

Drag Racing: A 4-Link Suspension Geometry Guide

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Problem Statement

The drag racing community continues to push for faster 1/4-mile times, driven by advancements in engine technology that deliver unprecedented power. However, many vehicles struggle to convert this power into effective traction, limiting their performance on the track. A potential solution lies in 4-link suspension geometry, a sophisticated system capable of optimizing load distribution and enhancing traction throughout a run. Despite its potential, the system's complexity poses a significant challenge for racers and teams. Properly configuring 4-link suspension requires an in-depth understanding of geometry, force dynamics, and their application to specific racing conditions. Improper adjustments in most prominently *bar angle* and *instant center* location can hinder performance rather than enhance it. Addressing these challenges by developing comprehensive guidelines and setup techniques as well as developing a much more universal 4-link system to bring to market is critical for unlocking the full potential of 4-link systems, enabling racers to achieve superior results and advancing the sport of drag racing.

Research

Background of the Problem

Drag racing, which originated in the late 1940s, has seen remarkable advancements in technology and technique over the decades. One key area of development has been racing suspension, which has evolved from basic traction bars on leaf spring setups to modern systems like parallel 4-link suspension and dual adjustable coil overs. Alongside these innovations, drivetrain technology has also progressed significantly. However, from the earliest days of the sport, the primary challenge has remained consistent:

traction loss. Racers have continually sought ways to keep their tires firmly planted on the track, minimizing wheel hop and spin to achieve optimal performance.

In today's high-horsepower applications, parallel 4-link suspension geometry has become the industry standard for its superior ability to transfer force downward onto the tires. This geometry is far more effective than earlier solutions like ladder bars, traction bars, and Caltrac systems. However, the most significant obstacle with modern 4-link suspension lies not in its design but in the knowledge required for proper setup. Many racers struggle to optimize their suspension systems due to limited understanding of how to adjust bar lengths and angles to accommodate variables such as wheelbase, center of gravity, total weight, and weight distribution.

Track conditions add another layer of complexity to suspension tuning. Modern drag racers compete on a variety of surfaces, including high- and low-prep tracks, low-prep tracks, and even no prep tracks. Factors like track temperature; which can fluctuate throughout the day and across various locations also influence suspension setup. For instance, excessive force applied to the tire on a track that is too warm or too cold can lead to traction loss, making precise tuning even more critical.

While there are resources available such as videos from chassis builders, articles, and forum threads, the industry still lacks a comprehensive guide to 4-link geometry as well as a prefabricated 4-link kit available to racers on the market seeking a 4-link system that accommodates most of any bar lengths and angles your car may require for optimal performance. Such a resource would address how to maximize traction, optimize suspension travel, and consistently achieve top performance, from the crucial 60-foot time to maintaining traction over the full 1,320 feet of a quarter mile drag strip. Bridging this knowledge gap is essential for unlocking the full potential of modern drag racing technology.

Applicable Standards

The construction of 4-link suspension systems on tube chassis racecars primarily falls under general vehicle design and safety standards, but it is not explicitly covered by a specific ANSI/OPEI (American

National Standards Institute / Outdoor Power Equipment Institute) standard. ANSI/OPEI standards are more commonly associated with outdoor power equipment such as lawnmowers, tractors, and heavy equipment rather than motorsports or automotive applications.

For tube chassis racecars, suspension construction is typically governed by the following:

1. SAE International Standards

The Society of Automotive Engineers (SAE) provides guidelines for automotive component design, including suspension systems. While not specifically about 4-link systems, standards such as:

- SAE J1587: Material properties and design for vehicle chassis and structural integrity.
- SAE J2492: Guidelines for lightweight chassis material usage.

2. NHRA (National Hot Rod Association) Rules

NHRA rules provide specific guidelines for tube chassis construction, suspension design, and safety compliance for drag racing. These include:

- Material requirements (e.g., tubing size and thickness).
- Attachment points and mounting hardware for suspension components.
- Safety-critical welding standards and inspection protocols.

3. SFI Foundation Standards

The SFI Foundation offers detailed specifications for motorsport safety equipment and chassis construction. Relevant standards for drag racing include:

- SFI 25.1: Professional chassis (full tube chassis) for high-performance drag racing cars.
- SFI 25.3/25.4: Construction specifications for sportsman-class drag racing vehicles.

4. ASME Standards for Welding and Fabrication

If welding is involved in the suspension or chassis fabrication, adherence to standards like ASME BPVC Section IX (welding qualifications) or AWS D1.1 (structural welding standards) may be necessary to ensure structural integrity and safety.

Although ANSI/OPEI standards are not directly applicable to 4-link suspension systems, builders must comply with regulatory motorsport authority requirements and ensure adherence to applicable general engineering and material standards, including those from SAE, NHRA, or SFI. It is essential to review the specific rulebook of the racing series in which the car will compete, as they often define acceptable suspension geometry, materials, and safety protocols.

Current State of the Art

The current solutions for addressing four-link suspension issues primarily consist of online forums, which vary in credibility, online videos from diverse sources, and advanced mathematical formulas and calculations that many find difficult to apply. Each of these solutions presents its own set of challenges, such as concerns with credibility, the complexity of the concepts, and the difficulty of practical application for the average drag racer. Information on this topic is provided by a wide range of individuals, from experienced chassis builders to beginners, which often results in a mix of reliable and inaccurate advice. Unfortunately, these resources typically fall short in terms of real-world applicability and ease of understanding. Developing a comprehensive beginner's guide would help educate racers on the principles of four-link suspension geometry while minimizing the risk of human error in calculating bar angles and lengths.

While four-link technology and a solid product base do exist in today's consumer market, I also thought it necessary to design and develop a four-link system that supports all the necessary needs in the diversity of

different racecar chassis weights, weight-biases, power levels, and categories of drag racing. Bringing a system to the market that fulfills the needs of all drag cars in the field regardless of these design factors would bring the first fully universal product available to the market that “checks all of the boxes.”

End User

The research and development of this model will benefit countless people all over the world. Designed to benefit and accompany the needs of racers in question all over the world, this guide will share the information necessary to provide racers with faster and safer passes down the dragstrip. Additionally, this user-guide could be used by chassis builders and race shops to set up new cars correctly for their intended uses based on horsepower, weight, and track prep.

The end-users of the parallel 4-link bar length and angle guide would include race car engineers, suspension specialists, vehicle builders, performance tuners, and racers. These professionals would benefit from the tool's ability to calculate optimal suspension geometry, ensuring that the 4-link system is configured for maximum traction and vehicle control under the extreme conditions of racing. By fine-tuning the angles and lengths of the links, these users can improve vehicle stability, handling, and acceleration, leading to quicker passes down the dragstrip.

In addition, drag racers, off-road vehicle builders, and custom suspension designers can use both the model and guide to optimize suspension setups for several types of racing, from drag racing to off-road competitions. This tool would be particularly useful for those looking to customize or retrofit vehicles with high-performance suspension systems, as it simplifies the often-complex process of achieving proper suspension geometry. By ensuring that suspension components are correctly configured based on vehicle specs and track conditions, the guide enhances safety and allows for superior adjustability, while also improving competitive performance with enhanced traction/tuning capabilities.

Summary of Research

Drag racers worldwide struggle every day with applying horsepower to the ground to push their car to run faster, smoother, and more consistent passes down the dragstrip. The majority of drag racers utilizing parallel 4-link suspension geometry lack the knowledge it takes to correctly configure these set ups to apply as much power to the ground in conjunction with the drivetrain as possible without the loss of traction. The absence of a universal guide on proper 4 link suspension geometry impedes potential in thousands of cars in the categories of performance and even safety. The current methods of 4 link set up on the vast majority of cars in drag racing consist of primary trial and error which raises serious potential issues such as severe tire spin, wheelies, or tire shake which all substantially raise the probability of a crash while substantially lowering the probability of a smooth, straight, quick pass down the drag strip.

Existing solutions to this need such as online racing forums, video explanations, and raw force calculations fail to provide credibility and illustrate correctly how 4 link suspension geometry works for the average consumer market of this information. The current solutions to this question do not necessarily adhere to the consumers' needs as there are no clear visuals that are proven through calculation but shown through illustration and simplified explanations. Many current solutions also lack the explanation of how much track prep and temperature are about how your suspension should be configured for various applications.

The creation of the new solution will be applicable to various racers in drag racing from no prep street cars to pro mods and top dragster class cars. It will require consideration of surface temperature and quality of surface prep. To ensure reliability and accuracy of this guide and representation, factors such as track temperature, track prep quality, vehicle weight, approximate wheel horsepower, weight bias, wheelbase, instant center of the vehicle, and center of gravity will be covered thoroughly to provide users with sufficient resources to foresee any potential issues in their own cars, and provide information clearly enough for racers to configure their own systems to articulate and travel smoothly enough to manage power and track conditions as needed.

The current solutions are inadequate for distinct reasons. Videos online lack credibility and personal application answers, online forums lack illustration and explanation of the concept, and the available calculations online are not user-friendly, nor do they illustrate why these forces must increase and/or decrease the way that they do.

My initial plans for this project are first to design my own 4-link system eligible of handling most of anything that it can be used for in a drag racing application with several factors including horsepower, vehicle weight, and track conditions. After this, I would like to model this design into 3D design software to obtain my final dimensions and research and decipher what materials and how much of these materials will be used in the construction of this design. Once this is complete, I will perform some FEA testing for material strength. I will also provide hand-calculated stress analysis on my system to prove that construction of this 4-link is suitable for most applications in the industry. Following all of this, I will quote and purchase the materials needed to build this system and fabricate this suspension system in my own fabrication shop.

When testing and fabrication is completed, I will utilize this fabricated model of 4-link to display the various factors of change in 4-link suspension performance in drag racing during the expo and all real-life track testing will be performed on a similarly setup racecar I own and drive to display differences through video in bar angles and bar length. I will explain how these differences correspond to my guide and these changes will be explained in my guide about what each change does to the performance of the car's stability/traction on the track and why.

Customer Features

A survey was conducted on the importance of certain variables covered in a 4-link guide. We surveyed 16 local racers in our area with varying combinations in power level, overall car weight, and racing class. These people were asked to rank each of these user input features with an importance level from 1 to 5. We used the results of this survey to create the table shown below in *Quality Function Deployment*.

- **Overall Car Weight with Driver:**

Total weight of the car, including all its components, fuel, and the driver inside the vehicle.

- **Weight Bias Front to Rear:**

Total weight in each corner of the vehicle read from force to the ground on each tire presented in pounds and percentage.

- **Estimated Wheel Horsepower:**

The estimated amount of power the engine delivers to the wheels, considering drivetrain losses but not measured directly on a dynamometer.

- **Rear Gear Ratio:**

The relationship between the number of rotations the driveshaft makes and the number of rotations the rear wheels complete, determining the balance between acceleration and top speed.

- **Wheelbase:**

The distance between the centers of the front and rear axles.

- **Center of Gravity:**

The point where a car's weight is evenly distributed, significantly impacting stability, traction, and acceleration dynamics.

- **Track Prep Quality:**

Quality and consistency of traction glue on racing surface if any; typically recorded as good, okay, or bad.

- **Track Temperature:**

The heat of the racing surface, which affects tire grip, traction, and overall performance during a run.

Tire Size/Type:

The tire size and type in a drag racing application are critical factors that influence traction, acceleration, and overall performance, with specialized slicks or radials designed to maximize grip and handle extreme forces during a run.

Link to Survey is Listed Below:

Link: [4-Link Criteria Feedback Survey](#)

Quality Function Deployment

A survey was conducted to determine the importance of different user inputs to implement into our user guide/segment on how 4-link geometry functions and reacts in various scenarios for the drag racing consumer market. I surveyed 16 different people local to my area of differing racing careers such as drivers in Super Pro, Outlaw, Sportsman, Top Dragster, and No-Prep along with a couple of local tuners. I used the results from this survey to construct the tables below to display our survey data and concluded results.

Survey Methodology and Results

Beginner's Guide		Importance of the Feature		Satisfaction with the information currently available	
		Average Rank	Standard Deviation	Average Rank	Standard Deviation
Customer Features	Total Surveyed				
Shock Setup	16	4.4	1.09	2.9	0.82
Optimal Bar Length	16	2.7	1.09	4.4	0.82
Bar Angle Explanation	16	5.7	1.09	2.2	0.82
Instant Center Explanation	16	4.8	1.09	2.1	0.82
Anti-Squat Line Explanation	16	5.4	1.09	2.1	0.82
Tire Slippage	16	4.2	1.09	3.2	0.82

Suspension Setup Characteristics

Using our data found via our survey, we decided upon the engineering characteristics below

- Tire Slippage
- Optimal Bar Length
- Bar Angle
- Instant Center
- Anti-squat
- Center of Gravity

House of Quality

The inclination of the upper and lower control bars, which affects how the rear tires plant power to the ground by controlling the car's weight transfer, traction, and anti-squat characteristics during acceleration.

2. Anti-Squat Line

The geometric line that determines how much the rear suspension resists squatting during acceleration, with its position influencing the balance between traction and weight transfer for optimal launch performance.

3. Instant Center

The theoretical point where the extended lines of the upper and lower control bars intersect, determining how the vehicle's weight transfers to the rear tires and influencing traction and launch dynamics.

4. Shock Setup

The adjustment of shock absorbers' compression and rebound settings, which control how the vehicle manages weight transfer, traction, and stability during acceleration and launch.

5. Tire Slippage

The loss of traction where the tires spin faster than the track surface during acceleration, reducing the efficiency of power transfer and impacting launch performance.

6. Bar Length

The distance between the mounting points of the control bars in a 4-link setup, which affects the instant center location, weight transfer characteristics, and overall traction during acceleration.

Designing a four-link suspension system requires precise control over geometry and materials to maximize traction and power transfer. Key elements include bar angles, the instant center, and the anti-squat line. Adjustable brackets (with multiple holes for tuning bar angles) let you fine-tune how the suspension reacts under load. The instant center's position relative to the anti-squat line controls how weight transfers to the rear tires, directly affecting launch performance and stability.

Strong materials are essential for safety and durability. Brackets should be made from 4130 chromoly steel with at least 1/4-inch thickness, and the four-link bars should use 0.120-inch wall 4130 tubing. Proper shock tuning complements the geometry to manage weight transfer, while bar length affects how aggressively force is applied. A well-designed system balances these elements to prevent tire slippage and deliver consistent, hard launches.

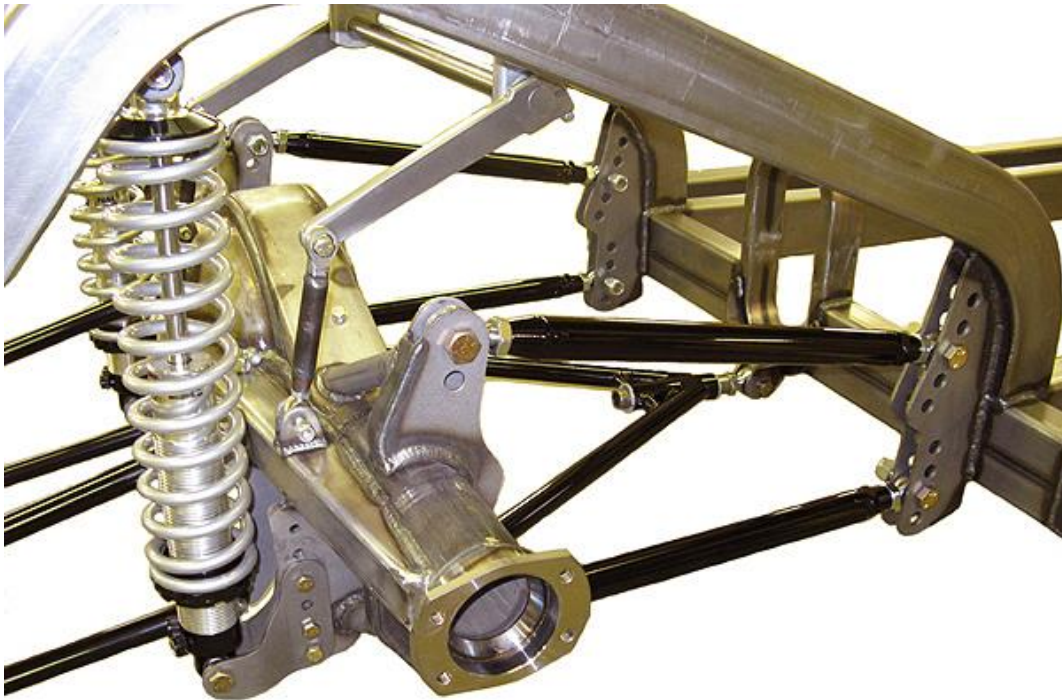
Concepts Design

Based on our *Quality Function Deployment* as well as sharing this idea with others within the racing community, it has become clear which aspects in the creation of this guide are most crucial to cover and include in the development process. Scoring highest in our survey on importance of coverage was *bar angle*. Following closely behind bar angle was the explanation and calculation of the *anti-squat line* and *Instant Center* which also ranked highly among those surveyed on criteria coverage. These three characteristics were ranked as the highest importance throughout our QFD process and yet are also the three characteristics that the current "state-of-the-art" solutions lack.

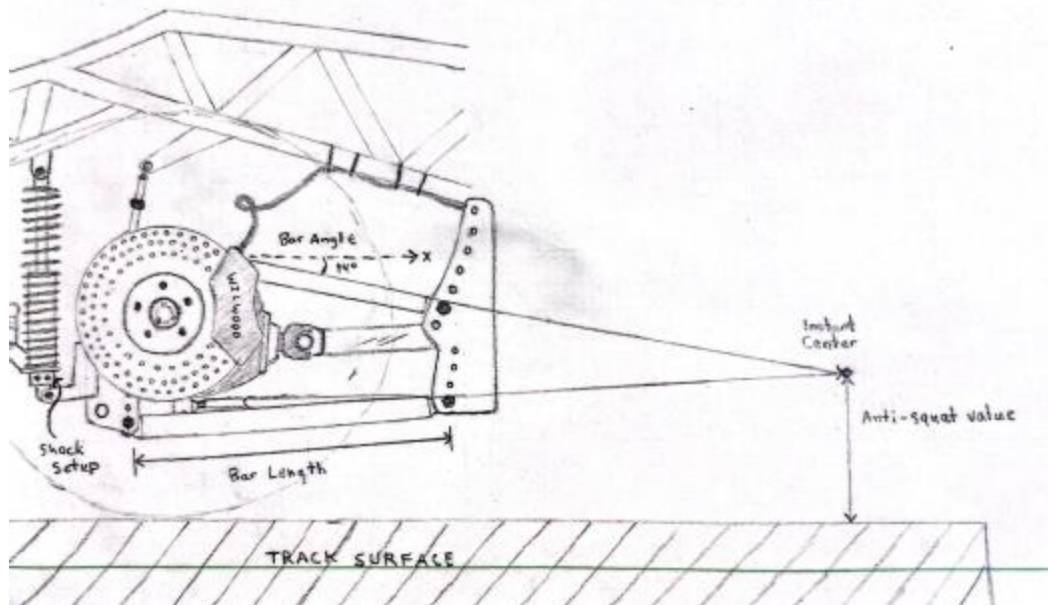
For a successful development and creation, this guide must contain and cover several key concepts to meet its requirements in success rate. These concepts include each of the following: Wheelbase, Overall Weight, Weight Bias, Center of Gravity, Horsepower, Tires, Gear Ratios, Track Temperature, and Track Prep Quality. I plan to illustrate each of these terms in an

illustration to allow for a fuller understanding of what each of these values mean in our explanations and final product. Additionally, the guide should present topics clearly and concisely, enabling users to apply the knowledge effectively to enhance their racing programs.

Our fabricated model must adhere to NHRA chassis guidelines by matching the correct thicknesses, weld strength, and material type.



4-Link Illustration:



Project Management

a. Team Members and Responsibilities

Project Manager/Engineer: Jett Westfall

Fabricator(s): Jett Westfall and Jacob Korn

b. Project Budget Limit

Given that this project entails most prominently research and labor done by me rather than material, design, and installation costs, I have set a goal of achieving a \$5,400 budget for the project in its entirety. This budget consists of all included costs such as tools, research, and software, and most prominently, labor costs necessary to bring this project to a finalized product. I calculated an estimated 130 hours (about 11 days) of labor invested into the development of this project including research, calculation, and development of this 4-link and a handwritten guide which comes out to 3,900 dollars USD. I have an estimated quote of around 1,000 dollars in material costs between purchasing the steel and having Goodman Steel cut the 4130 flat plate

using CNC into 4-link brackets. I also implemented an estimated budget of 200 dollars USD for all tools and equipment necessary to read and analyze any 4-link values such as angles and lengths needed to test and prove my concepts on a real drag car. While this cost would typically be much more due to the need for a TIG welder, I already own a TIG welder which brings the cost of this project down by about 5,500 dollars USD. As stated in the research section, I set out to design a 4 - link and a hand-written user guide for the drag racing community, but with the ability to obtain this knowledge free with some added labor to provide racers with answers along with the ability to buy these systems at lower manufacturing costs than I can offer, I must make this guide affordable to attract sales and save consumers of this software time and effort. At a projected cost of 40 dollars USD for this guide, it will take just over 8.6 months to surpass my total investment in this software if I average 15 sales each month.

c. Key Milestones

Data/Mathematics Collection	<u>01/21/2024</u>
Fabrication	<u>02/20/2024</u>
Testing	<u>03/17/2024</u>
Revisions	<u>03/19/2025</u>
Proof of Concept	<u>03/20/2025</u>
Final Guide Creation	<u>03/26/2025</u>
4-Link Release	<u>04/02/2025</u>

Design/Development Analysis

Fabrication & Plans for Assembly

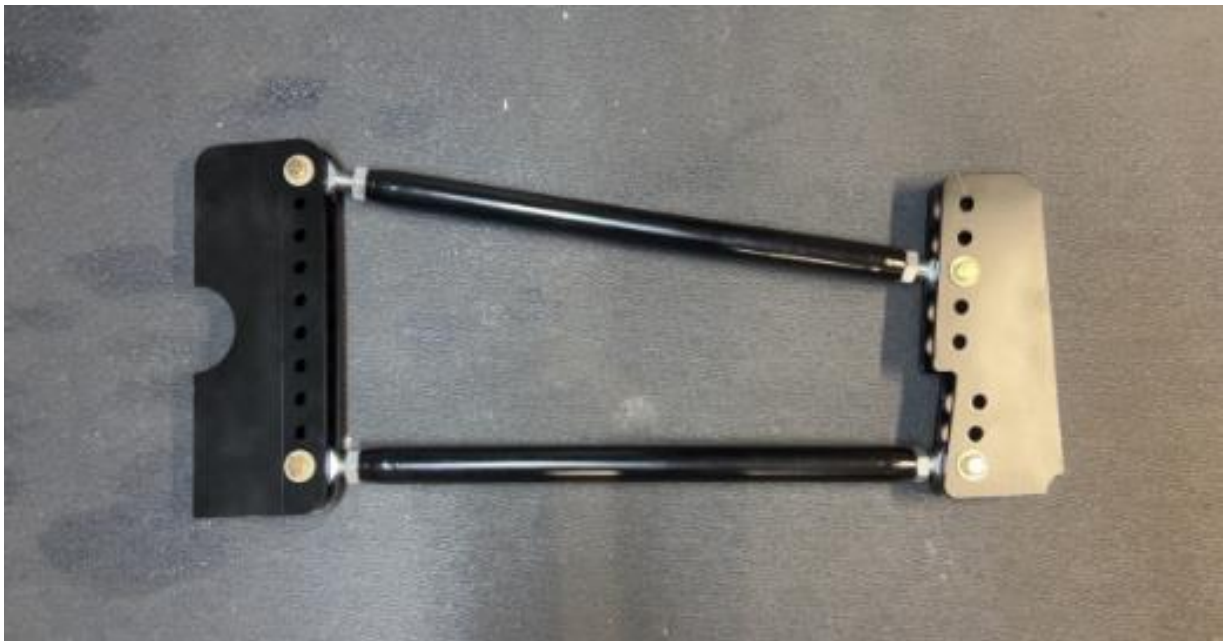
Plans for fabrication and assembly begin with design. The first step in the fabrication and design process was designing a 4-link system capable of handling horsepower, and vehicle weight while abiding by NHRA rules referring SFI safety codes, as well as BPVC Section IX (welding qualifications) and AWS D1.1 (structural welding standards) to ensure necessary strength and to remain legal in NHRA's chassis guidelines. These codes and standards refer most prominently to standard tube diameters, tube thicknesses, plate thicknesses, material selection, and weld strength.

Once the design process is complete, a bill of materials is created on what materials are needed, and how much of this material is needed. The next step is to contact Goodman Steel in Zanesville, OH for a quote on these materials and the CNC service to cut out the system's brackets design. I will then accept this quote and order the material. Once the materials are in and ready for pickup, I will pick up these materials to be brought to my fabrication shop for fabrication and assembly where each component will be cut, shaped, or welded to construct my final system.

It has since been decided that we will be using 4130 Chromoly 5/16" thick plate for our chassis and axle brackets as well as 1 1/2" diameter 4130 chromoly 0.120" wall tubing. Based on our Calculations we will need to buy a singular 5x4' piece of 5/16" chromoly plate and 100' of 1 1/2" chromoly tubing.

Solid model assembly

Fabrication went smoothly and resulted in a 1:1 scale model built to abide by NHRA and industry standard structural guidelines in which I have provided pictures of below:



Construction of this model consisted of a few key steps:

- Cutting: Steel was cut into shape and length at Goodman Steel
- Welding: Brackets were welded together and tubes all had weld bungs welded into them for threaded inserts for length adjustment.
- Grinding: Extra material on 4-link bars and brackets was ground off with a flap-disc and grinder down to smooth flat surfaces.
- Prime and Paint: Bars and brackets were cleaned, primed, and painted.

- Final Assembly: Heim joints and jam nuts were attached onto 4-link rod ends and hardware was installed and tightened to finalize the assembly.

Loading conditions/stress testing

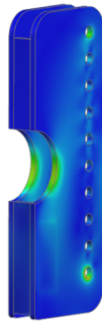
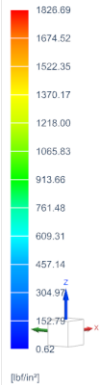
Throughout performing stress testing as well as testing loading conditions, I performed FEA structural analysis on Siemens NX as well as writing out hand calculations to begin ensuring required strengths for our 4-link construction during the design process. I found that our maximum stresses were all well within the yield strength of our selected material with the applied loads acting on these components and our factor of safety far exceeded what was required of these components. The maximum stress of our axle bracket was 1827 psi, our maximum stress on our chassis bracket was 853 psi, and our maximum stress on our 4-link bars was 471 psi.

We then hand calculated our compressive stress on our upper 4-link bars as these bars will carry most of the compressive force in the system, and we found these to have 382.5 psi of force on each bar. Which is well within the parameters of our required factor of safety of 4.

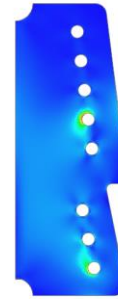
To finalize and truly prove the strength of our fabricated components, I continued to do some simple testing using simple tools like vehicle rated ropes and a crane scale.

Pictured below is my FEA analysis and hand-calculated compressive bar stress:

Axle Bracket Assembly_sim1 : Axle Bracket Result
 Subcase - Statics 1, Static Step 1
 Stress - Elemental, Von-Mises
 Min: 0.62, Max: 1826.69, Units = lbf/in²
 Deformation - Displacement - Nodal Magnitude



Chassis Bracket Assembly_sim1 : Solution 1 Result
 Subcase - Statics 1, Static Step 1
 Stress - Elemental, Von-Mises
 Min: 0.24, Max: 853.28, Units = lbf/in²
 Deformation - Displacement - Nodal Magnitude



* 14° bar angle *

Upper Bars

$$W_+ = \frac{\text{Total weight} \times h_{cg}}{\text{Wheelbase}} \rightarrow \frac{2000 \text{ lbs} \times 9.3''}{100.5''} = 185.07 \text{ lbs}$$

Rear Load = $2000 \times 0.55 = 1100 \text{ lbs}$

Total Rear Load = $1100 + 185.07 = 1285.07 \text{ lbs}$

$$F_{upper} = \frac{185.07}{2 \sin(14^\circ)} \approx 382.509 \text{ lbs compressive per bar}$$

Lower Bars

Minimal compressive force in parallel configuration, mostly handle horizontal load transfer

Factor of Safety

For factor of safety, FEA structural analysis was performed on both the axle bracket and the chassis bracket to ensure that the required factor of safety of 4 was met since my system consists of all repeating/cyclical loads throughout the duration of making a pass in a drag car. In our FEA testing, we found that our axle bracket had a maximum stress of approximately 1827 psi. Taking

the yield strength of 4130 chromoly steel which is 63,100 and dividing this by our maximum stress, we found that our axle bracket had a factor of safety of approximately 34.54 which far exceeds our required factor of 4. Similarly with our chassis bracket, we found that the maximum stress will be approximately 853 psi and using this same equation, we found that our factor of safety for our chassis bracket will be approximately 74.

For our 4-link bars, we found that the upper bar will experience 90% of the force throughout use rather than the lower bar. The upper and lower bars are identical in construction and dimensions and through hand-calculation it was found that our upper bars will experience a maximum stress of approximately 471 psi. Using our factor of safety equation and dividing 63,100 psi by 471 psi we found that our estimated factor of safety for our upper 4-link bars is approximately 134. Since our lower 4-link bars experience less than 10% of the stress on this compressive system and are designed identically, we found it unnecessary to calculate the factor of safety and is written off as a negligible force but were proven to carry a factor of safety that exceeds 10 times the factor of our upper bars.

Pictured below is my hand-calculated factor of safety for each of my components:

Factor of Safety

Axle Bracket : $63,100 \text{ psi} / 1826.69 \text{ psi} = 34.54$
Chassis Bracket : $63,100 \text{ psi} / 853.28 \text{ psi} = 73.95$
Fence Link Bar : $63,100 \text{ psi} / 470.93 \text{ psi} = 133.99$

Axle

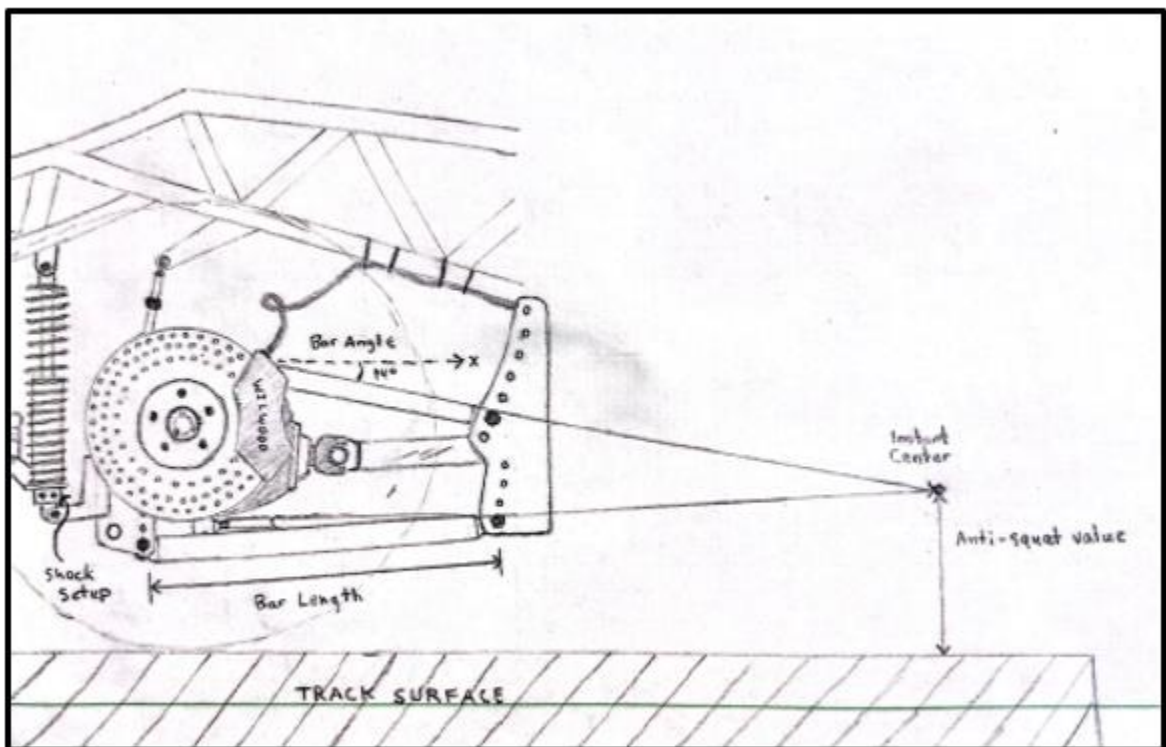
~~650~~ 2000 lbs $\xrightarrow{\text{total car weight}}$ 55% rear / 45% front $\rightarrow 2000 \times 0.55 = 1100 \text{ lbs}$

$1100 \text{ lbs} / 2 = 550 \text{ lbs}$ on each side of rear axle or on each tire

Chassis

Total car weight = 2000 lbs

Below is a hand-drawn illustration of how 4 link suspension looks on a tube chassis racecar:



Testing and Proof of Concept

For testing and our proof of concept, we will go through a set of steps to verify the accurate and reliable function of our 4-link system and verification of advice throughout our written guide at the racetrack.

Due to the nature of our 4-link system being a model, we will be utilizing my personal racecar and because my 4-link system retains all of the same materials, material thicknesses, and lengths as my personal racecar with the only difference being rear end width, all changes will directly correlate from my designed 4-link system to the 4-link on my current racecar.

First, we will prepare vehicles for testing with baseline 4-link measurements and adjustments on what we currently know works with prior trial-and-error efforts. We will follow by acquiring a private track rental to take the car to the racetrack in clear weather conditions and perform one initial test pass as our constant. After this, we will record all current settings from the car and the current weather and track conditions and consider these settings while utilizing our report to learn where we can improve based on our constant pass. From here, we will calculate our bar angles, and any other adjustments based on our report and make these adjustments to the car in real time in preparation of a second pass down the drag strip. Finally, we will perform our second test pass down the drag strip to observe and evaluate any improvements made between video and timeslip to note any differences in the car's performance due to the changes made by calculation.

Although our four-link system is a model, it has been engineered and fabricated to the same standards and dimensions as a full-scale, functional system. To validate its strength, I conducted load testing using precision scales, demonstrating that my custom design exceeds the strength of current four-link systems on the market and is more than capable of withstanding the forces experienced in real-world application.

Our testing involved securing the chassis and axle brackets with heavy-duty straps and subjecting the system to both extreme tensile (pulling) and compressive (pushing) forces. These

forces significantly exceeded the typical loads expected during real-world racing conditions when installed in a vehicle.

Throughout the testing process, the model exhibited no signs of stress, deformation, or failure. Notably, it withstood over 1,000 pounds of force applied in a direction opposite to its intended load path without any structural compromise.

Model Rigging:



(Pull) Testing:



(Push) Testing:



Cost Analysis

The cost of this project consists most prominently of labor costs because it does not require any abundance of material to design and develop. The cost criterion consists of the following factors: labor at

\$30/hr., necessary tools, materials/steel, private track rental, and fuel cost between hauling our car to the track with the truck and trailer, and race fuel for the car. Shown below is a table including all costs involved in the development of this product:

Cost Criterion	Budget
Estimated 130 Hours of Labor Costs at \$30/hour	\$3900
Tools	\$200
Materials	\$1038.90
Private Track Rental	\$100
Fuel Costs	\$200
Total Project Cost	<u>\$5438.90</u>

Material Receipts:

Visit us at goodmansteelsupply.com

GOODMAN

STEEL & SUPPLY LLC

2453 Linden Avenue
Zanesville, Ohio 43701



F 7963



We Specialize in Custom Fabrication
Email: quoteme@goodmansteelsupply.com

Local (740) 452-2728
Fax (740) 452-2729
Toll Free 1-800-589-3278

INVOICE # _____ PO# _____ DATE 3/7 20 25

SOLD TO Westfall, Jett

ADDRESS _____

CITY _____ STATE _____ ZIP _____

CASH CREDIT

QUANTITY	ITEMS	PRICE
1 pc	1/2" HR Plate 27" x 31 1/2"	200.00
	w/ Plasma cutting into (8) Pockets	
4 pcs	1 1/2" x 170" DOM Tube x	17.00
2 pc	1/2" x 1" HR Flat x 11'	17.00
2 pc	1/2" x 1" HR Flat x 4.445'	30.00
2 pc	1/2" x 1" HR Flat x 5.445'	30.00
2 pcs	1 1/2" x .075" ERW x 50"	32.22
		\$321.54
	TAX	23.13
		\$350.27

Paid
AMEX

REC'D BY → _____

Thank you for your order

Thank you for your order

Thank you for your order

Hi Jett,

Just to let you know — we've received your order #31478, and it is now being processed.

[Order #31478] (March 14, 2025)

Product	Quantity	Price
Weld-In Threaded Alloy Steel Bung Size: 1-1/2" OD x .125 7/8" Thread Thread Direction: Right	2	\$36.86
Weld-In Threaded Alloy Steel Bung Size: 1-1/2" OD x .125 7/8" Thread Thread Direction: Left	2	\$36.86
Subtotal:		\$73.32
Shipping:		\$19.66 via Ground (LPS)
Tax:		\$0.00
Payment method:		PayPal
Total:		\$92.98

Billing address

Shipping address

Jett Westfall
103 oak leaf lane
Granville, OH 43023
6143909037
jettwestfall@gmail.com

Jett Westfall
103 oak leaf lane
Granville, OH 43023

Thanks for using [rodendsupply.com!](#)

Hi Jett,

Just to let you know — we've received your order #31438, and it is now being processed.

[Order #31438] (March 7, 2025)

Product	Quantity	Price
Weld-In Threaded Alloy Steel Bung Size: 1-1/2" OD x .125 7/8" Thread Thread Direction: Left	2	\$36.86
Weld-In Threaded Alloy Steel Bung Size: 1-1/2" OD x .125 7/8" Thread Thread Direction: Right	2	\$36.86
Subtotal:		\$73.32
Shipping:		\$19.66 via Ground (LPS)
Tax:		\$0.00
Payment method:		PayPal
Total:		\$92.98

Billing address

Shipping address

Jett Westfall
60 Oak Leaf Lane
Granville, OH 43023
6143909037
westfaja@mail.uc.edu

Jett Westfall
60 Oak Leaf Lane
Granville, OH 43023

Thanks for using [rodendsupply.com!](#)

Hi Jett,

Just to let you know — we've received your order #31524, and it is now being processed.

[Order #31524] (March 20, 2025)

Product	Quantity	Price
Self Lubricating Nylabter Race Rod Ends Thread Direction: Left Gender: Male Size: 3/4" Bore 7/8-14 Thread	4	\$114.62
Self Lubricating Nylabter Race Rod Ends Thread Direction: Right Gender: Male Size: 3/4" Bore 7/8-14 Thread	4	\$114.62
High Misalignment Spacer Pairs - HMS 8-12 Part No.: HMS 8-12	8	\$149.84
Subtotal:		\$379.08
Shipping:		\$32.79 via Ground (LPS)
Tax:		\$0.00
Payment method:		Credit Cards
Total:		\$411.87

Billing address

Shipping address

Jett Westfall
60 Oak Leaf Lane
Granville, OH 43023
6143909037
jettwestfall@gmail.com

Jett Westfall
60 Oak Leaf Lane
Granville, OH 43023

Thanks for using [rodendsupply.com!](#)

Order information

Buyer jewest-26
Seller rr_components
Placed on Mar 20, 2025
Payment method Credit Card

Shipping address

Jett Westfall
60 Oakleaf Ln
Granville, Ohio 43023-9692
United States

Order total

4 items \$45.88
Shipping \$8.34
Tax* \$3.93

Order total \$58.15

*We're required by law to collect sales tax and applicable fees for certain tax authorities.

[Learn more](#)

Items bought from rr_components

Order number: 12-12849-66507

Quantity	Item name	Shipping service	Item price
4	(1LH / 1RH) 7/8" - 14 Thread, Jam Nut, Rod End, Heim Joint, Joints Rod End (164189603245)	USPS Ground Advantage	\$45.88

Material costs have been broken down into the table below:

Item	Price
Weld Bungs (RH) Thread	92.98
Weld Bungs (LH) Thread	92.98
Jam Nuts (7/8 - 14)	58.15
Heim Joints (7/8 - 14)	229.24
High Misalignment Spacers	182.63
Steel (Bars & Brackets)	350.27

Assembly Hardware	32.65
Total Cost	1038.90

All computed costs for this project come up to a sum of 5,438.90 dollars in USD with all expenses included.

References

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3. MCCULLOUGH, Joe. Drag shocks & struts guide: Suspension tuning and setup. *Speedway Motors* [online]. 16 February 2024. [Accessed 6 December 2024]. Available from: <https://www.speedwaymotors.com/the-toolbox/drag-shocks-and-struts-guide-suspension-tuning-and-setup/134188>
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5. SCRABA, Wayne. How to tune a four-link suspension system. *OnAllCylinders* [online]. 23 April 2015. [Accessed 6 December 2024]. Available from:

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9. FARMER, Russ. 19 February 2025.

