

GRM \$2000 Challenge

WRECK RACING

CONQUEST TS4

19XX CHRYSLER CONQUEST

Wide, low, and
effortlessly sleek

2004 AUDI S4

An automobile that has a
thrilling pure German
muscle and a 4.2L V8



BUILD BOOK

Wreck Racing 2024 - 2025

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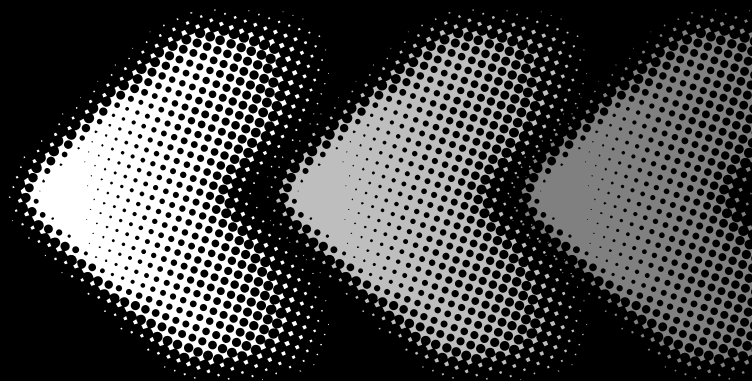
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MEET THE TEAM


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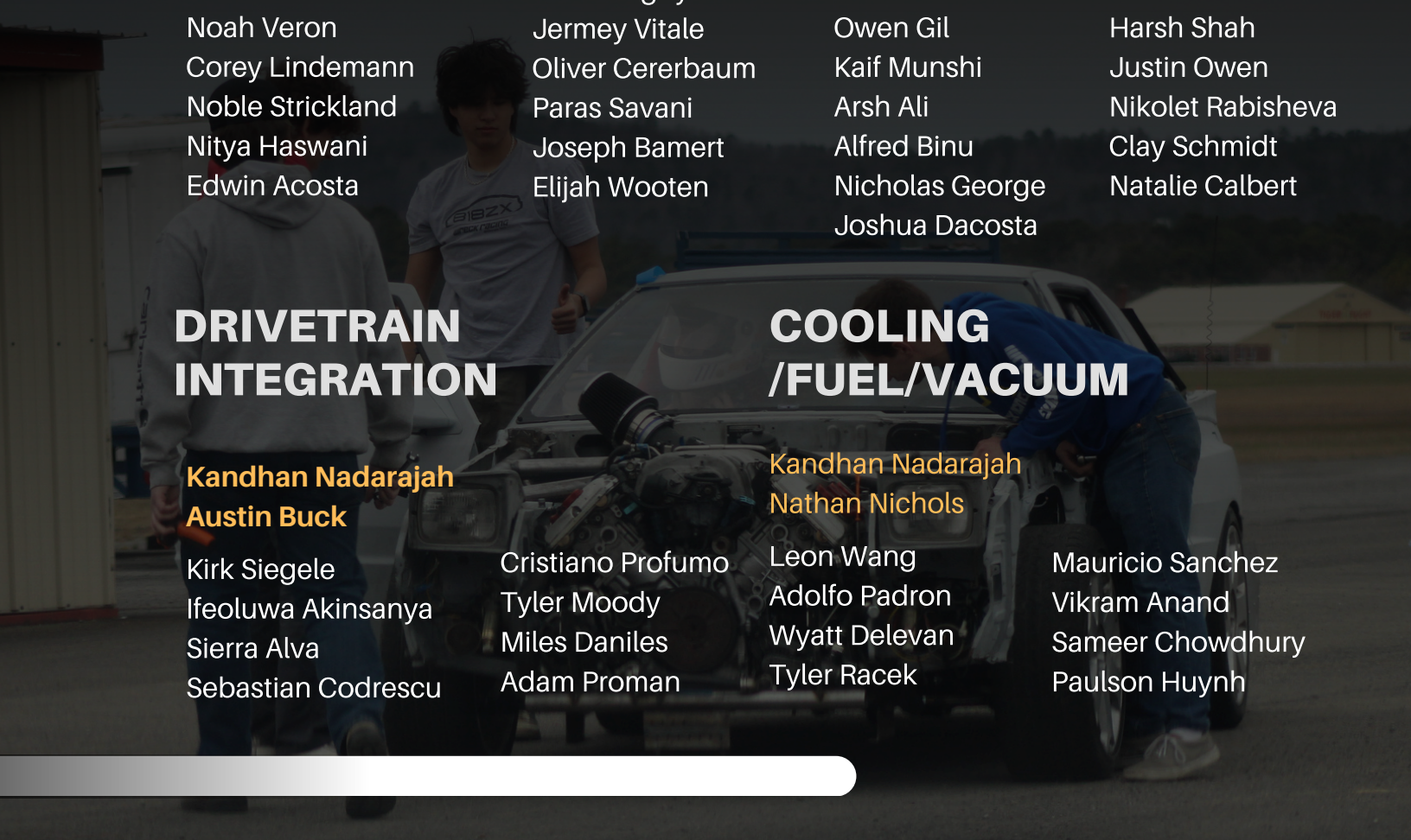
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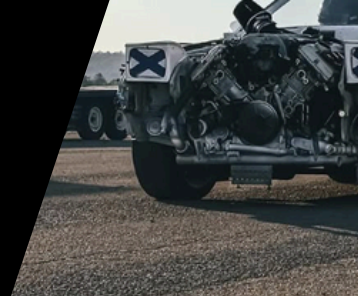
BUILD SUMMARY

HOW IT ALL STARTED

Finding gold... and a lot of ambition

It all began a few weeks before the 2024 GRM \$2000 Challenge. Despite the impending deadline, our habits of scrolling Facebook Marketplace were still strong as ever - and in the rough we found a lucky diamond. This was a 2005.5 Audi S4, which had experienced a tire explosion so violent, it sheared the fender lining and internal wiring harness. We purchased the car for \$1500 and set it aside for our next build. After the 2024 Challenge was over, we set to work getting the Audi running and driving. Soon we had a fairly capable Challenge car on our hands in stock form. We could have done a few powertrain mods and ran the car as-is - but that simply wouldn't be enough of a challenge for Georgia Tech engineers.

So, we set to work finding an insane chassis swap project. We settled on a 1987 Dodge Conquest, which was being sold in NC as just a shell. We bought the unibody, body panels, and interior bits for \$400 and some lexan windows for \$100.





OUR STEPS

Design. Test. Repeat.

First was recoup - we gutted the Audi and sold EVERYTHING that wasn't a drivetrain part. Even the bare chassis was sold to a metal scrapper - no turning back now!

Next was chassis design - custom tube chassis using boiler pipe we loaded up on at \$1/ft, and bespoke suspension geometry using our long-favored Suzuki Hayabusa coilovers from Ebay. All of this was created in CAD, finite element analyzed, and welded into the Conquest shell ourselves in the Georgia Tech shop.

We built an engine testing stand, removed everything from the Audi harness and engine that wasn't crucial to drive, fixed some vacuum leaks, and revived the V8 into a smooth (albeit angry) machine. Then, we fabricated custom drivetrain mounts and dropped all the parts into the Conquest.

In the process, we also had to shorten the driveshaft 8.4", which was also done completely in-house using our vertical bandsaw and welder. We hope the balancing isn't too far off (good thing it's not a highway car).

Finally, an 80s-inspired rally livery to round everything off - after all, it is all wheel drive!

With a 4.2L V8, 6-speed manual, and AWD in a 2,774 lb chassis, we just might have created the most monstrous \Wreck Racing build ever. Only one way to find out....



AUDI TEAR APART

REUSE

After acquiring a 2004 Audi S4, we methodically dismantled the car, dividing its components into two categories: parts to keep and parts to sell. Over the course of a month, we carefully removed all the components we intended to keep, ensuring each one was in good condition and properly cataloged. These salvaged parts were crucial for assembling the engine, allowing us to rebuild it with quality OEM components rather than relying on aftermarket or questionable replacements. The process required patience and precision, as we wanted to make the most out of what the car had to offer.



RECOUP

At the same time, we listed the remaining parts online in hopes of recouping some of our investment. Every usable component that wasn't needed for the rebuild was cleaned, photographed, and posted for sale, targeting enthusiasts and other Audi owners looking for reliable second-hand parts. The goal was to maximize value while minimizing waste, turning the teardown into both a learning experience and a practical financial decision. By the end of the month, we had not only assembled the engine with the best parts from the donor car but also managed to generate returns from selling the rest, making the entire project both rewarding and efficient.

CONQUEST RESTORATION

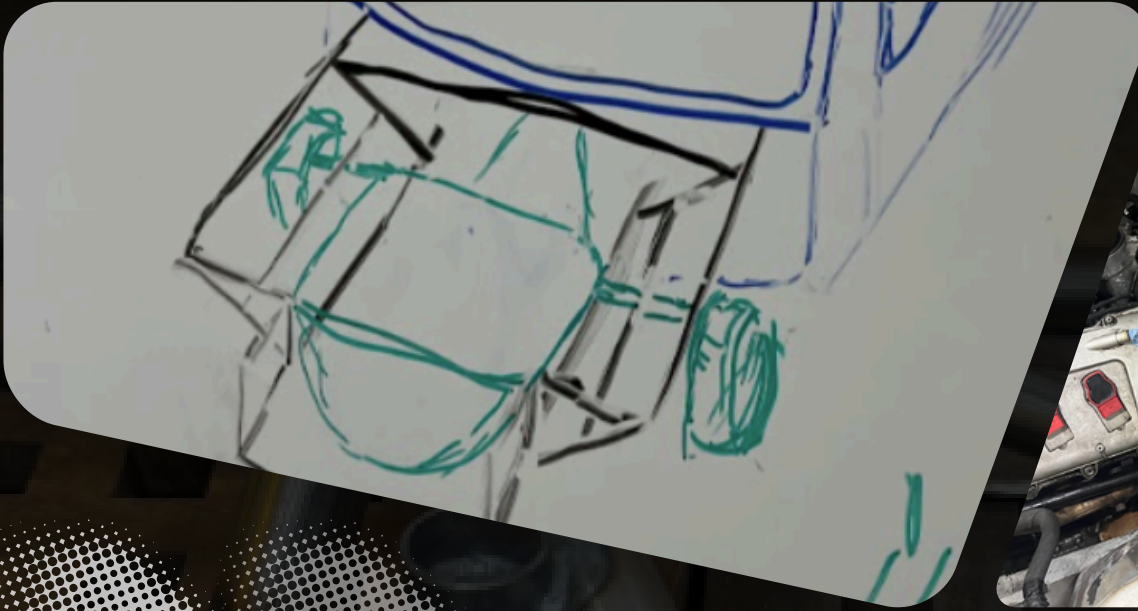
CAR PREP



CAR STRIPPED



We started with a rough Mitsubishi Conquest body that had been sitting in a forest for years, covered in dirt, leaves, and rust. The first step was a deep clean—pressure washing the exterior and scrubbing out years of grime from the interior. Once we could see what we were working with, we tackled the rust repair, cutting out heavily corroded sections and treating surface rust with converters and primers. Ruined areas were smoothed over with Bondo, carefully shaped and sanded to restore the body lines. After hours of work, the car was finally solid again, with straightened panels and a fresh foundation for paint, bringing the Conquest back from the brink.



CHASSIS

FRONT CHASSIS DESIGN

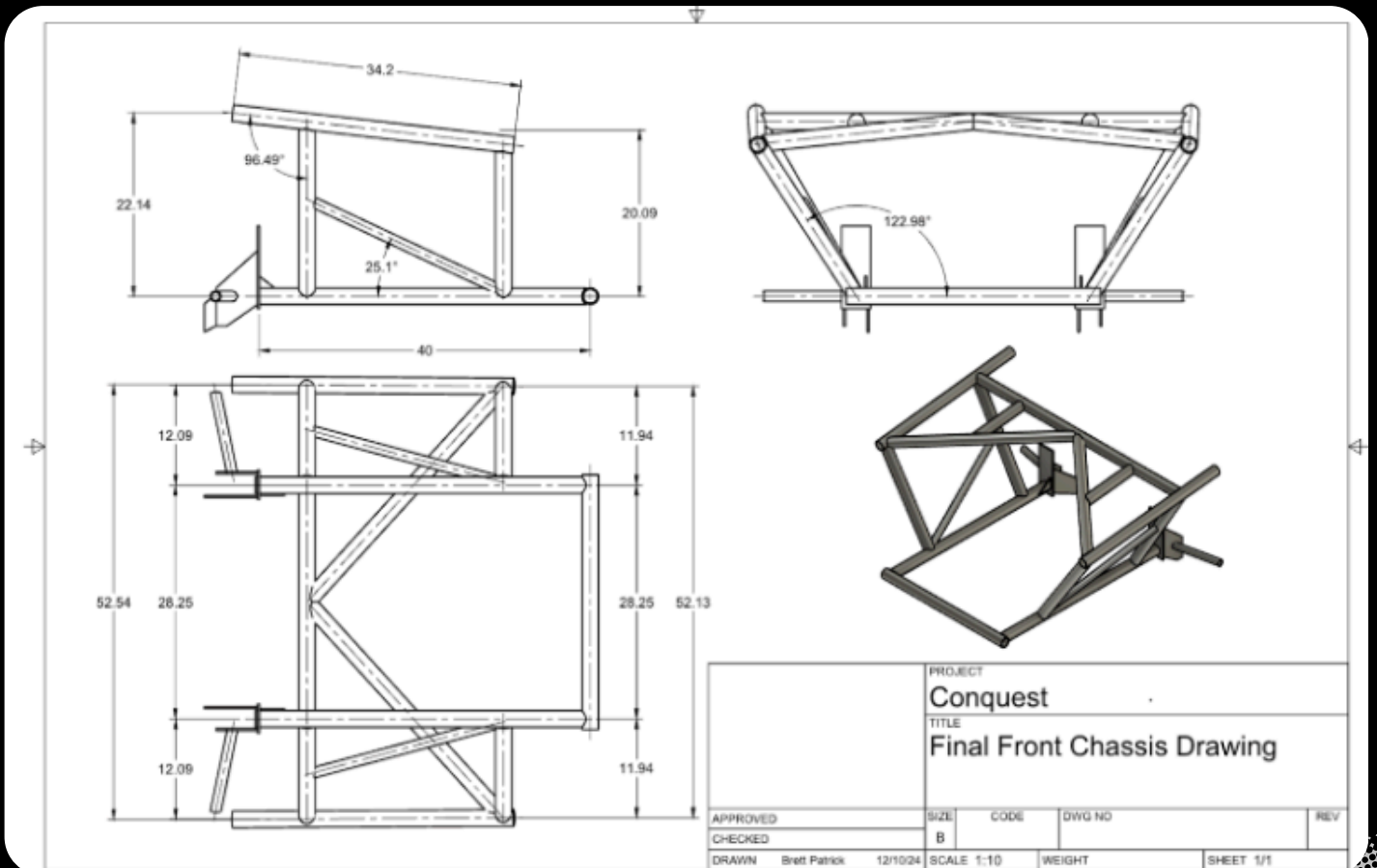
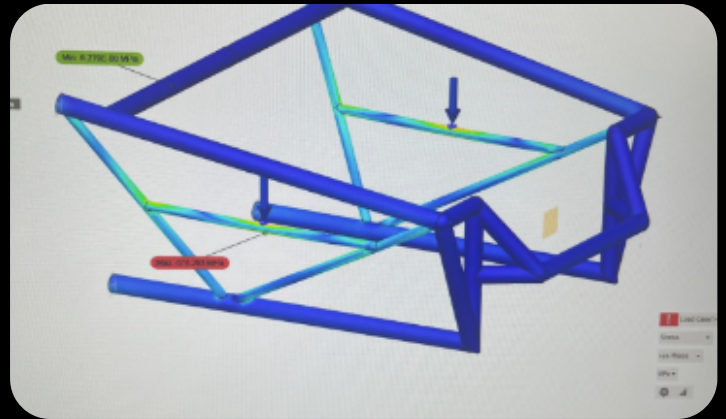
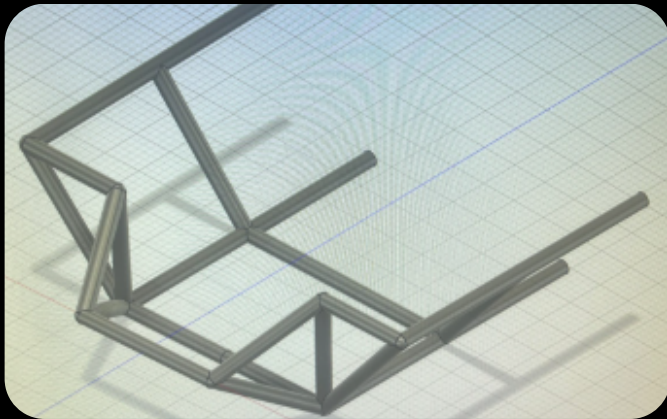
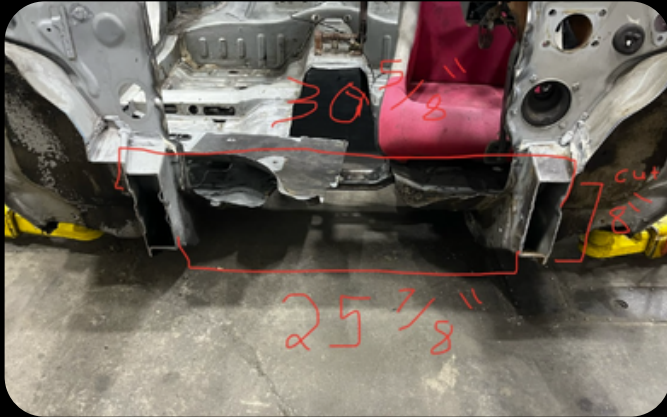
IDEATION, DESIGN, & TESTING

Initial Challenges & Constraints

The original engine in the conquest was rear wheel drive and much smaller than the Audi S4's engine, so we had to completely cut out the majority of the existing engine bay. This included cutting out the wheel tubs and the main frame rails. Once we finished cutting out all of these components, we had to design a new front clip that would not only allow us to mount the Audi engine to it, but also mount fenders, fully custom suspension components, the bumper, splitter, and steering rack to name a few things. We also had to ensure that the front clip would not interfere with the front CV axles and other moving components.

Collaboration

With these constraints in mind, the chassis team all created their own unique designs to fulfill these needs and performed FEA testing on their designs to analyze torsional rigidity, load bearing, and different stresses. Each team member created a presentation on their design, utilizing their data from testing, to argue why their design should be utilized. We then all reviewed each other's designs and noted places that could be improved upon. After coming to a consensus on a final design, we began to fabricate it.



chassis cont.

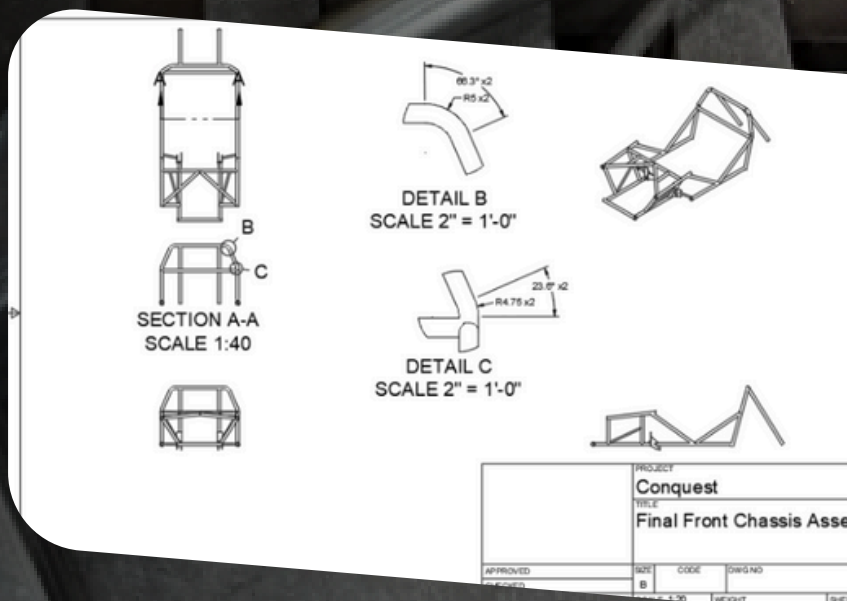
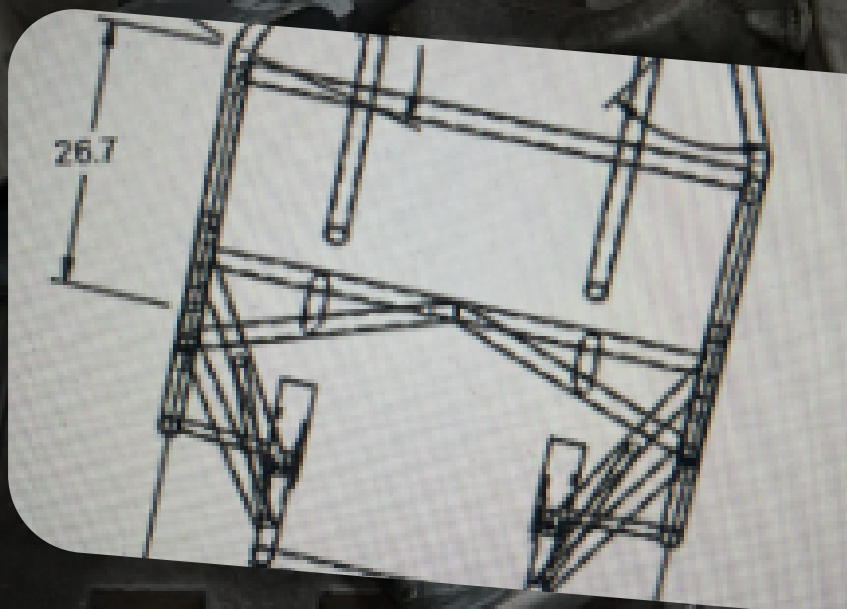
FABRICATION & FINAL PRODUCT

Mounting Brackets

We fabricated the chassis using custom 3d printed jigs to hold all of our chassis members in place when we fabricated them using tube notching, a horizontal bandsaw and angle grinder. We also used our custom 3D printed jigs to ensure the chassis was square and did not bow while we were welding it together. We used a mix of tig heliarc welding and mig welding to weld the entire chassis together.

Mounting Brackets

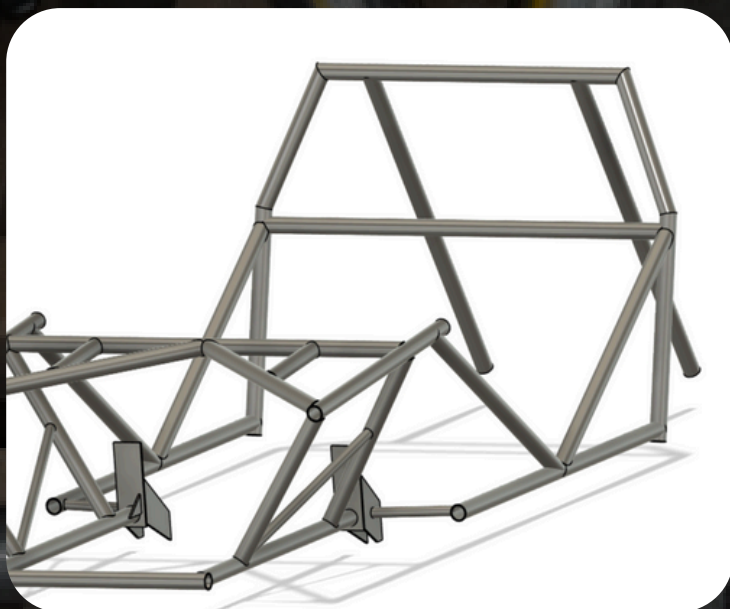
We had to make custom brackets to connect our front clip to our existing conquest chassis members. In order to do this, we waterjetted plates after creating them in CAD.





Mounting Brackets

In order to mount our roll cage to the existing chassis, we used custom waterjetted plates and boxes that we also had to bend to conform to the existing conquest chassis.



ROLL CAGE DESIGN

Starting Point & Constraints

Given that our conquest was missing a lot of stock material and rigidity along with wanting to have our car be able to run faster $\frac{1}{4}$ mile times, we decided to create a 5-point roll cage. We ran through multiple iterations of our roll hoop as we originally wanted to use more of our 2" OD tube that we had for \$1/foot for it. Because we did not have a bending dye capable of bending 2" tube nor did any other shops that we contacted locally, we had to improvise. This included creating a mitered roll hoop and running FEA for it along with determining potential load paths and loads that the roll cage would see. After determining that a mitered roll hoop would not be rule-compliant for a 5-point cage to run 10.00-11.5 seconds e.t., we decided to look for 1.75" OD MS tube that we would be able to bend. We found a good deal at Metals Supermarket for \$4.80 per foot and used it to fabricate our entire 5-point roll cage.

FENDER MOUNTS

Purpose

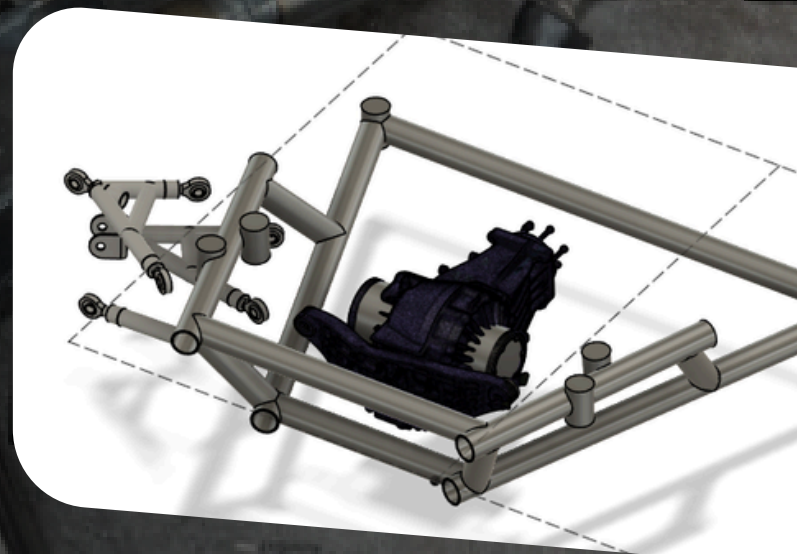
Since we cut out most of the wheel tubs and engine bay of the conquest, we had to create new fender mounting brackets. These brackets were used to mount the fenders onto our new front tube chassis and stiffen the fenders. These brackets were first modeled in Fusion360 using our 3D scan, then waterjetted out of 10 gauge steel @ \$0.08 per square inch. We then welded them to the chassis and bolted them to our fender mounts.

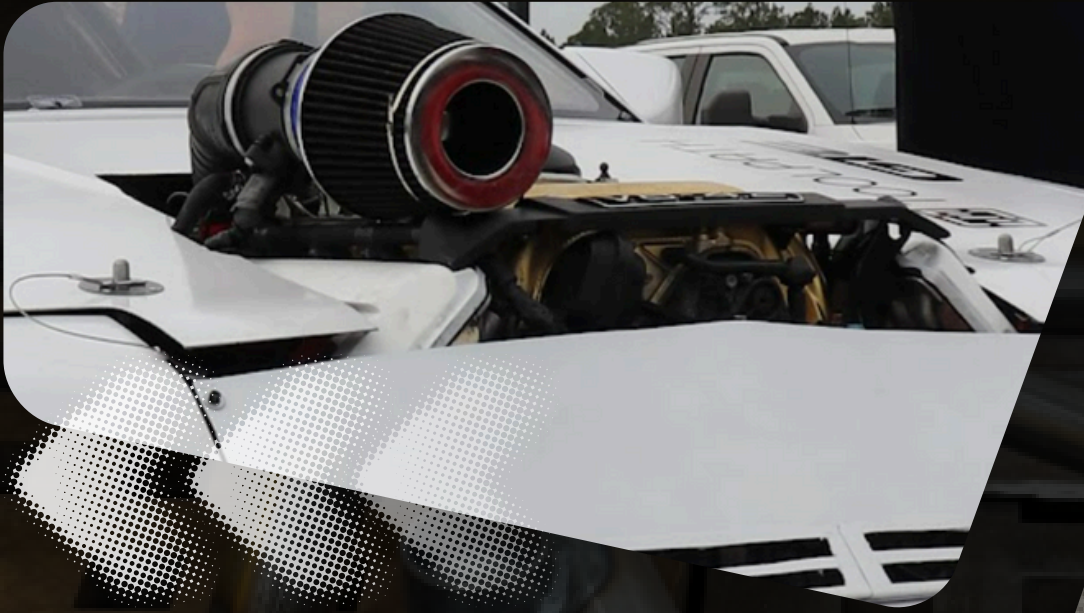


SUBFRAME

Fabrication

We scanned the subframe to determine the mounting points and identified the suspension loads and locations. Based on this, we designed a 2-inch subframe to mount to the stock Conquest locations. After coping the tube and fabricating the subframe, we proceeded to mount the differential and sway bars.

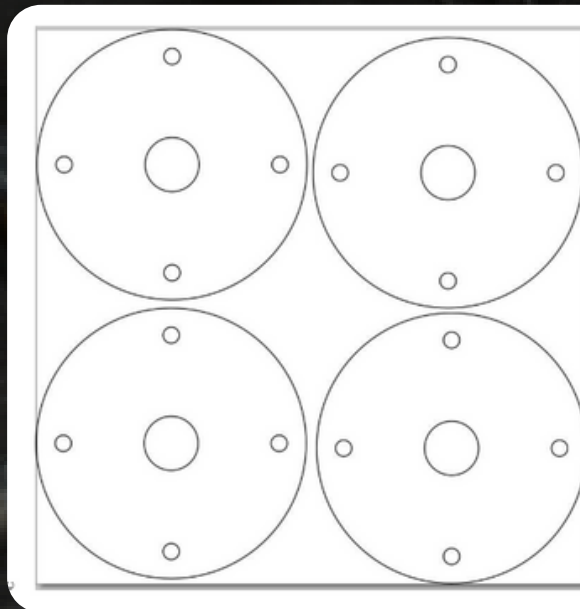




HOOD PINS

PURPOSE

As a result of our new front tube chassis and engine, we had to cut the hood bracing from the underside of the hood out and part of the front of the hood. This caused our hood to be flimsy, so we opted for making our own hood pins out of miscellaneous hardware. We started with two bolts that were approximately the size we needed for hood pins and parted off the head. We then created a custom radius machining bit out of high speed steel and cut that radius into the new head of the bolts on the lathe. We then created the holes in our chassis to be able to thread the bolts in and used two nuts to clamp the hood pin in place. We then modeled small discs in Fusion360 and waterjetted them out of a steel filing cabinet that we found in the dumpster. We cleaned these up and then riveted them to the hood to be used as protection for the hood pins. After we had the hood positioning perfect, we used the mill to drill holes in our hood pins. We were then able to insert cotter pins through those holes and we had functioning hood pins utilizing materials we had laying around the shop.



BODY/AERO

MAIN PROJECTS

BODY RESTORATION & LIVERY

The body restoration and livery design evolved over the entire build process, beginning with structural and cosmetic repairs in September, including dent removal and panel fabrication. By January, the car was primed to ensure a smooth and durable surface, and in March, the final livery was applied, completing its visual identity. The design was inspired by Doris, our BMW E36 trainer car, and featured a modern interpretation of Georgia Tech's colors—white, navy, and gold—blending classic and contemporary aesthetics to create a cohesive and professional look.



REAR WING

The rear wing was constructed using a polyurethane XPS foam core, resin, and fiberglass to achieve a lightweight yet structurally sound design. A 4-axis hot wire cutter was used to precisely shape the foam into an optimized airfoil profile, which was then reinforced using fiberglass layup techniques to enhance durability and aerodynamic performance. The wing was mounted using an aluminum bracket attached at the license plate mounting points, reinforced with additional struts for stability under aerodynamic loads. Sheet metal endplates were incorporated to minimize wingtip vortices and improve overall efficiency. Initially, the wing was designed as a dual-element airfoil; however, it was determined that the setup generated excessive drag. While at a dual element CFD was ran and the wing produced 50 lbs of downforce at 40 mph, offering an optimal balance between aerodynamic efficiency and performance.





FRONT SPLITTER

The front splitter was designed to improve front-end downforce by generating a high-pressure zone above the splitter while accelerating airflow underneath, increasing stability and tire grip at speed. The splitter was constructed using sheathing wood board as the primary material, reinforced with scrap metal to enhance structural rigidity and durability under aerodynamic loads. It was mounted using a four-bolt quick-release system, allowing for easy removal when engine bay access was required. A three-degree mounting angle was chosen to optimize airflow efficiency while minimizing unnecessary drag.



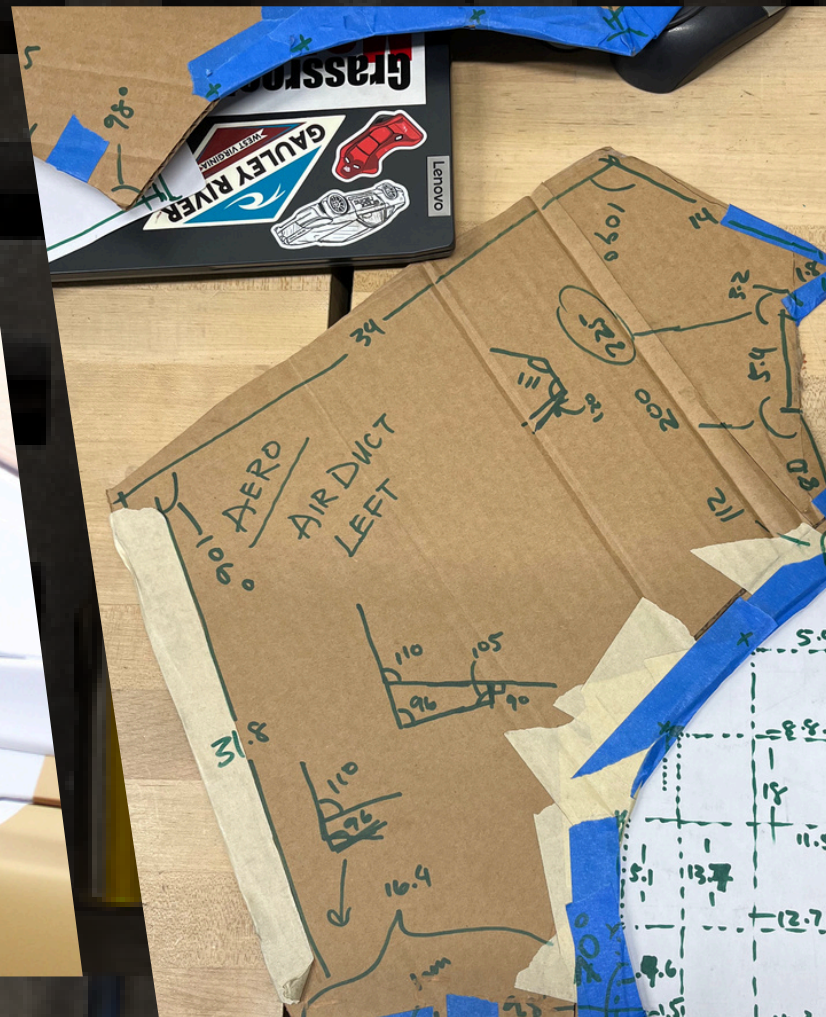
REAR DIFFUSER

With the radiator positioned at the rear, efficient airflow management was critical. A rear diffuser was integrated into the design to accelerate airflow exiting the vehicle, reducing pressure and generating additional rear-end downforce. The diffuser featured strategically placed strakes that directed airflow smoothly while minimizing turbulence. This addition contributed to overall aerodynamic balance, mitigating the car's front-heavy nature and reducing rear-end instability at high speeds.



AIR DUCTING SYSTEM

To enhance cooling efficiency for the rear-mounted radiator, an air ducting system was implemented. Rear side windows were modified to create dedicated air inlets, channeling fresh air directly into the cooling system. Internal ducting was also incorporated to guide airflow efficiently onto the radiator, reducing turbulence and maximizing heat dissipation. This setup significantly improved cooling performance while maintaining the car's aerodynamic integrity. To create the interior air ducting, cardboard was used to fit the complex shape of the back interior following the radiator and exterior airducting entrance. Using Fusion 360, a DXF version of the cardboard cutout was created and jetted. They were then bent to fit into the shape of the car and fit the battery in the back of the car.

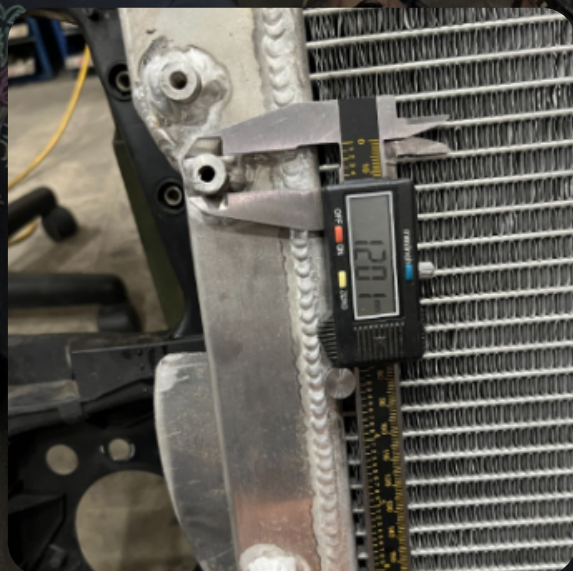
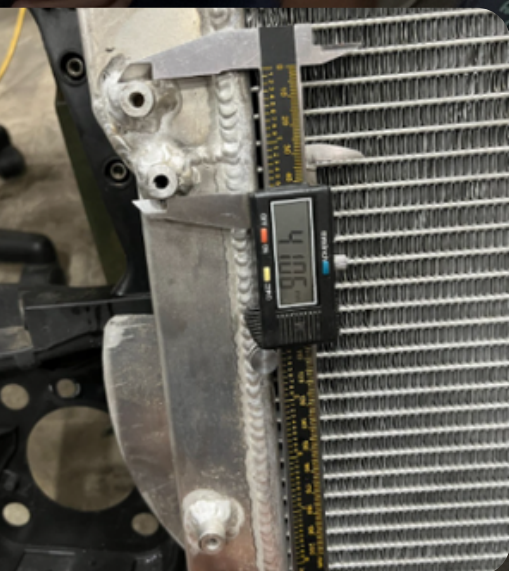


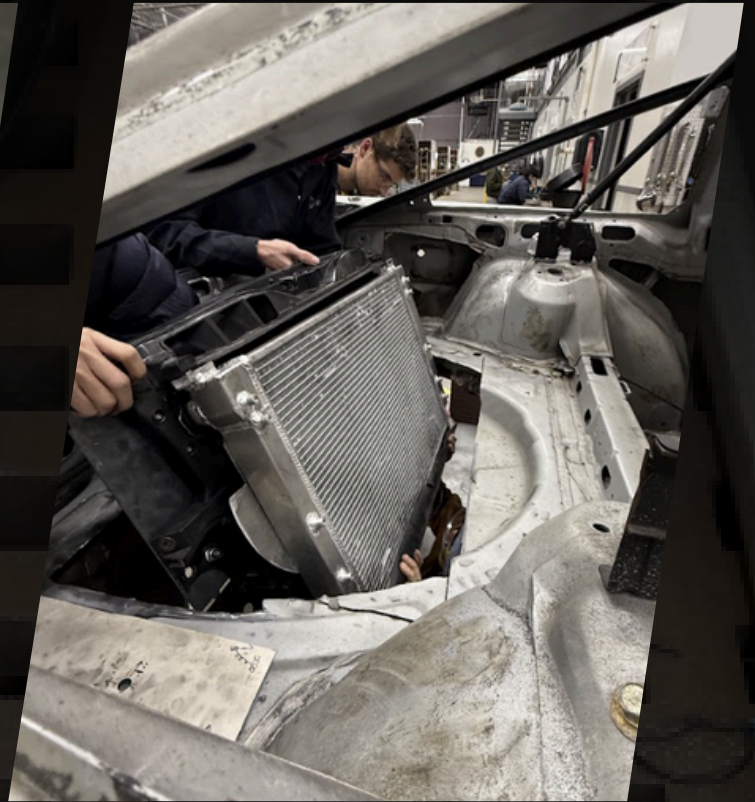
COOLING VACUUM FUEL

RADIATOR MOUNT

In the rear, the radiator had to be fitted at an angle to maximize airflow and clear the liftback. Bend perforations were designed to allow for greater tolerance. The OE mounting holes on radiator shroud were measured to design a metal bracket which would directly bolt up; this was then programmed into a water jet to create brackets. Scrap steel was water jet for test fitting. Bracket was then water jet from thicker sheet steel, bent to fit, then welded to the car's frame rails.

Additional bent and welded aluminum square tube was used to support the sheet steel mount. This was deemed unnecessary and later removed. The steel mount was later cut off and re-welded in a more forward position to clear the rear suspension and drivetrain components. More of the plastic radiator shroud was cut off (including the latch for the original Audi hood).





COOLING cont.

FUEL LINES

We found some discarded hard fuel lines in the dumpster from one of the other motorsport teams. Soft lines were used in areas in which the hard tubing could not be bent or where components needed to be connected. Fuel line mounts were made of plastic components that were screwed into the body. We utilized a tube bender to locate the lines beneath the body and as far away from heat sources such as cooling lines, and the drivetrain.

Cooling Lines

Because of the novel radiator placement, it was first decided that flex tube would be best for easy coolant plumbing. It was not leak-proof

MOUNTING FUEL CELL

The fuel cell location was chosen to be in the rear of the car in order to maximize the space for the engine in the front. The fuel cell was mounted using steel bars that are reinforced to prevent swaying of the cell. The direction was chosen to face inwards as an optimal location for fuel feed and return lines. This also allowed space for the fuel pre-filter and pump to be located within the car. Fuel filter was reused from the Audi and it acts as both a filter and a regulator. It was a return style fuel system with the regulator mounted near the tank to minimize tubing underneath the car.

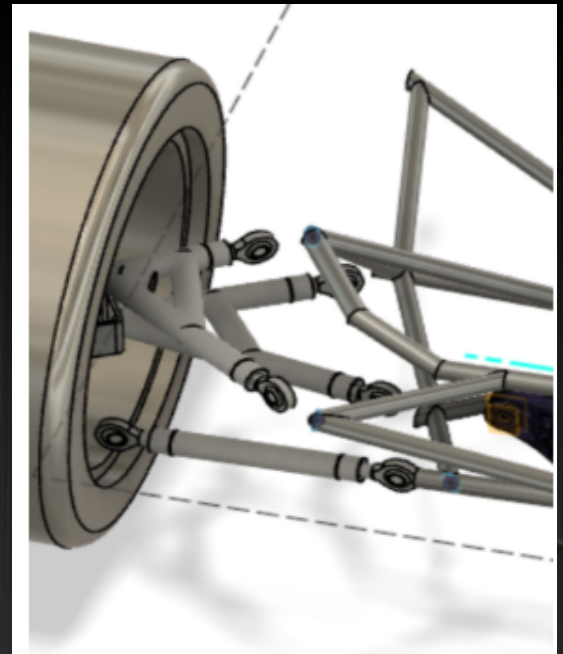


SUSPENSION

RESEARCH & IDEATION

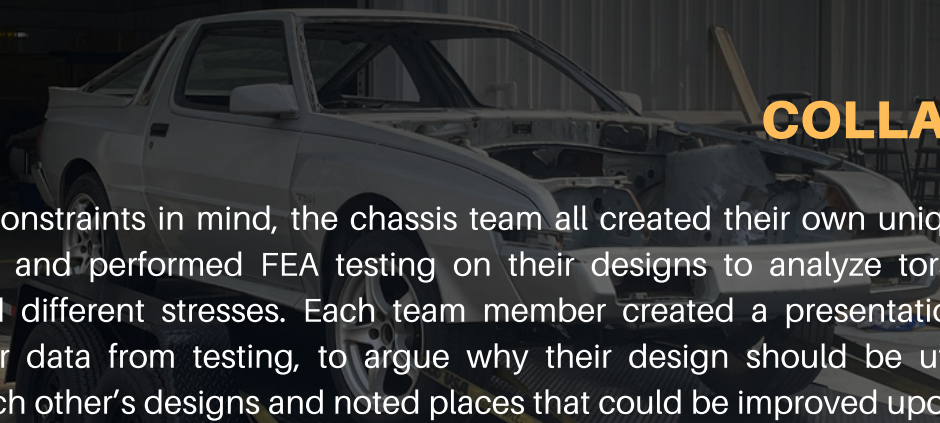
To ensure optimal performance, we began by researching the corner weights of the empty car and estimating final corner weights.

The original engine in the conquest was rear wheel drive and much smaller than the Audi S4's engine, so we had to completely cut out the majority of the existing engine bay. This included cutting out the wheel tubs and the main frame rails. Once we finished cutting out all of these components, we had to design a new front clip that would not only allow us to mount the Audi engine to it, but also mount fenders, fully custom suspension components, the bumper, splitter, and steering rack to name a few things. We also had to ensure that the front clip would not interfere with the front CV axles and other moving components..



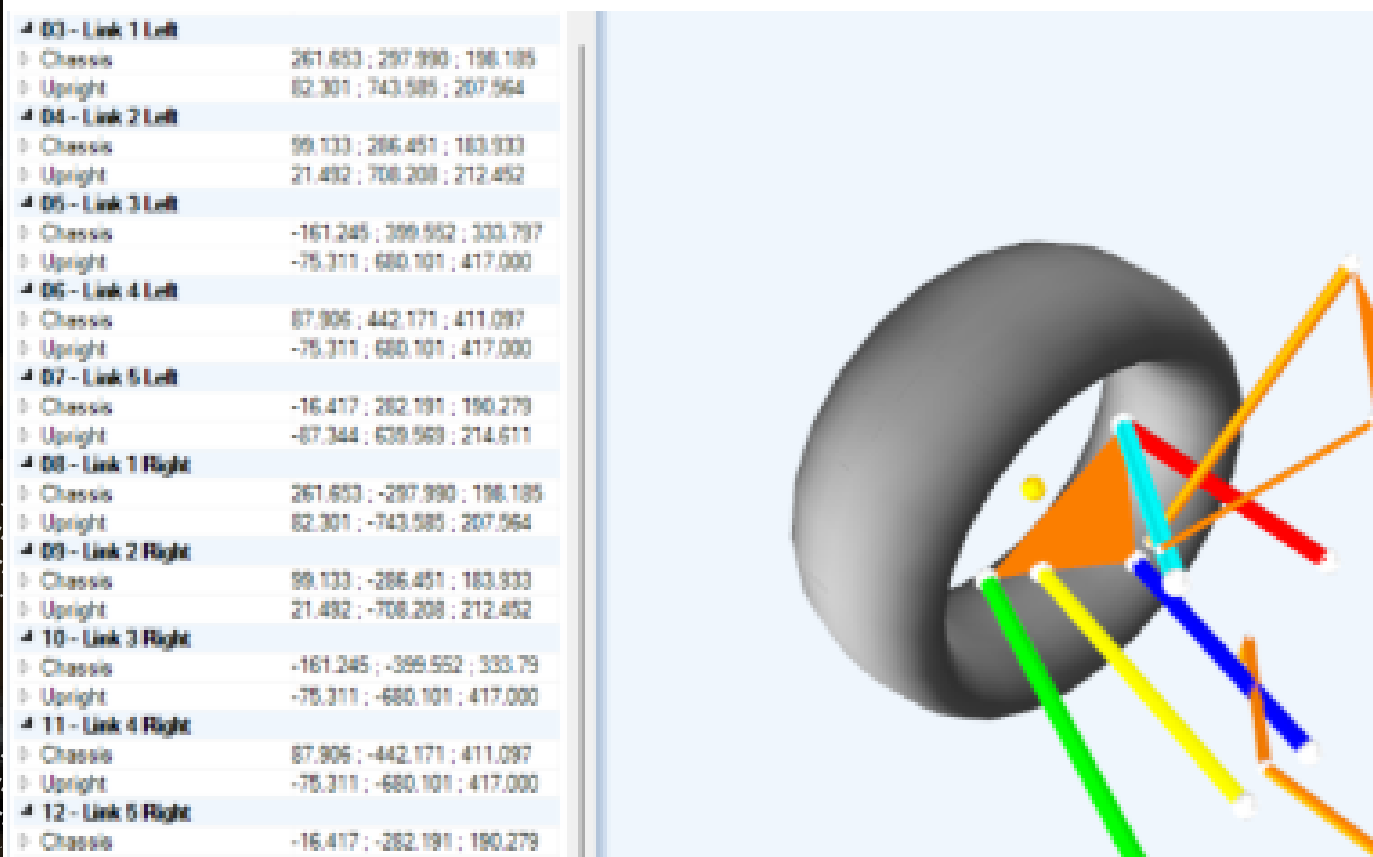
COLLABORATION

With these constraints in mind, the chassis team all created their own unique designs to fulfill these needs and performed FEA testing on their designs to analyze torsional rigidity, load bearing, and different stresses. Each team member created a presentation on their design, utilizing their data from testing, to argue why their design should be utilized. We then all reviewed each other's designs and noted places that could be improved upon. After coming to a consensus on a final design, we began to fabricate it. Corner weights to determine the appropriate frequency and motion ratio. Hand calculations for forces were conducted using MATLAB, allowing us to analyze the vehicle's dynamic response. Fusion 360 CAD software was used to model wishbones, knuckles, and their placement within the car. Additionally, parametric models were developed to streamline and optimize suspension component design.



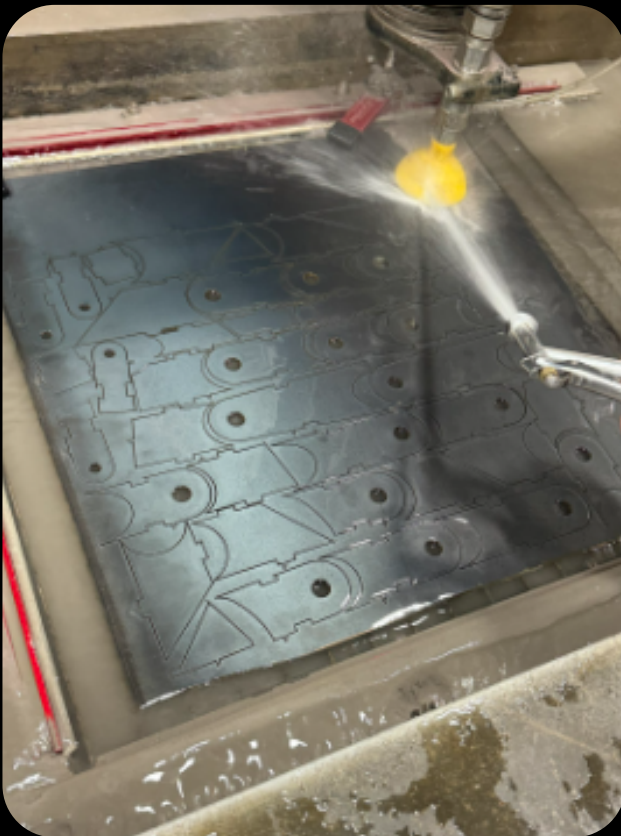
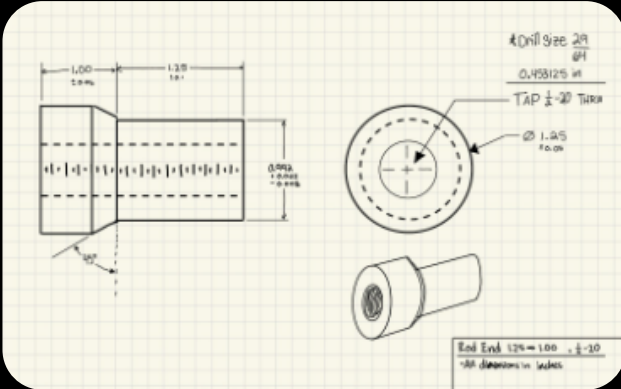
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OPTIMUM K

We utilized OptimumK to refine our suspension geometry. Since we aimed to maintain ABS functionality, we initially retained the Audi knuckles as outboard pickup points, though this approach ultimately did not pan out. OptimumK allowed us to generate multiple pickup point configurations within a defined bounding box and select the most optimal layout based on target suspension characteristics. The system was fine-tuned for low bump steer (minimal toe angle variation during suspension travel), precise negative 3-degree camber for our Hoosier tires, and ideal caster settings. Additionally, simulations were conducted to analyze roll behavior, acceleration, and deceleration effects to optimize anti-dive and anti-squat characteristics, ensuring controlled weight transfer during autocross.



FABRICATION

Control Arms

Fabrication of control arms involved cutting and notching tubes with precision, utilizing 3D-printed jigs for welding accuracy. Mounting tabs and water-jetted components were created to ensure proper alignment.

Steel Plate for Modified Front Knuckle

The front knuckle required modifications as its upper pickup point did not align with our optimized design. To address this, aluminum supports were welded onto the knuckle, allowing for an extension plate that repositioned the mounting hole correctly relative to the wheel bearing.

Bell Crank

The bell crank was designed parametrically in CAD to accurately space the shock, chassis, and pushrod mounting points based on OptimumK optimizations. It was then water-jetted from 3/16" mild steel, with machined brass bushings for reduced friction.

Steering Rack Mount

Plates for the steering rack mount were water-jetted with pre-aligned holes for the Audi steering rack. Tubes were then welded between the plates and the chassis structure to correctly position the rack.

Machining

Using a lathe, we turned new tapers and inserts for the front knuckles, along with spacers and bushings for rod ends. These machined components ensured proper fitment and function within the suspension system.



INTEGRATION

Knuckle and Control Arm Mounting

The integration process began by mounting the knuckles to the control arms and securing the control arms to the chassis tabs. In the rear, we cut the wheel wells to provide clearance for the bell crank, then welded the bell crank mounting structure to the rear chassis rail.

Steering and Braking System

Brake lines were fabricated and routed throughout the chassis, while the steering rack mount was welded to the front chassis structure. Additionally, chassis-side shock mounts were welded in place at the front to complete the suspension installation.

Clearance Adjustments

Several clearance modifications were required to ensure proper fitment:

- The front fenders were trimmed to prevent tire contact.
- The lower section of the front knuckles was clearanced to allow the ball joint to seat fully, ensuring the cotter pins could be properly installed in the castle nut.
- A significant portion of the driver's side firewall had to be removed and replaced with a removable plate. This adjustment allowed for brake booster servicing through the interior, as the new steering rack mount and chassis structure obstructed removal from the engine bay.
- The front knuckles were further clearanced to accommodate the wider Hoosier tires without interference.

These integration efforts brought together all of our design and fabrication work, resulting in a fully functional and highly capable custom-built autocross car.

INTERIOR/ CONTROLS

MAIN PROJECTS



The construction of the rear firewall began with a cardboard mock-up. Small pieces of cardboard were carefully cut and tested individually to ensure an accurate fit, then secured together with tape. This mock-up served as a precise template, allowing us to cut horizontal metal strips from available scrap material, which were subsequently welded together. To ensure complete airtightness, we applied seam sealer around the edges. The materials used for the rear firewall totaled approximately \$3.60 in scrap metal.

The front firewall required several patches, each fabricated from scrap metal as well. This portion of the project was completed using only \$0.40 worth of materials.

For the steering mount, we began by digitally approximating the Audi steering wheel to gauge necessary clearances. The mounting holes on the vehicle's body were replicated in CAD software, guiding the design of the mounting plate. We crafted the mounting plate from flat sheet metal, later folded into the appropriate shape. Additional material was strategically removed from the design to accommodate pedals and other components, ensuring proper clearance between the steering assembly and firewall.



FIRE WALL

The first step to building the rear firewall was to mock it up with cardboard. This involved cutting and testing small pieces of cardboard to fit, before taping them all together. Once this was completed, we were able to cut out horizontal strips from scrap metal to fit in place and then finally weld together. We then were able to use seam sealer to ensure an airtight seal around it.

The front firewall required various patches.

- \$3.60 in scrap (rear)
- \$0.40 in scrap (front)



STEERING MOUNT

The Audi steering wheel was roughly recreated digitally to get a rough idea of the clearance needed. The mounting holes on the body side were also recreated in CAD. The mounting plate was designed as a flat sheet metal object to be folded to the correct shape. Additional material was removed as needed to insure pedals and other components can fit within the space to the firewall.



DRIVE TRAIN

For the standalone Audi setup, we began by carefully removing the engine, transmission, and all essential modules from the Audi. Once extracted, we disabled all non-essential modules from the system, streamlining it for standalone operation. After these preparations, we successfully ran the system independently on an engine stand to confirm functionality.

Next, we addressed the need to shorten the existing driveshaft from its original length of 62.375 inches to the desired length of 58.25 inches, measured between the mounted transmission and the rear differential. Initially, we marked the driveshaft horizontally to ensure proper alignment post-cutting. The driveshaft was then precisely cut using a horizontal band saw, although an attempt to simplify this process by splitting the two-piece driveshaft proved unsuccessful and is not recommended. The final welding stage required meticulous care, ensuring our most skilled welder completed the task, thereby maintaining alignment and preventing any run-off.



Mounting the motor and transmission involved digitally scanning the mounting locations and designing accurate mounts using CAD software. After finalizing the digital models, we coped steel tubes, welded them accurately, and installed these mounts securely onto the chassis.



For the cooling system, we extended the original Audi wiring harness to accommodate the new setup. The radiator was repositioned and mounted in the rear of the vehicle. To manage coolant flow efficiently between the front and rear, EMT tubing was carefully bent and installed. Additionally, the stock Audi expansion tank was mounted and integrated into the system, followed by thorough bleeding to ensure proper operation.

My primary responsibility was designing and fabricating the engine mounts. I started by drafting initial concepts in Fusion 360, carefully considering critical factors like structural rigidity, correct mounting angles, and chassis clearance. The design underwent multiple iterations for refinement before reaching the final version. Fabrication involved cutting steel tubes to exact specifications and carefully shaping each component with an angle grinder. Multiple adjustments were necessary during this stage to ensure precision and optimal fit within the vehicle.



Furthermore, I was responsible for extracting wheel speed sensors from a spare Audi and installing them into the Conquest. This task demanded careful attention to mislabeled wiring, requiring methodical identification and correction to ensure accurate connections. Additionally, I ensured that wiring lengths were sufficient for proper routing, guaranteeing reliable functionality of the wheel speed sensors.

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