

## Astra comes to America

**Saturn** has completed the first phase of its revitalization efforts by bringing the European-designed **Opel** Astra into the U.S. The 2008 Astra will test the waters of the hatchback market, coming in three- and five-door models.

The Astra has been available in Europe since the early 1990s. But even before the changes needed for the U.S. market, it had undergone several upgrades that have led to its continuing success for Opel.

"Since a redesign in 2004, we've sold 500,000 per year," said Sarah DeVries, Vehicle Line Director, Global Compact Cars, **General Motors**. "Since the mid-cycle enhancements in 2007, it's been second in Europe behind the **Volkswagen** Golf."

Astra represents about 30% of Opel sales. It now gives Saturn an offering in the hatchback market, which has been growing at double digits for the past few years, DeVries noted. With both rear seats folded, the five-door Astra offers 44.7 ft<sup>3</sup> (1265 L) of storage space.

Over the past two years, Saturn has completely updated its product line, making the Sky roadster, unveiled in late 2004, its oldest vehicle.

Engineers in the U.S. and Germany worked together to make a number of alterations to meet the demands of the U.S. market. Many of those were tweaks to meet tighter emissions levels, among other requirements.

Most did not require hardware alterations. "There was a lot of recalibration and we made software alterations to meet U.S. requirements," said Al Monzor, Program Engineering Manager at GM. The car shifts into neutral when it's stopped to save fuel, DeVries said.

One hardware change was made to address safety requirements, mainly around occupant sensing in passenger seats. "We added occupant sensors and recalibrated the airbags for unbelted passengers. In Europe they are set for only belted passengers," said Monzor.

The Astra uses pressure transducers to determine whether there's a person in the



The Astra brings European styling and a competitive small-car offering to the U.S.

passenger seat. The passenger side airbags deploy in two different stages, depending on the severity of the crash and size of the passenger. Additional safety features include active head restraints, GM's StabiliTrak electronic stability control, and six standard airbags.

In the cabin, cupholders were squeezed in for U.S. drivers, who have longer travel times. Rain-sensing wipers and heated outside mirrors were also added.

Pricing ranges from \$15,995 for the XE five-door model to \$18,495 for the sport-tuned XR three-door. All models have a 1.8-L Ecotec four-cylinder with variable valve timing for output of 138 hp (103 kW). Standard equipment is a five-speed manual transmission, with a four-speed automatic optional.

*Terry Costlow*

# G coupe evolves

The 2008 G37 coupe exhibits an evolutionary appearance, which tells the world that the **Infiniti** model has established its position as a top competitor in the luxury sport coupe market, facing off against the likes of the **Audi TT**, **BMW 3 Series** coupe, and **Mercedes-Benz CLK**. However, this new model must demonstrate enhanced performance and driving dynamics, and it did during an Infiniti-organized test drive on twisty secondary roads near Seattle.



The evolutionary 2008 Infiniti G37 coupe has a drag coefficient of 0.30.

The “evolved look” notwithstanding, all the body parts are new, and the second-generation rear-drive platform has been much modified to improve overall stiffness.

Power for the 3.7 V6 is 330 hp (246 kW) at 7000 rpm, up from 306 hp (228 kW) at 6800 rpm for the 3.5-L V6 version in the 2007 sedan and 275 hp (205 kW) at 6300 rpm in the 2007 coupe. Torque is essentially unchanged at 270 lb-ft (367 N·m) at 5200 rpm, but its curve has been flattened a bit. Compression ratio was raised from 10.6 to 11.0:1, and along with sophisticated intake valve lift and timing control systems, the more powerful G37 coupe also develops better fuel economy. The numbers are 18 mpg city/24 mpg highway based on 2008 **EPA** methodology—vs. 16/23 for the 2007 coupe.

The major change on the V6 is variable intake valve lift, which ranges from 0.9 to 12 mm (0.04 to 0.5 in). Along with wide-band (65°) variable intake timing, lift control permits an aggressive throttle strategy in which dual throttle bodies control rpm from idle, then early into what would be “part throttle” they open wide. From that point, intake valve throttling controls engine speed, and the reduced restriction of the open throttle bodies helps performance. Valve lift is adjusted by a computer-controlled electric motor on a shaft. Valve timing is hydraulically controlled by a cam phaser and computer. Exhaust valve timing is fixed.

The modest 0.2-L increase in displacement results from a 4.6-mm (0.18-in) increase in stroke to 86 mm (3.39 in). Bore remains at 95.5 mm (3.76 in). Although a 4.0-L VQ V6 block exists for **Nissan** Pathfinder and Xterra SUVs and Frontier pickup, it doesn't provide the NVH refinement required for an Infiniti.

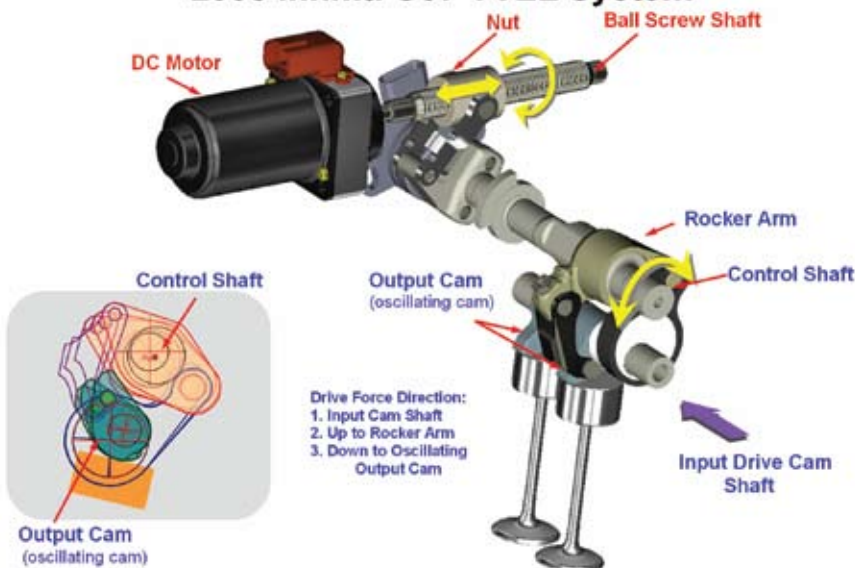
The coupe features a new braking system with very large vented rotors: 14-in (356-mm) diameter in front and 13.8-in (351-mm) diameter in back. The front calipers are fixed-type four-piston; the rears are fixed-type two-piston. Wheel sizes are up from 17 to 18 in, with 19-in units optional on a sport package.

Although upgrades to lateral stiffness were made at the front and rear suspen-



The G37's refreshed V6 moves up to 3.7 L with a small change in stroke, and dual throttle bodies fed by separate air cleaners are used to enhance performance.

## 2008 Infiniti G37 VVEL System



The variable-valve-lift system of the 3.7-L V6 uses a dc motor with ball screw shaft to turn a control shaft clockwise or counterclockwise. This varies lift by changing the operating relationship between rocker arm and oscillating output cam. Drive is from an input camshaft through a rocker arm.

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sions, the new model has not actually been tested for body-in-white stiffness because of Nissan's satisfaction with its CAE (computer-aided engineering) estimates. They are 46 Hz in bending, 48 Hz in torsion, which Nissan said have been proved accurate to within  $\pm 1$  Hz.

The four-wheel active steering (4WAS) system introduced as an option on the 2007 G35 sedan is available on Journey and Sport coupe models. It combines the rear steering system, with its one-degree

range (which had been a coupe option), with a front system whose range is not specified separately. But with inputs from steering-wheel and vehicle speed sensors, the 4WAS computer operates the front and rear steering actuators to provide a variable ratio system that is as high as 20:1 at high speed for stability, becomes faster (as low as 12:1) at low/mid speeds for nimble handling, and moves up to a mid-position for low speed and parking.

The five-speed automatic and six-

speed manual continue as the transmission offerings, the automatic with more sophisticated shift control strategies and torque converter clutch lockup, the manual with NVH upgrades.

The coupe wheelbase remains 112.2 in (2850 mm) and overall length is 183.1 in (4651 mm), an increase of 0.9 in (23 mm). Curb mass is 3616-3668 lb (1640-1664 kg), an increase of about 110 lb (50 kg).

*Paul Weissler*

## Inside Porsche's Cayenne hybrid project

**Porsche** has unveiled the Cayenne hybrid development vehicle (gasoline-electric) and demonstrated it to *AEI* on its high-security Weissach test track. The system is

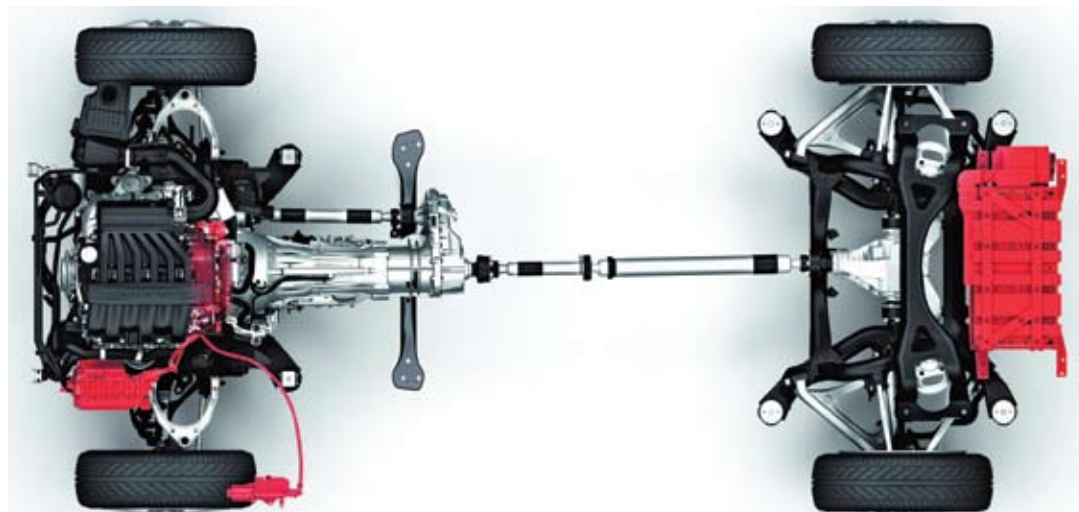
expected to enter production within two years and presages the four-door, four-seat Porsche Panamera grand turismo slated for 2010.

It was exceptional for Porsche to permit even limited media access (it invited only a small number of international journalists) to an upcoming product far in advance of its reveal, said Michael Leiters, Cayenne Hybrid Project Manager. The decision was made, he said, because of public debate on climate change and future CO<sub>2</sub> emissions limits for motor vehicles. "We are working all-out on the development of the hybrid car. We are in the middle of the process with our partners at **VW** and **Audi**," said Leiters.

Although Porsche has succeeded in reducing its products' fuel consumption and emissions in recent years (by 15% for the Cayenne over the past four years with the introduction of direct-gasoline-injection systems), Leiters admitted: "We are reaching the limits of physics, particularly in the development of large engines for large upmarket vehicles." With growing customer concern about the compatibility of their cars with the environment, social acceptance of even a brand such as



Porsche's parallel full hybrid Cayenne can be powered only by the electric motor at speeds up to 120 km/h (75 mph).



The Porsche Cayenne's Sanyo-sourced hybrid battery is placed in the spare wheel well.

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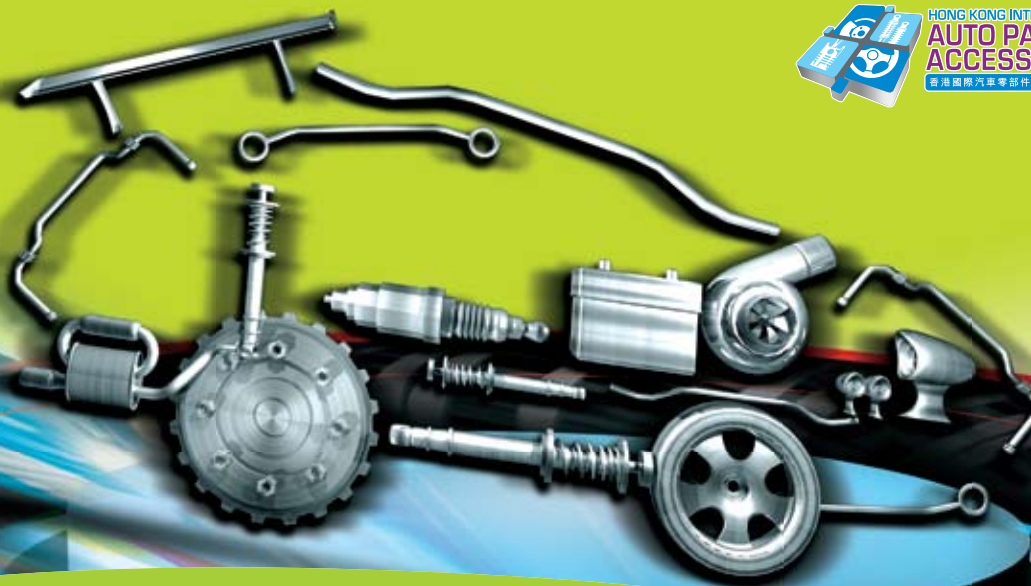
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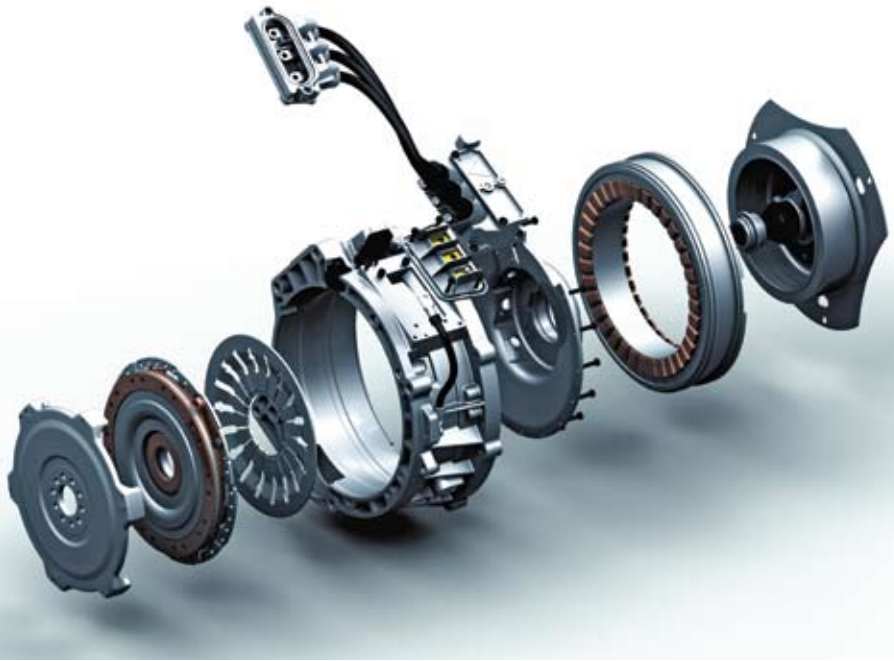
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The Porsche Cayenne hybrid module, part of which is shown, is slated for 2009 production.

Porsche would start to weaken.

"We have opted for a parallel full hybrid," he explained. "This ensures a high level of compatibility of hybrid components with the existing platform of the Cayenne. We are able to save more fuel than with other hybrid concepts. Under low load or 'coasting' conditions, the Cayenne can be powered only by the electric motor at speeds up to 120 km/h." The engine has a stop/start function.

Essential to the success of any modern hybrid vehicle is the application of sophisticated and comprehensive controls. The Cayenne's Hybrid Manager computer looks after the electric motor and V6 gasoline internal-combustion (IC) engine and ensures that the battery is never discharged below a fixed level nor charged and discharged too often in an "exaggerated cycle."

Leiters said the Hybrid Manager was one of the major challenges in the project, followed by the battery. A 38-kW, 288-V nickel metal-hydride (NiMH) battery is positioned in the well of the luggage area usually occupied by the spare wheel. It is large, at 347 x 633 x 291mm (13.7 x 24.9 x 11.5 in), and comprises 240 cells. Dissipating battery heat build-up has necessitated the installation of a system to extract cool air from the rear of the cabin to be drawn through the battery. The hybrid's air-conditioning operates via electric power, as does the steering, the automatic transmission's oil pump, and the "under pressure" pump for the brake servo.

The Cayenne hybrid development program, which started in 2005, is well advanced, and a New European Driving Cycle (NEDC) fuel consumption of 9.8 L/100 km—28 mpg on the U.S. Federal Test Procedure—has been achieved. However, the aim is to reduce this to about 8.9 L/100 km by the time production starts in 2009. The conventional V6 Cayenne's NEDC is 12.9 L/100 km. Performance figures include a 0-100 km/h (0-62 mph) time about a half second less than with the conventional V6 alone.

The electric motor used is a three-phase synchronous type producing 285 N·m (210 lb·ft). The hybrid module has a connection to a conventional automatic transmission via a flexplate, and there is a disengagement clutch to switch the IC engine on and off. The system uses what Porsche terms an "innovative" clutch disengagement control to start the IC engine quickly. Porsche analyzed other hybrid systems, including use of a planetary gearbox and two motors, but opted for a parallel approach, which enables either the motor or IC engine to be deactivated very quickly.

Porsche admits that its solution is complex, but regards it as appropriate for its products. Porsche (together with its partners) looks likely to be first to market in offering a parallel system on a production car, seeing it as highly efficient and offering very good start-off performance. Plus, the hybrid offers driving qualities the same as those of a conventional model.

The Cayenne body-in-white does not

need any changes to accommodate the modular parallel system. The decision to use electrohydraulic rather than electro-mechanical steering was because the former provides feel akin to what traditional Porsche buyers would expect. The car has a regenerative braking system.

The NiMH battery system, which is being developed in collaboration with **Sanyo**, has an operating temperature range of -30 to +40°C (-22 to +104°F) and has a mass of 69 kg (152 lb). The aim is to achieve a battery life of 10 years. The battery requires a 7-kg (15-lb) crash box to meet European rear-impact requirements.

However, Porsche is working on lithium-ion technology for vehicle applications. Typically, this would offer a weight reduction of about 50% compared with NiMH technology for the same output but would have the potential for up to 55 kW and more than 400 V. Its temperature range would be wider and use of energy 100% better, estimates Porsche, adding that its application would equate to a 3% reduction in fuel consumption.

It is possible that a lithium-ion battery suitable for use in the Cayenne and/or Panamera would be available by 2010. The NiMH system, complete with all controls, adds about 180 kg (397 lb) to the mass of the conventional V6 Cayenne.

*Stuart Birch*

## Audi previews mini

It may have a long, clumsy name now, but **Audi's** Metroproject quattro hybrid design study will eventually become the A1. Revealed at the Tokyo Motor Show, the four-seat concept is powered by a transversely mounted 110-kW (148-hp) 1.4-L TFSI gasoline engine driving the front wheels and a 30-kW electric motor driving the rear—thus achieving its quattro status. The combination is claimed to cut fuel consumption by about 15%, while CO<sub>2</sub> emissions are down to 112 g/km. When it is production-ready as the A1, the car is likely to be offered with a choice of gasoline, diesel, and hybrid power.

The Metroproject may be regarded in part as a response to **BMW's** enormously successful **Mini**, but unlike that design it is not based on late 1950s retro styling. In

a strong indication of how serious it is about the coupesque (there is no B-pillar) concept, Audi dug into its lexicon of broad hints to state that it was the “latest in a long line of Audi design studies, many of which have entered series production virtually unchanged.”

The concept is 3910 mm (153.9 in) long, 1750 mm (68.9 in) wide, and 1400 mm (55.1 in) tall. For reference, the next model up in Audi's range, the A3 three-door, is 4214 mm (165.9 in) long, 1765 mm (69.5 in) wide, and 1420 mm (55.9 in) tall. The concept has 240 L (8.5 ft<sup>3</sup>) of luggage space. Suspension is MacPherson strut at the front and four-link at the rear. Audi magnetic ride adaptive damping technology is fitted. Steering is electro-mechanical and speed-sensitive.

The capacity of the concept's lithium-ion batteries provides a maximum range in zero emissions mode (no gasoline engine intervention) of 100 km (62 mi). The batteries can be recharged via a domestic electricity supply, and regenerative braking is used. Gasoline engine torque is 440 N·m (325 lb-ft) and that of the electric motor, which is positioned behind the rear seats, 240 N·m (177 lb-ft). The engine is a modified version of a unit offered for the A3.

Performance figures include a 0-100 km/h (0-62 mph) time of 7.8 s and a top speed of 200 km/h (124 mph). Combined fuel consumption is 4.9 L/100 km. Transmission is S-tronic, dual-clutch.

Interior design and particularly its quality are top criteria for Audi products,

The Audi Metroproject quattro adds electric drive for the rear axle.



and the Metroproject continues that emphasis. But it also has a newly developed, removable, handheld “mobile device” that controls various functions and can also be used outside the car. It facilitates the entry from a remote point (typically within a home) of destinations into the satellite navigation system, and the actuation of heating and audio systems, so the car is fully prepared when needed. The handheld, touch-screen system, which is able to recognize both Latin and Japanese characters and even decipher handwriting, communicates with the car by way of a WLAN connection.

The Audi A1 is expected to be in production for MY2010.

*Stuart Birch*

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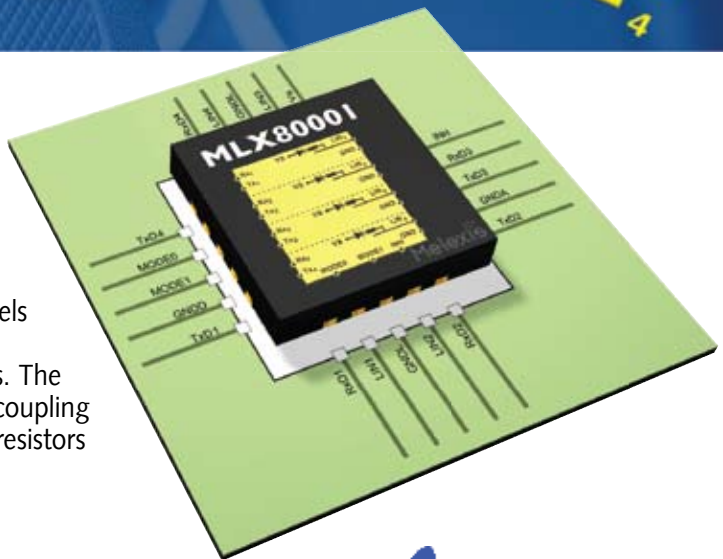
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