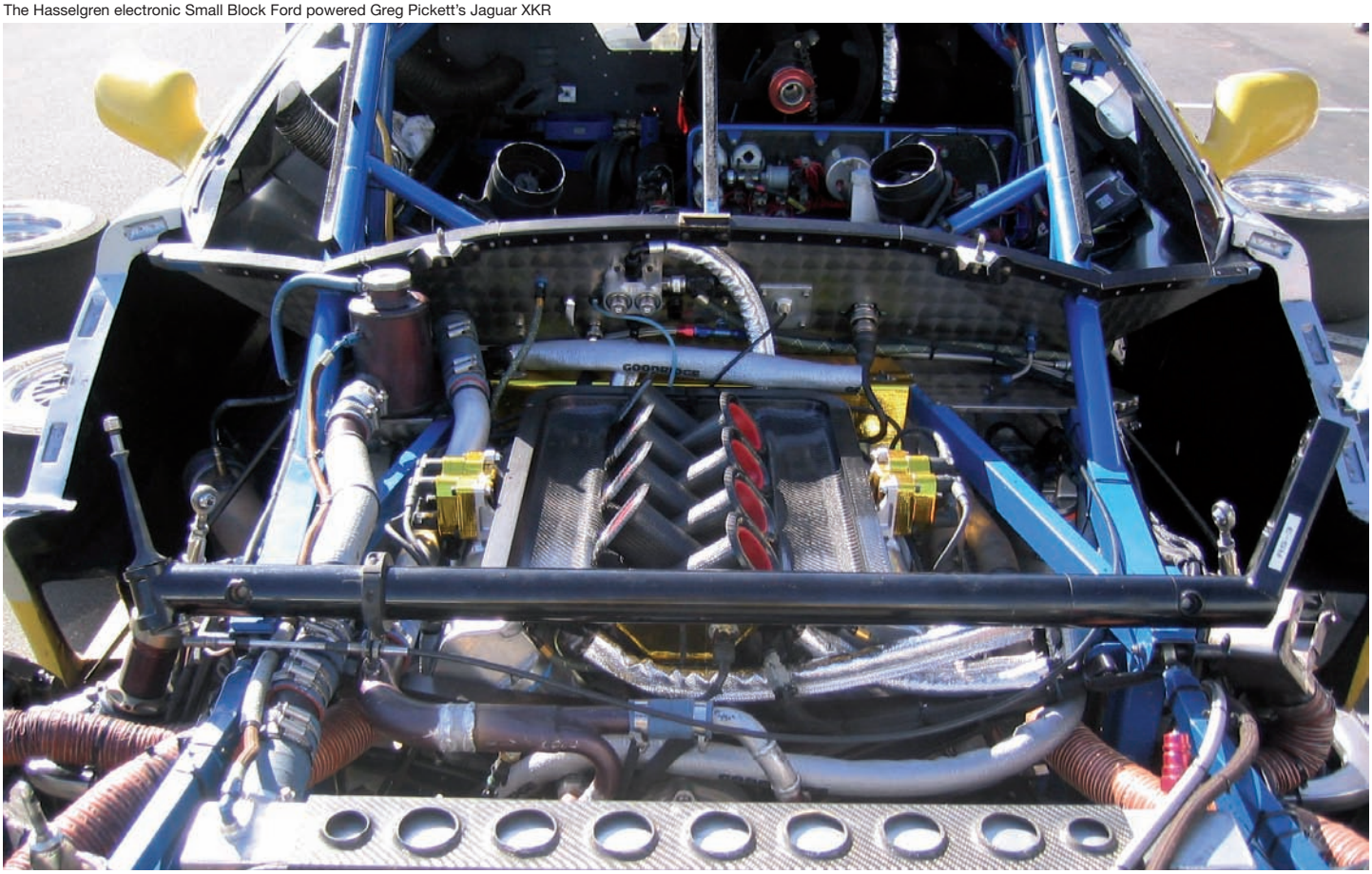
The Hasselgren electronic Small Block Ford powered Greg Pickett's Jaguar XKR



Computerising the Small Block V8

NASCAR keeps a very tight rein on the classic two valve per cylinder, pushrod V8, to the extent of mandating a traditional mechanical distributor and four barrel carburettor. What would happen if those restrictions were eased and a computer was permitted to run a Small Block racing engine? **Ian Bamsey** finds out from Hasselgren, which has developed an electronic version of the Small Block Ford

Hasselgren is best known for a highly successful involvement with four-cylinder engines for Formula Atlantic, which spans a quarter of a century. Surprisingly, a Hasselgren V8 designed for professional road racing did not emerge until 2005. This project was a fully electronic Trans Am Ford Small block for Greg Pickett, who was running a Jaguar XKR, a 2675 lb racecar with a carbon fibre body on steel tube chassis.

This pushrod V8 project kicked off in September 2004, following discussion in the paddock. The Trans Am series was sharing the bill with Formula Atlantic, for which Hasselgren supplied the spec Toyota engine. The Californian company emphasised its fuel injection expertise, which impressed Pickett. Included in the offer was trackside support, to maximise the potential of a computer-controlled engine. Pickett did not enjoy technical support from Ford or Jaguar so this made Hasselgren's offer particularly attractive to him.

Design work having commenced in February 2005 the engine was first run on the dyno in June, progress having been slowed by damage from a neighbourhood fire. From the outset the injected engine, which was subject to a mandatory 8200 rpm rev limit, gave maximum horsepower of 650 bhp at 8000 rpm with a nice flat torque curve. It was given a shakedown in the car prior to contesting the last four races of the 2005 season, replacing Pickett's existing carburettor version. It powered him to the podium in each of those events. Particularly memorable was Montreal, where Pickett drove from the back of the grid right through to second place.

"That caused a lot of interest in the Hasselgren Ford V8", remarks the company's R&D Engineer William 'Oz' Anderson.

Given the subsequent demise of the Trans Am series, the engine was not significantly developed from its initial specification. "There is a lot more potential in it", adds Anderson. "We had an off-the-shelf dry sump system, which we did not get the chance to replace with a bespoke system. We also had airbox volume, runner length and cam profiles all as areas to be developed."

THE BASE ENGINE

The Hasselgren Electronic Ford Small block is designed to run on gasoline of around 105 octane – the chosen compression ratio is 13:1 – and in Trans Am competition it is subject to a mandatory 8200 rpm limit. It is based on the Windsor/Cleveland iron race block and approved Yates aluminium, two valve per cylinder heads.

The engine is de-stroked to 5.09 litres (311 cu. in.) to conform to Trans Am regulations. The 3.000 in. stroke LA Billet steel crankshaft has 90-degree phasing as per regulations. An H-section Carrillo steel con rod connects to a three-ring, 4.062 in. bore Mahle light alloy piston through a DLC-coated titanium pin.

"Schedule concerns limited investigations of bore/stroke ratios other than 1.35/1", notes Anderson. Supplied by Ford Motorsport, the linerless block has siamesed cylinders and by regulation the stock 4.380 in. bore centre spacing is maintained. Anderson reports that the cylinder wall is run uncoated, the block benefiting from vibratory stress relieving and hot-honing in house. "We vibrate blocks at below natural frequency until the natural frequency shifts lower and stabilizes. The belief is that manufacturing stresses are thereby lowered and the part is effectively 'aged'," explains Anderson. ▶

"At Montreal, Greg Pickett drove the Jaguar from the back of the grid right through to second place"

HASSELGREN ELECTRONIC FORD SMALL BLOCK V8 ANATOMY

- TRANS AM SERIES 2005
- 90-degree V8
- 4.062 in. (103.9 mm) x 3.000 in. (74.9 mm)/ 311 cu. in (5.09 litres)
- Naturally aspirated
- Racing gasoline
- Iron block, aluminium heads
- Linerless
- 5 main bearings, plain
- Steel crankshaft, 4 pins
- Steel con rods
- Light alloy pistons; 3 rings
- Pushrod; belt-driven single camshaft
- 2 valves/cylinder, 1 plug
- Non parallel valves
- 2.125-inch inlet valve, 1.600-inch exhaust
- Electronic ignition
- Sequential injection
- Full engine management system
- 13.0:1 compression ratio
- Maximum rpm 8200

The Hasselgren Trans Am Ford is limited by the regulations to 8200 rpm. Running on gasoline of around 105 RON octane leads to the use of a 13:1 compression ratio. The engine is based on a Ford Motorsport-supplied 302 Small Block and is destroked for the maximum permitted 311 cu. in. (5.09 litres) displacement.

The block runs to the depth of the crank axis, with each main bearing supported by a four-bolt cap – two bolts are vertical, two are splayed. The dry sump is non-structural. The crank height is regulated at 7.5 in. and Hasselgren uses a 4.5 in. clutch.

The Hasselgren-modified Yates head is attached by ARP studs and is sealed by a Cometic gasket. The aluminium rocker cover is a carry-over from the previous carburettor engine and it incorporates oil squirters for the valve springs.

The pistons are Mahle 2618 aluminium alloy with three rings and there are oil jets to cool them. Each rod has a bronze-bushed small end, carrying a DLC-coated, 0.866-inch diameter titanium piston pin, secured by conventional circlips. The steel crankshaft is a 90-degree LA Billet production, balanced in house, which runs in Clevite bearings and carries an ATI damper.

The valves are titanium running in bronze alloy guides and in conjunction with copper-beryllium seats. PSI supplies the dual coil valve springs. The spring seat is steel, as is the valve tip, which is contacted by a roller rocker. A roller tappet is also employed and the regulations impose a steel pushrod. Belt driven from the crankshaft, the steel camshaft runs in needle roller bearings.

The engine is run by a Bosch engine management system, which controls a single injector and a single Bosch plug for each cylinder. A single coil for each bank is mounted on the respective rocker cover. The fuel pump is a Bosch electric model.

The crankshaft drives a single Stewart Warner water pump, a Dailey dry sump oil pump and a power steering pump, in each case via synchronous belts while the alternator is indirectly driven from it. On the nose of the crankshaft are (forwards, in order) the cam belt pulley, the damper, the oil pump pulley, the water pump pulley and the power steering pump pulley.

An aluminium motor plate from Rocketsports Racing, seals the front of the engine, with the drive pulleys ahead of it. This large structural plate forms the front engine mounts, supports ancillaries, and mounts the Teflon cam and front main seals. At the rear the bellhousing forms the attachment to the chassis. The exhaust is four into two into one on each bank.

SUPPLIERS

ARP fasteners
The ARP-supplied head retention system includes four steel studs for each individual cylinder. ARP supplies all of the key fasteners.

ATI crankshaft damper
This harmonic balancer is of the O-ring type, with the steel ring sandwiched between a hub that slips over the nose of the crank and a outer sleeve.

BOSCH engine management system, spark plugs, coils and fuel pump
A Motronic MS 3.3 system controls sequential injection and the ignition, which is distributorless with a single coil-pack for each bank working on the wasted spark principle. Bosch also provides the 11 mm spark plugs and an electric fuel pump.

CARRILLO rods with SPS bolts
Regular H-section, steel, two-bolt con rod

COMETIC head gaskets
Multi Layer Steel (MLS) three-layer stainless gasket, with the top and bottom layers embossed and Viton-coated both sides.

DAILEY oil pump
Combined oil pressure and scavenge pump, five stage. It has a gear-type pressure stage, three Roots-type scavenge sections for the crankcase, while the fifth stage is an oil/air separator.

DEL WEST valves
Solid titanium valves, each fitted with a steel tip and both intake and exhaust having the same undisclosed coating. Del West also supplied a titanium valve retainer.

FORD MOTORSPORT block and heads
The head is an approved Yates aluminium design, which is carried by the 'short deck' version of the 302 Small Block iron race block. This closed-deck, linerless block has siamesed cylinders. Both block and heads are modified by Hasselgren, with extensive machining.

JESEL timing belt, tappet and rocker, with MANTON pushrod
A short rubber drive belt powers the camshaft, which in turn operates roller tappets. A tapered steel pushrod, as per the regulations, in turn operates a roller rocker, with needle bearings for the fulcrum and the tip.

LA BILLET crankshaft with CLEVITE bearings
Produced by LA Billet, the 90-degree 'Kryptonite' steel crankshaft runs without centre counterweights but the rest are retained. Plain Clevite bearings are used on 2.25 in. main, 1.88 in. big end journals.

MAHLE pistons
Three-ring 2618 aluminium alloy piston of the X-box design. It carries 1 mm top ring, 1 mm second ring and 3 mm oil control ring, all standard Mahle issue, the second ring moly-embedded.

PSI valve springs
Performance Springs Inc (PSI) coil springs are distributed to the racing industry by CV Products. Here twin steel PSI coils are employed for valve return, these straight wound and having an interference fit.

STEWART WARNER water pump
The single water pump is Stewart Warner's Ford Pro Series model, which, designed for balanced flow between the two banks, has a twin volute housing. It is claimed to consume less than 2 bhp in pumping 50 gallons per minute.

"Our blocks are honed with torque plates that have passages through which hot oil is pumped to evenly heat the block. Cylinder 'roundness' is thereby improved." The 'short deck' version of the Small Block is used, which gives a deck height of 8.215 in. This is run in conjunction with 5.600 in. con rods for a rod/stroke ratio of 1.87.

The engine has the usual ATI damper on the nose of the crankshaft. A belt was chosen for the camshaft drive, primarily to provide vibration dampening. A standard Jesel drive belt was considered an efficient and reliable solution given the proximity of the camshaft to the crankshaft.

"The camshaft is not DLC coated, since it is perceived that this could lead to skidding of the rollers"

The camshaft position relative to the crankshaft could be raised to shorten the (regulation) steel pushrods without transgressing the rules but given the 8200 rpm limit and freedom of rocker ratio, this option was not considered a useful deployment of resources.

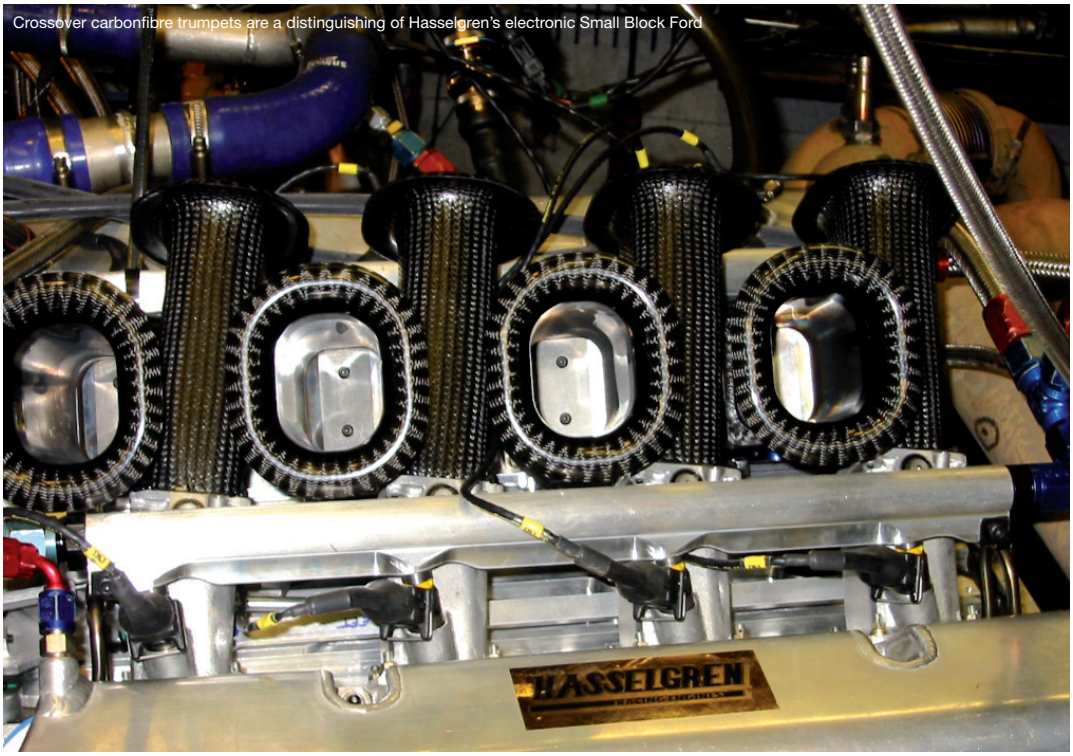
Roller tappets are allowed and roller rockers are also used. The coil spring closed valves are titanium. The rocker ratio is close to 2:1 and valve lift is far from conservative at 0.720 in. (18.3 mm) intake, 0.675 in. (17.1 mm) exhaust. Nevertheless, the camshaft profiles are described by Anderson as: "not especially aggressive – nothing 'tricky' – this motor is designed for a long life, in racing terms."

The camshaft is not DLC coated, since it is perceived that this could lead to skidding of the rollers. It runs in needle roller bearings with larger than standard journals maximising the base circle diameter.

The engine runs an oil pressure is 60 psi. Its Dailey Engineering pump is five stage having three scavenge sections for the crankcase. Crankshaft oiling is conventional, the potential for a nose fed arrangement not seen as rewarding of the effort implicit in such a step.

Water circulation is essentially standard, albeit, reports Anderson, with some 'tweaks' to make it as even as possible across the cylinders. The target water temperature is 195 degrees for the maximum horsepower.

The exhaust is four into two into one since this gives a broader torque curve than four into one. Further downstream the two banks



Crossover carbonfibre trumpets are a distinguishing of Hasselgren's electronic Small Block Ford

merge but the effect of this, if any, upon pulse tuning has not been analysed. It arises from the fact that the discharge from both banks is routed under the passenger door, so as to keep heat as far away as possible from the driver.

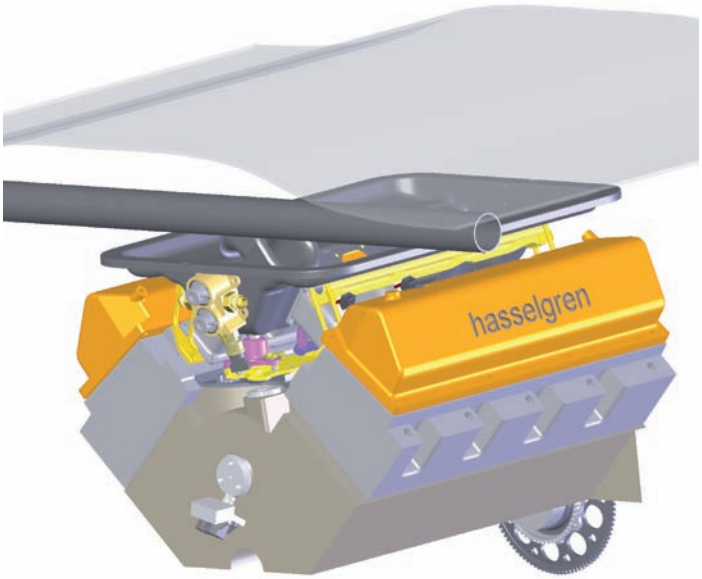
THE ELECTRONIC SMALL BLOCK

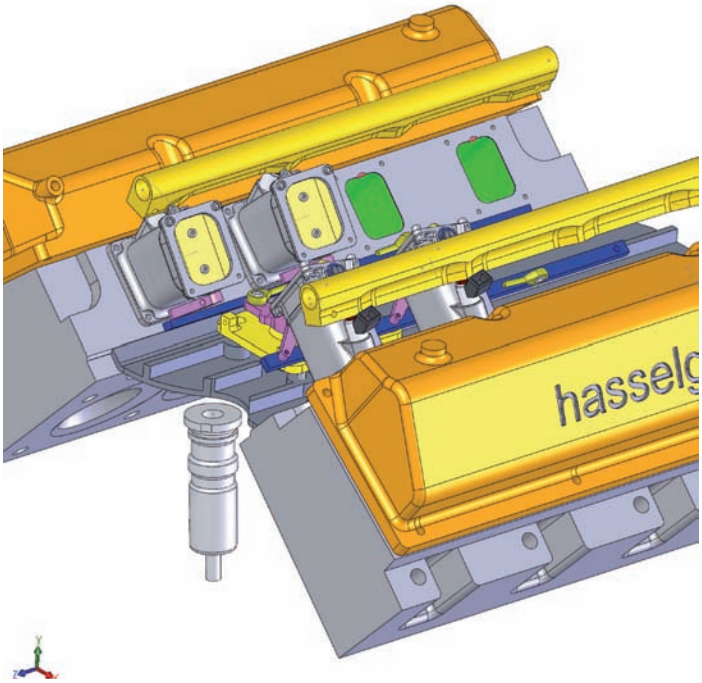
The 6049C3 Yates aluminium head is mandatory. This head provides the so-called 'twisted wedge' combustion chamber form, now superseded by the -D3 NASCAR Cup head. In effect the intake is rotated relative to the exhaust and the exhaust port is notably short.

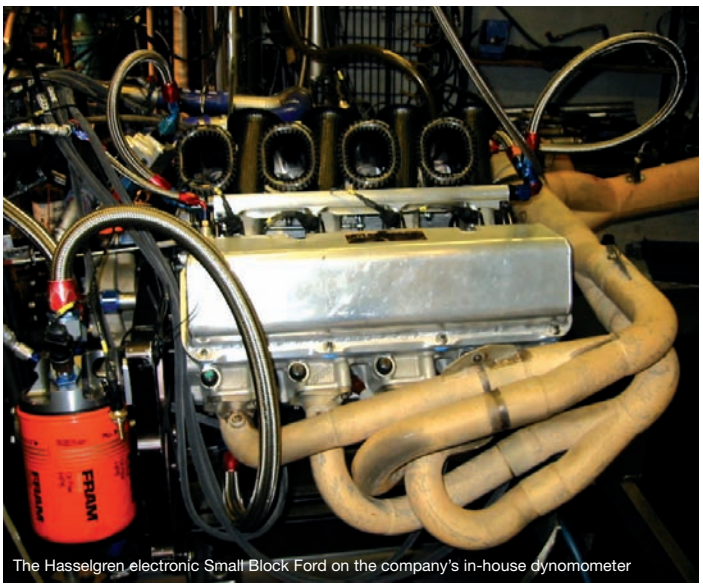
The Yates head is used in conjunction with a valve clearance notched, flat piston crown and there is significant squish area – around 25%, split between opposite sides. Under the rules the head can be ported provided the stock valve angles and port heights are respected. Open regulation on valve size led to a 2.125 in. intake and 1.60 in. exhaust.

Anderson admits that Hasselgren considered welding up and remachining the ports but on balance considered the stock Yates design to be an adequate base from which to machine. At Hasselgren a lot of preparation goes into the Yates head, in terms of modification of the chamber and porting, fitting bespoke seats and guides and so forth.

The head is symmetrical, which means that a crossover trumpet arrangement can be employed. With the traditional non-symmetrical head individual runners have to bend sharply to stand their trumpets upright, otherwise ones from opposite cylinders would clash with each other. The crossover layout allows the runner to continue the angled run of the port without a bend into the trumpet. This straightening of the air path from the mouth of the trumpet through ▶







The Hasselgren electronic Small Block Ford on the company's in-house dynomometer

BACKGROUNDER – HASSELGREN

Paul Hasselgren's Californian engineering firm has a quarter of a century of racing history and is particularly well known in the North American Formula Atlantic arena, where it was founded. Hasselgren Racing Engines was the Atlantic engine builder of the year from 1995 through to 2003. In 2004 Formula Atlantic switched to a 'spec' Toyota motor and Hasselgren was invited to be the sole supplier.

In 2005 Hasselgren moved also into Trans Am, supplying an electronic Ford Small Block V8 for Greg Pickett's Jaguar. The Trans Am series has been suspended this year but Hasselgren continues to work with V8 engines, preparing a Pontiac LS6 for the Pacific Coast Motorsports (PCM) Daytona Prototype team. This Grand Am engine project started in October 2005 and the team is running the full 2006 Grand Am schedule.

to the valve head is in the best interest of breathing performance. "The angled-trumpet entrances helped with interference of adjacent firing cylinders," remarks Anderson.

The crossover trumpets sit within a common air box. Each individual runner comprises a short cast alloy section containing a single injector and butterfly throttle and, above that, a carbonfibre trumpet. Slide and barrel throttles are not allowed, nor are variable length intake systems. On each cylinder bank the four throttles are connected by a linkage external to the air box.

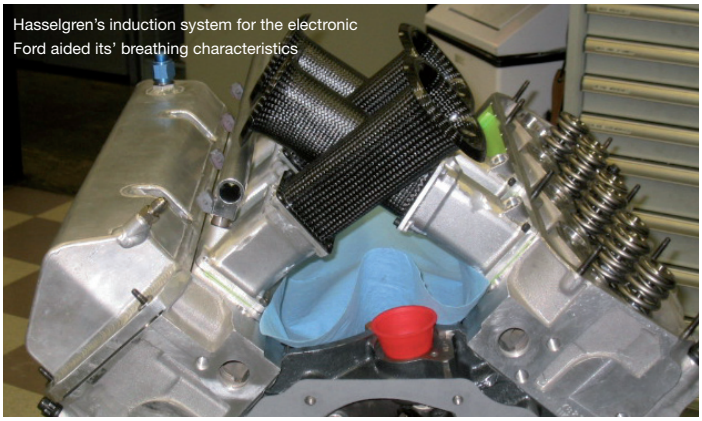
Anderson notes that Hasselgren makes the entire induction system, including bespoke butterflies, throttle shafts, fuel rails and so forth. "The bellcrank combines functions of throttle stops, TPS mount, and progressive ratio cable to throttle-arm motion translation".

The trumpets are manufactured by a composite specialist, using Hasselgren-made tooling. The throttle body section has to be cast aluminium by the rules. Having been designed using SolidWorks, the design data was emailed to the foundry and the finished castings arrived by post.

The butterfly and an idle air bleed is situated at the upper end of the casting while the injector is placed at the foot, spraying down towards the back of the valve. The long-term plan was to evaluate a second injector at the top of the trumpet, following experimentation with differing trumpet lengths and air box volumes.

Having imposed a maximum engine speed of 8200 rpm, the organisers control this via an additional crankshaft speed sensor, from

"The design data was emailed to the foundry and the finished castings arrived by post"



Hasselgren's induction system for the electronic Ford aided its' breathing characteristics

which data is fed to their own acquisition unit. The organisers also impose use of the Bosch Motronic MS 3.3 system, which is designed for the fully electronic control of eight-cylinder racing engines having sequential injection and distributorless ignition. Traction control is prohibited. Hasselgren needed written permission to be able to substitute smaller Magneti Marelli "Pico" fuel injectors, for packaging reasons. Bosch also provides the electric fuel pump, which supplies fuel to the injectors at 5 bar pressure.

Each cylinder has an 11 mm Bosch plug. The ignition is distributorless with a single coil for each bank working on the wasted spark principle. Triggering is by a light, compact trigger wheel at the rear of the crankshaft mounted adjacent to the steel flywheel. In terms of vibration, this is an inherently 'quiet' point on the shaft consequently providing a high quality of data. Ignition timing is in the region of 30-34 degrees BTDC, suggesting efficient operation in spite of the use of only two valves per cylinder. ■

THE HASSELGREN FILE

Paul Hasselgren

William 'Oz' Anderson

PRODUCTS
Competition engine preparation and development plus engineering services including engine design and dyno testing, chassis dyno testing and extensive machine shop

RACING MARKET
Diverse US series including Grand Am 2006

HEADQUARTERS
Berkeley, California

WEBSITE
www.hasselgren.com

KEY PEOPLE
CEO: Paul Hasselgren
R&D Engineer: William 'Oz' Anderson
Production Manager: John Davis
Systems/Project Engineer: Renu Malhotra
Lead engine builder: Tracy Baublitz

SCALE OF OPERATION
16 employees; all work is on competition engines

BACKGROUND
Established in 1977 in current location by current owner Paul Hasselgren

GLOBAL DISTRIBUTION
Deals direct with customers