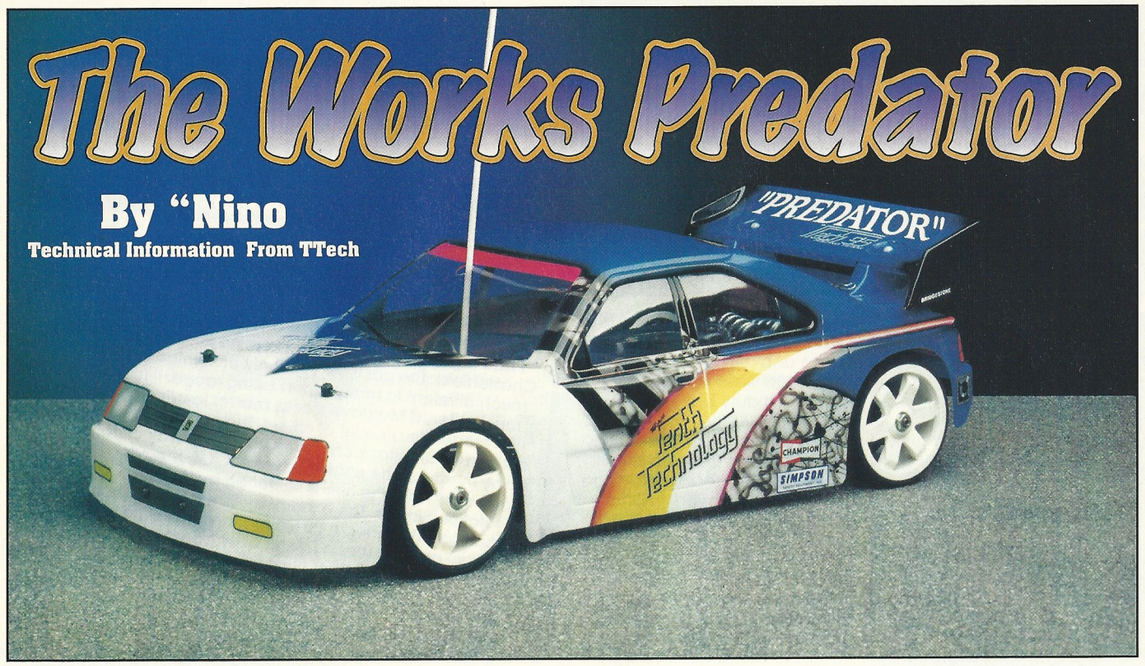
The Works Predator



By "Nino

Technical Information From TTech

The Predator is a championship winning car with many unique and striking features. In Part I we took an in-depth look at the transmission. In Part 2 we will investigate the suspension, from design concept to building and tuning tips.

Part 2 ... The Suspension

In the past, l/lOth scale R/C racing cars have always had what has come to be known as "Outboard Suspension". That method placed the shocks outboard of the cars body, with one end of the shock screwed to the wishbone. The Predator's suspension looks quite different to those others, with smaller shocks mounted within the car's chassis, which is known as "Inboard Suspension". We talked to the car's designer Richard Weatherley, and asked him why a Predator features this type of suspension.

Design Concept Explained by Richard Weatherly:

Outboard suspension was the way racing cars were sprung for many years. The reasons that Formula 1 and infact almost all purpose designed racing cars have changed to inboard, are that it offers many technical advantages over the old system. Here are the 8 main advantages :-

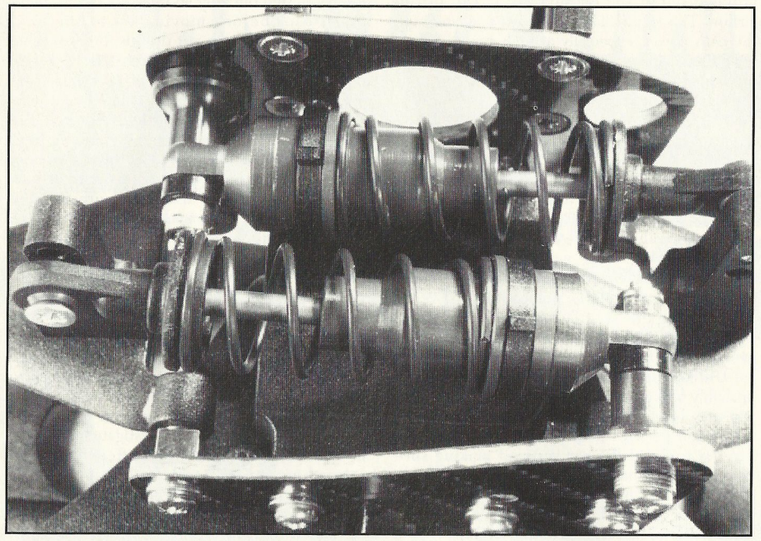
1. Lower Centre of Gravity
2. Reduced Polar Moment of Inertia
3. Reduced Overall Weight
4. Reduced Unsprung Mass
5. Variable Rate Geometry
6. Shocks are Protected from dirt and Crash Damage
7. Bending Moment in Lower Wishbones Eliminated
8. Reduced Aerodynamic Drag

The following paragraphs give a brief attempt to explain these key factors ...

1. Lower Centre of Gravity:

The centre of gravity of a car, is the balance point of the car. It has been proven by experimentation that the ideal weight distribution for a 4WD is 40-45% of its total weight onto the front axle and therefore 55% - 60% onto the rear. Side to side, as you would expect, the distribution should be even. As you might also expect, the Predator's weight distribution is exactly to this formula. But there is an additional and very important dimension of the C/G to consider, it's height. The distance from the ground to the C/G is of no consequence when the car is stationary, but comes into play the moment the car begins to move, and will have a dramatic effect upon the car's performance. It often helps to visualise the effect of something, if you exaggerate it in your mind. Imagine your car with a long & rigid aerial, with a large weight (say a motor) tied to the top. It is easy to picture how this would make your car prone to roll excessively in a corner and probably turn over quite often, because the C/G has been raised by a large amount. The car would also be prone to pull wheelies because the front wheels would try to lift clear of the ground under acceleration, reducing your 4WD car to a 2WD.

As this little exercise demonstrates it is very desirable to lower the C/G as much as possible, and this should be one of the main aims of every car designer in every class of motor racing. The Predator's chassis design and many other of it's features contribute to its very low C/G. Inboard suspension also scores points here, which is one of the reasons it is specified. Because the shocks do not have to be screwed directly to the wishbones the designer has more scope when considering their placement. Without any compromise to the "Rate Geometry" (see 5/"Variable Rate Geometry"), they can be placed low in the chassis and can even lay down on their sides.



Mounting the shock absorbers in-board gives all the benefits detailed in the text, looks "racy" too.

2. Reduced Polar Moment of Inertia:

Polar moment of inertia sounds very grand, but is actually very simple. As a demonstration of the principles, imagine the following test rig. A long rod with a hole drilled through it, about halfway along its length. The rod has a bearing pressed into the hole and a heavy steel ball slid onto each end. They can be moved along the rod, from the very ends of the rod or up to the centre bearing. Picture spinning it around like the vanes of a windmill, and imagine how much easier it would be to start and stop, if the balls were moved to the centre, compared to when they are at the very ends. The steel balls represent the equipment and ancillaries of your car. The closer all of the parts can be placed to the middle of your car the faster your car will respond to the steering and a responsive car is a fast car. Large shocks placed on the extreme corners of a car are therefore undesirable from this view point. The inboard suspension of the Predator, enables dampers to be placed closer to the car's C/G. This is an important factor in making the Predator very agile and responsive.

3. Reduced Overall Weight:

The ability to race a car at the minimum allowable weight limit is obvious desirable.

A lightweight car will be more responsive, accelerate and decelerate faster than a heavier one and will increase battery duration. Inboard suspension helps in this respect too. The suspension rockers, can be used as levers to reduce the amount of movement required by the spring/damper units. Therefore the units can be reduced in size and weight. Outboard mounted shocks require steel for the piston rods for strength, because of their vulnerability to other cars and the track scenery. The Predator units can use light weight alloy rods instead of steel, because they are safely housed inboard.

4. Reduced Unsprung Mass:

The primary job of a car's suspension is to try and keep the tyres of the car firmly in contact with the ground. If this is not achieved, grip and controllability of the car are reduced. The spring and damper work together to absorb bumps and to press the wheel into depressions on the tracks surface. When a car is travelling at speed. the wheel must move up and down very quickly in order to stay in touch with the track's surface. The lighter the moving parts of the suspension are, the quicker they will be able to move up and down. (To picture this effect, imagine holding your arm out straight and moving it up and down as fast as possible. Now imagine how fast you could move it up and down if you were holding your 12v battery) The "Unsprung Mass" is any part of the suspension which must move up and down over bumps and undulations on the track, for example the wheels, tyres and the outer ends of the wishbones. Moving the dampers into the chassis as on a Predator, means that the moving parts of the suspension can be reduced in weight. They can also be placed for more optimum weight distribution (see parts 1,2,3,&7)."

5. Variable Rate Geometry:

Consistency of handling is a major factor especially with a radio controlled racing car. It is desirable that the car runs as level as possible, so that the tyres are presented in a consistent fashion to the track. However, setting the car up to achieve this is difficult, because the ideal suspension settings for small ripples in the track will be different to the ideal settings for large bumps. The small ripples need soft compliant suspension, while the bigger undulations require stiff and highly damped settings. Drivers must find some middle ground, the best compromise settings for their car to suit the track and conditions. Formula 1 cars, and all cars equipped with inboard suspension, face less compromise. This is because the rocker allows the suspensions characteristic's to change as the suspension is compressed. Early in the suspension movement a Predator's wheel will move 3mm to the spring damper units 1mm, a ratio of 3 :1. As the suspension is compressed further, the rockers geometry will cause this ratio to decrease to 2 :1. When measured at the wheel therefore, the spring and damper rates appear to have increased. In other words the more the car is compressed, the harder it will resist the compression. This enables the Predator's suspension to be very soft for the small ripples and yet very stiff when pressed harder. No compromise !!!

6. Shocks Protected From Dirt and Crash Damage

The racing car designer who utilises inboard suspension gains a great deal of freedom when placing the shocks. Because the shocks no longer have to be screwed to a lower wishbone they can be sited for optimum weight distribution, which as explained in previous paragraphs, means within the chassis. This brings with it, the bonus advantage that the shocks are now well protected from the elements. Your precisely engineered shocks will not become smothered in mud and dirt, bunged up with grass or attacked by other competitors. And when you come to work on them, they are nice and clean.

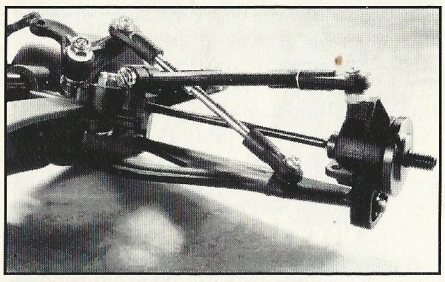
7. Bending Moment in Lower Wishbone Eliminated:

In racing, compromise must be eliminated as much as possible. The designer must optimise as often as he or she can. When designing a component with just one function to perform, it can be optimised. If it must perform more than one, there must be a compromise of the design. The primary function of the lower wishbones is to accurately position the wheels. Compromise is introduced with outboard suspension because the necessarily long wishbones must now also resist the bending moment introduced by the spring/damper unit screwed to it, and must therefore be made heavier than would otherwise be necessary and not aerodynamic.

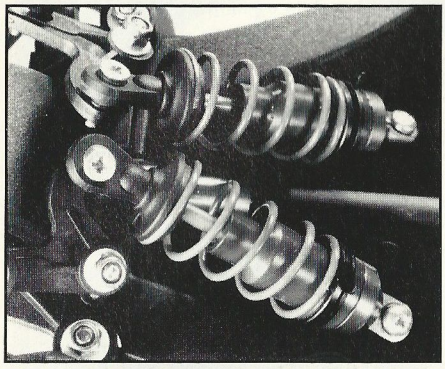
° (It is a valid criticism that earlier Predators took this advantage to the extreme, utilising very thin wishbones. This caused the wishbones to break too easily in a crash. The new Predator XK5 has new wishbones which do not have this problem).

8. Reduced Aerodynamic Drag:

The Predator is developed using a wind tunnel. TTech have learned through these experiments, that it is very hard to find a measurable improvement from any single detail change. However when adopted as a design philosophy, the many detail changes add up, to make a



As can been seen from the photograph the Predator has definitely got an aerodynamic advantage from it's design concept.



By using "Rocking Levers" in the front suspension lay-out, a range of "rising rate" can be included. (see text)

difference you can see and measure on the track. Perhaps the greatest single step forward in the pursuit of low drag was the utilisation of inboard suspension. On a car with outboard suspension, the large shocks and shock mount plates are perched out at the corners of the car, in the airflow. This significantly increases drag and saps the car's power, especially at high speed. When everything else is equal, a Predator will always out run the competition due to its reduced aerodynamic drag.

Suspension Building Tips

A Formula 1 engine is a masterpiece of engineering and performance. It can produce 800BHP at 17,000rpm! However, if for example the engine valves didn't completely close but only nearly closed, the masterpiece would not even start. What has this got to do with model car suspension ? Well the point is this ... Even if you are using the latest factory team car and set-up, it will not perform properly unless everything is working exactly as it was designed to. Unlike the Formula 1 engine example, it probably will go around the track and therefore you may be mislead into thinking everything is OK, when perhaps it isn't. The only way to be sure, is to build the car yourself making sure that each part functions soundly as you assemble it. Remember, that even the best quality kit in the World will need some filing and fettling if you want to obtain the maximum from it. Only a car built with this approach is worth the time and trouble of testing and tuning it, once you are at the track. A well built car will also respond to small set-up changes and be reliable and rewarding to drive.

Here's some things to look for ...

Attach the suspension parts to the chassis one by one. Each time you assemble a component to the car, check that it fits accurately with very little slop and yet moves very freely. If it does not, try to find out why and correct the problem if you can, before moving on to the next component. If you do not do this, but assemble the whole suspension instead, it may be impossible to tell which component is causing any problem that may exist. Once a complete corner of the car is assembled, (without the shock) check that the whole assembly is free, through the entire movement of the suspension. (It should be free enough to drop under its own weight). At the front, also make sure that the steering is very free through the entire suspension movement. Only when all four corners and the steering move very easily, with little slop, should you fit the shocks.

When building dampers, it really helps to use TTech gear lube on the piston rod seals and bearings. This is a special formula grease which performs this function perfectly. Enabling the action to be very smooth and it also helps to prevent grit from entering the damper. Check that the dampers feel the same as each other before filling with oil, and investigate and rectify any differences. Check again after filling, and only when you are satisfied that they are performing evenly should you ft them to the car.

Adopt this philosophy to every detail of your car and if you have chosen your equipment wisely, your car will be capable of taking you all the way to the top.

The car is now a fully assembled masterpiece, and just needs adjusting to the latest Factory Team set-up. The performance and peace of mind that your car can now deliver, will allow you to get on with the best job of all .... the driving. Good luck.

The next part of the series, takes us to the track for a test session with the TTech Factory Team. We'll bring you the knowledge that has brought 3 British Championship titles to The Team in 3 years.