



**Team 9**

**SAE BAJA**

**Dylan Wisniewski**

**Logan Gerard Wilson**

**Claire Pescatore**

**Erik DiMaria**

**Tanner Bunch**

**Robert Gerlinger**

**Jared Bonds**

**Zachary Biehl**

**Samuel Larios**

To: Mr. Armin Eilaghi

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From: Team 9

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**Team Individual Analysis**

***Front Suspension:***

Dylan Wisniewski **-** Lower Control Arm

* The topic of analysis for Dylan involving the front suspension will be the lower control arm. This design will consist of a traditional A arm design. This was chosen due to the known strength and popularity of this design; the team is confident it will perform at a high caliber. Along with considering the 4-wheel-drive system that will be integrated in the car this design leaves plenty of room for the components to complete the 4-wheel-drive system. The analysis will consist of stress analysis using the SHARK software provided by “Lotus Cars”. This software allows you to enter in the geometry of your design and it will perform various calculations with the other parameters you enter about the vehicle. These calculations will provide an analysis, determining if the geometry and chosen lengths work without failure. Along with the software hand calculations can be made using statics and dynamics problem solving methods to be certain in the confidence of the design.

Jared Bonds – Upper Control Arm

* The topic of analysis for Jared involving the front suspension will be the upper control arm. The front suspension team is very diverse in the automotive industry with Jared having a knowledge of off-road racing, while Zachary and Dylan have a knowledge of street cars. From this background, the team noticed both areas doing the same with the upper control arms when there is limited space and wanting to achieve the most out of the steering angle these companies gravitate to the J arm design. This J arm design has a sweeping motion to provide space for moving parts, in our case that would be the 4-wheel-drive components like axles, suspension and steering. The J arm design has one major job, keeping the steering knuckle upright. To achieve this the J arm is to have one degree of rotation, this being in the up and down orientation. From the above, Dylan has explained the benefit that our team has from the SHARK software to provide great calculations and parameters for our designs. From this feedback from the SHARK software, Jared will implement the results to shear and moment diagrams. Allowing Jared to design the lightest J arm design that will withstand the stresses. Giving the max stresses the components will experience, implementing shearing equations on hardware to attach the components to the vehicle is needed to keep the one degree of rotation. The shear equations will be analyzed on all hardware, hiems, mounting bolts, suspension tabs, ball joint connections/ shoulder bolts, etc. From the calculations there is confidents that this design will hold up to the challenges from SAE Baja while maintaining the lightest weight.

Zachary Biehl – Steering Knuckle

* Zac has been tasked with designing the front steering knuckles for the Baja vehicle. This involves considering the control arm designs as well as clearances around the CV axles, tie rods, and shocks. In our case, utilizing an upper J-arm design and a lower A-arm design, the stress from impacts and shock compression will be directly transmitted through the lower steering knuckle mount. Conversely, the upper knuckle mount can be narrower and lighter because of the minimal loads it will absorb. The tie rod mounting location will be front mounted to allow ample space for the front axles as well as the front shocks. The factor of safety for these knuckles will be determined by the connection points. For our suspension design we plan to utilize a combination of heim joints and simple shoulder joints, therefore the factor of safety should be higher than these components to ensure the connections are the first mode of failure. Material for these knuckles will be aluminum. This is based off its optimal low weight and strength relative to other options such as steel. Lastly the final thing to consider when designing these knuckles is the ability to manufacture them in the on-campus machine shop. In the hopes of reducing the budget as much as possible the design must include features that are relatively conservative and do not require a 5-axis CNC to create.

***Rear Suspension***

Robert Gerlinger:

* Robert is tasked with doing the modeling of the rear suspension. This includes creating the CAD (computer animated design) for each individual member of the rear suspension and analyzing the stresses that are applied to each member. To analyze the members, he will be utilizing the built-in features in SolidWorks as well as checking calculations using “Engineering Mechanics Statics fourteenth edition by R.C. Hibbeler”. SolidWorks will help him do this because when parts are designed properly and given their designed materials, SolidWorks will analyze the input loads. This will show which members will be receiving the most stress and if they will be able to handle these loads. This will aid in the design process to ensure that the final design will be able to perform properly. The text Engineering Mechanics Statis will aid in the design by providing calculations for the stress of each member. There is a pleather of examples showing how to analyze members with specific materials and to show what forces need to be examined. This includes torsional, axial, and bending forces.

Samuel Larios:

* Samuel is tasked with further calculations of the rear suspension. This will include analyzing CAD (computer animated design) parts made by Robert and utilizing “Lotus Cars” SHARK Software which will help visualize our design on a moving vehicle. This software will provide valuable information such as camber and toe which are detrimental to the final rear design. By changing any part of the design this will give our design new plots and charts so by consistently tweaking different members of the design, the rear end team will find the most optimal lengths and positions to put each member. This will determine how we place and how well we will do in terms of overcoming obstacles during the event.

Tanner Bunch:

* Tanner has been assigned the responsibility of design concept development. His vast experience with the offroad industry makes him well suited to have valuable input on successful designs. The objective is to design a rear suspension system that will optimize suspension travel while delivering the power from the drivetrain. Using engineering tools such as product research, design matrices, and concept selection Tanner has decided to pursue a trailing arm design with two links in the back of the BAJA vehicle. The idea is to create a strong, light, and adjustable trailing arm. He will also work very closely with Samuel and Robert to continue progress undergoing CAD construction and “shark” suspension simulations respectively. If results do not meet the standards the team has set, Tanner will consider alternative dimensions to correct and maximize results. Kinematic analysis and stress calculations from “Engineering Mechanics Statics fourteenth edition by R.C. Hibbeler” will also be used during the team design process. Once the final design is completed, Tanner will lead the fabrication of the design. His skills with shop tools and machines will help speed up the construction process of the design. Once the rear suspension team has completed the rear suspension design, Tanner will continue to help with any other decisions, fabrication, and designs that need to be done on the vehicle.

***Drivetrain:***

Erik DiMaria:

* Erik is tasked with doing research and analysis on calculations and the entirety of the gears specifically made for the gearbox component of the drivetrain. He will be using “Shigley’s Mechanical Engineering Design, eleventh edition” due to most of his calculations and drawings because the examples that are in the book are precisely what is needed for this project. The bulk of the analysis will be the calculations proven to work and shown in detail why certain equations must be used over others. The entirety of the analysis is based on design and choosing the right gears for this specific drivetrain including stresses that occur on the gears. Shaft design will also most likely be coming from the book as well, but the team is looking at more experimental methods to design with. He will be looking at the factors and components that affect bending, contact, stress, and strain of spur gears that could possibly cause the factor of safety of a gearbox to drop causing fracture or unfixable bending.

Logan Gerard Wilson:

* Logan is tasked with designing the new shaft for some of the gears. Logan will be checking his calculations using, “Engineering Mechanics Statics fourteenth edition by R.C. Hibbeler.” The textbook will also be useful for proving the viability of a rounded triangle shaft design. The assumption for this design is most of the load will take place on the edge of the rounded triangle, so the design needs to be capable of withstanding the forces on the thinnest part of the triangle. This analysis considers standard proven key designs and compares how these keys will be replaced by a rounded triangle. Because of this, the equations used will be used the same for circular keys. A corrected yield strength, max force possible, and a desired factor of safety will be used to find the diameter needed for the rounded part of the rounded triangle. These triangles will handily be capable of handling loads of standard shaft key designs, while still being variable enough to optimize the design. These new triangles serve the purpose of allowing in-house machining of the gears. The factor of safety will be designed to be around 1.2 after considering all three sides of the triangle will be carrying an equal load.

Claire Pescatore

* Claire is tasked with specifically taking over Dreamweaver aspect of the capstone project. Past this she will be working on designing the sprocket that will hold the chain drive together. Sprocket and chain calculations will be done in order to fully understand the working chain drive together. This will be done by calculating gear ratios associated with the addition of the sprockets, sizing, sprocket pitches, and chain length. These calculations will be solved using, “Shigley’s Mechanical Engineering Design, Eleventh Edition” and a few documents having to do with chain drives. With the analysis that the rest of the drivetrain team has made, this will be easy to finish with equations found in the books and papers above.