CAT

Cecil Schumacher's idiosyncratic brand of car design has finally come to 1/10th Off-Road racing. Geoff Driver has been sampling a kit-CAT.

For months rumours of the release of the *Schumacher* 'CAT' have been getting stronger and stronger. As each expected release date approached however, *Schumacher* issued a statement explaining why the car would be further delayed. Not an altogether auspicious launch for what is probably the most innovative 1/10th vehicle to appear since *Tamiya* launched the 'Toyota 4x4 Hi-Lux!

Now fortunately all the waiting is past and the 'CAT' is out of the bag. This article looks at building the car and some of the unique design features of the first serious 4x4 1/10th racer to be made in Britain.

I must be one of the few (it seems to me) that have not entered the 1/10th hobby through an apprenticeship of 1/12th racing. For this reason I am not so familiar with the spartan and sometimes utilitarian packaging of 1/12th cars that eminated from the USA and UK.

Brought up on a diet of Japanese-made and packaged goods, whose standards of kit presentation is now folklore, I was pleasantly surprised to see that the *Schumacher* camp have made a commendable attempt at a box design.

Mind you, how the car on the box lid managed to get airborne and have its wheels stationary raises a bit of a question, and I was a little disappointed to see one of the detail pictures on the side of the box with a body that looked as though it had been trimmed with a meat cleaver, but enough of this trivia. The kit comes packaged in plastic bags with a set of building instructions detailing kit assembly and a set of operating instructions which give some useful maintenance and setting-up information.

Before describing the building of the kit it is worthwhile detailing some of the features that make the car so unique.

The chassis is of two plates of glass reinforced polyester (GRP) separated by about 30mm. The gap is large enough to accommodate batteries, steering and speed controller.

At the rear of the chassis is the main transmission assembly with the motor mounted in front of the rear wheels. The motor (not supplied) drives the main reduction gear made from plastic, which also incorporates the rear axle differential. As this differential is mounted high in the gearbox the drive is transferred to the rear axle by a pair of toothed *Kevlar* drive-belts, one for each wheel.

The drive to the toothed belts comes from either side of the differential gear. The drive from the side of the differential closest to the drive belts is virtually directly coupled to the belt-drive gear.

The other side of the differential output (the outside of the gear) is connected to a shaft which runs through the centre of the differential gear, through the centre of the first drive cog and connects with the drive cog furthest from the differential gear by a pin drive. This apparent complication is necessary in order to keep the final drive gear small and hence give a reasonable ground clearance.

In the case of the *Schumacher* we have only covered half the story because the drive is now connected to the front axle by another toothed belt. Power is fed to the front drive-belt by taking the drive from the two final drive gears. It would be pointless to take the drive from one or the other of the final drive gears because (you will remember) they are in turn being driven through a differential and each wheel could be travelling at different speeds.

The important thing to remember about a differential is that the mean of the two output velocities should equal the input velocity. If you now apply this in reverse, namely if the outputs are in fact the inputs then the new output will be the mean of the two inputs. Any questions?

In the case of the *Schumacher* 'CAT' to get a drive to the front wheels which is taken from the rear wheels then you must use a differential in reverse. If in mathematics the converse of differentiation is integration then it seems that the opposite of a differential should be an integrator, hence the name given to the device by *Schumacher*.

It is possible to vary the amount of torque delivered to the front axle by varying the pressure of the drive of the integrator, in much the same way as the drive to a ball differential can be altered by varying the pressure of the differential side-plates against the balls in the centre of the gear.

However to achieve an over-driven front-end it would be necessary to lock the rear differential virtually solid, causing all sorts of handling problems at the rear of the car.

The rear to front drive-belt passes over a drive guide between the two rear wheel drive gears and over the top of the uppermost GRP chassis to the front axle and returns under the lower GRP chassis plate.

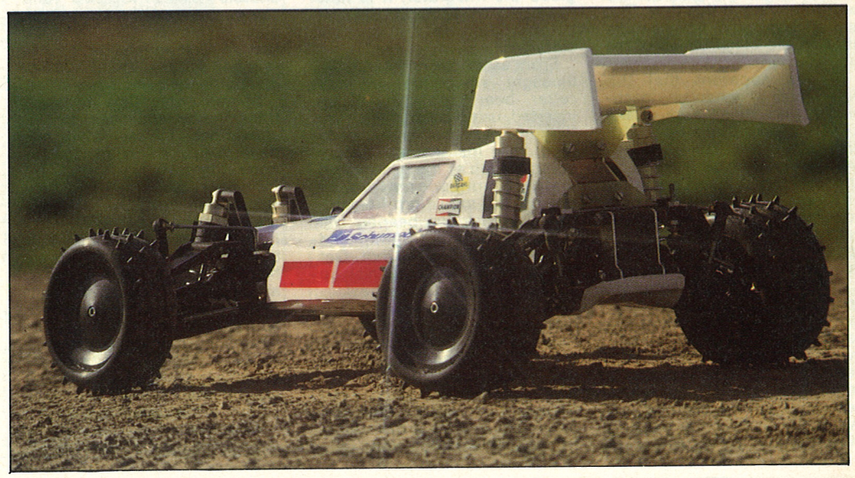
The front axle on the first models to come from the production run have no front differential, instead a pair of one-way (sprag) clutches are fitted inboard within the centre section of the front axle assembly. *Schumacher* tell us that by the time this article is in print there will be available a conventional differential for the front axle.

Drive from the gearboxes to the wheels is by plastic drive-shafts. Not just an ordinary drive-shaft but a full length telescopic drive-shaft that takes care of any variation in the distance from centre mounted axle gearbox to the wheels.

Because the axles are telescopic, *Schumacher* have been able to adopt a conventional Hooke type universal joint either end. These universal joints are made from plastic with metal centre cruciforms. Ballraces are supplied with the kit and are of substantial dimensions with removeable seals for cleaning and lubrication. So much for the drive system.

The suspension

Based on conventional unequal length wishbones the suspension arms pivot on quite thin steel pins and are similar front and rear. The rear suspension requires the addition of a fixed track-rod to



prevent the rear wheels turning as the hub ball-joints are the same as the front steerable joints.

The movement of the suspension is large with 60mm of movement. The front suspension has the additional novel feature of foldaway front arms. The idea being that when some immovable object is encountered, the front wheels spring back to avoid catastrophic damage aided by a couple of rubber bands.

The materials used in the kit are mainly injection-moulded plastic, GRP chassis and damper supports and stamped aluminium main gearbox side-plates.

The instructions initially supplied for assembling the kit were best described as pre-production and as such were definitely lacking. I was sent an updated set of instructions that I was assured would be included in all future kits. These later instructions are without doubt a dramatic improvement on the original, but I still found some areas that left me in some doubt.

My main complaint is the separation of photographs from the text. I find it irritating having to leaf backwards and forwards to find the appropriate picture. I also feel that most people would find the sight of sheets of type-written text more than a little daunting.

Now for it!

At the start of the text there are a couple of paragraphs that thank you for buying the car, tell you that you will have many hours of enjoyment and success on the race track and that time and care spent on the assembly will be rewarded with performance and reliability.

In fact it is essential that you spend some considerable time on the assembly. I found that this kit took about five times as long to build as any other I have built, and was the most difficult and frustrating build I have undertaken.

In all fairness to potential buyers (of whom I hope there are many) it must be said that if you ever had difficulty putting a *Tamiya* kit together then you should ensure that you have some skilled assistance at hand during the assembly of the 'CAT'.

I must now justify my comments.

Most of the screws used in the assembly of the kit are of the self-tapping variety which must be screwed into the plastic mouldings, the problem is that the holes in the mouldings are often a little on the small side. The force I have had to exert to drive in the screws is such I expected the plastic to split at any time. The same applied to putting the track arms into the ball-joints. On the credit side I would say that it is unlikely that any of the self-tapping screws are ever likely to fall out.

Most of the GRP parts must be finished off with a file to remove small points that the milling machine left, this should not be necessary in a kit costing £175.00.

The universal joints on either end of the drive-shafts was a whole new experience in self control. The problem was that the individual arms of the Hooke joint had to be eased over the metal cruciform. There is a small GRP tool supplied to help you with the assembly, but it is not entirely successful.

By the time I had finished the last UJ I was down to about 5 minutes each, not bad when you consider the state of my torn, scarred and bleeding hands. I am definitely of the opinion that this part of the operation should be completed in the factory before the kit is dispatched.

There are other points worthy of mention, but the previous

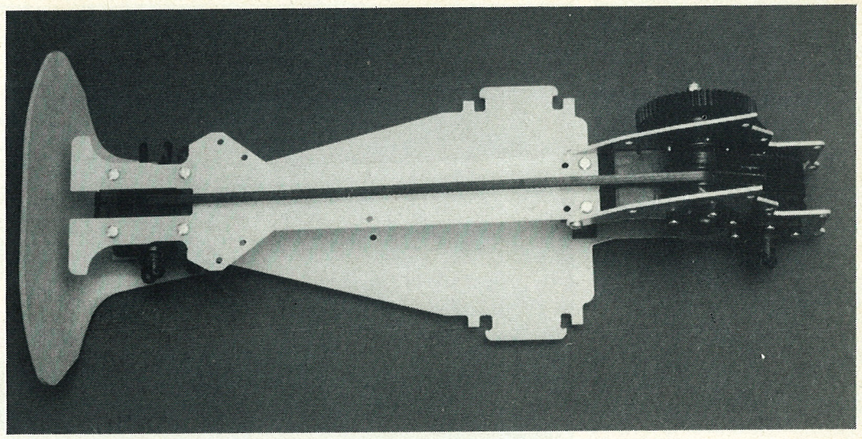
items are the main ones. Perhaps a look at the suggested list of tools required will give some idea of the work involved, they include: hacksaw, soldering iron (not for electrical work), drill and a vice.

After removing the various components from the sprues the assembly work can commence. Although perhaps not very significant, I did think that it was not a good idea to mould the drive pulleys to the sprue by a gear tooth as it meant that particular care had to be taken in cleaning up the moulding at that point.

The first part of the assembly was to fit the eccentric bearing housing to the main gearbox sideplate. The eccentric is necessary in order to adjust the final drive-belt tension. It is a neat and effective method of belt tensioning.

The assembly of the small drive gears that connect to the differential comes next, which includes gluing into place the main drive pins with a good quality cyanoacrylate adhesive. I think that it would be a good idea to apply a little grease to the centre bearing at this time. The use of 'Superglue' figures quite often in the construction of the kit.

It was apparent that the differential mechanism occupied a very small area of the available space of the differential gear. This I thought was rather odd as it must be apparent that a much smoother differential action can be achieved with the differential balls fitted into a larger radius. I spoke to *Schumacher* about this, and as it happens there was a good reason to this apparent anomaly. It was envisaged from the early design stage that the car should have a gearbox. To fit the drive and get all of the necessary clutches installed a small differential hub was necessary as the gearbox will eventually fit over the existing differential.



Back to the gluing. The next stage involves the building of the differential assembly and gluing the thrust washers to their carriers. The same applies when you come to assemble the integrator. Having built and glued the integrator, it is now necessary to dismantle the unit before fitting to the gearbox sideplates.

Front axles now come into the limelight when the one-way roller bearings have to be inserted, using a vice makes the job quite easy, but remember to read the instructions before doing the job as it is pointed out that the bearings do not lay flush against the moulding. Remember also that one bearing will have the writing showing and the other bearing will not. Get this wrong and you will finish up with drive only to one wheel.

It is worth remembering that *Kyosho* also went for a similar type of drive in the 'Progress' but eventually acknowledged that you could not beat a conventional differential when they fitted it to the 'Gallop'. *Schumacher* seem to have come to the same conclusion, only quicker as they tell us that a differential for the front is now available.

The front drive assembly is now fitted between the two chassis plates. Two chassis brackets are used to hold the chassis plates together and clamp the transmission unit in place. This is quite a good feature as it allows the front to rear belt to be adjusted and still maintains the same wheelbase.

At the same time the rear transmission unit can be installed once the rear drive belts have been adjusted to the correct tension.

I liked the design of the suspension wishbones. They are well ribbed and the ball-joint housing looks to be of ample bearing area. The ball-joints are held in place with a novel arrangement. To keep the balls in their housings there are pinch screws that are tightened. The interesting point is that the ball sockets are not split, you are effectively squeezing the plastic around the balls. Odd it may sound, but it seems to work.

As with all of the pins that are fitted to the plastic, some force is necessary to fit them. The wishbone pivot pins are no exception, the instructions ask you to remove any burrs on the ends of the pivot pins. This deburring is a feature that with a £175 kit should not be necessary.

The instructions advise that the wishbones can be fitted as shown, referring to the pictures. It was not at all clear to me, however, commonsense should be enough at this point.

Front suspension incorporates the swing-back arrangement where the front wheels will hinge on a pivot pin to avoid breaking off the wishbones. This is a unique feature and should save money for the inexperienced driver. Although not strictly a criticism more a question, I wonder if the wheels are actually hinging back and forth along bumpy tracks? No doubt drivers will discover this soon enough.

The assembly of the driveshafts is next. I have already mentioned the problems of building the shafts, but it must be said in all fairness that once assembled the UJs are extremely smooth and I liked the action of the telescopic driveshafts, although they would certainly benefit from the addition of a little lubrication.

The durability of the Hooke type UJs must be one of concern as the earlier versions of some 10 years ago made from brass, steel and plastic had a very limited life. The ends of the drive-shaft stub axles that connect the drive to the wheels look to be barely man enough to do the job, but with the wheel securely held in place with a single socket screw I guess that this particular area has now been well tested and is unlikely to cause a problem.

The hub carrier is in turn very large indeed and virtually fills up the inside of the wheel. This looks very neat, although the fitting of the steering ball-joints is a little tricky. The large diameter ball-races fit very well into these housings, and I am pleased to note that all the ball-races used on the car are of the same ample size.

This just leaves the dampers to be constructed, which are straightforward. The damper design is quite conventional incorporating a lip seal at the piston rod end. It is worth mentioning that some care must be exercised during the assembly of the dampers to ensure that the open side of the seal must face into the damper and at the other end of the unit the 'O' ring must be fitted into the cap, not around the threaded body of the damper.

I found that the dampers were quite oil-tight and worked adequately, although the springs seemed on the strong side, but once again this is an item that race use will determine.

I did not like the steering ball cranks pivoting on the threaded portion of their mounting screws, I am sure that it will work OK, but it is the sort of thing that an amateur would do, not a respectable engineering company.

The final mechanical item that needs to be done is the bending of the anti-roll bars. This is much easier to do if you have access to a vice. I felt that the instructions were not really adequate for this. Take for example the front anti-roll bar. This involves a double bend. If you have any smattering of engineering drawing knowledge it is possible to see this from the template drawings, but not every builder will have this knowledge, much better to have a perspective sketch as well as the template to show what the final job should look like, there is not even a photograph of the completed anti-roll bars. Also some suggestions on which bend to put in first would not go amiss. I found hints on bending like "bend the swivel pin neatly and accurately" superfluous.

The only job remaining is the bodywork and the fitting of various covers.

The body is held in place by *Velcro* patches, a good idea borrowed from across the Atlantic.

I have not detailed every single part of the construction. To be fair to the makers, most of the assembly is easily understood. It is also true to say that if you want a kit that does not fall apart after the first few outings, then the assembly will require some care and effort. This kit is not easy to build, but on the credit side it should not fall apart too easily. There are some parts that, in my opinion should be assembled in the factory. However many people have already managed, as lots of kits have already been sold and have made an impression on race times. This is particularly true of Germany, where the car is proving to be really successful.

As far as design is concerned the car incorporates some interesting points. One design feature, the positioning of the motor in front of the wheels is claimed to give low polar movement of inertia.

This is probably true. I suppose you could compare this to swinging a weight around on the end of a piece of string, with the weight on the end of a long piece of string it is difficult to change speed, or direction. With the string short, the problems of changing direction and speed are much reduced.

This could be compared to a car with a large mass (say a motor) outside of the wheelbase (a long piece of string) or a car with a low polar movement of inertia (a short piece of string). This sounds as though the 'CAT' has everything going for it.

Unfortunately this is not the whole story. For those interested in full-size rally cars you may remember the *Lancia* 'Stratos', a car with a centre mounted engine and a very low polar moment of inertia. The fact was that only a few drivers could get the best from this design as the car was so twitchy. Cars with characteristics achieved from apparent design inadequacies, such as more weight over the rear wheels are more predictable.

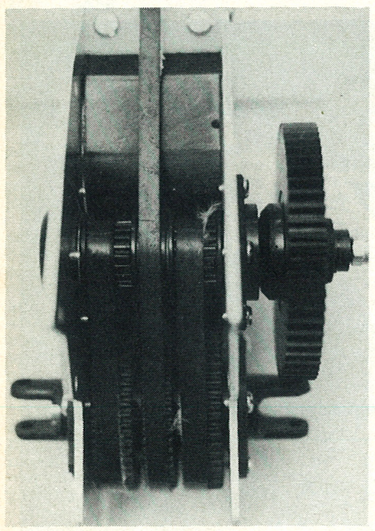
It remains to be seen if the 'CAT' will produce a higher echelon of driver with super fast reactions and a sixth sense.

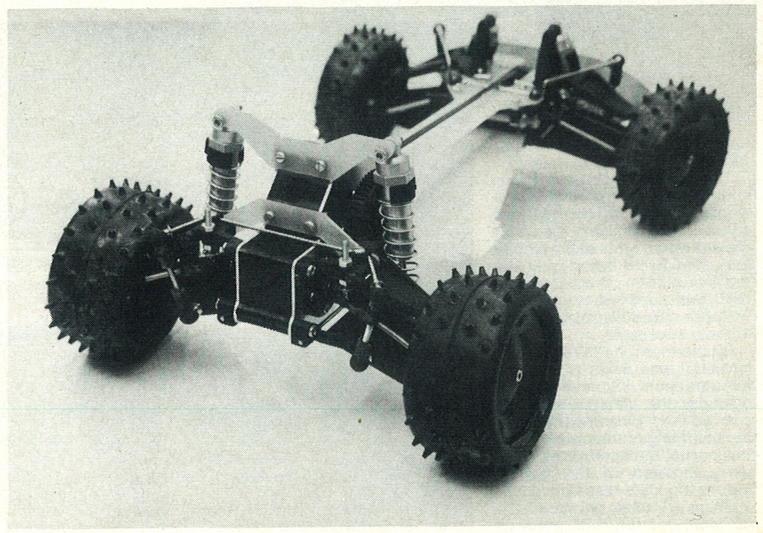
It may appear that I have been overly critical of this unique car, this is not my intention. I have tried to be fair. There are many good points in both design and manufacture, there are (in my opinion) a number of shortcomings that can be overcome if you have some mechanical ability and understanding, whether you should have to do this with a kit costing £175 is another matter. If you are not of a mechanical mind, then I suggest you enlist the help of someone who is when building this kit.

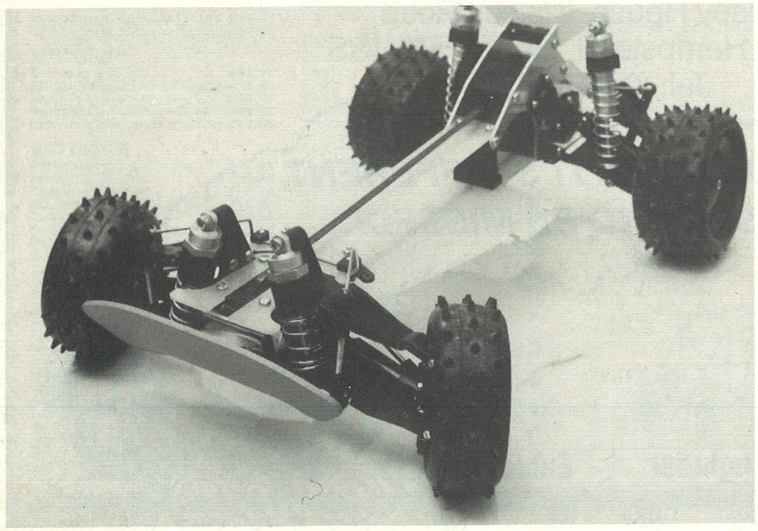
Manufacturer: Cecil Schumacher, 'Rudge', Church Brampton, Northants.
Price: £175.00 (approx.)

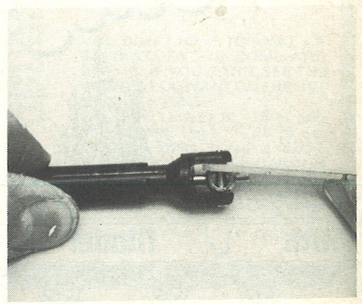
Specification check

Car	CAT
Type	1/10th scale Off-Road
2WD/4WD	Four-wheel drive
Differentials	One
Length	345mm
Width	235mm
Height	150mm
Wheelbase	250mm
Front track	236mm
Rear track	236mm
Ground clearance	30mm
Tyre sizes — Front	32 × 83mm
Rear	40 × 85mm
Weight	1500g (approx.)
Motor	Not included
Bearings	
Plain	
Ballrace	14
Total	
Manufacturer	Schumacher Racing Products, 'Rudge,' Harlestone Road, Chuch Brampton, Northants.
Price (approx.)	£175.00









Far left: inside the rear transmission showing differential, twin Kevlar drive belts and integrator.

Centre left: rear suspension.

Centre right: front suspension, incorporating unique 'knock-back' system kept in place by rubber band.

Below: installing the UJ's, a time-consuming and painful job.