R/C Handbook

by Scott Guyatt

About *R/C Handbook*

This material first appeared as a printed booklet by Scott Guyatt of Heavy's Hobby Shop, Australia. It was written "to help local kids avoid all the pitfalls we didn't manage to" over eleven years of racing off-road buggies. It proved effective, so he decided to publish it on the web, calling it *Oz-R/C Online, Building & Setting Up Your R/C Car.* Associated came across the material and entered into an agreement with Scott to incorporate it into this site. Associated modified the pages of Scott's web site to update it with today's technology and to relate it directly to the concerns of Associated kit owners. With this e-Book, we've updated it a little more.

Have you ever wondered just how the pros always get their cars set up perfectly, choose the right tires, and have just the right motor in their car? Here's the answer: they've practiced and practiced and practiced. We've done that too — practiced and practiced and practiced. Over the last eleven years of racing R/C cars we've learned a thing or two about exactly how to go about setting up the car.

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Introduction

R/C Handbook is designed to help you set up, maintain, and drive electric radio controlled off-road buggies. It can take you many years to learn the intricacies of building and setting up R/C cars.

The most important word in learning about car setup is *compromise.* Altering one part of your car will always affect another. You will often make compromises between two conflicting requirements. The second most important word is *practice.* The best way to learn is to alter your car, drive it, alter it again, drive it again, and so on. This e-Book is not designed to take the place of practice or experimentation, nor should it be considered to be infallible.

I have been racing off-road buggies for over ten years and have achieved much both on and off the track within the sport in Queensland. I have collected some knowledge of car preparation and setup during that period. During my R/C career, I have raced in all classes, with cars from such diverse manufacturers as Kyosho, Marui, Mugen, Schumacher, Tamiya, Team Associated, Team Losi, Traxxas, Yokomo, etc. I have used electrical gear (including speed controllers, radios, motors, and batteries) from just about every major manufacturer. It is this knowledge that I hope to pass on to you.

Heavy's Hobbies is Queensland's premier R/C car specialist retailer. Heavy's has been in business since 1994 and proved to be an invaluable source of products, advice, and assistance to Queensland's R/C racers.

We take this opportunity to wish you all the very best in your R/C racing. Remember above all that we're here for fun. Race hard, but race clean, and walk off the driver's stand with a smile on your face. We'll see you at the track.

—*Scott Guyatt*

Glossary of Terms

Following is a brief listing of R/C terms you may come across in your instruction manual or on the track.

Anti-roll Bar
An anti-roll bar is a wire device fitted to the car which limits, or prevents, the car's body from "rolling" from side to side through corners.

Anti-squat
See also *Caster.* Anti-squat is generally used on the rear suspension of the car and refers to the angle of the rear suspension arm hinge pins in relation to the chassis.

Camber
Camber refers to the angle of a wheel in relation to the vertical (perpendicular). Negative camber means that the top of the wheel leans in towards the center of the car. With positive camber, the top of the wheel leans out, away from the center of the car

Caster
Caster refers to the angle which the kingpin leans back from the front of the car in relation to the vertical. It is measured in degrees. A kingpin may be either a solid pin, or imaginary line through the center of the steering block. A typical caster angle for a two-wheel drive buggy or truck is 25°. A four-wheel drive buggy may vary from 5° to 20°.

Droop
To put in simply, droop refers to the amount your suspension arms hang down. More droop means more hang.

Piston
A piston is a crucial part of the internal mechanism of a shock absorber. A piston is mounted on the shock shaft and is typically a thin plastic disc with a number of holes drilled in it. Changing a piston for one with either larger, or smaller holes or a different number of holes can have a dramatic effect on the performance of the shock absorber.

Ride Height
Ride height refers to the distance between the ground and the bottom of your car's chassis when it is at rest. To check ride height, work your car's suspension up and down a few times, then drop it onto a flat surface from a height of about 3 to 10 inches. Some manufacturers will give you a reference point for checking ride height, e.g., Rear suspension arms level, or Drive shafts level. This helps you compare your ride height settings repeatedly.

Shock Absorbers & Springs
The shocks, shock absorbers, or dampeners are silicone oil filled cylinders used to slow the motion of the springs supporting the car's suspension. Shock absorbers can generally be adjusted by either altering the internal configuration (see *Piston*) or by using oil of differing viscosity (or thickness).

Sway Bar
See (Anti-roll Bar)

Toe
Toe is the angle of the wheels in relation to the centerline of the chassis. With toe-in, the wheels point inward. With toe-out the wheels point outward. You can check Toe by placing a ruler against each wheel on the outside. If the ruler points inward, that's Toe-In.

Wheelbase
Wheelbase is the distance between the front and rear axles of your car.

Setting Up Your Car

Learning to tune your car is about practice. There are, however, some basic ground rules, which we can lay down to help you when you go to practice or tune your car.

Basic Setup
Try to develop for yourself a stock, or basic, setup. These are the settings you should use every time you go to a new track, or any time the conditions at your track are much different from normal (e.g. new dirt, new track layout, etc). In most cases, your standard setup should be the kit settings. Associated provides standard setups for many of its kits.

Be An Individual
It's good to share setup information with others, particularly if they're using the same equipment as you. It's important to recognize, however, that each individual drives a little differently, and prefers a different balance to their car. Once you've reached a ballpark setup (usually tires, shocks, and springs), do the fine tuning on your own. Don't worry if you're not using exactly the same settings as the guy next to you; you're just as likely to be right as he is.

Write it down. Get a notebook to take with you to the track. When you change your car, make a note of what you changed, what affect the change had, and the track conditions at the time of the change. Soon you'll build up a database of information about what tuning adjustments do to your car's handling. Many manufacturers now produce blank setup sheets for their cars. These setup sheets let you mark all your settings in a simple, easy-to-understand manner. Grab a blank sheet, make some photocopies, and keep them in a folder in your track box. After each race day make a note of what settings you ended up using and what the track conditions were like.

Don't be afraid to ask. Never fear asking for help. If you've got some difficulty adapting your car to strange conditions, and you're just not sure how to change it, ask. Top racers are happy to help those less experienced than themselves — until you start beating them! Look around for someone whose car is running hot and ask him for some advice.

Change one thing at a time. If you changed tires and suspension settings, how will you know which cured your steering problem? If you raised your ride height and added a stiffer spring, how will you know which cured your jumping problem? My advice is to always make one change at a time, then try the car. If it doesn't work, change it back and try something else. This is the most effective way to track down the correct settings and learn about setting up your car.

Choosing the Right Tires

The choice of tires is probably the single most crucial factor in getting your car to handle well. If you choose the wrong tires, there is often very little you can do to rectify the situation. We'll cover a number of variables at work in determining the correct tire choice to help you to guess correctly the first time you run on a new track. Let's concentrate on rear tire choice (front tires will be considered near the end of this chapter). I won't treat truck tires differently; most of the tires listed here have an equivalent in the truck tire range. You just need to check with your retailer as to the approximate truck equivalent.

Tire Compound

The *compound* or *softness* of the tire can often have a major impact on its performance. Each tire manufacturer has its own range of tire rubber, giving different names to each compound. Here's a table to help you compare equivalent tire compounds across manufacturers. Associated generally recommends Pro-Line tires.

Manufacturer	Hard	Medium	Soft	Super Soft
Pro-Line	XT	XTR	M2	M3
Losi	HT	Gold	Silver	
Schumacher	Blue	Green	BIBX	

A softer tire compound is not necessarily better. The new generation "super soft" compounds such as Pro-Line's M3 work only in certain situations. Super Soft tires should be used when the track reaches blue groove conditions. (This is when there is practically no dust on the racing surface; just a rock-hard surface where the racing line comes up blue from deposited rubber.) Super Soft tires should be used when the rubber compound generates tire traction.

In general, the soft compound tires will perform best. Well packed track surfaces with some loose material on the surface are particularly well suited to these types of tires. Dusty conditions also suit soft tires.

Medium compound tires can be most effectively used when the track condition is bad. When predominantly loose material is on the surface, when the track starts to break up into rubble or in moderately wet conditions, medium compound tires should be your first choice.

Hard tires are rarely used. Only if the track is particularly wet/muddy, or if the track surface is grass, should hard compound tires be used.

Tire Profile

Tire *profile* or *carcass shape* can be roughly categorized as square or rounded. There are other profiles and tires which fit between the two extremes.

A square tire is one which has a flat crown. That is, a tire which will stand on it's own on your pit table and where most of the tire contact patch sits in contact with the table surface. Examples include Pro-Line's 8083, 8086, 8088, 8089, or 8110. Square profile tires almost always provide excellent forward traction (due to large contact patch). In smooth track conditions, square tires can also provide excellent “through corner” traction. These tires suffer most when tracks start to break up, or in conditions where the car is constantly sliding sideways. In these types of conditions, square tires can slide unpredictably, or can “catch an edge” in ruts and holes, causing the car to flip or get out of shape.

A rounded tire is predicable through corners, and excellent in rough, rutted conditions. While not as good at generating forward traction in smooth conditions, the rounded tire is almost universally chosen when the going gets rough. Examples of rounded tires include Pro-Line’s 8081, 8082, 8087, or Holeshot.

Tread Pattern
We’ll categorize the most commonly available tires, and give some description of the conditions in which they’re put to best use.

Buggy/Truck Rear Tires
Buggy and Truck rear tires are similar in appearance. In this section I’ll use the accepted buggy tire name/number. If you’re a truck racer you should find that most of the tires I refer to are also available for the truck, usually with the same name.

Micro spike tires include Pro-Line’s 89 and Holeshot, Losi’s Sprint, and Schumacher’s Micro spike. These tires are used when track conditions reach, or approach blue groove status. When the track is almost dust free, and fairly smooth, reach for a set of these tires.

Fuzzy tires include Pro-Line’s 8082, 8083 (truck 8092), Losi’s IFMAR Pin and Big shot, and Schumacher’s Fuzzy. These tires are most suited to hard packed, but slightly dusty, track surfaces. They work well in blue groove conditions, and can be acceptable in looser conditions. One pair of these tires should definitely be in your pit box.

Mini spike tires include Pro-Line’s 8080,8088 (truck 8090), and Schumacher’s Mini Spike. Perhaps the best compromise tire of all, these will work in almost all conditions. This tire choice is most risky in blue groove conditions when low contact patch can count against them.

Stud/Stubby tires include Pro-Line’s 8081, 8086 (truck 96), Losi’s IFMAR Stud, and Schumacher’s Square Stubbies. These tires are at their ultimate in loose, broken conditions. When the previously smooth track starts to deteriorate, grab a set of Pro-Line 8081 or Losi IFMAR studs out of your box. These tires have also been known to perform exceptionally well in well-packed track conditions. Pro-Line 8081 in particular lays a lot of rubber on the track through large, round studs and thus can generate traction in most conditions. Again, a tire of this type is worth having in the pit box.

Step Pin tires include Pro-Line’s 8087, 8110 (truck 97), and Losi’s Step Pin and Mini-Step. These tires are perhaps the ultimate compromise tires. At their best in looser conditions, step pins also work well in broken, messy track surfaces and the Mini-Step in particular works well in anything up to blue groove conditions. The 8087 and Mini-step are the pick of the tires. One of these should probably be in your arsenal.

2wd/Truck Front Tires
Most 2wd or truck front tires are of the ribbed variety. That is, they feature a series of vertical ribs running the length of the tire. The differences are in the width of tire, shape, height and width of ribs, or external reinforcing braces. There are a couple of other tires not fitting this description, notably Losi’s Diamond and Pro-Line’s Holeshot. These two tires will only work in very specific track conditions (blue groove), and can most easily be left out of general discussion about front

tires. 2WD front tires are an individual preference. You should keep a couple of different pairs of front tires in your box, but don't be too concerned about what other people are using. Run the front tires which give the level of front grip you feel comfortable with. As a general rule of thumb, run the hardest compound tire you can that provides the necessary traction. There are many setup options in your car that can assist in providing steering — exercise these before moving to softer tires.

Standard Ribs include Pro-Line's 8105 Rib and Losi's Wide Body or Standard Rib tires. These tires feature four square, upright rubber ribs with no external reinforcing or bracing. Standard rib tires are the most commonly used front tires. The tire shape will work in almost all conditions, with compound choice being the critical factor. In looser conditions, opt for the medium or hard compound front tires. These will help the tire ribs stand up under cornering pressure and produce consistent front grip. In dusty or harder track surface conditions, a slightly softer compound may be necessary to generate necessary traction.

Supported ribs include Pro-Line's Wide 5's, Quattro, Edge, and Losi's Directional or Wedge. These tires use either shaped ribs or external bracing to help the tire ribs stand up under extreme pressure. In general, these tires can be used in a softer compound and are at their best in hard packed or blue groove conditions.

4WD Front Tires
There are only a limited number of options, and choice of front tire very much depends on rear tire choice. There are a number of rules however, which should be followed.

Always run a front tire with the same overall diameter as the rear tire. For example, if you're running a Pro-Line 8089 rear tire, you should not run a tall front tire like the Pro-Line Stubby. Similarly, with a rear tire such as the Pro-Line 8081, you need to avoid low profile front tires such as the Pro-Line 8135.

Foam Inserts
Most rear tires (except hard compound tires) require foam inserts. In most cases, these will be provided with the tires. Foam inserts can generally be used as supplied, with just a minor modification. Cutting the square edge of the outside of a foam insert can produce a slightly softer tire sidewall and slightly more rounded profile when using square tires. This can help to make the tires more consistent through corners, and less likely to grab and roll in rutted conditions.

Softer tires also require more dense foam inserts. The inserts included in Pro-Line Holeshot M3 tires, for example, are made of a much denser foam than other Pro-Line inserts. If you're planning on using the Super Soft compound tires, you should try to make sure that you've got a set of dense foams.

Front tires too, will often require foam inserts. Soft and super soft compound tires should always use inserts. You can, however, sometimes get away without inserts in a medium compound tire. Running no insert will result in a slightly softer tire that behaves almost like a tire compound in between medium and soft. They're sometimes worth a try if you're not sure of the right front tire compound.

Shock Absorbers and Springs

Shocks and springs are the most misunderstood, yet critical part of an off-road R/C buggy suspension. When you car can be jumping up to three feet into the air or flying up to 10 feet before landing, it's important that your shock absorbers and springs can control the car on landing. The difficulty is that those same shocks and springs must help the car get around corners and manage many smaller bumps, ruts, holes, and lumps of rock and dirt.

Perhaps more than any other part of the car setup, choosing the right combination of shock absorber and spring setup is a compromise. You need to weigh very carefully the need to get the car through the corners — for which low ride height, stiff springs and 'hard' dampers can help — with the need to help the car soak up bumps and jumps (high ride height, softer springs and lighter damping!). Let's start by taking a look at the shock absorbers and how they work.

Shock Absorbers

It's the shock absorbers' job to control the car's suspension. While the springs keep the car off the ground, the shocks must control, or slow down, the spring's action. Just how much to slow down that action is the racer's dilemma.

A shock contains a number of parts. The shock body keeps it all together and contains the shock oil. The shock shaft protrudes from the shock body and connects the piston at one end and the suspension arm at the other. Shock seals keep all the oil on the inside, and the volume compensator makes allowance for the oil that is displaced when the shock shaft and piston enter the shock body. The dampening effect of a shock absorber comes from the resistance of the piston to moving through the oil-filled shock body.

The variable parts of a shock absorber are the length of the overall unit, length of shock shaft, travel limiters on shock shaft (both inside and outside the shock body), the piston attached to the shock shaft, and finally the viscosity (thickness) of the silicone shock oil.

Shock oil is the simplest, most universally used adjustment to the shock. Using thicker shock oil will help to slow down the suspension motion of the car. Lighter oil will do the opposite, letting the suspension react more quickly to the demands of the track.

Shock oil viscosity (or thickness) is measured in weights. The higher the number, the thicker the oil, while most company's shock oil is reasonably close to each other's, there are variations. The solution is to use oil of the same brand.

Thicker oil is often used when track conditions are smooth and hard packed and traction is high. In these conditions suspension movement detracts from the handling of the car. Thicker oil is also useful for controlling the car when landing off big jumps. When the going gets rough — if there are numerous ruts and holes or a lot of small jumps, or if the track is particularly slippery — lighter shock oil should be used. This will let the car react more quickly to the track, helping to keep the tires in contact with the track.

Variables in shock pistons include the size and number of holes in the piston. Pistons with larger holes allow the shock oil to travel through more quickly, and smaller holes will slow the travel of oil through the piston. The difficulty is in knowing how to use this adjustment. In most conditions, your car's standard piston configuration will be fine. When the track is particularly rough, with lots of small to medium bumps and holes, pistons with larger (or more) holes will be helpful. When the track is smooth, or if it has big jumps or drop-offs smaller holed pistons could be the go.

What is important to remember is that pistons and shock oil have a very close relationship. Sometimes if you change one, you need to change the other. An example of this would be that when fitting larger holed pistons to your car your should probably use slightly thicker shock oil. Most manufacturers offer a range of pistons for their shock absorbers (Schumacher shocks allow for adjustment to the number of piston holes without changing pistons) and there are a number of aftermarket alternatives. Some drivers have taken to drilling different sized holes in their pistons. Such fine adjustment is not really necessary for the majority of us and should be left as a last resort. Similarly, the use of dual stage pistons, which have a different action on the up stroke when compared to the down stroke, is not advisable for drivers early in their R/C career. If you wish to try some of these options, then it's probably best to consult the local experienced driver.

Travel Limiters are small spacers placed over the shock shafts to limit the travel of the shock absorber. Limiters placed outside the shock body limit the up travel of the shock absorber, whilst placing spacers inside the shock body limit the down travel (and hence overall length) of the shock absorber. This is not an adjustment commonly used — once set it's usually forgotten.

Adding travel limiters to the inside of the shock absorber can be useful on a very smooth track, while a track with big jumps will probably favor limiters to the outside of the shock absorber to prevent bottoming out of the chassis on landing. Again, this is an adjustment not commonly used in the early stages of your racing. Set the shock limiters according to the manufacturer's suggestions.

Shock shafts can sometimes longer or shorter if more or less overall travel is required. This type of adjustment is rarely used. The Team Associated RC10B2 is one car that can benefit from the use of longer shock shafts for some tracks. Again, the best advice is to consult your experienced driver and see if he is using longer or shorter shock shafts than the stock ones.

Springs are a very useful adjustment for the suspension of your car. Springs vary in length and stiffness. A stiffer spring is harder to compress between your fingers than a softer spring. Stiffer springs will tend to hold the car off the ground more, while softer springs allow the car to ride lower and to roll from side to side more.

Springs, Jumps and Bumps

Springs are often changed to reflect the size and shape of bumps and jumps on a track. If your track is relatively smooth with lots of big jumps, you should try a slightly stiffer spring to help the car land off jumps without bottoming out. On the other hand, if the track has lots of bumps and ruts, but no real large jumps, you can try a softer spring to let the suspension soak up the little bumps without effecting the chassis balance much.

Springs and Handling

The springs you choose heavily influences your car's handling. Changing to stiffer springs can result in lower traction at that end of the car — e.g. putting a stiffer spring on the front of your car will often give you slightly less steering; adding a softer spring to the rear can give more rear grip, to a point. Amazingly, in some conditions, the opposite can be true — stiffer springs can add traction. If you are racing on a high traction track, sometimes adding a stiffer spring can give you more traction by helping the suspension to keep more pressure on the tires. Remember this tip if you're on a high traction track. Most importantly, when you're choosing springs, there's a compromise between handling and ability to cope with bumps and jumps. You've got to experiment a little to find the right combination for each track.

Many people adjust the compression of their springs by either adding spring clips to the shock body, or moving the spring collar up or down the shock body. This adjustment is only for adjusting the ride height of your car. Adjusting the spring compression does not stiffen or soften your springs. For more discussion of ride height and its effect on handling, see chapter 4, "Suspension Geometry."

It's good to have a range of springs to choose from. Most manufacturers these days tend to color code their springs to help you identify stiffer and softer springs. Manufacturers have tables listing their springs in order of stiffness.

Shock Mount Positions

R/C cars offer differing standards of tuning options from manufacturer to manufacturer. Almost all offer alternate mounting options for shock absorbers. Mostly, the options relate to the distance along the suspension arm that the shock mounts, or the angle of the shock. These options provide various responses in terms of the handling of your car.

Moving the bottom of the shock along the suspension arm basically affects the stiffness and droop of the suspension. Moving the shock mount further out results in a suspension that appears both stiffer (sprung) and harder (dampened). Conversely, moving the shock inward gives a softer feel. The reason for this is simple. The easiest way to explain this is to think back to the playground seesaw of your childhood. When the people on either end don't weigh the same, by simply moving the heavier person closer to the center the seesaw can be made to balance. It's just a question of leverage. As the shock moves out along the arm, it can bring greater leverage to bear on the suspension arm. Moving the bottom of the shock along the arm also affects the suspension droop — further out equals less droop, further in equals more droop. Droop is covered in depth in "Suspension Geometry."

Moving the top of the shock absorber has a more subtle effect on the car's suspension. What is changing here is the angle of action of the shock absorber. Changing the angle makes the shock absorber more or less progressive. A progressive suspension setup is when the suspension becomes stiffer as the shock/spring/suspension is compressed. Leaning the shock absorber over further results in a more progressive suspension. This is useful in landing off big jumps (helps stop the car from bottoming out), handling on smooth tracks, and handling in high-speed corners. Standing the shocks straighter helps in rough conditions, or with tracks with lots of quick changes of direction. Adding interest to this setup option is the fact that standing the shocks up gives some degree of anti-roll effect while laying the shocks down encourages, or allows, more chassis roll. The shock angle you choose can thus be closely related to the use of an anti-roll bar.

Suspension Geometry

Explaining suspension geometry is not easy. We'll try to give you an overall picture of what 'geometry' is and does, and give you some general hints on what changes affect the handling of your car. More than any other section of this book, the motto for this chapter must be: change your car, practice, change your car, practice, change your car, practice . . . . You've sometimes just got to make a change to the car and try it, and do your best to pick out the difference.

Suspension geometry refers to a lot of things. Basically, it is the various angles and mounting points of wheels, axles, suspension arms, and uprights. Shock absorber mounting positions can also be considered to be suspension geometry but we've already covered them in Section 4 so we won't do it again. Words most commonly heard when talking about suspension geometry are camber, caster, ride height, and toe-in. If you don't understand what's meant by these terms, look them up in the Glossary (Section 2) before you go any further.

Camber

Camber is probably the easiest component of suspension geometry to adjust, if your car is fitted with turnbuckles or some kind of threaded rod for an upper suspension link. Here are some general rules of thumb.

On the front of your car or truck. Adding negative camber will, in general, slightly increase steering up to a certain point, and then decrease it after that. That point is around 3°–4°. I would suggest that you start with about 2° of negative camber (whatever the car) and NEVER adjust it more than 1° either way. Running more negative camber will simply take away too much steering and add unpredictability to your car's handling, while running positive camber of any kind is generally not a great idea. Positive camber can induce unstable handling and a particular loss of traction for the outside tire in any corner (and the outside tire is the one that does about 80% of the work).

On the rear things get a little more complicated. We need to consider both driving traction and cornering traction. Driving traction is what gets us going in a straight line, the more you have, the faster you can accelerate. Cornering traction is what helps the car to track around corners without the back of the car spinning out. In general (gee, I use those words a lot), the most driving traction comes with the tires at 0° camber, neither positive or negative. This is because the tire is flat to the track with the most possible amount of rubber touching for more grip. Unfortunately, cornering traction can be enhanced by adding a little negative camber, just like the front of the car. Interestingly enough, most cars will run fairly consistently with around 2° of negative camber on the rear. Again, as per the front, I would suggest you adjust this by only 1° either way. Again, NEVER run positive camber, it'll lead to unpredictable driving traction and probably a lot of spinouts in corners.

Camber Link Mounting Positions

Many modern R/C racecars have some options for mounting the camber links in different positions. Manufacturers spend a lot of time testing the cars and the kit settings will be the most consistent for the vast majority of racing conditions. There are no valid generalizations that I can give you to help decide when and how to change the mounting location of your camber links. Suffice to say, that I believe firmly that you should trust the manufacturers' judgment in this matter. If you feel the need to try some other options, then just try the holes immediately adjacent to the standard position. Really, its a case of try it and see.

Caster and Anti-squat

Caster and anti-squat are basically the same thing, except that caster refers to the angle of the suspension ‘upright’ (and is generally used in reference to front suspension), while anti-squat refers to the angle from horizontal of the whole suspension arm mounting pin (and is generally used in reference to rear suspension). Let’s take a look.

Caster adjustment on the front of most buggies is by using different front uprights. In most cases, 2wd cars run between 20° and 30° of caster, whilst 4wd cars run a bit less, typically 10° to 15°. This is another instance where your manufacturer has done a lot of work to find the best answer. Usually, you should trust them. There are some generalizations that can be made, however. Adding caster (leaning the uprights further back) will generally give less initial turn-in, but more on-power steering and better straight line stability, while decreasing caster will generally add some turn-in, but at the expense of on-power steering and straight line stability.

The other possibility is that your car may be fitted with a ‘variable caster’ setup. This means that as the suspension compresses, or extends, that caster automatically changes. While common in on road cars, variable (or ‘active’) caster is less common on the dirt. In fact, Schumacher is the only major manufacturer to offer such a suspension package (available for Cougar 2000/Fireblade as well as Losi and Associated 2wd buggies).

Anti-squat adjustments are available on the rear of most modern buggies and trucks. Anti-squat is typically adjusted by either replacing the rear suspension arm mounts, or placing washers or wedges under one end or the other of the mount before tightening the mounting screws. This results in a change in lifting the front edge of the arm higher than the rear edge. Anti-squat does exactly what you might guess by its name, it prevents the rear end of the car from squatting under power as the car accelerates and weight transfers rearwards. Anti-squat does also have some other effects (as with any adjustment, there’s always a trade off). Let’s take a look at the effect of altering anti-squat on both acceleration and cornering.

Increasing Anti-squat. If you add anti-squat, your car will (in general) get more ‘driving traction’ and hence accelerate faster. When you come out of corners, you will be able to use more throttle and your car will be more stable. But (and it’s a big *But),* when you back off to turn into a corner, your car will have less rear grip. This might result in you spinning out when you back off the throttle. Adding anti-squat also affects the way your car drives through bumps on the track. If the track is bumpy right where you want to accelerate, anti-squat is not a good thing, it will make the rear of your car very ‘bouncy.’ On the other hand, if the rough stuff is in a place where you are cruising on constant throttle, or even decelerating, then anti-squat will actually help your car to ‘cruise’ through the bumps more smoothly.

Decreasing Anti-squat. When you decrease anti-squat you lose rear ‘driving’ traction. Your car will be a little more prone to power slides and fishtails. However, you will have more traction on a trailing throttle, resulting in your car being more stable into corners. It will also accelerate better through bumpy parts of the track.

Toe-in and Toe-out

The adjustment of toe is one of the most useful fine-tuning aids in making your car handle just how you like it. On the front of your car, lengthening, or shortening the steering rods adjusts toe, whilst on the rear it is usually adjusted by changing the suspension arm mounts, or using different hub carriers or suspension uprights.

Essentially, toe adjustment works like this. Adding toe-in (front of wheels point inward) adds straight-line stability, while adding toe-out (front of wheels point outward) tends to make the car wander a little. Like all suspension geometry adjustments, this is only true up to a certain point, beyond which the results are generally unpredictable. Let's look at that in a little more detail.

Front adjustment. Changing toe on the front wheels is probably the best way to get that last little fine tuning adjustment right. Adding a little toe-in will reduce turn in slightly, and produce a car that tracks well in a straight line. On the other hand, reducing toe-in, or adding a little (very little) toe-out can provide a slight increase in steering. As with all suspension adjustments - go a little at a time. Front toe adjustment should never exceed 3 degrees negative, or 1-degree positive toe (RPM make a great toe-gauge to help you measure exactly what you've got).

Rear adjustment. Due to the nature of rear toe-in (adjusted by replacing suspension mounts or hub carriers/uprights), adjustment of rear toe-in is quite uncommon. Just as with the front adjustment, more toe-in will add traction and stability, while less will promote sliding and instability. Rear toe-in should probably never exceed 4° negative or be less than 2° negative. Most modern cars are supplied at 3° negative and will never need to be changed. The other interesting part of rear toe adjustment is that some cars use different suspension arm mounts to achieve the adjustment, while others use different suspension uprights to make the change. The first case (suspension arm mounts) is called 'inboard toe-in' because adjustment is made at the inboard end of the suspension arm and affects the whole arm. Altering the upright is called 'outboard toe-in' because (you guessed it) it's making an adjustment at the outboard end of the arm. Inboard toe-in can produce slightly different handling characteristics to outboard toe-in in rough track conditions.

Ride Height
Ride height describes the distance between the track surface and the underside of your car's chassis. Sounds simple. The simple truth is, ride height adjustment can sometimes be easy to get wrong, and can have a devastating effect on your car when you do get it wrong.

Fortunately, there are some relatively simple rules that you can follow to help make sure you get the ride height right, most of the time.

First, let's accept this basic fact. Ride height is controlled by the amount of pre-load applied to your springs through the use of spring spacers or the movement of an adjustable spring collar. Adding spring spacers does not stiffen the spring, it just lifts the car higher off the ground. You can also adjust ride height by using travel limiters inside the shock absorber or by selecting different shock mounting positions on some cars. Basically though, spring pre-load is it.

Simple Rule 1 Always run the car with the chassis level. That is, the ride height at the front must equal the ride height at the rear. While there may be some very odd circumstances where you'll want to run the front higher than the rear (or some even more odd circumstances where you'll want to run the front lower than the rear), it is true for most conditions that the car will be most consistent if the front and rear ride heights are equal.

Simple Rule 2 The rougher the track, the higher the ride height must be. As the race day progresses, if the track starts to break up. One very simple method of adjusting your car to cope is to slightly (and I emphasize the word slightly) raise ride height. Make adjustments on the spring collars of about 2 mm per time.

Simple Rule 3 The higher the traction, the lower the ride height. If traction is very high (wet track, or good gripping clay, or ‘blue groove’ conditions) your car will handle best (and resist traction rolling) with a lower ride height. If the track has a lot of grip, and is very rough, then you’ve got a typical suspension-tuning situation and you need to compromise.

Simple Rule 4 Remember that changing tires can drastically change ride height. For example, put a pair of Proline 8089 tires next to a pair of Proline 8081 tires. See the difference in radius of the two tire types? That’s the difference in ride height if you change from one to the other. When you change your tires, recheck your ride height.

Anti-roll Bars
Anti-roll bars (or sway bars) do one thing. Prevent, or inhibit, a car’s natural tendency to have chassis ‘roll’ or ‘lean’ towards the outside of a turn. This happens when you ask your 1.7 kg car to turn left. A lot of that weight wants to keep going straight ahead, thus throwing more weight onto the right side (or outside) suspension and cause the whole car to ‘lean’ over.

The anti-roll bar prevents this lean by transferring some of the ‘leaning force’ across to the other side of the car. Anti-roll bars (as the name suggests) help your car to sit ‘flatter’ through corners. Anti-roll bars are most useful in high grip, smooth track conditions, and probably in high-speed corners too.

In lower grip, or rougher conditions, anti-roll bars can take away grip from the end of the car you use them on, or simply prevent the suspension from working as freely as it possibly can.

Variables with anti-roll bars include the thickness of the bar, the location of the anti-roll bar mount on the suspension arm, and the location of the mounting joint on the anti-roll bar.To ‘stiffen’ the bar (or increase it’s effectiveness) use a thicker anti-roll bar, mount the anti-roll bar further out on the suspension arms, or mount the connecting joint further ‘up’ the bar (closer to the bend). To ‘soften’ the anti-roll bar, do the opposite: use a thinner bar (or no bar at all), mount closer to the center of the car, or further out along the bar itself. Some cars, like the NTC3, have ‘blade’ type anti-roll bars. You rotate the blade and it changes the effect. The flatter the bar (parallel with the ground) , the less anti-roll effect. The more you rotate the blade vertically, the more pronounced the anti-roll effect.

For testing purposes, if you’ve got an anti-roll bar fitted to your car and you want to disconnect it, you can simply disconnect one end of the bar. That will remove the ‘anti-roll’ effect and leave you free to try without it. In racing situations, it’s always safer to completely remove the anti-roll bar from the car if you don’t want to use it.

On a 4wd it is a very good idea to have an anti-roll bar available for the rear of your car. In my experience, 4wd cars use an anti-roll bar at least 50% of the time. 4wd cars are different from 2wd in that the saddle pack battery setup means that more weight is distributed further out along the chassis, thus increasing chassis roll.

On a 2wd you are not going to use an anti-roll bar anywhere near as often. I use a rear anti-roll bar on my XX-CR perhaps 30% of the time, while the front anti-roll bar is connected perhaps 15% of the time. You should be able to race very happily without any form of anti-roll bar on your 2wd (although having said that, a soft anti-roll bar is a very good tuning tool to have, particularly on fast, smooth, high grip tracks.

I have personally never seen an anti-roll bar used on a truck. Not sure why, perhaps trucks tend to sit flatter due to different shock mounting positions. If you’re a truck racer there’s certainly no need to rush out a pick up an anti-roll bar.

Other ways to get anti-roll: use different shock mount positions. This topic is covered in Section 5. Remember that if you change the shock mount positions to get better Anti-roll effect, you’ll probably upset some other part of the suspension setup.

Suspension Droop

Suspension droop is adjusted by the use of shock travel limiters inside the shock, or by mounting the shocks in different positions on the tower or arm, or by droop screws. Simply put, more droop is useful on a rough track, and sometimes on a slippery surface. More droop can also help your car to land better after big jumps. Less droop results in sharper handling and is best used on a smooth, high speed track. Less droop will help your car to change direction more quickly.

Wheelbase and Weight Distribution

Wheelbase and weight distribution are inextricably linked. They are also very useful fine tuning tools. Many modern cars include the ability to alter both wheelbase and weight distribution within the framework of the standard car. Additionally, there are many manufacturers offering longer, or shorter chassis options for their cars.

Weight Distribution

When you're building your car, you should always do your best to have weight evenly balanced across the car (from side to side). A car that is not balanced from side to side will struggle to jump, accelerate or handle consistently. Side to side weight balance is not a tuning option. You should get it evenly balanced and forget it.

Altering weight balance from front to rear is both more easily achieved, and more useful as a tuning tool. Basically it works like this:

More weight towards the front of the car equals more steering, and less rear grip. Moving the weight up front will also tend to encourage your car to jump more nose down, and stop the car from 'wheel standing' in extreme traction conditions. The easiest way to achieve a change in weight balance is by moving batteries forward in the chassis (suitable for XX, B2, XXT, XX4, etc.). Alternately, you can relocate electrical components further forwards but this is both fiddly and time consuming. Battery placement is the way to go.

Moving weight towards the rear of the car adds rear traction, takes away steering, makes the car more stable under both acceleration and braking, and can encourage some degree of wheel standing in extreme traction or rough conditions. Rearward weight balance can also help the car to jump a little flatter if it is jumping 'nose down'. Altering weight balance to the rear is achieved by moving batteries backwards within the car.

As an alternative, you might want to add more weight to front or rear without taking weight away from the other end (this shift in weight happens when you move the batteries around). In this situation, seriously consider adding some small lead weights. Add this weight at the extreme end of the chassis, and as low as possible. Many 2wd cars and trucks have a perfectly shaped hollow inside the front bulkhead for this purpose. Adding a little weight (probably no more than 10 grams) to the front of your car can add a little more steering, and help the car to jump a little more 'nose low' but without taking away rear traction.

Wheelbase

Wheelbase can be typically altered in two ways. The first is to add a longer, or shorter, chassis to the car. The second is to move the rear axle forwards or backwards by relocating spacers on the outer hinge pin. These two adjustments do completely different things.

Changing Chassis Length: This is a major operation. Adding a longer chassis will give you more balance, more stability in high speed corners, slightly more rear traction, slightly slower turn in, better stability on rough tracks, and better jumping. Conversely, adding a shorter chassis will give you more steering and quicker response through corners, particularly when you have to change direction from left to right (and maybe back again). Longer chassis are most often used in a truck, and on bigger, faster tracks. The short chassis option is mostly used only on short, tight, twisty tracks (and usually only with the 2wd buggy).

Changing Rear Axle Location: Most modern R/C cars have the ability to alter wheelbase by changing the spacing of the rear axle. Some cars have two options (short/long) and others will have a medium wheelbase option. The real effect of altering wheelbase in this fashion is to alter the car's weight distribution. Moving the axle back (longer wheelbase) is, in effect, moving the center of gravity of the car closer to the front axle (almost like moving the battery a little forward). Conversely, moving the axle forward is just like putting more weight over the rear wheels. A simple rule of thumb: move the axle forward for more rear traction, backward for less.

Setting Up Transmission/Gearbox

The transmission of your R/C car is a piece of fine mechanical design and should be maintained carefully. I don't intend to go into great detail here about how to clean or rebuild transmission components; your instruction manual should cover that. Suffice to say that you should keep bearings, gears, and diffs as clean and smooth as possible. Let's take a look at your transmission and see just what kind of tuning options you might have.

Gear Ratio
The primary tuning option relating to your car's transmission is the ability to change gear ratio by using different spur gears or pinions. Before we talk about the effect of gear ratio changes, let's spend a moment sorting out the terminology.

Gear ratios are most often quoted in the form "2.4 to 1". This can be represented in writing as 2.4:1. This means that the motor must rotate 2.4 times for the car's driven wheels to complete one full revolution. Most instruction manuals should tell you the internal ratio of your car's gearbox. If not, here's a list of common off road Associated cars and internal gear ratios:

Car	Internal Gearbox Ratio
RC10B2	2.4:1
RC10B3	2.4:1
RC10T2	2.6:1
RC10T3	2.6:1
RC10 Team/Worlds	2.25:1

The formula for calculating gear ratios looks like this:

(# Teeth on spur divided by # teeth on pinion) multiplied by Internal Gearbox Ratio = Gear Ratio

We've already seen how gear ratios can be represented as numbers (e.g. 7.8:1). The tricky part is in describing ratio changes in general. If you put a bigger pinion on the car, the ratio will change to a small number (say 7.4:1). Whilst the numerical figure has become smaller, the actual gear ratio 7.4:1 is said to be a 'higher' ratio than '7.8:1'. Similarly, moving to a smaller pinion will produce a 'lower' ratio (say 8.2:1). Without wanting to confuse you, changing the spur gear has the opposite effect. A smaller spur gear will result in a 'higher' gear ratio, and a larger spur gear will give you a 'lower' gear ratio. Confused? Stay with me.

Gear ratio changes do a couple of things. Let's look at both the 'lower' and 'higher' gear ratios separately to see what we find.

A lower gear ratio will mostly give you more run time and more acceleration. It's also generally easier on your motor.

A higher gear ratio will generally give you more top speed, and less run time. It's also tougher on your motor. Once you get to a certain ratio point (lets call it the 'optimum ratio') continuing to change to a higher ratio will do nothing but damage. It will result in your motor overheating and being damaged, and in extreme cases, your car may actually go slower.

How’s that. Did you understand it all? Have another read, and think about it carefully. Then look at this simple chart, which might help make things clearer.

Pinion	*Spur Gear*	*Ratio*	*Gearing*	*Top Speed*	*Acceleration*	*Run Time*	*Motor*
bigger	smaller	higher	up	more	less	less	harder
smaller	bigger	lower	down	less	more	more	better

Hope that helps! For help on choosing your actual gear ratio for any given motor or track, consult your instruction manual or check with the local fast guys.

Differential

Your buggy or truck gearbox (transmission) is fitted with a differential. The purpose of the differential is to let the wheels turn at slightly different speeds. This is necessary to help the car turn corners. When you car turns a corner, the outside wheel has to travel further than the inside wheel, thus it needs to turn slightly faster to keep up. Differentials (or diffs) in model cars are typical of two kinds. Entry-level cars (from companies such as Tamiya or Kyosho) often use ‘gear diffs’ while more competition oriented manufacturers use ‘ball diffs’. Both work in the same way, and largely achieve the same thing.

Ball diffs, however, are slightly adjustable. By slightly increasing or decreasing the tension on the diff screw (see your instruction manual for details on how) you can make the diff ‘looser’ or ‘tighter.’ A tighter diff is one that is hard to turn. Tighter diffs help your car to put down power coming out of corners and in a straight line, while looser diffs help your car to turn corners better. If you loosen the diff too far, it will allow the diff to slip, which is a bad thing. Diff slip damages the components of the diff and is inconsistent. Your instruction manual will describe how to tell if your diff is slipping or not. I never recommend running any diff slip, because that’s what a slipper clutch is for. Read on for more on this.

Slipper Clutches, Hydra drives, and Visco drives

The slipper clutch, hydra drive and visco drive all have one aim in mind - to help you put the power to the ground more effectively. Most modern R/C cars (well, the race oriented ones anyway) come fitted with a slipper clutch as standard. Team Losi vehicles also include a hydra drive, whilst Schumacher offer a ‘visco drive’ for their cars (and other manufacturer’s cars as well). Let’s take a look at the use of a slipper clutch, and then the hydra/visco drive option.

Slipper clutches are designed to do exactly what you might think by their name, slip. When you jam on the throttle, the slipper clutch is designed to slip a little before transmitting that entire horsepower to your overstressed rear tires. The slipper clutch (or ‘clutch’ as it’s usually known) helps when the track is slippery, or rough, or when you bolt in an enormous motor. The best way to set your clutch is to loosen it right up (‘back it off’ is the term you’ll mostly hear) and place your car on the main straight at your track. When you pull the trigger to accelerate away, the car should move slowly off, with the transmission emitting a loud whining noise. That’s the clutch slipping. Now slowly tighten the clutch about 1/2 a turn at a time (trying a full throttle take off after each adjustment) until the clutch only slips for about one meter (three feet). This is a pretty good setting for most tracks. If the track is particularly high traction, or if you’re not having any problems with too much wheel spin, you might even like to run the clutch tighter still. I would recommend against locking the clutch entirely. Just tighten it enough so that there is no slip on acceleration. This will still let the clutch slip when your car comes down hard off a jump or through rough sections of the track, thus protecting the transmission.

Visco drive & Hydra drive: Losi and Schumacher would probably disagree with my analysis, but the hydra drive and visco drive basically carry out the same function. They're like a more advanced version of the slipper clutch. They are designed to assist in smooth delivery of power. Each is fluid filled and adjustable. Each is at its best in rough, or broken, track conditions. Each manufacturer provides good instructions on setting up and using their product. My advice to you is to follow the manufacturers' instructions to the letter. Leave the hydra drive or visco drive on at all times unless the track is very smooth and offers high traction. Then you could consider running without it.

Choosing and Maintaining Motors

Motors are the driving force behind your R/C car. You need to take care of your motor and treat it with respect. In this section, I'll give you some basic, no-nonsense guidelines about caring for your motor, and some simple rules for choosing your motor once you graduate into the modified ranks. I'm not a technical guru, and I don't intend to get technical here, but I've raced at the top level of modified in Queensland and Australia with some success using the simple guidelines I'm going to present to you here. Some may disagree with my assessment, but I'm here to tell you this stuff works in real life, which is good enough for me!

Motor Care

Stock motors are very easy to care for. After each race, brush the loose dirt and dust off the end bell. After every second or third race, add one drop of light machine oil (Mobil One or any light machine oil) to each bushing. After every second race meeting, take the motor out of the car, and spray it out with R/C motor cleaner. Don't run the motor while spraying it; don't dip in water, or any other such things. When you finish spraying out the motor, add a drop of oil to each bushing and work the oil in (by turning the shaft by hand a few times). Then add a drop of Break-In fluid or commutator drops to each brush (inside the motor) and run on a four-cell pack for about 30 seconds. Now replace it in your car. That's it, simple, quick, and reliable. If you want more performance from your Johnson 540, you can use commutator drops. My advice would be to use them sparingly, only one drop at a time, and preferably only on big race days. For your club racing you should be pretty right without them.

Once you've graduated from stock, you'll move either into a spec-modified class (Club Spec in Queensland, Group 20 elsewhere in Australia) or full-blown modified. Now there's heaps more to maintaining a modified motor than a stock, but again I'll tell you how I do it simply, quickly, and relatively cheaply.

Race day maintenance of a modified motor is not much more difficult than a 540. After about every three races or so, pull the motor from the car. Start by brushing loose dirt from the end bell and can. Next, remove the brush springs and slide the brushes out. Spray a little motor cleaner spray onto a cotton bud, and slide the cotton bud into the brush hood, pressing firmly to ensure good contact with the commutator. Now rotate the commutator a couple of times. Repeat this process about three or four times (with clean cotton buds each time), ensuring that you use both brush hoods. Now get a new cotton bud, and again, spray with motor cleaner. Use the cotton bud as a cleaning stick, wiping the face of the brush clean of any debris or carbon build up. Take a very fine points file (or a specialist comm cleaning stick from Trinity or similar) and smooth the sharp edges of the brush. Don't do this on your own for the first time, ask someone experienced to help you. Put the motor back together and back in the car. That's it. Don't oil bearings, or spray out the insides of the motor with spray, you can do more harm than good.

After every second race day (or approximately 10 runs), you should disassemble the motor entirely, and give it a full clean. Here's a basic procedure to follow:

1. Remove the motor from car and brush off any loose dirt and dust

2. Remove the brush springs and slide the brushes out of the hoods

3. Take a hobby knife and mark the can and end bell to ensure you get the timing right when you re-assemble the motor

4. Loosen the timing ring screws (on top of motor), taking care not to damage the capacitors. Twist the end bell and remove from the can. Place the complete end bell on a clean, clear section of your workbench next to the brush springs.

5. Take the motor shims off the top of the armature and place next to the end bell. Be sure to make a note of how many spacers there are and what order they may be in. There will probably be a fiber washer closest to the commutator. This is to trap oil and grease that may leak down from the end bell bearing.

6. Remove the armature by hand from the can. Set it aside on the bench after removing any shims from the shaft. Check inside the can for more shims (they'll often fall off the shaft and stick to magnets) and place all shaft end shims together on your clear area. Set the can down next to them (again remember to count how many shims there are on that end)

7. Liberally spray the armature with motor cleaner until runoff is clean (do this over a rubbish bin, or outside, it's not good stuff to get on your carpet). Spray a cotton bud and carefully clean all areas of the commutator.

8. Use a clean tissue to wipe out dust and dirt from inside the motor can and end bell. Don't use spray.

9. Check motor bearings for wear and dirt. To do this, put the armature through the bearing from outside the can or end bell (do one at a time) and spin the armature. If the armature spins freely and quietly, you're fine. If it grinds to a noisy, quick halt, chances are your bearings are either very dirty, or just plain stuffed.

10. You can try cleaning your bearings if you like. Remove the bearing from the can/end bell using a 'Motor Bearing Tool' from Trinity or similar. Then clean as per other bearings in your car. Oil lightly with a good quality bearing oil (Mobil One is a good alternative) and replace carefully. If you're not confident about this, ask for help.

11. If you decide that the bearing is stuffed (or you try to clean it and it just doesn't improve) then it's time for new bearings. Replacement bearings are available from different companies and can be fitted using a Motor Bearing Tool. Again, if you're not confident, you can ask for help.

12. When you're done with all this, reassemble the motor, taking care to get the shims in the correct location, and get the timing back to the original mark. At this stage I'd recommend fitting new brushes, although if your brushes are still smooth, clean and a nice consistent copper color they're probably OK. Look at the side of the brush. If it is discolored at all (maybe purplish, blue, or off-white) then it's time to replace the brush — no argument. Solder new brushes on just where the old ones come off. As always, ask for help if you're not sure.

13. *You're done!*

After two cleaning cycles (about 20 runs), I recommend that you consider having your commutator re-trued. This is done using a purpose built motor lathe (often with a diamond tip). Lathes can cost between $85.00 and $300 so the odds are you won't have one yourself. Some hobby shops may have motor lathes and can do this for you, usually for about $5. Ask around.

Modified Motor Brush Selection
When you're using your modified motor you'll quickly discover that there are a range of motor brushes available. These might be called soft, hard, cut, timed, serrated, silver, copper, etc. Pretty confusing. Let's try and give you some very simple guidelines.

Brush compound: some brushes are known as hard or soft. You might liken brushes to tires: the softer the brush compound, the greater the performance, but the greater the wear rate, too. With brushes, however, the performance gain is small, and the increase in wear is great. Only when you're seeking the ultimate little extra in horsepower is it worth considering a soft brush. The fact is, they're probably not worth the hassle. You need to clean your motor more often, and change brushes more often, sometimes after just two or three runs. I recommend that you always use hard compound brushes.

Brush material: brushes are a copper color. That's because copper is one of the ingredients of the average brush. There's a whole cocktail of other ingredients that go into every brush. One of the more common ingredients is silver. Brushes with a high silver content are generally expected to perform better, although, as with softer brushes, there's usually a trade-off for both brush and motor wear. Again, a standard material, standard compound brush is the best choice for consistency and life of the motor.

Brush Shape: brushes can come with different shaped (or 'cut') faces. Some have half the face cut away, others have a slot across the center, or a hole drilled in the center. There's even a brush called the 'H Cut' (guess what the face of that looks like!). All of these 'cuts' are designed for different purposes, often for US style 'Stock' racing, or even for on-road. For off-road racing, you are better off sticking to a standard, full-faced brush. Some otherwise full-faced brushes in recent years have a series of small grooves, or serrations across the face. These serrations are designed to help the brush run-in faster. These types of brushes are ok.

Lay Down Brushes: A standard modified motor takes standard 'upright' brushes. That describes the brush that is taller than it is wide. Some motors are available with 'lay down' brushes, like a normal brush tipped on its side. Additionally, some manufacturers offer 'lay down' conversion kits for standard modified motors. In some conditions, lay down brushes can offer a slight performance gain. It's hard to say when, where, and what those conditions exactly are. It's mostly a case of experimentation.

Motor Selection
In 540, or spec modified classes (such as Club Spec or Group 20), motor choice is very, very easy. Just take it out of the box and bolt it into the car. That's it. When you're racing modified, however, it's a whole different kettle of fish. Choice in motor wind is great and there are certainly no hard, fast rules. There are, however, some general guidelines to help you choose a good strong motor. Remember, these guidelines are general only. There will always be exceptions.

The less turns of wire on a motor (e.g. 11 turns compared to 15 turns), the faster it will generally be. However, it will also be generally tougher on batteries, and harder to drive. Higher turn motors will be easier on batteries, and generate more torque, allowing you to gear higher.

The more strands of wire on a motor (e.g. triple compared to double), the more top end it will generally have (very general statements here). A multi-strand motor will generally be easier on batteries, and smoother to accelerate. You'll generally be able to gear it higher (thus the higher top speed). But (and it's a big but) you probably won't get stump-pulling acceleration out of it. That's where low strand count motors are strong (singles and double). I have to stress this again - this is a very general understanding.

In years gone by, the choices were fairly simple. The more power you wanted, the lower the number of turns and strands you opted for. Something like an 11 double would have been considered to be an enormous motor. That is no longer true. New motor winding technology has meant that multi-strand motors like 15 x 6 or 11 x 7 are more common (and incredibly fast). Still, here's a rough guide to motors for each class:

2wd: When you're choosing a 2wd motor, steer clear of stump-pulling torque, since you've only got two tires in contact with the ground. Try to run multi-wind motors like triples or quads (or even quint or sextuples) and generally stay around the 11- 12- and 13-turn range (until you've got some experience). For tighter tracks, or higher grip, you might try a 12 double. When you first start out, a 13 triple or quad will be an excellent, consistent choice.

4wd: For four-wheel-drive, you need a little more grunt. This is exactly where double (and sometimes single) wind motors come in handy. Try an 11 or 12 turn double. 4wd is tougher on batteries, so you'll need to use a lower gear ratio than with an equivalent motor in your 2wd. If you've got some of the newer cells and want ultimate horsepower, seriously consider something in the 10 turn range, probably a triple or quad. Save this last option for when you've done heaps of practice and are good, very good.

Truck: Like the 4wd, trucks demand a little more from your motor than the 2wd. Often you'll need to run a double, or maybe triple wind motor. For trucks try to stay in the 12 to 13 turn range. You'll get the best combination of performance and run time. Really low turn motors (10, 11) struggle in a truck because of the very high load involved. You'll chew through brushes and wear out your motor like you won't believe if you stray too low in turns.

Driving the Beast

After all this effort setting up your car, you've still got to drive it. If I could tell you exactly how to become a perfect driver, I'd be a pro racer on my way to the Worlds. The fact is, we can't all drive like Masami Hirosaka or Mark Pavidis. We all can, however, improve ourselves. Here are a few tips to keep in mind when you're striving to improve your driving:

1. *Know exactly where you want to drive.* Sounds simple, doesn't it? This means, go for a walk around the track before racing starts. Look out for nasty holes or bumps. Figure out where to hit the jumps and exactly (like down to the inch) what you want your racing line to be. When you go out to drive, try to remember everything that you decided on earlier. Don't try and think of the whole track in one go; just concentrate on the corner you're on now and the next two or three corners. If you notice yourself getting off your chosen line, it's easy to fix: SLOW DOWN until you're back where you want to be.

2. *When you have your first run at a new track, take the first few laps slowly.* Try different lines and figure out where your car is best over the jumps and bumps. If you're having trouble on one particular jump try different lines, different throttle openings - keep experimenting until you have a method of consistently negotiating the whole track.

3. *Watch others drive.* Next time you're at a big race meeting, take some time to watch the 2wd or 4wd modified races. Pick out the fast guys and watch them closely. Look at the lines they take; listen for their throttle movements (especially when the car is in the air). I'll guarantee you, they will be smooth on the throttle, and gentle with the steering. They'll also be utterly consistent. What you need to learn is this: if your car is consistently on your chosen racing line, you'll never crash, and you'll win more than you'll lose. Simple huh?

4. *If you're attending a big race meeting, try to draw out a complete map of the track on some paper.* Mark in corners, jumps, ruts, holes and bumps. Mark in your preferred line and make notes to yourself about things to remember for each corner or jump. Take it home, and spend a little time the night before the race just reading through the comments, memorizing the whole track exactly as you want to drive it.

5. **YOU MUST PRACTICE**! Race on your own, get to club meetings, drive with other (and better) drivers, race on-road whatever. The more you drive, the better you will drive - provided that you think about what you are doing and strive to improve.

Money

R/C car racing can be a bottomless pit for your money if you let it. My advice to you is to think very carefully before you spend your hard earned bucks on new gear. As a retailer, I'd rather you were careful with your spending, enjoyed your racing, and stayed in the sport for many years, than have you spend heaps of money, get disillusioned, and give up after a few months.

Don't rush out to buy every option part manufactured for your car. Good car performance comes more from practice and hard work than spending money indiscriminately. There are certainly things you should consider buying, but be sensible and approach it from a cost benefit basis. Here's a rough priority for spending money on your car:

1. *Ball Bearings for Wheels and Transmission.* Bearings will enhance run time, performance, reliability, and strength. If your car doesn't have them, they are your first priority.

2. *Spare Batteries & Radio Crystals.* If you're racing with just one battery, you should make it a priority to get two more. Three is ok, but five (enough so that you have a fresh pack for each race on each race day) is ideal. You don't need big buck matched packs. Pick up a spare set of radio crystals as well. To race, you'll need at least two pairs, preferably three. They're cheap. If you take care of them, they'll last a long time.

3. *Spare Pinion & Spur Gears.* The ability to alter the gear ratio is very important. Pinions and spurs are relatively cheap, so always carry a range.

4. *Spare Tires* are very important (possibly the most important) tuning tool you have. As you can afford it, try to build up a range of tire choices. Some races require that you use a particular type of tire.

5. *Electronic Speed Control.* If you're struggling with a manual speed control - this will turn your life around. Electronic speedos give more power, more run time, and much more reliability. Best of all, if you sell your old car, you can move your electronic speed control straight into your new one.

6. *Spare Springs & Shock Oil.* Most manufacturers offer a choice of softer or stiffer springs for your car. Pick up some optional springs and shock oil to help you tune the car. Usually it's best to get the springs and shock oils that are slightly softer and slightly stiffer than the kit parts.

7. *Reliability Parts.* By reliability parts, I mean items that will help you car to be stronger, break down less, or be more consistent, not necessarily to perform better. Things like titanium turnbuckles, or 'un-popable' ball joints.

8. *Performance Parts.* Performance parts are items that may help your car to go better, such as lightweight transmission parts, optional graphite chassis parts, different tuning options such as anti-roll bars, or different toe/anti-squat blocks.

9. *Appearance of Parts.* If you've still got money left over, you might want to make you car look better. Anodized alloy screw sets, different bodies, wings, wheels, sticker sets etc. The options are almost endless.

Let me say one more thing on this topic. If you're running a cheap low-end buggy not specifically made for racing (say some other non-high-end brands) it's best for you not to spend too much money trying to hop up your buggy and make it competitive. Instead you should concentrate on saving for a better car. Even a well looked after second hand race car is a good investment. If you want to go faster, concentrate on items that you can move into another car if/when you save the $$$. Things like batteries, electronic speed controls, radio gear etc.

Electronics and Radio Gear

One important policy I’ve always used when buying electronic gear is to get the absolute best equipment I can afford. Electronic gear is not cheap — and you don’t want to have to replace it after a year or so if you find that your gear is not up to scratch. A good quality electronic setup will last a long time and deliver good performance. You don’t need to buy the ultimate top of the line equipment, but good mid-range gear that is from a name, quality manufacturer.

Important notes about radio/electronics: the manufacturers who've built your equipment understand everything about it. They designed it, built it, service it, etc. Listen to their instructions. The instruction sheet/booklet you got with your gear is the best advice you can listen to!

What's Next?

We've covered a lot of ground in these pages. You might not have understood it all, and you almost certainly won't remember it all. Let me encourage you to go back to the section on setting up your car and seek to follow the basic guidelines we presented there. Use this e-book as a reference, but remember, there is no substitute for practice and personal experience. Don't believe something just because I tell you it's true. Go out and prove it, or disprove it, for yourself.

Most of all, remember that R/C racing is an enjoyable activity. I'm not trying to take that joy away by making it all hard work. I'm just trying to help you to get your car going a little better, and to therefore enjoy it more. The most enjoyable races for me are those when my car handles just like I want it to. The search to make every race like that has led me to collect the information that's contained in this e-book.

If you need more help, again, let me encourage you — just ask. Ask the guy pitting next to you, ask the local pro. If you want parts or accessories for your car contact your local R/C shop.

I hope you've enjoyed reading this e-book and I hope it helps you to enjoy your R/C racing more. I wish you every success in your R/C career.

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