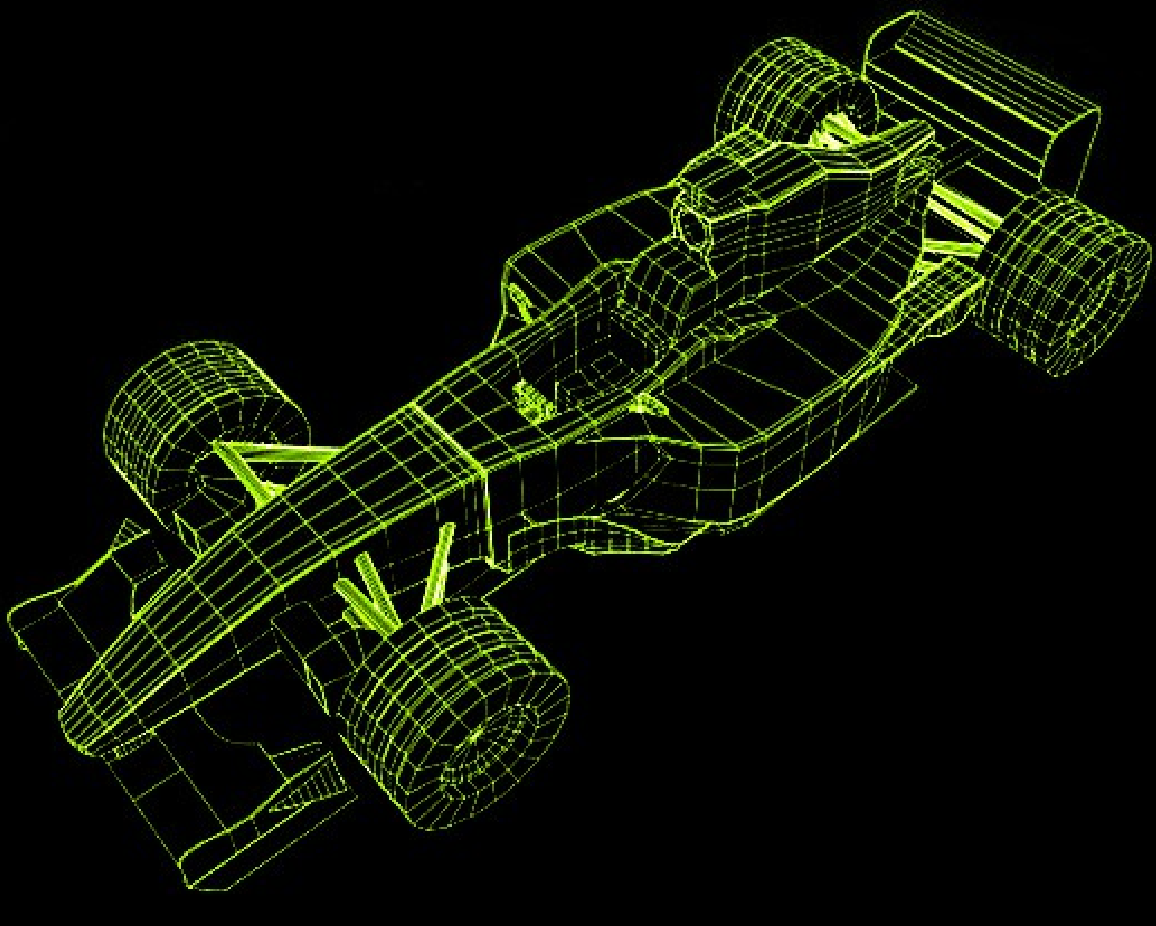
VERMIN RACING TEAM
VIRTUAL MOTORSPORT

Set up Guide



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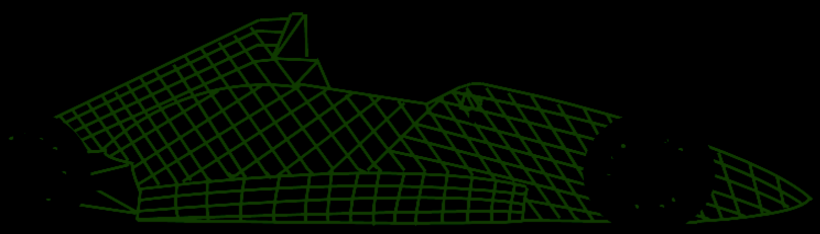
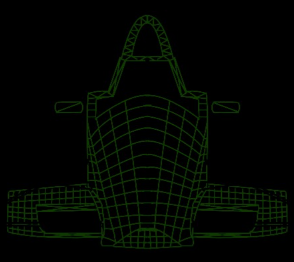
Introduction

Welcome to the Vermin Racing Team set up guide. This will aid you in perfecting your car set ups for most racing simulations as it covers the fundamentals of racing car adjustments. Throughout this guide you will find abbreviations RF,RR,LF,LR. These stand for right front, right rear, left front, & left rear respectively.

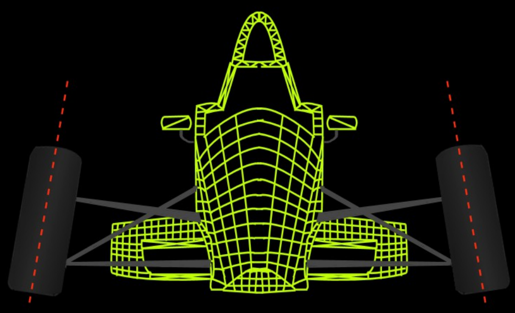
It is important to understand that for every adjustment made, it may not produce the desired results immediately as mentioned below. There may be other adjustments that are not quite right masking any problems the adjustments are trying to cure. There may not be a drastic change in any adjustments after just one change. Readjustments may need applying to other areas of the chassis to gain any effect from the original adjustment. When the set-up feels close to the drivers preference, yet seems to be lacking that one minor adjustment, it may be more involved that just adjusting one more component. There may be cause to "undo" other adjustments elsewhere then go back to the original adjustment to get it correct.

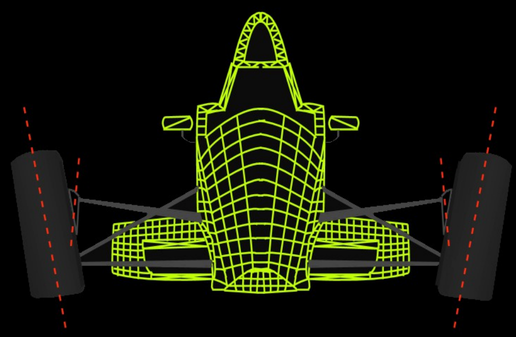
For every action taken, there will be a counteraction that may not appear at first to be in the best interest of the set-up. There may be times when taking two steps back to gain one step forward. Because of this, chassis adjustments can become frustrating to figure out. It isn't easy, this guide will hopefully point you in the right direction with patience.





Camber





Positive Camber **Negative Camber**

Camber is the inward or outward tilt of the wheel at the top of the tyre. Negative camber is the tilt of the top of the tyre towards the centre of the vehicle.

Positive camber is the tilt of the top of the tyre away from the centre of the vehicle. Camber adjustments are utilized to help maintain the maximum grip allowable from the surface of the tyre through the corners of the track. Camber adjustments are very critical for achieving maximum cornering speeds.

Camber adjustments are achieved by reading tyre temperatures. Read the section on tyre Temperatures for how to decipher the tyres/camber data.

Contact Patch

When camber is set correctly it allows the entire surface of the tyre to adhere to the track thus maximizing the use of the tyre contact patch when taking a corner at high speed. Running excessive amounts of camber will cause premature tyre wear due to the fact that the tyres aren't running on the full contact patch of the racing tyre.

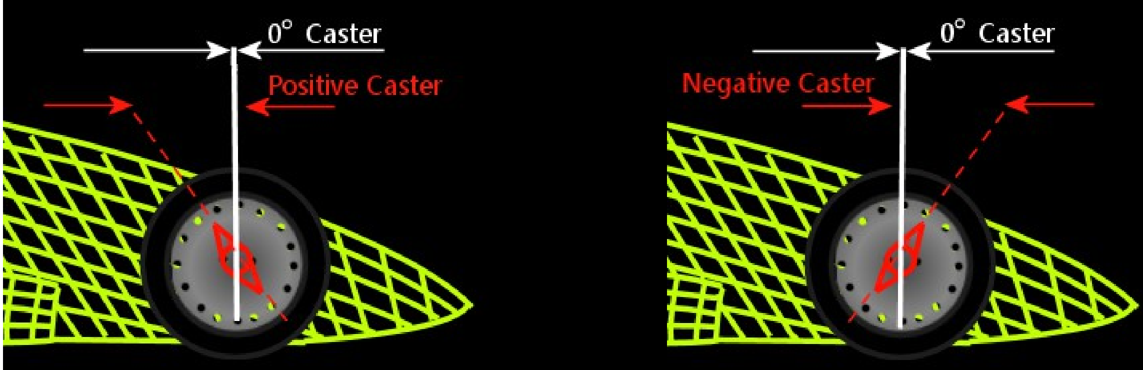
As a general rule, the flatter or slower the track the more camber is needed on both front tyres. For circuit racing where the car is making both left & right handed turns,it is better to keep the camber set up in line, adding equal negative or positive camber to the front tyres. For Oval racing the camber can be asymmetrical, Unequal side-to-side camber of 1° or more will cause the vehicle to pull or lead to the side with the most positive camber. Body roll can also play a factor in camber settings, try minimizing body roll with stiffer springs or sway bars.

Knowing how to read & understand tyre temperatures will be the determining factor in how much camber to set on the car. Adjusting one part of the car & not readjusting camber could be throwing off any original adjustments.

Here is a synopsis of how camber effects the h&ling of the chassis:

Action	Effect
Increased negative RF camber Positive LF camber	The car will turn into a corner quicker, excessive wear will occur to the inside of the tyre, car will pull slightly left (to the side with positive camber)
Increased negative LF camber Positive RF camber	The car will turn into a corner quicker, excessive wear will occur to the inside of the tyre, car will pull slightly right
Equal LF & RF positive camber	The car will have less cornering stability & slide, tyres will wear on the outside
Equal LF & RF negative camber	The car will have more cornering stability, less slide, tyres will wear on the inside
Increased positive RR camber Negative LR	Generates more under-steer into a corner
Increased positive LR camber Positive RR	Generates more over-steer into a corner
Equal LR & RR positive camber	The car will have less cornering stability & slide, tyres will wear on the outside
Equal LR & RR negative camber	The car will have more cornering stability, less slide, tyres will wear on the inside

Caster



Caster is defined as the lean of the tyre either forward or backward at the top of the wheel. Not to be confused with camber which is the inward or outward tilt of the wheel at the top. Positive caster is when the wheel is tilted back toward the rear of the vehicle. Negative caster is when the wheel is tilted forward toward the front of the vehicle.

Caster is used to provide directional steering stability. To simplify the understanding of caster, think of shopping trolley with 4 wheels on it that swivel to help you move it across the floor. When you push this across the floor you'll notice that the wheels will swivel back allowing you to push forward with ease. This is positive caster. When 4 swivel wheels & turn forward 180 degrees, this becomes negative caster, & causes difficulty in pushing forwards when the wheels are in this forward or negative position. This also has the side effect of unwanted direction change until the casters spin in a positive direction.

When setting your chassis you'll want to tip the top of the wheels back adding positive caster to provide you with that straight ahead directional stability.

More caster can also provide increased difficulty in steering input, but can also provide better feel for the car. Increased caster will provide good indication of how the car is h&ling on track.

Too much positive caster also has drawbacks. When a car corners left with positive caster the LF rises while the RF drops. This changes the weight on all 4 corners of the car. In effect taking cross weight out of the car the more the wheel is turned. The more positive the caster, the more cross weight there is being removed. The more cross weight you remove the grip in the car will lessen.

Caster synopsis:

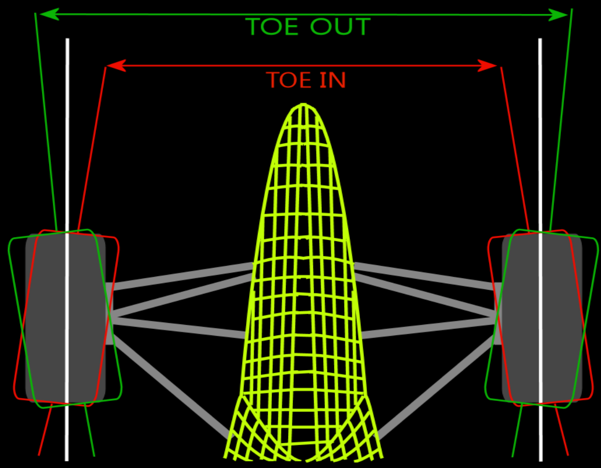
Action	Effect
Positive caster	Car will have more stability into a corner but higher tyre consumption. Too much positive caster will produce steering resistance, slower & less responsive car.
Negative caster	Car will require less steering input into a corner but less stability. Too much negative caster will produce a nervous h&ling car & higher rate of slide.

Toe

Toe is an alignment parameter that describes how the front wheels are oriented with respect to each other & how the rear wheels are oriented with respect to each other. With the steering wheel centred, if the front wheels are pointing toward each other (from a top view), they have "toe-in" or are "toed-in". If they are pointing away from each other, they are said to have "toe-out" or be "toed-out". The same definitions apply for the rear wheels. Toe can be measured as an angle between the perfectly straight position of a wheel & its position after toe is adjusted. Toe can also be determined by finding the difference between the distance separating the front edges of the wheels & the distance separating the rear edges of the wheels. More distance between the front edges than the rear edges is toe-out. More distance between the rear edges than the front edges is toe-in.

TOE-IN occurs when these lines are in "A-shape", lines cross in front of the wheels.

TOE-OUT occurs when these lines are in "V-shape"; lines cross behind wheels.



Toe is used to change the way a car behaves on corner entry. The more toe-in you have on a pair of wheels, the harder it is to make those wheels turn into a corner. The more toe-out you use, the easier it is to get that pair of wheels to turn into a corner.

Why does this happen? Let's take an example where a car with toe-in on the front wheels is about to enter a left turn. The driver begins to turn the wheel left. Now, the left-front tyre is pointing only slightly to the left while the right-front tyre is pointing much more to the left. The problem with this is that the left-front tyre needs to turn with a greater angle than the right-front tyre because the left-front tyre is on the inside of the corner &, therefore, must trace an arc with a smaller radius than the outside tyre. However, with toe-in, the left-front tyre is actually trying to trace a larger radius arc than the right-front tyre. It is difficult to make the car turn because the left-front tyre is fighting the right-front. When the car is already in the turn, weight transfers to the right-front tyre & diminishes the effect of the left-front tyre. Because of this weight transfer, toe mainly affects corner entry.

With toe-out, the inside tyre in a corner turns with a greater angle than the outside tyre (as it should). This improves the grip of the front tyres on corner entry.

In addition to corner-entry h&ling, toe affects straight-line stability. Toe-in improves stability while toe-out worsens stability. This can be explained through the same reasoning as was used to describe corner-entry h&ling. Toe-out encourages turn-in since the inside tyre turns at a greater angle than the outside. Hence, the car is sensitive to the slightest steering input. Toe-out will make the car wander on the straight requiring corrective steering. The car will always be turning unless the steering is perfectly centred. With toe-in, the inside tyre fights the outside since the inside is trying to trace a larger radius arc than the outside. As a result, toe-in discourages turn-in & makes the car less sensitive to steering input. In other words, it is more stable.

An example of the straight-line stability concept. Assume there is toe-out on the rear wheels. Travelling in a straight line the right-rear tyre hits a small bump. It gets pushed back slightly by the impact, & it is now pointing more to the right than the left-rear tyre. Therefore, the back of the car turns to the right until the right rear suspension comes back to its original position. The same thing can occur with the front wheels. In fact, the effect on the front suspension is even worse because the right-front wheel getting pushed back, for instance, will also turn the left-front wheel to the right.

With a front-wheel drive car, it is sometimes helpful to add some rear toe-out to decrease the stability of the rear tyres & counter the under-steer inherent in front-wheel drive cars.

For a rear-wheel drive car with independent rear suspension, the torque produced on the rear suspension when on the throttle tends to pull the rear wheels forward on the suspension pivots. This creates toe-in. To counter this effect, toe-out can be applied to the rear wheels so they will become straight when on the throttle.

Toe increases tyre wear due to the tyres are fighting each other, therefore scrubbing along the ground. Toe-in tends to increase tyre wear on the outside edges of the tyres. Toe-out tends to increase tyre wear on the inside edges of the tyres. Consider the camber setting when adding toe-out. If using negative camber, already there will be wearing on the inside of the tyres more than normal. The combination of excessive negative camber & toe-out can quickly wear the inside of a tyre.

Front Toe Out synopsis:

Action	Effect
Toe out front	Slower entry speed into a corner, increased stability in a straight line, less slide
Toe in front	Faster entry speed into a corner, decreased stability in a straight line, more slide
Toe out rear	Improved traction, less slide
Toe in rear	Decreased traction, more slide

Suspension

Preload

Preload can come from several sources. A coil over shock that has a threaded collar for supporting the spring. If the collar has been turned up a number of times so the spring is compressed even when the shock is fully extended then the spring would be preloaded. In other words there is a load on the spring before there is any shock compression. On the whole car, due to spring placement, suspension positioning, & tyre diameters, etc., you can have a preloaded affect just like the single coil over unit. Adjustments (in or out) on the weight jack screws is the most common way the preload is changed.

Compression or bump damping controls the unsprung weight of the vehicle (wheels, axles, etc.). It controls the upward movement of the suspension such as hitting a bump in the track. It should not be used to control the downward movement of the vehicle when it encounters dips. Also, it should not be used to control roll or bottoming. Basically it affects the interaction of the tyre with the track, getting it right maximises the grip.

The rebound damping controls the sprung mass of the car, it controls transitional roll (lean) as when entering a turn. It does not limit the total amount of roll; it does limit how fast this total roll angle is achieved. How much the vehicle actually leans is determined by other things such as spring rate, sway bars, roll centre heights, etc.

The reality is rebound is the most important part of the damping, not enough & the weight transfer will play havoc, too much at one end & there will be a loss of response & cause undue loss of car balance & too much in total can cause 'jacking down' where the shock gets compressed under bumps & never extends back up, hit enough bumps in a short time & the shock will be compressed onto the bump stops. Contact with the bump stops causes a drastic increase in roll stiffness. If this condition occurs on the front, the car will under-steer; if it occurs on the rear, the car will over-steer.

Below is a general guide that should assist you in fine tuning your shocks.

Shock Compression:
The stiffer the FRONT shocks, (higher the number) the under-steer the car will be when braking.
The softer the FRONT shocks, (lower the number) the over-steer the car will be when braking.
The stiffer the REAR shocks, (higher the number) the over-steer the car will be under acceleration.
The softer the REAR shocks, (lower the number) the under-steer the car will be under acceleration.

Shock Rebound:
The stiffer the FRONT shocks, (higher the number) the under-steer the car will be under acceleration.
The softer the FRONT shocks, (lower the number) the over-steer the car will be under acceleration.
The stiffer the REAR shocks, (higher the number) the over-steer the car will be under braking.
The softer the REAR shocks, (lower the number) the under-steer the car will be under braking.

Shock synopsis: Asymmetrical changes will have greater influence than individual shock changes.

Action	Effect
RF & LF Higher compression	Will under-steer the chassis entering a corner
RF & LF Lower compression	Will over-steer the chassis entering a corner
RF & LF Higher rebound	Will under-steer the chassis accelerating out of a corner
RF & LF Lower rebound	over-steer the chassis accelerating out of a corner
RF & LF Overall stiffer shock	Will under-steer chassis
RF & LF Overall softer shock	Will over-steer chassis
RR & LF Higher compression	Will over-steer the chassis accelerating out of a corner
Action	**Effect**
RR & LR Lower compression	Will under-steer the chassis accelerating out of a corner
RR & LR Higher rebound	Will over-steer the chassis entering a corner
RR & LR Lower rebound	Will under-steer the chassis entering a corner
RR & LR Overall stiffer shock	Will over-steer chassis
RR & LR Overall softer shock	Will under-steer chassis

Spring rate refers to the amount of weight needed to compress a spring an inch (Example:500# per inch) If a springs rate is linear (most racing springs have linear rates) its rate is not affected by the load put onto the spring. For example, a linear rate spring rated at 500#/inch will compress 1" when a 500# weight is placed onto the spring. If another 500 pound weight is put onto the spring the spring will compress another inch. At this point the load on the spring has increased to 1000 pounds. The rate of the spring, however, remains constant at 500#/inch.

If the load put onto a spring increases the rate of the spring, the spring is said to have a progressive rate. Progressive rate springs are sometimes used on torque arms to absorb engine torque. Keep in mind that the load (or preload) put onto a progressive rate spring can greatly increase the rate of the spring.

Typically, progressive rate springs are made by varying the spacing between the springs' active coils. During compression the close coils bottom out & deaden. This reduces the amount of active coils & spring rate increases as a result.

Springs that are designed to include coils of different diameter or are wound using a tapered wire will also produce a progressive rate.

Spring synopsis:

Action	Effect
Overall stiffer front springs	Car will be under-steer
Overall stiffer rear springs	Car will be over-steer
Overall softer front springs	Car will be over-steer
Overall softer rear springs	Car will be under-steer

Steering

Steering ratio is the difference in how many degrees your front wheels are turned compared to how many degrees your steering wheel is turned. Steering ratio is measured by dividing the number of degrees the tyre is turned into the number of degrees the steering wheel is turned. If for example you turn your steering wheel 180 degrees & your front tyres were to turn 10 degrees you would have a 18:1 steering ratio. (10 into 180 = 18)

A car with a higher steering ratio will require more steering input to get through a corner. Too high a steering ratio might give the feeling of a under-steer race car as you find yourself turning the wheel further to negotiate a turn.

As a general rule of thumb, the smaller the track & under-steer the radius of the turn, the lower the ratio you'll want to run. High speed long sweeping corners would not require such a low steering ratio since you are not required to turn as sharply on tracks like these.

Steering Ratio synopsis:

Action	Effect
Lower Ratio/Number	Quicker steering response, less turning of the wheel to negotiate a corner
Higher Ratio/Number	Slower steering response, more turning of the wheel to negotiate a corner.

Tyres

Tyre Pressure

Tyres are the most important component on a race car. every adjustment on a race car is for the benefit of the tyres.

Tyre pressure adjustment will aid in achieving the best possible grip. tyre pressure is simply how much air is in a tyre. The hotter tyres get, the more they exp&. Air contains moisture. Moisture becomes steam as the air gets hot & increases pressure.

Improper tyre pressure can cause an ill h&ling car. Correct tyre pressure can be determined by reading tyre temperatures. A tyre with a temperature reading higher in the centre of a tyre indicates an over inflated tyre. A tyre with a lower centre temperature, when compared to the inside & outside of a tyre indicates a under inflated tyre. Over inflated tyres will have a tendency to make the car under-steer. Under inflation can slightly over-steer a chassis but give better grip. Lower tyre pressure will also increase the amount of heat in that tyre. Excessively low tyre pressure produces more heat which can result in quicker wear. Higher pressure tyres run cooler, have less drag & will be quicker at higher speeds.

tyre psi synopsis:

Action	Effect
Lower Psi	Hotter tyre temperatures, more grip, higher wear rate
Higher Psi	Cooler tyre temperatures, less grip, lower wear rate

Tyre Temperatures

By comparing the average temperature of all four tyres, it can be seen which corner of the chassis is working harder than the other. To figure the average temperature of a tyre, add the 3 temps across the tyre & divide by three. If the RF is a lot hotter than the other three tyres, that tyre is working too hard. Work on cooling that tyre off by lowering the RF spring & allowing the other tyres to share some of the work load. By comparing the RF average to the RR average will indicate if the chassis is over-steer or under-steer. A tyre is being under worked when it's temperature is a lot lower than the other three tyres. When a tyre is cooler or under worked, it's better to concentrate on that corner of the car. adding weight to that corner of the car to increase the temperature of that tyre should resolve the issue. If a tyre is a lot hotter than the other 3 work on making that tyre cooler.

The ideal process to decipher tyre temperatures is to run 10 laps on a particular set-up & monitor tyre temps. It will take a number of 10 lap sessions to decipher the temperature data of the tyres. When analysing tyre temperatures it should be done in a specific order. This is because a problem in one area may mask a problem in another area.

When checking tyre temperatures it is important to make sure the car is not locking up the brakes or making any sudden changes in steering outputs. These will create erroneous tyre temperatures readings.

Tyre temperate guideline

Effect	Cause
Tyre has excessive high temperature on the inside edge	Too much negative camber
Tyre has excessive high temperature on the outside edge	Too much positive camber
Tyre has excessive high temperature in the centre of the tyre	Over inflation of that tyre
Tyre has excessive low temperature in the centre of the tyre	Under inflation of that tyre
Both front tyres have higher temperatures on the inside	Too much toe out
Both front tyres have higher temperatures on the outside	Too much toe in
A tyre with the highest average temperature	That tyre is working the hardest
A tyre with the lowest average temperature	That tyre is working the least

Gears

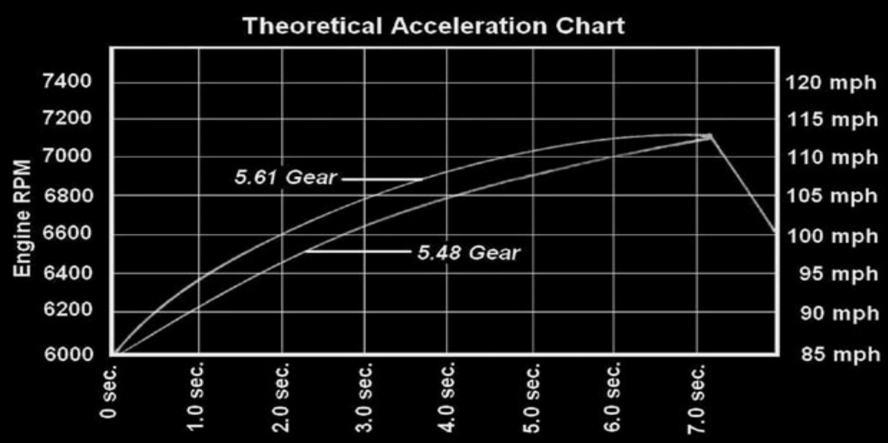
The transmission is designed to change the high rotational speed & low torque (turning force) of the engine's crankshaft into the higher-torque rotation needed to turn the wheels over a range of speeds. Transmission ratios vary through the gears selected during shifting & are adjustable in varying increments for each individual gear.

Like the differential & transmission ratios, the final drive ratios are read in the same manner. A lower number means a lower (or shorter) gear. Short gearing gives quicker acceleration, but because the engine must turn faster, fuel mileage & top speed are lower. Longer gearing gives smoother acceleration & higher top speed, at the expense of quick acceleration.

The aim is to maintain as high an RPM as possible when shifting through the gears. To large a split ratio between gears will cause slow acceleration & lost time whenever shifting is required.

Transmission Ratio synopsis:

Action	Effect
Lower Ratio/Number	High RPM, Quick acceleration, slower top speed
Higher Ratio/Number	Low RPM, Slower acceleration, higher top speed



In this exaggerated example, we can see where the use of a lower gear (5.61) might improve acceleration while showing the same RPM at the end of the straight, Looking at 6,800 RPM, we see where we reached that speed approximately 0.8 seconds sooner with the 5.61 gear. The real gains will be smaller, but still significant. Notice how the 5.61 speed gain trails off toward the end of the straight but is still higher than the 5.48 gear gain at 7,200 RPM.

Final Drive Ratios

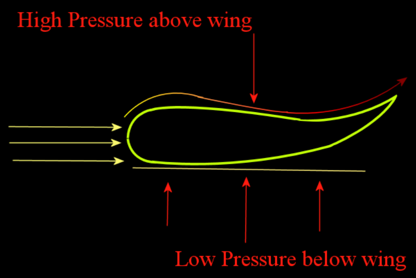
The final drive ratio represents the number of engine revolutions to rear wheel revolutions. Like the differential & transmission ratios, the final drive ratios are read in the same manner. A lower number provides a shorter gear. Short gearing gives quicker acceleration, but because the engine must turn faster, fuel mileage & top speed are lower. Longer gears give smoother acceleration & higher top speed, at the expense of quick acceleration.

Final Drive synopsis:

Action	Effect
Lower Ratio/Number	High RPM, Quick acceleration, slower top speed
Higher Ratio/Number	Low RPM, Slower acceleration, higher top speed

Aerodynamics

Probably the most popular form of aerodynamic aid is the wing. Wings perform very efficiently, generating lots of down force for a small penalty in drag. The wing works by differentiating pressure on the top & bottom surface of the wing. As mentioned previously, the higher the speed of a given volume of air, the lower the pressure of that air, & vice-versa. What a wing does is make the air passing under it travel a larger distance than the air passing over it. Because air molecules approaching the leading edge of the wing are forced to separate, some going over the top of the wing, & some going under the bottom, they are forced to travel differing distances in order to "Meet up" again at the trailing edge of the wing. This is part of Bernoulli's theory.



Aerodynamics start to have a more noticeable affect on a vehicle at around 50 mph. If the car is travelling slower than 50 mph, the weight of the aerodynamic devices are probably more of a penalty than any perceived gain in performance. Down force & drag values go up roughly with the square of the increase in speed & the power required to overcome the drag forces goes up at a slightly steeper rate.

Rear Wing/Spoiler

The flow of air at the rear of the car is affected by the front wings, front wheels, mirrors, driver's helmet, side pods & exhaust. This causes the rear wing to be less aerodynamically efficient than the front wing, Yet, because it must generate more than twice as much down force as the front wings in order to maintain the h&ling to balance the car, the rear wing typically has a much larger aspect ratio, & often uses two or more elements to compound the amount of down force created.

The rear wing is always a compromise of rear down force Vs top speed. High down force settings produces drag, therefore greatly hindering the cars top speed. When setting rear wing angles, the goal should always be; to obtain the maximum rear down force without impacting on the cars ability to reach a competitive top speed.

Front Wing/Spoiler

The function of the air foils at the front of the car is twofold. They create down force that enhances the grip of the front tyres, while also optimizing (or minimizing disturbance to) the flow of air to the rest of the car. The front wings on an open-wheeled car undergo constant modification as data is gathered from race to race, & are customized for every characteristic of a particular circuit

Front wings do not impact drag as much, even at their highest down force settings. Therefore the rule of thumb is to use as great a front wing angle as possible without upsetting the cars rear end balance.

Aerodynamic synopsis

Action	Effect
Increased front wing angle	More over-steer in fast corners, reduces effectiveness of rear wing
Decreased front wing angle	More under-steer in fast corners, increases effectiveness of rear wing
Increased rear wing angle	More under-steer in fast corners, reduces top speed on straight
Decreased rear wing angle	More over-steer in fast corners, increases top speed on straight
Overall increased wing angle (front & rear)	Increased corner speeds in fast corners. reduced top speed on straights
Overall decreased wing angle (front & rear)	Decreased corner speeds in fast corners. increase top speed on straights

Braking System

Brake Bias

Since the performance of a race car is based on it's ability to exploit weight transfer, it is necessary to alter the brake balance of the car. Changing the braking balance simply shifts the force of the brakes so as half the car experiences more stopping power to the wheels than the other. Shifting the bias to the front is the preferred method of adjustment as the weight transfers to the front under braking.

If the brake bias was 50/50, the car would experience premature locking of the rear wheels as the weight shifts away from them under braking causing over-steer during corner entry. The general rule of thumb is to set a higher amount of front bias without locking the wheels under normal braking conditions. Moving the bias too far forward will cause a tendency to under-steer on corner entry.

Brake bias synopsis

Action	Effect
Increased front brake bias	More stability on corner entry, more under-steer
Increased rear brake bias	Less stability on corner entry, more over-steer

Quick Set-up Guide

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But it as well decreases the car's responsiveness & requires higher ride height.
Balance grip/wear Vs. response by adjusting spring (bump/rebound) & sway bar tensions</td></tr>
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increasing front toe-in makes for better turning, but increases tyre temps & wear
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Credits

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(www.verminart.weebly.com)

Sources:

RacerAlex

Grand Prix 2 Manual

Vermin Racing Team Guide v.01

Speedsims Set-up Guide

Performance Tuning Guide

Racelinecentral Ultimate set-up guide.

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