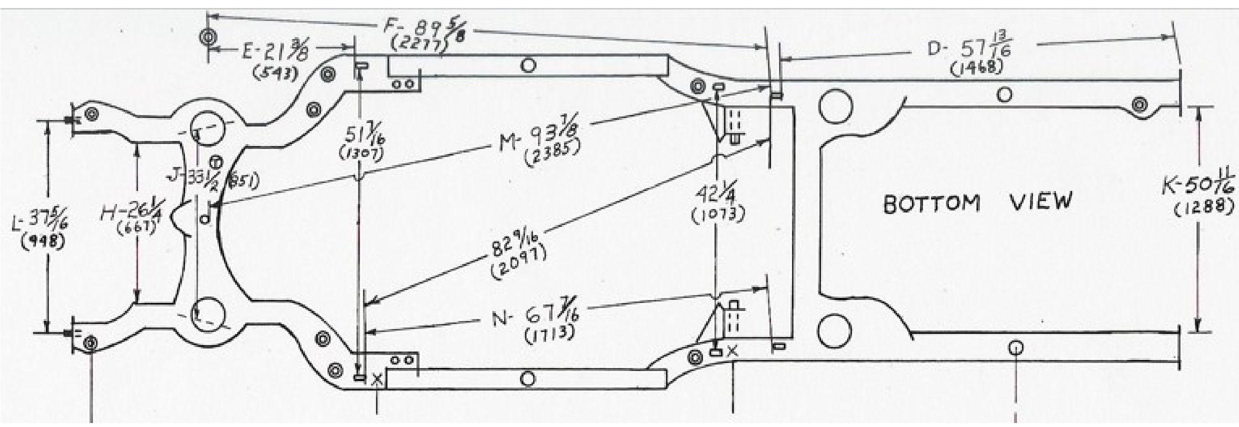
Race the complete primer as I see it…

There is a bible full of racecar media. You can find it everywhere, but this is a "primer", keep that in mind.
Racing 101…

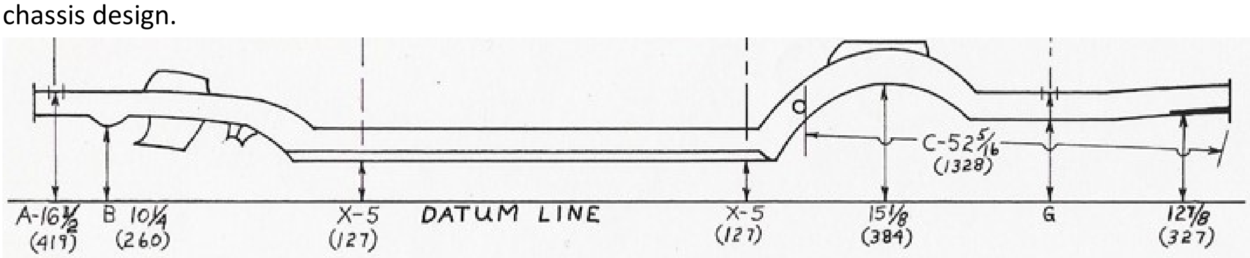
One must understand that this article is not about highly engineered tubular race frames or ultra-light low center of gravity racing chassis. This article was not written by an engineer nor was it written by a mathematic genius. This article is based upon experience with GM metric "G" body passenger cars that have been adapted to race tracks. The race track in this case is a basic one-half mile clay oval. The author has an effective background in high school math, and a basic education in algebra, trigonometry and geometry…mostly geometry. Actually, I was a straight "A" student in geometry. I did rather well in algebra and trig became a "fair exposure" study course of education to my portfolio.

I would say that algebra and trigonometry have a place in racing only because the triangulation of a racecar chassis is important to its structural design. A poorly designed chassis will fail under the stress of racing, but the placement of tubes and bars shares a lot of engineering components with the end result of proper overall geometry. I mean, the car has to be well designed in order to take a beating and yet it must be flexible enough to transfer weight properly around the car during all stages of race-track maneuvers.

The "GM" metric chassis is not a complicated design. There are literally hundreds of articles written about this "box frame" passenger car design, but not too many regarding its stock impression.



The stock, standing at curb weight, of a "G" body chassis is not documented. The ride height without engine, body or interior is not documented. What is generally written only covers the axle locations fore and aft. There is not much illustrated about the design concept. The visual concept that GM (and some Ford) chassis were trying to accomplish prior to unibody construction, was a short wheel base vehicle that had relatively little roll side to side or front to back. The handling characteristics, while undocumented, they were considered the best ever applied to a rolling frame and chassis design.



Note: The ride height at the front and rear axle lines, the ratio at these two points should be considered when you make any suspension changes to the car (10.250 – 15.125).What remains behind the <u>rear axle center line is not important.</u>

For this presentation we must touch on both axles so one can understand where to begin. Either front or rear, makes little difference because you will modify all of your GM passenger car if you intend to run outside the "pure" or "strictly" stock-car class. I might inject here, even classes like "pure" stock, for the sake of racing, these cars are not "grocery getters" by any stretch of your imagination. Stock car racing has evolved over the years into a science that incorporates thousands of dollars into a "stock car" that you would have paid less than a few thousand, showroom new, only three decades ago.

Where to begin: What say we cover the basic chassis from rear to front and back to rear. Since the rear axle is basic to all these metric designs let the discussion begin. The car was designed with a "four bar" trailing system that locates the axle fore and aft under the chassis. As engineered it works well, but for dirt racing it has two problems that we must consider.The GM design eliminates rear steer during normal vehicle roll. We want rear steer, or it would be nice to allow rear steer with managed control. It would be helpful to have the rear axle rotate around itself so that the car can be sharply pointed down into a turn left after running the straight stretch when the chassis is neutral. The GM design eliminates most of the "axle wrap" that occurs during brake and throttle action. This helps to maintain stability in the rear and it provides us with a relative stable roll center L-R located above the rear axle housing. However this kind of design does not lend itself to "throttle" up response which many racecar drivers desire. The "hike" or lifting action on the left side of the car is all but eliminated in the stock metric chassis. Rear "squat" and chassis "roll" is limited by length the location of the stock arms in the GM design.

I must inject something here. I raced a 1959 Impala on local dragstrips. My 348 CID motor was strong enough to put me in a fourteen second bracket over the quarter mile. But the rear design was a three link suspension. It had one over axle trailing arm that was too long and the axle was held in place by two lower trailers and a radius arm. There was no way to control axle windup on the left side. The result, I tore the upper arm out of the car so many times, it eventually could not be repaired. GM added a second upper arm later in the design. This became the standard for "A" body cars and it was redesigned for the metric units around 1978 and was adapted to many mid-sized models.

The metric upper arms were placed at angles so this eliminated any need for a panhard bar (track bar) and because of this, there is limited lateral movement, therefore there is limited rear steer effect. The early designs of "A" body cars placed the rear springs in front or behind the axle. That all depended on the make and model, but the metric units, the springs must be seated onto the axle housing. The springs atop-axle location are the rear axle pivot points. This location eliminates most rear axle "roll center" motion. Changing arm lengths and position will change the roll center. We must maintain some controlled level of roll in a racecar. Too little roll, shocks and springs are worthless. Too much roll and our shocks and springs are worthless. *Note: In Pure Stock there are several "no roll factors" we cannot assuage.*

The metric 4 link rear suspension (OEM stock looking from rear to front)

For Street Stock applications some track rules allow us to change the rear axle from stock 7.5 inch rear axle to a 9 inch Ford unit. *Note: This is a huge safety factor, because modern Ford axle tubes incorporate tapered axle bearings*. This rule allows us to change bars, adjust the lengths and tweak the axle right to left under the car. Doing so, we can adjust the "roll center" location closer (lower) to the pinion center and perhaps a little to the left along the housing. That location is important, because in a dirt car application we want "a controlled dive" forward during braking that will result in our left front axle instant center moving inside the right wheel of the car. More on this later. [4]

The GM metric front clip, less the steering box. The obvious first impression is the upper control arms. These arms are so short and by design they are engineered to eliminate most all chassis roll in the front suspension. That coupled to a heavy sway bar, the "G" body handling ability was widely accepted as genius innovation for mid-size passesger cars. This suspension, when modified, works very well for Pure Stock racing. That is why these cars were so popular.

The longevity of design…good or bad, this particular design has withstood the test of time. Gazillions of these chassis were made. All GM midsize tradmarks sat on this chassis. From Buick to Pontiac and all in those between. Names like Cutlass, Regal and MonteCarlo, all incorporated the "G" body metric foundation. Racers have been using these in almost every class from Pure Stock to Semi-Late, from Street Stock to Economy Modified. The entire chassis or the clip was used for racing. But the years have passed on and the cycle of "clunkers" cashed in long ago. There are a few originals still racing, but the trend toward third-party design and remanufacturing of stock production units has increased the cost of racing dramatically. We could build a race-ready "Charger" car for under three grand. Today the chassis alone will cost anywhere from six to ten depending on the setup. Hell's fire, the original passenger car was under five grand for the most luxurious models.



The life of so many two door sedans was never replicated into as many Street Stock racecars as the metric "G" body units from GM. You towed your SBC powered, metric chassis racecar on a flat-bed trailer using a Ford F150 pickup. I cannot begin to imagine how many of these old cars were track champions long after they were pulled out of some aging garage or old barn. They were saved from the fate of rusting to death; brought back from the bone yard to live a better life as a racecar. What a story…imagine all the drama of the build…the time spent with family and friends. Grass Roots, Saturday Night racing…there was no greater fantasy. The "metric" racecar is a historical part of Americana.

The changeover from driveway to speedway:

The basic interpretation…"this is going to be a raceccar" . You had to see the look on my wife's face!! We, my son and I, began by removing the stock body. This does not take long because the "G" body sedan uses a rolling chassis. Remove the front clip, the fenders, hood, and core support . The entire back of the car can be lifted off the frame after removing the doors and a half dozen mounting bolts. Cut the cords that tie all the accessories together and prepare to strip the chassis of unwanted weight. You will have a firewall and rear deck pan. There will be two long box rails, a rear end housing and a front suspension. The bumpers will be removed and the fuel tank scraped. You will pull the engine and begin the process of a total inspection. What needs replaced and what needs repaired??

Roll out the welder, a mig machine, and get started. You don't need a degree in welding but a little support and some training will make you a better fabricator. I would recommend a visit to "instructables workshop". There is a very nice tutorial there that can certainly help the novice.

If you are a reasonable MIG welder, you will soon find out that building your own racecar is not all that terribly hard. There are as many tutorials on roll cage design and development as you can possibly think of…probably more than you need. There are kits available on-line. You can fabricate a basic cage or purchase a metric chassis kit for less than 500.00. Some kits can be confusing and many are over-rated and too technical. You are not building a rocket ship to Mars. You choose your level of expertise and find a local track that offers an entry level Stock Car with rules supporting minimal changes to the overall design. Minimal changes means your front lower control arms must remain stock and in OEM location. The rear suspension must resemble OEM parts and in original location. The wheelbase must remain stock (108") and the engine setback is limited. Whether or not floorboards can be removed is questionable in today's Stock Car, but the firewall should remain in the original location. You will need to add some safety features like a racing seat, harness and a fuel cell. Read your rules and do some research. Above all, get some help. Family members are a good place to start. Make sure you have a budget for hand tools and a compressor in your garage for air tools. Be smart, buy smart, the Bauer brand at Harbor Freight, this will save you money and help control the budget.

The basic Street Stock chassis from Speedway Motors. Nothing fancy here, yet it is perfect for "Pure Stock" racers. Keep in mind, these cars are heavy up front, adding a heavy cage middle to rear is not going to affect front percentage.

Note: Above all do not skimp on the "roof hoop and door cage". Triangulate wherever possible.

So what comes next? Your racecar is ready for its debut. Good for you. If you built a Pure Stock, Charger, Strictly Stock or any of the entry level Street Stock racecars, you will have to learn how to drive before you can adjust the car, so don't go off the deep end of the gene-pool. Stay in the shallow water for a season. Learn the ropes. Understand what your limits are and lay out a plan for the future. Unless Pure Stock has some fancy rules, you are racing a "grocery getter" and chances are the car is not very high tech. So don't spend money like a drunken sailor on fancy shocks, springs or tires. Take the time to learn how to race the track. There is a good chance you might actually win a heat or a feature, so apply your talent and reach for consistency. Before you finish "first", you must "first" finish, take the "checker". This must be your primary goal.

Level two, the Street Stock. The "grass roots" Street Stock is the first racecar you will actually learn how to adjust. You will start by building your own or buying new, possibly a used racecar. You can upgrade that pure stock if you have the tools and some time. Always remember used is probably abused. However, not in all cases, we sold winners in Pure and Street Stock because we wanted to move up a class. Moving up is generally a huge mistake. Without money, moving up is bankruptcy in action. The rule of racing is simple, if you want to win a million as a racer, start out with two. If you can KISS, "keep it smooth sailing" you will eventually succeed. <u>Kiss a little ass</u> make friends; mix in with the race community.

Moving up from Pure to Street or Pro Stock will cost you money and lots of headaches, but if you are willing to step up your game, and the family is on your side, go for it. Street Stock is the "grass roots" of all racing no matter what anyone tells you. <u>This class is the most fun</u>. This class is where it all started…even NASCAR. Move above Street Stock, and you are into "sanction body" territory. Pro Stock is over-rated for just one reason alone…sanctioning rules. Pro Stock is "limited late model" and nothing like Street Stock. Pro Stock sounds like "major league" but for all it is or is not, it is "major league" expensive. You can race "crate late models" for less money and win larger purses.

Sanction bodies at "grass roots" level wastes money for everyone. The car owner, driver, pit crew, volunteers and the promoter. Everyone has to open their wallet. The rules are obscure and they favor the traveling teams. Local track officials tend to overlook the rules because the technical arguments can require an attorney, judge and jury in the pits. Your best technical official is not going to look for a "one inch" adjustment at the rear trailing arms, but that inch is a mile when it comes to rear steer. Open motor rules that lack common sense nullifies the most important aspect of racing, the race itself. While the "crate" engine limits the "horsepower" the motor rules tend to generate terrible racing and cheating becomes common place. The cost of your race engine is brought under control, so you spend three times what you would on springs, shocks and tires.

Finally, the cars…<u>they don't look stock anymore</u>. In Street Stock, the fans, the drivers, the "first time" visitors, they are not intimidated by what they see…or don't see. Street Stock bodies look stock, front and rear. They are 67 inches wide. Pro Stock bodies are 80 inches wide with Late Model noses and no tail. Most fans like the "old school" racecars, because they are familiar with them. They don't understand a racecar that is called Stock Car that looks like the premier division Late Model. For instance, Pro Stock open motor racecars are generally faster than their counterpart "crate" Late Models, which receives "headliner" publicity alongside a higher purse. In reality…the cost of a Pro Stock "open motor" is far more expensive than Late Models with a "crate" or a "steel block limited" cubic inch power-plant. The Pro Stock rolling chassis is well over 15 grand. <u>It is not a stock GM metric</u>. Many of them have been modified for a wider stance and setback roll cage. Today's modern Late Model built with Docal tubing is superior in strength, yet it has not increased the cost to go racing professionally. Pro Stock in the meantime has all but eliminated "grass roots" from the playing field. Basically, like Little League ball on AstroTurf.

The Street Stock and Grass Roots. Long live these racecars. We all desire common sense promoters to bring them back. Those years were classic. For these racers the season never ends, they spend their lives in the shop, with thier family.

Born in the USA, garage. The Street Stock is generally located in the family garage; no different from the garage where mom parks her car; where most racers maintain the family wagon. The lawn tractor is relegated to the driveway and the garden tools end up on the back porch. If the garage is conventional, the family will add a small shed in the yard. This will become the spare parts building. Grass roots racers are not a large group of sanctioned body professionals. They are your neighbors, the guy you sneak a peek at when you are out walking the dog. The grass roots bucket list, add a few more items to your tool shed. Find a set of scales, a pair of toe plates, a caster camber bubble gauge and, if you have a little extra money, build a shock dyno and some form of basic spring compressor.

Ok, that said, let's start with springs. A new spring compressor will not do much for you but it can help you modify used springs. Most spring manufacturers tag the spring rate to the coil so you really don't need a compressor but you will need a few springs that can be interchanged. Remember we are not talking about "coil-overs" or "struts". The common GM Street Stock will use "double wishbone" front suspension with one active axle housing in the rear. The springs you place on the rear will be mounted out on the ends of the axle near the caliper and seat into a chassis perch above, where weight jacks have been installed. Weight jacks are adjustable perch devices that can load the spring using a simple "jack screw". Jacking plates (make your own from ¼ plate) are welded into stock locations front and rear and the jack nut (shown here with grease fitting) is welded onto the plate. The cup fits into the spring and when screwed up or down, you adjust the spring rate for that wheel. Remember the weight you "jack" into one corner will affect the opposing corner. Weight jacks do not add weight to the car; they are designed to roll the weight around the car. We will get into mass (ballast) a little later. Weight jacks in the front are installed on the frame and adjust the weight applied to the spring between the upper frame perch and the lower control arm. In a GM metric chassis weight jacks are used to set "ride height", spring rates are important, but ride height is most important because the upper control arm angle determines your roll instant center. The roll axis effects car handling and changes with track conditions. *Note: The best spring and shock guru you can find, his/her hands are tied if the car has erratic roll centers. You must know your roll center motion from standing quiet to hard turns, in and off the throttle.*

Front springs will be heavier than rear because the greatest concentration of weight will be up front in a Street Stock. Start with a neutral setting …1000 pounds in the left and 900 on the right. On the rear try 200 on the left and 190 in the right. You can see that the right side springs are lighter to start with. At this point you take a few practice laps, and make adjustments…tight (push) on turn entry; you can soften the left front or stiffen the right front. You may also soften the right rear. If you are loose, you reverse those changes L-R. Counter adjust till you solve turn entry. You will make similar changes to the rear after you determine your turn exit condition. Loose is fast, but there is not a lot of room for driver error. Over-drive a loose car and you will certainly have to lift off the throttle, or worse you will bring out the "caution flag". On the other hand, you simply cannot race a tight car.

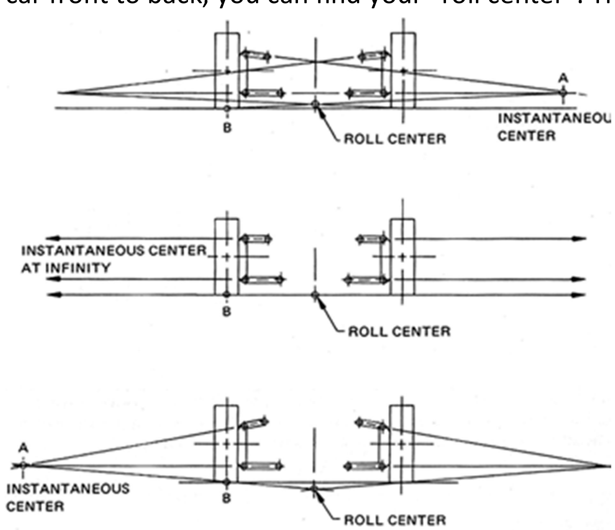
Springs are not the only changes you can make, but you must start somewhere and springs are significant when tuning a racecar so start here, and remember; make only "one change at a time". You must keep in mind; tires, air pressure and stagger are all important tuning tools. Shock absorbers are the icing on the cake!

We mention scales and weight jacks because jacking weight into a racecar changes percentage side to side and across the car. *I mention again…"jacking weight" does not physically affect mass*. Percentage change affects the front to rear instant moment. Engineers use terms like an airplane, roll, pitch and yaw. Roll is the motion around the center line R-L. If you end up on your roof, you have "rolled over". You can also "pitch over" if the car flips back side over the front end. Yaw is turning left or right, but in a circle track racecar we tune the car to turn "left" too port side. None of those terms will be used here. However, I will say "Yaw come out to the track this here Saturday night."

I **will refer to ROLL LEFT to RIGHT, PITCH BACK to FRONT with PERCENT rates ACROSS and on the CORNERS.**
I mentioned roll center and instant centers some time ago. You must find your roll center now and apply it to your Street Stock. There are three instant centers in your car, but the two most important will be the left front and the rear roll center. The easiest to find is the "rear roll center". You are in a GM metric with four adjustable bars located in stock position. These locations are predetermined by your rules and in a stock chassis the roll center would be located about 8-10 inches above the pinion gear. Since the only pivot points are located at the springs, the rear roll center is going to remain along the axle line. Spring rates left over right will determine the amount of roll and the location of instant center or moment axis. The lateral CoG (center of gravity) is located mathematically along the centerline of the car front to back. Chassis roll is determined by total mass and physical location of ballast. If weight balance is correct, the rear of the racecar on a soft surface will attempt to rotate around the front of the car. As the driver enters the turn he or she sets the rear in motion. This rotates the RR around the RF so the driver must turn right to go left. Near the exit of the turn a smooth transition from throttle will momentarily tighten the car and the driver will steer up off the turn. If the car is balanced properly, the driver can maintain throttle and run along the top of the track, thereby maintaining momentum.

Gummy Bears it all. Take my favorite candy a Gummy Bear, place it on the table face up. Now push on any corner, the opposing corner will lift off the table. Do the same front to rear. This is a racecar. If you push on the front the rear becomes loose, on the rear the front does the same. Look at your scale data and consider the Gummy Bear, a solid object supported on a flexible foundation. The heaviest corner affects the overall condition in your car. This simple example proves; pushing down too hard on one corner, the opposing corner may lose contact with the surface.
Your heaviest weight is located up front. You overcome this by placing the ballast properly in the chassis. Ballast must be adjusted to satisfy the driver's technique and the driver technique may require some adjustment as well. Understand too much weight behind the rear axle line the car will oversteer; too little the car will understeer. Too much right side weight you unload the left rear wheel early, too little the "roll centers" are sluggish. Attempt to control ballast at the CoG. The principle, enter the turn pushing down on the right front, exit the turn pushing down on both rear wheels.

The front roll center; this can be found by drawing three lines from the right to three lines from the left. Looking at the car front to back, you can find your "roll center". The lines are drawn through the upper arms and the lower arms on to a point where they meet. This is the "instant center". You can adjust the "instant center" by adjusting the height of the ball joint above the spindle or adjusting the pivot point where the arm is mounted on the frame. *Making adjustments to the lower control arms are generally not recommended.* In a racecar the location of the roll center is then determined by adding a third line that is drawn from the center of the tire "scrub patch" to meet the "instant center". Where these two lines cross L-R, this is the "roll center". The illustration displays a stock passenger car front end suspension. First is the stock stance at normal ride height. Next will be the same car under acceleration, and finally the same with extreme rear weight transfer. Look closely at the upper control arm angle. These angles change with the "pitch". If you look carefully you see the changes in the "instant centers' generated by the upper arm motion. As you accelerate the car is "pitched" front to back. When the brakes are applied, the "pitch" returns to the front of the car and the motion rebounds again. It is this "pitch" that we want to control. In your racecar we want the "pitch" low and away to a LEFT HAND batter!



*Note: Suspension software you can demo or purchase is available for Windows. Performance Trends **SuspAnal_2.4B** is a very nice analyzer program that professional teams use. It is free for ten days so take advantage of the offer.*

Mapping your front suspension. You will need a large sheet of cardboard or a 4 by 10 sheet of RAM board. Now lay your map paper under the entire suspension in the front. We will do the rear at a later time in this article. You want the spindle height to set at 14 to 15 inches from the floor. This number depends on your normal tire radius. A 29 inch tire (91 inch circumference), set the spindle, on stands, at 14 ½ inches. You should draw your map with the car at your baseline ride height, so make certain your rear axle is sitting on tires or on stands at proper axle height. If you must, go ahead and adjust your weight jacks to your normal ride height.

Ok, now find a single plum-line and begin by dropping the line through the center of your crankshaft to the floor. Mark this spot. Now drop the line at the rear of your transmission tail-housing. Draw a chalk line through these two points. This is engine center liner (ECL). *Note: This center line travels back through the rear axle line regardless of any rear axle offset*. Now, looking from the front of the racecar, the RF spindle in on your left and the left is on your right. The line you drew is the [X axis]. In theory the lower RH ball joint will be around 25 inches "X" of the ECL, the left should be the same. Go ahead, measure from the Zerk fitting to the ECL [X axis]. Are you close to 25 inches?

Our second line; drop your plum from the spindle end to the floor. We do this for both sides and chalk a line across the floor to each point. This is the front "axle center line" we call it [Z axis]. We use PLUS (+) and MINUS (-) for "Z". Your radiator is –"Z" your transmission is +"Z" (toward the rear of the car) as compared to the front "axle center line".

What you have done is created a two dimensional map, but we need another dimension for this to work, that would be [Y axis] or height above ground. Let us take a quick measurement for the lower ball joint. Measure from floor to center of the ball joint; you should be close to 9 1/4" this is "Y". Now measure the distance it is behind the "axle center line" (FACL). That should be approximately 1/4" ahead of "Z". So the RH lower ball joint is located at 9.250 [Y] by -.250 [Z] by 25.0 [X]. *Note: We will do the same tri-axial measurements for more than a dozen points on our suspension.*

Ok, score these measurements on your "floor-map". Now do the same for all ball joints, upper and lower left and right. Do the same for the pivot points of your control arms. Now note the steering arm dimensions, drop your line to the floor from your tie rod end points, where they attach to the spindle and where they attach to the center link; measure "X", "Y" and "Z". Do the same at the pitman arm pivot point and the idler arm pivot point. Don't forget the pivot points along your center link. There are four of these measurements. There is an "X", "Y" and "Z" measurement for all these points including your upper and the lower shock mounts and spring perch at center, this would be at the weight jack screw and the spring seat in the lower control arm. Take these measurements in the center of the spring.

If you made your marks on the floor, you now have a steering map of your front suspension. So what do you do with this information?? Go here: www.PerformanceTrends.com and download the Suspension Analyzer V2.4B. This is a full version that will run for 10 days. After you setup the program, run the full version less the data logger. You will open the suspension file "Limited Late Model". Take some time to play, get an idea of what inputs your map has to offer and from your "floor-map" data enter your numbers into the spreadsheet. As you do so, the "X", "Y" and "Z" plot will change in the program and a wire frame image of your "suspension-map" will gradually appear. Save this file. Switch to TOP VIEW; it should look like your racecar's front suspension. The program will display a very accurate map of your "CoG" [3] your "Roll Center" and the "Instant Centers". You can animate or enter dynamics as "steer", "dive" (pitch) and "roll". One example, enter a MINUS 3 "dive" and the wireframe will lift the front end. If you enter PLUS 3 "roll" the effect will show your LEFT WHEEL dynamics and display the steering angle results for the RIGHT FRONT. Now add some steer, the results are instantaneous for each dynamic you enter. This is computer generated visible information that allows you to tune your car ahead of time before entering the pits. You will have an advantage over the competition. You can set spring rates, caster and camber and stagger rates too. This is good stuff. You can make changes to your data and see the potential results instantly.

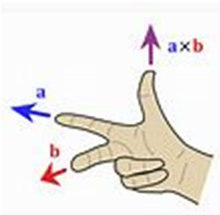
Install the program on your lap top and take it to the track.

Example: I want you to increase your "upper arm front pivot" by 2 inches [Y]. This would move the front control arm up to the next hole on the frame bracket. Did you see your instant center change? What effect do you think this will have on your racecar?

Here comes the pitch. In your racecar this motion is generated by acceleration on and off the throttle, and includes braking action. This is the physical application of forward and aft mass movement around a "center of gravity". *Note: The longer the wheelbase, the greater these dynamics are added to the equation. Short wheel base racecars have less pitch. This is because the shorter the "circle of " the less the pitch motion effects the dynamics of roll.*

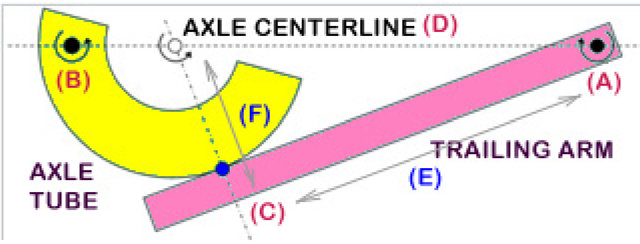
Since our racecar is balanced on four corners and each corner rests on a surface of gravitational pull our mass (racecar) must be powered forward so the vehicle can over-take resistance of the tire patch. Interesting enough, racecar tires are very sticky. They have a large scrub patch. So the vehicle requires horsepower to move this mass forward. This movement pitches the weight rearward, pushing hard on the surface through the tires attached to the differential. When the vehicle reaches intended speed the weight transfer will stabilize until reacted upon by deceleration, braking or changing direction. Deceleration pitches mass forward and onto the front suspension. In a normal passenger car we want this pitch motion to be stable front to rear. In a racecar, that setup is not going to win races. Keep in mind that the higher we place the center of gravity the more dynamic the roll will be. This affects all dynamics of our racecar as it pitches fore and aft and side to side. We must control the pitch, the amount of the pitch and the timing in and of these dynamics. We use shocks, springs and ballast to control dynamics.

The "right hand rule" applied to "left hand turn". This law of physics must be considered when tuning your racecar because racing requires motion of a mass be controlled in a three-dimensional environment. Acceleration generates mass motion but not only in one direct line (A) forward. In fact this motion is three dimensional. The front lifts up (AxB) removing weight from the front wheels, this effect loosens up the steering. The pitch back to the rear wheels tightens up the rear end of the car and depending on the spring and ballast settings the effect of mass will be applied to one side or another (L-R). Also we have a third rotational force to contend with (B). Acceleration will attempt to rotate the mass in a direction that opposes engine rotation. The (B) factor is not as noticeable until we realize our mass when moving



forward at a high rate. Any slight maneuver will rotate the mass left to right. If the mass is moving forward (A) and we change direction rapidly (B) the opposing corner will rotate up (AxB). Asphalt racers have a natural factor of control because their planar surface is rigid, it rarely changes, and therefore their "instant centers" rarely change from one lap to another. These drivers must hit the same points every lap in order to remain stable and consistent. However on dirt or clay, this surface is not rigid and it tends to give when pressure is applied. The clay surface changes with every lap. The top surface (1 to 2 inches) on a dirt track offers little resistance; therefore we must tune the suspension in order to "plant" that corner of mass down into the track to gain "instant center" contact.

The "instant center" of the right front wheel rolling along a clay track surface without slipping is near impossible to imagine. The wheel rotates around its axis, which is located at center of the outer spindle bearing. This rotation is parallel to the track, and at the very center of this point there is no rotation at all. Also, at the "point of contact" where the "tire contacts the track", at one small point there is no rotation, no velocity, this is the tire's (wheel) instant center. The wheel rotates around a fixed centrode which is the track race surface. This centrode is variable and not a straight planar surface like asphalt. We must realize, the top of the wheel rotates twice as fast as the portion of the wheel where it contacts the track. *Note: This motion of physics is why we set the upper ball joint behind the lower. This is spindle setback or caster.* Understanding "instant centers" is very important for tuning your racecar because during a single wheel rotation the radius of the wheel rotates in both directions. Imagine if you can, we only use half our front wheel to steer the car. That half is the radius from the "instant center" to the spindle center. Rolling or pitching mass from the driving tire to the steering tire affects these instant centers. The more force we apply to the right front during deceleration the greater the possibility the steering tire will tighten up and the car will push. Likewise if we don't push hard enough on the steering tire we face a similar dilemma. The car becomes loose.



At the other ends! This illustration shows us the rear end lower trailing arms and their physical attitude, or dynamic, whatever you choose to call it. What we must realize here, if the trailing arms are perfectly equal right to left; meaning they are the same length and are attached at (C) in the same locations L-R, the centerline point between (A) and (B) will be equal on both sides. If we want the car to lift harder on the left side driving the right rear down, we can adjust the left side so that (D) is closer to (A). However we cannot over adjust, we must adjust this point according to the drivers interpretation of what the car is actually doing. Taking a "try this and let me know" attitude is Ok but chances are things will go astray unless you keep a notebook. *Note: An example of trailing arm adjustment would be to "decrease" angle (F) on the left-rear if the car is tight on entry*. These adjustments can lead to bad things like burning up the right rear tire. The two adjustments you can make on a GM metric chassis would be (E) and (F). Upper arm adjustments are usually not allowed in this class; however upper arm adjustments will cause lateral movement that might affect over all lap times. The GM metric chassis is designed so the upper arms <u>resist lateral movement</u>. We overcome this issue using wheel offsets.

Ballast but not least. This is a heavy subject mainly because principal of MASS is widely misunderstood. But before we get into adding or moving BALLAST around the car, let me offer you a little help. You can't take your scales to the track. Yes, you could, but you will waste more time trying to level them while in the pits, so don't go there. I want you to do is this; after you have scaled the car and you are happy with the results, check all four weight jacks and mark them in your notebook. Check the height they extend out of the perch. Now with the scales under the wheels take two turns out of the LR. Look at the scales again and note the percentage change. Now add the turns back and add two more. Check your scales again. Do this all around the car. Now set the scales back to your baseline and take those notes to the track. You will have an idea what percentages you are moving when you adjust your "spring jacks". *Note: (corner weight) divided by (total weight) = "**result**" times (100%) = **"corner weight percentage".** In example, 800 = RF corner (1550 = total MASS up front).*

$$\frac{800}{3300} \times 100\% = 24.2424242424\%$$

The calculation for single corner, one side, front or rear…uses the same formula. <u>Now, if you know how much</u> "two turns" adds to, or subtracts from any corner, you can calculate the percentage changes you make while your car is at the track.

Driving the car. Here is where it gets interesting. If you are an experienced driver your ability to communicate with your crew is the second most important thing you can do toward that next win. You know how the car feels in your hands and through the seat of your fire-suit. You accelerate and the car steps out, you brake and the car darts toward the wall. You know when there is an accelerator push, you hit the "go pedal" and the car starts coming around. These anomalies are basic driver sensations, and they must be conveyed properly to your crew so they can make a decision how to cure the problem. If you are a rookie you could make things worse. You could allow an experienced driver to take a few test laps, <u>but that rarely solves the problem</u>. As a novice you have no style, no specific approach and no habits driving a racecar. As a rookie you don't know your limits any more than you understand the limits of the racecar or track conditions. Young rookie drivers on asphalt all begin their career with the same technic. Follow the guy in front. Drive up to the wall, turn down in and roll along the bottom apex then back up to the wall. Around and around you go, count down the laps, if the driver in front makes a mistake, you gain a position. That's it…and no wonder most asphalt professionals won't visit a clay oval let alone get into a racecar and take a few turns. They can't comprehend turning right to go left. The chances are neither do you, but that is exactly how you drive a dirt track because the first inch or so of track surface is going to move under the weight of your car. You can't get out of the pits without turning over the left rear, so why would you expect the track, which already has a couple hundred laps run on it, to settle under any of your tires??

You are in a racecar now; so all bets are off, and you ain't going to Burger Bob's tonight. First time in a racecar, prepare to soil your shorts!! *Note: You are in first gear. That is a Bert transmission with a 2:1 ratio, those 6:33 final gears in that nine inch Ford , you do the math…on a 92 inch tire, your final drive ratio is 12:66 and 3000 RPM will drive you off under 25 MPH. No, don't push in the clutch to start the car, push in the clutch to mover the car…in first gear!* Now, does your pit crew now what to do?? I hope so, what you need now is that experienced driver; he should be watching you carefully because his driving feedback is not going to fix your "rookie" mistakes. Have someone take video. Take some laps and let's replay. Ask questions because only someone with real experience can help you the most.

Communicate or bust. Your crew chief can't fix your racecar if you don't know what or how to communicate with him or her. Simple as that, if you don't feel the car tight, it can't be loosened up. You must give solid feedback. That only comes with experience. So let's start with the simple adjustments first. These are the primary things a crew chief would do to loosen up or tighten up your car. The first thing you are going to tell him is "I can't turn down on turn entry". Most rookies make their first turn "on the bottom" so they can avoid trouble. I don't believe in that, but most young drivers on dirt start there, so if you cannot turn left the first adjustment should be yours…brake bias. Let us get that one out of the way. You are sitting in a Street Stock; beyond steer and throttle up there are no other adjustments you can make.

Driver Brake Bias:

Tight on entry – increase bias to the rear.

Loose on entry – gently increase this toward the front.

You can do the same with the right front bias control, if you have RF control, decrease the RF bias if the car wants to push (tight). You can increase the RF brake bias if the car feels loose, but do so gently as well.

Note: Wheel offset, tire pressure and stagger (step) will accomplish similar results; however you cannot make these adjustments from where you sit in the car.

Now we communicate and put it all together. Now you must explain the conditions to your crew. There are six possible scenarios throughout each full course turn. There are four turns and two apex on an oval track; (one and two) and (three and four) each set has an apex (middle). Some half mile ovals are "short corner", that means the measurement between the inside of the front straight and the inside of the back straight is rather narrow. This gives you longer straight away speed with very tight turns. On these tracks the apex at the bottom is almost non-existent. The longer the "infield" distance between front and back stretch, the better you can tune your car for momentum style racing. Your crew chief should always know the outside circumference, the infield measurement and length of straights for any track you race on. The pit steward should have these numbers available for you.

Entry condition	**Wheel offset**	**Stagger**	**Tire Pressure**
Tight on Entry	RF move in	Increase front	Decrease front
Loose on Entry	RF move out	Decrease front	Increase front
Apex condition			
Tight in Middle	LR move in	Increase front	Decrease RF / Increase RR
Loose in Middle [1]	RF move out	Decrease front	increase RF / Decrease RR
Exit condition			
Tight on turn Exit	RR move out	Increase rear	Increase rear
Loose on turn Exit	RR move in	Decrease rear	Decrease rear

Your crew chief can adjust weight percentages around the car if necessary.

Adjusting spring jacks: You must understand what happens around the car upon making these changes. Increasing one corner will affect other corners. An over-adjustment may upset the car at some other point throughout turn sequence. Your intent to fix a problem entering turn one may create a greater problem exiting turn four. This is why I insist you learn to "race the track". *In addition to weight transfer you may physically change springs.* *See spring changes below.*

Handling condition	Left side percent	Rear percent	Cross (diagonal) percent
Tight on Entry	Increase %	Decrease %	Increase %
Loose on Entry	Decrease %	Increase %	Decrease %
Tight in Middle	Increase %	Decrease %	Decrease %
Loose in Middle [1]	Decrease %	Increase %	Increase %
Tight on turn Exit	Decrease %	Decrease %	Decrease %
Loose on turn Exit	Increase %	Increase %	Increase %

Note: In your shop, scale the car and keep a log. When complete, take two turns out of the RR and the LR weight jacks. Now note the percentage changes as displayed on your scales.

Keep this number for reference at track (you can do the same at the RF). Reset the jacks back to previous settings and then add two turns, again taking notes. These percentages will change with each spring you swap out. The height of your jack screws is an important reference.

Weight control also requires proper **placement of ballast** (mass). Adjustments can be critical and you must keep a log. Try snapping a picture using your cell-phone. Anytime you make an adjustment you will have a reference to start from. Remember that BALLAST is MASS and we are required by rule to end the race with a specific weight as we cross the finish line. The rule of physics state we cannot change MASS dynamics unless we add or subtract weight. In our racecar we adjust MASS around the car. We must start the race with a MASS greater than what we expect to finish. Burning off fuel will lower the cars total MASS. We add BALLAST to the car so we can meet the weight rule with our driver in the car. So, where do we place the BALLAST we need to meet weight?

Place your ballast as close to the car's "center of gravity" while allowing it to hang more to the left side. Keep the ballast low in the car. Generally the intention is to keep ballast in the smallest area. Locating the ballast evenly through the car makes it sluggish and slow to respond. You want the ballast to work for you. If you must add MASS it only makes sense to get some use out of it. Your CoG is the car's pivot point side to side and front to back. Like a tight-rope walker, weight is controlled at the pivot point where the artist holds the balance beam as he or she walks on the wire. The person would certainly fall off if there was MASS hung out on either end of the balance beam. If the mass was balanced on the beam, the wire-walker would have a very hard time controlling the beam. Keeping the weight low and at center makes it much easier to control. You control the balance beam action using your shocks, springs and weight jacks.

In a racecar we try to place the ballast close to the CG while adding some left side weight (the driver). This principal allows the car to be controlled by component settings; otherwise it will be up to driver consistency, track conditions and dumb luck.

Moving BALLAST is frustrating and should be limited at the track. Unless you can scale the car, don't relocate MASS during racetrack events. Leave those changes for the shop.

Tight condition	Ballast	Loose condition	Mass
Tight on Entry	Lower position	Loose on Entry	Raise location
Tight in Middle	Lower position	Loose in Middle	Raise location
Tight on turn Exit	Lower position	Loose on turn exit	Raise location

Raising and lowering of BALLAST or MASS, generates a counterbalance. You can raise the weight too high or drop so low that it renders a negative effect. You should attempt to stay inside the usable area of your natural CoG. Make your counteraction adjustments with springs and shocks. Learn how to use weight jacks to your advantage.

The ideal spring and shock combination on a racecar is the "coil-over" device. Most Street Stock rules do not allow the use of "coil-over" units. Therefore we must learn to SOFTEN the springs we have installed.

If you scaled your car in your shop, you have a specific baseline SPRING setup. At the track you will be limited to a few possible spring changes; I have highlighted, in yellow the suggested change for specific handling conditions. Subtle changes like 25 pounds will not affect the handling characteristic on dirt, so start with a 50 pound spring adjustment. You may try a 50 pound combination using 2 opposing spring locations at 25 pounds each.

Handling Condition	Left Front	Right Front	Left Rear	Right Rear
Tight on Entry	Soften	Soften	--	Soften
Loose on Entry	Soften	Soften	--	Stiffen
Tight on turn Exit	--	Soften	Soften	Stiffen
Loose on turn Exit	--	Stiffen	Stiffen	Soften

Note: You do not change springs for middle turn conditions. Tune your racecar, begin with turn entry.

That brings us to the shocks. The expense of carrying proper shocks is budget buster. The more combinations we have the more subtle the changes can be and shocks are very important if we are going to win on a regular basis. They control all factors of racecar handling and without proper communication between driver and crew; you might as well not use them at all.

How hard the right front tire is planted into the track is dependent on roll center, ballast control and mass movement over the CoG. What controls wheel reaction is the spring, what controls the spring from violent reaction is the shock. What controls the spring from sudden collapse, is the shock. What controls the length of time the spring is under control…yes the shock. This action, by shocks, presents itself at all corners throughout the race. Each wheel is affected, least of the corners, the left front, however all corners must be considered.

Mono-tube Steel Shocks have two cycles…compression and extension. Some consider extension as rebound, however rebound is not exactly what happens in a mono-tube shock. We will get into details a little later on but now let us look at handling conditions and how to adjust with shocks.

Handling Condition	Left Front	Right Front	Left Rear	Right Rear
Tight on Entry	Decrease Comp.	Decrease Comp.	Decrease Ext.	Decrease Ext.
Loose on Entry	Increase Comp.	Increase Comp.	Increase Ext.	Increase Ext.
Tight in Middle	Decrease Ext.	Decrease Comp.	Decrease Ext.	Decrease Comp.
Loose in Middle [1]	Increase Ext.	Increase Ext.	Increase Ext.	Decrease Comp.
Tight on turn Exit	Increase Ext.	Increase Ext.	Increase Comp	Decrease Comp.
Loose on turn Exit.	Decrease Ext.	Decrease Ext.	Decrease Comp.	Increase Comp.

There are pros and cons to mono-tube shocks; supporting factors do outweigh the cons. Your application is racing so control is more important than ride quality. To begin, you can mount them at any angle. Generally mono-tube shocks are not prone to temperature problems and the piston valve is larger so it creates an even more precise damping effect. The piston moves in the oil chamber while the gas chamber is separated by the free piston, which helps to eliminate cavitation. However, mono-tube shocks are expensive to build and the tube can be damaged which will render the shock useless. No matter what, twin-tube shocks are not a good choice for dirt track racing.

Our track rules allow any "non-adjustable" shock, steel or aluminum. However there is a shock claimer rule. This is in place to daunt those racers who will spend thousands of dollars on shocks. We are a team that does not have that kind of a budget.

It is obvious that shocks are not equal, and we all understand that, but Street Stock racers are the cross-over drivers who must balance their racing between "novice class" and "professionals". This "grass-roots" race class must never become economically out of control, but shocks and tires are the second most expensive investment after the engine. In reality, shocks and tires cost more over the long run than the purchase of one crate motor. Restricted engine racing is just as expensive as open-motor because fresh tires and expensive shocks will increase speed and lower lap times. Open motors are "bully" fast while limited motor racing is "smart" fast.

Most promoters know how to balance engine rules, but they have little understanding about shocks and suspension, so they resort to very expensive tire rules. Meanwhile…what good is a tire rule if the race track is prepared improperly?? The best tires in the world are out of control on a rough track. It takes a different tire on a slick track or a heavy track; so overall we must depend on shock selections that are best suited for track conditions. You can spend more than 1000.00 at each corner and still not have enough shocks, springs or tires. Shocks keep the tires on the track.

Shocks work for and against the springs. The "bump" phase is where the spring works to control the shock, however during the "rebound" the spring is working against the shock. You can see this in your mind; the spring is trying to push down the suspension on to the track. This "push down", force on the tire, is controlled by the shock extension. In many cases 50/50 shocks have more rebound than compression because of the spring. The 50/50 or 40/60 shock is a good choice on a rough track. The 60/60 7 inch steel bearing shock is a good balance for a heavy track.

Racers must remember that rebound is utmost important because we carry the car on the springs; more so in a Street Stock because the springs are perched into the chassis. We do not use coil-overs. If the rebound is too stiff, the spring cannot reset the chassis back to ride height. This action can cause the shock to hold the tire up off the racing surface. We can't afford to lose our contact patch, the car will push. That is why we adjust our suspension to control the roll centers. If the tire patch is off the track, our roll center disappears and we are out of control. If you feel out of control on a rough track, soften the rebound. Keep in mind too soft will cause wheel hop. This transpires when the spring begins to oscillate, this introduces a "basketball" effect and the wheel bounces out of control. This type of problem will require a stiffer rebound. Tune your shocks to hold the tire down on the track. This increases your ability to maintain consistent RPM and consistent lap times.

A little talk about stiffness…the stiff shock, say 70/40 or 90/10, these numbers are good on a smooth, even slick track because we are trying to keep the tire down, however if you encounter a rut or hard bump, the stiff shock or spring will cause that wheel to hop and that corner may leave the track. The ideal setup allows the ride height to stabilize throughout each lap. Under all track conditions you want to keep the car down on the track.

Note: I might suggest you try a different shock rebound rate before you start cranking turns into a weight jack.

We will rap this up with tire temperatures and trailing arm settings.

Temperature	**Right Front**	**Right Rear**	**Left Rear**
Condition HOT	Tight on Entry or Exit	Loose on Entry or Exit	Tight on Exit

Note: The Left Front tire should always be the coolest tire temperature on the car. Compare it with the Right Front. The temperature should be 25-30 degrees cooler.

Trailing Arms:

We discussed these earlier and we noted how the adjustment effects rear steer. You must remember what your rules offer you, but in many cases, making adjustments to lower arms are allowed. Some rules insist that the length of the trailing arm remain specific, however you can move the arms up or down along the rear axle pivot bracket. Here are suggested changes for handling conditions.

Handling Condition	**Left Rear Trailing Arm**	**Right Rear Trailing Arm**
Tight on Entry	Decrease the Angle	Increase the Angle
Loose on Entry	Increase the Angle	Decrease the Angle
Tight in Middle	Increase the Angle	Increase the Angle
Loose in Middle [1]	Decrease the Angle	Decrease the Angle
Tight on turn Exit	Decrease the Angle	Increase the Angle
Loose on turn Exit	Increase the Angle	Decrease the Angle

Note: Trailing arms are more effective when adjusted for turn exit.

Scaling your racecar:

I cannot suggest what scales you use. There are a lot of types available; I do suggest you take good care of them. When scaling the car for your "baseline" set the car at ride height and try to balance all four corners as close as possible. Do this without your driver or ballast in the car. Reset the scales for each attempt and make sure you keep notes. Be certain you know where your "center of gravity" is located. Multiply your wheelbase by the front percentage. This location will be forward of your rear axle centerline and just below the engine camshaft. Set your ballast near the CoG and as low as possible, stack your lowest weight mass higher in the car. Keep the heavy shit down in the chassis. Never place ballast behind the rear axle, you can always add fuel (six pounds per gallon).

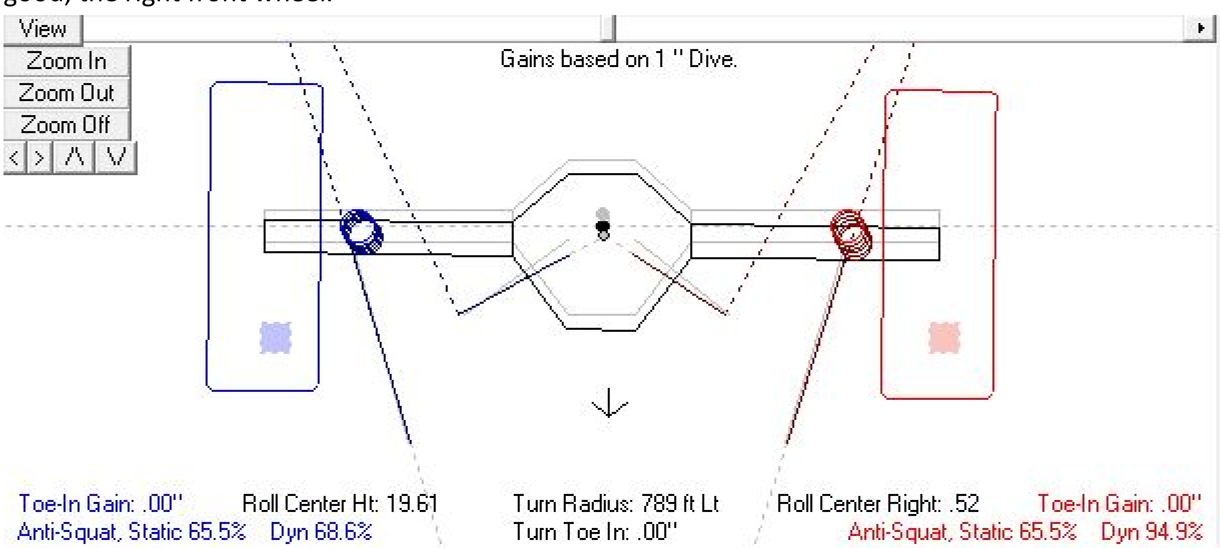
Finally we reach the end…rear end that is. I passed over the rear axle earlier, so let us do this last. I have mentioned ballast and springs, front suspension, pivot points and roll centers. At the back of the car there should be a fuel cell. If you must know, a 10 gallon cell is all you need for a Pure Stock. But consider the weight, a 20 gallon is cell not much more mass, but it can add 60 more pounds to the rear of the car when you fill it with fuel. Gasoline is about 6 pounds per gallon, this depends on additives, but 6 is the number and 60 pounds is good, especially if the track slick. Remember that this is liquid mass and it does burn off, but that can be used to your advantage as well.

Fuel is located behind the axle so it is dynamic in that it moves with the car; turn hard left the weight moves right. It also moves left so keep in mind that cell location is dynamic as well.

The rear axle has a “roll center”. The pivot points are the spring locations. The shock locations must remain stock and we are limited to mono-tube so there is not much we can adjust. We will adjust compression and extension to meet track conditions. We have covered this before, so forget the shocks. We will concentrate on axle adjustment. In a Pure Stock with strict rules, you cannot do much except change out trailing arm bushings. You want the right upper to have steel bushings and the left upper to be soft rubber. This will allow the axle to move ever so slightly, but as I said before, an inch can be a mile. You should beef up the stock lowers, again considering steel bushings at one corner or the other.

Note: You will be racing on a stock GM axle, you should lock the rear end spiders.

The rear axle “roll center” height is located above the pinion gear in relation to the upper arms. That should be around 21 inches above the ground [Y axis] and slightly forward by an inch or so. The “instant center” is located forward [Z axis] and changes with chassis dynamics. This is important to know because your wheelbase does not change, but the forward “roll center” does and it can reach out beyond the wheelbase by as much as 2 feet. I don’t want to confuse anyone here, but take a minute and look up catapult or trebuchet. In reality our control arms act like a counterweight trebuchet as it transfers rear axle energy to the springs which will counteract against engine weight. Keep this in mind because the “rear instant center” is where the payload from our catapult is going to land. That payload is fuel cell, rear axle, battery and ballasts all rolling over the CoG which is located somewhere along the ECL. Like the ballet dancer, we want this payload to strike firm but soft onto the front of the car and at a location where that payload can do the most good; the right front wheel.



The **Performance Trends** software program rear axle top view shows exactly what happens when squat and roll are applied to the rear axle. The black dot is “roll center” the arrow points to the “instant center” which can be drawn along the lower control arms to the front where the right intersects the left, nearly 120 inches from the rear “roll center”. In this view the left lower arm [Y axis] is lower than that on the right. Remove the dynamics and the turn radius is zero.

The basic metric rear axle is included in the wireframe examples. Load this file and enter your rear end measurements. These are done using the same tri-axial lines as your front suspension. The [Z axis] is drawn through the rear axle. You will never discount or ignore your rear axle again…felicity is ignorance.

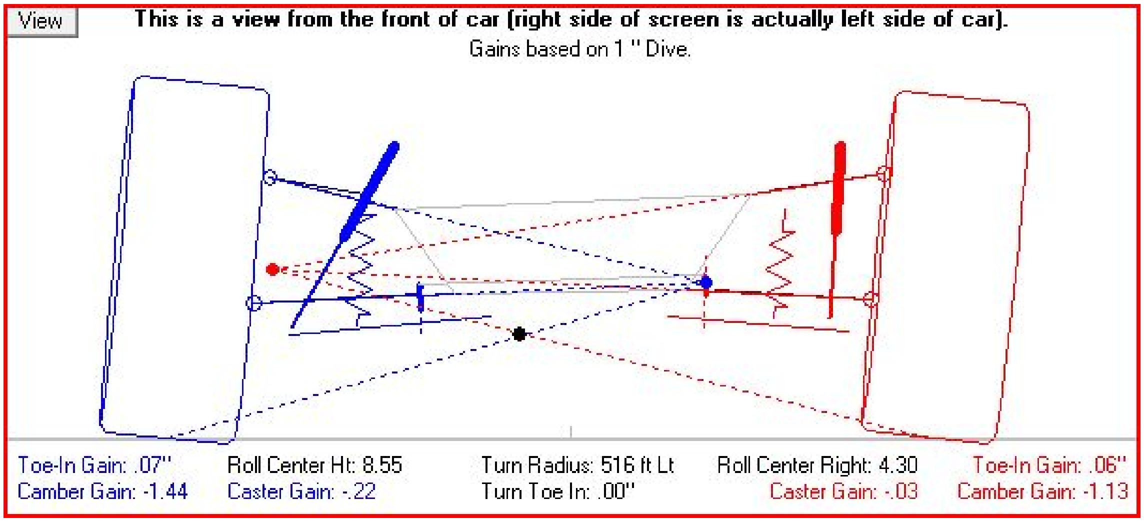
The appendix…

[1] Loose in the middle is not always a bad thing and can be related to driving style or track condition.

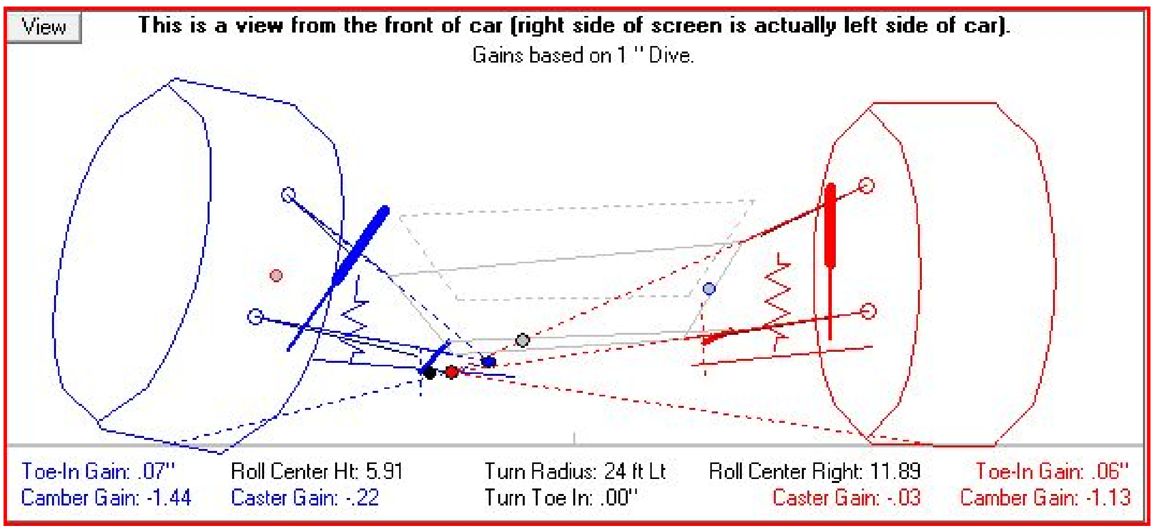
[2] Items highlighted are recommended as your first step to resolve a handling problem.

[3] The CoG is located at a point where weight is balanced F-B and L-R. (Wheelbase times front percent)

[4] Dynamics of a metric front end turning into a banked turn:



Look at the information displayed. The black dot is roll center. The red dot is LH instant center.



The dive is 40%, the roll is onto the RF tire and the turn is rather sharp to the left. You can clearly see how the roll center moves with the instant centers. This data result is from our "suspension map" as applied in software.

In closing…I am not an engineer, nor am I the GM metric GURU. I have no championships to my name and as a crew chief I would classify myself as mediocre, but one factor remains, this article was written to help the novice racer understand what the principals are. In everything we do in life, there must be principal, there must be some form of law. We will never succeed in life or racing if we continue to push the envelope beyond scientific fact. Facts are meant to be challenged, but defying the laws of physics will backfire more often than not.   Thanks, "Church"

Reference Links:

The adjustment Chart is available here: www.churchfield.racing /download/CheatSheet.pdf

The chassis sheet is available at: www.churchfield.racing/FAQ/ChassisSheet.pdf

The weight percent on-line form is available at: http://www.churchfield.racing/2020WeightCalc.html

Performance Trends – Suspension Analyzer 2.4: http://www.performancetrends.com

Scott Bloomquist: Place it Right for Bite -- http://www.playlandspeedway.com/setup.html

Reference Internet Articles:
Balancing Weight in a Dirt Street Stock racecar (PT1) -- by Kevin Katzenberg.

Left side weight percentage seems to be the key effect on the car. To get maximum traction off the corner both rear tires should be loaded to the maximum of their available traction. Traction is dependent on loading the tire to its maximum slip angle and slip ratio, but that is a completely different article. As the car enters the corner, weight is transferred from left to right. If left side weight is too high, not enough weight is transferred to the right and the car won't stick and turn into the corner. It just goes into a four wheel drift up the track. If left side weight is too low the car will either be very tight or very loose into the corner, but not have the traction off the corner that it should. Another aspect of left side weight percentage that needs to be considered is that as the track dries out and slows down, weight transfer from left to right goes down because the amount of lateral G forces exerted on the car goes down. To keep the car balanced a change should be made to keep the weight balance the same left to right. Some common adjustments could be decreasing the left side percentage, lowering the roll center, or raising the center of gravity.

Wedge seems to go hand in hand with the amount of left side percentage. As a car starts it's decent into the corner, the wheels turn left and the driver lifts off the gas and the car starts to transfer weight to the right and to the front. The left rear tire loses the most weight of all the tires. Wedge is defined as the difference in weight between the left rear and right rear tire. Since the left rear tire loses the most weight it is usually the heaviest corner weight on the car. Too much wedge, the left rear tire is much heavier than the right rear, and the car will be loose into and through the middle of the corner when off the gas. Too little wedge and the car can be tight into, too much side bite on the right rear tire, and through the middle of the corner and loose off the corner. A slight amount of excess wedge the car will have a little snap of tightness as the car initially starts to accelerate off the corner.

The trend in dirt racing seems to be leaning toward a left side weight percentage of around 53.5 to 55 and somewhere between 75 and 125 pounds of wedge. These numbers are just averages and are very dependent on the class of car and the tires being run. I have heard of many cars running well outside of these parameters and winning. I always say, don't pay more attention to the numbers than to what your car is telling you it needs. Remember there is no right or wrong as long as you end up in victory lane.

Good luck, till next time.
Kevin http://www/hogantechnologies.com

Reading Reference:
Mark Donahue produced a book "The Unfair Advantage". He wrote this racing book back in the mid 70's. It is still quoted today. But his concept of racecar tuning was "balance". His belief centered on wedge and his attempt to keep both rear wheels on the racing surface. His theory was chassis balance so the car would turn anywhere on the track. The ultimate wedge is not a number; it is that feeling which convinces the driver he can go anywhere on the track at any time during the race. Mr. Donahue drove every possible racecar. His book is still very popular. His engineering practices are used in modern day racecars.

Reference Software:
You can download a software simulation illustration here: http://www.churchfield.racing/FAQ/SS_FrontToBack.pdf