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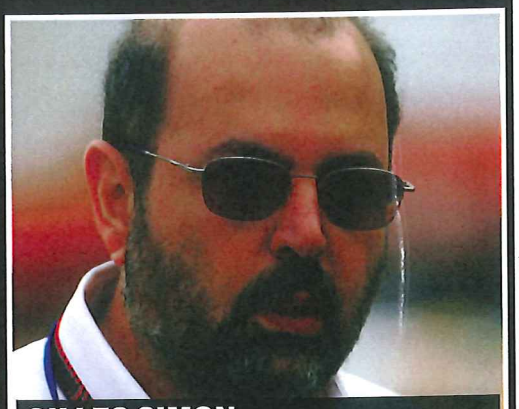

GILLES SIMON:
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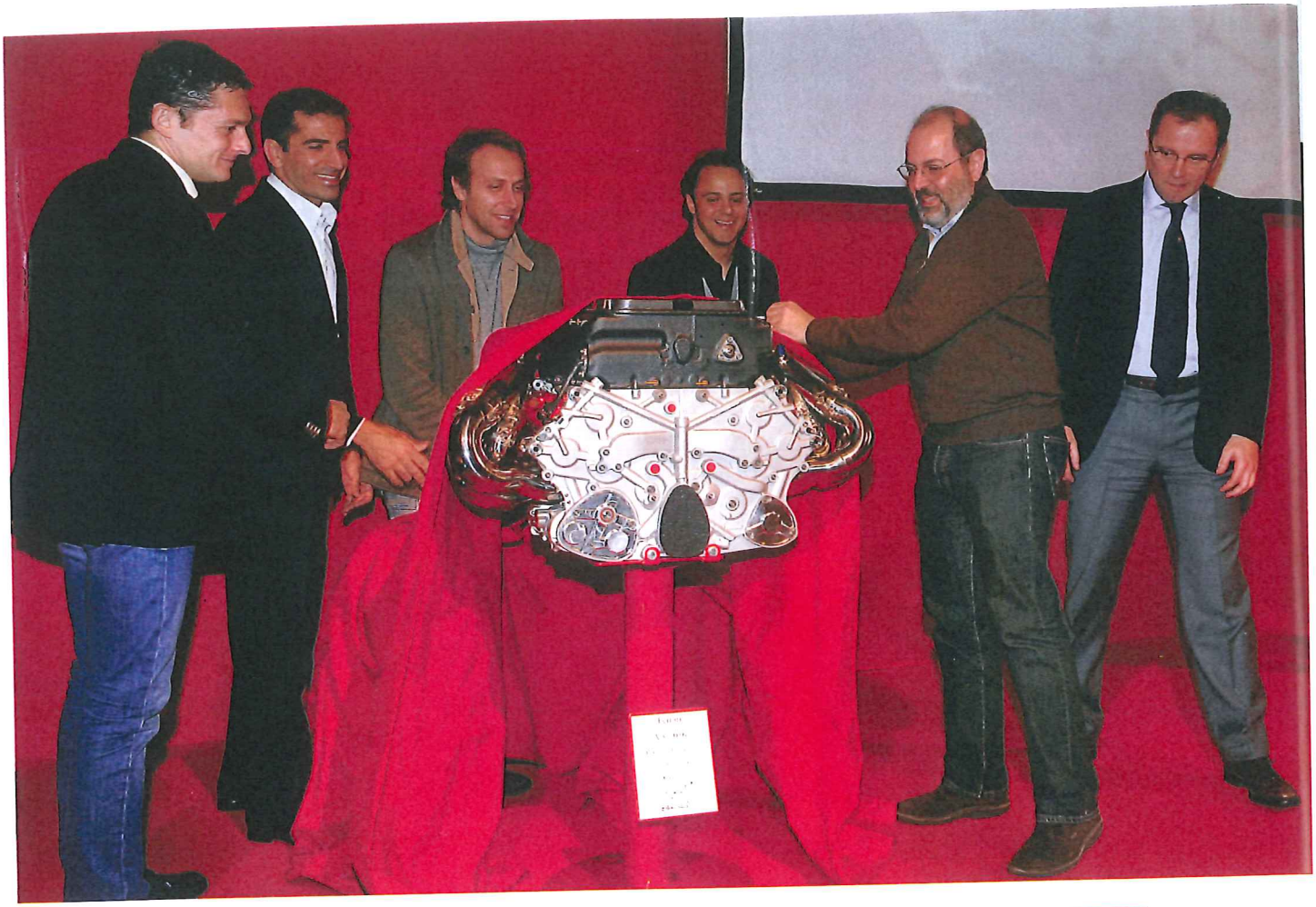

PURE adventure

Former Ferrari Grand Prix engine designer Gilles Simon is heading PURE's 2014 Formula One engine project. Here he talks to **Ian Bamsey**

Gilles Simon says of getting back to hands-on Formula One race engine design and development after 18 months serving governing body the FIA, "I knew I would love it but it is even better than I remembered!"

As technical director of new company Propulsion Universelle et Recuperation Energie (PURE), Simon has the funding to design a state-of-the-art 1.6 litre V6 direct gasoline injection turbo engine to 2014 Formula One regulations. PURE is a company set up by Craig Pollock and supported by private investors, which will be selling customer engines. Simon joined it on August 1, 2011.

Although PURE is a Swiss company, it is using the facilities of TEOS in Paris and TMG in Cologne. Subcontracted to assist the design and development of the new PURE Formula One engine, TEOS is a subsidiary of Mecachrome, which has long been a partner of Renault in Formula One. TEOS is headed by Jean-Francois Nicolino, who oversaw development of the recent Mecachrome/Mader GP2 and Le Mans engines. At TMG, PURE from May will be renting the high-tech facilities where just a few years ago Toyota Formula One engines were built and developed, so it will have offices there, as well as at TEOS. René Bertheau, who was with Simon at Peugeot Sport and Ferrari, is

Born in Oujda, Morocco in 1958, Gilles Simon studied at the Mines Paris Tech, the prestigious French engineering school, and started his career working for Renault on r&d. He then moved to Peugeot to assist in the design of its V10, which won Le Mans in 1992 and 1993. In 1993 he moved to Ferrari, where he worked under Paolo Martinelli in the Formula One Engine and Electronics department. He was appointed head of the department in October 2006.

This photograph shows the presentation to Simon (removing the shroud) of a 056 Formula One engine that won the Constructors' title in 2008. This was on the occasion of Gestione Sportiva's 2008 Christmas lunch. Making the presentation, Ferrari president Luca Montezemolo said, "I wish to thank this engineer for all he has done, winning so much with us, a man of class and a good person."

Simon stayed at Ferrari until October 2009, then joined the FIA as director of powertrain and electronics, in which position he headed the working group that devised the 2014 Formula One regulations. He left the FIA in July 2011 to join PURE as its technical director.

leading PURE's design team.

I caught up with Simon at the Autosport Engineering Show on January 12, 2012. I put it to him that, given the 2014 fuel-flow restrictions, within the context of maximum rpm of 15,000 and no restriction on boost pressure, there would appear to be a fundamental decision to be made by the engine developer between exploiting the maximum permitted rpm or running to lower rpm and instead using higher boost.

"Yes, to use the same permitted amount of fuel you have those options," he replied, "but I think it is not obvious that you will always have to make the same choice from case to case; there will be a strategy issue."

So the trade-off might vary from track to track?

"Or from one set of conditions to another. Maybe in qualifying you use a certain setting, and in the race another, or even during the race you could have different possible strategies in this respect."

So you need to develop the engine for both scenarios, given the flexibility that will be required?

"Yes. It's always a compromise. However, you do have to decide which scenario you favour because, for example, you cannot have the optimum camshaft profile for both. I think this is not bad because it could lead to differences in engine performance at different stages of a race."

So you cannot design the engine on the basis that, say, you will always use the maximum revs; you have to allow for higher boost potential when it comes to specifying crankshaft bearings and suchlike. In terms of the fundamental specification you always have to give yourself this compromise?

"Yes, we will need to have the flexibility."

From the engine design perspective, how significant is the fuel limitation; presumably it is always going to cause you to have to run lean?

"For sure. We will run our first engine on the bench in July; until then we are not sure how lean we will be able to run. But yes, the mixture and fuel preparation will be very important, which I think is fine because this is also relevant to roadcar engine development."

Presumably you will have to push to run the engine as lean as possible and then find ways to make it survive?

"I think it is not only a problem of reliability but also one of efficiency. Yes, for the moment we are doing a lot of calculations to try to anticipate the problem of running lean – of the nature of fuel preparation, of the knocking and so on. But obviously we need to have precise measurements from the dyno to understand how far we can go. This will be a huge development topic for us."

Under the 2014 regulations you have an 80 mm maximum bore – how much of a problem is that?

"Speaking as a Formula One engine engineer, it's ridiculously small. But it is a bore size that is typical of today's production cars. It is very complex to put everything in such a small bore because you cannot have a spark plug much smaller than what we use today in Formula One, and you cannot have an injector much smaller than what you can see today, so you have to reduce the valve diameters. To a certain extent on a turbo engine it's less of a problem, though."

In the last turbo era we saw oil gallery pistons widely used – do you anticipate them making a comeback?

"Well it's one solution but I don't like it. I'm not sure it is the most efficient way to cool a piston, but yes, it's one solution."

A lot has been learned about piston cooling in Formula One in recent years, what with the enforced increases in mileage.

"Yes. In Formula One, when you have big teams working on a topic you go really to the limit of it and you gain a really detailed understanding. In Formula One we had access to real-time measurement of piston temperature, we had access to good hydraulic simulation and so on, so we gained in-depth knowledge of such topics."

Do you think there is a case for the use of lightweight steel pistons in Formula One, given these new conditions?

"That is one solution. Like the use of oil gallery pistons, I don't like this solution but it is a solution we may need."

Is it really too early to anticipate the use of such solutions?

"No, you do have to make an early choice. I think you may see different technical solutions between the various engine manufacturers. Each of us will be faced with the same problems, but we may have different solutions to solve those problems."

Turbo-MGU layout

During his presentation at December's excellent technical conference accompanying the IMIS show in downtown Indianapolis, Simon very briefly revealed an illustration of the PURE engine, one that appeared to show the single turbocharger and its associated electric motor/generator unit (MGU) located at the front of the engine, above the other permitted MGU mounted (as today) on the front of the crankshaft.

That layout appeared strange to me, given that the logical location for a single turbo is behind the V6, over (and probably partly embedded within) the bellhousing. I reported on this layout in the Grid section of our previous issue, and I now had the opportunity to tell Simon how puzzled I was by it. He explained that the briefly-seen schematic had deceived me; in fact the turbo is located behind the engine with its associated MGU (which by regulation has to be connected to the shaft linking turbine to compressor) at the front of the engine, driven by a driveshaft running through the valley of the V6. Intriguing!

Under 2014 rules, given that the turbo-connected MGU has to be powered by the shaft running between the turbine and the compressor, it follows that it runs at a speed that is proportional to that of the turbocharger (the development of which is free). Simon remarked, "You could have this MGU running ten times slower than the turbo, but then it will not be competitive, so this rule will push everybody, I think, to go to a speed that will be near the speed of the turbo." ▶

Ferrari days – Simon (far right) at the launch of the 2008 Ferrari Formula One car

I asked Simon to explain how the turbo-linked MGU and the crankshaft-linked MGU will work together?

"You have the combustion engine supplying energy from its crankshaft. Its exhaust will also supply energy to the turbine and you can use that energy, as captured by the turbo-linked MGU, to supply electricity directly to the crankshaft MGU, or you can feed it to the battery. You will have to manage the energy flows between these three sources of energy – the combustion engine, the MGU on the turbo and the MGU on the crankshaft."

Feeding electrical energy into and out of the battery implies losses so, I asked, presumably as far as possible you want to avoid that?

"To a certain extent yes. I suppose the battery will act as a buffer. When you have too much energy then you store it; when you need the maximum energy you use it. But you will tend to use the battery as a buffer only, which means it can be smaller. I think this is a solution that is relevant to roadcars because there you see more and more applications where the battery weight is huge, compromising the car."

So in simple terms you can have the turbocharger's MGU acting as a generator, supplying electricity direct to the crankshaft's MGU, which is then acting as a motor?

"Yes. What I would say is that if you are looking for maximum horsepower, which happens quite frequently when you are racing, you will try to use directly the energy coming from the exhaust back to the crankshaft; you will just complement that through the battery."

Regarding the permitted use of 500 bar pressure direct injection from 2014, how do you envisage that?

"These days direct-injection pressure is limited on production cars; this is a huge limit to the efficiency of combustion. I'm sure that in Formula One we will find very interesting solutions for high-pressure injection that will push the motor industry forward."

Do you then anticipate that all of the available 500 bar pressure will be used, or will there perhaps be a situation where the losses associated with driving the high-pressure injection pump overcome the theoretical gain of the higher injection pressure?

"I believe we will use it all but it's maybe too early to be sure of this. My belief is that we will use it – and that in the process we will find new solutions for the pump."

There's been talk of the possibility of returning to coil springs, for superior efficiency compared to a pneumatic valve return system. Have you looked at that?

"I have to say that these days it's so easy to design a pneumatic system that you don't want to go back to problems; it's so difficult to design an engine with coil springs. I think there is some interesting potential in pneumatic systems, even for passenger cars. If the pneumatic system was quite complex 20 years ago, now it is leaner and it is not impossible to think of using it in production."

Having thus discussed various issues associated with engine design and development for the 2014 Formula One regulations, I wondered how PURE was progressing with its V6 project, which began when Simon joined the company (it having previously worked to the earlier I4 rules).

Simon told me that PURE plans to have its first V6 turbo engine running on a TMG dyno this summer. He is realistic enough to believe that there will be a second-generation engine for the summer of 2013 that incorporates lessons learned from the initial design; that definitive race engine will be ready for the 2014 season. It is hoped that two or three teams will commit to it but as yet it is far too early in the PURE project to anticipate which teams they might be. In the meantime Simon is heading a great technical adventure, having the resources to deliver pure performance!