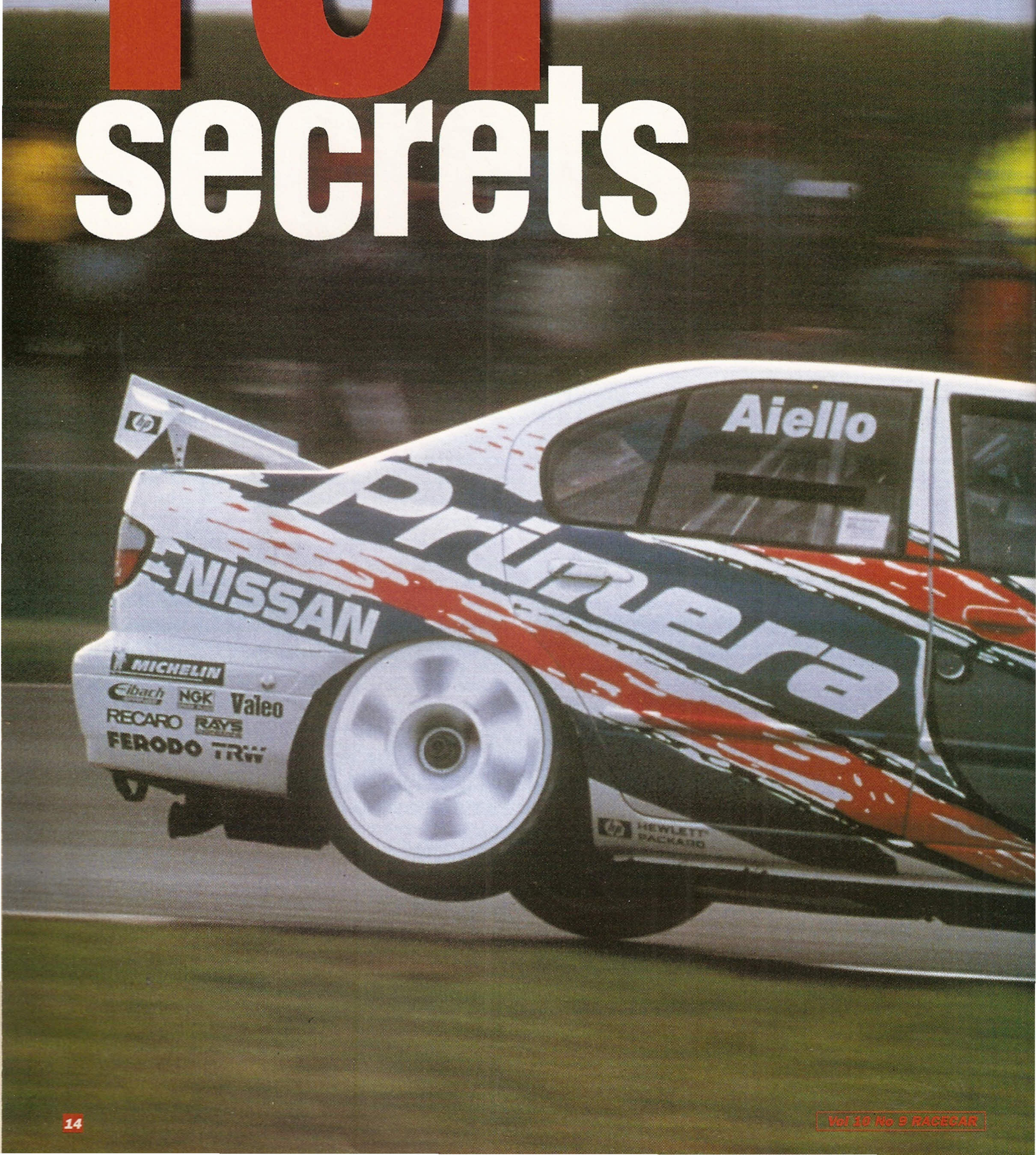
TOP secrets

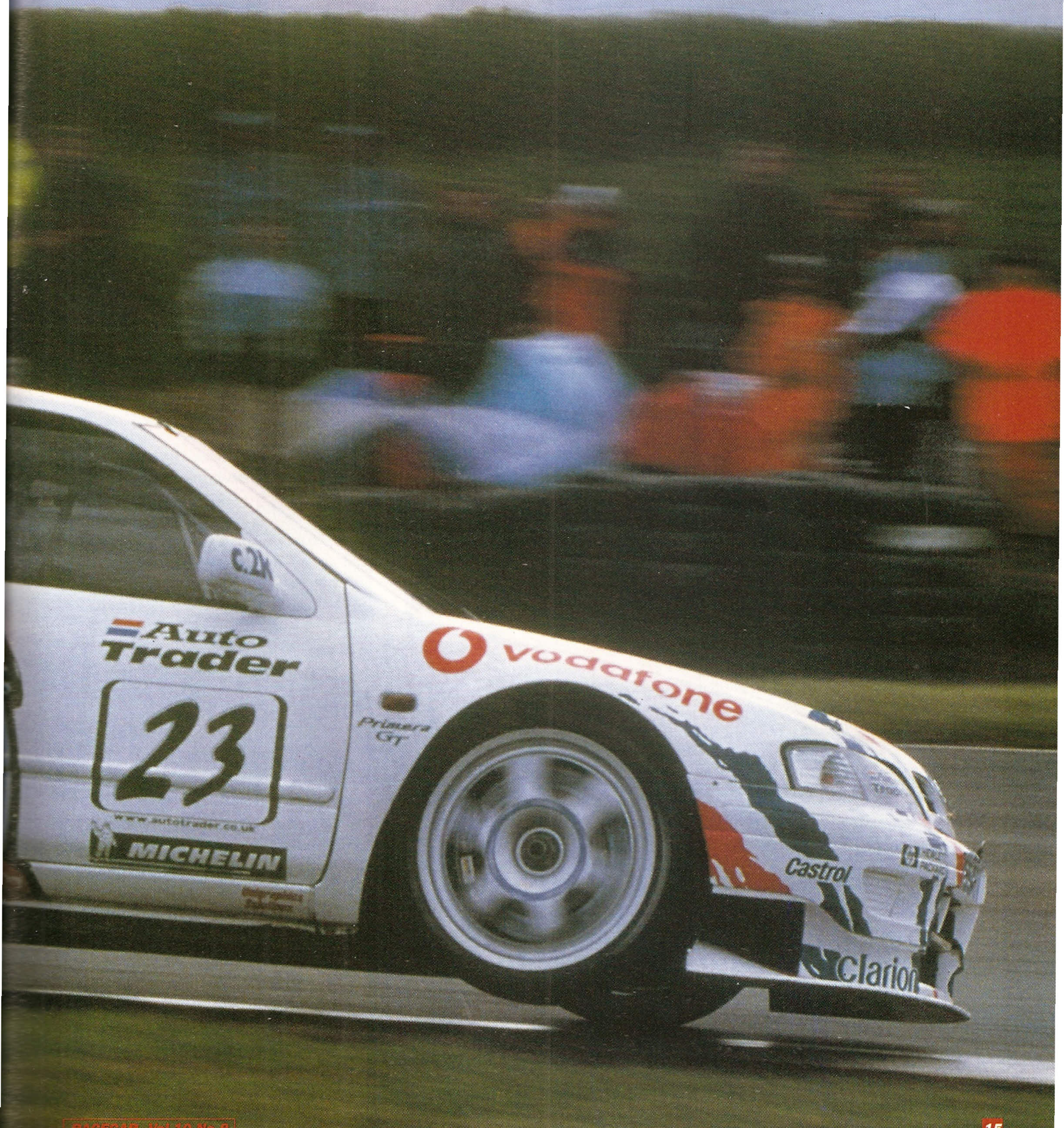
In an exclusive interview with former Nissan Motorsport Europe technical director Richard Divila, we reveal the secret's behind Nissan's domination of last year's British Touring Car Championship

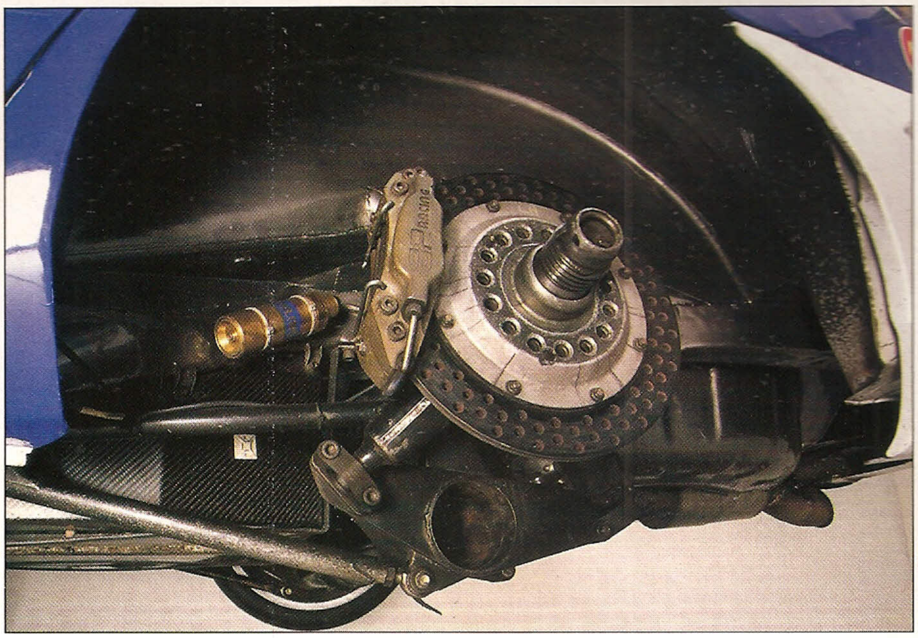


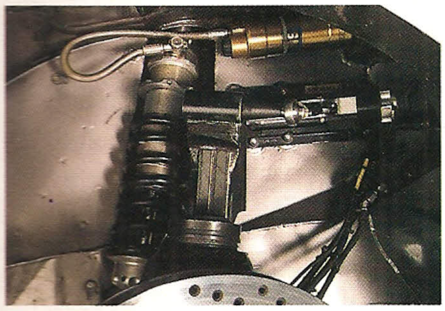
Having won two British Touring Car Manufacturers titles and one drivers championship in the previous two years, Nissan announced its withdrawal from the series in October 1999. This was part of a world-wide rationalisation of the manufacturer's competition programmes which followed the serious financial problems that had afflicted the parent company in Japan and led to its eventual acquisition by Renault.

By May 2000 its UK-based motorsport division, Nissan Motorsports Europe, which had been instrumental in the BTCC programme, had been disbanded. The ending of the project resulted in the 'de-classification' of related material and the willingness of one of the key members of the project to talk about the challenges of engineering a successful Super Touring racecar. Richard Divila, NME's technical director from 1997-2000 offers his unique insight:

'The Nissan Primera GT's that raced until the end of 1998 were front-wheel-drive cars based on the four-wheel-drive chassis platform, which had been allowed by the Super Touring rules. In fact, for 1998 four-wheel drive was made illegal by a new FIA ruling, but Audi got a one-year deferment and was able to continue using the A4 with front drive and that allowed us to do the same thing.







The Primera GT's beam axle rear suspension and the gooseneck of the front upright

'NISMO in Japan had had a bad experience racing with a beam axle rear end, like on the front drive road car, so they really wanted to play it safe. They wanted to keep on running the four-wheel drive platform, which used Macpherson struts at the back, for as long as possible. For 1999 we had no choice, we were obliged to use the beam axle rear end that was fitted to the front wheel drive road car and I had no problem with that.

'Naoki Tokanaga, Nissan's chief vehicle dynamicist in Japan, was very much involved with the rear axle design for the Super Touring racecar along with Martin Brigden-Gwinnutt and Nick Wasyliw at NME. Very few people knew anything about racing a beam axle on a front-drive Super Touring car because apart from Nissan nobody else ran one.

'After a lot of work we managed to sort out quite a lot of little tweaks in geometry that were not very obvious. To combat roll steer on the back axle you can do some very strange but effective things with link positions. I think it would take a long time to suss out if you tried to do it for yourself. Having the people who designed it and had worked with all of the characteristics from the beginning with the road car was very helpful.

'The 1999 rear axle ended up being quite a complicated affair. From the production car we inherited a torsion beam that twisted around an inner torsion bar. Under the Super Touring regulations anti-roll bar design was free so we set the beam in a very stiff arrangement with twin bearings that gave us a fixed suspension which pivoted around the middle giving zero bind effect. That allowed us to play around with the suspension geometry and improve the car's natural tendency to understeer.

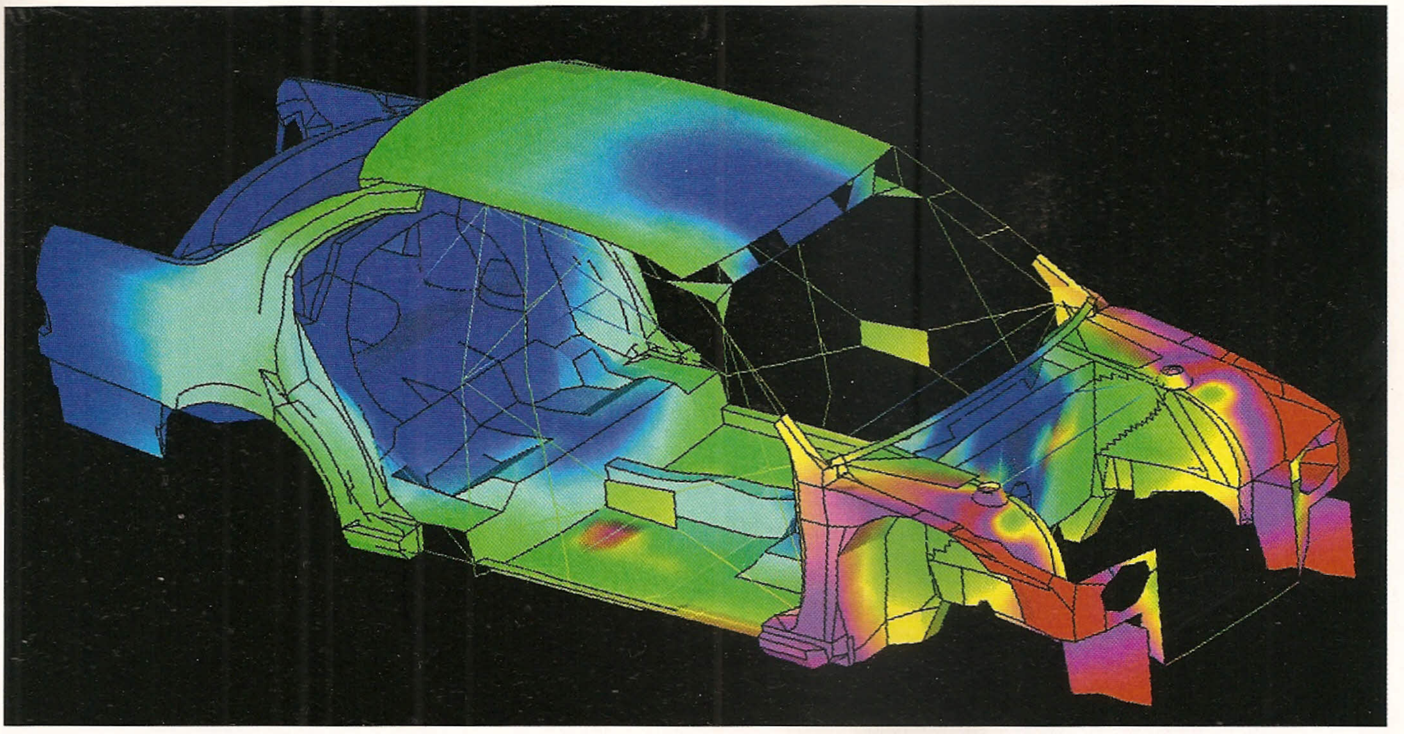
'The beam axle helped us to overcome a weak point of the Primera with the Macpherson strut rear end. On those cars it was very easy to flat spot the inside rear tyre. At fast tracks like the Salzburgring we were really running on the ragged edge. Several times the cars came in with the tyres worn down to the steel cords. At Salzburgring it was a particular problem because the tyre that gets flat spotted is the one the car leans on going through the fastest corner on the track, a big 220kph corner.

'Getting the friction out of the struts to reduce this problem was a big challenge. We did a huge amount of work on using needle bearings in the Macpherson and a lot of development on the dampers using the four-post shaker rigs at Servotest and Shrivenham to improve the whole system. When we had to use the beam axle things got a lot better and the problem effectively went away.

'Adapting the front suspension geometry for racing was also a challenge because of the limited room available. On full bump the top of the gooseneck upright, which wraps over the upper surface of the front tyre, would hit the wheelarch. Also the top link from the gooseneck to the chassis frame was so short that it kinked the wheel over after a fairly small amount of travel. By using very short effective swing axle lengths, we were able to ensure that regardless of the attitude of the car at the front, the contact patch was flat.

'That was hard to achieve but it gave us an added advantage in that it made the car very easy on its front tyres and we could always use the softer compounds. At some tracks the drivers might miss out on that extra 10th of a second in qualifying, but while after three or four laps of the race everyone else's tyres started to go off the Primera's would last a lot longer due to the fact that the tyres on the Nissans were slower to heat up and were being used less aggressively. So what we lost in qualifying could usually be made up in the race. If the car was on the first couple of rows of the grid there was a good chance of winning.

'On the positive side, the gooseneck did provide a lot of adjustability. It allowed us effectively to take the king pin away from the suspension point. That way we could have two suspension points and change the kingpin angle just by changing the bearing angle. It also allowed us to move the points. The king pin axis is really the bearing axis and the castor axis too – it is not where the suspension points are, we did a lot of work on this. This means that we could run trailing axles, leading axles or whatever was wanted.

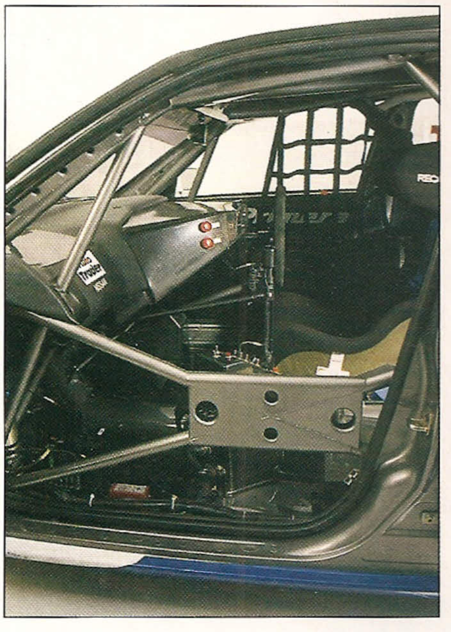


'Talking of trailing and leading axles, we came up with a variation for the 1999 beam axle car to give Laurent Aiello steering more to his liking. What he wanted was very quick and light steering with a lot of feedback. Peugeot had achieved that on the 406 he drove, by having different power assistance blades for every track. They were running something like 160 bar but the maximum our seals could take was 100 and that meant we never got beyond initial testing. Laurent liked it as an input but we couldn't get enough power assistance.

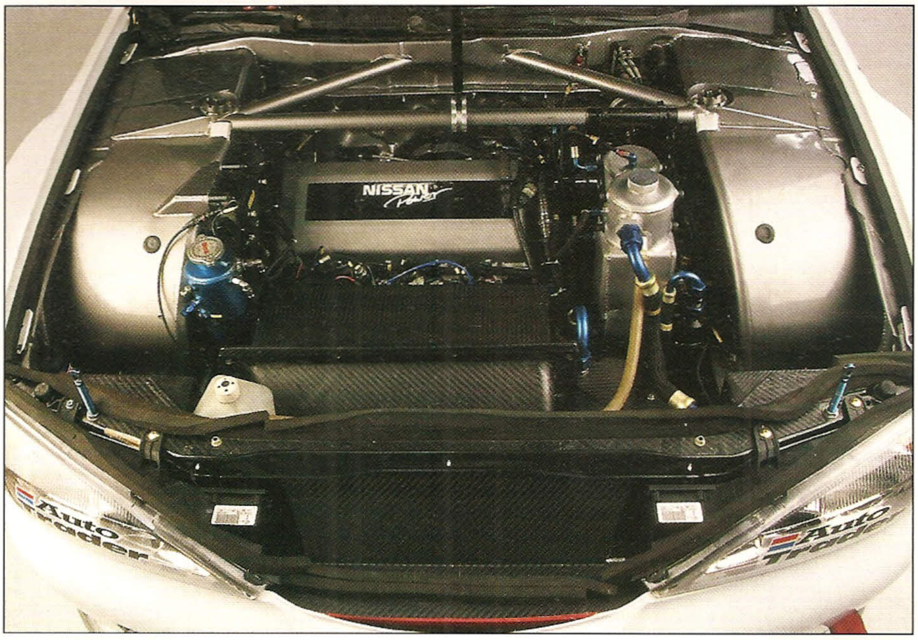
'I'm not sure it was really necessary because in general, on most tracks, we effectively had power oversteer. The front end would tuck in so well because of all the work we had done with the steering geometry – kingpin angles, castor angles and so on – that when the driver booted the throttle the car would oversteer rather than understeer. Not because the rear came around, but because the front was pulled in. I was quite happy to have that problem. The best comment I heard was from a driver who tested it and said that it handled like a bad Formula 3 car!

'One of the major areas of development between 1996 and 1999 was in roll cage design. The first iteration, done by Jean Claude Martens of NME (Nissan Motorsport Europe), tested at 26,000Nm/deg but by 1997 that figure was up to something like 48,000Nm/deg and the cage weighed 7kg less. For comparison, that's about twice as stiff as a Formula 1 monocoque although of course a touring car cage is made in steel and has a huge section. That big step came from the use of finite element analysis for the first time and as we got better using FEA so the cage and chassis stiffness improved too, even with the Macpherson rear suspension.

For 1998 Phil Truman took over responsibility for the rollcage design at NME and we made another gain, up to around 57,000Nm/deg and cut the weight by another 14kg. The improvement that year came from having access to all the meshing for the FEA programme from Nissan in Japan. That meant that we had the whole body that we could integrate with the roll cage and also led us to a different build method for the 1998 car. It was more a case of assembling the body around the cage than fitting the cage into a bodyshell. A good reason for doing that was to cut down the amount of preparation work. If you get just the component panels rather than a pre-assembled body shell it's far easier to do a proper assembly job and build it the way you want



Finite Element analysis allowed enormous improvements in the torsional stiffness through the design and mounting of the car's integral roll cage (left). Below: most of the suspension mounts feed loads directly into the cage



Upper mounts on the front suspension were never a problem, but difficulties with the lower pickups were resolved using a stressed sump

it. If you control the welding you can get a much stiffer structure and you can also make sure that the car is the right size.

One of the surprising things that building a Super Touring racecar shows is that there can be a lot of 'drift' in the dimensions of production cars. If you build the bodyshell yourself you can make it to the spec. In the rules there is a tolerance on width, but as far as I know nobody has ever been measured for height. If you do your build job carefully and really push the limits, I think you might be able to make a 1-2% reduction in frontal area.

'Front suspension mount stiffness was a problem with the early versions of the Primera racecars but for 1998 Andreas Els of NME came up with a sump that was used as a stressed member. It carried the lower front suspension and the top pick-ups were on the cage. Before we moved to the stressed sump we had an aluminium cross plate under the engine but it was impossible to tie it down and make it stiff enough to keep it from moving. The only real solution was to attach it to the sump.

'Unfortunately, early in 1998 there was an oil scavenge problem with the new engine which meant that we had to go back to using the 1997 engines. But as we had proved that the engine could take the loads we fitted a stressed sump to the older engine too and we had no problems at all. Engine manufacturers are usually reluctant to have the block used as a stressed member. But we were not twisting the whole engine like in an F3 car on an in-line mounting, we were using the sump to do some structural work. That was the big step we made from 97-98, the whole front end was a lot better.

'One drawback about having to switch back to the 1997 engine was that there were only about eight of those engines to do both the BTCC and the STW Championship in Germany. We had to fly to some races carrying engines as hand luggage. There were about 30 of the newer engines that needed modifying to fix the scavenging problem. I think it was that workload, in addition to having to build enough modified 1997 engines to keep the cars running, that really cost us the 1998 BTCC drivers championship, although we did win the manufacturers' championship.

'In 1999 aerodynamic development became a lot simpler because we could concentrate on the BTCC. Before that we had to allow for cars racing in Japan and Germany too. The aerodynamic characteristics for Japan are concentrated on Fuji, with a top speed of 270-280kph. In Germany the car would be operating on tracks with very slow corners and long straights. Then in England the circuits don't usually require a lot of grunt but a lot of torque, they have fast corners and a relatively limited top speed. Sorting out a package for that was pretty complicated and opened my eyes to a lot of things. The big problem was that we had to homologate one package to use in all countries.

'There was a way of homologating a different aero package for each country by claiming cars were different models but Nissan only had the Primera GT and that was it.

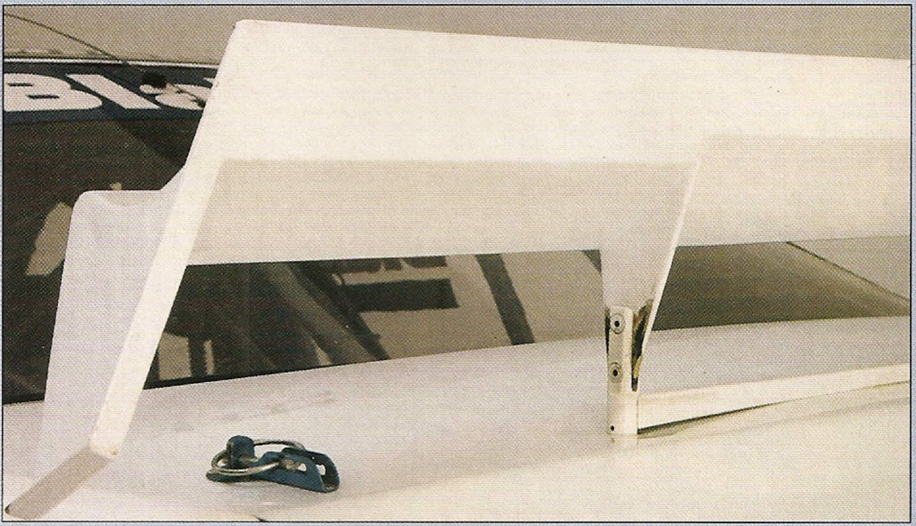
'Going by the MIRA papers on the production Primera, our base car had more drag than the Ford, the Vauxhall and the Peugeot and we also had a lot of rear end lift. So we had a very limited choice on the aero package. Even with minimum downforce on the car, the drag factor would still have been too high. The only correction factor we could do was run more downforce and since we had a drag penalty anyway it wasn't really going to hurt us. Fundamentally that approach also worked very well in the BTCC and the German STW series too.

'Usually NME had final call on the aero layout for the BTCC car although most of the work was done with Ron Hartveldt or Andy Coventry at RML. They ran the various test packages and we more or less chose, from the design brief, what we wanted on the car. The evolution was done mostly in the NTC wind tunnel in Japan at which we could test at speeds of about 270kph at full scale. We also went to the MIRA full-scale wind tunnel to do rear wing work and there was also a lot of work done on coast-down testing on the 1-mile straight at Millbrook.

'The biggest challenge in Super Touring aerodynamics is getting the front and rear elements to balance. The front splitter is working in ground effect but the rear wing sitting behind the cabin area runs in dirty, turbulent air and only really works when the car is in yaw.

'The front splitter design has to be done very carefully to reduce pitch sensitivity. If you look at the 1998 and 1999 Primera splitter designs, more of the front wheel is visible than on most of the other cars. That area above where the front diffuser is swept up is sealed off on the other cars. On those cars, when the nose goes down with aerodynamic load, the diffuser actually generates a whole lot more downforce as the splitter gets closer to the ground which can upset the car.

'The two little dive planes in the Primera



Imaginative design of the front splitter and the rear wing made the Primera GT much more stable and progressive than some competitors

splitter design mean that as the nose goes down the air stacks up ahead of the front tyres and blanks off the exit of the diffuser. So although the downforce increases, initially it's not to the same almost exponential degree, and in fact when the Primera splitter gets very close to the track surface the downforce level flattens out. That makes for a much more stable car. The drivers could really stand it on its nose under braking without getting the large, unwanted gain in downforce. The Primera was very fluid through corners and transitions from straightline to turning, to braking, to mid-corner, to the re-application of power.

'Water-cooled brake calipers also helped with the aerodynamics and we ran them all the time. In addition to being a stiffer caliper which helped braking performance, being able to run without air scoops on the car to flow air to the brakes was a big plus. Dumping air into the wheel wells is a loss for a start. Every time you cool the brakes that way you lose front downforce, that was something we tried to avoid.

'At the back of the car one of the main improvements we made was to use the wing supports as trim tabs to kill the lift caused by the surface of the boot lid. The rule that said that the rear wing had to fit in a 150mm square box gave you two choices. You could either go for height and try to get the wing to run in clean air, but in my opinion that would give you drag in a straight line and we already had lots of that. Also in cornering, a high mounted rear wing can lose downforce because it is more prone to a roof spill vortex occurring on the upwind side of the car while the downwind side of the wing is blanked off by the cabin area.

'What we went for was running the wing a bit closer to the bootlid. The box really starts with the wing mounts and most bootlids are bowed in the middle so you can get another 5-6mm on wing height anyway. If you bring the wing down and run widely spaced mounts, like those BMW used, with lateral strips, you can kill the lift. We went to the extreme, I think the Primera had the widest spaced wing supports of all. As the car went into yaw it would drop some front downforce but pick some up at the rear. That meant that the problems we had with the rear end could be corrected with the aerodynamics on fast tracks. That's why the car was always so well balanced at Thruxton – even with the Macpherson rear end the Primera was quite stable.

'We managed to make the Primera GT a well-balanced racecar overall. The success we had came from a combination of playing around with front and rear suspension geometry, roll centre migration and the contact patch to optimise the whole. I think that's where the package scored. It worked so well that we could always run the softest compounds and not eat the front tyres. In Super Touring that's a winning advantage.'

Brazilian born Ricardo 'Richard' Divila has more than 35 years experience in racecar design and engineering having worked on various projects in Formula 1, Indycars, Formula 2, Formula 3000, Formula 3, World Sports Car Championship racing, Group C, GT-1 and GT-2, Super Touring and Group A & Group B Touring cars.