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Jack Roush (left), Doug Yates (right) and Ford Racing Director Brian Wolfe with the new Ford FR9 NASCAR Cup V8



Ford's fresh start

NASCAR

Ford has launched its first ever purpose-designed NASCAR Cup engine, which will see action later this season. The wraps came off during the course of January's NASCAR Media Tour, at the Embassy Suites in Concord, North Carolina, not far from the birthplace of the Cup series.

The Blue Oval marque has been integral to the sport since taking the flag first at the inaugural NASCAR Strictly Stock race, held on the now defunct Charlotte Speedway dirt oval in 1949. Following the downsizing from Big Block to Small Block V8s in the Seventies, to this day Ford alone has continued to campaign a production-based pushrod engine in Cup. But now it has its own 'new generation' V8 ready to race, one designed from a clean sheet of paper to the dictates set down by NASCAR in 2006, which govern the current Toyota (Phase 11), Dodge (R6) and Chevrolet (R07) contenders, none of which has a production block.

Ford's current Cup engine is based upon the 'Windsor' stock block,

introduced into NASCAR in 1991 to replace the 'Cleveland' block, which had been phased out of mainstream production. There has only ever been one significant upgrade of the Windsor Cup engine, when the current D3 cylinder head was introduced in 2004. However, from July 2007 through to the September 1 2008 NASCAR submission deadline Ford designed a replacement 'new generation' engine.

When Toyota had joined NASCAR it had lacked a production pushrod V8 to base its engine upon – it had been permitted to study the existing NASCAR engines and cherry pick the best features of each to produce its initial Truck engine. With Toyota's graduation to Cup, NASCAR clearly felt the time had come to permit all four manufacturers to produce purpose-designed engines. NASCAR consequently set out more detailed dictates to which each competing engine had to conform. Thus was determined the parameters of new generation Cup engines, which have no production base.

The Windsor is characterised by a 4.380" bore spacing – the

smallest of the old generation production-based Cup V8s. Under the new dictates, while retaining the established 4.185" bore the FR9, as Ford Racing's newcomer is provisionally known uses a 4.5" bore spacing. Thus, it is a complete departure from the engine that has served Ford well for more than 15 years and from the family that spans twice that length of time. Having been approved for NASCAR Cup racing in September, the FR9 started testing on track last November.

The FR9 has been produced by Dearborn based Ford Racing, which is directed by Brian Wolfe, who last year replaced the retiring Dan Davis. The head of FR9 design and development is David Simon, the lead NASCAR engineer at Ford Racing. Mose Nowland, a Ford

engineer since 1955 who led design of the Windsor Cup engine and the D3 head, is an advisor to the project. Roush-Yates Engines in Mooresville is the primary Ford Cup engine builder and has been closely involved throughout the project, under the leadership of co-owner Doug Yates.

The FR9 represents Ford's unique approach to the current NASCAR engine dictates, which were outlined in RET 029. In a number of respects it is a major advance over the Windsor and its D3 head: very few parts are interchangeable and even the firing order is different. We look forward to providing a detailed profile of this exciting newcomer in issue 037, which will be published in March.

Powertec ramps up

BHCC

Powertec is ramping up its British Hill Climb Championship bid with Trevor Willis. As we reported in RET 026, in 2007 OMS driver Willis stepped up from the 2.0 litre ranks using the 2.8 litre Powertec RPB V8, which is based upon a pair of Suzuki Hayabusa (GSX1300R) 1300 I4 cylinder heads and cylinder blocks sharing a common crankcase. Last year alone, Powertec, which is owned by the Radical Sportscar company, sold two dozen of these compact and light (88 kg with clutch, less exhaust and ecu) motorcycle-derived engines, which produce 450 bhp at 9500 rpm. Willis used his engine, prepared by SB Developments to win a round of the BHCC at Bouley Bay in 2007 and last year he added two more wins plus a dozen podium positions in the course of the 32-round series.

Both of Willis' 2008 wins were on drying tracks, emphasising the only thing his nimble car lacks against its 3.5 litre V8 NME Cosworth and 4.0 litre V10 Judd-equipped rivals is sheer grunt. That has come for 2009 in the form of a 3.4 litre version of the Powertec V8, which was unveiled at the Autosport International show in January.

For this latest version, Powertec boss Ted Hurrell tells us that the stroke has gone from 63 mm to 71.5 mm and that the bore has gone from 84 mm to 86 mm. That is about the limit of the current architecture and it has only been made possible by unusual cylinder blocks devised by Muzzys, the NHRA Pro Stock motorcycle specialist, which feature offset bore centres. Rather than even, unusually the bore spacing is staggered either side of the central point of the bank, which means that the four cylinders no longer line up perfectly with the head above. Nevertheless, Hurrell says that Powertec has not found this to significantly compromise performance, if at all. The offset cylinders still squeeze into the existing V8 crankcase, although there is now a spacer plate in between and longer con rods are employed to attain the required piston height.

Where this intriguing 3.4 litre V8 uses the Suzuki GSX1300R internals, these are the very latest specification, there having been a lot of revamps to the stock motorcycle engine for 2008 including slipper pistons (with an 18 mm diameter pin) and titanium valves. Hurrell reports that the starting point for Willis' super unleaded-injected BHCC



Exploiting offset cylinders, the Powertec V8 now has a 3.4 litre displacement

engine is a 14:1 compression ratio and that its initial output is a healthy 560 bhp at 9500 rpm. "It still has very good throttle response and the torque curve is very flat. The power curve is very similar to that of the 2.8. There is a little more drop off at the top end but these are early days of development. We haven't lost driveability with the move to 3.4 litres."

It will be fascinating to see how Willis' OMS goes on the British hills with an additional 25% horsepower in essentially the same, notably nimble car package.

Honda's lightweight V8

PROTOTYPE

The fact that Honda Performance Development (HPD), the Japanese manufacturer's California-based US motorsport operation, is to take Honda's Acura brand up from LMP2 to LMP1 in the American Le Mans Series (ALMS) was announced in August at Detroit – well before Audi decided to lynch its

ALMS programme, writes Anne Proffit. But we had to wait until the open cockpit ARX-02a prototype made its public track debut at the ALMS 'Wheels Down' winter test session, held on the 3.7-mile Sebring road circuit in late January for confirmation of its chosen engine configuration.

EGE BAMYASI

OK, I now have egg on my face, writes Ian Bamsey since I confidently predicted that the new Acura-branded Honda LMP1 engine from HPD would be turbo-supercharged, would exploit direct injection and would burn E85. So far, wrong on all three counts. At the same time I am disappointed and puzzled by the news that, while it is indeed a 4.0 litre V8 it seems to be no more than a straightforward, un-ambitious upgrade of HPD's existing (naturally aspirated 3.4 litre) LMP2 engine. One word regularly associated with Honda since the very early days of its involvement in car racing has been 'inscrutable'. This word appears to perfectly fit this particular project, designed initially to compete in the IMSA-governed ALMS rather than ACO events.

Essentially, with its move from LMP2 to LMP1 HPD has progressed from an 800 kg, 3.4 litre V8 to a 900 kg, 4.0 litre V8. The respective intake air restrictor sizes for these, apparently closely related, indirect-injected engines are 1445 mm² and 1805 mm². The former is good for around 540 bhp, the latter for perhaps 675 bhp (this according to much empirical evidence). So there has been an increase in bhp per ton (from 675 to 750). So far so good: but at the same time the car is less nimble. It was the nimbleness of its Acura-branded LMP2 car that on occasion allowed HPD to embarrass the first-generation Audi turbodiesel. Now in LMP1 it is on a level playing field in terms of weight, particularly as Audi is wheeling out a second-generation turbodiesel – one benefiting from a powertrain that is significantly more compact and significantly lighter.

At the time of writing we were awaiting details of the new Audi turbodiesel engine. Its architect Ulrich Baretzky told me that it retains the existing 5.5 litre displacement but is smaller and lighter. More than that he was not at liberty to reveal. All we knew for sure was that this engine has given the Audi LMP designers the opportunity to design a lighter and more effective LMP1 car.

There is no doubt that in 2009 the Audi turbodiesel will be right down to the 900 kg LMP1 limit – on paper any significant difference between it and the new 'Acura ARX-02a' will be turbodiesel versus gasoline engine output. The gasoline car may still have a centre of gravity height advantage but this can no longer be expected to be one that really tells. At the same time neither tyres nor aero can reasonably be expected to factor. Or can they?

At its official launch HPD announced that the ARX-02a's 'secret weapon' is having the same size tyres at the front as at the rear. This does mean that overall it beneficially has more contact patch area but at the same time it has very significant implications for weight distribution and aero balance, both of which need to be uncommonly forward biased. So it follows that it employs the lightest possible engine, hence no turbochargers. At the same time its impressively aggressive front aero reflects this almost-novel concept: hands up those who recall the IMSA Ford Mustang of the mid-eighties (that particular ill-fated *front-engined* prototype could offer a theoretical aero

advantage, to boot). Fascinating but puzzling...

So we can reasonably expect the ARX-02a to excel under braking. Getting off the turns might be an issue particularly as HPD admits that the car lacks at least 30 bhp. In fact in 2008 the Audi engine was good for at least 770 bhp. There has been a decrease of intake air restrictor size and boost pressure for 2009 but on-going engine development will have recouped part of that theoretical 10.5% cut – turbodiesel race engine technology is nowhere near as mature as gasoline engine technology. For example, common rail fuel pressure keeps increasing and Audi is only just starting to exploit the potential of the steel piston. Surely, HPD is at least 50 bhp down on turbodiesel power?

One reason I anticipated HPD fielding a 4.0 litre V8 turbo running on E85, is that currently IMSA – for reasons only it understands – offers such an entry a massive 17% air intake restrictor area break. Such an LMP1 engine when running E10 under ACO rules as per normal produces up to 675 bhp. However, on paper that restrictor break takes its output in E85 IMSA trim to a turbodiesel-rivalling (now beating) 790 bhp. AER has fielded such an engine in E10 ACO and in E85 IMSA trim and hasn't yet bothered to optimise its potential under the massively increased restrictor size – even without optimisation from regular ACO trim it has far too much horsepower for its own good!

I wonder if HPD is anticipating IMSA to give its new engine a comparable restrictor break. Is that how it hopes to beat Audi (not that Audi will be there to beat after Sebring, at least in 2009)?

This is what HPD boss Eric Berkman said to my colleague Anne Proffit in response to that suggestion: "Get a break? Why would we need a break? Our car was designed to beat the diesels under the rules that existed two years ago. The ACO changed the rules for 2009 last September reducing the diesel's performance, not ours."

You cannot accuse Berkman of lacking confidence in his radical new car. At the same time, he told Proffit that – air restrictor dimension aside – currently HPD gets more horsepower from E10 than from E85, so it favours the former. This is somewhat surprising since ethanol is in most respects an advantage over gasoline, so the higher the proportion the better, at least on paper. Ethanol increases the fuel octane number, increases the rate of burning and provides slightly higher specific energy for a given volume of air (significant for an air restricted engine), and offers more of a cooling effect. There are really no downsides, other than the implicit increase in fuel consumption and IMSA has proven that in response to that factor it is prepared to increase tank size and decrease car weight by way of compensation. Oh, and IMSA has also shown that it is prepared additionally to offer a handy intake air restrictor break for the use of E85...

To my mind all this adds up to the very definition of inscrutable. But there again, nothing is certain in racing. Maybe the radical chassis concept will prove a winning edge and I will have more egg on my face!

2009 HPD LMP1 engine



There it was revealed that the 900 kg ARX-02a would employ a naturally aspirated 4.0 litre V8 with port injection of IMSA's E10 spec fuel. It rolled out with ACO-compliant intake air restrictors – a pair at 33.9 mm providing a total area of 1805 mm². This normally results in an LMP1 engine producing in the region of 650-675 bhp and HPD conservatively states "620-plus bhp". It does admit that it will be down on power compared to the turbodiesels but it has put its faith in a radical chassis concept (see sidebar).

The use of a naturally aspirated 4.0 litre V8 echoes Honda offshoot Mugen's LMP1 engine. However, according to HPD boss Erik Berkman, his concern has not adopted that engine but has produced in house what is fundamentally an evolution of its existing naturally aspirated 3.4 litre LMP2 V8. That engine has been campaigned successfully in the ALMS for the past two seasons (seven class wins and two overall victories). Nevertheless, "there are very few interchangeable engine parts," according to Berkman. He added that the decision to go with E10 rather than E85 was made for simple reasons: "We make more power from the E10 fuel and we didn't want to give up that output potential. The primary goal," he stressed, "is to go fast."

Clearly, Acura is not placing its priorities toward the ALMS Green Challenge with this decision to run E10. However, Berkman did add the engine could run E85 if HPD felt that would be in the company's best interests. Of course, there are reasons to think that E85 should provide more performance than E10 (see sidebar).

Development of the new P1 car has been ongoing over the past two seasons. Leading up to the Sebring test, the new ARX-02a had seven private track test days and "a lot of dynamometer hours," according to Berkman. "Testing both on and off the track has progressed smoothly. There have been the usual hiccups but nothing out of the ordinary."

Performance progress

NASCAR

Performance Research, the valvetrain specialist continues to venture further into uncharted NASCAR Cup territory. Following its introduction of the extended lifter in 2008, the innovation for 2009 is a variable height lifter.

By regulation the Cup engine uses a flat tappet lifter, which is confined to a 'magnetic-steel, straight barrel' production with 'a diameter of 875 thou (22.225 mm)'. The regulations say nothing about the height of it. In view of this Performance Research owner Bret Conway has developed two extended tappets that are respectively 1.0" and 2.0" taller than usual (RET 028), so as to shorten the pushrod a corresponding amount and thereby to gain a pushrod that is less prone to buckling deflection in the face of the enormous forces to which it is subjected to in operation.

Contributing Editor Jack Kane remarks: "This is a very interesting idea, especially since in the case of a hinged-end, long, slender column (which is precisely what a pushrod is) the buckling stiffness, by the Euler analysis, is inversely proportional to the square of the length of the column. For example, a 2.0" reduction in the length of a 12" pushrod would, for the same cross-sectional area, increase the critical load by a factor of 1.44."

Jack adds a further thought: "the height of a normal Chevrolet Cup lifter is 1.88". If you think about it, one effect of a 3.88"-tall lifter could be rapidity of wear in the lifter bores due to the very high overhung moments imposed by the pushrod load, which is applied at the top of the lifter, being resisted by a bush of about 1.0" height down near the bottom. This might be helped by the use of very thick wall bushings of 2.5 or 3.0" height".

Conway tells us that careful selection of a steel alloy and its heat treatment has now enabled the production of a 'Super-Light' extended tappet that has thinner walls, which cost nothing in strength but reduce weight from 76 g to 48 g in the case of the 1.0" extended version. For the 2.0" extended version this 'Super-Light' tappet provides a saving of 62 g, which will bring its weight down to that of a normal height production, according to Conway.

On top of this, Performance Research is working on an adjustable height flat tappet lifter, which will telescope as much as 40 thou (1.016 mm) so that, for example, the engine can effectively have the equivalent of a 660 thou cam lobe for initial acceleration, increasing to 700 thou as engine speed increases. Conway reports that this is a hydraulic/mechanical system. In essence, the tappet is fitted with its own little pump as a sealed unit. As it reciprocates a pumping action builds pressure that lifts the seat against which the pushrod runs. It starts at a particular minimum height and as engine speed increases, through the consequent pumping action it gains height, until at a certain rpm the unit becomes hydraulically locked at a predetermined maximum height.

Conway says that this device only adds 15 g to the weight of the tappet and that it can be installed in his latest 'Super-Light' flat tappet lifters. These tappets promise to assist on re-starts in particular. "I aim to have it at the Daytona 500", remarked Conway, talking to us at the PRI show in December.

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