The **Rush** of racing

Entry-level racecars aimed at providing cheap thrills are nothing new, but what sets the Rush SR-1 apart is the innovative way in which many of its components are produced in-house. This has resulted in a svelte, sportscar-bodied, single seater with an affordable price tag

By LAWRENCE BUTCHER

The Rush SR-1 is set to race in a NASA-sanctioned one-make series this season

The Rush SR-1 is the brainchild of mechanical engineer David Hosie, who originally harks from Scotland. Having completed his engineering degree in Aberdeen the oil and gas industry was the natural place for him to hone his skills, and this explains why he now resides in Houston.

Hosie serves on the board of directors of an oil and gas company but, parallel to his career in this industry he's been heavily involved in racing for quite some time. 'I've always been in motorsport for one reason or another, be it karting to running a five-car Formula Renault team [known as Fran Am 2000] for three years here in the US,' says Hosie.

Working in junior open wheel series brought Hosie into contact with many young racing hopefuls and their families and he started to notice the darker side of the motorsport progression ladder. 'Running a junior formula team, you are basically a service company,' he says. 'Your customer is between the age of 16 to 22 and has access to half a million of Dad's money to pursue their dream of becoming a

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racing driver. In the years I was involved, I saw that destroy families,' he says.

Racing has never been cheap, but the current ladder system to becoming a top-level driver – karting and then through various single seater championships – is very far from being affordable. While Hosie admires efforts such as that of the FIA F4 series, with cost caps keeping things under control, he still feels that 'it hasn't worked. An arrive and drive package with a decent team will still be $300,000.'

Ready market

Hosie felt that there must be a way to provide relevant seat time – relevant being the key phrase here – without the need for a six-figure price tag. So it was that the idea of building a car to meet this need started to take shape.

'I felt that the sport needed a platform that was affordable, provided performance, had good reliability and wasn't fragile,' says Hosie. He admits that open-wheel racing is where his heart is, but adds: 'The truth is, the very nature of [those] cars tends to drive costs. You touch wheels and corners get ripped off.' Therefore, he quickly concluded that an open-top, sportscar-type platform was the logical choice.

Hosie's first concepts were what he describes as 'more of a kart with a body on, with a 600cc engine.' But, after around nine months of developing this idea, he decided that it was a non-starter. 'I mothballed the idea for about a year, then, on January 1, 2019, I decided to start a new design and got on the computer.'

One of his early conclusions was that the car needed to be small and light. 'The size doesn't really affect the cost of construction, but it does affect the weight, which in turn dictates powerplant choice, and power is expensive,' he says, noting that the size, weight and power of the final car are quite comparable to a Lotus XI, 'and that was an idea that worked pretty well'.

Explaining the concept's development process, Hosie says: 'The design of any racecar starts with the tyres. Once you have decided on the approximate weight and size, you then need to find a tyre that is going to work. You then start working around that.'

The architecture of the resulting racecar is relatively conventional. A mid-mounted 1000cc bike engine sits in a fabricated steel chassis, with a sportscar type fibreglass body and unequal length double wishbone suspension front and rear. But the true innovation here would come in realising this design in a ready to race package that costs just $28,900.

'You realise very quickly that a lot of the costs come from the components that you buy in,' Hosie says. 'The standard path these days is that you design your suspension, and then your chassis and your bodywork, and then everything gets bought in [such as] the steering rack, shocks, brakes, all of that stuff.'

Shock tactics

To make that point Hosie presents the example of the dampers used for the first prototype. 'We had a set of Ohlins on there. That was $2800 worth of shocks. You can't spend that when the total car price is $29,000.' His solution to this and other, similar, cost related issues? Where practical, build components in-house.

Most might think that this would be an expensive option, but then one comes to Hosie's key skill. He is a design and manufacturing engineer by trade, and while he knows racecars, he also knows how to manufacture parts to a cost. 'I've been building, manufacturing and designing products my entire life and you learn how to do production manufacturing,' he says. 'Most of the [racing] products out there are not really geared to production manufacture. They are bespoke. Through the design process and gearing for batch production, you can start to get some manufacturing efficiency.'

In practice, this means careful consideration of every aspect of the car where costs can be saved, without compromising performance. For example, ensuring commonality of components, such as dampers, throughout the car.

'All four shocks are the same,' Hosie says. 'So when you build 20 cars, you have 80 identical shocks, that becomes a nice, cost effective CNC run. You are getting the cost of the components down. Then translate that to other components, like the uprights; billet machined aluminium plates that are identical left to right. It is the same thing with the A-arms side to side and the anti-roll bar is the same front and rear. Volume drives the cost down.'

The dampers are a mono-tube design with a nitrogen charged piston (no external reservoir is used) and compression and rebound can be adjusted. 'We designed the shock body so that it could be assembled at different lengths,' Hosie says. 'That allows us to alter the ride height without changing the spring platform if we want to.' There are five different spring rates available, moving in 50lb increments.

Another element that Hosie felt was needed to keep the car relevant was the use of what he refers to as a 'proper LSD in the back.' By this, he means a plate type differential, with the ability to alter the locking characteristics. Having looked at some of the diffs on the market targeted at motorbike-engined cars, it again became clear that cost would be an issue. The solution? Build one in-house.

Bespoke diff

Hosie got in contact with a supplier called M-Factory, which builds aftermarket differentials, and found that the internals of a unit it produced for the Mitsubishi Evo provided an excellent starting point. 'They said that they would sell us any components we wanted,' he says. 'So we took their gears, pressure plates and friction discs, then engineered the housing, axles and mounts, to build our own diff. We even do our own ramp cages.'

The diff can be used as either a 1.5 or 2-way unit. 'You probably wouldn't use the 2-way setting very often, unless you want to go drifting,' Hosie says. It has a total of 12 plates, which can be arranged in different orders to

TECH SPEC: Rush SR-1

Chassis
4130 Chromoly steel tubeframe.

Body
Fibreglass.

Engine
1000cc Suzuki I4.

Transmission
Suzuki 6-speed sequential with paddle shift; plate type LSD.

Suspension
Unequal length wishbones front and rear; two-way coilover dampers.

Brakes
274 x 25 mm floating discs; 4-piston calipers front and rear.

Electronics
Standard Suzuki ECU (remapped); AIM data logger dash.

Wheels and tyres
7x13in front, 8x13in rear.

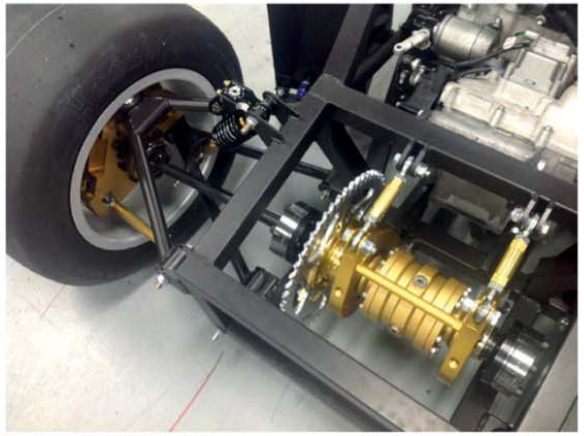
Dimensions
Length, 3325mm: width, 1499mm; height, 990mm

Weight
386kg (850lb).

'Once you have decided on the approximate weight and size, you then need to find a tyre that is going to work'

While the SR-1 is a single seater, sportscar bodywork was chosen for practical reasons. This is made up of 19 different panels, which helps keep repair costs down

Dampers are of a mono-tube design with nitrogen charged piston. Compression and rebound can be adjusted



The plate type limited slip differential is just one of many components that Rush has manufactured in-house

vary the friction characteristics of the unit. 'I wanted to provide enough adjustability so that the driver can adjust for track conditions or their own driving style, but not so much they end up chasing tiny gains and need an engineer to set up their diff.'

Racked up

The SR-1 even has an in-house produced steering rack because, once again, a suitable rack was not available at a competitive price. 'I wanted a decent rack, there are a few that you can get at lower price but I'm not sure I would even want them on a kart,' Hosie says. 'The obvious place to look was manufacturers for formula cars, but then you are talking around $1000. We ended up building our own for around a quarter of that.'

Hosie does admit that: 'I'm in a fortunate position that the company that I am a director on has a full CNC prototyping shop, which I have full access to, and it's next door to my shop. That gives us the ability to build a lot of prototype stuff ourselves, then, by outsourcing production to shops that are set up to run production, we can get parts at prices we couldn't do internally'.

Next to the engine, the main chassis frame is the single most expensive part of the car, and Hosie put considerable effort into making it cost effective to produce. 'The traditional way of doing a chassis is to use round tubing for everything, but that makes it hard to mate parts together,' he says. 'Everything you want to add to the chassis, you need a welded-on mount.'

This adds to the time and thus expense of fabricating the chassis, and it was therefore logical to use 1½in square section 4130 chromoly tubing where practical instead. Unfortunately, square tube of the required quality is uncommon compared to round stock. 'Some of the big tubing manufacturers have it in stock and you can buy it at $24 a foot, which doesn't work from a cost perspective.'

Going back to his industrial roots, the solution was obvious to Hosie, buy the tube in bulk. 'We order the tubing in mill run quantities, three metric tons at a time, which is enough to build 65 chassis and some spare parts,' he says. The added bonus being that the steel mill is able to laser cut all of the tubes to length: 'There are 48 different components and they all arrive from the mill pre-cut.'

Where round tubing is used, it is DOCOL R8, an increasingly common alternative to chromo that provides numerous benefits like ease of welding and smaller heat effected areas at joints. 'I love the DOCOL and if they made a square tube, the whole chassis would be that'.

Further aiding fabrication, Hosie has designed the joints between tubes to incorporate a tongue and groove, 'that locates the tubes together and eliminates a lot of jigging issues. That, in combination with the pre-cut tubes, greatly reduced chassis construction time'. As an indication of just how cost effective these methods are, a complete chassis retails for $3000.

The chassis is made with square tubing, which helps make the build process cost effective. Note the sturdy double roll bar

Safety is clearly a critical concern in a car that will be used in both spec and open series and here Hosie has taken a belt and braces approach. 'We could have just used 1½in tubing on the cage and been legal for all series, but we went for 1¾in, 0.95in wall thickness tube.' Going on the requirements for SCCA racing, this would be sufficient for a car weighing 3000lb (the SR-1 weighs just 850lb). The braces part? Hosie opted to double up the roll bars, rather than simply bracing the main hoop. 'That helps keep everything in the right place if the car goes upside down, and also, as a side effect, improves the aesthetics of the car,' Hosie says.

Ergonomics

In order to accommodate as wide a range of drivers as possible without needing chassis alterations, the SR-1 incorporates a fully adjustable pedal box, again, built in-house. Not only is the pedal box adjustable for reach, the spacing between the pedals can also be altered to accommodate those with bigger feet. Complimenting the adjustment available in the pedals, the seat can also be moved fore and aft. 'We can fit drivers from 4ft 8in to 6ft 4 in, there is four inches of travel in the pedal box and the seat can be moved five inches,' says Hosie.

Body image

Next came the bodywork. 'Having been a mechanical engineer my whole life, the nuts and bolts of the car were relatively straightforward, but I've never built any bodywork before,' Hosie says. 'I realised very quickly that my engineering ability far outweighs my artistic ability.'

For the first iteration of the SR-1 he designed the body, but putting the matter bluntly says, 'it wasn't sexy enough'. At which point an expert was brought in; Michael Young, whose CV includes, among other projects, designs for Scuderia Cameron Glickenhaus and Palatov. The inspiration for the bodywork design stems from another backburner project Hosie has for a GT car, with its roots in a concept penned by Young which Hosie purchased a license on.

As with the chassis, the body is designed with much thought given to ease of production and cost control. 'Taking a nice design from concept to something that is manufacturable is quite a step,' says Hosie. For example, he wanted to ensure that the body was made from multiple sections (there are 19 in total), rather than just two or three large panels. Contact is inevitable in racing, and by using smaller panels the cost of repairs can be kept under control. Impressively, no panel is so large that it cannot be shipped by regular US Postal Service ground services.

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'We wanted a power level that was satisfying for the seasoned race driver, but still usable for those with less experience'

Time machining

But manufacturing the fibreglass bodywork would prove challenging. Here Hosie went to the extreme when it came to utilising his in-house capabilities. 'We went through about six months of hell trying to get the bodywork done,' he says. 'It is a four-step process, design, pattern making, creating a plug and then making parts. The most expensive part of that is CNC machining the patterns.'

Buck production requires the use of a five-axis CNC router so, of course Hosie, having got quotes way out of budget, decided to buy his own and produce the bucks in-house. 'It was an interesting journey. We looked at some hobby level CNC routers, but none matched the spec needed. Then, one night, I was on Ebay and found a 1998, Motion Master five-axis. It belonged to a semi-retired pattern-maker who needed it out of the way after it had died on him. We paid a ridiculously low price, flew up to North Carolina, put it on a loader and drove it to Houston. We had it up and running with a new VFD [variable frequency drive] and within six weeks, had made all of the bucks ourselves.'

This sounds straightforward enough but suffice to say there was some lateral thinking needed to get a 20-year old machine working with modern CAD/CAM. 'We were trying to drive it with Fusion 360, that wasn't happening,' Hosie says. 'We went back to the previous owner and got the original software which hadn't been updated since 2005. We found an old Windows XP machine lying around which we used to run it. So we used a 1998 router, with a 2005 PC and Surfcam 2005. It might not be the latest and greatest, but it got the job done. I just wish we had found it six months earlier.'

Bike power was the logical choice for the SR-1's propulsion and Hosie settled on the Suzuki GSX-S 1000cc motor. 'We wanted a power level that was satisfying to the experienced driver, but still usable by drivers with less experience,' Hosie says. With around 145bhp at the rear wheels giving a power to weight ratio of nearly 400bhp/tonne, it hits these goals.

While a sportier GSX-R engine would provide more power, it was not deemed necessary and the lower-spec GSX had a number of added benefits. Firstly, it is a widely available new from Suzuki, while secondly, it is better suited to a racecar installation. For example, the S model, being a touring motorcycle, has a much larger sump than the R, which removes the need for a dry-sump system in the SR-1.

The styling of the Rush SR-1 is certainly eye-catching; its aesthetics benefited from the input of car designer Michael Young

The twin exhausts connect to a Suzuki GSX-S 1000cc powerplant. Aero includes a wing and a modest diffuser at the rear

The standard transmission from the GSX-S motor is retained, but equipped with a paddle shift system, again, developed in house. 'It uses a gear head drive to actuate the shifts and we developed a control system,' Hosie says. 'Again, we can't be spending $1500 on a shift system, it had to cost less than that.'

Hosie's hopes for the project are admirable. 'The goal might seem lofty, but I want to bring people back into the sport,' he says. To help achieve this aim, concurrent to the development of the racecar he has been formulating a one-make series run by NASA (National Auto Sport Association), with the first round due to take place in April 2020.

Additionally, he has been approached by potential customers looking to run local series for the car right across the USA, as well as some racing driver schools who see the Rush SR-1 as an ideal teaching vehicle.

With such a low price, and with that considerable performance on tap, the SR-1 will likely become a common sight at tracks across the US over the course of 2020.