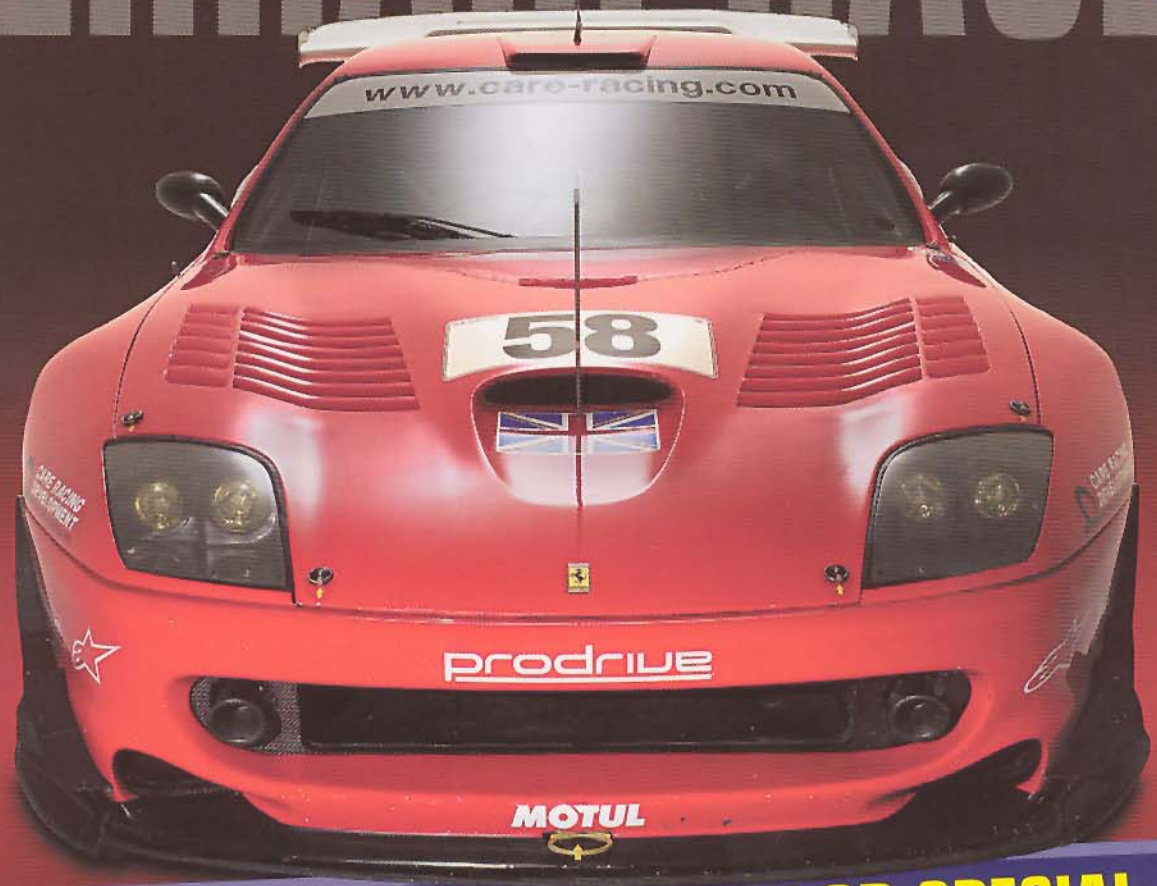
WIN A CAR! RALLYCROSS RACER UP FOR GRABS – FIRST DETAILS p58

CARS & CAR CONVERSIONS

ccomagazine.com
Dec '02
£3.30

FERRARI RACER

THE SECRETS BEHIND PRODRIVE'S 200MPH ITALIAN STUNNER



RALLY GB SPECIAL

- DRIVING A STAGE IN THE FOCUS RS
- BUILDING THE WINNING WRC 206
- WORLD RALLY CO-DRIVERS' SECRETS

PLUS • TURBO'D FIESTA DRIVEN • WIN SONY PS2 WORLD RALLY GAMES • EXPERT GUIDE TO DRIVING FAST IN THE WET • PRODUCT REVIEWS

tech HOW TO... FIT THROTTLE BODIES AT THE CLINIC: SETTING UP YOUR LOTUS ELISE THE WORKS: AUDI, SEAT AND VW ENGINE TUNING Q&A: DR DAVE ANSWERS YOUR PROBLEMS PROJECT CARS: BMW 2002

Driving Forza

During 2000 an approach was made by one of Prodrive's long time rally customers to consider taking on a GT programme with the Ferrari F550 Maranello. Tech director (racing) George Howard-Chappell recalls: "we had wanted to do a sportscar programme, and this approach was the catalyst. We had people here who already had sportscar experience, and with the withdrawal of Ford from the BTCC [Prodrive had built and run the Mondeo to dominant championship success in 2000] we obviously had some spare capacity. But it was clear that the only way to do it properly was to start from scratch."

And so one thing led to another – but to a very punishing schedule indeed. The project kicked off on January 2 2001, with the aim of making the Silverstone round of the FIA GT series on May 13. That meant there were just 16 weeks to do the whole job from the bare chassis up – allowing for enough time to do minimal testing prior to the race.

The car made that first event at Silverstone, but following a run in with the FIA scrutineers – of which more later – it didn't actually race until Hungary in July. By its second race at the A1 Ring in Austria in mid-August, following further "discussions on rule interpretation" with the FIA (again, more of this anon) the car sat on pole position and won the race. So, zero to hero in just seven months... Not bad at this level of competition.

One complicating factor was the existence of similar race categories in which to compete. The initial target was the FIA GT series, but there was also the American Le Mans Series (ALMS). The ALMS 'GTS' class rules, which differ in certain key areas from the FIA regs, are based on those of the Auto Club de l'Ouest (ACO), the Le Mans 24 hours organisers.

So no surprise then that Le Mans was on the agenda, and 2002 saw Prodrive debut the car in that legendary event. What perhaps was surprising was the sheer pace of the Prodrive F550, which shook the establishment on its first appearance at the famous La Sarthe circuit. But let's not get too far ahead of ourselves here...

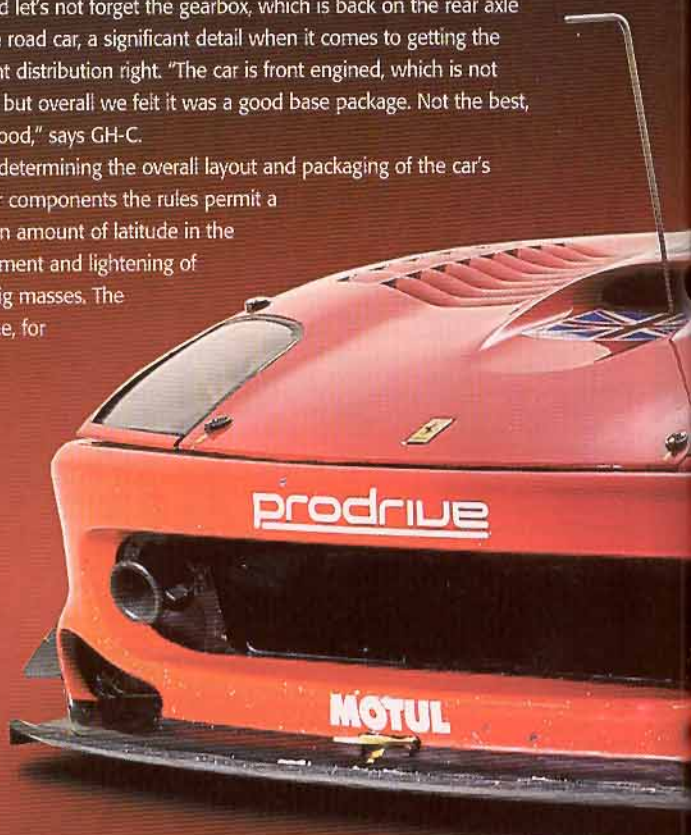
Basics and layout

Rewind to January 2001, when George Howard-Chappell (GH-C) wandered down London's King's Road armed with a company cheque and bought not one but two used F550s! The next step was to strip the cars down totally so that, with rule book in hand, Prodrive could figure out just what was going to be possible with the F550, and so that the chassis structure could be tested. Incidentally, the principle players in this project, in addition to GH-C, were Martin Ogilvie and Mick Metcalfe on the chassis, and Jason Hill and Christoph Bruderer on the engine.

"You have to look at what you have to carry over to the racecar," explained GH-C in reference to rules that require the engine castings to be retained; the engine and transmission to remain in the same basic location; and the suspension to be of the same type as on the production car. "With the F550 you get a very nice road engine. It's a large capacity V12, four valves per cylinder, with a good combustion chamber and port designs. You also get very good double wishbone suspension. The body shape is alright, not brilliant, but it offers a large plan area and there are good overhangs front and rear." These last two points allude to the potential for downforce generation, the performance enhancing side of a vehicle's aerodynamics. "However," continued GH-C, "the 'greenhouse' is quite large and it's not the best shape overall," which of course is a reference to the generation of aerodynamic drag, the performance sapping aerodynamic effect.

And let's not forget the gearbox, which is back on the rear axle in the road car, a significant detail when it comes to getting the weight distribution right. "The car is front engined, which is not ideal, but overall we felt it was a good base package. Not the best, but good," says GH-C.

In determining the overall layout and packaging of the car's major components the rules permit a certain amount of latitude in the placement and lightening of the big masses. The engine, for example, had significant weight removed, both with reductions to its internals, but also by the scrapping of the production variable inlet system. A lightweight fixed system on the racecar saved a whopping 20kg. As this weight was high on the engine, the centre of gravity was lowered significantly with this modification.



The engine was also lowered thanks to a re-worked dry sump system to replace the standard one, and then moved back in the car, which involved some typical Prodrive thinking. GH-C explains: "The cockpit dimensions have to remain fixed, and you

Here's two names to conjure with: Ferrari and Prodrive. Put them together and you get the Ferrari F550 Maranello GT challenger, possibly the most beautiful car ever featured in Tech Focus. But, as **Simon McBeath** discovers, that beauty is not just skin deep

PRODRIVE

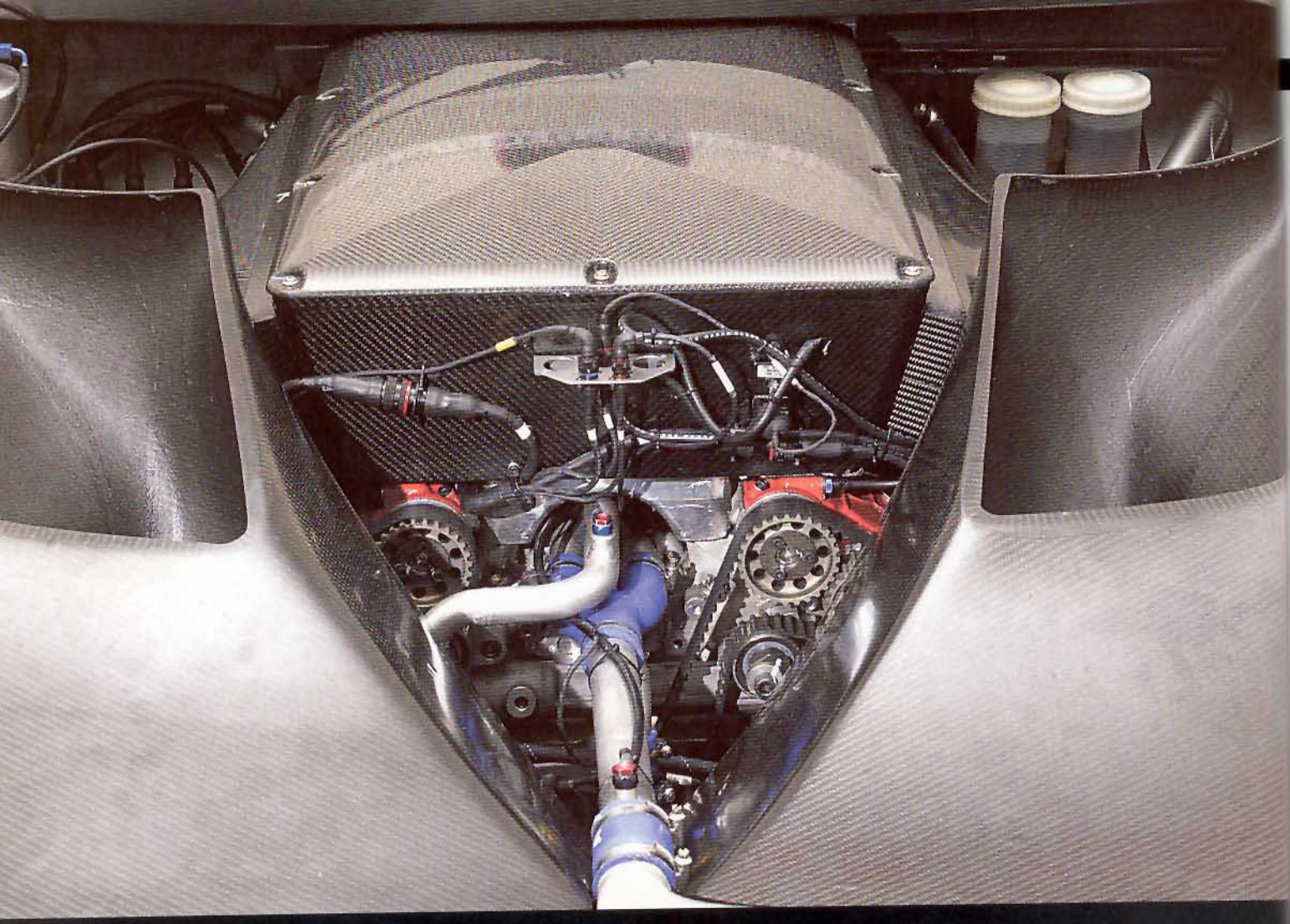
FERRARI F550 MARANELLO GT/GTS

cannot let the engine into the cockpit. So we machined off the outer corners of the cylinder heads and cam covers." This provided a chamfer that enabled the engine to be moved several centimetres further back without altering the firewall.

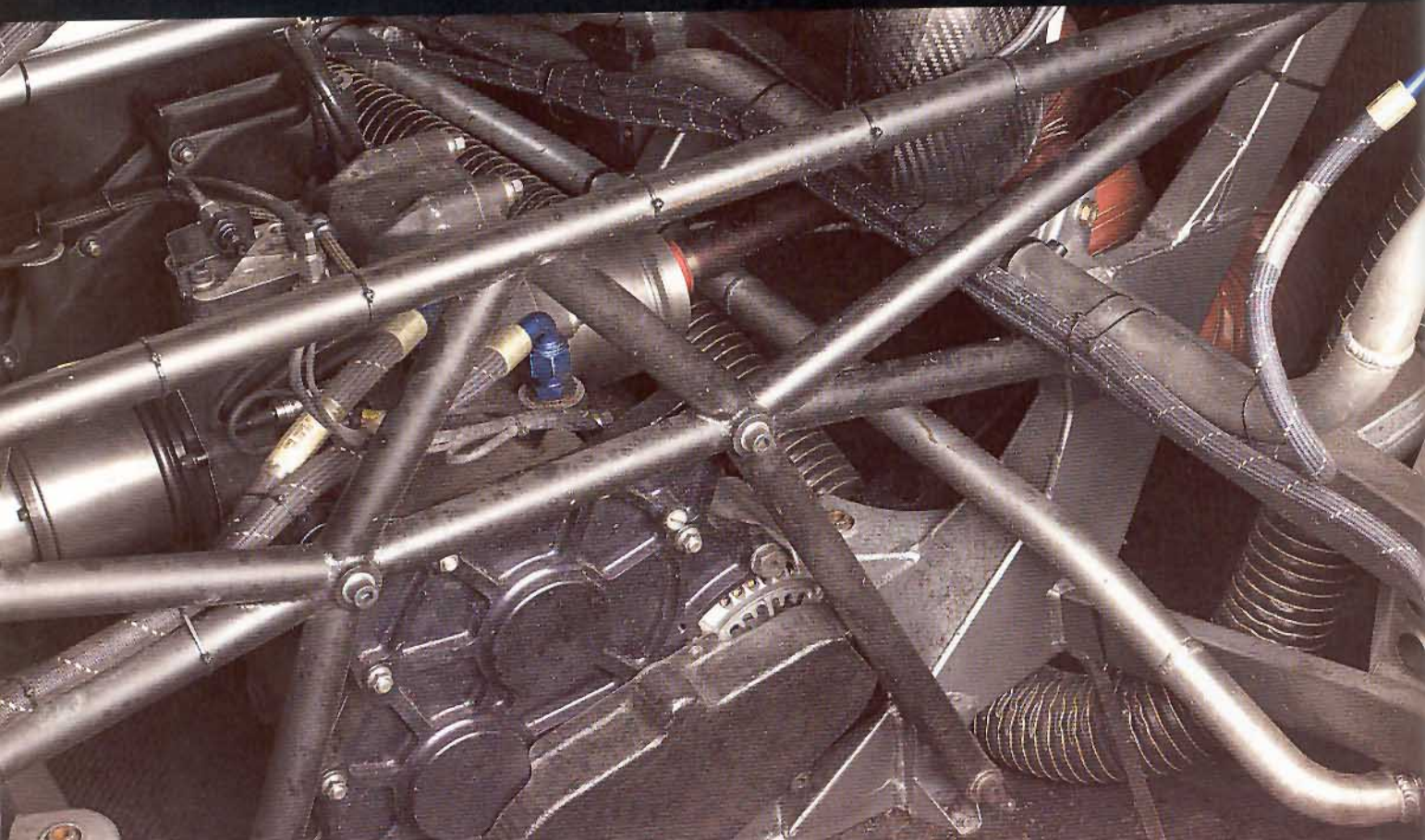
This in turn produced a packaging problem that was also overcome in true Prodrive style. "With the engine low and further back the steering rack could no longer run underneath it any more. So we've located it behind the cam pulleys which was a bit novel" said GH-C. Those who recall that Prodrive ran a driveshaft within the V on the much-lowered transverse V6 engine of the BTCC Mondeo will not be surprised at this solution.

The gearbox, with its gear cluster ahead of the final drive, is part of the rear axle assembly, and hence the transmission is in much the same location as on the production model, simply because the wheelbase is fixed, and so the rear wheels are in the same position. To cope with the hike in power it wasn't possible to lose much weight from the transmission. However, it is likely that the designers

continued p68 ➤



"On its first appearance at Le Mans, the sheer pace of Prodrive's F550 shook the establishment"



wanted a rearward shift in weight anyway so this presumably was not a problem.

As for the chassis itself, the original pressed steel 'monocoque' has been supplemented with a complex rollcage made with varying diameter round tubing to provide driver protection and to stiffen up the chassis. GH-C remarked that the stiffness, hub to hub, was now similar to a touring car – meaning that it's pretty rigid.

Suspension and wheel systems

Both the FIA GT and ALMS/Le Mans GTS regulations require the original suspension type to be retained, hence the earlier reference to the standard double wishbones. But GH-C put the relative importance of suspension geometry into context: "Power, centre of gravity height and aerodynamics are bigger issues than suspension geometry, so the thing to do is to go with what you know. Martin (Ogilvie) and I had done the Lotus GT1 programme so we knew what worked." Which is why a set of suspension pick-ups was homologated to take advantage of the freedom regarding their location.

The wishbones attach to new fabricated steel uprights, with outboard springs and Koni dampers all round, and the lower rear wishbone is supplemented by a toe link. There is no rear anti-roll bar, but a neat pushrod actuated front bar runs across the firewall behind and above the engine.

Suspension set up changes are done basically with spring rates, bump rubbers and the front anti-roll bar. The day before our studio shoot Prodrive had been doing suspension set up work at Snetterton. "That was the car's weak point insofar as top speed has always been there, but cornering speeds were not the best. But it's better now by some margin following yesterday's test."

Brakes comprise large ventilated discs (carbon for ACO events, iron for FIA) and six-piston calipers. Initially it became clear that they required more cooling, and the front brakes now have twin feeds to their cooling ducts. The rear brake cooling ducts are fed from the NACA ducts atop the rear wheel arches. Cockpit adjustable brake bias adjustment is provided.

Engine

Prodrive's chief engineer (engines) Jason Hill takes up the tale of the engine's development: "The timescale had a big influence on what we could do. And our basic philosophy was to order parts as late as possible. So for the first month we did calculations and simulations, and meantime the machine shop was screaming for designs so they could get on! But we *had* to be right first time. We originally had no drawings from Ferrari either, so we had to measure everything and build up the requisite drawings ourselves. We ran the first engine after just three months. To achieve that we had to focus first on the long lead-time parts, namely the crank, cams and pistons.

"It usually takes around 12 weeks to manufacture a crank which, counting backwards, meant we had about one or two weeks to design one! So we carefully examined the standard (steel billet) crank, and decided it was very nicely made, at reasonable cost, and would be okay to race. That decision also defined the stroke (75mm), bearing journal size and so on.

"Next we had to decide the bore size. The (mandatory) inlet restrictor limits airflow, so you have to reduce friction as much as possible, and one way to do that is to have as large a capacity as you can. But we decided that increasing the bore from the standard 88mm to 91mm, giving 5853cc, was a big enough risk initially.

"So then we moved onto the conrods. Again we looked at the standard (titanium) components, and decided to run these, slightly modified to take our own piston/gudgeon pin assembly. The piston design was governed by the compression ratio we wanted to run, and by the top of the block."

The top end also received much attention. Jason Hill again: "The heads had a lot of work done on them, and the valve train was entirely new." FIA rules prohibit the use of titanium where it was not originally specified in the production engine; so steel valves are used for that series, whereas titanium valves are used for ALMS/Le Mans. Cam design was also studied long and hard, and the ports are now very different.

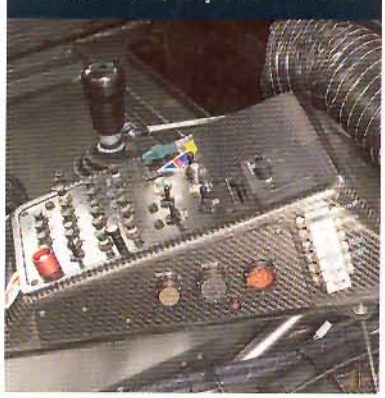
Jason Hill said: "The original head design is very good, with a narrow valve angle similar to Formula 1 engines. That gives a low volume combustion chamber that makes it easier to achieve the compression ratio we wanted with a tidy piston design. We had to consider (the possibility of) detonation, but there was insufficient time to incorporate

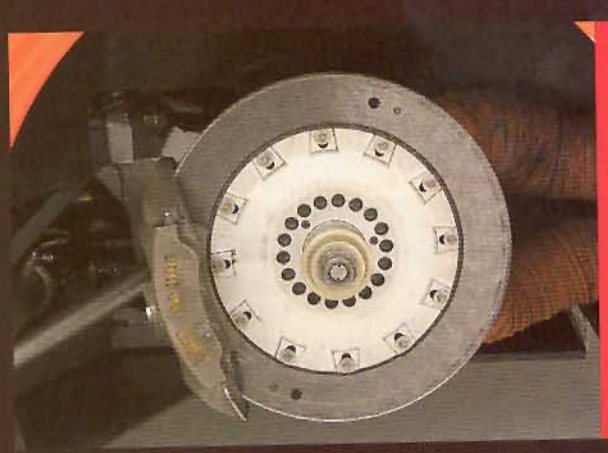
continued p70 ➤

Race relations: from any angle Prodrive's GT racer is all Ferrari. Body is steel with carbon panels

Fast work: Prodrive turned Ferrari's Maranello into a top flight GT racer in just 16 weeks

Shifty business: gears selected via a H-pattern shift for ALMS and Le Mans, sequential for FIA





Top stoppers: brakes at both ends are large ventilated discs with AP six piston calipers. Cooling was a worry at first, but extra air feeds and NACA ducts saw to that

closed loop knock control [into the engine management strategy]."

The airbox design became the topic of some controversy, as we shall see shortly, but the engine's output depends heavily upon it. As Jason Hill said: "You've got [more or less] the same size holes for air to enter [as your competitors]; it's what you do with it that matters. We used computational fluid dynamic (CFD) simulations, and a fair degree of common sense in this aspect of the design."

The controversy surrounded Prodrive's interpretation of the FIA's rules on airbox design, as GH-C relates: "The airbox was originally declared legal by the FIA, but later we were asked to change it. The regulation had a volumetric control on the airbox design. For our interpretation to be allowed to run in FIA races we had in the interim to use smaller restrictors."

Jason Hill said: "The rules allow twin 32.1mm restrictors which we employed at the first race we competed in at the Hungaroring. The FIA then imposed a smaller size of 31.6mm for the A1 Ring, where we qualified on pole and won. That led to an even smaller restrictor of just 31.1mm at the Nurburgring. However, the FIA then insisted that we had to change the airbox after all, so we did a new design, which involved quite a lot of work, for the latter 2001 FIA races. The airbox was never deemed illegal though, just outside the spirit of the regulations. The ACO was happy with our original design."

That passing reference to putting the car on pole and winning in just its second race demonstrates the excellent job Prodrive had done. As Jason Hill said, "The schedule meant

we had only one chance to get it right. We could have played safe, but with no time to develop the engine initially we had to hit the ground running, and I think the performance was actually pretty good right away."

Then prior to Le Mans 2002 an engine upgrade was done, based on the earlier FIA specification. The bore was upped to 92mm, giving 5983cc swept volume; a redesigned oil pump was installed; and performance was further enhanced with modified cam profiles, a raised (but undisclosed) compression ratio, new pistons and different electronics. "But the basic tuning configuration is the same as we first designed it," said Jason, "which justifies the time we spent in design. In reality once we'd finalised the design all the parts became available in just two weeks! Most parts were made in-house, except the cams and the pistons, which obviously helped."

Transmission

Problems with the FIA scrutes first occurred at the Silverstone debut in May 2001, again over differences in interpretation of the rules, this time relating to the transmission layout. The regulations stated that the gearbox had to be in the same location and orientation as the production base car. But as far as GH-C was aware there was no mention of the use or otherwise of a transverse layout for the gearbox internals in a gearbox located and orientated as specified by the rules, and so Xtrac's 'off the shelf' sportscar gearbox was initially fitted to the car. "The written regulations were the same as

TECH SPEC

Prodrive Ferrari F550 Maranello GT/GTS

Body/Chassis: Steel shell, steel roof, tubular steel rollcage, carbon fibre body panels, front splitter, rear diffuser, single element rear wing

Weight: 1100kg

Engine: Ferrari, front-located, longitudinally mounted, all aluminium, 5983cc, double overhead cam, 48 valve, V12, bore 92mm, stroke 75mm, Pectel EMS, 600+bhp at 7000rpm, 550lb.ft+

Transmission: Carbon propshaft, AP triple plate 5.5in carbon clutch, Xtrac 6-speed magnesium-cased gearbox, H-pattern (ALMS) or sequential shift (FIA), longitudinal, mounted on rear axle, plate-type limited slip differential

Suspension: Unequal length double wishbones, outboard springs and dampers, pushrod actuated anti-roll bar front. Koni dampers

Brakes: AP six-piston calipers, 380 x 34mm ventilated carbon (ALMS) or iron (FIA) discs, cockpit adjustable front to rear bias

Wheels & tyres: OZ forged magnesium wheels, 12x18in front, 14x18in rear; Michelin tyres, 29/65-18 front, 31/71-18 rear

Fuel Tank: 100-litres

Dimension: Overall length 4550mm, overall width 1995mm, wheelbase 2500mm, front track 1703mm, rear track 1665mm, weight

when we had done the Lotus GT1 gearbox." Explained GH-C. "But unbeknown to me, while we were working on the Mondeo Touring Car programme there had been rule clarifications agreed, but seemingly not published, to say you could no longer do this." And so, amazingly, the F550 was not allowed to run at Silverstone. After 16 weeks of graft, you can imagine how the crew felt...

The upshot was that an in-line gearbox had to be hurriedly designed, a feat accomplished in just five weeks by supplier Xtrac, and Prodrive's Mick Metcalfe, GH-C is full of praise for both: "Xtrac were brilliant and Mick starred. And we got it done."

The remainder of the transmission system comprises a carbon propshaft feeding the drive to the rear mounted triple plate carbon clutch, housed in the Prodrive bellhousing (which also accommodates the flywheel and starter) ahead of the gearbox/final drive unit. The diff is a limited slip, plate type. A transmission cooler is located in the left side of the boot, fed from the NACA duct on top of the wheel arch that side, in common with the brakes, exhausting through the rear panel.

continued p72 ➤

Body and aerodynamics

With a relatively tight budget and an incredibly tight schedule there was no opportunity for a scale model wind tunnel programme, so one of the road cars purchased was put through a limited full scale wind tunnel programme at MIRA to "sort out the main surfaces," as GH-C put it. Rear wing configurations were also determined in this way, but because MIRA's full-scale tunnel is of the 'fixed floor' variety, the aerodynamics of the front splitter and underbody were developed through track testing. Prodrive has devised its own method of aero testing which it was not going to enlarge upon, but we can be certain that it involves logging suspension movement and loads, and air pressures around the car.

This achieved "a reasonable balance for the first race" recalled GH-C "but it wasn't brilliant. We then concentrated on the aero package and at the A1 Ring we put the car on pole and won. That was partly down to the aero improvements."

Nice aerodynamic details abound on the car. At the front the splitter has an elevated front lip and a diffuser profile beneath. There are also mini-diffusers that lead air around the outside of the front wheels. The twin dive planes on the sides of the front airdam are also downforce producers, and the exit ducts behind the front wheels help prevent lift-inducing pressure build up in the wheel arches.

The ducting to and from the large engine cooling matrices is a work of carbon art, ensuring efficient flow with minimum drag, possibly adding some downforce too. Bonnet louvres help the cooling air on its way. The main floor is flat between the wheels basically, and the rear diffuser is permitted to rise only 150mm above the flat floor level. Multiple vertical strakes in the diffuser help steer the air smoothly through what otherwise could be a complex and potentially disturbed region, to the betterment of downforce. Interestingly the F550 was said to be short of downforce, but it was definitely not short of top speed at Le Mans, where it peaked in excess of 200mph.

Performance

One way of measuring the Prodrive Ferrari F550's performance is to look at how it fared at Le Mans in 2002. In qualifying it set 3m54.091secs, just under a second faster than the 2001 class winning Chevrolet Corvette C5-R – as profiled in October's CCC. Once the race started the F550 pulled away gradually, and at around half distance was two laps ahead of the lead Corvette. However, the fairy tale went up in smoke after 174 laps when an oil line fractured, and the Corvettes went on to score their second successive one-two finish in the GTS class. As George Howard-Chappell succinctly put it "we might have been fast, but the Corvettes finished." Still, there's always 2003…

Thanks to Prodrive and to Philip Rose at Market Engineering.