

# How Not to Crash

*Drive fast, don't crash, keep the car on the road. Go, go, go!*

***Through this article I'll be giving lots of definitions, how to save it in certain scenarios, and lots of things to learn about your car and driving.***

## What is "Driving on the Limit"

Essentially, if you want to drive as fast as possible you will need to drive through corners using the maximum available grip. In other words, to drive on the *limit* of grip. You want to be on that limit because it allows for you to travel at the fastest speed possible around a corner before you slip too much and lose lap time. And, trying to stay right there is why you see incredibly skilled professional drives spinning out or crashing often.

There are a bunch of conditions that affect how much grip your car has, such as tires, wind, temperature, track conditions, and your inputs. Every time you drive, they are different, and you cannot rely on memory of how much grip you have at each turn. Rather, you must learn to be able to determine this in real time depending on the corner you are coming up to.

Becoming good at this will take a lot of experience. And the more experience you have driving the limit the more you will be able to push the car closer to it. It just takes seat time and learning to get to that point.

Pushing your car to the limit means that you are going to be slipping a bit at the entry of corners, only slightly as you will be able to know how fast to spin the tires to keep the grip on throughout the corners. Beginners need to be far off the limit so they can learn lines and how their car responds before they are able to go as fast as possible. One needs to be honest with themselves about their skill level, as

just because one is slipping a little does not always mean one is on the limit. You may just be too sharp with your inputs, unsettling the car and losing traction as such.

Early into your driving career your mistakes will likely come in the braking and entry into the corner. Until you have experience and when you know line theory better and can 'feel' grip better, you will overshoot or brake too much. Get close to being uncomfortable and sliding, then be smoother and more gradual with your changes to your entry. This is the approach to use in order to make much of your progress.

Now some words of wisdom before we get onto the actual stuff.

In almost all cases (unless your wheels and brakes are shot, and you should not be on the track then) there is no good reason to not have confidence in your car to not push it, it is really all about your confidence in yourself.

Also, please avoid endangering innocent people at all costs. So don't be pounding down the throttle or doing Hoonigan things in rush hour traffic. Try and get track time, go do autocross, or find empty parking lots in the middle of the night. The more closed off the road is the less chance there is of issues with cops or other cars.

## ***Driving Principles***

### ***Grip***

At all times there is only one square foot of tire directly in contact with the ground, this is your contact path. Depending on what your car is doing there will either be longitudinal (front to back) or lateral (left to right) force applied to this patch. Longitudinal is with braking and accelerating, and lateral is with turning.

When you lock your tires only this patch is in contact with the ground, and it stays on the same part of the tire. Which is a serious wear issue as you can create bald spots on it that will throw your whole setup out of whack as the wheel spins.

Grip also varies with weight transfer, as you turn or brake less mass will be over certain wheels and these ones will therefore have less grip. This is partly why when accelerating hard you may encounter understeer as the rear squats and the front tires have less grip.

You can increase the available grip outside of driving techniques by adding downforce with spoilers, splitters, and the like. Tires can also be switched out for summer or performance-developed ones that will give you better traction (beware the increased wear). Do not stance the fucking racecar, you need all the tire you can get.

Not only does your grip change from day to day, even between laps and breaks during a track day will it change. Weather, wear, and heat all change how your car will handle, and if you have the expertise and ability to, you should make changes to combat this. For the majority of us all we can change is tire pressure during a track day, so we're forced to adjust our driving techniques.

Unfortunately, this varies greatly car to car, but for the most part it will simply involve getting a feel for your grip again and keeping a clear mind to be able to deal with grip changes throughout the race.

## ***Weight Transfer***

### ***What Happens as you Drive and Why***

Weight transfer happens when weight is shifted around the roll centre of the car, which is the middle of the car where forces will act upon.

Acceleration will push the weight to the rear of the car and cause it to squat, more grip is now available to the rear tires and less to the fronts. This helps to stop wheel spin in RWD, and oversteer in FWD. But it causes understeer in all cars and the fronts have less grip and cannot apply as much turning force. And the rears are under more stress and without as much grip on the front it makes it harder to prevent sliding.

Deceleration, especially under hard braking will transfer weight to the front of the car and cause it to dive. This helps prevent understeer as more grip is available to the front wheels, however, you can overdo it and cause understeer by passing the grip threshold of the tires. As well, in RWDs you will have less grip on the rear tires so the weight must settle before you can get full acceleration and avoid wheelspin.

Turning moves the weight away from the wheels on the inside of the turn and most of the turning grip is provided by the outside wheels, this isn't a major issue, so long as you avoid drastic moves that will unsettle the car while this happens.

The summary is that whatever direction you put force on the car in, the weight will transfer to the opposite end of the car. So gassing it puts weight to the back (you're pushing car forward, weight

shoots rearward), brake puts it to the front (momentum rearward, weight forward), left puts it to right, and right puts it to the left.

### ***How to Feel***

**(I swear, this isn't a sadboy edit)**

It's relatively easy to feel how your car reacts to weight transfer, with the body rolling to one side or the other, it diving forward to throwing you back into your seat. And with practice these help you to know what's going on between the car and the ground and the degrees of motion you feel can help you judge how much grip you have left to spare.

In most cases this is the case, though body roll can be a little tougher in newer cars and higher-end cars. As they tend to mask the feeling between the ground and you, at least I find it harder to tell what is happening to the car. But making it easier to feel your car is never a bad thing and gives you a solid reason to modify your car!

Bucker seats with harnesses so you are strapped into the chassis help, so can tighter suspension. But if you are not looking to spend possibly thousands before even completing a track day (which is not a good idea) you can also slightly change how you drive.

When you steer you can either 'push' or 'pull' the steering wheel. If you maximise how much you push the steering wheel rather than pull it you will effectively be pushing yourself back into the seat rather than pulling yourself out of it, and this is said to help you feel the car more.

An easy way to picture pushing the wheel is to use the hand on the outside of the corner more than the one of the inside.

I've given it a shot and I find it does help a good bit with feeling weight transfer. Especially so if you do not have bucket seats, as you tend to fly around the cabin without them. Being more planted helps a lot with feeling the car with stock seats.

### ***What Information does Weight Transfer Give You***

Weight transfer principles allow you to test the grip threshold of your car. There are three things you need to do to test. Also, it is best to do so on a long flat corner without any walls or things that will total your car.

First, you need to go fast enough to create understeer, thereby determining the max speed for the corner. Understeer will present itself as the steering lightening up.

Second, braking hard enough to lock a wheel before a corner, this lets you know more about your car and tire conditions on that day. But be sure not to hold the tire locked so you do not rub a spot on it.

Lastly, accelerating after a corner hard to just before you get wheel spin, now you can see roughly how hard you can gas it after corners.

In addition, you know you are going in too fast if you feel vibrations in the steering wheel as the tire has rolled onto its sidewall. Hearing steady screeching of the tires is good, as your inputs are steady. However, changes to the pitch mean you have made unnecessary adjustments in the corner.

All of these rely on having a lot of seat time under your belt so that you know how to estimate based on these notes into other corners. This will come as you try it and learn for your success and mistakes.

### ***How to Control it with Driving***

You can control weight transfer on your car through smooth driving, or minimising the amount of weight transfer your actions have on the vehicle. Steering should not be jerky or haphazard, and always keep the steering under your control, so unwind the steering manually not simply using the power steering to push it for you.

Braking by squeezing the pedal with consistent force and not slamming it down is strongly advised if you not only want to stay on the track, but have competitive times. As this will prevent unwanted brake lockup and transfer weight gradually.

Just like braking, progressively increasing throttle is good to avoid spinning the wheels or squatting too much. The same goes for coming off the throttle, not only will braking shift weight to front, so will cutting throttle suddenly.

Taking care when changing gears is also important, any lurching will likely unsettle the car enough to cause you issues, rev matching is also super important when track driving, but you will want to release the clutch with care, clutch kicking is not advised with grip driving.

When you combine everything, your car will be right on the grip threshold, this knife's edge is hard to run along because any small input can throw your car out of whack and end up with you sliding away from your line.

### ***How to Control it with Mods***

One way to control weight transfer on your car is to modify changes to your vehicle to make more grip available. Getting the centre of gravity closer to the ground lowers the angle of force acting on the car, which results in less weight transfer. So, there are some non-RICE reasons for slamming your car!

Stickier tires also are better because they increase the amount of friction between the ground and the car, thereby increasing its inertia or 'weight' so it takes more force to unsettle it. But keep in mind that performance tires will also wear much faster due to increased friction.

The centre of gravity of a car is at the centre of the car (duh). Therefore, there is a 3D angle between the centre of gravity and the tires, so widening the tires, and putting them farther away from the centre of gravity is beneficial as it lessens the angle between the force and the centre of gravity.

### ***Line Theory***

By maximising braking, turning, and acceleration you will be forced to take a certain line around the track, and this is the resulting race line. No matter the kind of course you are racing or the type of event, there will probably be corners, and the only way to go as fast as possible is to maximise your usage of the grip threshold and acceleration out of the corner.

Essentially, you want to minimise how much you are turning in order to go faster. You want to be at full throttle as close to apex as you can while avoiding wheelspin, but sometimes acceleration must be held off until the car is almost fully straight. Ideally you want to use all of the tarmac available, but if you can corner using less you should shoot for an earlier, faster apex.

By straightening out the line you are better able to use the grip threshold for acceleration and braking rather than for turning. Your braking, turning, and acceleration points will all change depending on the track, car, and driver conditions for that day. So, it is very important to be able to determine your car's shape to drive the best line.

Two main strategies for cornering are either lowering your angle of turn and keeping speed through the corner. Or on the gas early to exit faster. The first is good in the rain and low-power cars, and will be



closer to the geometric line. The latter is better on high-power cars and has a late apex, being closer to the ideal line.

The geometric racing line minimises angle of corner to free up grip for forward force, the angle of entry and exit are nearly identical. This is the most efficient way to corner, as it maintains momentum very well. Your chances of oversteer and understeer are lower, and the lower grip thresholds help to lengthen the life of your tires. However, it is not always the fastest line to take.

The late apex or more “ideal” line has a sharper angle of entry, but the exit angle is very open. Because, by straightening the car out early you can open throttle sooner and take advantage of more powerful engines. Most consider this the optimal strategy for cornering; you sacrifice entry speed for exit speed. With this strategy you will have better lap times in faster cars, you’re on the power sooner, and you can brake later than with geometric lines. It is smart before straightaways as you can gain more speed than others quicker. The caveats here are that low-powered cars cannot use it as well, and tires are under more stress making understeer/oversteer more likely, and they will also degrade more.

## ***Braking***

### ***Threshold Braking***

You want to brake for as short a time as possible as close to the turn as possible. Therefore, threshold braking is something you must be familiar with. Threshold braking is important even with ABS, as it only kicks in after recognizing wheel locking. It is a reactive system, not preventative. So, it’s slightly more effective to keep the car under your control, rather than a computer’s.

Unfortunately, as a beginner you are unlikely to make any improvements above what newer ABS systems offer. However, more experienced drivers will, and in some cases take advantage of a lack of ABS to save the car (more on this later).

Threshold braking is pushing the brakes to the point just before they lock in order to get maximum braking force without locking the wheels. Manual pulsing of the brakes just before the point of locking is how you keep them on without locking (this is what ABS tries to recreate, but it only happens after the first initial locking).

To learn this you must learn much about when locking happens and what causes it, what are the signs that it is about to onset, etc. And as with literally anything, practice, practice, practice to the point where you intimately know your brakes and are able to prevent them from locking in essentially all scenarios.

### ***Trail Braking***

The steadfast rule of only braking in a line can be bent somewhat with the technique of trail braking. You still want to do the majority of your braking in a straight line; however you decelerate right up until the apex of the turn. The brakes themselves are not used so much as engine braking and drag induced by tires and aero.

Basically, you brake slightly less before the corner, and continue using braking forces in order to be able to have more speed going into the corner, hit the apex better, and therefore also have better speed out of the corner too. What you are not doing with trail braking is adding in a second braking section.

You are just continuing with initial braking into the corner up into the apex. The truth still applies that the more you turn the less you want to be on the brakes. This is true so that you keep the vehicle under grip, and so that you start your acceleration as soon as possible.

This technique is most useful on slower, tighter corners, as you must turn the car more before you want to be on the gas. Faster corners will not benefit from it as you can carry your momentum through

it well. Countering understeer is another reason to use trail braking, if your vehicle tends to understeer late into the corners, you might benefit from keeping more weight on the front longer.

### ***Left-Foot Braking***

Left foot braking is primarily (and originally) a rally technique, but road and track racing times can improve through its use as it can be implemented to reduce understeer, wheelspin, and pedal transfer times.

You can reduce understeer by feather the brakes (trail braking) and easing into transition to throttle you keep the weight on the front of the vehicle longer.

If your FWD car does not have an LSD you can benefit from left-foot braking on the exit of a corner by feathering the brakes as you accelerate to slow how fast the wheels spin, thereby reducing wheelspin through brake input.

Your left foot is on the brakes and your right is on the gas so there is effectively no pedal transfer time. Those milliseconds are the difference between winning and losing.

This is a tough technique to learn, as you will be teaching your foot to operate in a way it is not used to. With lots of (empty parking lot) practice it will be no different to teaching your right to use the brake and gas, albeit it is you left working the clutch and brake.

## ***How to Save***

### ***Proper Car Setup***

You should be in a comfortable position with your hands at the nine and three positions, and arms should be bent between 90 and 120 degrees. Always make sharp turns with the 'hand-over-hand' technique, as this offers you the most control and knowledge of where the car's wheels are pointing.

Try to maintain two hands on the wheel at all times, this lets you act most effectively at any time, never let the wheel slip through your hands to centre a turn, as you lose time when immediate action is necessary.

Have a gentle but firm grip on the wheel, no need to white-knuckle as it only causes you to make unnecessary and often unconscious adjustments. In addition, thinner gloves are better for feeling and gripping the wheel. However, you also don't really want to catch on fire. Just saying...

### ***Oversteer and Understeer***

#### ***Oversteer***

Oversteer happens when the rear tires run out of grip, where the back-end swings out more and the car takes the corner more than your steering input calls for. The added demands on the rear tires of RWD cars causes them to be more prone to this.

Oversteer can be caused by going too fast into a corner, accelerating too early or aggressively in the corner, braking into a corner or midway through, or lifting off the throttle mid-corner.

Noticeable factors for oversteer are that the back end becomes unstable or lightens up, or that the car rotates more than the driver should expect.

To counter oversteer you want to apply counter steering lock as you slide into the corner. You'll need to learn how your car reacts so you can predict how much steering will be needed to correct but not send you spinning in the opposite direction.

In all technicality, in oversteer you still have control over the car, you just need to adjust your steering to allow for the larger corner angle the rears are now taking. Whereas in understeer you need to take action to get the car back under control before you can fix your steering.

### ***Understeer***

Understeer happens when the front tires run out of grip, and this causes the car to not be able to steer as much as your input calls for. The added demand on the front tires on FWD cars causes them to be more prone to understeer, but much less to oversteer.

Understeer can be caused by accelerating into a corner, going too fast into said corner, braking in the corner, or low traction conditions like ice, oil, rain.

You can correct it effectively by doing the opposite of whatever got you into the situation you are in. Say you were gassing it, ease off and add some brake, if you were braking, stop it. If you are going too fast and lose traction it's best to brake, which will increase grip demands on tires, but also puts more weight over them and thereby gives them a higher upper limit to grip.

To stop a car from going where you do not want it you will want to be able to recognize understeer early. Which can be tough. You must watch that the car is taking the line you are shooting for. Focus your eyes on where you want to be and drive towards it. Keep a light touch on the steering wheel to feel if it lightens up, then act so you can steer back on course.

## ***Brake Lockup***

Overheating, the wrong brake fluid, damaged parts, a malfunctioning ABS, or broken e-brake can all lead to your brakes locking up. Residual hydraulic pressure can cause callipers to push down on the pads even in you are not on them, and if this happens it means there is something badly wrong. If you slam on the brakes they will lock on their own if you are not careful, again, practice threshold braking.

In either case, if they locked due to you or not, you would want to press on the brakes to get control back, then release, then back on pressure to avoid the wheels from locking so you still have control over the steering. Pulse the brakes like this until you come to a stop or are at the speed you need.

As you go around the track, your brakes will heat up and will not be as effective, this is brakes fade. Heat has caused bubbles to form in the brake fluid lines. If this is an issue for you, switch to a higher-temperature brake fluid (look at the boiling temperature). Keep in mind though that racing fluid has a short life and will need to be flushed at least once a year.

## ***Hydroplaning***

Hydroplaning happens when there is too much water on the ground and your tires cannot clear it out from your contact patch quick enough, and you lose traction. You will feel this in the steering going light, similar to understeer. If this happens there is absolutely nothing you can do, you have to wait until you reach a portion of asphalt that is dry enough for you to get grip back. Try to stay calm and hope for the best.

Preventative action is the only solution, so slow down if you see large puddles ahead. Worn out tires might end up costing you a lot more in rainy places.

Racing in the rain changes everything, therefore wet races tend to even out the odds. You need to change your corner strategy to account for both less grip and the odds of totally losing grip. Your line

will have to change to stay away from the usual line taken as the rubber lines on the track will release oil from the rubber and make it much harder to keep the little traction you have.

### ***Spinning Out***

If you do not have ABS, channel your inner Takumi, slam the brakes down, locking the wheels until you start to face where you want to go, then ease off them so you get traction back and can keep on racing.

But it is usually safer to just slow down, keep the wheels straight, and pull off the track until you can get back on it safely. That is what they do in F1, so you probably should too, right?

Spin outs occur due to oversteer, or poor track surfaces like oil, rain, or ice that will throw any car off its line. If your spin was caused by oversteer you are putting too much demand on the rear tires.

Coming off the brakes or even adding a bit of throttle will get you back under control into the corner if you start to feel a spin. On the other hand, if you are starting to spin out of a corner as you accelerate; let off the throttle slightly. In both situations you will need to counter steer, just as mentioned in how to correct oversteer, to get your line back to straight.

## ***Wear***

On the extreme, one mile of hard track driving can be equivalent to ten to fifteen normal miles. Not only will brakes, tires, and fluids need to be changed sooner. As will control arms, bearings, bushings, joints, and radiator items (often replaced annually on heavily used race cars).

However, tracking your car as a newbie now and then is not awful for the car, so long as you do not light it on fire or slam a wall. Competitive track driving hurts your car infinitely more, and any real door-to-door racing will almost guarantee you some sort of damage. Tracking your car once or twice will not have much effect on the car, and autocross tends to be negligible for wear unless you are going all the time.

Make sure all liquids are full, not only does it ward off wear, they move around under hard driving, making it better for their functioning to be topped up. Using higher octanes is best when pushing those limits because your engine is less likely to grenade, more on fuel here. It is actually not best to have a full tank in most races, as it is just extra weight, and in most tanks will slosh around, causing excess weight transfer.

Tire pressure should also be a little higher than usual, to prevent wheels from rolling onto their sidewalls while cornering. Usually 5-10% more is solid, with experimentation on your setup you can figure out what tends to work for you. Check tire pressure once you come off the track because pressure changes with heat, and this is good to note for what pressure your tires tend to perform best at.

However, do not go too high or there will be grip issues, as well as wear issues as temperature goes up with pressure. You must make a trade-off between the added performance of slightly more inflated tires and the resulting wear.



Tires of course will wear out quicker with performance driving, but apart from drift there is almost never a need to replace them after one race. A lot of tires tend to make it around ten to twenty races depending on factors (based on average track days). Of course, things will depend greatly on the type of tires you run, how hard you use them, and the road conditions. Make sure you have a good alignment and balance on your wheels or else you will be replacing tires much sooner than needed as they will wear unevenly and not use the full amount of rubber.

Wear around the sidewall is atrocious because this area is weak and any wear above a certain degree will rip a tire apart. More negative camber, tire pressure, and a lower slip angle while driving can help.

Suspension issues tend to be relatively easy to diagnose, with the car pulling to one side, being especially harsh on bumps (tougher to notice with coilovers as they are harsh to begin with), the car being off-centre with one part bent too much, excessive weight transfer, difficulty steering the car, or oil on the shocks.

Make sure to store your tires properly. Keep them clean. Put them in airtight bags (garbage bags work fine), keep them out of the sun, cold, or extreme heat. You can stand them up (best option), stack them on their sides, or hang them. Really it just depends on the space you have available.

Running metal bearings is better for tire and suspension wear, as they keep the wheel and suspension in better place, so your alignment holds for longer. Polyurethane is also quite good, and is more common in performance cars, but not all that common due to the noise they make. As well, they are worse than metal in holding alignment. Polyurethane/bronze hybrid bearings are something of goldilocks, and do not have too many issues to speak of. Of course, these all depend on your budget and what is available on your car. All in all, any of these options are far better than the stock rubber.

Engine failure happens, not often but it can. A blown engine is one with some sort of huge failure, and the damage tends to be rather extensive. Sometimes you can repair the engine, but most times it is easier and cheaper to swap in a new one. You will feel the damage in a failure to start, lots of metal or knocking, smoke, and vibration. Running out of oil, excessively high rpms (past redline), or overheating tend to be the most common culprits in blown engines.

Keep up with the maintenance on your engine, change gears at the right times, check oil and coolant whenever you can, and just take care of it on the track in general. Do not gun it right away without letting it warm up, and let it cool off before you kill the engines. Ignorance of these two things tends to be the reason why boosted cars explode, and Subarus get reliability jokes made.

## ***Understanding Your Vehicle***

You should learn how your car works and take time to learn what makes the traction control and ABS kick in. Both research and behind the wheel experimentation should be used to achieve this. No matter how much or little your car's design works with you, it is imperative to understand how you can use it to push those limits on the track and have the best times. I find this to be one of the most exciting parts of driving; learning and exploiting every part of a car is something I love. If you. Are not quite the same way maybe you just have not tried it, or need to watch more Initial D or other shows. Have a good time out there, be safe, go fast!

***Let me know what you think, I love any feedback.***

*MTR out :)*

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