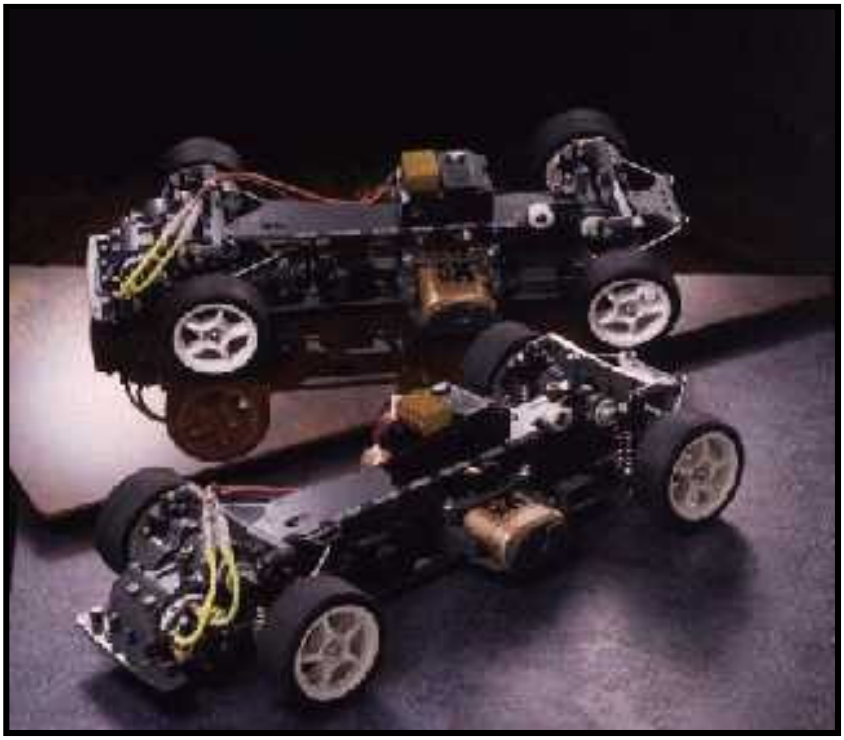
PERFORMANCE TUNING THE TAMIYA TA03



Written by C Hughes

Introduction

As a Tamiya driver, we have to contend with a vehicle that is heavy and sluggish at the best of times, but this can be addressed. Through this site, I will explain all the worthwhile hop-ups and modifications that can be made that make the TA03 not only lighter but also easier and faster to drive. The key to getting performance out of the TA03 is efficiency: efficiency in the drive train and efficiency in the electronics. With the pinion gear removed, your TA03 should easily roll down a 5° slope without being pushed! Impossible? No!

This information includes all the set-up tips and preparation information that I have gained over the last two years of preparing and racing the Tamiya TA03 on both club and national level. By the time you have gone through this entire site, assuming you follow the guidelines, your TA03 will have the potential to put you on the podium after every race.

1. Drive Train

1.1. Gears

As I mentioned before, the key to the TA03 is the efficiency of the drive train, let's start with that.

Weight is a big problem on the TA03, and with all the rotating parts, rotational mass is a killer. Removing weight from a rotating part that is spinning at the same speed as the wheels, is the same as removing three times that on the chassis. But, even more impressive: removing weight that is rotating at motor speed is the same as removing fifteen times that from the chassis.

1.1.1. Pinion Gear

There is not much that you can do to modify the pinion gear on the TA03, suffice to say that you should ensure that it is clean and well lubricated. Tamiya Ceramic Grease is the best lubrication for the pinion gear that I am aware of. Convert your pinion/spur gear combination to the TA03 Pro 0.4 module, this allows for a greater variety of gear ratios and offers better efficiency.

As explained earlier, rotational mass is a killer on the TA03. The pinion gear is spinning at the same speed as the motor, and weighs in at about 8 grams. Multiply that by 15, and it is the same as carrying a static weight of 120 grams - almost half your battery pack! Installing an aluminium pinion gear (which weighs about 3 grams) is the equivalent to removing about 75 grams from your chassis.

1.1.2. Spur Gear

Once again, there is not much that can be done to the spur gear on the TA03, besides converting it to the TA03 Pro 0.4 module. Before installing, or after a re-build, take a course brush (like an old nail brush) and clean all the teeth to remove any old bits of dirt and plastic and then lubricate with Tamiya Ceramic Grease. Make sure that the two bearings that the spur gear runs on are smooth, if not, clean or replace them (see chapter 6: Cleaning Bearings).

1.1.3. Lay Shaft

Here again, rotational mass comes into play. Replace the steel lay shaft with the aluminium version.

When building the gearbox, make sure that the casing is very clean especially then housings that hold the bearings in place. Install the complete lay shaft only and then screw down the end cover. Spin the shaft by hand. Nine times out of ten, it will encounter some resistance and not spin for a very long time. The problem is that the fitting is too tight and the shaft is pushed up against the very small bearing in the end cover. Remove the shaft, and then remove the gear from the shaft. With a smooth file, carefully remove about half a millimetre off the end (see diagram 1). Re-install and try again. The shaft should spin very freely now.

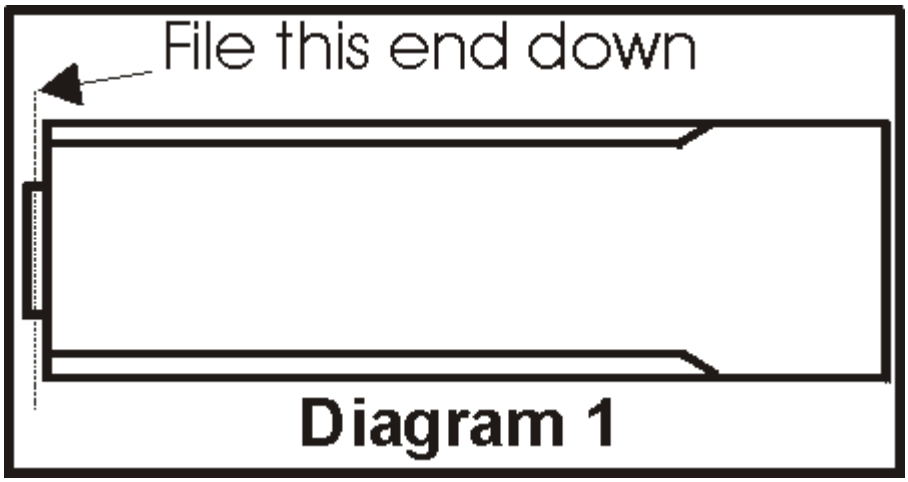


Diagram 1

1.1.4. Torque Splitter

If you are still learning to drive, then try to avoid this chapter. The torque splitter can make your TA03 a difficult beast to drive. Most drivers have tried the torque splitter, but give in and end up just leaving it in their toolbox. However, with a lot of practice and perseverance the torque splitter can vastly improve the speed and handling of your TA03.

The purpose of the torque splitter is to allow one of your axles (either front or rear) to spin freely when braking and is accomplished by a one-way bearing on the lay shaft. The reason this makes your car difficult to drive depends on which axle the torque splitter is installed.

Front Axle: With the torque splitter installed on your front axle, you only have rear breaks. This can take some getting used to. If you apply brakes while in a turn, the back of the car can spin out very easily, especially on slippery track surfaces. The trick here is to brake before the turn and then start accelerating as you enter the turn. Also, you need to make sure that your steering trim is set precisely to the centre i.e. when no steering is applied, your car MUST still drive in a straight line.

Rear Axle: This can be even more tricky to get used to, as it is not consistent, and depends on the speed of your car and the amount of brakes that are applied when taking a turn. As you brake, the centre of gravity of your car moves forward. Now since the front wheels are doing the braking, you might think this is a good thing, but, if you brake hard enough, you could end up with no weight on the rear axle, almost as if the rear wheels were in the air. Once again the rear end will slide out. The trick here is also to brake before the turn and then accelerate as you enter the turn.

Once you reach top speed with your car, the torque splitter reduces the strain on your drive train by allowing the axle where it is installed to rotate freely, while the motor is only driving the opposite axle. This can be further enhanced by a method called "Over Drive" which I will explain in the next section.

1.1.5. Over Drive

On a four-wheel-drive car, the front tires PULL the car, and the rear tires PUSH the car. If the front tires are pulling just as hard as the rear tires are pushing, the overdrive ratio is considered to be 1:1, and you have a neutral handling car. You can greatly effect the way your car handles by making one end of the car work harder than the other can. With the front wheels pulling the hardest, you almost have a front-wheel-drive car. It will be very stable, but with too much front wheel drive you won't be able to go as fast as other racers with properly set up cars. On the other hand, with the rear wheels pushing the hardest, you have a car more like a typical two-wheel-drive car. Get on the throttle too hard, and the car will try to spin out. You'll probably find that your car

will be a little more difficult to control, and again, you won't be able to go as fast as other racers with properly set up cars.
Over drive is only beneficial as long as you are using a torque splitter or one-way differential, without either of these you would just be creating a lot of drag on your drive train as each axle would be fighting the other.

Front over drive is where the front wheels are being driven faster than the rear. Your front tires having a larger diameter than the rear accomplish this, or by installing the smaller belt pulley on the front lay shaft. If you have the TA03F chassis, then your rollout calculations are applicable for the front tires. If, however, you have the TA03R chassis, then to calculate the rollout of your chassis you will need to multiply your final rollout by the ratio between your front and rear belt pulley. Be very careful with this as you could end up over-gearing your motor.

Rear over drive is where the rear wheels are being driven faster than the front, and is accomplished in the opposite way to front over drive.

So, what does this actually mean?

On acceleration, the axle with the higher over drive will start to accelerate the car. If the tires on this axle begin to slip, the one way bearing will lock up and start to drive the opposite axle as well, until the slipping stops. This will continue until the car stops accelerating. Once the car has reached it's optimum speed the motor will only be driving the axle with the higher over drive, while the other axle will be free to follow. This greatly reduces the drive train friction and thereby allows for a higher straight-line speed.

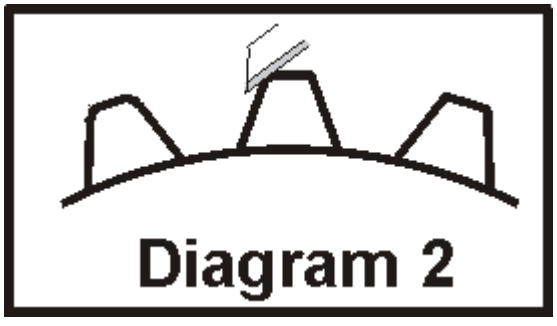
During cornering, the same characteristics apply as explained in the section on torque splitters. The only difference is that if you are using front over drive, the car will be pulled through the turn, thereby giving a much better turn-in and less understeer. Using rear over drive will induce more understeer.

The key to over drive is to experiment. Find the type of overdrive that best suits your driving style and then practice, practice, practice. Never try to experiment with overdrive during a race meeting, the characteristics of your car will change considerably, and will not allow you enough time to get used to it.

1.1.6. De-burring

This is a trick I learned during the last Nationals. Since most of the gears in the TA03 are moulded and not machined, they all posses a small amount of material on each tooth which gets in the way and creates friction in your drive train.

Remove all the larger plastic gears from your car and clean them properly. Using a sharp knife or blade, carefully scrape along the edge of each of the gears teeth to get rid of the sharp corners (see diagram 2). Be very careful to hold the blade perpendicular to the gear, you do not want to make a deep cut into any of the teeth. Once you have finished scraping both sides of all the gear teeth, use a course brush (like a nailbrush) and make sure that all shavings are removed from between the teeth. It could take a long time to do all the gears, but the effort is well worth it.



1.2. Differentials

There are three different types of differentials available for the TA03; each with it's own characteristics. I will discuss each one individually

1.2.1. Gear Differentials

These are the types that you get with the standard TA03. They are very smooth. Besides using different types of grease in the differential, there is not much you can do to tune them.

1.2.2. Ball Differentials

Ball differentials are a great tuning device for your TA03. Always ensure that they are smooth by being well-cleaned and lubricated with quality differential grease.
If you set them too tight, your car will loose a lot of speed during a turn and induce a lot of understeer. Run your front differential as loose as possible without it slipping under heavy acceleration and run your rear differential slightly tighter.

1.2.3. One-way Differentials

As with the torque splitter, the one way differential can get some getting used to, as it brings about the same characteristics as the torque splitter during braking. When no power is supplied, the wheels on either in of the differential are able to rotate very freely, but, when power is supplied, it's almost as if the axle becomes one solid bar and drives both wheels. This is the perception of most people, and the reason why they avoid it.

However, during cornering, the one-way differential does wonders to the handling of your TA03. Installing it in the front, creates a large amount of oversteer under acceleration, and the exact opposite, understeer, while coasting or braking. Installing it in the rear, has a similar effect to installing it in front, but not as aggressive.

If you can adjust your driving style accordingly, and turn down the dual rate on your radio, you can vastly improve on your lap times with a one-way differential. I personally reduced my average lap times by more that a second after installing a one-way differential (in the rear).

1.3. Drive Belt

Replace the standard drive belt with the Aramid Fibre version. Not only is it thinner, thereby reducing friction, but it will also not stretch after use and leaves less dirt build-up on the belt pulleys.

1.3.1. Belt Tension

The tension of your drive belt should be as loose as possible without slipping under hard acceleration or braking. Use the 16 tooth belt pulleys and remove the belt tensioner to reduce the drive train friction.

1.3.2. Belt Pulleys

Replace the standard plastic belt pulleys with the aluminium hop-up versions. They reduce the friction between the belt and the pulley and offer better grip, allowing you to run your belt a little looser than normal.

1.4. Drive Shafts

1.4.1. Dog Bones

The standard dog bone drive shafts that come with the TA03 can create a lot of friction in your drive train, especially when they start to wear out. If you must run your car with dog bones, try to set up your suspension in such a way that the dog bone is running as straight as possible from the differential out-drive to the wheel axle. Lubrication on the dog pins will reduce some of the friction, but will also collect a lot of dirt. The best lubrication is Tamiya Ceramic Grease, as most other kinds of lubricants will spin off. If you do use any type of lubrication on your dog bones, make sure that you clean them regularly, otherwise they will wear out very quickly.

1.4.2. Aluminium Dog Bones

Aluminium dog bones have the same shortfalls as the standard dog bones. The only benefit to using them is the reduced weight they have to offer. Remember, they are rotating at the same speed as the wheels, and therefore have the same effect as reducing three times their static weight from the chassis. I speak under correction, but I think they weight about 4 grams less than the standard dog bones each. So, it is the same as reducing the static weight of the chassis by 4 grams X 4 dog bones x 3 = 48 grams.

1.4.3. Universals

These offer much better efficiency that the dog bones, but are expensive. If you can only afford one set, use them in the front.

1.4.4. CVD

Constant Velocity Drives (CVD) offer the best efficiency available, but once again, are very expensive.

2. Suspension

2.1. Shocks

Your shocks should be as smooth as possible and have no air bubbles in the oil. When building your shocks, here are some tips:

- Put a little shock oil on the threaded end of the shaft before installing them into the shock body. That way you will minimise the risk of damaging the o-ring seals.

- If you are using the standard plastic shocks, drill a very small hole (about the diameter of a pin) in the shock cap, as close to the centre as possible. Make sure you remove any sharp edges from the inside after doing this, as it could make a hole in the shock bladder. This little modification will allow your shocks to breath easier and move a little more freely.

- Pull the shaft all the way through until it stops, then fill the body with shock oil until just below the top of the shock body. Slowly move the shaft up again until just below the level of the oil and then pull it down slowly again. You will notice some air bubbles coming up from beneath the shock piston. Let the shock stand for a few minutes until the bubbles have disappeared. Repeat this process until no more bubbles appear. Every now and then, you may have to top up the shock oil. Take your time and be patient. Allow the oil enough time to get rid of any air bubbles.

- Once there are no more air bubbles in the shock oil, you are ready to put them back together. Move the shaft and piston about three quarters of the way up the shock body, and then put the bladder on top of the oil. While holding the bladder in place, slowly pull the shaft back down, creating a suction effect, which will seat the bladder in position. Now screw the cap back onto the body.

- When screwing on the bottom ball cup, gently hold the shock shaft with a piece of cloth wrapped around the jaws of a pair of pliers. Be very careful not to scratch the shock shaft.

2.2. Caster Angle

The caster angle is not adjustable on the TA03. For better turn-in, replace the standard caster block on the front suspension with the TA02 caster block. This reduces the caster angle from 8° to 3°.

2.3. Camber Angle

If you are running on rubber tires, then the standard set-up is ideal. There is no real need for turnbuckles. However, if you are running on foam tires, you need to take tire wear into consideration so you will need a set of turnbuckles. The ideal camber angle for the TA03 is 2° negative.

If you do not have a camber gauge, then try this:

- With a piece of chalk, draw about 6 lines across the tire.

- Run the car around the track for a lap or two.

- Check the chalk lines on your tires as these will give a good indication as to how evenly your tires are wearing. Adjust your camber accordingly.

2.4. Toe Angle

The toe angle depends on the track type and you're driving style. The general rules are as follows:

- Toe-in is good for straight-line stability, but reduces turn-in.
- Toe-out improves turn-in but reduces straight-line stability.

Never adjust your toe angle to more than 2° either way. All you will do is create extra drag, as the tires will start to scrub.

3. Chassis

3.1. Types

There are three basic types of chassis available for the TA03, namely the tub chassis, the Fibre Reinforced Plastic (FRP) and the carbon fibre chassis. I will explain each individually.

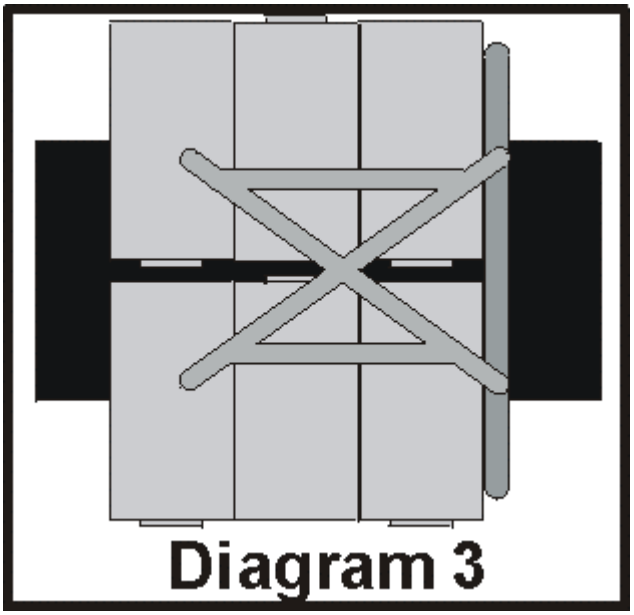
- The standard **tub chassis** for the TA03 is very strong and can stand up to a lot of beatings. However, it is also very heavy, and does not allow much in the way of component layout configuration for better weight distribution.
- The **FRP chassis** is also very strong and slightly lighter that the tub chassis. It offers a little more in that it is flat and can therefore allow you to move components around.
- The **carbon fibre chassis** is the same as the FRP chassis except that it is a lot lighter and stronger.

3.2. Component Location

3.2.1. Battery Pack

The battery pack is the heaviest component on your car; so it's location plays an important roll in the weight distribution of your chassis. Try to mount it in a more forward position for better cornering.

If you have the TA03F FRP or carbon fibre chassis, assemble your battery pack as a saddle pack, then use a strong tape and tape the two halves together. Remove the front battery-mounting bracket. Slide the battery pack beneath the existing battery bracket and tape it into place. This reduces the amount of weight off the centerline of your chassis and therefore reduces chassis roll when taking a turn (see diagram 3).



3.2.2. Steering Servo

Avoid using servo tape to mount your steering servo. It may not come loose, but the servo tape does allow it to flex slightly under load, leading to inconsistent steering.

3.2.3. Speed Control Mounting

Your speed control is not the lightest component on your chassis. Try to mount it as low as possible while keeping the power cables as short as possible.

3.2.4. Receiver Mounting

If you are using the TA03F chassis, remove the excess material from the front of the rear gearbox. This creates an ideal position for your receiver. Always try to mount your receiver as far away from your motor and speed control as these can cause interference.

4. Electrics

4.1. Batteries

When building your battery packs, keep the following in mind:

- Try to use good quality solder as this can rob your batteries of power by creating extra resistance.
- Solder the connectors, as close to the cell as possible, the less solder between these joints, the less resistance there will be.
- Use a hot soldering iron, and try not to keep it in contact with the battery for extended periods of time as excessive heat can destroy the cells.

4.1.1. Charging

I am not going to go into detail about how to charge your batteries; there are plenty of articles that already do this. What I will mention however, is different charging rates and peaking.
As a general rule, the higher the charge rate the more punch your batteries will give at the sacrifice of run time. The opposite applies; a lower charge rate will offer a slight improvement in run time at the loss of punch. Depending on the rating of your cells, never exceed more than 5 amps when charging.

A charged battery pack will loose about 1% of its charge over a period of 24 hours. For this reason, to get the most out of your battery pack, try to peak it again about 10 minutes before you race. Not only does this improve run time, but it heats the cells slightly, thereby lowering the internal resistance and offering more of a punch off the line.

If you do not have a peak detection charger, connect a voltmeter in parallel with your battery pack and charger while charging. Monitor the voltage as the pack is charging. You will notice that it will increase as the cells are charged, stay stable for a few seconds and then start to decrease. Once the voltage has decreased by about 0.05 volts, the pack is fully charged. Obviously, this is assuming that your pack is in a good condition and your cells are reasonable matched.

4.1.2. Discharging

Never drive your car until it comes to a dead stop. Different cells in your pack will discharge at different rates. You could reach the dangerous position where one cell is completely flat, so the others try to charge it again - in the reverse direction!

Rather pull your car off the track when you notice that it has started to slow down, then use a set of light bulbs or discharge tray to discharge them down to about 5.4 volts (about 0.9 volts per cell).

4.2. Speed Controls

If you have the basic speed control that has two red wires and two black wires going into the casing, here is a tip to reduce the overall resistance of your wiring.

The positive wire going into your speed control from the battery is merely there to supply power to the speed control. If you look at the circuit board inside your speed control your will notice that the two red wires are actually connected. Rather remove these two wires from the speed control and replace them with one thinner wire. Connect a positive lead directly from the battery to the motor, at a convenient

location, remove some of the insulation and solder the thinner wire coming out of the speed control there.
Think of the power wires going from your battery, through the speed control to the motor as a water pipe. The more kinks and twists in the wire the more resistance it will offer. Try to keep your wires as straight as possible.

4.3. Receiver

When mounting your speed control, try to mount it as close to the antennae shaft as possible. Avoid mounting the receiver in such a way that the antennae wire can rub against the chassis, not only will the insulation wear through with time, but the vibration of the chassis can cause interference.

4.4. Motor

4.4.1. Cleaning

- The first thing you need to do is remove your motor from the vehicle. Now remove the brush springs and take the motor brushes out from under the brush hoods.

- Using a high-quality motor cleaner insert the spray tube into the endbell and spray for about 2 to 3 seconds or until the fluid coming out of the motor is clear. Be sure to spray either bushings or bearings at the ends of the motor. If the motor brushes are still attached to the motor be sure not to get any motor cleaner on the brushes.

- Install a pinion gear on to the motor shaft. Insert a comm stick into one of the brush hoods and turn the motor about 10 or 20 revolutions until the comm is nice and shiny. Now spray the motor again to get rid of any comm or comm stick material that might be in the motor.

- Determine whether or not you're going to replace your brushes or motor springs. Both springs should look identical when placed side by side. The brushes should be replaced if they look damaged, worn, or show signs of bad discoloration from heat. If you decide not to replace the brushes clean the brush faces with your comm stick.

- Reinstall the brushes and springs and add one drop of oil to each bushing or bearing at the ends of the motor. Be sure to use a bearing or bushing specific oil and use one drop only. Bearing oils are thinner than bushing oils. That's it. You're all done and your motor is back in shape.

4.4.2. Installing and Gear Mesh

When installing your motor, use the asbestos disk that came with the kit. I have melted quite a few gearbox casings by not doing so.
The spur gear of the TA03 is moulded and therefore not 100% round. When checking for the correct gear mesh, rotate the transmission and check the gear mesh around the full circumference of the spur. For the ideal gear mesh, place a piece of paper between the pinion and spur when tightening up. Remove the paper afterwards.

4.4.3. Brushes and Springs

Always replace your brushes after truing your comm.

4.4.3.1. Full Face Brushes

With the maximum surface of the brush touching the comm this brush will definitive give us maximum punch out of the corner, but also maximum current flow! Due to the full contact we can not expect an increase in rpm.
This brush is not advisable to be used in combination with soft (90-115) springs, as brush bounce and sticking brushes can occur very easy. If RPM or efficiency is needed, rather change to cut brushes.

4.4.3.2. Cut Brushes

A cut brush is a narrowed full-face brush, with the sides narrowed to a maximum of 50%. Some manufacturers shave 25% of each side; this is done to stabilise the brush on the comm as the springs apply pressure to the middle.
Each percentage you shave of the sides, to a max. of 50%, will increase the rpm and decrease the current flow and acceleration. The trick is to shave of as much as possible without losing too much punch. For Touring cars and off-road it is advisable not to shave off more than 20%, as this will overheat the brush and comm.
In most situations the 135-150 spring will work the best, use only the 150 in combination with a max 20% shaved brush. The brush shaved 10% will help drivers with a very punchy driving style who do not have the ability to save energy.

4.4.3.3. Serrated brushes

This is the latest revolution in brush technology. The added lines (serration's) on the brush face increase the run in sequence as well as the efficiency. The big advantage is that no running in is required at all, which decreases the chance on having a "slow" motor. This brush is always the safest bet for the start.
Medium (135-150) springs are again the best choice, if you are an aggressive driver or need a little more efficiency or top speed, use 135.

4.4.3.4. Timed Brushes

A timed brush has been cut in a way to increase the timing. This has been done to increase the rpm and power in motors where you can not change the endbell timing, like stock motors. The brush has to be placed in the brush holder with the non-cut part in the direction of the timing of that particular motor. Especially care has to be taken to slide the brushes at both sides the same way in the brush holder.
Medium springs will work well; a 150 spring may be used when high silver content brushes are being used to avoid brush bounce and arcing.
Hard springs will work fine to increase punch, but a big loss of rpm will occur!

As a general rule, lighter springs produce higher RPM, while stronger springs produce more torque. For higher RPM, try to run a lighter spring on the negative side of your motor than on the positive.

5. Driving

5.1. Tips

If you see a bunch of kids out playing basketball, the kid with the $150 basketball shoes probably isn't the one who's doing the best - it's more likely some kid with old worn-out shoes. You can't "buy" success, you've got to work at it - and the name of the game is PRACTICE. There's no substitute. You can buy "speed", "horsepower", and all the rest, but you can't buy better lap times - those, you've got to earn. OK, enough of this, here's some tips on how to do just that…

The most important single thing I can think of, is to be SMOOTH. Never yank on the throttle - gently pull on it. Ditto for the brakes - when you apply them do it smoothly, both getting ON the brakes, and when you're getting off them. You can spend hundreds of dollars on speed controls and high-tech radios that do this for you, but the truth is that all the control you need is in your trigger finger. The same thing applies to the steering - never twist the wheel violently one way or the other - try you're hardest to turn it smoothly, both going into a turn and coming out of the turn. I know this is easier said than done, as everyone in a race is too busy trying to go fast to worry about stupid stuff like being smooth, but believe it or not, the ONLY way to get fast is to get SMOOTH first. Don't believe this if you don't want to, but if you don't, cut this paragraph out and show it to anyone who is really good, and I'll bet you that every single one of them will tell you it's true.

How do you know if you're driving smoothly? Next time you go out to race or practice, have someone time you for four or five minutes then compare your lap times. If your lap times vary from fast, to slow, to maybe fast again, then slow, then slow, then fast… you need more practice. On the other hand, if your lap times are consistent, lap after lap, you're on the right track. First get smooth and consistent, and only then try to go faster.

Next tip: don't use full throttle all the time. There are two reasons for this. First of all, when you're in a turn, there is an optimum speed for taking the turn. If you give your car more throttle than you should, you will actually be slower going around the turn. "Roll the throttle", going around the turn smoothly. The only way to learn this is by practice. Again, when you're coming out of the turn and you want to apply more power, do it smoothly. The second reason for this is that it's more efficient. Giving your car more throttle than it can use for any given part of the track just wastes batteries and tires. If you haven't yet learned how to do this, all I can say is just keep practising at it. If you find your car staying on the proper "racing line" (one more thing you have to learn), you're probably doing things pretty well. If you're going faster than you should, or you're giving your car too much throttle, you'll go wide in the turns. Not only is this a longer way around the turn, which means you'll be slower, but you'll be on a part of the track that isn't where everyone wants to be driving, and therefore will be dirtier than the rest of the track. This means your tires will get dirty, so you'll have less traction for a while until the dirt wears off the tires. With dirty tires and less traction, you have to go even slower than usual, until the tires are back to the way they should be.

Tip: the start of the race is probably the most critical part. Everyone wants to be first to the first turn, consequently all the cars try to occupy the same piece of real estate at the same time, and voila, there's that famous multi-car pileup that everyone expects. It's great fun for spectators, but much less fun if you're a part of it. When the race starts, drive off smoothly - if you try to accelerate too quickly, you'll just spin out. With practice, you can learn how quickly you can take off at the start. Next, don't drive like you have to be on the right line - if everyone else is bunched up, you might be better off to take a slightly different line keeping you out of the pack of cars. Stay close, but if they start to trash each other, be prepared to go around the wreck, not plow right into it. Remember this: you can NOT win the race in the first few seconds, but you definitely can LOSE it then and there. The name of the game is "defensive driving" as much as anything else - and it's better to come out of that first turn in third or fourth position, chasing after the lead car, than for you and the lead car to crash fighting for the lead, letting everyone else go on by. If you are in the lead, be especially careful that the guy behind you doesn't take you out this way. If it looks like he's going to run into you, try to move a little so he can't hit you. Once you get through the first couple of turns, the race usually sorts itself out and you can get on with trying to do well, but survival should be your instinct for the start of the race.

By the way, if your heart is beating so hard you think it will bust, your hands are so nervous that they're shaking uncontrollably, and you find it hard to breath, everyone else probably feels the same way. It's hard to relax in a situation like this, but try to remember this is supposed to be fun, and enjoyable. A week from now it won't make any difference how you did. Breath hard before the race, relax, and maybe think of your favourite something-or-other.

Tip: electric racers can ignore all the junk people tell you about how you have to walk your car over to the starting line, leave it "off" until just before the race starts, then have a buddy turn it on. If you've made it to the A-Main at a National, maybe that's true, but for a club race, forget it. What I do, is to walk over to the driver's stand, put the car on the track, then go up to the stand, then drive the car over to the starting line.

When the event starts, some people I've known put all their "common sense" away, and go out and RACE. Naturally, they go as fast as they can. Usually, within a minute or so, they've had at least one crash, if not two or more. You can NEVER make up what you lose in a crash.

Have patience during a race, and try not to do anything that will put you out of the race in a crash. Backing off and letting someone by is better than both of you crashing. Besides, it's easier to follow another car than it is to lead the other car - chances are, if someone does pass you, if you follow close enough and long enough, the other car will try to go even faster, and either mess up in a turn, or crash. Crashes are almost always your fault, no matter what happened. Every so often you'll get into a wreck where you had no chance, but 99.9% of the time, if you crash it's YOUR fault no matter who did what. Even if the other car did something stupid, it's still your fault for being in a spot where this could happen to you. There are things you can do to minimise the chances of getting into a wreck. For starters, don't pass on the outside of another car. Always try to pass on the inside. If you're going down the straightaway with another car, try to position yourself so you'll be on the inside for the next turn coming up, which will give you the line and force the other car to back off or go wide.

If you do crash, and your car is sitting in the middle of the track upside down, don't keep it a secret. This is especially so in gas races, where the cars are going so fast they're hard to control. Yell out that your car is dead in the straightaway, or the sweeper, or wherever, and yell it LOUD. The other racers presumably would like to avoid hitting your car, if for no other reason just so their car doesn't get damaged while driving through yours. Don't assume they'll see your car - they won't. Yell out loud, and yell loud enough so everyone on the driver's stand can hear you. Doing this means your car might be marshalled, and you'll be able to continue on with the race. Not doing so means there's a good chance your car will be damaged or destroyed when it's smashed into by an oncoming car.

If you're following another car, don't drive directly behind it, but instead try to be a little off to one side or the other. Don't get into a spot where if the other car messes up and hits a board, you're going to crash right into the other car. If you have enough confidence in your ability not to hit the other car, drive as closely to it as you can. Most of the time, the other driver will get rattled, and do something silly, letting you by. Don't hit the other car … and if you do hit it, causing it to wreck, pull off to the side, let the guy back in front of you, and then do it all over again, but cleanly this time. (We're all doing this because it's fun… nothing will make another driver angrier at you than you taking him out, and nothing will alleviate the situation better than you pulling off to the side, letting him back in front of you, and then doing it right. It's good sportsmanship, and people will respect you for it.)

If you find yourself in the middle of a pack of cars, be especially careful not to get taken out in a multi-car wreck. You may lose a few tenths of a second if you back off a little, but you'll lose much more than that if you find yourself in a wreck with all the cars.

One of your most important goals during a race should be to avoid crashes. Not only can a crash put you completely out of the race right then and there, but even if you don't break down, chances are your car won't work as well after a crash as it did before. Even if you lose a few tenths of a second slowing down, going wide, or whatever it takes to avoid an "incident", that's nothing compared to what you'll probably lose if you do hit something. Rule #1: don't crash. Rule #2: see rule #1.

Final tip - if you're a Mike Blackstock or a Josh Cyrul or a Joel Johnson, you can take turns time after time with your car ¼" away from the turn marker, and get away with it. If you're good enough to do so, that's the fastest way around the track. Unfortunately, most of us are nowhere near that good. So, give

yourself some room on the track. Don't cut the turns too close - if you cut the corners too close, chances are that one of the times you're going to be too close and hit something, possibly ending your race right then. If you're relatively new to R/C car racing, ignore this advice and always drive in the middle of the track. If you're in the middle of the track, you're as far away from boards as possible, so you're least likely to hit them.

The above information may help you drive better. Driving better is good, but it's only part of the picture. If your car is set up properly, it's easier to drive better. If your car is set up wrong, it's hard, even for a good driver, to drive the car well. The problem for beginners is they don't know how the car should work, so they have no way of knowing when it's not working. If you're not sure how to set up your car, or if it's working right, let someone who seems to know what they're doing try it out. Find out what changes they think you need to make, and more importantly, WHY they feel that way. The more you learn this, the better you'll be at setting up and adjusting your car for different tracks you race at.

5.2. Overtaking Manoeuvres

Going fast is one thing, but being fast and being able to race closely with others without taking them or yourself out of the race is an entirely different matter. For years I've seen racers come up through the ranks, gaining speed all the way. But the one thing that most of these 'young guns' lack is the ability to actually race, and not just put in fast lap times. So when it's crunch time, and these racers are put out on the same track with drivers of equal speed, carnage is often the result because few if any of them actually understand the concept of really 'banging doors' with other cars without actually crashing. Part of becoming a well-rounded racer not merely a fast one is learning how to drive in traffic. This might include drivers who are as fast as you, faster, or painfully slower. It takes skill to drive with and get past all three types of driver. Reading this article will hopefully teach all of us how to get past other cars without putting yourself or fellow competitors out of the race.

5.2.1. LOOKING AHEAD: THE FIRST STEP.

In order to successfully pass another car (or cars), you will need to develop keen peripheral, or side vision, i.e. the ability to sufficiently widen your line of sight to include not only your own car, but the track both in front and behind it. It's not really that hard to do, but like any skill worth learning, building peripheral vision takes practice and patience. The best way I've found to increase side-vision is to practice by following another car that's just a few meters in front of mine. The trick here is to, of course, remain focused on your car, but also keep the other car within your line of sight. By practising this, you will develop the ability to "scan" ahead to judge the space between your car and those in front of you, as well as to see any crashes that may lie ahead so you can avoid them. This also works in the opposite direction. Practice by keeping a car that's a few meters behind you in your line of sight. The reason peripheral vision is important is that it's an essential tool if you are going to be able to successfully pass another car. You need to see the other car and where it is on the track in order to formulate your passing strategy.

5.2.2. THE SHADOW KNOWS.

The next skill you should learn is that of 'shadowing' or driving extremely close to another car without touching it. Although you must remain focused on your car as well as the one you are shadowing, good peripheral vision also helps here because it allows you to judge both cars position on the track. This exercise is also great fun, as the aim is to turn as many laps as you can while driving as close as possible to the other car without bumping. When you are racing against very good drivers, who can stay clean in heavy traffic, racing becomes much more close and exciting. It's no fun at all racing against other drivers who will punt you off the track whenever you get close to them. And because passing often involves getting very close to the other car, becoming comfortable in such close proximity will help you.

5.2.3. SPYING AN OPENING.

Now that you've developed keen peripheral vision and you are comfortable in traffic, it's time to learn some racing strategy. Before you can make a pass, you have to learn to identify where and when to 'go for it'. In other words, you need to spot an opening to make your move. In almost all cases, passing will take place while you and your intended victim are cornering. Since corners are usually the slowest sections of the track, and the places where good lines always pay off, it's here where you should concentrate in making your moves. Good passes can occur at any one of the corner's three points: these are the entry, the apex (middle), and the exit. Your chances of making a clean pass are usually better during the entry and apex, as trying to pass on the exit, when both cars are accelerating, is often the most dangerous. To get by your opponent, and to make the pass stick, you'll need to call your peripheral vision into play. When you know that you're close enough to try for a pass, you'll need to look slightly ahead of your car to see the other driver's line into the corner. If he's towards the outside of the turn, your opening to get by will be toward the inside. If he's hugging the inside change your line toward the outside of the turn. The point here is to try to take advantage of any gap between your opponent and the track borders that are as close to the 'fast' driving line as possible. You don't want to drive way out into the boonies to make a pass, as you'll no doubt lose valuable time (and may even get passed yourself). The following is an explanation of some typical passing techniques.

5.2.4. THE INSIDE BLOCK PASS.

This is when you pass the other car by going to the inside of the turn and basically stealing his line. In order for this pass to work cleanly, several conditions must be in met. First, you must be very close (almost dead even) with the car you intend to pass. Secondly, the car you intend to pass must be toward the middle or outside of the turn. Lastly, the other driver should be courteous enough to give up his line once you've occupied it (if not, you'll both get tangled up). The trick to this type of pass is to quickly occupy the space that your opponent was planning on using. To get by the other car, you'll need to enter the turn "hot" i.e., faster than you normally would, and use the brakes to slow the car so that you don't overshoot the turn (you can also slide your car to slow it down). Essentially, you be out-braking the other guy. Once you commit to the pass, you'll need to protect your line to prevent the other car from passing you back. Just stay as close to the inside of the turn as you can, and the other car will be forced to drive a longer line in order to get back around you which he shouldn't be able to do if you executed the pass properly.

5.2.5. THE OUTSIDE/ INSIDE MOVE.

This is the racing equivalent to a head-fake in basketball. As its name suggests, this is a pass in which your car enters towards the middle or the outside (depending on where the other car is), leading your opponent to believe that you're taking the outside line. Instead, as your car approaches the middle of the turn, you suddenly square your line and head out of the turn toward the inside, hopefully driving past the other car towards the inside of the turn. This type of pass usually works best when the turn exits onto a fast section of the track such as a straightaway. This helps makes your pass stick because, if done properly, a good outside-inside pass will give you car greater speed when exiting the turn.

5.2.6. THE OLD INSIDE OUTSIDE PATH.

This uses the technique of late-apex-ing (also known as the middle of the turn). To allow you to slide by your opponent while simultaneously blocking his path out of the turn. To make this type of pass, you must enter the turn while sticking to the inside as closely as possible. Once you've reached the turn's apex and are ready to accelerate out of the turn, let your car drift wide. Under most circumstances, this drift will carry you right in front of your opponent, blocking his line. He will either have to hit you or back off. If you've done this manoeuvre cleanly and properly, it's a perfectly legal and clean move.

5.2.7. THE PLAIN OLD 'BLOW HIS DOOR OFF' MOVE.

As it's name suggests, this type of pass can only occur when you either have much more straightaway speed than your opponent (rare nowadays) or if you are able to carry much greater speed out of the corner preceding the straightaway. This, by the way, is one of the few types of passing techniques that doesn't involve cornering. Unlike passing, which takes place during cornering, passing another car on the straight is best done with as much space between your car and the other car as possible. Because straights are the fastest area of a track, any contact between cars can cause dramatic accidents (barrel rolls in particular). Always give the other guy a wide berth when making a straightaway pass.

Above all else, be courteous. Remember that no matter what, racing is a game- you're supposed to be having fun out there! If you think you are faster than someone, make the effort to pass them cleanly. Too many people choose instead to bully their way past other cars. These people take some of the fun out of racing because to the rest of us, driving a clean race is nearly as satisfying as winning. Whenever I'm in a close battle with someone and they get by me cleanly, I almost always will think to myself-nice pass, man! If every person drives with respect and courtesy, racing will become even more fun.

6. Cleaning Bearings

I left this as a separate section as most racers don't clean their bearings properly. They let them first have a huge built up of dirt or mud and then just spray them with air. No wonder bearings are the No1 spare on sales. Firstly, don't let your bearings have a dirt build up.

- Hold them by the sides and see if can rotate freely (avoid touching the surface, that could result of dirt infiltrating the seals). If not read the next section. If yes, then here a few quick and effective tips. Get a hold on a very thin screwdriver. Then, gently in circular motion scrape the dirt out between the outer and inner ring.

- When the most of the dirt is out, take a semi hard thin brush and clean by moving the brush from the inner ring to the outer (from centre to edge). Avoid pushing the brush down. Do it that way because if not done carefully you could "push" the dirt on the inner ring and it could go inside the balls. Lastly, put a damp paper napkin or kitchen paper towel on a flat surface and by holding the sides, rotate the bearing. Gently push the towel onto the inner ring section with your fingers. That takes the dirt from the inner bearing axle. Do it gently!

- It may seem as a long process but believe me you can have a very clean ball bearing in about 2 minutes. Also in that way you don't have dirt built up, dirt doesn't infiltrate into the bearing and you don't have to clean it. What happens if the bearing doesn't move freely? Well you're screwed! Just joking. That means that unfortunately dirt has infiltrate inside the bearing and you have to open it. If you don't then dirt will rapidly wear off the balls and the bearing will fail.

- From there on you must replace it a.s.a.p. Not to mention that a failed bearing will cause excessive wear on the axles, make your car behaving strangely and could even result in bigger damage. So before you start buying new spares, replace your bb or clean them properly.

- If your bb is Teflon sealed them you probably have to replace them anyway. Nothing you can do about that. If they are standard sealed, then with a pin or a thin screwdriver take off the safety pins. Then remove the seals on both sides. Dip them on a shallow container filled with methanol, alcohol or fuel (not as effective) until covered. Leave them for 2-4 minutes (sounds like a cooking recipe). Then rotate the inside cup. If you feel resistance, move it back and forth. Do it until all the dirt is out the bearing and inside the container. Place the bearing on a suitable axle and rotate them quickly by turning the sides. Dip and rotate, dip and rotate (you must have already see that the bb turns freely before you do this!). Do that until the bb turns and you don't feel the slightest resistance or funny sound (like a scratching). Putting the bb on the axle and turning it it's a great way of removing dust. The particles that are inside the balls with the balls are "loosened" and "grabbed" by the methanol and by turning the centrifugal sends them away from the bb!

- Finally, put ball bearing grease (only that kind of grease!) on the one side, seal it, put on the other and seal that too. Don't overfill cause grease will leak to the seal's surface and surely "collect" dirt while running. That procedure can take 10-12 minutes. Decide 12 minutes loss or a new set of bb? If you have a lot of money then why bother, just replace them.

- Spraying the bb is a suicide. Dirt that is not yet infiltrated will be in that way. Besides the dirt from the inside just resides on the seal's inner surface, it doesn't go away.

- If with the above method, your bb refuses to turn or it makes really funny sounds then replacing them is inevitable.

Well there you have it. By following that guide I guarantee that it'll take a long time until you buy a bb again. Ok in very harsh racing conditions you can have losses but there is no reason spending money for 10 minutes worth of your time.

7. Roll-Out Chart

Here is a simple rollout chart for the two different types of gear pitch.

48 Pitch

	Pinion Gear									
Tyre Diameter	16	17	18	19	20	21	22	23	24	25
58	22.95	24.48	26.01	27.54	29.07	30.60	32.13	33.66	35.19	36.72
59	23.35	24.9	26.46	28.02	29.57	31.13	32.69	34.24	35.80	37.36
60	23.74	25.32	26.91	28.49	30.07	31.66	33.24	34.82	36.41	37.99
61	24.14	25.75	27.36	28.97	30.57	32.18	33.79	35.40	37.01	38.62
62	24.53	26.17	27.80	29.44	31.08	32.71	34.35	35.98	37.62	39.26
63	24.93	26.59	28.25	29.91	31.58	33.24	34.90	36.56	38.23	39.89
64	25.32	27.01	28.70	30.39	32.08	33.77	35.46	37.14	38.83	40.52
65	25.72	27.43	29.15	30.86	32.58	34.29	36.01	37.72	39.44	41.15
66	26.12	27.86	29.60	31.34	33.08	34.82	36.56	38.31	40.05	41.79
67	26.51	28.28	30.05	31.81	33.58	35.35	37.12	38.89	40.65	42.42

64 Pitch

	Pinion Gear									
Tyre Diameter	24	25	26	27	28	29	30	31	32	33
58	24.01	25.05	26.10	27.14	28.19	29.23	30.27	31.32	32.36	33.41
59	24.42	25.49	26.55	27.61	28.67	29.73	30.80	31.86	32.92	33.98
60	24.84	25.92	27.00	28.08	29.16	30.24	31.32	32.40	33.48	34.56
61	25.25	26.35	27.45	28.55	29.64	30.74	31.84	32.94	34.04	35.14
62	25.67	26.78	27.90	29.01	30.13	31.25	32.36	33.48	34.60	35.71
63	26.08	27.21	28.35	29.48	30.62	31.75	32.89	34.02	35.15	36.29
64	26.49	27.65	28.80	29.95	31.10	32.26	33.41	34.56	35.71	36.86
65	26.91	28.08	29.25	30.42	31.59	32.76	33.93	35.10	36.27	37.44
66	27.32	28.51	29.70	30.89	32.08	33.26	34.45	35.64	36.83	38.02
67	27.74	28.94	30.15	31.36	32.56	33.77	34.97	36.18	37.39	38.59