

Edited by **Kevin Jost**

Ford Edge aims to quiet competitors

The **Lexus** RX 350, backed by all the resources a luxury vehicle enjoys, put up a good fight but fell short in a wind-noise battle against the nonluxury **Ford** Edge, according to an engineer involved in development of the latter.

With small benchmarking victories such as that, Ford hopes to carve out a large territory in the five-seat nonluxury crossover segment.

Among the competitors sitting exposed in that territory is the aging **Nissan** Murano. Against the fresh-out-of-the-gates Edge in

Ford wind-noise engineering tests, the Nissan competitor came up short. "The Edge is absolutely just worlds better than the Murano in wind noise," said Rich Kreder, Vehicle Development Manager for the Edge and its sister vehicle, the **Lincoln** MKX. (Ford notes that its engineering wind noise tests on which it bases its claims involved only one Murano and one RX 350; in a straight-line 80-mph [130-km/h] test, the Edge registered about 22.5 sone, the Murano about 24.5, and the RX 350 about 25.25.)

Although late to the program, Kreder had a direct hand in the Edge's wind-noise attribute, thanks in part to Ford's million-mile test-drive requirement. During a weeklong trip from Oakville, Ontario (where the car is built) to Las Vegas in a production prototype earlier this year, Kreder and two colleagues noticed an unwelcome whistle that presented only during hard left turns with the driver's window down.

"It took us a few days to figure out where it was coming from and how to fix it," said Kreder. Convincing a chief nameplate engineer—in this case, Elaine Bannon—that a late fix is necessary can be an even more difficult task than engineering the solution to a problem. But Bannon approved the proposed change.

"No one wants to make a change late, but this is something that the customer will never see now," Kreder said.

The customer will not "see" the mirror wind noise, but he or she will see the solution: two tiny fins incorporated into the top surface of the mirror. "Some people might think it's a styling cue, but it was for the whistle," said Kreder. "We worked with the styling studio to make sure it didn't disrupt the theme of the vehicle, because we could have solved the problem in a number of ways. But with the spacing of the fins, it turned out great.

"We've really moved the needle on wind noise," Kreder continued. "I think all of the competitors will have to make some significant changes to try to catch up."

Reducing interior sound levels on the Edge's Lincoln cousin was given even greater priority, said Kreder. In addition to the changes designed to combat wind-noise intrusion, he noted three key areas of focus on the MKX.

"First, the Lincoln features a multi-laminate windshield designed specifically to reduce the amount of road noise entering the vehicle," he said. "It's heavier than the windshield used on the Edge, but it's also more effective acoustically."

Engineers and others from Ford put more than 1 million road-test miles on the Edge.



A "hard-nosed decision maker" is how Ford Edge Chief Nameplate Engineer Elaine Bannon describes herself. "I knew that when we hit a certain chinning bar of excellence, I had to tell people no; it's done."



Curtain airbags for front and rear seats are among the Edge's many standard safety features.



Also unique to the MKX is thicker, heavier side glass.

"The other key differences that [contribute to] lower cabin noise are thicker carpeting and a thicker dash pad applied to the cabin side of the [firewall]," Kreder said.

The Lincoln also receives a greater amount of sound-deadening foam-based material behind interior trim.

The Edge and MKX are notable for many reasons beyond noise levels, from a brand-new powertrain to a bevy of standard safety features and what it calls good driving dynamics.

The Edge is the launch vehicle for Ford's new 3.5-L Duratec 35 V6 engine with variable cam timing and electronic throttle control. It delivers 265 hp (198 kW) at 6250 and 250 lb-ft (339 N·m) at 4500 rpm. The engine is mated to an all-new six-speed automatic transmission that Ford developed in partnership with **General Motors**. The 0.74:1 overdrive sixth gear provides what Ford calls exceptional fuel economy at 18 mpg city/25 mpg highway. All-wheel drive is available.

Acceleration from 0-60 mph (0-97 km/h) comes 1 s faster for the Edge than for the

Murano, according to Bannon (no official 0-60 time has been released by Ford).

The chassis is an area where many of the components and much of the engineering were shared with **Mazda**, according to Bannon. The new platform for the Edge, MKX, and Mazda CX-9 is evolved from the Mazda6 platform on which the Ford Fusion is based.

Among other major partners were **TRW** on the electronic stability control system, **Toyota** on the all-wheel-drive system, and **Intier** on seating.

Patrick Ponticel and Lindsay Brooke

Tesla leads new electric-car wave

Tesla Motors, a San Carlos, CA, startup, grabbed headlines in July when the company announced its plans for a speedy two-seat roadster with a battery-powered electric drivetrain. The announcement came during a period of high fuel prices, supply uncertainty, and a general-release film decrying the cancellation of **General Motors'** EV1 electric car program.

Tesla's backers include Elon Musk, founder of **PayPal** and CEO of **SpaceX**, as well as **Google** founders Sergey Brin and Larry Page. Martin Eberhard, CEO of Tesla, and Marc Tarpenning, Vice President of Electrical Engineering and acting Chief Financial Officer, founded and sold **NuvoMedia**, an electronic book maker. The result is that Tesla lacks for neither funding nor technical expertise.

Nevertheless, even with its \$60 million in backing, Tesla is still dwarfed by the resources GM dedicated to developing the EV1, so the obvious question is what makes Tesla's attempt different from the previous efforts? The answer lies in simple motivation of the participants, insists Tarpenning. "We love to drive, and our company is full of gearheads. We are building a car by and for people who love to drive. That is why we built a sports car first."

The Tesla Roadster boasts true sports car performance, with a projected 0-60 mph (0-97 km/h) time of about 4 s and a top speed of 130 mph (209 km/h). Driven less vigorously, the car can achieve a highway range of 250 mi (400 km).

Attacking the electric car market with a car that prioritizes performance also gives Tesla the benefit of participating in a segment where high prices are not unusual. Previous economy-oriented electrics have typically stumbled on their high prices, but Tesla expects that, in the sports car segment and at the low sales volumes forecast, the \$100,000 price should not be an obstacle. Indeed, the car sold out its initial production run of 100 cars just a month after its announcement.

"We are a small company, so we're going to pay too much for all the bits and pieces of our car for a while," he said. Later, as production volumes grow and costs shrink, Tesla ex-



California Gov. Arnold Schwarzenegger received a ride in the Tesla Roadster at the car's announcement, where the car attracted orders from other Hollywood types such as George Clooney.

pects to expand its line. "Our next car will be less expensive and a little more practical, but it will carry forward the design philosophy of being quick and powerful and a joy to drive.

Tesla is working with low-volume specialist **Lotus Cars**, which provides a proven crash structure, windshield surround, and airbag system, giving the company a head start on complying with U.S. crash safety requirements. Unlike some small manufacturers, Tesla will seek no waivers to federal safety standards for its cars, Tarpenning said.

With help from Lotus, and also conversations with **Panoz** Auto Development on matters of building and selling low-volume sports cars, Tesla will be able to meet federal standards, but Tarpenning admits that the job was harder than expected. "A certain amount of naiveté is required to be an entrepreneur," he chuckled.

An issue unique to electrically powered cars is the safety of the high-voltage battery systems. Batteries must be treated with care while charging and discharging, as well as protected in the event of a crash. "We've gone through some learning exercises to learn what makes battery systems safe," said Tarpenning.

Those tests included deliberately setting fire to the battery pack. After three generations of development, Tesla has overcome all of the problems, he said.

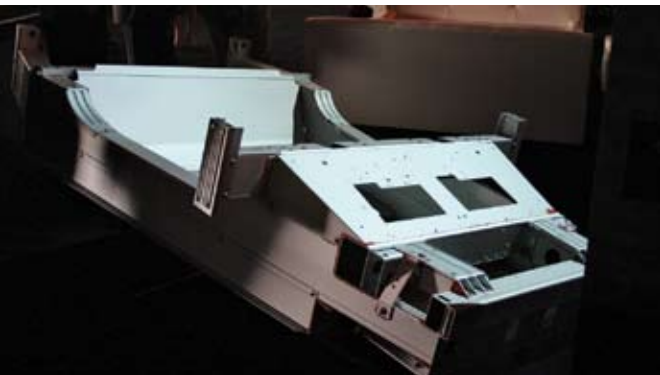
A big advance came with the decision to build the battery pack using many small cells rather than fewer, more powerful ones. "That leads to a much safer battery pack because in each individual battery the energy level is controllable."

That strategy brought its own problems, however. "Getting that many batteries to work together is not trivial," Tarpenning explained. Great care must be taken in charge balancing and watching the temperature of the 6831 cells, a job that has consumed about half the effort the company has put into developing the car, he said.

Those batteries are off-the-shelf 18650 lithium-ion cells whose technology has been advanced by their use in cell phones, laptop computers, and other portable electronics in recent years.

AC Propulsion, a company that both supplies electric powertrains and builds complete electric cars, estimates that a Li-ion battery pack installed in a converted compact car such as a **Honda Civic** has a mass of 500 lb (227 kg) less than a lead-acid battery pack, according to Vice President of Engineering Paul Carosa.

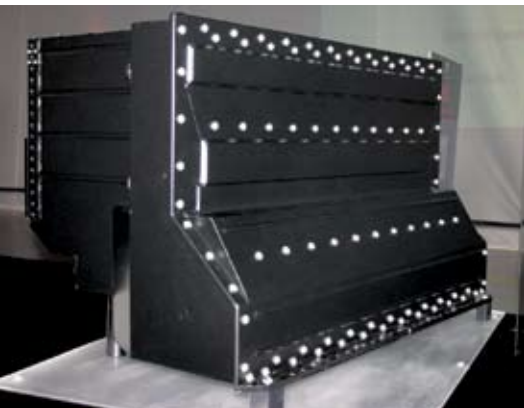
And the Li-ion batteries have the advantage over nickel-metal hydride batteries of using less scarce materials, so they have good long-term potential for cost reduction, said Tarpenning.



The Tesla Roadster's Lotus lineage is apparent in the design of the aluminum chassis, which is light and already proven in federal crash testing.



Tesla builds its own 185-kW electric motors using copper windings for maximum power density.



The lithium-ion battery pack is smaller and lighter than traditional batteries, and because it contains 6831 off-the-shelf cells rather than custom-designed batteries, the pack is less expensive than it would have been.

Li-ion batteries do use some cobalt, but battery makers are beginning to use manganese oxide to reduce the need for cobalt, Tarpenning explained. Within three to five years, the batteries will have eliminated cobalt, "so there won't be anything in them that is rare," relieving a cost and supply constraint.

The motor is the other challenging portion of an electric car's powertrain, and in contrast to the off-the-shelf approach to the batteries, Tesla has designed and is building its own motor that will provide maximum performance with minimal weight.

Tesla's motor is less than 100 lb (45 kg), said Tarpenning, while producing 185 kW and spinning 13,500 rpm. "Getting that kind of energy density requires some special manufacturing techniques," he said.

The motor uses copper rotor windings

rather than aluminum, which is more difficult to assemble, he said.

An unconventional aspect of Tesla's car is the use of a transmission. Because electric motors produce maximum torque at zero rpm, they do not need torque reduction to move the car from a stop, and because they can spin backward, no reverse gear is needed. But because Tesla wanted to maximize performance from a compact motor and battery, it will use a custom-made, electrically shifted two-speed transmission. This also provides the opportunity to include a parking pawl as seen in conventional automatic transmissions to ensure that the car does not roll when parked. "It is crucial that the car not move while charging," Tarpenning said.

Charging is another challenge for electric car builders. In addition to providing for 240-volt charging for regular recharges, which can be done in 5.5 h, Tesla also provides a 120-volt charger for emergencies to avoid stranding drivers.

Tesla has designed a charging plug that it says is simpler and more durable than those used by previous electric cars. Because the company believes that this charger plug is the best available design, and because of the desire to establish an industry standard that will help drivers avoid the frustration of charging stations with incompatible plugs, Tesla is offering the use of the plug design to any other electric car makers free of royalties, Tarpenning said. "What customers don't like is finding the wrong kind of connector."

Dan Carney

Plug-in hybrids lead NAIAS introductions

As the automotive industry continues to globalize, the stature of the word "international" in the **North American International Auto Show**—still widely known as the Detroit auto show—gains importance. But even with the array of strong offerings from around the world, the 2007 NAIAS at Cobo Hall this



GM's greater investment in upscale interior design and higher materials quality is manifest in the 2008 Chevrolet Malibu's two-tone cockpit (shown) as well as the interior of the 2008 Cadillac CTS.

month will be remembered as pivotal for the former U.S. Big Three automakers.

Of the 33 new vehicles entering North American production during 2007, 25 of them are collectively coming from **General Motors**, **Ford**, and **DaimlerChrysler**. A number of these vehicles, including the 2008 **Chevrolet Malibu** and **Cadillac CTS** as well as **Dodge** and **Chrysler Caravan** are expected to be unveiled at NAIAS this month.

"This year's launches are extremely important to those companies' future profitability," said Mike Jackson, Director of North American Market Forecasting at **CSM**

Worldwide. He said GM plans to launch 10 new vehicles within the year, representing more than 27% of its total volume. DCX's eight new launches will account for roughly 15% of its volume, and Ford's seven launches will represent 25% of its volume.

Also confirmed for the show are a future **Honda Accord** concept and the production crew cab version of **Toyota's** new Tundra pickup.

As this issue of *AEI* went to press in mid-December, the following vehicle introductions were confirmed:

GM will unveil a new electric concept vehicle called the Chevrolet Volt that is essentially a pure-electric vehicle using a 16 kW-h lithium-ion battery pack but supplemented by either a small internal-combustion engine (ICE) or fuel-cell stack to create additional electricity when battery charge diminishes. It can also be recharged from a 110-V stationary charging stand when the vehicle is not in use.

GM calls this new technology E-Flex and



ZF technology – the intelligent choice. Because with the new generation of 6HP automatic transmissions, it takes just 100 milliseconds to get you into the right gear.



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The new automatic 6-speed transmission by ZF is setting standards: No other automatic attains such dynamic power transmission. Since shift times have been cut by 50 percent, they now fall below the level of physical perception. And when it comes to fuel consumption – there's nothing more economical thanks to the new Twin TD Torque Converter.



For the first time at any auto show, Honda will unveil a concept version of an upcoming Accord, in this case a coupe.



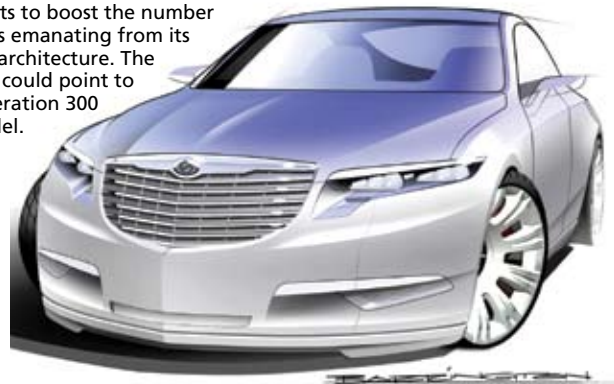
Stacked exhaust tips hint at the Yamaha-tuned 5.0-L V8 in Lexus' IS-F super sports sedan.



DCX also wants to boost the number of nameplates emanating from its LX rear-drive architecture. The Nassau sedan could point to the next-generation 300 or a new model.



DCX is looking for additional volume on its currently unique Wrangler platform. The Tomahawk wagon concept shows one potential spinoff.



considers it to be a "range extender," with some characteristics of a series-type hybrid. Vice Chairman Bob Lutz said in a background session last month that Volt's powertrain—136-kW battery pack, 53-kW generator, 120-kW drive motor, and 1.0-L three-cylinder gasoline engine—will allow it to travel up to 40 mi (64 km) on the battery charge alone, essentially eliminating fuel stops for most U.S. commuters who travel round-trip less than 40 mi to work. (By comparison, Toyota's Prius can travel less than 2 mi or 3.2 km on its nickel-metal hydride battery alone.)

Equipped with a 12-gal (45.4-L) fuel tank, the concept car has achieved a roughly 640-mi (1030-km) maximum range during computer simulations of its performance. If fitted with a small diesel—GM aims to offer a portfolio of engine types to suit fuel preferences in global markets—total range would be even greater.

"I've never been as excited about anything in my nearly 40-year career as I am about this program," said Lutz. "If you lived within 30 mi of work and charged your vehicle every night when you came home or during the day at work, you would get 150 mpg."

Added GM's Vice President of Global Program Management, Jon Lauckner: "This program is not a science project or a PR ploy. We're very serious about taking it to production, in high volume."

The Volt concept is based on GM's next-generation Delta small-car architecture, which Lauckner said has been package-protected for both ICE and fuel-cell-hybrid powertrains. (Next month's *AEI* will have a detailed report on this program.)

GM will also show a number of new pro-

duction vehicles at NAIAS. Its 2008 Cadillac CTS features a subtle exterior revamp, but its dramatically redesigned interior boasts far higher materials quality and fit/finish. Compared with the outgoing CTS, GM saves nearly \$200 per unit on the new interior, said Cadillac General Manager Jim Taylor.

The 2008 Malibu gets a larger, more muscular body-in-white to go with its new global Epsilon platform underpinnings and also benefits from GM's new focus on upscale interiors. The rich materials and precise fits of its two-tone cockpit are almost shocking for a midsize GM product.

DaimlerChrysler's Chrysler Group will showcase two concept vehicles, the **Jeep** Trailhawk and Chrysler Nassau. The Trailhawk is built on 2007 Wrangler ladder frame and suspension, but its body resembles the larger, more street-oriented Grand Cherokee and also hints at the smaller Compass crossover.

The Nassau sedan shares its LX rear-drive architecture with the Chrysler 300, Dodge Charger and Magnum, and the upcoming 2008 Dodge Challenger coupe. It may signal a new styling direction for Chrysler-brand vehicles. Sketches issued for publication in December and shown here were released to gauge public reaction to the concepts. Also shown will be the refreshed Caravan minivans, which are expected to feature retracting glass on the sliding doors.

Ford's vehicles slated for NAIAS were shown to company employees and retirees in early December as morale boosters as the company undergoes moves to stabilize its fi-

nances and lay the groundwork for future vehicles in development. Media were shown the same set of vehicles one week later but could not report on them prior to the show.

A new global B-car and a new, more car-oriented, non-SUV take on the Explorer will be shown at Detroit's Cobo Hall.

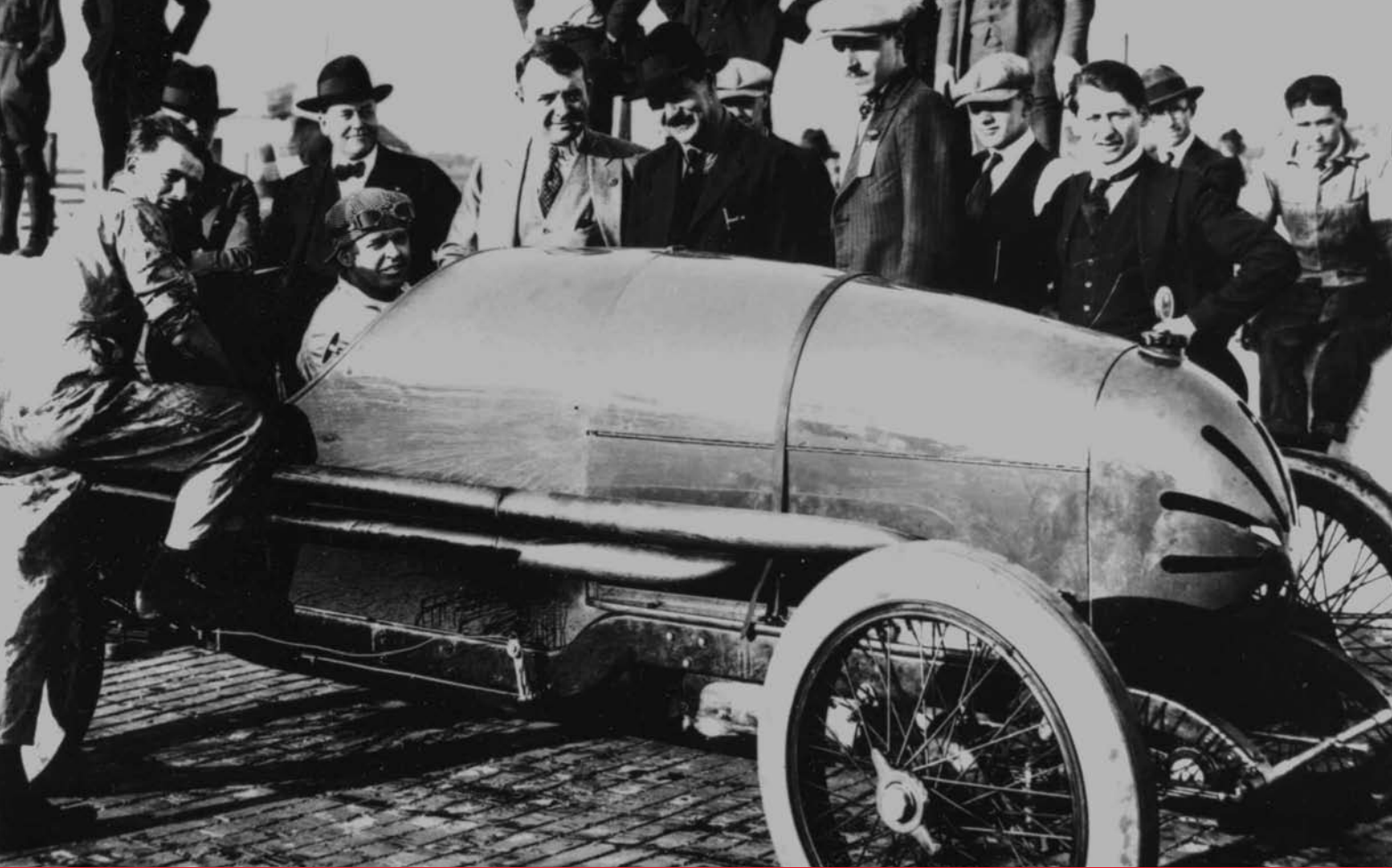
Nissan will roll out two crossover models, one officially slated for production and one still a concept. The 2008 Rogue is a compact, car-based crossover, smaller than the current Murano with base 2.5-L four-cylinder engine and front-wheel drive. It is due to enter production in the fall. The Bevel is a crossover concept that resembles a small panel truck.

Toyota will use the Detroit show to unveil its new "F" performance division, designed to give its Lexus brand the hardware and image to compete with **BMW's** M division, **Mercedes-Benz's** AMG, **AudiSport**, and Cadillac's V-series. Toyota officials said in December that the F model shown in Detroit will be an IS sedan boasting a **Yamaha**-tuned, 425-hp (317-kW) 5.0-L V8, plus other hardware including **Brembo** brakes.

Toyota will also show the CrewMax crew-cab versions of its new Texas-built Tundra pickups.

Additional pre-show intelligence confirmed the showing of the revamped **Porsche** Cayenne; **Mitsubishi's** new global Lancer; and the BMW 3 Series retractable-hardtop convertible (see December *AEI* page 38).

Lindsay Brooke



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