

MAKE IT YOUR OWN: MUSTANG SUSPENSION UPGRADES

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1 Introduction

Some auto enthusiasts happen upon their ideal hobby car by good fortune, a few have the wherewithal to trade in the sub-optimal and buy the best performance available, and a bunch of us make do with what we have, compromises and all. When that hobby car purchase opportunity knocked what we thought we wanted at the time may no longer be quite it. Maybe features we thought we could forgo for a better price turned out to be important, or as we grew into our version of the auto enthusiast hobby our vehicle use priorities changed.

What to do when that Mustang one has stretched to buy and attentively care for just isn't quite the car of one's dreams and one's financial plan precludes replacing it with a shiny new Mustang Mach 1 Performance Package or Shelby GT500? Why, just make your car your own! For some, a forced induction system is the powerful answer to be master of the street and strip and an absolute bargain relative to a new 760 hp GT500. For others, upping the appearance with engine dress up components, aero body kits, graphic wraps and after market wheels ups the cruise night sparkle. For me, limitations of the base S550 Mustang GT suspension became all too clear in the twisty bits on the highway and on the track. Thus, a journey of discovery began.

2 The Suspension Issue

When it comes to performance driving on the track, how the driver perceives the capabilities of the car is nearly as important as the actual capability of the vehicle. Case in point, my Mustang was a quiet, comfortable, composed ride up to, say, 6/10's driving. Push it harder and turn in was OK but then the body seemed to roll and rear suspension seemed to move about more than one would expect for a proper sports coupe. Toss in a mid corner dip at speed and things got decidedly unsettled. Regardless of the actual capabilities of my Mustang, these behaviors sapped my confidence to drive the car to its potential.

3 First Mistake

Suspension is a system. There is a bit of wisdom that says an optimum system is necessarily the assemblage of sub-optimal parts. Why? This is because each part needs to sacrifice optimization in isolation in order to accommodate compromises needed to work well in combination with the other parts of the system.

Given a perceived issue with excessive body roll and a desire to be frugal, my first approach was to start with a cost-effective replacement of the stock front and rear stabilizer bars with adjustable track bars from the folks at Ford Performance. Set in the stiffest settings, body roll was eliminated, ride and comfort not impaired and driver confidence greatly enhanced.



Over time this optimal part solution began to fail, literally as the sway bar end links and mounting bracket bushings had to absorb much higher forces than they were designed for. I came to learn that the flat cornering at the track actually limited grip and exacerbated understeer. I had failed to take a systems approach.

4 Get Expert Help

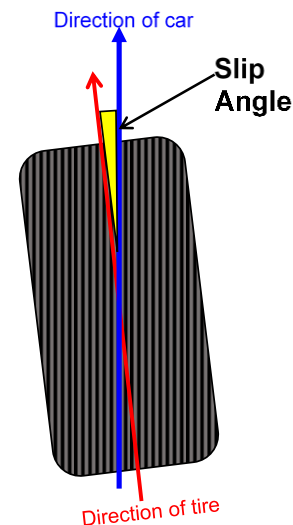
Heading into a high speed left turn at 200 kph, do you really want to trust the DIY guy who has tinkered with suspension just once to modify and set up your car? I certainly would not trust a novice using my car as a learning experiment. Therefore, consult with knowledgeable enthusiasts, read to get a better understanding of performance suspension¹ and engage expert mechanics to give advice and to work on your car. In my case, folks at the track referred me to Simpson Racing Solutions (SRS) in Penticton, BC. In addition to being an active drag racer, Chris Simpson builds and sets up track cars from Corvettes to Porsches for members at the track.

A meeting to discuss the current set up of my Mustang, my perceived problems, how I intended to use my car and my desired performance improvement outcomes was the first step. Even the experts get help, so Chris reached out to other shops that specialize in setting up Mustangs for autocross and track days before offering any advice.

5 Too Much – Too Little

Successful suspension tuning involves understanding causes of undesirable suspension behaviours, as well as the unintended consequences of adding too much or too little of a good thing. The following offers examples of suspension issues that can be caused by various components and suspension settings.

Both understeer and oversteer limit the cornering capabilities of a car. A moving vehicle wants to continue in a straight line. It is necessary to introduce slip angle by turning the steering wheel so the tires can generate the force necessary to change the direction of the car. As slip angles become excessive the tire starts to slide as traction limits are exceeded. Understeer is when the front tires go to higher slip angles than the rear causing the car to push or plow straight ahead. Conversely oversteer is when the rear tires go to higher slip angles than the front causing the car to be loose or spin. A moderate amount of understeer is deliberately built into most production cars as it is more stable, provides early warning of excessive cornering speeds and affords the driver time to slow down and control the car through the corner. Oversteer can progress quite quickly into a dangerous loss of control and spin.



Excessive body roll in a car is unsettling in corners, however adding too much roll stiffness (e.g., using a big track sway in its stiffest setting) limits weight transfer to the outside front tire

¹ The key references for this article are:

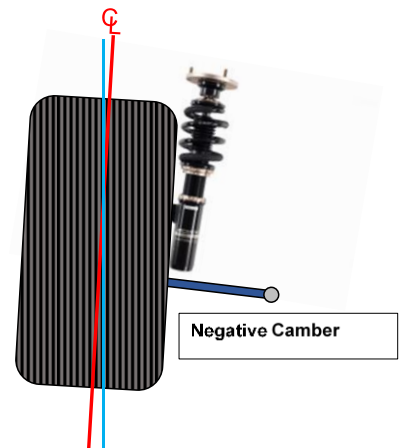
- First and foremost, personal discussions with Chris Simpson of Simpson Racing Solutions, Penticton, BC
- Paul Haney and Jeff Braun. *Inside Racing Technology*. TV Motorsports, Redwood California
- Rapid-Racer. *Suspension Tuning*. <http://www.rapid-racer.com/suspension-tuning.php>

increasing understeer as the front of the car slides without taking a set. Too little front anti-roll stiffness, especially in combination with too much rear roll stiffness, can actually lift an inside wheel and/or increase corner exit oversteer. Generally, moderate anti-roll settings result in a better balanced car.

Over-stiff springs can turn the whole car into an uncomfortable upsprung mass. Just think how a stiffly sprung, empty utility trailer, tires and all, bounces off the ground on a rough road. Too stiff front springs result in understeer and, on a rear drive car, too stiff rear springs can result in wheel spin and oversteer. Too soft and the suspension bottoms out under hard braking, roll is excessive, understeer occurs on turn in and power-oversteer can occur under acceleration.

Shock absorbers, or more correctly dampeners, control excessive suspension movement and spring oscillations in both compression or bump and rebound. Very firm bump settings are not only uncomfortable but also transfer upward motions directly to the chassis. Too soft and the car dives under braking, squats under acceleration, rolls excessively and results in varying downforce on tires with loss of grip. Too much rebound dampening and the tires may not follow the road surface in dips, too little and the car floats over heaves, oscillates after bumps and wheel hop may limit acceleration. Oversteer can result from too much rear bump and rebound dampening and from too little front and rebound dampening. Understeer is exacerbated by too little rear bump and rebound dampening and too much front bump and rebound dampening.

Camber describes the tire footprint relative to the road. Neutral camber means the tire is perpendicular to the road and minimizes tire wear and enhances straight line braking and acceleration. Positive camber means the top of the tire leans outwards from the chassis and reduces steering effort especially for off-road applications. Negative camber means the top of the tire is tilted in toward the chassis and enhances grip during cornering. While passenger vehicles tend to set up with near neutral camber some level of negative camber is desirable for sports cars. Too little negative camber (or positive camber) in the front causes understeer and, in the rear, oversteer. Too much negative camber causes excessive tire wear and heat all around, as well as reduced braking and acceleration grip.

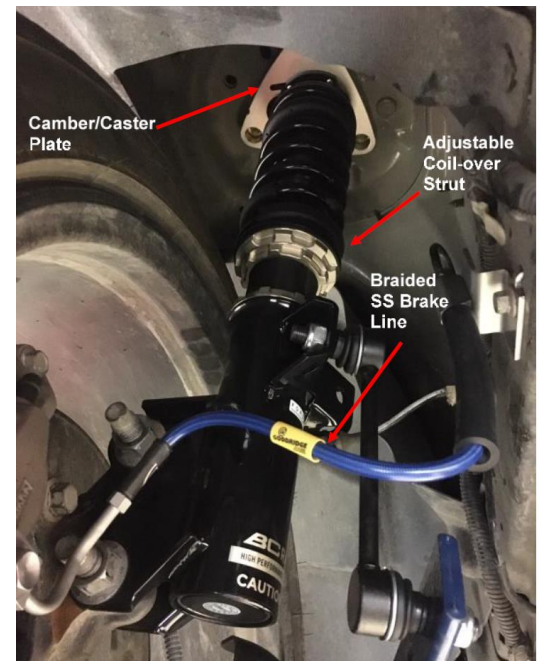


6 The Fix

My first suspension upgrades turned out to be reasonably useful so the track sway bars and wider tires on wider wheels were not a waste, just incomplete and not set up properly. Not unexpectedly, somewhat stiffer springs that also lowered the center of gravity an inch or so and adjustable struts and shock absorbers were recommended. The unexpected learning from the Mustang tuning experts was that the OEM use of rubber bushings to locate the independent rear suspension (IRS) subframe, differential and suspension components was problematic. The rubber bushings are cost-effective parts to isolate the suspension to reduce noise-vibration-harshness (NVH) for that nice smooth quiet ride. Unfortunately for a sports coupe, rubber deforms under load inducing suspension geometry changes that make S550 Mustangs feel less than composed taking corners at speed. Lastly, the stock suspension mounts did not allow sufficient adjustment to properly set the car up for more aggressive driving.



When it came to a retiree's budget, having expert advice makes a difference. An upgrade package featuring a host of premium name parts was eye watering in cost. SRS did some research and developed a more budget-friendly suite of components and separated the nice to haves (extra chassis bracing) from the essential bits for improved performance. A key solution was an affordable coil-over kit that is used by several drivers on their racing BMW GTU cars at the track. The final suite of components included the coil-over package (adjustable coil-over front struts, adjustable rear springs and shock absorbers and adjustable front strut camber/caster mounting plates), IRS subframe bushing support system (billet aluminum collars that control bushing deformation), IRS subframe alignment kit (machined Delrin inserts for subframe mounting holes), urethane differential bushing inserts, Ford Performance forged rear toe links and forged front control arms (the links and arms use Delrin lined spherical bearings instead of rubber bushings), DOT approved braided stainless steel brake lines and high temperature DOT4 brake fluid. Notably a major focus of the project turned out to be installation of a bunch of innocuous parts to quell the rubber bushing shakes.



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All the performance bits are of no particular benefit if not properly set up. A key benefit of the adjustable coil-overs and rear springs is the ability to not only lower the center of gravity of the car but also to adjust the springs to balance the car



side to side and cross-balance it left rear to right front and right rear to left front. This involved placing each wheel on an electronic scale with a suitable set of weights (OK a lot of weights) in the driver's seat and adjusting the spring perches to optimize chassis balance accounting for the driver. Lastly, the suspension was aligned dialing in negative camber and a small amount of toe-in (both front and rear) to enhance safe handling while maintaining reasonable tire wear.

Counter intuitively this optimized set up did not involve making the suspension as stiff and unyielding as possible. Rather the sway bars were set in their softest setting and the shock absorbers at a medium but definitely not firmest bump and rebound dampening. The result is a firmer street ride

to be sure, yet the much more controlled suspension response makes the Mustang feel more refined and connected to the road. A brisk drive on back roads revealed better turn-in and no drama with mid-corner dips and bumps, proper sports coupe handling. At the track, the difference in having a suspension set up suited to the demands of a technically challenging road course was immediately and abundantly apparent. Balanced, settled and easier to drive fast with confidence, the first track outing on the upgraded suspension was most enjoyable to date!



It may look no different sitting still but it is vastly improved at speed in the twisty bits.