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LEGENDARY

THE REMARKABLE ELISE FAMILY. WE TELL THE STORY
BEHIND THE MOST SUCCESSFUL LOTUS OF ALL TIME

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ELISE



This is the definitive story of one of the most successful sportscars of all time: the Lotus Elise. Exclusively for CCC, Lotus gathered almost every variant of the car for inspection, and gave **MARK HALES** access to the people who made the car great

The Elise is now the most successful Lotus of all time. The Norfolk company has been making cars since 1956 and the classics that have rolled out of the same factory in Wyndham are many and legendary. Lotus Seven, Elite, Elan and Esprit are all bywords for high performance, light weight and innovative engineering. But it is the recent Elise that has made it possible for the company to survive a succession of different owners and enter the new century in good shape. Approximately 11,000 of the Rover-powered two seaters have now been sold to a diverse ownership. Smart city dwellers, track day specialists as well as dozens of go faster firms, are all Elise converts.

But why and how did the people at Lotus carry company founder Colin Chapman's original concept through to the new millennium? Or did they? Is it the 1950s inspiration that makes the car great? What was the thought process that led to a glued chassis? Where does Lotus go when everybody who wants an Elise has filled the space in their garage? The original Elise and the recently announced Mk2 version have already been tested to death by all and sundry and by CCC – and both the engineering and driving stories have been told many times. Rather fewer column inches have been filled with accounts from the car's creators as to why and how they did it. Exclusively for CCC, Lotus gathered an example of every Elise variant made in the car's four year lifespan – every one that is apart from the Elise-based VX220 for which Vauxhall were unable to give approval. Lotus also identified the key players to explain how the Elise came to be and what it means to each of them. And most amazing of all, CCC went to Lotus for a photoshoot and it didn't rain.

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a design for
life



CCC: Why did the Elise turn out the way it did?

RUSSELL CARR: Probably because styling and chassis engineering at Lotus aren't separate activities like they were in the 1950s at GM or Ford... and probably still are. Stylists are engineers as well and we all work together. We have to understand what they do and they understand what we do, because one obviously has an impact on the other. So we ran the two activities side by side and Richard (Rackham - chassis) and Julian (Thompson - styling) sparked off each other. They'd have conversations like: wouldn't it look cool if we exposed all the inside, made a feature of it. Yes, OK, but then we'll have to change the section of the extrusion...

There was a lot of that kind of process in the position of the seating, which is key to the car's identity. You sit low, but it's how you sit low in the car that matters because the further down you go, the closer to the centre you have to move because of the sideboxes. But moving to the centre means you can do styling things with the car's shoulders. Lean the shoulders in and put a curve on the glass, make the car look lithe and low. That makes it look agile. It's always good to sit the occupants low, sit them in the car rather than on it, but usually it's hard to do on a modern road car. We even built a seating buck to prove it could be done. Just think of the MGF which is aimed at a basically similar market, but is a very different car.

I'm pretty sure that if we had just drawn it all on the computer we would have dismissed it because it probably wouldn't have met all the criteria. The Elise definitely wouldn't have happened the way it did if we'd had conventional, separate engineering and styling departments. There was and is, a very special interaction between the two.

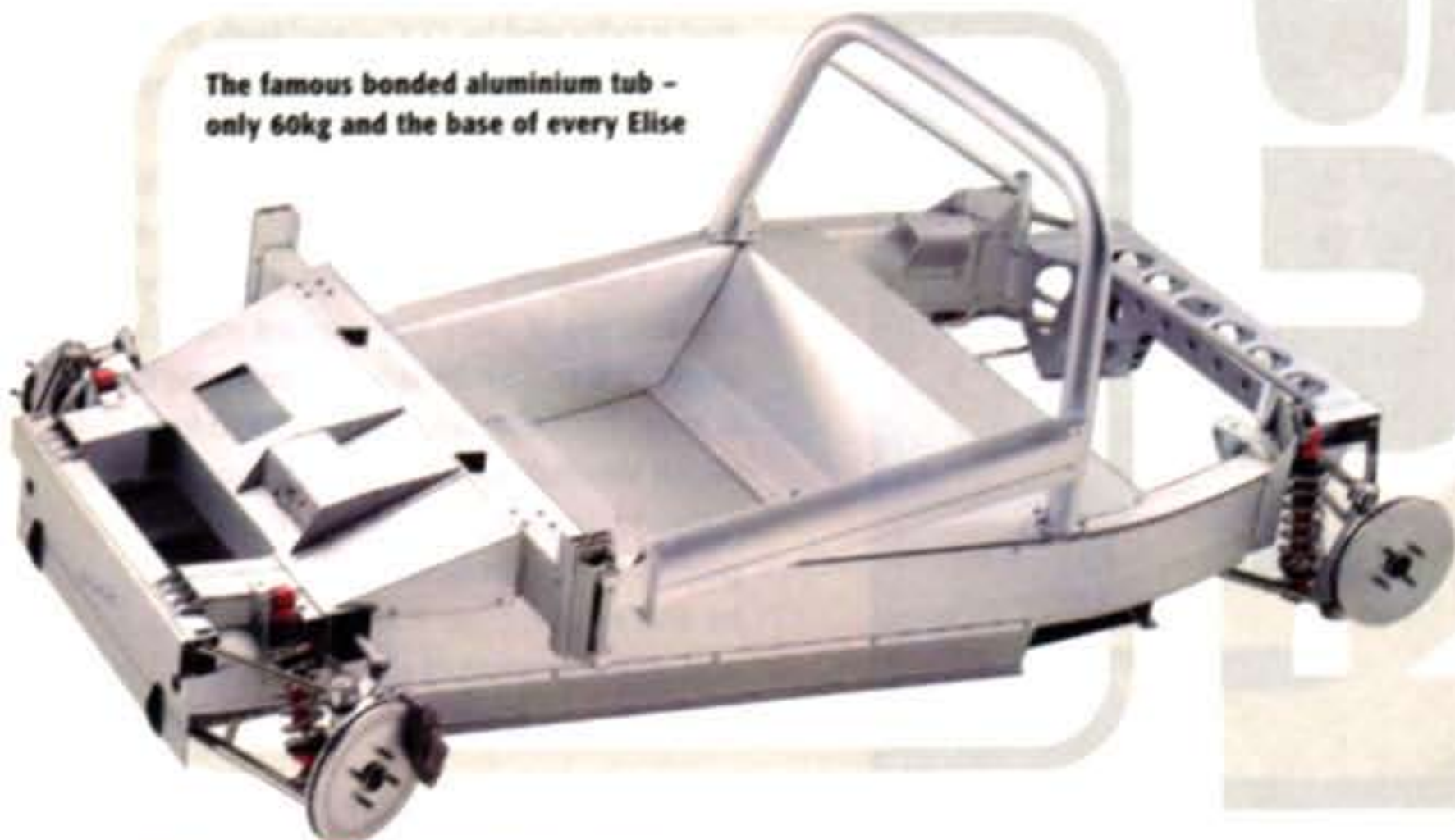
CCC: How did you arrive at the concept?

RC: Well, we'd been through the Elan - the front drive one - which was technically fantastic, but visually and in the driving experience it didn't connect with people. One of the DNAs here (the driving forces) is to keep it small and compact. It's a visual agility which comes from nature as much as anything and it was something the original Elite and Elan had. Even the Esprit communicates lightness. The Seven was a guide too, but I don't think it suits modern day driving conditions. Track days, yes, you've only got to look at how many Caterham has sold, but for us to do it again would have been too easy to create a pastiche.

So we had to think of something different and we thought it would be unique to have a functioning structure

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The famous bonded aluminium tub - only 60kg and the base of every Elise



RUSSELL CARR -
Chief Designer. Worked
with Richard Rackham
and Julian Thompson on
the Elise programme.





Russell Carr

– the bare chassis – as a styling feature. It fulfils the concept of light weight, there's no trim which is always a big investment, so that saves money and keeps the accountants happy and it's light so it helps performance. Everybody's happy. But it's not just that. If we do make something visual – like the chassis – it must be beautiful in both the visual and the technical sense. Some of the bike makers are very good at that because although a bike doesn't have much on it, it's visible and in the case of a Ducati, it's beautiful. Both Richard and I are big Ducati fans.

CCC: How did you arrive at the final shape?

RC: It's back to the agility thing. If you look at the GT40 or the Cobra they have this fleeting stance, they look shrink wrapped, tight on their wheels. That's the sort of thing we were after, but specifically, the Lotus 23, Lotus 30 and 40 and the 62 were all a big influence on us, and so was the Ferrari Dino but it wasn't until we put them all in the studio together and looked at them that we realised they were all designed for a different purpose, and at a different time in history. I suppose we sampled a bit of each. That was also when we finally decided that the Seven was too compromised, and that bodywork would enable us to meet the legislation more easily. I think if we'd opted for the Seven theme it would have restricted us to low volume type approval so it's as well we didn't. When we started this thing we thought there would be a market for about 700 to 800 cars a year and now it's about 4,000. Just shows what happens if you get the product right.

Whether it's all down to Chapman's legacy, I don't know. It's hard to quantify that sort of thing. I do know that we try hard to think of different ways to do things – even if it's making one bracket do five different jobs.

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Inspirational: The Elise design was influenced by cars like the Lotus 23 and 30, seen here (right) with Jim Clark at the helm at Silverstone



TechSpecs

Standard Elise, Elise 49,
Elise 79 (1995-2000)



Engine/transmission: Transverse mounted Rover K series. Four cylinders in line, double overhead camshafts, four valves per cylinder. Electronic fuel injection and engine management. 80mm bore 89.3mm stroke, 1796cc.

Max power: 118bhp@5500rpm

Max torque: 122lb.ft@3000rpm

0-60mph: 5.5sec.

Max speed: 126mph.

Dry weight: 755kg

Front tyres and wheels: 185/55 on 5.5Jx15in 12-spoke aluminium rims

Rear tyres and wheels: 205/50 on 7.0Jx16in 12-spoke aluminium rims

What CCC said then (Dec 1995):

The word is it's going to be pretty sensational, and knowing Lotus' reputation for producing dynamically inspiring cars, then we wouldn't doubt it.

The car that revived the concept of driving for fun, of motoring for the sheer joy of it, was the new Lotus Elise...

CCC - Dec 1996

...A technical tale that's not for the complacent: it covers glue, bondage, extruded aluminium and more sheer blind faith than a lemming wearing water wings.

CCC - Mar 1996

When Lotus created the Elise, it not only reinvented the lightweight sports car for the '90s, it reinvented its own flagging image along with it...

CCC - June 2000

CCC: Why did the Elise turn out the way it did?

RICHARD RACKHAM: Well, the first point to make is that Julian Thompson – who did the styling – and I, are really good mates. Best man at each other's weddings and all that. So because of that I had a greater empathy with the stylist than I might have done, as usually the two departments are in conflict. The stylist will want to put something where the structure demands a vital piece of metal and the two departments argue. But anyway, I don't think there should necessarily be a difference between style and function.

Before the arrival of marriage and children, Julian and I had a lot more spare time so we went a lot to the races and developed a great interest in bikes, which led to a fascination with the Ducati 916. Everything on that is both functional and visible, but it is also desirable. Very focused and desirable. The visible parts are sculptured, if you like. We bought one each, and yes, you could say it was a fundamental inspiration. We knew it was no good thinking of a modern Seven. A new car had to be desirable in a modern sense.

The problem is that engineering today is no longer difficult. The days of the man with a slide rule are history, so making engineering desirable is the way to get an edge. It's the kind of thing you'll find with a camera or a watch but in the case of the Elise, it was the interior. All cars have one but none has one which is quite so visible.

And aside from all this was the commercial reality. We had a mission to attract business for Lotus's engineering consultancy so that was another reason the Elise had to be aesthetically pleasing. I think we succeeded because it's been on the cover of Engineering Design Magazine and it led to Vauxhall's VX220. And yes there are rumours about another very significant project for another manufacturer, but I can't say anything about that. The Elise has attracted business and I don't think it would have done that as a bit of welded steel.

CCC: Why was the Elise constructed in the way that it was?

RR: I had been involved with all the racing Esprits, been to Le Mans with Hugh Chamberlain, and I realised how important tolerances were – for things like suspension points. Yes, even with rubber bushes, it's vital. This little car absolutely had to have accurate mountings for the suspension. I had also

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RICHARD RACKHAM
– Chassis Engineering

Elise 111S



Engine: Transverse-mounted Rover K series. Four cylinders in-line, dohc with variable valve timing, four valves per cylinder. Electronic injection and engine management. 80mm bore 89.3mm stroke, 1796cc
Max power: 135bhp@5750rpm
Max torque: 121lb/ft@5200rpm
0-60mph: 5.38sec
Max speed: 133mph **Dry weight:** 714kg
Wheels and tyres: Front, 185/55 on 5.5Jx15in aluminium wheels, rear 225/45 on 7.5Jx16in aluminium wheels

Elise Sport 135



Engine: Transverse-mounted Rover K series. Four cylinders in line, dohc with variable valve timing, four valves per cylinder. Electronic injection and engine management. 80mm bore 89.3mm stroke, 1796cc
Max power: 135bhp/7000rpm
Max torque: 121lb ft/5200rpm
0-60mph: 5.8sec.
Max speed: 127mph. **Dry weight:** 710kg
Front tyres and wheels: 185/55 R15 on 6Jx15 ET 10 alloys
Rear tyres and wheels: 225/45 ZR16 on 8Jx16 ET 10 alloys

Elise Sport 160



Engine/transmission: Transverse mounted Rover K series. Four cylinders in line, double overhead camshafts, four valves per cylinder. Electronic fuel injection and engine management. 80mm bore 89.3mm stroke, 1796cc.
Max power: 160bhp@7000rpm.
Max torque: 128lb.ft@5000rpm.
0-60mph: 5.0sec.
Max speed: 129mph.
Dry weight: 714kg.
Front tyres and wheels: 185/55 on 6Jx15in aluminium MIM five-spoke rims
Rear tyres and wheels: 225/45 on 8Jx16in aluminium MIM five-spoke rims





Elise Sport 190



Engine/transmission: Transverse mounted Rover K series. Four cylinders in line, double overhead camshafts, four valves per cylinder. Electronic fuel injection and engine management. Modified cylinder head, valves, pistons, crankshaft, flywheel, solid valve lifters (used to permit increase in maximum revs to 8000rpm), carbon fibre air-box assembly, oil cooler kit, lightweight competition silencer and tailpipes. 80mm bore 89.3mm stroke, 1796cc.

Max power: 190bhp@7500rpm.

Max torque: 139lb ft@5600rpm

0-60mph: 4.3sec.

Max speed: 145mph. **Dry weight:** 670kg

Front tyres and wheels: 185/55 on 5.5x15in aluminium Lotus six spoke alloys

Rear tyres and wheels: 225/45 on 7.5x16in aluminium Lotus six spoke alloys

Lotus is a name synonymous with motorsport, so when the Norfolk marque embarked on a one make race series with the legendary Elise the car was always going to be special...

CCC - Feb 2000

Lotus Exige



Engine/transmission: Transverse mounted Rover K series. Four cylinders in line, double overhead camshafts, four valves per cylinder. Electronic fuel injection and engine management. 80mm bore 89.3mm stroke, 1796cc.

Max power: 177bhp/7800rpm

Max torque: 126lb/ft/5000rpm

0-60mph: 4.7sec

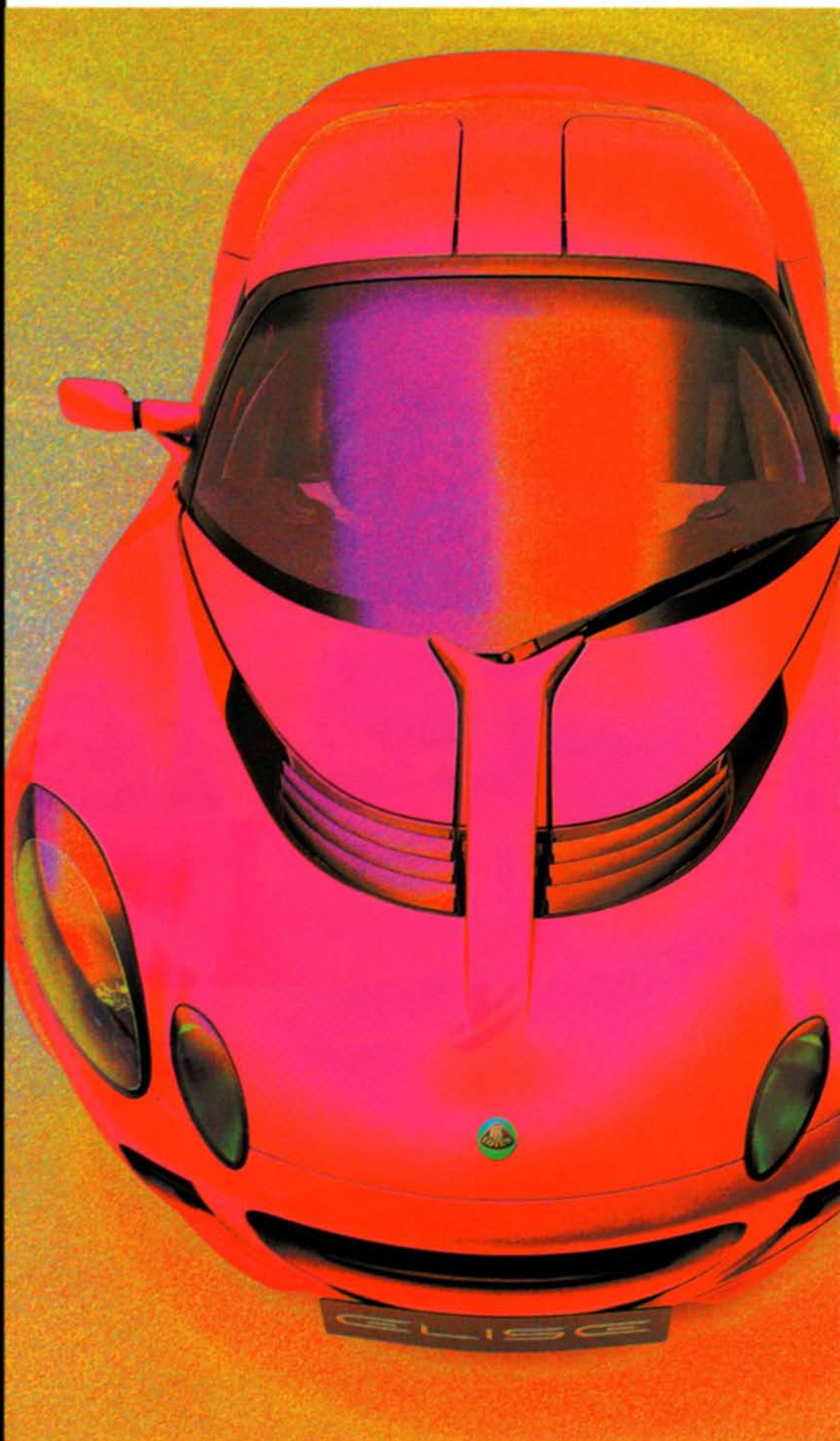
Max speed: 136mph **Dry weight:** 724kg

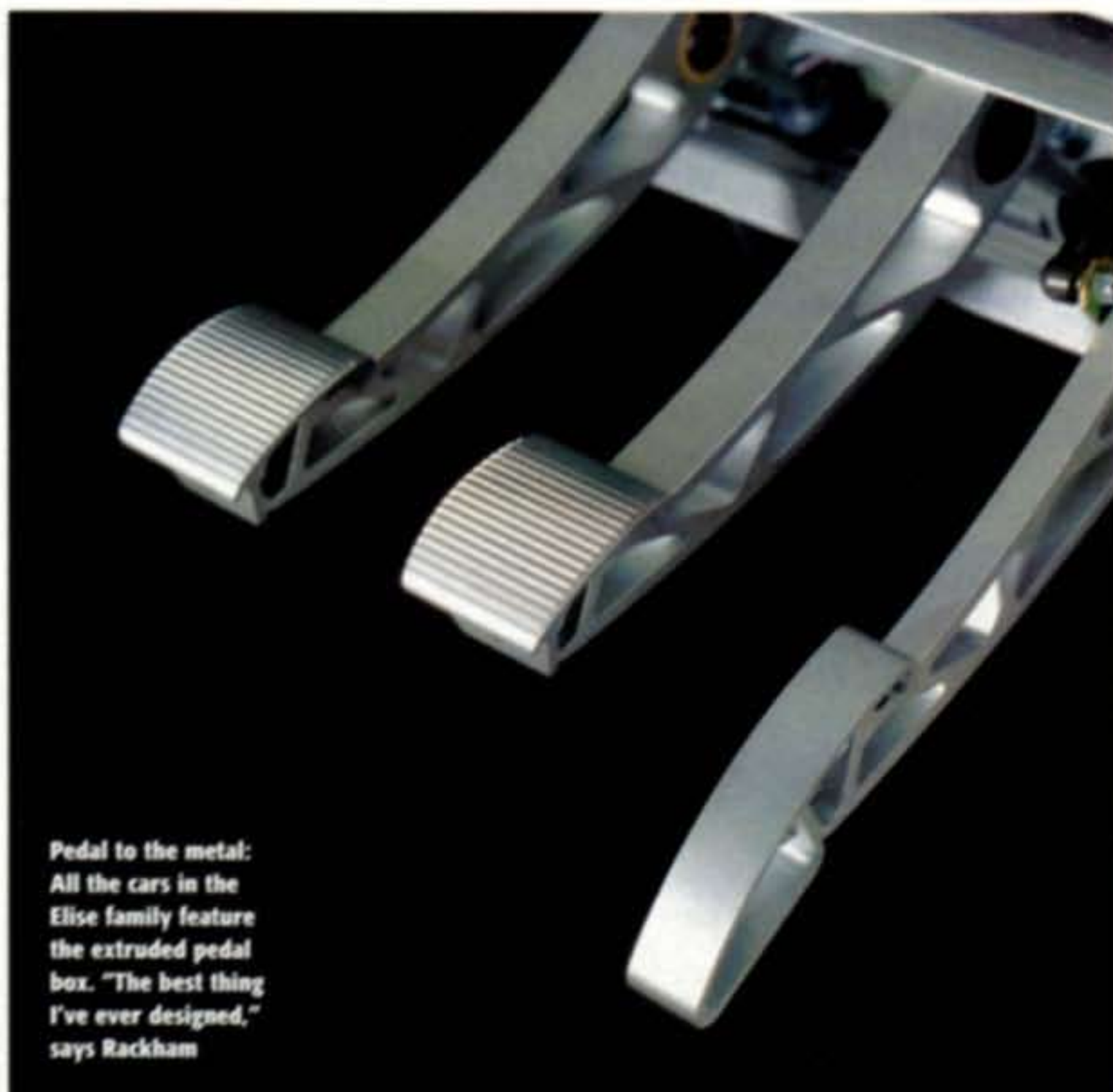
Front tyres and wheels: 195/50 on 7x16in aluminium rims

Rear tyres and wheels: 225/45 on 8.5x17in aluminium rims

At a price of just £32,995 it [the Exige] looks to offer incredible thrills-per-pound, and is almost certain to clean up in the rapidly booming lightweight coupé sector...

CCC - June 2000





Pedal to the metal: All the cars in the Elise family feature the extruded pedal box. "The best thing I've ever designed," says Rackham

worked in ride and handling and I'd learnt how to make race cars handle and I knew where the stiffnesses needed to be. A welded steel structure distorts hugely but a bonded one doesn't. It's a lot to do with the area of the joins – if you think about it, the weld is a thin seam where a bond is a much larger area. You don't get the distortion. And it's lighter. The Renault Spider came out about the same time with a welded tubular aluminium structure but the chassis weighed about 150kilos. The Elise chassis weighs 60.

Having decided to use extrusions, you can't exploit the benefits of the extrusion process if you try and use an old process of construction, like welding. Extrusions interlock and the shape can make places for things like seat runners, or little cavities where the excess adhesive can collect, you can see the excess on the suspension mounts but you don't see any on the interior because we wanted to hide it for aesthetic reasons. It all makes for fewer parts in the car and it was amazing how once I had my extrusion hat on, there were all sorts of things that made sense. Like I just couldn't find a pedal that was suitable, so, let's extrude one. Why not? It turned out to be the best thing I've ever designed. It was so simple. If you look around, you'll

see a lot more extrusion than there used to be... in the shops for things like kitchenware where once it was only used for greenhouses.

CCC: So why hadn't anyone else done it before?

RRR: It was because the bonding technology didn't exist. People always assume it was, but you go and look up all the books and there are loads of procedures for welding but absolutely nothing for bonding. We had to do all that and it was masterminded by a guy called Daryl Greig who worked closely with Hydro Aluminium who were the material suppliers. There was a guy at Hydro called Pete Bulivant-Clark and he and Daryl worked closely together to develop a new bonded system – one that had to involve anodising. We wanted anodising for the aesthetics so they had to select an adhesive that worked with the anodising process. They tested lots and lots of different ones, together with the fasteners and the pre-treatment, until they came up with the best one.

The Elise is still a very simple design though, it's just like a toy going together. There have been other designs since which had three times as many people and three times as many parts. Doing the Elise was as much a release of frustration for me as anything else because I suppose I had always wanted to do product design.

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Elise 340R



Engine/transmission: Transverse mounted Rover K series. Four cylinders in line, double overhead camshafts, four valves per cylinder. Electronic fuel injection and engine management. 80mm bore 89.3mm stroke, 1796cc.

Max power: 179bhp@7800rpm

Max torque: 126lb ft@5000rpm

0-60mph: 4.5sec

Max speed: 126mph

Dry weight: 658kg

Front tyres and wheels: 195/50 on 6Jx15in aluminium rims

Rear tyres and wheels: 225/45 on 8Jx16in aluminium rims

Good as the Lotus Elise is at providing cheap, raw thrills, there will always be those who hanker after something a little more extreme. Enter stage left the new 340R.

CCC - Oct 1999

2001 Elise



Engine/transmission: Transverse mounted Rover K series. Four cylinders in line, double overhead camshafts, four valves per cylinder. Electronic fuel injection and engine management. 80mm bore 89.3mm stroke, 1796cc.

Max power: 120bhp@5500rpm

Max torque: 124lb.ft available between 3500-4500rpm

0-60mph: 5.6sec

Max speed: 125mph

Dry weight: 710kg

Front tyres and wheels: 175/55 on 5.5Jx16in aluminium rims

Rear tyres and wheels: 225/45 on 7.5Jx17in aluminium rims

The Elise had to evolve without losing what made it successful. So, the new car doesn't weigh any more and costs about the same as the old.

CCC - Jan 2001



CCC: Why did the Elise turn out the way it did?

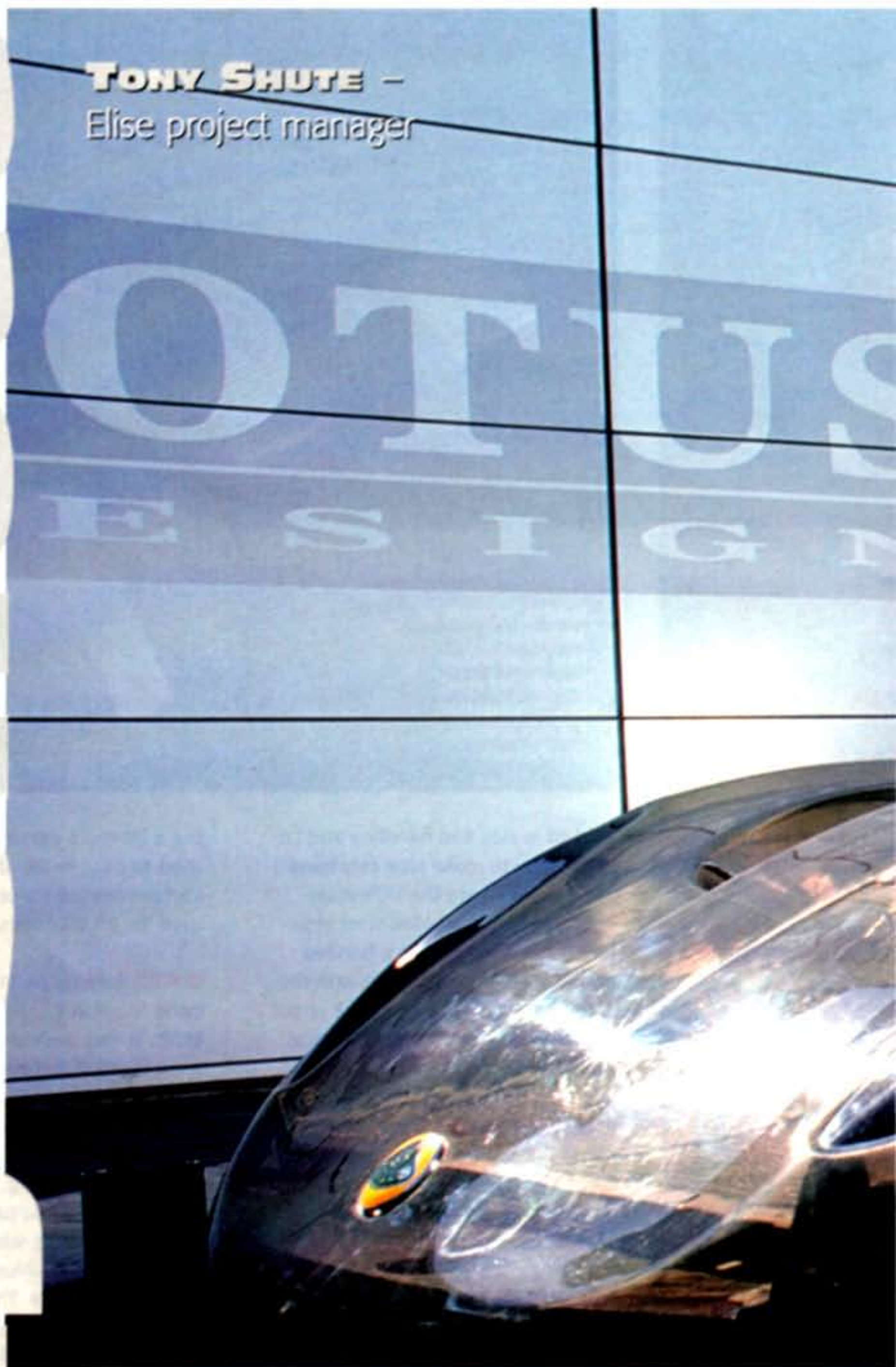
TONY SHUTE: Well, the easiest way to do a project is to do everything yourself, but no-one is that clever. So you have to get the right people in the right places. Then you have to let them dream a little. That's kind of crucial and most companies interfere. The clever bit is to let the guys dream but bring everything back to reality without spoiling everything and without consciously making decisions. I've always found that decisions in this business only have to be made when you don't have all the information. When everything is right, decisions just happen.

CCC: How did the Elise actually start?

TS: It started as a project together with Rover, but when BMW came along that sort of scuppered everything. Rover were very good though, they came to us and said, sorry chaps, but we would be happy to supply parts which is one reason we used the Rover engine. The other is that it is still the lightest engine of its type around. There are actually a lot of front-drive power units to choose from but the Rover met the targets we had for both weight and of course, cost. We had some pretty aggressive targets to meet everywhere and not just in the engine department. We had funded the whole project out of the engineering research budget. The car side had no money and engineering wanted something back but it did make everybody very nervous because they couldn't afford for it to fail. But they wanted a showcase and they got one. Every design manager in every car company has been to look.

The style of construction, you mean extrusion rather than fabrication. That was obvious from the point of view of cost, so we never really thought about it. Extrusion dies are peanuts and you can make the production item from the prototype die and do it by the mile. The glued construction was simply a continuing quest for a cheaper way of doing it. Originally, the chassis was welded together but only because we were told initially that was how we had to do it, being told you have to, is always a bit of a challenge. And we knew aircraft had been glued together although we also knew the aircraft industry does things in such an exotic way. We had a bloke from British Aerospace here who asked us why we extrude a piece of aluminium when we could just machine it from the solid. So extrusion and bonding just emerged as the obvious answer. We just had to find a cheaper way of doing it.

TONY SHUTE –
Elise project manager



CCC: Why hadn't anybody else done it before?

TS: You can say that about so many things like the E-jot fastener. That's a device like a large headed rivet that we borrowed from the building industry. We use as it an anti-peel device and it's to do with crashworthiness. I'll explain. With bonded joints like these, you would simply never be able to just pull them apart. The metal would fail before the joint. But if you were to lift a corner and peel the joint like an apple, you might be able to. Obviously you can't predict exactly how a car will crash so you put in something extra to stop it

happening and the E-jot is amazingly effective. In fact, you could probably build the car with E-jot fasteners and no bonding.

CCC: Why is the rear subframe made of steel?

TS: Originally it wasn't, it was made of aluminium like the rest but we found that didn't work. There's so much going on in that area – suspension, engine mounts and so on – that it kept cracking. Aluminium is brilliant for certain parts where you don't have lots of mountings but it was easier to make that bit out of steel.

Chronology

1995 The year that saw the end for the Lotus name in Formula 1 but also the beginning for the Lotus Elise. The car is unveiled at the Frankfurt Show where it is undoubtedly the star - British petrolheads are treated to their first sight of the car at the Earls Court Motor Show in October.

1996 The Elise hits the streets in the summer, and it's pitched against a posse of new two-seaters, including the Renault Spider and the Caterham 21, yet still there's a two to three year waiting list from the start. CCC gets its first drive - the long love affair begins...

1997 The 1000th Lotus Elise rolls off the Hethel assembly line - the Norfolk plant is now churning out 11 a day. An ill-fated GT racer, the Elise GT1, also breaks cover, but Lotus lose faith with it the following year, although a few road going versions were made for homologation reasons - these are now hard to trace. Easier to find are the Lotus Sport Elises, or Sport 190 cars, launched as a club motorsport charger.

1998 The wackiest of the Elise variants is unveiled at the Birmingham motor show - the Elise 340R. Aggressive and lightweight, the concept car's noticeable for what there isn't rather than what there is - no roof or doors - the wheels are open but for cycle mud-guards. The Elise Sport 135 is also launched in only limited numbers.

1999 Lotus celebrates its 50th birthday with a special Anniversary Edition - only 50 of the metallic green cars are built. The 340R concept becomes reality - it's capable of 130mph and its highly tuned version of the 1.8 K-Series will propel it to 100mph in 10.9 seconds. Lotus promises a limited production run of 340 priced at £35,000. Meanwhile, the Variable Valve Control K-Series motivated Elise 1115 is shown off at Geneva for the first time and the Lotus Elise 49 is unveiled at the Earls Court Show. Built to celebrate Lotus' racing heritage the 49 features Gold Leaf red and gold paintwork - just like the Lotus 49s of the late 1960s, while Lotus' 70s F1 success is marked with the Lotus Elise 'JPS', or Heritage, to use its official moniker. Finally, a Millennium edition was launched to take the Elise into the 21st century.

2000 The Lotus Sport Elise - which is to star in an all-new arrive and drive TOCA support racing series - is launched - as is the Elise Sport 160. Later in the year the VX220, Vauxhall's Elise cousin which is very much Lotus in spirit if not badge, is presented to a stunned public. And if that's not enough for one year there's also the Exige, the hard-topped road going version of the racer. But the big news is the launch of the all-new Elise S2 at the October motorshow - CCC was the first to drive it soon after.



First sighting: the Lotus Elise's British unveiling in 1995 at Earls Court



CCC: Any future developments planned?

TS: Yes, there's one or two. We could always stretch the Elise and make a four seater. All you have to do is make the aluminium longer. The architecture of the chassis - as in how it works - would allow that without any loss of stiffness. Or we could apply what we've learnt in bonding to some other industry. Right now though, we've got a polycarbonate body for the 340R that I'm using in sprints this year and I think that is a really exciting technology. It's the same stuff they use for police riot shields and modern crash helmets and it's light and easy to tool and

so cheap it makes extrusion look expensive. To give credit where it's due though, it was actually my 12 year old son's idea. He races these electric model cars which are technically incredible and he just asked me one day, "Why are your bodies so heavy? Why don't you make them like my model car's?"

And I thought, why not. I proposed it to management and got the response "you're mad!" and when you get that you know you're on to something. But I found some budget and we're on with it. The one on the 340R is actually see-through, like a Swatch and it saves about 30 kilos, which as a percentage of the body's total

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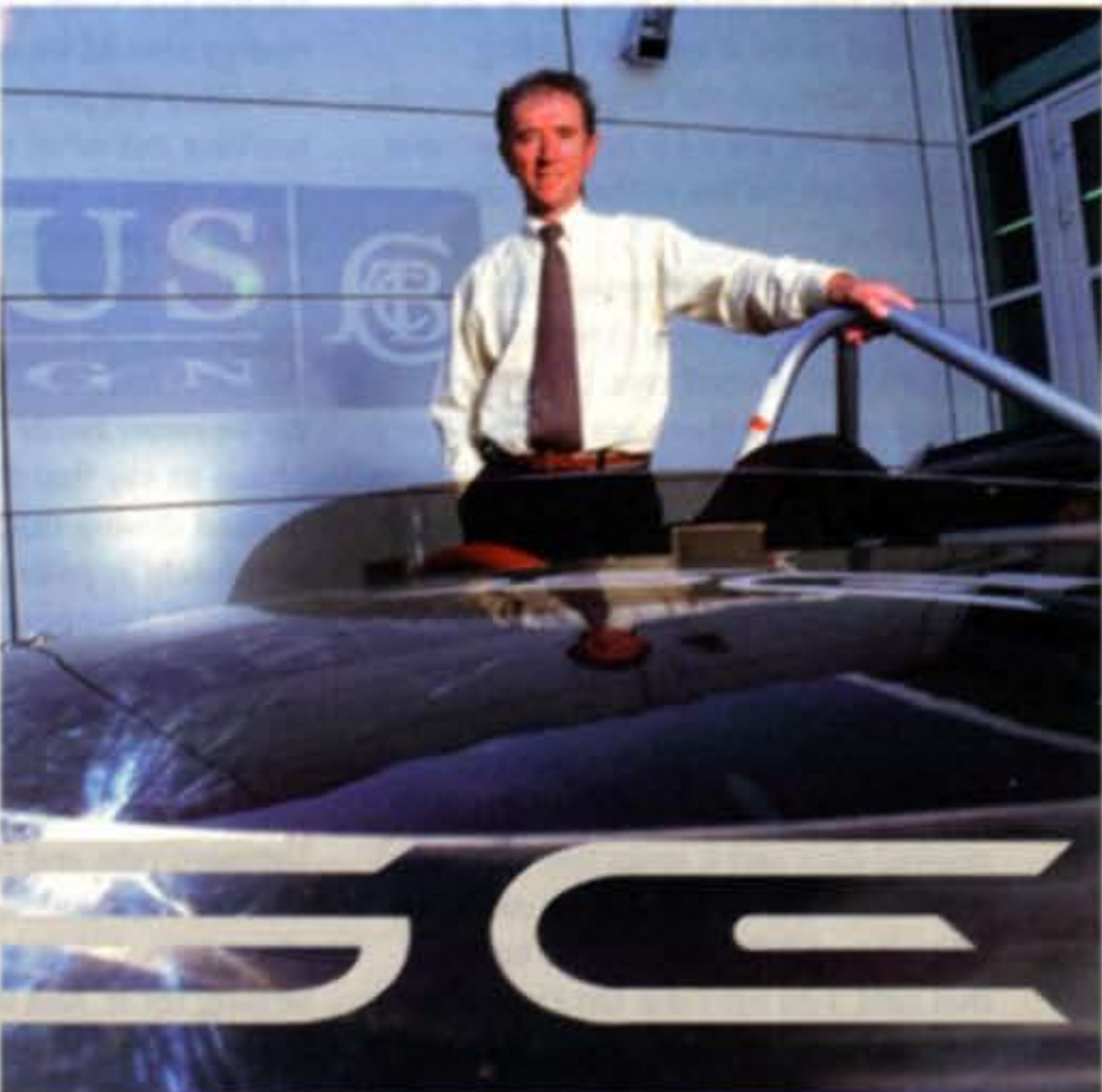


weight, is massive. I think we have to get away from conventional thinking. With this, you could have a different set of bodywork for different race meetings, or even during the race meeting. Buy a new one when you want, change it when you feel like it. It could happen, and by comparison it costs zilch. And there are commercial applications, like Federal compliant bumpers. You could even shine the headlights through the bodywork. No lenses. That would save some money. And I can see you're about to ask why hasn't anyone done it before.

But the biggest challenge is not design in itself, it's design which maintains Lotus values but meets legislation because

legislation is the biggest challenge and meeting it by clever means is the way to access more and bigger markets. Then we have to sell the technology. Everything clever we do has to be of interest to Ford or GM or whoever. Scalable technologies. Like our MMC (metal matrix composite) brake discs. That's aluminium reinforced with silicon carbide. The disc costs less, weighs next to nothing and you can do 10 laps of the circuit and put your hand straight on them. You don't need drums for the hand-brake and they don't wear. They grow. Everybody seems to be interested in that.

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ELISE





CCC: Alastair McQueen. Test driver, ahem, Evaluation Engineer. He's been at Lotus for 30 years. He's driven everything. He can still whip the kids. He rolls his own. Why did the Elise turn out the way it did?

ALASTAIR MCQUEEN: I think it goes back to Chapman's original principles. It's "what is a Lotus." Performance through light weight, simple, no frills, manual controls, lots of technology in the car but the sort which doesn't take away from the driving experience. He'd have been really pleased with it.

Evolutions, well, everybody wants more performance but the evolutions have all been natural and so far we've managed to do it without adding weight, although the Exige and ironically, the race cars, are a bit heavier because of steelwork for the rollcage or extra bodywork.

Do I like the rear engine? Umm, I think front engine-rear drive has maybe had it's day in small cars. It's OK for bigger ones, but there are so many very compact engines and gearboxes in front wheel drive cars these days, it would be difficult to do it any other way and still keep the weight down. That availability means there are good commercial reasons for using what's there and besides, engines are taller these days – you look at the old Twin Cam in the original Elan and it looks tiny compared with the Rover in the Elise. It would be difficult to get that under the front. All that said, I do miss the old Esprit. I really liked the four cylinder ones. Then on the other hand sometimes you forget how they really were because nostalgia

creeps in. They might have been way ahead at the time, but times have moved on and it was still essentially 1970s technology. Legislation is our biggest battle these days, but it would be a pity if we can't continue to build a car like the Elise. It's not that we couldn't meet the legislation, it's that we might have to add weight and spoil the concept.

CCC: What about the future?

AM: Part of it is to hand on what I know to the younger guys and it's not easy to find them. There's lots who can drive reasonably well, but it's the last 10 per cent that makes them suitable for the job. Only 20 per cent of your energy should be spent driving the car, the other 80 per cent is reserved for working out what the car is doing. That's what makes a test driver. But for what I do which these days is mainly teaching, driver training, sorting out the press fleet and running track days, the Elise has been the ideal tool. We've never really had that before. And I have to say that the general standard of road driving that I come across is absolutely appalling. Why is the Elise so good? I suppose because it requires above average skill to get the best out of it but it won't bite if you don't have those skills. At the same time it has what I'd call a normal balance between ride and handling. It does flatter a less skilled driver, but you do always need that edge, you need to be striving for it. And what would I like to change? I might like a bit more front end grip, but that's me speaking, and we're not here to build a personal car.



Alastair McQueen

ALASTAIR MCQUEEN
– Evaluation Engineer

