BELOW Created by a small group of friends, the Eclipse SM1 has proved itself in the 750MC's Sports Specials Championship (Photo: Steve Jones)

FROM PUB TO THE PODIUM

The origins of the title-winning Eclipse SM1 were humble but, as **Graham Templeman** discovers, the design is packed with clever features

IT WOULD be interesting to know exactly how many championship-winning campaigns started after a discussion in a pub. Certainly that is where Paul Boyd, his wife Lesley Wilson and fellow competitor Clive Hudson trace back their decision to design, build and race a kit car of their own. It started out as a discussion about whether to repair or replace a damaged racing car and, some pints later, ended up with the conclusion that the only way to get a proper mid-engined kit car was to build it themselves.

And worse than that, because of the rules, there had to be five cars to prove to the organisers that it was a genuine kit and not a one-off. The design brief was simple. They wanted to end up with something that could be road legal, was nice to drive at the limit and had good mechanical grip. The three were great fans of the Lotus Elise and enjoyed the benefits provided by that car's long suspension travel, long wishbones and efficient structures, especially with regard to the suspension. The aero brief was that the car should look nice and have low frontal area, low drag and no lift.

The whole thing was designed on the computer with the styling done by Boyd using Rhino and the mechanical bits by Hudson using Pro Engineer. This division of work did not need much thinking about. Hudson spent 10 years as a design engineer for Cosworth and is currently involved with the development of a novel compressor design for, amongst other things, supercharging, so it was fairly obvious who was going to get the mechanical design part of the brief. Lucky then, that not only does Boyd have a flair for design, but is also remarkably practical so he could get out the welder and start building the chassis.

In order for the work not to get in the way of their day jobs, many of the parts were contracted out. The comprehensive computer modelling made it easy to convey their requirements to subcontractors although there was a certain amount of disappointment that so much of what they wanted was not available commercially. They ended up making many things that they had expected to be able to buy in, citing pedal box, inlet manifold and sump and oil system as the sort of thing that they expected to be off-the-shelf but which eventually they ended up designing and developing in-house.

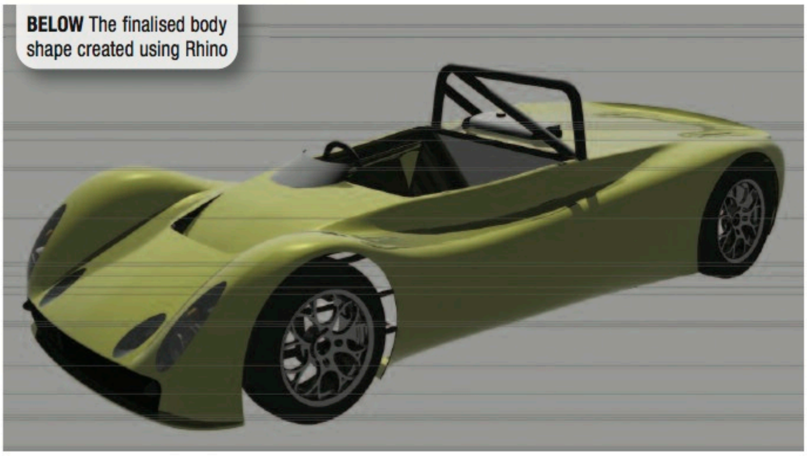
Making a car that met their criteria and was capable of being road legal presented an interesting set of challenges. The rules state that rear-engined cars must use a donor engine that was originally fitted transversely in the chassis and must retain that orientation in the new car – a requirement that according to Boyd and Hudson meant that the car would have to be rear-engined rather than mid-engined. Unless you were very clever. Which they were.

By the simple and slightly off the wall expedient of using two chains to transmit the drive from the driveshafts to the rear hubs they were able to lengthen the wheelbase and achieve the weight distribution that they wanted. Well, not that simple actually. The drive chains were taken care of by a swinging arm that supports the driveshaft at one end and is fixed to the aluminium rear upright at the other. This means that the rear sprocket moves in an arc around the driveshaft as the wheel rises and falls, so that whatever suspension system they used, would need to accommodate this trajectory.

The solution was a de Dion axle located by four long radius rods and a Panhard rod. There were a number of reasons for the choice. Wishbones might have necessitated another pair of CV joints and would need the extension of the spaceframe to the rear end of the car. This would entail extra weight, cost and complexity. The de Dion simply needed long radius arms that pick up at the roll-over bar bulkhead and a small triangulated structure behind the solid mounted Ford Duratec engine as a strong point for the Panhard rod.

The spaceframe chassis was designed by Hudson, only being finalised after nearly 200 iterations using Finite Element Analysis (FEA) to optimise the stiffness to weight ratio. An interesting outcome is that the top chassis rails on each side of the chassis ahead of the roll-over bar are of larger diameter than a purist might expect. An obvious potential solution for this tube would be to direct it from the bulkhead at the footwell to the foot of the roll-over bar, increasing the height of the chassis side. However, this elegant solution showed only marginally increased stiffness, made other things less convenient and raised the centre of gravity by 12 mm.

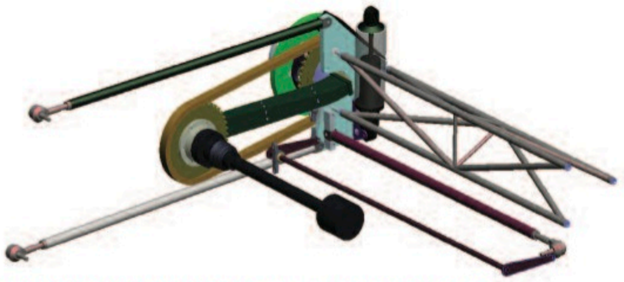
> **“They were able to lengthen the wheelbase by using two chains to transmit the drive from the driveshafts to the rear hubs”**



BELOW The finalised body shape created using Rhino

The first batch were home-built by Boyd on an ‘inside-out’ jig where the frame is actually built round the jig, which is then threaded out through the bulkheads. The advantage of this form of construction is that the jig can be supported at each end and rotated to give good access to all the parts of the chassis.

The gearbox lives where Ford intended it to in the production Mondeo and the driveshaft joints are standard road-going units with special driveshafts. The distance between the joints of the nearside shaft is only 153 mm, since the minimal movement of the shaft means that the engine can be moved across the chassis to assist in weight distribution. The shafts exit the differential horizontally and are supported at their outer end, not by the suspension upright, but by a bearing carrier supported on a single strut suspended from the top rail of the chassis. And here is another surprise. First instinct would be for a substantial structure here, bearing in mind that the shafts are transmitting about 200 bhp and rotating at anything up to 2,000 rpm. But ▶



ABOVE & BELOW The CAD layout of the rear suspension and the real thing (below). Note the slender strut supporting the front sprocket

Hudson's calculations indicated that the loads on the support strut were much less than they appear at first sight and resulted in a laughably small tube with a 1 mm wall thickness. There have been no casualties in the three years that the cars have been running.

The swinging arm that supports the chain is an interesting artefact in its own right. It was designed using CAD as a fabricated aluminium box with billet aluminium at each end to allow for machining to provide precise alignment. When presented to their fabricator (Wayne Saunders at AW Fabrications in Irchester), he suggested that it would be easier to manufacture with a couple of aluminium bulkheads in the section to locate the parts like a 3D jigsaw. This advice was duly taken and the end result was that subsequent FEA showed a significantly improved stiffness.

The chains are the sort that would be fitted as standard to a large motorcycle and as Hudson points out, if you do the usual calculations to ascertain the correct size, these are, in fact, a little lighter than they should be. On the other hand, there have been no problems even in race conditions and if one manifests itself, there is still room to step up a size or two.

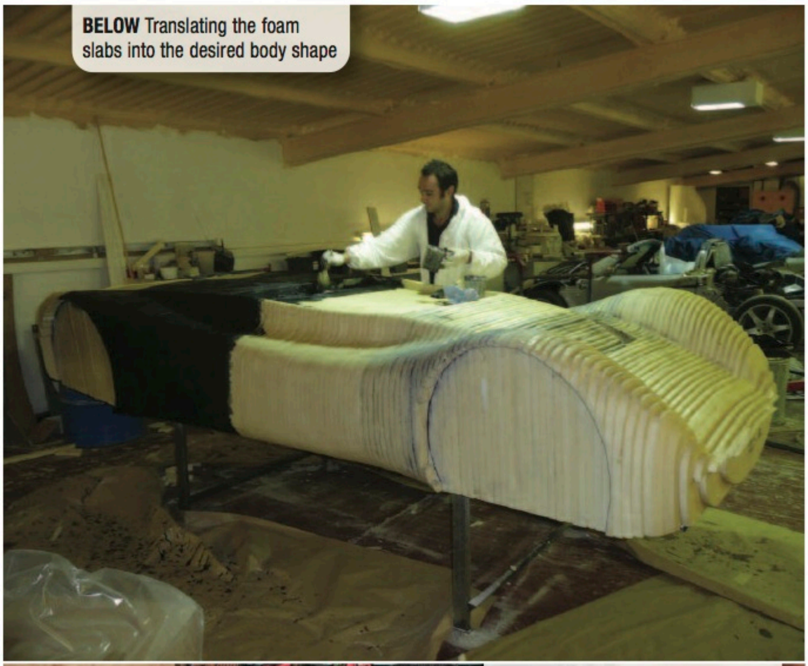
The chain drive tends to take your attention away from the other clever features of the car. The rules require a wet sump engine and given that cornering forces are generally around 1.3g with 1.4 being seen on occasions, this is another potential problem area. The solution is as clever as you might expect. The sump is modified by welding on an aluminium fabrication and providing it with a swinging pick up pipe. This follows the (apparently) standard bike-engined car practice of articulating the end of the pipe that picks up the oil so that it can revolve the full 360 degrees in the horizontal plane. It moves forward under braking, rearwards for acceleration and to the correct side for corners.

> ***"With cornering forces around 1.3g, the wet sump engine is another potential problem area"***

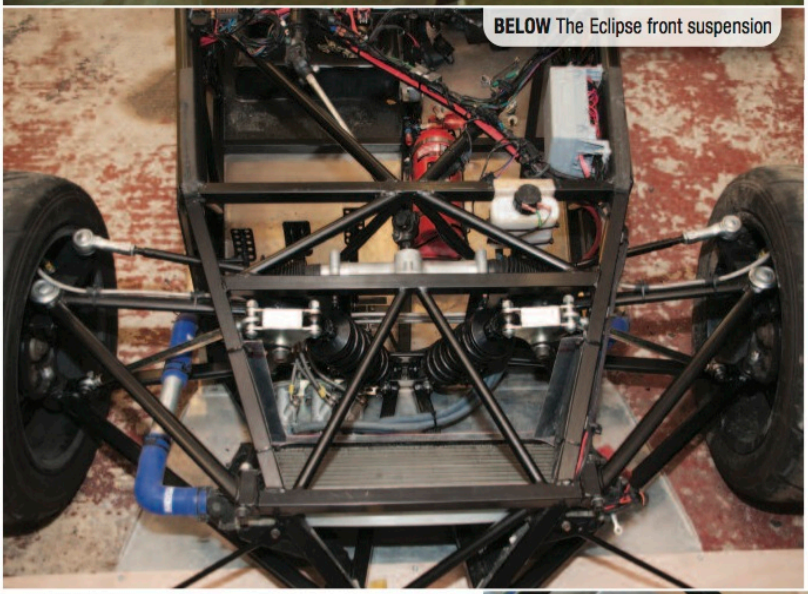
LEFT & BELOW The foam cores for the inlet manifold fitted to the jig prior to laying up, above. The finished product, below, includes bell mouths made using the same technique

The decision to get the engine as close to the bulkhead as possible necessitated a special inlet manifold. It had to be home-made partly because no one sold anything that would fit. They designed the simplest possible manifold with four identical pipes that simply change the direction of flow through nearly 90 degrees and the cross section from round (at the throttle body) to square (at the cylinder head). They had a core box CNC-machined to represent the internal dimensions required and this is used to cast polyurethane cores. These are bolted into a jig along with inserts for fasteners and the whole thing wrapped in glass fibre and polyester resin. When cured, it is removed from the jig and the cores removed. Brilliant!

Another departure from the norm was that the bodywork was professionally manufactured by Mark and Rob Turner's Silverstone Paint outfit. They admit that this was the expensive option, but the finished product is superb and someone else had the difficult job of translating the design into a foam buck, finishing the surface to a very high standard and manufacturing the production moulds. The original rendering of the shape was translated into a series of carefully cut foam slices that were stacked together to create the basic shape. One edge of each slice is precisely the correct shape so by painting the whole thing black, the foam can be sanded down until there is a series of black pinstripes that indicate that ▶



BELOW Translating the foam slabs into the desired body shape



BELOW The Eclipse front suspension

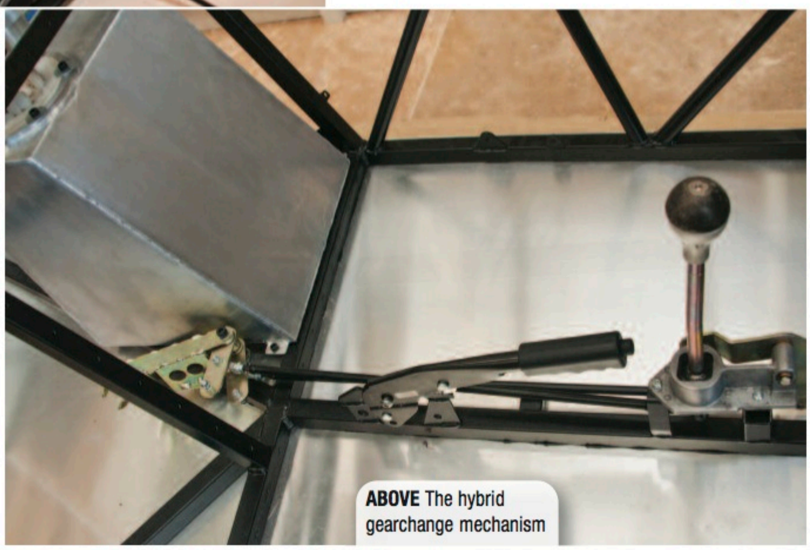
enough material has been taken off.

The front of the car is very racey, with pushrods operating inboard springs via a rocker arrangement; long wishbones are fabricated from aero tubing and a purpose-built rack comes from Titan Engineering. The beautifully-made monotube aluminium dampers are single adjustables from the Dutch company AST. Front uprights and brakes are taken from crashed Lotus Elises and bearing in mind that the brakes include an aluminium AP calliper, they represent very good value.

The pure racing feel of the suspension gives way to a road-going approach to the controls. The gear lever is a standard Elise item (and probably Vauxhall/Opel before that) that operates rods first before joining up with cables for the final leg of the journey into the gearbox. The steering column, stalks and switches all come from road cars and are necessary to meet the SVA requirements, including such niceties as brake fluid level warning lights. The prototype's wiring loom was made in situ and then removed and fastened to a board to create a jig from which all subsequent versions could be manufactured. The dash display and data logger come from Race Technology. There is no windscreen, just a small acrylic piece that deflects the air over the driver's helmet and avoids the need to provide wiping and demisting when the car is being approved for road use.

So far, only one car has been used on the road – and it has been driven to Cadwell Park, raced and driven back home again. Don't run away with the idea that this is not a serious racecar, though. It qualified 1.2 seconds off the pace on its first outing and within four more races had a lap record to its credit. At the time of writing the design has claimed four lap records, a handful of fastest laps and a championship. Four cars have been campaigned, one has been sold to last year's championship runner-up and the fifth is due out this season.

This level of success has attracted interest from potential buyers and this has created something of a dilemma for the team. Remember that the pub-inspired plans involved designing, building and racing a mid-engined car – what was not included was a proper business model. They built the first batch because they wanted to and the rules required it. Now that people are beginning to take notice, the team is going to have to bite the bullet and do some cost accounting. The components for the next batch are under construction and should soon be ready for sale. One suspects that they find the building and racing more fun than the cost accountancy. RT



ABOVE The hybrid gearchange mechanism