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Racecar engineering™



World Rallycross 2015



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A stricter enforcement

How stronger rules will leave Rallycross in rude health

By SAM COLLINS

Rallycross was at a crossroads when the World Championship started last season, but the new series has given it the structure it needed. In 2014 many of the cars did not fully comply with the technical regulations; from incorrect dashboards to incorrect engine mounting positions there were a number of issues. Many of them were resolved during the season but some of the major ones resulted in 40kg weight penalties being applied to the cars in question. However, for 2015 things are getting serious and the rules are being enforced fully.

'Basically the rules have not changed, but the interpretation and implementation of them have,' says Bruno Famin, head Peugeot Sport. 'This year the checking of the cars will be stronger, and the implementation of the rules will be stronger. The rules themselves are fine, it's just that they need to be enforced!'

There have been changes to the technical regulations, including the arrival of bespoke competition engines, which will be covered in a future edition of *Racecar Engineering*.

There have also been some subtle changes to the sporting regulations and with an eye on cost control, a personnel cap has been applied to teams contesting the championship. For each two-car team, only ten engineering and technical staff can be in attendance along with two non-technical personnel. That number can increase if teams choose to add third or fourth cars. Additionally, all of the work taking place in the paddock has to be recorded in an attempt to enforce the personnel limit.

Tighter controls

Testing restrictions have also been put in place, stating that outside official test and media days, only four days of testing may be conducted in a single year, with no more than 40 laps per day. These restrictions though do not apply to national events (including the GRC). Overall the RX Supercar class remains little changed for 2015, but that does not mean that some of the teams have not changed in response

to the many clarifications dotted throughout the latest version of the technical regulations. Indeed there was a very detailed FIA inspection of Petter Solberg's World Championship winning Citroën at the official season launch, and while it was at the teams own request, the thoroughness of it sent a clear message out to all of the rival teams this year – the FIA really means business in 2015.

Already there have been some rumblings of cars pushing the rules to the limit and beyond, and some in the paddock are keen to highlight them. 'This year the big thing will be electronics – there has been a request about torque control which came very late,' Famin reveals. 'Torque control is clearly forbidden in 2015, like it was in 2014, and I think the FIA must be very strong about that. The FIA have guys with very good skills to police this sort of thing, so they have to check the software. To develop torque control is very expensive, so it must remain forbidden. It very surprising to find that someone is asking at this point as it is clearly forbidden.' ECUs with torque based models, however, are allowed though this is not torque control in this sense.

Electric future?

To guard against such debate some, including Famin, are in favour of a common ECU to be introduced to the series. With most of the engines in RX Supercars being of similar configuration, it would perhaps be something to expect in the future although a recent proposal was rejected at a recent TWG meeting. Another area of technology that has apparently been discussed behind closed doors is the use of hybrids or EVs in the World Championship. *Racecar Engineering* has learnt that at least two hybrid power train specialists have been contacted by organisations developing or already running RX Supercars with a view to using them on the cars.

'It makes a lot of sense when you think about it,' adds one long-time RX Supercar engineer. 'The duty cycle of these cars is such

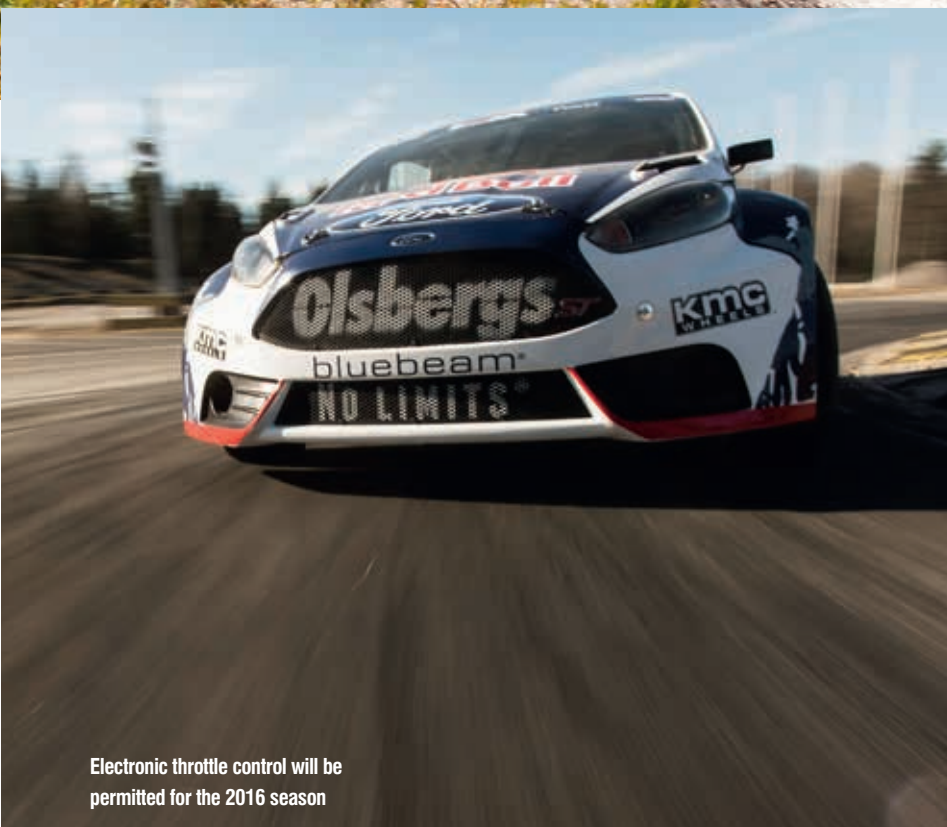


that hybrids or EV's are perfectly suited to Rallycross. What concerns me a little is the cost; I could see it getting out of control.'

While some manufacturers such as Nissan, which have a clear interest in Rallycross and electric cars, would favour the introduction of the technology into rallycross, others are concerned about the reality of it. 'Hybrids in racing are always complex,' says Famin. 'A one make system is good for the promoter because he can say his formula is green, but for the teams and the manufacturers there is no interest because it is not their system. If you let everyone develop their own, then manufacturers like us at Peugeot are interested, but the costs can escalate quickly as you see in LMP1.'

However, it does seem likely that at some point in the not too distant future, all-electric RX Supercars could be a reality, although it is highly unlikely to happen this season. And one of the barriers to the arrival of such cars will be removed in 2016 when the prohibition on electronic throttle control comes to an end.

**‘This year the checking of the cars will be stronger,
and the implementation of the rules will be stronger’**



Electronic throttle control will be permitted for the 2016 season

Next season electronic throttle control will be allowed on single-valve, single throttle layouts although only using commercially available throttle units. Multiple valve throttle units will be allowed but must be purely mechanically controlled. Changes to engine component specifications are also being introduced as a way of excluding exotic, and expensive, materials.

Another change that will happen next season is a blanket minimum weight of 1300kg for all RX Supercars, meaning that cars using the smaller WTCC/WRC derived 1600cc engines will lose their 90kg weight break allowance in comparison to racecars using the maximum engine capacity of 2050cc. With such an approach to rule making, and generally few complaints from teams (almost unheard of in other FIA World Championships), it seems that the re-birth of Rallycross is well underway. Under the management of IMG and the FIA it is rapidly looking to become one of the most exciting motorsport classes.





Mini revolution

How JRM's RX MINI hopes to take the Rallycross world by storm

By SAM COLLINS

At the end of the 2014 season JRM made the unexpected announcement that it was going to start competing in Rallycross. The organisation is best known for its sportscar racing projects which include the development of NISMO's GT3 specification GT-Rs and in the past has seen JRM contest the GT1 World Championship as well as the LMP1 class in the World Endurance Championship. It has recently moved into loose surface motorsport with the development of a Group N Subaru rally car.

To move into Rallycross, JRM acquired Prodrive's MINI Countryman JCW RX SuperCar project and its technical lead Paul Eastman, who has worked on the project since its inception.

'Technically the car started life as a S2000 rally car,' Eastman explains. 'The RX Supercar technical regulations do not really allow you to take a homologated World Rally Car and use it in Rallycross, but what you can do is convert a car homologated in Group A which is what the S2000 was. It's a technicality, but we don't want to fall foul of the rules.'

Falling foul of the rules has become a lot easier in 2015 as there has been a significant move by the FIA to enforce the RX Supercar regulations after it was realised that not a single car contesting the 2014 World Championship fully conformed with the rulebook.

'One of the approaches we have is to ensure that we have a clean car as the recent history

of RX has been quite ambiguous as to what the regulations are,' continues Eastman. 'They are a close knit community, they have done things their own way and found a mutual way forward. Now RX is opening out and becoming a bit more technical and we need to have more controls in place.'

The S2000 MINI was launched in 2011 as a project between Prodrive and BMW Motorsport, but it had mixed results. A programme to convert the design into a Rallycross supercar began in 2012 and was completed a year later when the car won on its debut at the Munich X-Games in the hands of Liam Doran.

'The conversion did not take too much as the essence of what we did with the rally car



‘In the rally guise it was not the most powerful car in its class, but it did allow the driver to get good feedback from the car’

was to create a nicely balanced and packaged vehicle that had a couple of main criteria, one of which was allowing the driver to get a good feel for it,’ Eastman explains. ‘In the rally guise it was not the most powerful car in its class, but it did allow the driver to get good feedback from the car.’

The changes from the S2000 version to RX Supercar saw it stripped of many rallying essentials, including the co-driver’s seat and instrumentation, tools, spare wheel, heater and protective undertrays. The headlights have gone too, as have many other minor components designed for the stages. The radiator has been moved from the front of the car to the boot area where it is fed by ducts



Top: The cooling fans can clearly be seen – these play a huge role in keeping performance consistent

Above: The intercooler is front mounted as is standard practice in rallycross

from the side. Once the project was taken on by JRM, work continued and the car now bares little resemblance to when it was in its original specification.

Remapped powerplant

One thing that remains from the rally car is its engine – a turbocharged 1600cc four cylinder BMW with direct injection, although here, too, the JRM development has been extensive. ‘The engine has a production block and that’s a key to it,’ says Eastman. ‘The rally project was conceived in partnership with BMW motorsport and they developed the engine. BMW wanted the engine to be designed so that it could be used in both the rally car and the WTCC car. In

the touring car it was mounted longitudinally but in the RX car it is transverse, so in its development there were trade offs between some design elements. But, because the regulations the engine was designed for would always have a restrictor, or one so large, there was never the thought of running it to these extreme horsepower levels. So, for the intended applications the production block and head are suitable, but now in RX we are going to make them work a bit harder. BMW’s official line was ‘we would not recommend it’. What they did was design an engine to last a season in racing or 1600km in rallying before it needed a rebuild.’

With a production block, the engine in RX trim is clearly performing at levels way beyond



'In 2016 all RX Supercars have to go to 1300kg, regardless of engine'

its original design parameters. During its first phase of development the engine was remapped to deal with the larger restrictor allowed in Rallycross. This, when combined with a larger intercooler and increased boost, raised the power level by about 20 percent.

'At the time when the car was being developed, all the effort was put into the chassis, but the next phase would have been engine development for WRC. That never came,'

Eastman continues. 'In rally use it had restrictors of 29mm-33mm, so it was heavily restricted and never got more than 330bhp maximum. But with a 45mm restrictor we immediately pushed the engine way beyond what the rally car was meant to be, so we had to do some work on the chassis as a result.'

The MINI is almost certain to be the only car contesting World Championship with a 1.6-litre engine, but despite being at a clear power

deficit Eastman does not feel that the car is at a disadvantage. 'The beauty of the regulations in 2015 is that a 1600cc engine gets a 90kg weight break over the 2.0-litre cars, so for us it makes a lot more sense to stick with that for now. The question we are now asking as JRM is what to do going forward – do we develop the 1600cc engine further and further? As we know, there's still a lot more to come from it; bear in mind F1 engines are 1600cc too. But how much of that performance can be unlocked and at what price? You have to think about the economics.'

It could be argued that a more cost effective route would be to drop in a developed version of the 2.0-litre engine used in some MINI production car variants, but it is not as straightforward as it seems. The engine bay of the car is already cramped, so fitting a larger capacity engine could be an issue.

Light weight is key

'Installing a 2.0-litre engine is a challenge with the chassis. Not just from fitting it in the space available, but also from accommodating the extra 90kg you would get as a result of going to a 2.0-litre unit. With that 90kg you have to think about stopping it, how it impacts the car when it lands off jumps and even the driveshafts have to be slightly larger to cope. It impacts massively on the whole car,' Eastman admits. But he also goes on to acknowledge that this is a path that JRM will ultimately have to take. 'The decision has been made for us. In 2016 all RX Supercars have to go to 1300kg, regardless of engine, so we will have to do all of that work and get the extra power.'

But, for the 2015 season at least, the MINI's 1.6-litre engine and resulting weight break is, in Eastman's mind, actually an advantage, as he believes his car to be a much lighter package all-round due to its S2000 roots. 'Fundamentally the whole rally package is a lot lighter than the conventional RX Supercar, as the car was first developed to S2000 there were certain limits on things,' explains Eastman. 'The engine, for example, has to weigh 82kg, so obviously between us and BMW we made sure it was 82kg. The gearbox had to be 55kg, so that's what its weight is. In RX there is no component weight minimum so they tend to have a lot more weight in those parts, and that's a lot of weight to have on the front axle.' This weight advantage gives the MINI an advantage off the line over its bigger engined and heavier rivals, but testing and the GRC outings it has completed have shown that it does lose out slightly on long straights. However, it makes up time elsewhere on a lap.

Generally it seems that the chassis of the MINI was a very solid basis for a RX Supercar with its roots in stage rallying, and while the demands of Rallycross are obviously different,



Top: The RX MINI uses an S2000 asphalt brake setup with gravel spec discs and calipers on the rear
Above: Engine bay is already extremely cramped and would struggle to accommodate a 2.0-litre powerplant





much of the design has carried over. 'The base geometry of the car, the heart of the car if you like, in its centre of gravity, its geometry, that has not changed,' Eastman claims. 'It is all about traction and that has already been optimised on this car. Even with more power you won't get any more traction out of that geometry if you have fully maximised it already. The one equalling factor in this series is the tyre, and the cars are under-tyred for the performance they have. You will always have this condition of ultimate power and ultimate torque balanced against having to look after your tyres. In distance terms the races are not that far but they are very intense on tyres. If you have too much power you will simply eat those tyres, and you do see a drop-off in performance throughout the event.'

Consistency is paramount

Avoiding a performance drop-off as the car is used has been a key part of the MINI's design since its original conception as a rally car. This was something which was wanted in its design in order to ensure that the car was user friendly and consistently competitive.

'If you look at the MINI, the concept was always that it would have consistent performance throughout an event,' continues Eastman. 'We still want the same level of performance as the car starts the final as we had when we arrived and set the car up for free

practice. It's quite tricky to do that throughout a race weekend with mud build up, general wear and getting bashed into by other cars. There are so many factors that can come into play that I think by the time a lot of RX cars get to the final they are simply not as good as they were at the start of the weekend in terms of performance. The MINI can keep its performance consistent and we have seen that in events.'

It is a design philosophy that Eastman is continuing with the car under its new JRM ownership and it is having a clear impact on the car's development. 'It's about having the right strength in the right components in the right places. We are lucky that this chassis has done so many miles as a rally car that we know that it can do the distance. We have all of the data on the brakes, the cooling and all of that. For example, this car has a set of fans pushing air through the radiator, which are on all the time, and another set sucking air through it, and those are on a temperature control. In GRC events the fans would not come on during the first six laps, they would only come on in the final two laps usually. It was all about keeping the oil and water temperatures in an optimum working range to ensure the engine

performance was not reduced in any way, shape or form. Some of the other top cars did not have that and they suffered.'

Breaking convention

This 'no performance drop-off' mentality can also be seen in the braking system, which from the outside appears to be very conventional, mainly because it is, but it is a conventional rallying setup, not a RX setup. Paddock wisdom suggests that the short sharp races in Rallycross favour different friction materials which warm up to their working range faster but can overheat in a much shorter amount of time, but this is not a theory that JRM and Eastman subscribe to.

'So far with the brake friction material we have not seen the need to change, because in rallying, like RX, you don't get the chance to warm up the brakes much. It's all about going from cold to the working range in the shortest possible time – that is as true for RX as it is for rallying. The thing with rallying is that you have a 20-minute stage which means that the brakes must last, so you have brake cooling. Yet with the short races in RX you don't need that endurance, but you can also do away with the

'We want the same level of performance as the car starts the final as we had when we arrived'

cooling too,' Eastman explains. 'We use the AP braking system and that has a full suite of discs available for different conditions, so we select what we need from that. So what we use is an S2000 asphalt setup on the car with a gravel brake on the rear, but it's something we can play with and swap around.'

Other lessons that have carried over from Prodrive's rallying experience are clear to see in the way the car is run at the track. Some of the design features are straight out of the 555 Subaru WRC teambook and even the design of the stands the car sits on in the garage have come from the Prodrive rally team. 'The serviceability of the car is key. When we sustain

damage it's very quick to repair with this car, the suspension for example can be swapped out without the driver noticing a difference,' Eastman reveals. 'But in some areas there are RX specific demands. Running the car in GRC we discovered a weak link in the rear suspension from where the drivers lean on each other a lot. All of the load cases of the car running on a stage, both in testing and in reality, were fine. But in Rallycross, where the cars are making frequent contact, we realised it needed strengthening. In a similar way body damage is a factor so we have used some flexible panels on the car – if you use a brittle composite panel it can get a hole in it and

reduce driver comfort. It only takes the smallest distraction to put a driver off in Rallycross and the races are not long enough to recover from mistakes.'

The JRM developed MINI RX Supercar will make its official World Rallycross Championship debut at Hockenheim in round two of the series, where two examples are scheduled to take part and will then take in other selected rounds of the series. With as many as five manufacturers looking to enter the championship in 2017 it seems that JRM's RX MINI project is a statement of intent, and perhaps an advert to potential future partners.



JRM

The JRM Group was established in 2008 with the aim of becoming an internationally-renowned motorsport preparation and advanced engineering specialist. In the seven intervening years, JRM has swelled its skilled workforce to 60 people and has recorded success in every category of international motorsport that it has entered.

Under the eye of owner, James Rumsey, it has won on race tracks and rally stages across the world and is now bidding for international Rallycross success with its MINI RX.

JRM has established a formidable reputation in sports car racing and has constructed and engineered competition cars that have won various endurance championship titles, including the

FIA GT1 World Championship and the Blancpain Endurance series. JRM has even tasted success at the classic Le Mans 24 hours after it engineered its own LMP1 Honda to sixth place overall in 2012.

Today, JRM is the official partner for Nissan Motorsports International and plays a key role in the successful development, test and build of the marque's GT3 racing programmes.

JRM is the official partner for NISMO and Base Team for Subaru

As well as constructing Nissan GT-R NISMO GT3s that are being used around the world, JRM currently provides engineering and parts support to customer teams as they target success in

the Blancpain Endurance and Sprint series, GT Masters and the Pirelli World Challenge.

Away from endurance racing, JRM is also an official Base Team for Subaru Tecnica International (STI), the motorsport division of Subaru. The company's first Subaru-backed rally car rolled out of its Daventry headquarters in Group N specification in 2014 and went on to set fastest stage

times in every round of the toughly contested FIA European Rally Championship that it entered in the hands of multiple British rally champions Mark Higgins and Keith Cronin respectively.

This season, JRM is building a fleet of 2015-specification Subaru WRX STI rally cars that meet the FIA's new-for-2015 NR4 regulations. The car is believed to be the only one of its type in Europe and brings Subaru's latest vehicle technology to the production rallying category.

Key to the success of all JRM motorsport programmes is its Advanced Engineering business unit that delivers in-house, round the clock engineering support.

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Vorsprung durch Technik

When it comes to Rallycross, not all Audis are the same

By SAM COLLINS



'We just made the bodywork look aggressive, the way we thought that it should look – we have not done any windtunnel testing'



The Larsson A1 uses a Trollspeed prepped engine mated to a Sellholm gearbox



The EKS car is the only Audi in the competition to be equipped with a transverse powerplant



The Münnich Motorsport team's Audi S3 runs a Unic transmission

Audi is exceptionally well represented in the World Rallycross Championship, with five examples contesting every single round, and three very distinct car designs. The best known is the works supported EKS team, owned by Swedish Audi Sport DTM driver Mattias Ekström. His rallycross team made its debut in the World Championship part way through last season with an all-new Audi S1 based RX Supercar.

Because of the clear link to Audi many people think that this car is really just a works car in an unconvincing disguise, but team technical director Janne Ljungberg says that appearances can be deceptive. 'Audi is just a sponsor of the team, like Red Bull. We do the whole car on our own. This is not an Audi factory car. They provide the shells but we have to buy them.'

But the Audi influence does impact on the overall layout of the car, specifically its transverse engine layout. 'The car is like that because, in our philosophy, that is how the cars should be. With Audi as our sponsor and the base car having a transverse engine it is better all round to keep the layout the same. Of course the gearbox is not the same, but the rest is.'

Different states of tune

The EKS Audi uses the same Sadev six-speed unit featured in most RX Supercars, although when the project was first instigated an Xtrac transmission was tested. Driving all four wheels via that transmission is a 2.0-litre Volkswagen-Audi four cylinder engine tuned by Lehmann of Lichtenstein. 'It's an engine that has been used a lot in other classes. It's the same used in LMP1 a few years ago and it's proven for 24 hours. We have a bigger turbo on it and the 45mm restrictor,' Ljungberg adds. In LMP1 guise (with the Swiss Hytech team) the engine proved troublesome on the components around it, including the Torotrak hybrid system, but in RX guise it appears to be a strong performer. It features direct injection and funding for its development is reportedly from Audi Sport.

Julian Godfrey prepares the four cylinder engine used by the Münnich Motorsport Audi S3, while Trollsport prepares the engines used by Robin Larsson's one-off Audi A1. The EKS cars are the only Audis to be fitted with a transverse engine while the Larsson and Münnich cars mount the engines longitudinally, a feature that some claim gives more options in terms of transmissions. The Münnich cars run with a Unic transmission (the same as the title winning Citroën of Petter Solberg), while the Larsson car uses a gearbox from Swedish supplier Sellholm, with an Alcon clutch.

Style and substance

The EKS car has its radiator mounted at the rear of the car fed by inlets on the side, with the intercooler mounted at the front, a standard layout for current RX Supercars.

There has been some speculation that the suspension on the EKS car is in someway 'a bit trick' – something encouraged by the refusal of the team to discuss its layout in one well-syndicated interview. However, Ljungberg claims that there is nothing unusual going on.

'There are not really any tricks in it,' he explains. 'We use a McPhearson layout with Öhlins dampers. The uprights are identical all round, we just fit them with different mounting brackets for which ever corner they are on. The front suspension may not be the lightest but it works well. Our dampers maybe slightly longer than others as they are mounted on the side of the upright, not on the top as normal. That gives a slightly longer damper, but I'm not sure that the stroke is any different.'

In terms of the bodywork the look of the EKS car is quite dramatic but apparently it was designed for the way it looks rather than the way it actually works. 'We just made the bodywork look aggressive, the way we thought that it should look – we have not done any windtunnel testing. Aerodynamics don't really matter in rallycross,' says Ljungberg.

Of the three Audi RX Supercars, the EKS car seems to be the best funded with the best driver line up, but the nature of Rallycross is unpredictable. Larsson has won European titles in the recent past while the Münnich team has a long history in GT racing and is also well funded. Whatever transpires, it seems that the Audi brand will continue to be well represented in Rallycross.



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Full factory

Peugeot is RX's only official works team – the French manufacturer is clearly hoping for big things from their new car

By SAM COLLINS



Peugeot Sport is the only official works entry in the World Rallycross Championship and it operates its team in conjunction with Hansen Motorsport, a long time partner of sister company Citroën. In the first season of the World Championship Peugeot developed a RX Supercar based on its R5 Stage rally car, but it was found lacking in a number of areas. As the organisation's engineers learnt more about RX Supercars it decided to the best course of action was to rework the car substantially.

'In 2014 we had the 208 T16 Rally car and just adapted it to RX, changed engine and used a big gearbox' Peugeot Sport boss Bruno Famin admits. 'But this year we have decided to design a new chassis to push the rules to the limit, we have moved the engine, changed the suspension, made the whole car lighter.'

One of the weaknesses of the R5 based 208 RX Supercar was its inability to run at full power in high ambient temperatures, something that has had a major impact on the revised car. 'The only changes to the engine have been for reliability, but we have done some work on the inlet, and improved cooling. We need to have the engine working properly in all conditions. We need to be able to get maximum power even when it is very hot,' Famin continues. 'On the aero side, most of our development was on cooling, we tried to put more air through the water radiator at the back of the car so we revised the




Top: Peugeot switched from an adapted 208 T16 Rally car to a purpose-built, lighter RX machine in 2015

Above: Engine development has focused on improving reliability and cooling

openings on the side of the car. They are now a bit bigger. But it's not a major focus, the aero effect is a bit less than it is at Le Mans! All of the aero work was done in CFD – there is a wind tunnel close to our place in Velizy but we have not used it on the RX car.'

The philosophy of the reworked 208 was simple; build a proper RX Supercar and not merely adapt an existing stage rally car. This resulted in a car that is not only lighter but also, according to Famin, much more suited to the

demands of RX. 'The new chassis allows us to push the technical regulations. There are some limits on the engine position in the car and we have exploited them to the full, moving the block backwards, but the transmission is fairly similar. The suspension is lighter with revised dampers, wishbones and uprights, all now optimised for the demands of RX.'

Peugeot appears to be very serious about capturing its first World Championship title in the Rallycross discipline. 



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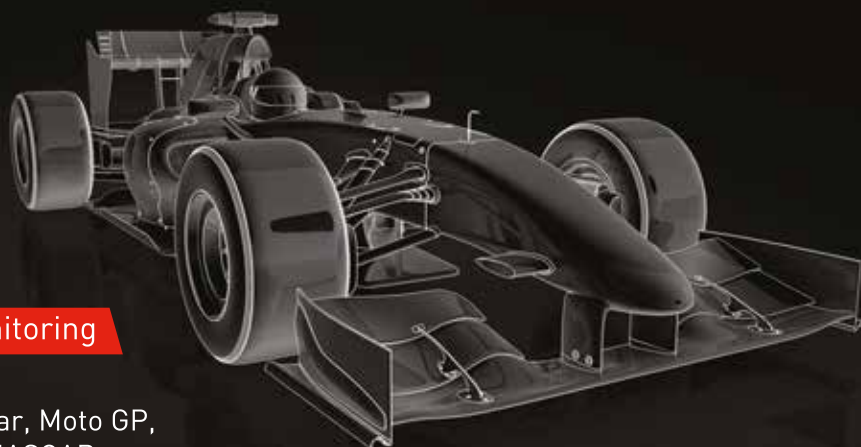
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Extreme revolution

Subaru give its RX Supercar a radical overhaul – it's more powerful, lighter, faster and boasts better handling

By SAM COLLINS

Subaru has made no formal announcement of any intention to contest the World Rallycross Championship, but when it revealed its new RX Supercar earlier this year it made a point of stating that the car meets the 2015 world championship technical regulations.

Developed in secret jointly by Vermont Sportscars and STI, the Subaru Impreza WRX STI VT15x is the third car developed by the same partnership for the Global Rallycross Championship and the X Games.

'We made huge strides in durability and competitiveness last season,' explains Vermont

Sportscars team principal Lance Smith. 'The VT15x is almost entirely-new technology. This car is a revolution, not just an evolution. The foundation of every great racecar is the chassis you start with. Using the 2015 WRX STI, we have seen gains in handling and cornering in both our stage rally and rallycross cars; which is a testament to advancements in design from the factory.' Indeed the new car has been developed alongside a new Subaru stage rally car which will contest the US national championship.

The VT15x features a 580bhp 2.0-litre Subaru Boxer engine and the popular six-speed SADEV sequential gearbox. Other features include a

rallycross-spec widebody, and METHOD® race wheels. Updates and revisions to the VT15x are widespread compared to the VT14x version run by Subaru Rally Team USA last year. Optimising weight distribution, centre-of-gravity, suspension geometry and aerodynamics were key focuses to improve handling, while increased engine power and response led to gains in overall speed and launch capability at the start.

The new Subaru does not only have the longest name in the championship, it is also the longest new spec RX Supercar in competition currently, although the older Saab or Per Eklund is probably a touch longer.





Rubber rules

Examining how Cooper Tires met the challenge of supplying the RX series with its tyre requirements

By SAM COLLINS



‘You end up with a tyre that is the best compromise – it has to work on tarmac, on the loose and its got to handle big jumps’


Rallycross may have been created for television audiences, but it has resulted in a class of racing which presents serious challenges for engineers. The big power outputs, rough and tumble racing and mixed surfaces together with a very open set of technical regulations combine to make the RX Supercar class one of the toughest there is from a technical standpoint. This is especially true when it comes to the tyres used on the cars; for years RX Supercars could run pretty much whatever they liked but, for the launch of the FIA World Rallycross Championship, it was decided that a single spec tyre should be used.

US company Cooper Tires was chosen as the sole supplier, and due to the history of its motorsport supply department, which is based in the UK, that came as a relief to many in RX as it was the choice that the teams themselves would have made.

‘Despite the fact that we are not heavily involved in rallying we took an interest in RX at an early stage, and as a company we have now been in Rallycross for 25 years,’ Paul Coates, Cooper Tires general manager for motorsport explains. ‘We have been there as the sport has evolved from the two-wheel-drive cars right through to what we have now. During that time it was always open tyre with between five or six suppliers – we were taking on Michelin, Yokohama, M&H and others. It got to the point over the last 15 years where we ended up being dominant and we have had 19 European RX championship titles in total. In 2013 we achieved the feat of having a 100 per cent market share in an open tyre formula, which is something pretty much unheard of in motorsport. So we ended up becoming the exclusive partner of the World Championship when it was launched. The organisers had to convince a lot of people about what they were trying to do when they launched the world championship, so with the tyre it was one thing everyone already knew and had lots of faith in as they had all chosen to use it in 2013. I’m sure that there were companies with bigger marketing budgets, but I think they knew our product was one that the competitors would all accept.’

Tried and tested

With the tyre supply deal inked, the engineers at Cooper Tires motorsport R&D facility in Melksham in the west of England had to create the tyres that would be used for the new World Championship, except they didn’t really do much as they felt that they already had a product that did not need to be much improved upon. ‘At times a promoter will ask you for a very specific brief with the tyres and how they perform, but we did not get that with IMG or the FIA for this tyre. A lot of tyre companies would have provided something rather conservative at that point, but we elected to use the most popular tyre we offered in the European RX Championship in 2013, and that is what was selected in the end. We had something of an advantage doing that as we already had all the tooling and designs done, and all the patterns were already homologated,’ says Coates.

The tyre was something of an unusual design, simply due to the demands of the RX Supercar class, which by its nature is not one thing or the other. 

‘RX tyres are heavy, hand-built units with a complex construction’



RX tyres don't use kerbing ribs in a bid to save weight, but they do feature layers of Kevlar and nylon for strength



The tyres must be constructed so that they can be hand cut from slicks to intermediates to wets

‘A lot of people compare it with a Tarmac rally tyre but that's really not right. I think that there are a lot of companies doing rallycross tyres but none of them really see it as a totally separate application to their other products, especially rally tyres, so they can get them to launch better, or brake better or be better on the loose, but none of them can deliver the good lap time and the level of controllability ours has,’ claims Matthew Vincent, development chemist motorsports, Cooper Tires Europe.

All tyres used in Rallycross must have a homologated tread pattern which complies with FIA regulations, and this is the case with Cooper's ACB11 RX tyre. The rules state that between 17-25 per cent of the tyre must be a pattern or 'void'; this is often referred to as the 'land-to-sea ratio'. With the mixed conditions and variable surfaces of the World Championship, the tyre has been specifically designed to be able to be hand cut to turn it from a dry to an intermediate, and finally a wet.

‘If you compare what an RX Supercar tyre needs to be with other tyres, it requires a real mix of expertise to actually make it. Fortunately we have lots of experience in circuit racing. We have a very advanced GT3 tyre, but we are also involved in drag racing with the Mickey Thompson brand and that gives us knowhow – that is very important in RX. The launch is crucial in both drag racing and RX; if you get into the first corner last you have a real uphill struggle,’ Vincent continues. ‘From a compound technology perspective you can't really use tyre warmers, so you have to have a compound that comes in at just above room temperature to get off the line rapidly. You also have to build in enough mechanical grip into the tyre to allow it to put the power down and accelerate faster than an F1 car, but you then need the transient response that you would expect from a GT3 tyre. What you end up with is a tyre that is the best compromise – it has to work on tarmac, on the loose and its got to handle big jumps. The tyre

also has to be able to be used at much higher slip angles than a normal circuit tyre would ever do, because being able to overdrive the car in a controllable manner is part and parcel of RX, so you have to be able to get out of shape in close proximity to other cars and recover it progressively without the behaviour you would find in a full race slick.’

Typically a rallycross compound will work at 90°C on mixed surfaces but the compound will go up to 120°C in hotter conditions or on tracks that are mostly paved.

Performance not strength

Externally the tyres look more like circuit racing designs than those seen on rally stage, but that does not mean that these are as delicate as racing rubber – RX tyres are heavy, hand-built units with a complex construction.

‘With this tyre we have looked for pure performance, and we have resisted things like kerbing ribs because of the weight. They are a tough tyre with a lot of material in them and they take forever to make, but they wins races. Kerbing ribs on a rally tyre are largely to protect against lateral impacts on rock outcrops, so they are not really needed in Rallycross,’ Coates adds.

Damage limitation

But with the very close wheel-to-wheel racing in the World Championship, along with the frequent car-to-car contact it brings, the tyres do sometimes get damaged, although Cooper has taken steps to reduce that with multiple layers of Kevlar and nylon in the tyre sidewalls. ‘The thing is, if you made the sidewall so robust that the tyre could withstand that bodywork during contact events, then you would not get the transient response you need or the grip off the line. We have used some lightweight aramids in the sidewall which are designed to try and stop some of the bodywork coming through, but they don't provide a major impact on the tyre performance,’ Vincent explains.

While most of the discussion is around the dry weather tyre Cooper also supplies a bespoke wet weather tyre to the World Championship, and this differs significantly to its sibling. The 17in full RX race wet tyre features a radial construction while the dry weather tyre is a cross ply unit. The wet tyre also features a silica-based compound.

Cooper Tires has clearly played a key part in the launch of the World Rallycross Championship and will likely remain involved in the series for a long time to come, but the company is reportedly interested in increasing its activities and rolling out its knowledge and experience to other areas of the sport. Perhaps in the future the Cooper brand will be seen at the front of more than just one world championship – watch this space.





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Foursight

Kenneth Hansen's new C4 Rallycross contender might appear to be a development of last year's Xsara, but his will to win ensures it's bristling with innovation

By **Tim Whittington**

On the surface it may seem entirely logical that Kenneth Hansen has a Citroën C4 for the 2006 FIA European Rallycross Championship season. After all, the Swede has enjoyed a close and successful relationship with the French manufacturer since 1993 and the C4 replaced the Xsara [with which Hansen won his 13th ERC title in 2005] in the production line more than a year ago.

However, things were not that straightforward.

The C4 is not yet homologated, and that particular hurdle was cleared when the FIA decreed that mass produced, non-homologated cars would now be eligible for Rallycross. With Citroën Sport not finalising its own WRC plans until the very end of 2005, Hansen was left waiting for the manufacturer to give him clearance to run a C4, and it was the New Year before he got a bodysell.

'The body came to us on 2 January, but then I had to take a risk to build the car because the FIA

did not make a final decision about non-homologated cars until April. Even now we don't have any real paperwork for the car, just a letter from the FIA saying we can use it,' he explained.

And yet, despite this late start and uncertainty over the eligibility of the car, Kenneth Hansen Motorsport had its new car up and running by the third week of April. Not only that, it also managed two tests in Sweden, and another with engine supplier Öreca at Magny Cours, while on route to



“KHM HAD ACCESS TO WORKING DRAWINGS FROM THE C4 WRC PROGRAMME”

the first ERC event of the year in Portugal. Meaning, while other teams put the finishing touches to new cars in the paddock and then had to test and race in the event, KHM was one step ahead and came out of the season opener with the event win.

Based on production cars homologated in Group A (or, like the C4, a mass produced, non-homologated car which would fit the Group A criteria) Division One Rallycross cars are highly developed and very specialised racecars, which makes KHM's compressed 16-week build of the C4 all the more impressive.

Manufacturer involvement

Its links with Citroën Sport meant that KHM not only had access to a 'motorsport' bodyshell, plucked from the production line in bare metal and before the application of sound deadening materials, but also to working drawings from the C4 WRC programme. Although the Rallycross car

differs significantly from the WRC prototypes, this level of information helped to shorten the design and build time. The rollcage, for example, is based closely on the WRC version, albeit with the addition of extra tubes, which tie the structural element of the car in with the wishbone suspension that replaces the WRC's MacPherson struts. The T45 cage was made and installed by Rally Produkt in Sweden.

“2000CC INSTEAD OF THE MAXIMUM PERMITTED 2056CC”

The suspension design is the work of Swedish company Epsilon and, while many of the components are carried over from KHM's previous Xsaras (see RE V14N8), the set up is unique

to the C4, which is both longer and wider than the Xsara. Picking up from the subframes that locate the rear differential and, at the front, the engine and front diff, the double wishbone suspension set up contains some elements drawn from Citroën's rally parts bin. The fabricated uprights are of WRC origin, but modified to suit the wishbone application, and the design allows for almost 200mm of wheel travel. Controlling →

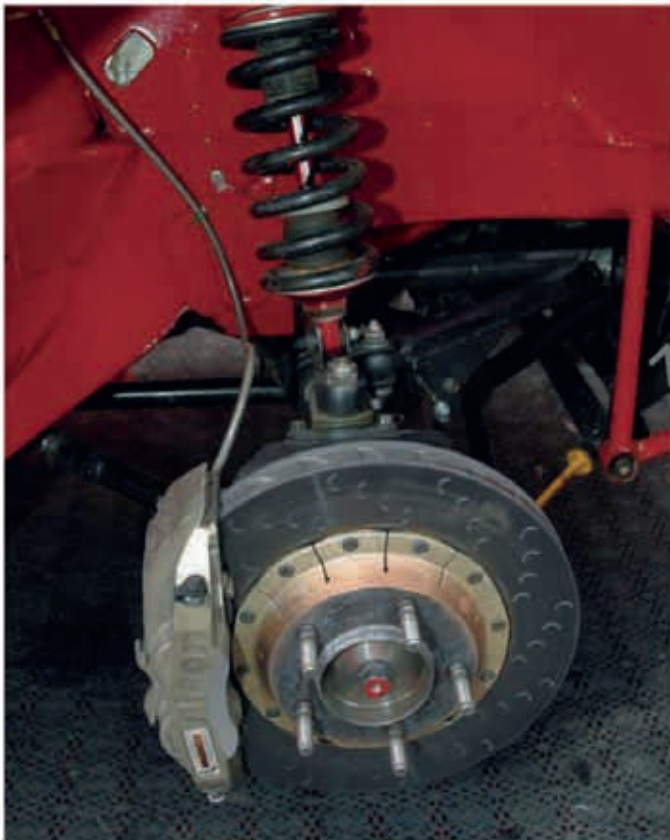
KHM Citroën C4 – technical specifications

Chassis:	Citroën Sport/ Epsilon/ KHM
Bodywork:	Citroën Sport/ KHM/ MC Racing
Aerodynamics:	Citroën Sport
Suspension:	Epsilon-designed double wishbone, Lemförder joints, Sachs four-way adjustable spring/damper units
Steering:	ZF
Clutch:	Sachs two-disc carbon
Brakes:	Alcon 310mm discs and four-pot calipers
Wheels:	Speedline 17 × 8in
Tyres:	Avon 17 × 9in hand grooved Rallycross
Transmission:	six-speed sequential Sadev gearbox, mechanical front, rear and centre differentials
Data acquisition:	Magneti Marelli
Engine:	Citroën XU7 by Oreca
Number of cylinders:	four
Displacement:	2000cc
Spark plugs per cylinder:	one
Injection:	Magneti Marelli
Wheelbase:	2608mm
Front track:	1800mm
Rear track:	1800mm
Weight:	1200kg
Power:	520bhp
Torque:	820Nm



Oreca-prepared engine uses alloy XU7 block and 16v head from 1.8-litre Xsara

Double wishbone suspension design is by Epsilon, using Sachs coilovers. Alcon discs are limited to 310mm to allow the use of 15in wheels in the wet



this are Sachs coilover spring/damper units, related to the German company's F1 product, but here in a heavier construction to deal with the variable surfaces and the 1200kg racecar. There are also blade-type anti-roll bars front and rear, to which a cockpit adjustment facility will be added during the season.

With the handling of its previous Xsaras well sorted, KHM opted to play safe with the C4's suspension and, while Hansen says the new car is better than the old one at high speed, he is already thinking of revisions: 'After two events there are some things we know could be better. Not big things, but bits that will make the car nicer to drive. At the end of the year the question will

be whether to sell this car and build a new one or make the changes to this car,' says Hansen.

The C4 is fitted with 310mm vented Alcon brake discs and four-pot callipers both front and rear –

“THE FABRICATED UPRIGHTS ARE OF WRC ORIGIN”

the conservatively-sized discs chosen both as an element in the car's startline performance – critical in Rallycross – and also to facilitate the fitting of 15in wheels in bad weather conditions.

For dry or damp track conditions the 17in Speedline wheels are shod in 9.0/25.0 x 17 hand-grooved Avon crossply tyres.

While the suspension differs little from that found in the Xsaras, the engine and driveline has moved on considerably. The first thing that strikes you when looking at the C4 is that the engine appears to be an incredibly long way back in the engine bay. This, however, is more of an illusion than anything else. Only the forward most spark plug is clearly visible in the engine bay, the next one back partially obscured by the scuttle panel and the two rearmost completely hidden beneath the 'screen'. While the engine is mounted as far back as possible (the regulations do not →

Carbon fibre rear wing utilises WRC-style vertical vanes



permit it to be installed through the bulkhead) Hansen says appearances are misleading: 'Relative to the front axle, the engine is further forward in the C4 than in the Xsara. It's the way the windscreen is that makes it look as though it's very far back,' says Hansen. 'We did a dummy build with the rollcage and suspension fitted and a bare motor and were quite concerned about how everything would fit and if it would be possible to change spark plugs. It has worked out better than we had thought – it's not easy, but we can change the plugs and the turbocharger and [the mechanics] do not complain.'

Mounted slightly to the right of centre to allow space for the front differential to be mounted to the left, the engine is an Oreca-prepared item based around Citroën's alloy XU7 cylinder block. As well as being 2000cc instead of the maximum permitted 2056cc of the previous engines, this year's Oreca engines are fitted with an alloy 16v cylinder head sourced from the 1.8-litre Xsara: 'There was nothing wrong with the head we used before, except that it was quite old and difficult to get replacements. This engine is closer to the WRC one in the main components, but we have different internal parts. It's the best engine I've ever had – the power and torque are about the same as before but everything starts lower down and continues over a wider rev range. It takes a little getting used to, but it is better like this and it makes the gearing less crucial. I drove my old Xsara recently and it's much more nervous than the C4. We're still learning the car but it seems to react better to adjustments,' explains Hansen.

Electronic advancements

While the mechanical build of the motor is important, it is in the electronic tuning that the biggest advances appear to be coming in Rallycross, noticeably through the more friendly characteristics that Hansen describes. The C4 uses



Body panels are a mix of steel, aluminium, GFRP and polyester. Duct flows air to rear-mounted radiator

a Magneti Marelli ECU, dash and data acquisition system – the version fitted being an update on that in the 2005 Xsara. Ever more sophisticated anti-lag systems improve throttle response on the turbocharged engines and, while the C4 is so heavily silenced that it's difficult to audibly detect the anti-lag in operation, its presence is given away by the puffs of black smoke created by fuel that is burning in the exhaust.

A positive point to be drawn from the seemingly large engine bay is the large amount of space ahead of the engine, meaning the intercooler and oil cooler – mounted low down beneath the intercooler – have both been installed with good clean airflows, as well as being far enough behind the front bumper to be relatively safe from damage in competition. To illustrate how important this kind of detail is, we

were also scheduled to get a look at French champion, Olivier Anne's C4, the engine of which is installed lower and further forward than that in Hansen's car. However, Anne got tangled up in a first-corner incident in qualifying, one result of which was that the front bumper was pushed back, its inside edges catching on the oil pump belt, which subsequently failed, causing the team to withdraw one heat later with an ailing motor...

As well as the major components, there are also some lovely details to the KHM engine installation, like the small carbon fibre mounting for a whole host of engine sensors that sits on the inlet side of the motor. Other details, Hansen is eager to point out, are not yet finalised: 'We put an aluminium shield over the top of the engine because we were a little worried about water dropping onto the engine if it rains. This, and the protection above the intercooler, are temporary things we will make better when we have time.'

The Haldex all-wheel drive system to which Hansen has previously enjoyed exclusive access in Rallycross has now effectively been ruled out by changes to the technical regulations. Aimed at

“IT IS IN ELECTRONIC TUNING THAT THE BIGGEST ADVANCES APPEAR TO BE COMING IN RALLYCROSS”

preventing the proliferation of 'hi-tech', the regulations now forbid sensors anywhere in the transmission or driveline (with the lone exception of an indicator to show which gear is selected) and this item may not be linked to the engine ECU. Although the Haldex would, Hansen says, work without the sensors, it would be difficult to make work well and its advantages would be minimised.

The C4 uses a Sadev six-speed, sequential gearbox, together with mechanical front and rear differentials also from the French company. The centre diff – of undisclosed origin – is also of mechanical operation and will be replaced by a Sadev item for the 2007 season.

Rallycross drivers and teams are currently split on the number of gears necessary, many currently opting to use four speeds. Hansen, however, remains a fan of the six-speed option: 'It's rare to use all six gears on one track, usually I will use four or five at the top or bottom. More than half the tracks we go to I use second to start, but even then you will sometimes use first in the lap. At my home track [the Kinnekuller] I use second to start but there is one tight bend where first gear is best. With six gears you have more options.' →

Losing weight

The basic 'shell' of the C4 is heavier than that of its Xsara predecessor, but KHM still managed to put its first C4 on track 50kg under the 1200kg minimum weight limit, and there's a little more weight to come off the car yet. In production form the C4 has an aluminium bonnet, and this was still fitted to Hansen's car at the start of the season, though with some of its internal bracing cut away. The regulations demand the standard driver's door is retained, but the C4 also had an OE steel door on the passenger side, as well as the production tailgate in the early events. Both of these will be replaced with composite items. The C4 is clad in body panels copied from Citroën Sport's C4 WRC prototype, made in Sweden by KHM and MC Racing in a mix of carbon fibre, GFRP and polyester. The only notable alteration to the WRC panel design is the addition of a NACA duct in the rear three-quarter panel, from which air is ducted to the rear-mounted radiator. Inside the car, this beautifully finished carbon fibre ducting, along with the carbon door cards and dash panels are all made by KHM.

It is also notable that Hansen sits a very long way back in the C4 – as far as possible in fact: 'It looks like a DTM car and it feels slightly strange to sit so far back, but it's better with every kilometre I have in the car,' he says. 'We have quite good front-to-rear weight balance in the car, although really I would like the weight a little lower and further back [hence his extreme seating position] but that will come as we develop the car.'

Hansen has strong links to Citroën Sport, but the manufacturer has no direct involvement in this car: 'The WRC is very different from a Rallycross car, but where there are things that are

Regulations stipulate the use of OE steel drivers' doors, but inside carbon is used extensively. T45 rollcage from Rally Produkt is developed from WRC version, but here ties into wishbone suspension, too

similar, of course, we share information,' says Hansen. 'Now that we have mechanical differentials here, and they also use them in the WRC, we are talking the same language as the factory engineers, and it's very interesting to talk to the people at Citroën Sport who build the diffs.'

It's talking in tongues, but an indication that Hansen can call on help when he needs it, and also that while the spec of the still-to-be-homologated C4 WRC remains fluid, that Citroën Sport has more than a passing interest in what KHM is up to with its Rallycross version.

“KHM PUT ITS FIRST C4 ON TRACK 50KG UNDER THE 1200KG MINIMUM WEIGHT LIMIT”



There is also the possibility of a much closer working relationship between the two in the future if the relative technical specification of the cars moves closer together.

The future...

With one or two less than successful exceptions, all Division One Rallycross cars have been built using longitudinal engine/transmission arrangements as, with power and torque outputs significantly higher than those of WRC cars, Rallycross car builders have always favoured the bigger, stronger gearboxes this layout affords them. Hansen, however, has already discussed the option of building a C4 that uses the WRC's transverse engine and transmission installation. 'Citroën Sport believes the [WRC] gearbox is strong enough for our engines,' reports Hansen, 'but when they make something strong they then try and make it as light as possible and I think that could be a problem for us with more power. There

are some advantages – you could put the engine lower in the car for example – and it is definitely a possibility for the future, but it would depend on working closely together with the factory. Perhaps we need to test some things together first.' Although fairly conservative by nature, Hansen has never been afraid to try something new in search of a technical advantage. His enthusiasm for the new C4 leads you to believe that its full potential is not yet unlocked. And his affirmation that adopting a transverse engine/transmission layout is a possibility for the near future is probably an indication that what he actually knows about the car is more than he's willing to let on at present. The impact for the sport as a whole if he's right is enormous, as a wholesale switch to transverse engine and gearbox installations will spawn an entirely new generation of cars altogether.

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Building on success

Following the FIA World Rallycross Championship's successful debut season, the managing director of the series looks ahead to what appears to be a very bright future



RACECAR: The 2014 season was deemed a success by seemingly everyone. What are you hoping for this year?

ANAYI: We have made huge strides behind the scenes. We have put out a 120-page event manual to all of the promoters in order to make sure that we are raising the level of each of our event promoters to the correct standard. We also have some amazing new tracks like Germany and Spain. We know that this format works, this stadium environment is great for Rallycross.

RACECAR: This time last year you were hopeful that there would be a lot of new manufacturer backed teams joining the championship. Why has that not happened?

ANAYI: I think part of the reason is that we have changed our short-term goals. I don't think we wanted manufacturers coming in with full works entries, we wanted them to come in behind an existing team. That concept probably assumed too much. It just happened that one manufacturer wanted to work with one team at a particular time, Peugeot with Hansen, VW with Marklund and Audi to an extent with EKS. That's a nice model – they get people they trust and know and that can give them the best of both worlds, but it's not the case for other manufacturers. I think that there are manufacturers that want to come in themselves rather than the channels we have made available to them using that model of existing teams.

RACECAR: When are we likely to see these new teams and manufacturers joining the World Championship?

ANAYI: We are talking to five or six manufacturers behind the scenes and they are all testing cars right now, but because these manufacturers are building things up themselves, rather than going with existing teams, it's taking them longer to be ready and be competitive. I think we are really talking about 2017 as a time frame.

RACECAR: With the arrival of full manufacturer teams what can be done to keep RX as the spectacle it is today?

ANAYI: We need to find out from them what we need to do to safeguard the existing



‘It’s an interesting dynamic – the privateer teams won’t want 17 rounds with lots of flyaways, but manufacturers will’

core of private teams. It’s all about trying to have things in place that let us engage with the manufacturers but keep what is core to Rallycross. We are trying to get them all in a room with the FIA, and Jost Capito (VW’s Motorsport Director) is setting that up as a manufacturer working group specifically for Rallycross. The next year or so is going to be spent sitting down with that group and working out a solid entry route for the manufacturers.

RACECAR: There are some new events in 2015 that are quite exciting but what about going forward? Will RX grow even more?

ANAYI: It is an interesting dynamic – the privateer teams won’t want 15, 16 or 17 rounds with lots of flyaways, but manufacturers will.

There is an obvious point that we are going to have to deal with; the demands of those two types of entrant are going to be completely different. Manufacturers want to be in all the core car sales markets – Japan, China, Mexico, Brazil markets like that. We as the championship promoter have been tasked by the FIA with spreading the word of Rallycross in as many places as we can. But we have the core privateer teams that don’t have the budget for so many events. Yes, one two or three events outside of Europe are realistic, but a fourth fifth or sixth event outside of Europe could be a step too far. We have to grow at the right time and with the right competitors. So I think you will see us going to places like Japan and Asia in 2017, 2018 and 2019, with a mix of existing and new teams.

RACECAR: What is the relationship like with the Global Rally Cross championship in the United States?

ANAYI: We know them well now and there are a lot of cross over teams like OMSE, and I think it’s just a matter of time. I think it would be great fun to have a head-to-head on neutral ground, a kind of duel. It would be an amazing chance to do something different and I’m really keen to avoid getting into a rut, the way some motorsport has ‘let’s just do it the way it’s always been done.’ That goes for everything; our teams, our drivers and that’s why you see people like Dave Mirra here. We have had people like Tanner Foust and Ken Block come over and the more drivers that do both the better. It’s a really cool way forward.





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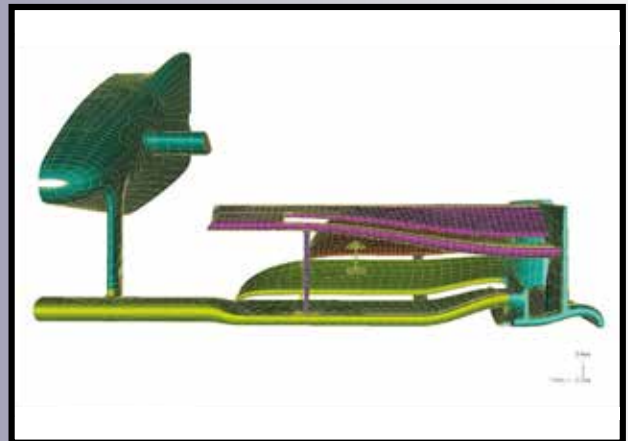
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