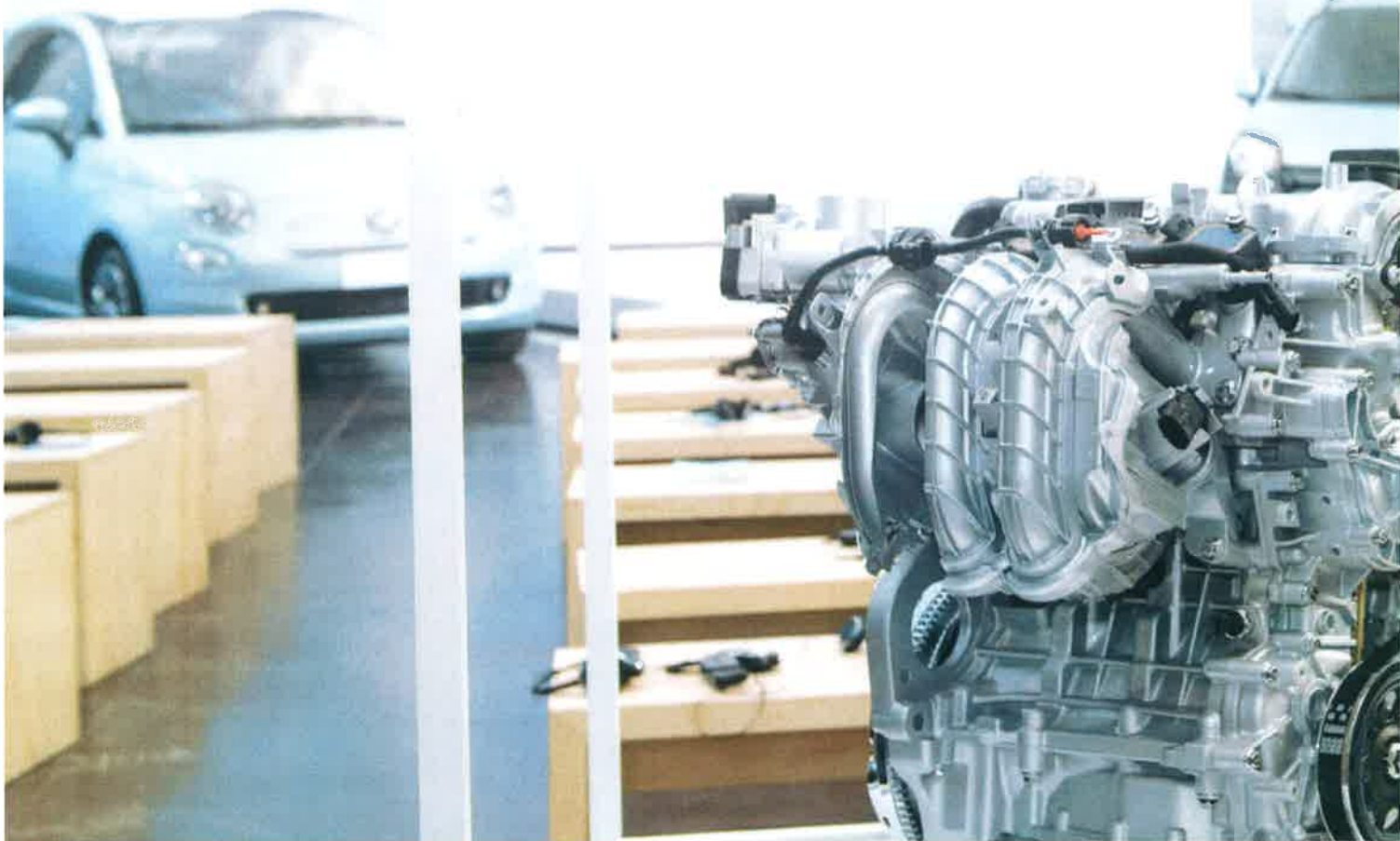


FAMILY PLANNING

FCA is readying a new family of compact gasoline engines. Project chief engineer Carlo De Marino says the company's smallest powertrains face the biggest challenges

WORDS
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The formation of Fiat Chrysler Automobiles in 2014 seemed like a clash of well-established automotive cultures, but the group has become more than the sum of its parts.

With a product portfolio spanning from the Fiat 500 city runner to the unmistakable Americana of the RAM 3500 dually truck, FCA is finding opportunities in new markets and leveraging some unlikely sounding synergies. This includes the tough task of simplifying what could become an overly complicated drivetrain line-up.

From a global perspective, the FireFly three- and four-cylinder engines form a cornerstone of that process, as they have the greatest geographical reach. They are the modular



foundation underpinning offerings to an ever-broader customer base with associated variations in operating conditions and user expectations.

Importantly, they are developed against the backdrop of – and in readiness for – seemingly unending regulatory change. For the project's chief engineer, Carlo De Marino, finding a line of best fit meant calling in the sharpest minds FCA had to offer.

"I am coordinating a team of 350 people all over the world, which has been the best experience ever," he says with a broad smile. "Not only from a technical standpoint, because I could pick the best competencies, but also anthropologically because bringing together Chinese, North American, Brazilian and Italian engineers is not easy. This

was a very interesting aspect of developing a global engine family."

The Fiat that De Marino joined in 1996 is barely recognizable today. A graduate of both aeronautical and mechanical engineering, he spent his first years at the company testing solutions for Euro 3 emissions compliance and onboard diagnostic port integration, before moving into ongoing development of the outgoing four-cylinder Fire engine series.

His career spans a period of mixed fortunes for the automotive industry, let alone for Fiat itself, and his familiarity with the company, including driving his own 500, formed the basis for ideas of what should come next for the manufacturer.

Thinning the crowd

FCA will phase out two engine families – four-cylinder Fire and two-cylinder TwinAir turbo – as new models adopt the FireFly units. These are based around a lightweight aluminum engine block with an offset crank

"We keep as much flexibility in our design activities as possible, to be ready for the unknown"



KEEPING IT REAL

The FireFly program began with a huge global simulation aimed at understanding the use and environmental demands presented by different markets and applications. DeMarino says better digitization has enabled the company to use around 25% fewer engine and vehicle prototypes during development than in the mid-2010s, reducing the time required for development and cutting costs.

"Ten years ago we were talking about road-to-rig activity – reducing the number of vehicle prototypes and moving to the dyno. For example, the tilting dyno can be a very good answer to the 'Jeepness' requirements, the climbing requirements, but you can't simulate a sudden rock that the vehicle would encounter, so you need to test that. Now we're talking about road-to-computer, and this has made a lot of progress."

But, he says, it's a complementary technology rather than a replacement: "There is a limit to simulation, beyond which you need to create prototypes. There are a number of maneuvers that the drivers might make but we can't simulate, such as fast gear shifting or a change of mind. You can predict the reliability of the system, with some tolerance, but a physical test needs to provide the definitive answer."



1. Fiat plans to phase out its Fire and TwinAir engine ranges, with the OEM's new lightweight FireFly engines taking their place

2. FCA's parts toolkit allows the FireFly engine unit to be adapted to vehicle-specific needs, enabling capabilities including deep water fording

3. The latest gasoline mild hybrid engine from FCA combines a 1.0 FireFly unit with a lithium-ion battery and a belt starter generator

4. Jeep's plug-in hybrid system for the Renegade and the Compass features a four-cylinder FireFly engine and a GKN electric rear axle

and either three or four 333cc cylinders in strong cast-iron liners.

Internal hardware adaptations for regional market differences are minimal; changing the pistons can raise the compression ratio to suit 'aggressive' bioethanol fuels for Brazil or lower it to mitigate knocking while running on 89-91 RON gasoline, common in both North America and China. Neither requires alterations to the block, which was developed and manufactured in partnership with FCA subsidiary Teksid.

Further scalability is available using two or four valves per cylinder, electrification, forced induction and the ability to fine-tune responses based on customer tastes. "Engine calibration development is another crucial element, because driving style and customer expectations about responsiveness to the gas pedal, or the way the vehicles ramp up with

engine speed, are really quite different. Regional calibration needs to understand customer needs, so that customers accept and appreciate the engines according to the way they drive," De Marino explains.

"Let's say that in a typical control system 35% is dedicated to the driveability feeling, and the rest is base calibration that varies depending on the fuel choice, fuel quality and environmental conditions. This can be done with a global standard approach."

"I calibrate my system to cope with the worst and best fuel, and the FCA team will put that in the map so that the system can recognize the kind of fuel it is dealing with and switch to the right map. It takes a little bit more effort and time, but then you have the insurance that anywhere you go, your engine will behave in the best way."

They also face operating conditions no previous units would have seen. The FireFly family is designed with the full spectrum of electrification in mind, not only in terms of accommodating physical components, but also the demands of spending an increasing share of the journey switched off and cooling down. De Marino says the aluminum block halves the warm-up phase, which is further accelerated by a specific combustion strategy. Additionally, thermal insulation is able to ensure components retain the heat



KNOWN UNKNOWNNS

In a shared architecture, the FireFly engines can be adapted using a toolkit of parts to tailor them to applications across the FCA portfolio. De Marino highlights that Jeep-specific vehicle requirements include modifications for water fording and to avoid oil starvation on steep inclines, all of which can be added as a bolt-on where required without increasing costs elsewhere.

This approach also readies the vehicles for electrification, and the first hybridized versions will launch this year. Jeep is introducing plug-in hybrid versions of the Renegade and Compass, based on the 180hp 1.3-liter four-cylinder turbo FireFly engine, but featuring a GKN electric rear axle, underbody protection and 23in wading capability.

A 70hp three-cylinder, naturally aspirated version of the same engine is being paired with a Valeo 12V mild-hybrid system for the Fiat Panda and 500, where the priorities were low cost and efficient city driving.

"We protected the layout, the packaging and the hardware features for any kind of known electrification technology – meaning projects are still in the advanced design phase and not yet in production. At one end is benchmarking, and at the other is consulting with engineering companies that have a broader view of what's going to be the future. This has been pulled together and put into the design features of our family," De Marino explains.

1. FCA's shared powertrain architecture allows models across the entire brand portfolio to be electrified.

2. The Fiat Panda's mild hybrid powertrain variant combines an atmo FireFly engine with Valeo's 12V powertrain technology.



"Regional calibration needs to understand customer needs, so that customers accept and appreciate the engines according to the way they drive"

from the engine for as long as possible even while deactivated.

A flexible approach

"Government rules are changing pretty fast, so the only possible answer now is flexibility," says De Marino. "Be flexible for any possible regulation that may be around the corner. We have solutions for what is known so far, what is going to be dictated by regulation, what is now in place and what is going to be put in place. Meanwhile we keep as much flexibility in our design activities as possible, to be ready for the unknown."

Those possible unknowns include top-level company changes. The OEM's long-rumored merger with the PSA Group was confirmed in December 2019, focused on delivering economies of scale by sharing resources, reducing the number of platforms and engine architectures, and reinvesting the savings in CO₂-reducing technologies. The merger is likely to further broaden the requirements for new projects, but De Marino says it's too early to predict how it will pan out. He is, however, optimistic about what this might enable him to work on next.

"We have a lot of experience of company marriages in the past, and are ready to catch any opportunity for our line-up and develop a much wider competence on a number of different products."

"It's our call as an engineering department to develop proposals that can balance costs, have the flexibility to switch to a slightly different solution as soon as possible and be ready for the market with off-the-shelf commodities. I can't say more than that, but that's the message I provide to my team – that this new adventure we are going to start will represent a really huge opportunity for both companies," he concludes. ☐

