

NAIAS production vehicles

The strength of light trucks and crossovers in North America was on display as a majority of the all-new vehicles debuting at the event were for those segments of the industry. This special edition of *Global Vehicles* provides highlights of new-vehicle technology for 2003 and beyond.

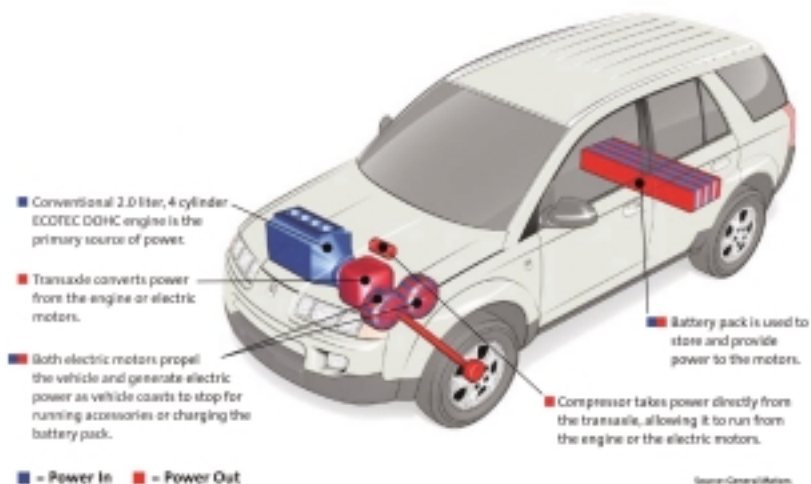
GM hybrids

General Motors Corp. will offer optional hybrid powertrains on several of its most popular models including trucks, SUVs, and midsize sedans starting in late 2003, GM President and CEO Rick Wagoner announced at the North American International Auto Show.

"This is a major commitment to offer consumers three different hybrid propulsion systems on three vehicle architectures, representing more than a

The announced GM systems vary in complexity and cost, stretching from the "very aggressive" dual electric-motor VUE, to the "more practical" combination of electric motor assist with other efficiency gains from technologies such as Displacement on Demand cylinder deactivation and VTi continuously variable transmission. The ambitious hybrid program begins with the already announced production of the **GMC** Sierra and **Chevrolet** Silverado hybrid pickups, which start production in 2003 for fleet customers and retail consumers in 2004. Starting in 2005, GM will begin production of a **Saturn** VUE with an advanced dual electric-motor system and control electronics to boost composite city/highway efficiency up to 50% to nearly 40 mpg. In 2006, the Chevrolet Equinox will get a "value-focused" hybrid option that mates electric-motor assist and GM's VTi variable transmission to an efficient Ecotec four-cylinder engine for a fuel economy increase of nearly 15%. This system will also be offered on the Chevrolet Malibu, with production scheduled for 2007, and other midsize models if demand exists. Also in 2007, a revised version of the pickup system will be augmented by Displacement on Demand for the next generation of GM's full-size SUVs to boost fuel economy by an additional 15-20%.

GM's hybrid pickup will be able to haul and tow as much as its gasoline-only counterpart while getting 10-12% better fuel economy, with the added benefits of being able to power tools at a construction site or run appliances at a campground. Based on the GMT-800 full-size pickup, the hybrid truck features a 5.3-L Vortec V8 engine and, instead of



dozen of our most popular models," Wagoner said. "If consumers were to select the hybrid option on all of the models included in our multi-year plan, it could eventually exceed 1 million vehicles." Wagoner believes that, because hybrids cost several thousands of dollars more than conventional vehicles, consumer-based tax credits will play a critical role in gaining market acceptance by making the technology more affordable.

a conventional starter motor and alternator, a compact electric motor integrated in a patented, space-efficient manner between the engine and transmission. The electric motor provides starting power and the ability to generate up to 14 kW of continuous electric power, which can be stored in a 42-V lead/acid battery pack, used to support onboard electric accessories, or employed to operate power tools or other appliances by a pair of ac outlets in the cab and bed. Total available power output is 110 V at 20 A. GM says that, as more 42-V accessories become available, the electrical architecture of the parallel-hybrid pickup can accommodate them.

At a stoplight, the hybrid pickup's gasoline engine stops running, but the accessories continue working on stored electrical power. When the driver steps on the accelerator, the gasoline engine starts "with little or no delay or disturbance." To ensure full accessory capability while the engine is temporarily stopped, an electrically driven hydraulic pump provides power steering, an electric pump continues to circulate hot water if cabin heat is needed in the winter, and cold, dry air is supplied in the summer for an extended period through intelligent control of the conventional HVAC system.

The truck's efficiency gains are derived mainly from the engine start/stop function and regenerative braking, which turns the motor into a generator as the truck decelerates. Extra savings

come from fuel shutoff any time the truck is coasting or braking.

The advanced hybrid system in the Saturn VUE combines a four-cylinder engine with twin electric motors for fuel economy gains of up to 50%, improved 0-60 mph (0-97 km/h) and 50-70 mph (80-112 km/h) performance, and a Super Ultra Low Emissions Vehicle (SULEV) rating. The 125 hp (93 kW) of the 2.0-L Ecotec engine is augmented by two 20-kW electric motors for the transverse, front-wheel-drive application.

Vehicle propulsion comes from the two electric motors at low vehicle speeds when the efficiency of gasoline motors is lowest. At higher speeds and/or loads, power comes from the internal combustion engine. The electric motors contribute to improvements in fuel economy and vehicle performance by starting the engine; propelling the vehicle at low speeds; charging the battery when the engine is running and during braking, storing power in the system's 300-V battery pack; synchronizing gearshifts; operating the electric-powered reverse gear; and driving the air-conditioner compressor even when the engine is off. GM says the advanced hybrid system's adaptability to a variety of engine displacement configurations makes it suitable for a range of future vehicle applications, including front-wheel-drive passenger cars and SUVs.

GM's "value-focused" belt alternator starter (BAS) hybrid system in the 2006 Equinox is a simple solution to making hybrid-electric powertrain technology

available to more types of cars, trucks, and sport utility vehicles. GM engineers developed the BAS for improved fuel economy in stop-and-go driving by shutting the engine off at idle and by enabling early fuel cutoff during deceleration. The system combines sophisticated engine controls with GM's VTi variable transmission, an electric motor/generator, regenerative braking, and efficient charging. Estimated EPA composite fuel economy savings range from 12 to 15%.

BAS benefits include adaptability to four- and six-cylinder engines with minimal impact on engine and transmission architectures. Electric power comes from a single 36-V battery, while maintaining the main 12-V electrical system. All vehicle accessories and passenger comfort systems, such as air conditioning, remain functional when the engine is automatically stopped.

Though GM is putting considerable resources into affordable and effective hybrid technologies stretching from mid-decade into the next, Wagoner emphasized that, in the near-term, the company will continue to refine and improve the internal combustion engine's efficiency and power. However, GM's vision of the long-term future includes the Hy-Wire concept and the potential of the hydrogen economy and fuel cells as the ultimate solution to efficiency and environmental compatibility.

Kevin Jost

Ford F-150

Ford has talked a lot about flexibility as it relates to how the 2004 F-150 will be built, but the adjective applies to the vehicle itself as it is available in three cab configurations, three body styles, and five trim levels (XL, STX, XLT, FX4, and Lariat). The F-150, Ford says, now offers the industry's widest variety of body and trim configurations. All cabs feature four doors.

The Regular Cab offers a single row of occupant seating and rearward-swinging access doors that open to stowage area 13 in (330 mm) wide when the seats are moved forward. With an extended cab, the SuperCab has a second row of seating accessed by two small rearward-swinging doors. Both the Regular Cab and SuperCab are 6 in (152 mm) longer than the previous model.

Most spacious of all is the SuperCrew, with two rows of seating and four forward-swinging full-size doors.

Two box styles, Styleside and Flareside, are available, and there are three box lengths: 8 ft (2.4 m), 6.5 ft (2.0 m), and 5.5 ft (1.6 m). Boxes are 2 in (50 mm) deeper than on the current F-150. An assist feature using an internal torsion bar helps in raising and lowering the taller tailgate.

The F-150 achieved targets in ride, handling, and quietness in part via a fully boxed frame with hydroformed front rails. The frame is about 9 times stiffer in torsion and 1.5 times stiffer in bending than the 2003 F-150's. Critical crossmembers are secured to the rails with a "through-rail" joint to prevent



localized flex. The F-150 marks Ford's most aggressive use yet of structural adhesives to spread loads over the length of a seam.

Both 4x2 and 4x4 models use new coil-on-shock, long-spindle, double-wishbone front suspension with cast



aluminum lower control arms—a first in the pickup truck segment, Ford says. Advanced bushings—soft in response to road impacts but stiff to cornering loads, with ride tuning and handling tuning optimized independently—are used. The front shock absorbers are mounted inside the springs, allowing four-wheel-drive models to use coil springs instead of the traditional torsion bars, thus permitting more precise suspension tuning and commonality across the lineup, says Ford. The design also moves the shock absorber closer to the wheel for a 25% increase in mechanical advantage, which allows for more precise shock tuning.

The Hotchkiss-design rear suspension has been optimized with shock absorbers placed outboard of the frame rails—a segment exclusive—for improved control of body lean and a smoother ride. The shock position also provides better control of the axle on washboard-type surfaces. Rear leaf springs are now of the same width as those on the F-Series Super Duty.

The rack-and-pinion steering system is the largest and strongest ever used on a Ford vehicle, replacing the 2003 model's recirculating-ball system. A **Johnson Controls**-supplied modular overhead rail system with integral power supply is standard on some models.

Two V8 engines power the F-150: the 4.6-L Triton and the new 5.4-L, three-valve Triton. The 4.6-L engine is of two-valve design and delivers 231 hp (172 kW) at 4750 rpm and 293 lb•ft (397 N•m) at 3500 rpm, with 90% of torque available at 2000 rpm.

The 5.4-L engine generates 300 hp (224 kW) at 5000 rpm and 365 lb•ft

(495 N•m) at 3750 rpm. It marks the industry's first mass application of a variable-cam timing that shifts the intake and exhaust valve timing together, according to Ford. A new aluminum cylinder head and improved cast-iron block balance power with better fuel efficiency and quieter operation. Camshaft covers are magnesium.

New on both engines is a segment-first torque-based electronic throttle control that uses driver input from the accelerator pedal to actively modulate the torque at the drive wheels. Replacing the mechanical throttle linkage is an accelerator position sensor, an electronic control circuit, and an actuator at the throttle valve on the engine. The controller assesses the status of the engine and the ambient conditions and then adjusts the throttle to deliver the desired result, producing seamless and consistent engine response as well as improved fuel economy.

Patrick Ponticel

safety engineer or guardian angel ►►



Nissan Titan

Nissan knew what it did not want to do when it entered the full-size truck market, and that was to follow **Toyota's** path with first one, then another truck that was smaller and less capable than full-size domestic competitors. So the company benchmarked those domestic competitors and set out to match or beat all comers. Even with **Ford's** introduction of an improved 2004 F-150, the Nissan Titan should be a class leader.

The Titan's Endurance 5.6-L DOHC aluminum V8 cranks out more than 300 hp (224 kW) and 375 lb•ft (508 N•m), matching the power of Ford's new three-valve 5.4-L Triton engine and topping the torque output of **Chrysler's** 5.7-L OHV Hemi engine. The Endurance engine shares only its bore centers with the **Infiniti** luxury-sedan V8, according to Larry Dominique, Chief Product Specialist. The block is cast with larger oil passages for durability and to

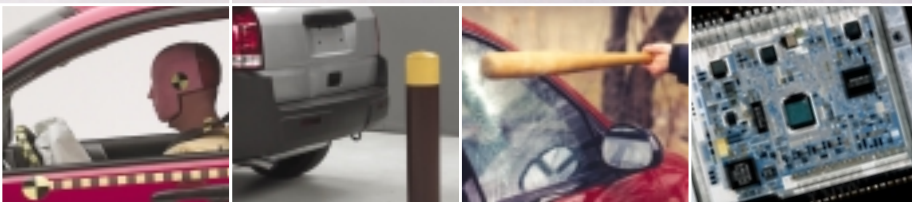


accommodate the larger bore and stroke. Cast iron lines the block and molybdenum-coated pistons cut internal friction, while a silent timing chain reduces mechanical clatter under hood. The engine is matched to the IK-A five-speed automatic transmission, which is derived from the Infiniti IK transmission, but which employs different gear ratios to suit the truck's need for low-speed pulling power.

Additional power should be available from the Endurance engine as it is developed with features such as variable valve timing, so Nissan is confident of its

position in the ongoing power war. "My roadmap is to establish our engine as reliable and durable first," said Dominique. Using aluminum for the block casting might spook some conservative full-size truck customers, but the company wanted to save weight in a bid for best-in-class fuel economy, he said.

Underneath, the Titan employs a **Bosch** antilock system for its four-wheel disc brakes. The 4x4 versions use a **Dana** electronically controlled transfer case and Dana 44 electronically locking rear axle. **Rancho** gas shocks, popular among off-road enthusiasts, are also used.



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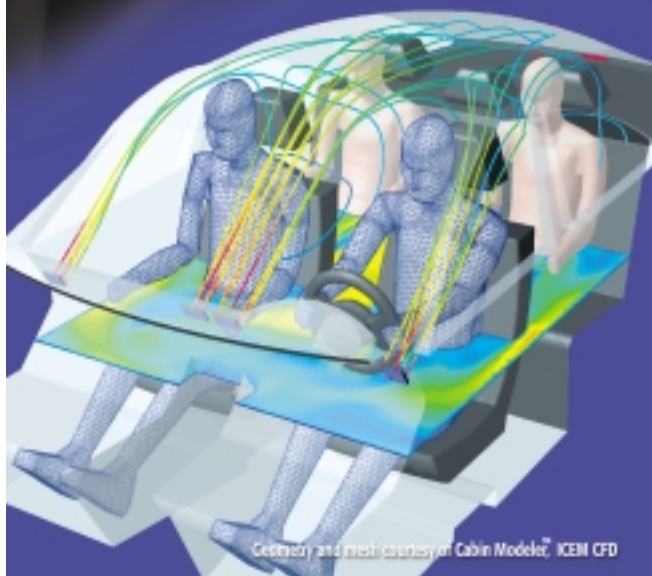
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The Titan's ZW chassis has a resonance frequency of 17 Hz, compared to 11 Hz for its competitors other than the 2004 F-150, which Nissan has not had a chance to test, according to Dominique. Bucking the current trend, Nissan does not employ hydroforming to build its frames. The reason, said Dominique, is that hydroforming demands uniform material thickness throughout, whether the thickness is needed or not, so foregoing that technique let Nissan make the Titan's frame lighter.

The truck will be available in King Cab extended cab or Crew Cab four-door configurations, with no "standard" cab offered. Rear-hinged access doors on the King Cab mount on articulated hinges that let the doors flip open nearly 180° for more convenient access to the rear interior.

The cargo bed is the focus for truck buyers, and here, too, Nissan brought innovation to the Titan. The company applies an industry-first spray-in bedliner on the assembly line. The 78-in (1980-mm) bed is a true full-size cargo box that contains Nissan's Utili-track bed channel system. Five rails—three in the floor, two on the sides—mount removable utility cleats for tying down cargo. A driver-side locking storage bin in the bed's fender provides a secure spot to carry items such as a hitch ball, chains, or flares that the customer doesn't want in the cab, but that should not be left loose in the bed either.

The Titan, in both cab configurations, will go on sale November 1. A full-size SUV based on the same platform will go on sale ahead of the Titan, on September 1. The SUV will differ from the Titan in its use of an independent rear suspension. Nissan's IRS will differ from the system Ford uses on the Expedition and Navigator, with high-mounted lower control arms to provide additional ground clearance for off-road use, said Dominique. The system will also use a separate spring and shock absorber layout, rather than a coil over shock design, he said.

Eventually a V6 engine will be available for both vehicles. A turbodiesel V6 is also a possibility, according to Dominique. "We could get 25-27 mpg with our SUV and the same torque as the V8 with a good turbodiesel V6," he said. "The cost of a diesel engine is high, but it is not as high as a hybrid-electric system."

Another technology that is likely for Nissan is **Delphi's** QuadraSteer rear-wheel-steering system. Nissan has studied the system closely and is impressed with its potential, according to Dominique. He attributed poor sales of **General Motors** QuadraSteer-equipped trucks on poor marketing and the packaging of the system with other options, which made it too costly.

"We are talking with Delphi about QuadraSteer and we have built a prototype to test," he said. "I believe the SUV market is a big one for QuadraSteer," he added.

Nissan plans to use the Titan's ZW platform as the foundation for its next generation of Frontier pickups and Xterra SUVs, which will grow from the waning compact segment to the more popular midsize segment. "The compact pickup truck market is abysmal," groaned Dominique.

The new midsize trucks will have shorter, narrower frames, but they will nevertheless share key components and dimensions with the Titan, so they will be considered to be based on the same platform, he said. The V6 engine will be shared across both truck lines.

Dan Carney