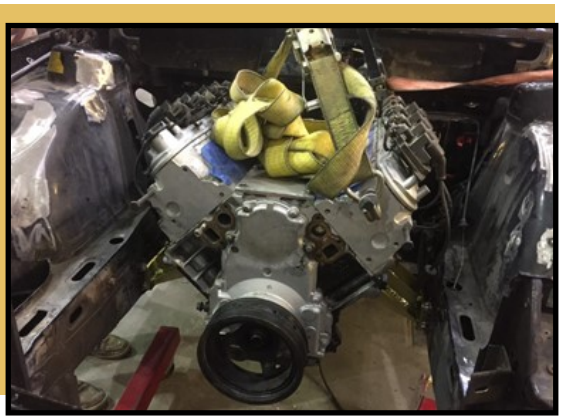


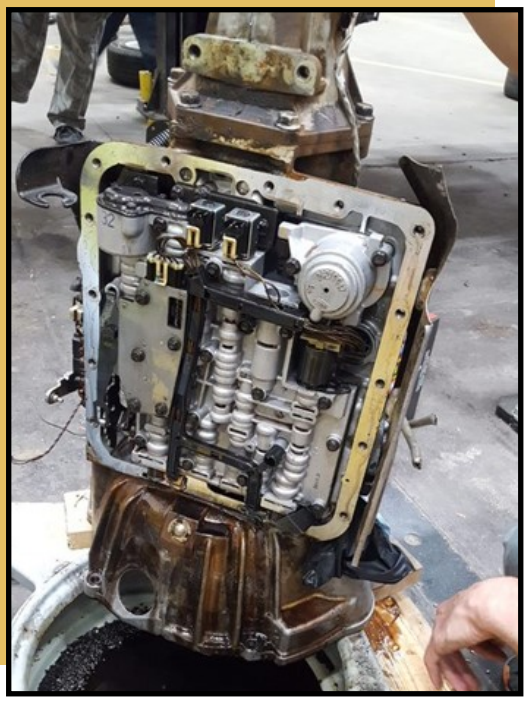






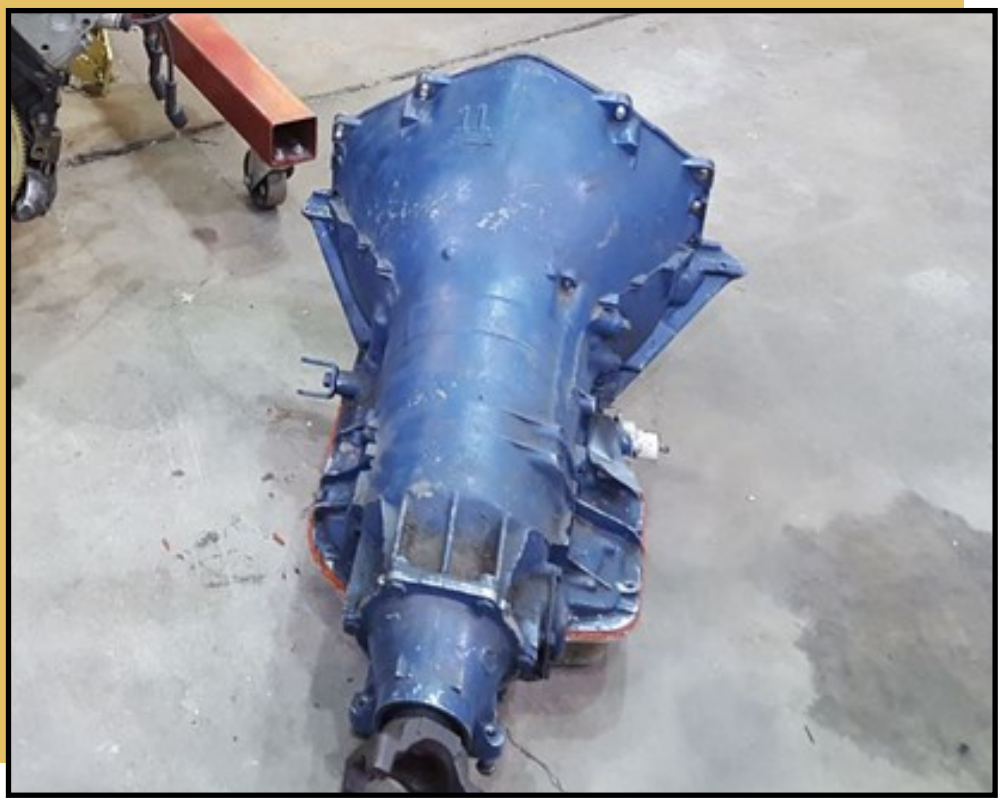






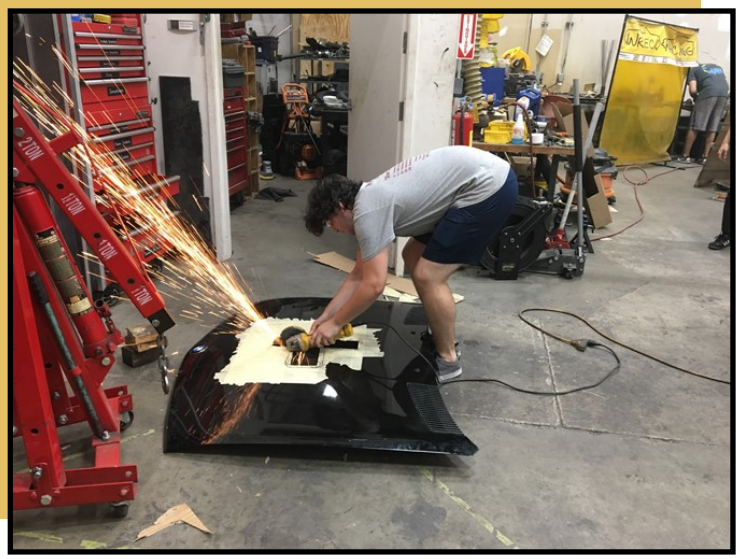
The Transmission

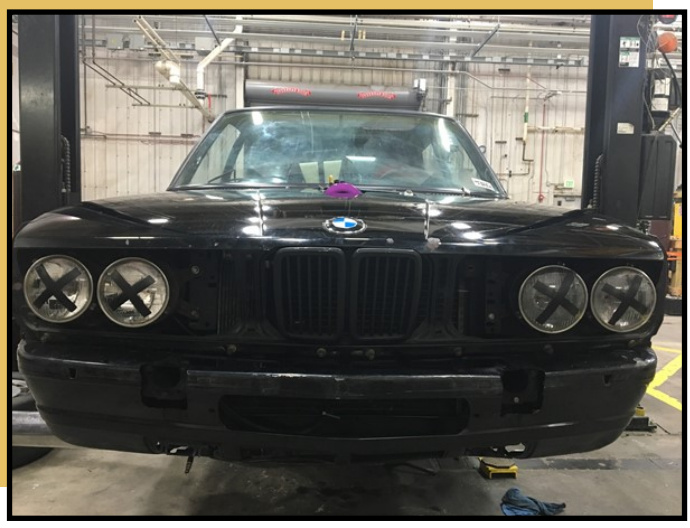
A TH400 automatic transmission is used because we wanted the consistency of an automatic transmission for drag launches, as that is the focus of the E28. The TH400 is a common transmission which can be easily replaced if needed and would be plenty capable of handling the power we expect to produce from the engine.



The Hood

Due to the size of the engine, the hood would not fit properly when closed. Therefore, with the all the accuracy and precision of a piece of plexiglass, cardboard, and masking tape, a hole was cut out of the hood.





The Oil Pan

The original oil pan extended below the modified subframe. Using a spare oil pan, we chopped and modified the structure to shorten the depth of the pan allowing it to sit above the subframe.

The pan proved difficult to weld, resulting in minor leaks after the first test. This problem was quickly solved with JB weld and Flex Seal to STOP LEAKS FAST!

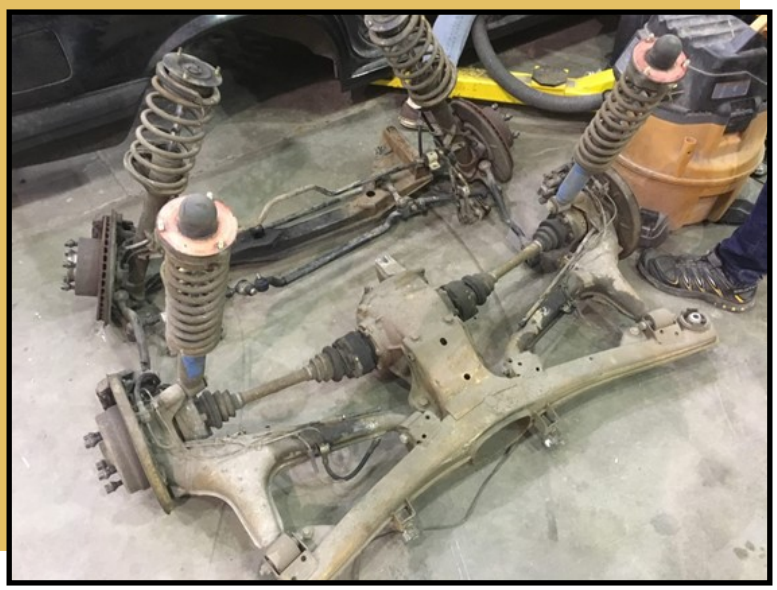
Modifying the oil pan.

The modified oil pan sitting above the subframe.

Instructions according to FlexSeal

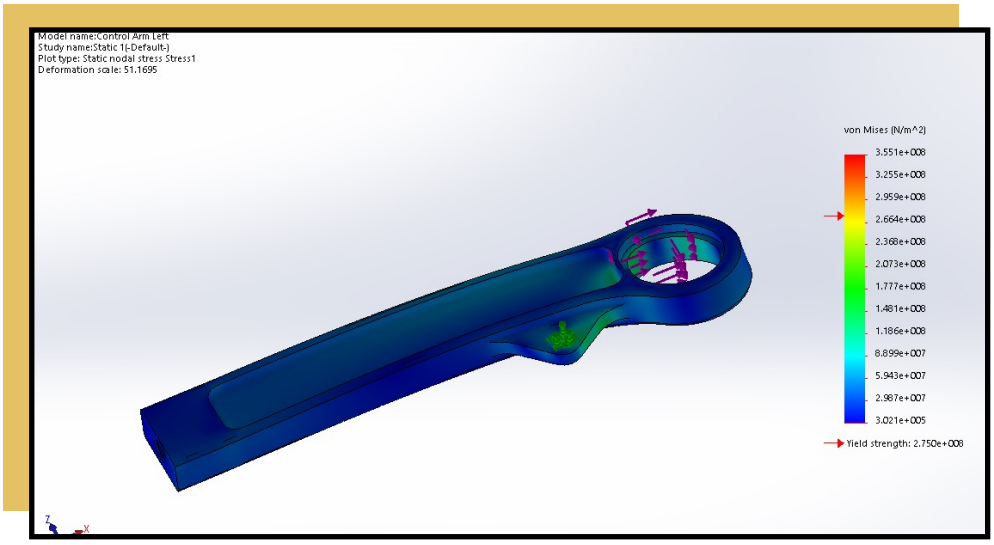
Subframe

In order to switch from the E28's recirculating ball steering to a more responsive and lighter rack and pinion steering system, the subframe of the E28 was replaced with a BMW E36 subframe. This gave us better suspension mounting points and steering geometry.

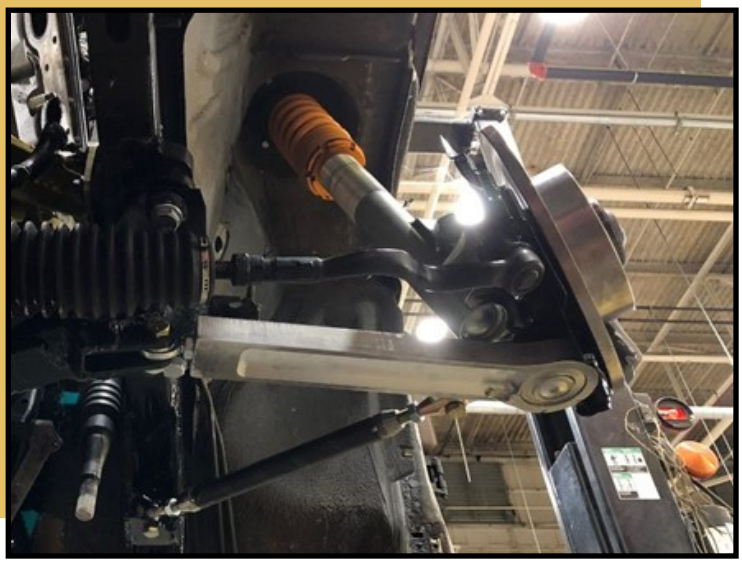


Front Suspension

As we could not use the E36 control arms because they were not wide enough for the top mounts, we had to design custom control arms for the front suspension. Inspired by the control arms of DTM E30 BMWs, our control arms were designed and underwent FEA in Solidworks before being machined. This gave us more adjustability for camber and caster.



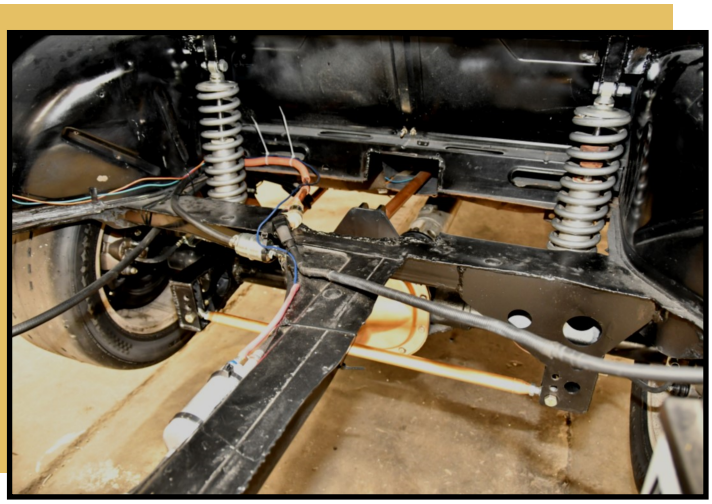
Running the FEA on the control arm design.

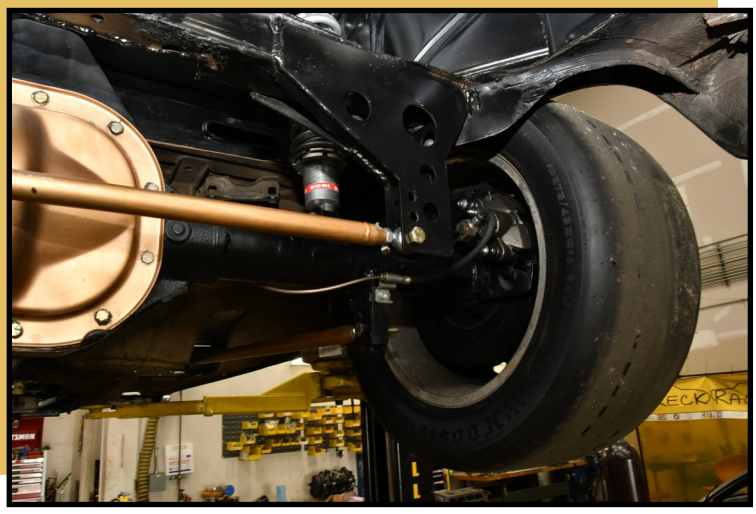


Rear Axle

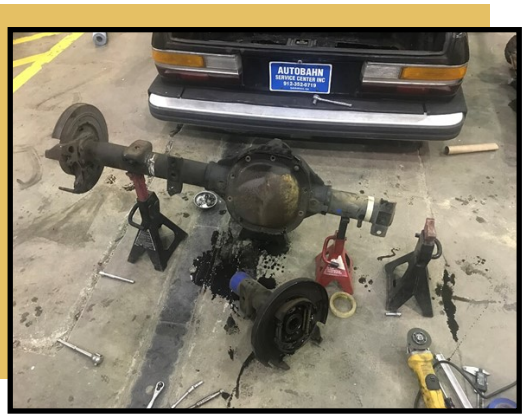
A solid Ford 8.8 axle with a limited slip differential was taken from a Ford Explorer to be used in the E28 as the original rear end of the E28 would not have been able to handle the power of the LS engine. The solid axle would also help us on the drag strip by facilitating even weight transfer to the rear upon acceleration.

The axle was shortened and welded back together in order to position the wheels correctly. In order to locate the axle, a 3-link suspension design was utilized because it was a simple geometry and easy to fabricate, also allowing for plenty of adjustability.

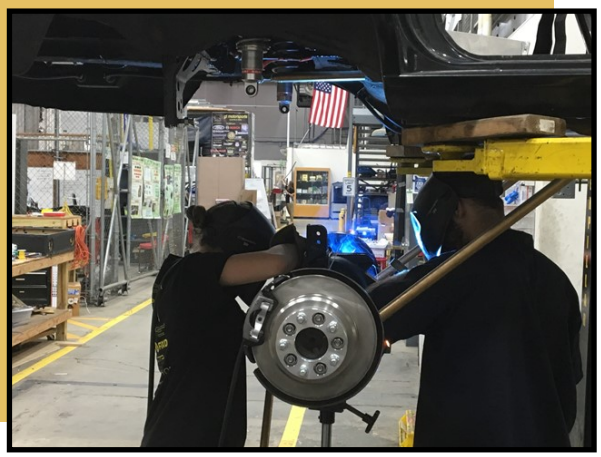




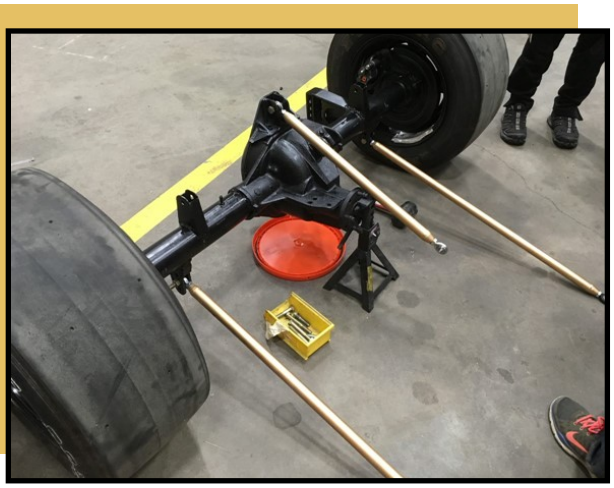
Bringing the axle home.



Cutting the axle.



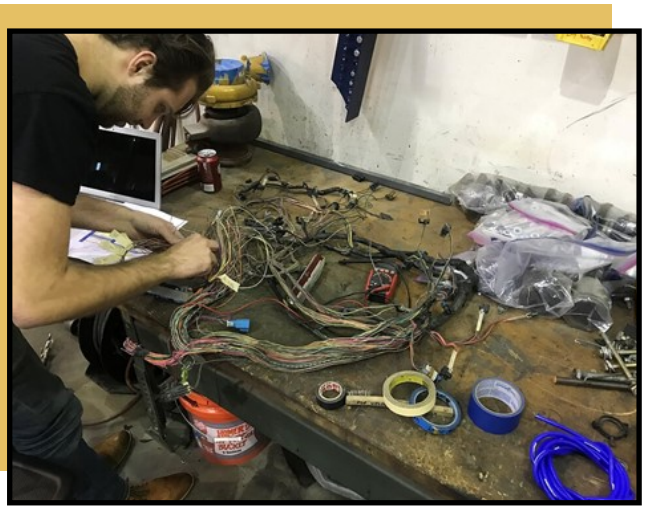
Welding the pieces to the axle.

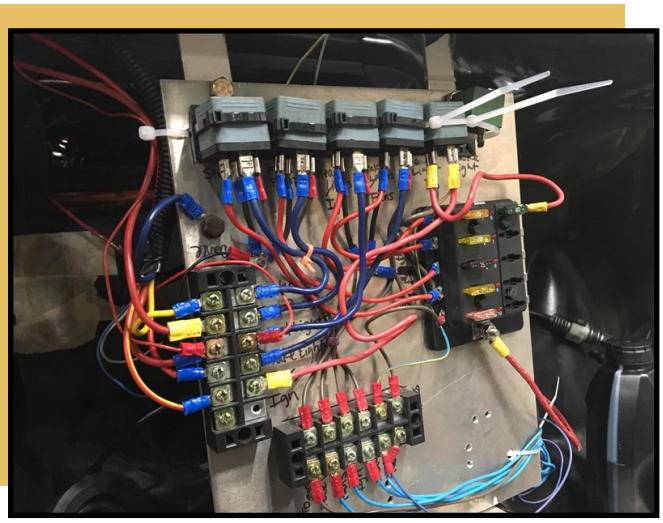


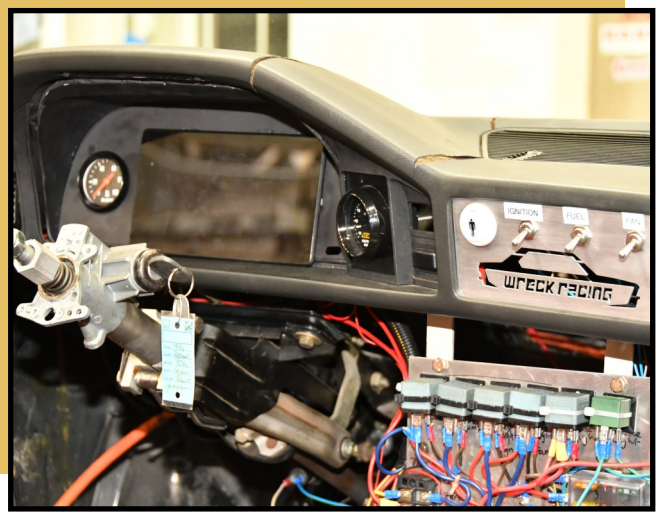
Adding the links

Electronics

The E28 utilizes a factory engine control unit to run the engine. Unnecessary engine controls like emission as well as provisions for the electronically controlled transmission were removed from a factory GM wiring harness. Original BMW relays were used to power the main ignition, starter, fan, fuel pump, and lights. A relay panel with mini fuse box was made with distribution blocks which provides easy diagnostics and allows for quick changes. A custom switch panel was made to house the switches. Battery cables were salvaged from the hybrid system of our Honda Insight.





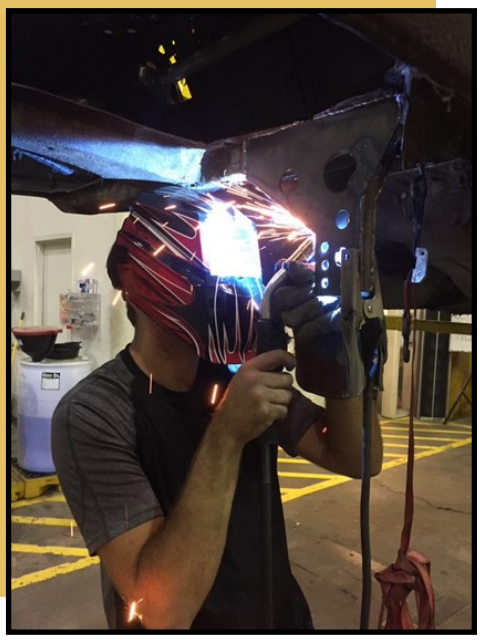


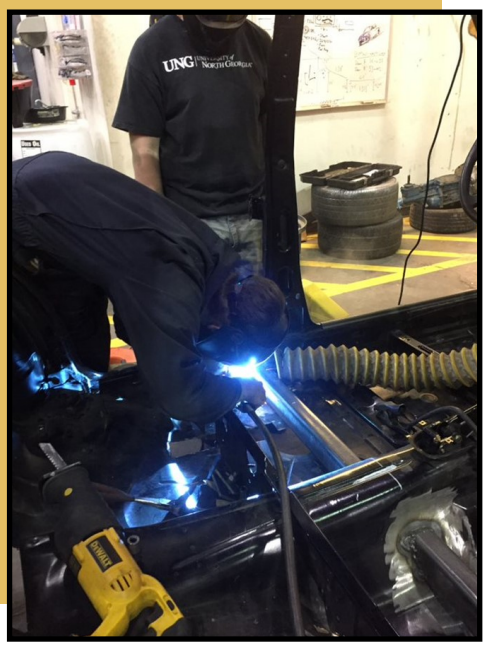
Sunroof

When you give an aerospace engineer a sunroof panel, you should expect nothing less than airplane quality. After measuring, securing (with clecos!), drilling, dimpling, painting, securing (again), and riveting, the sunroof panel was complete.

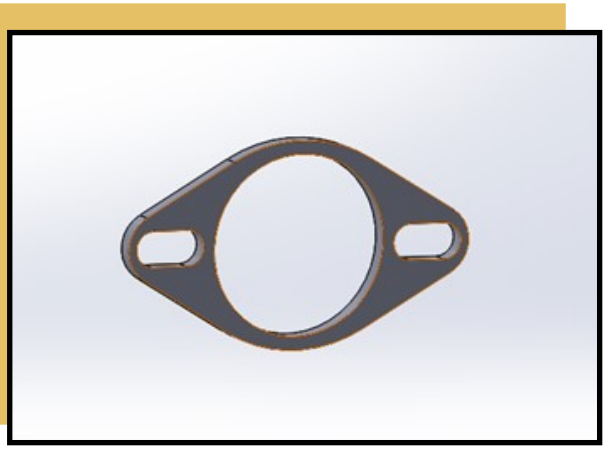
Machining

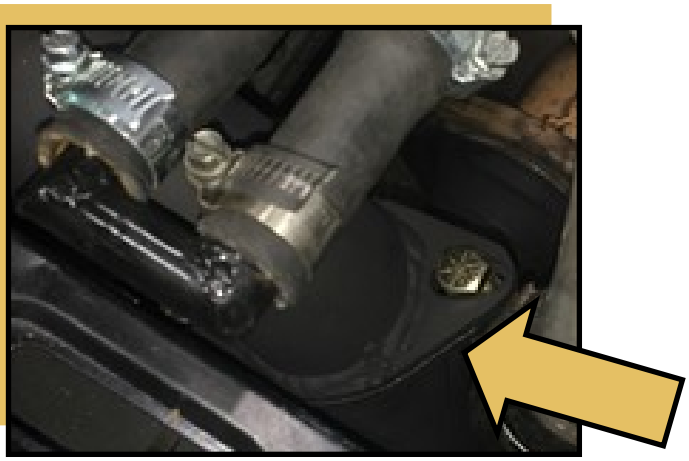
Designing the E28 utilized many manufacturing and design techniques including SolidWorks CAD modeling and finite element analysis, CNC milling, and waterjet cutting along with TIG and MIG welding.



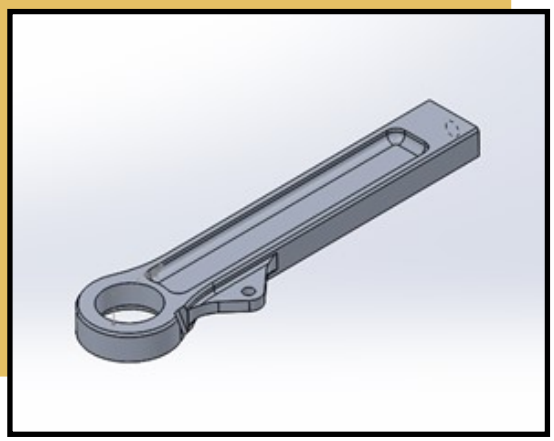


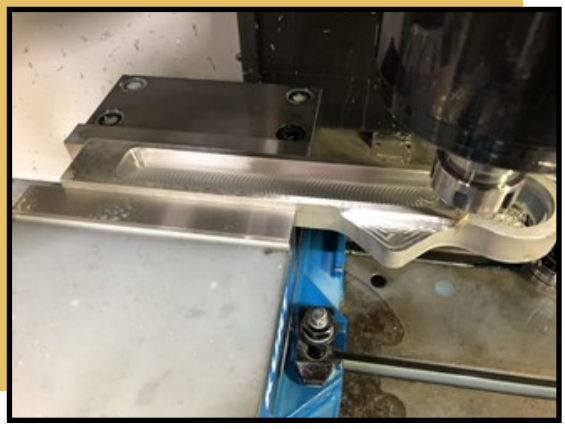
Exhaust Flange





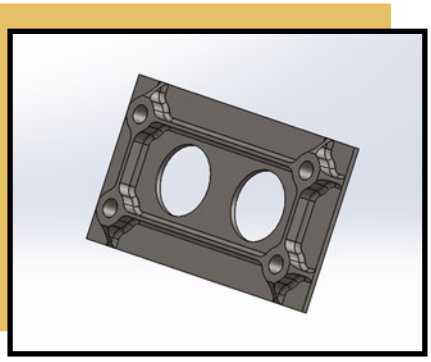
Front Control Arms



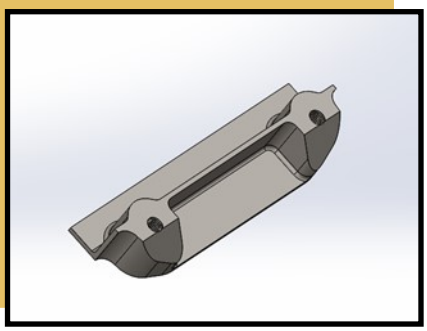


Motor Mount

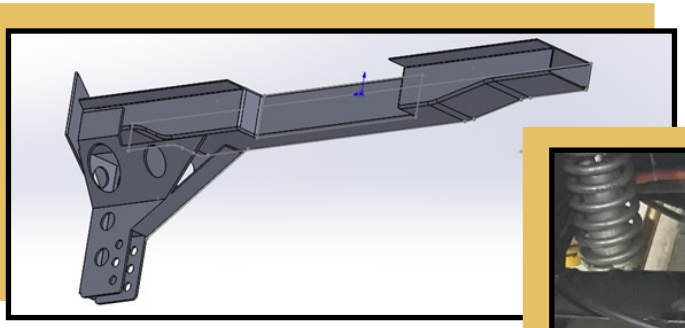
Motor Mount Plate

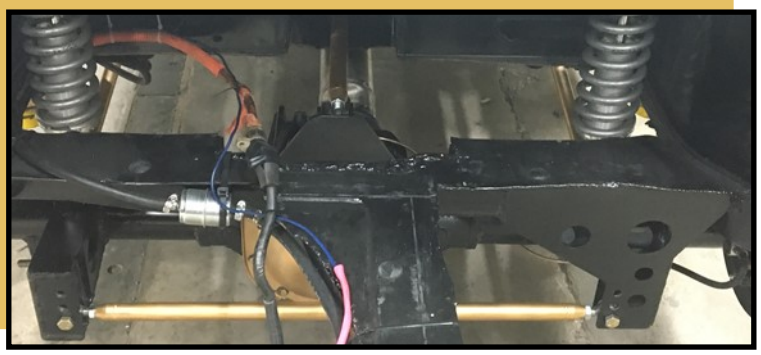


Subframe Brackets

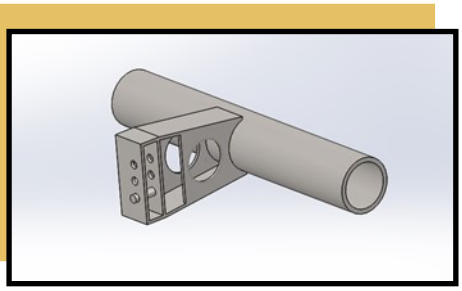


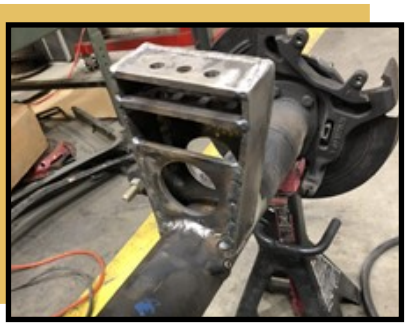
Panhard Mount



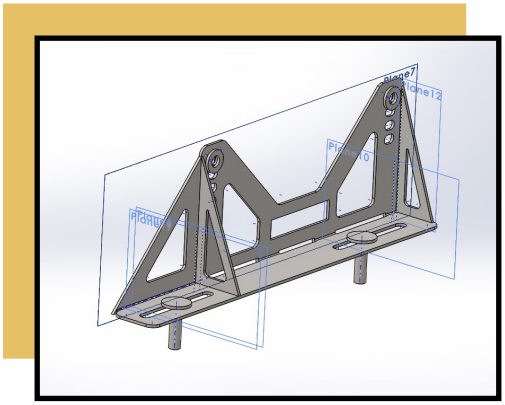


Panhard Mount Axle





Seat Bracket



Thank you to our sponsors!