One souped-up EV

North Carolina-based Li-ion Motors draws upon the region's motorsports heritage to engineer and build what it calls the world's first all American-made electric supercar.

by **Ryan Gehm**

North Carolina is **NASCAR** country—and, apparently, high-performance electric vehicle (EV) country, too.

In Mooresville, NC, a mere 30-min drive north from Charlotte on I-77, **Li-ion Motors**' scant but spirited team of designers and engineers has channeled the region's racing roots to create an all-electric, two-seater supercar that can accelerate from 0 to 60 mph (0 to 97 km/h) in 3.4 s and boasts a top speed of 170 mph (274 km/h).

"Absolutely," declared a company executive, commenting on whether there is a deep pool of talent in the area from which to draw, "as far as getting talent in here, and also just having a creative pool with dialogue that's ongoing because you have a mixture of people who build cars that go 200 mph for 4 hours [straight] on a regular basis.

"Charlotte to Mooresville is the center for stock car racing in the country, in the world. And we have the best fabricators, the best body builders anywhere," he asserted.

About two and a half years ago, Li-ion Motors hired one of those talented fabricators—and, suitably, racecar drivers—to oversee development of the Inizio electric supercar, which at the time was already "fairly well on the concept table," Paul Daigrepont recalled.

"I've been pretty much in racing most of my life," Daigrepont shared. "I owned a little company down in Louisiana until [hurricane] Katrina hit, building racecars, mostly drag racing." In 1999, he raced an **NMCA** (National Muscle Car Association) Pro Street Car and finished number two in the world championship.

Later he built chassis and suspension components for a NASCAR team, before moving on to **Dale Earnhardt Inc.** (DEI) for a couple of years to run the chassis plate, building the so-called "Car of Tomorrow" chassis for drivers such as Dale Earnhardt Jr. and Paul Menard.

"Then I ran into these guys [at Li-ion Motors] and it was a whole different world. I kind of fell into this as a custom fabricator and have been moving up ever since. It's been a fun thing, and now

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Li-ion Motors' Inizio may evoke European flair, but the all-electric supercar was built from the ground up in Mooresville, NC.

driving this," Daigrepont said, nodding to the candy-red supercar with its doors and hoods pointing skyward.

"It's a 114-in wheelbase, 78-in wide footprint, which will tell you that inherently the car handles like a **Formula One**-type car. And the way our frames are built, you can see there's a lot of race inspiration in it," he continued. "If you open the back door of our facility, there's **Jack Roush Racing**, and right next door is **Team Red Bull**. There's a good bit of experience in that area, and a lot of suppliers for race-type parts, so that's beneficial to what we do, too."

The nuts and 'volts' of Inizio

The Inizio development project, from its onset, aimed to showcase the performance potential of EVs—to illustrate that they are "not necessarily little putt-putt-around golf carts," as Joe Berardi, Engineering Manager for Inizio, plainly put it.

The first prototype was unveiled at the **SEMA** Show in November 2010, followed by a tour of other major auto shows, including Los Angeles, Detroit, and D.C., to gauge consumer interest.

"We've held true to our concept of building a high-performance road car that has European flair. That's why when most people look at it they can't believe it was built ground-up here in North Carolina," Berardi said.

Many of Inizio's components and most of its systems are proprietary to Li-ion Motors, from the battery management system (BMS) and transmission to the suspension and body, including the molds—a remarkable feat, really, considering the size of the staff.

In all, Li-ion Motors employs 23 people, 19 of which are "techies"—engineers, designers, chemists, fabricators, and the such. They work not only on the Inizio but also its decidedly non-supercar, X Prize-winning sibling, the Wave II (see sidebar).

Power for Inizio is provided by Li-ion's patent-pending lithium-ion polymer batteries and management system, which generate more than 40 kW (an upgrade to 97 kW is available), and its **UQM** electric motor that delivers 175 kW in the R and RT models. For the RTX (Rally Touring Extreme), two 290-kW UQM motors are standard, offering output nearly equivalent to that of a NASCAR Cup Car, appropriately enough.

"The advantage of electric motors is that they can be run very comfortably at high rpm," Berardi explained. "Most electric vehicles run on a single-speed gearbox in order to run in the power band of the electric motor, so you end up sacrificing some pick up to get your top-end speed or vice versa. The Inizio compromises nothing in that area. We have a four-speed manual gearbox, and we're working on that to go to a paddle shifter, which is unprecedented in an electric vehicle."

While the battery chemistry was concocted in-house, according to Daigrepont, the batteries themselves are manufactured in South Korea by **Kokam**.

Another innovation Li-ion Motors has developed is a quick-change battery system.

> *"Big manufacturers have one engineer who focuses on just one little latch for a month at a time; I need my engineer to make that during lunch."*
>
> **–Paul Daigrepont, Project Manager for Inizio**

When the car is taken to a service center, the batteries can be removed from underneath the car and a new stack installed "in a matter of minutes," Daigrepont claims.

For the BMS, a dash-mounted LCD touchscreen monitor displays remaining power and notifies the driver of nearby charging stations when necessary. It also monitors and displays battery temperature, power consumption, drive time, and distance driven.

A regenerative braking system is employed as well.

The engineering team spent considerable effort upgrading the chassis design to improve safety and manufacturability of the vehicle. Suspension is, no surprise, racing-inspired: a fully independent Le Mans style setup. Standard brakes are four-piston caliper oversized four wheel disc; optional are six-piston caliper oversized brakes. Li-ion plans to offer carbon ceramic matrix brakes in the future.

The car features a full steel frame with some honeycomb composite structure within the floor pan and A-posts, and the door beams are carbon with a polypropylene hybrid material to absorb side impacts. A fiberglass body is standard; a carbon-fiber body upgrade is available for about $25,000.

To ease entry, rotational doors raise on a 90° angle and a custom hydraulic lift system raises the car 3 in (76 mm).

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As Daigrepont points out, "Weight is king in an electric car, like with any car, really." The R model tips the scales at 3100 lb (1406 kg). The RT and RTX, with their unique battery configurations, weigh more, accordingly (see table).

Inside the Inizio are full-power leather and suede **Recaro** seats with heating and cooling. A complete entertainment system includes a 5.0 digital surround sound system with 12-in subwoofer, GPS navigation, and video monitor with DVD, audio/video, and MP3 input.

Developing an electric supercar—with limited resources

Hundreds of engineers labored for years to create the **Chevrolet** Volt extended-range EV and to bring it to market in late 2010. Daigrepont's engineering team for the Inizio can be counted on two hands.

"Some of the big manufacturers have one engineer who focuses on just one little latch for a month at a time, where I need my engineer to make that during lunch," the project manager quipped, in earnest. "But that's what we have to work with.

"We can't afford to compete with 100 engineers in an engineering farm; it's just not doable. Hopefully through leases in technology and some investors, we'll get there."

Source: Li-ion Motors

Inizio's 'grocery-getter' sibling

As is often the case with siblings, the very green (both in color and performance) Wave II battery-electric vehicle couldn't be more different than the red-hot (again, in color and performance) Inizio supercar, especially in their outward appearance.

In September 2010, **Li-ion Motors** was awarded the Progressive Automotive X Prize—along with a $2.5 million check—for winning the Side-by-Side Alternative Class with its two-seat Wave II, which boasts a coefficient-of-drag figure (0.157) more akin to a motorcycle than an automobile.

"The primary focus for Wave II development has been just the opposite [than with Inizio]; this is more of a grocery-getter—[about 28 ft³ of] storage in the rear, extremely aerodynamic, and it gets 202 mpg equivalent" according to tests conducted by the **U.S. Department of Energy**'s **Argonne National Laboratory**, said Li-ion Motors' Paul Daigrepont.

The **X Prize Foundation**, an educational nonprofit prize organization, and **Progressive Insurance** awarded $10 million to three teams—**Edison2** of Lynchburg, VA, and **X-Tracer** of Winterthur, Switzerland, in addition to Li-ion Motors—out of a field of 111 competing teams, representing 136 vehicle entries from around the world.

The winners emerged from nearly 30 months of vehicle and business plan development, on-track testing at Michigan International Speedway, including dynamic safety testing by **Consumer Reports**, and laboratory verification at Argonne.

According to X Prize, the EV demonstrated "outstanding low mechanical and aerodynamic drag," resulting in 187 mpg equivalent in combined on-track and laboratory efficiency testing, a 0-to-60 mph (0-to-97 km/h) acceleration time of 14.7 s, and over 100 mi (161 km) range during a real-world driving cycle.

The car tops out at 90 mph (145 km/h).

The Inizio and Wave II, despite their obvious differences, do share some technology. "Obviously, [Inizio] has a much higher kW motor in it than the Wave II for obvious reasons, but the batteries and battery management system—battery monitoring and cell balancing, the electrical componentry—are basically the same in both cars," Daigrepont explained.

The basic vehicle structure is also the same—a full steel frame, honeycomb composite within the floor pan and A-posts, and door beams of a carbon/polypropylene hybrid material to absorb side impacts.

A 47-kW **Azure Dynamics** ac induction motor and single-speed gearbox are employed in the Wave II, while the Inizio sports a 175-kW permanent magnet motor (R and RT models) and Li-ion's proprietary four-speed gearbox.

"This was a concept car originally and we played with it as far as the aerodynamics; we wanted to see if it would even work," said Daigrepont. "It almost seemed as if X Prize built their competition for us. We tailored it for the race, put racing seats in it, things like that. But now that we've proven the technology, we're going back and refining it into more of a passenger car—more comfortable seats, restyle the dash for more creature comforts, and use the same aero advantage and the same basic styling."

For the X Prize competition, the Wave II weighed in at 2176 lb (987 kg). The production model is about 2300 lb (1043 kg).

The Wave II is expected to hit market at $39,900 retail—right around the cost of a new **Chevrolet** Volt extended-range EV. As with the Inizio supercar, production of this all-electric "grocery-getter" has been pushed back (from its original December 2011 goal) due to government certification testing and a lack of funding.

"We recently obtained funds to move through the certification process," a spokesman said. "We are a bit delayed but still on track."

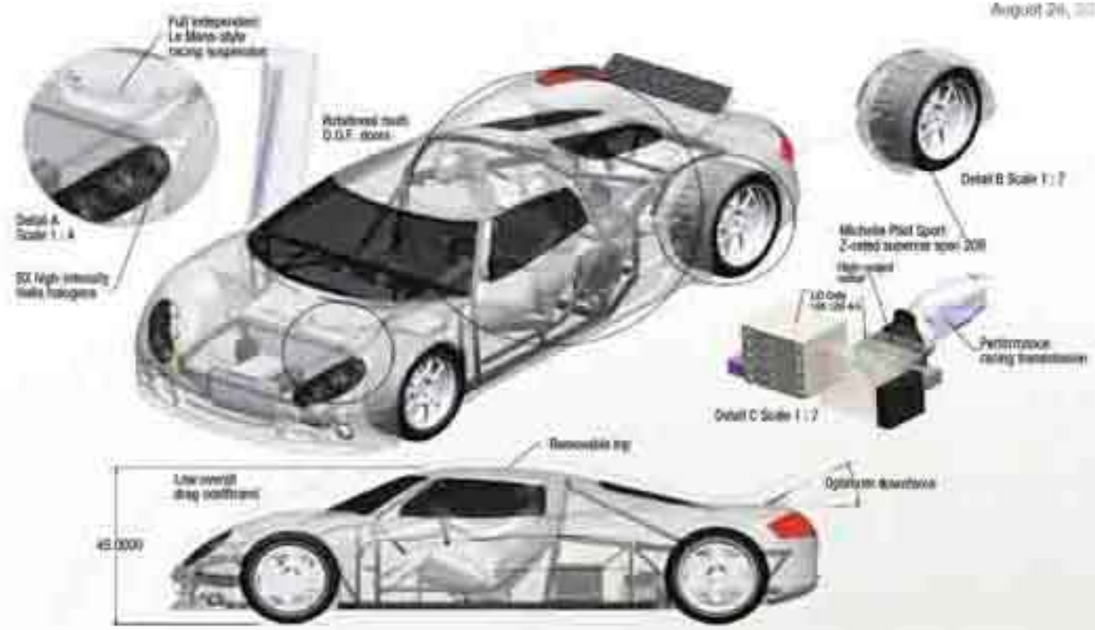
Ryan Gehm

Inizio by the Numbers

	R Model	RT Model	RTX Model
Motor	175-kW permanent magnet	175-kW permanent magnet	290-kW permanent magnet
No. of motors	1	1	2*
Battery	Li-ion polymer type	Li-ion polymer type	Li-ion polymer type
No. of batteries	12	12	24
Capacity, A-h	100	240	100
Peak energy, kW-h	40	97	80
Charge time, h**	8	10	10+
Charge time, h** with additional charger option	4	5	5+
Cycle life	Up to 2500 full charges	Up to 2500 full charges	Up to 2500 full charges
Estimated range, mi (km)	150 (241)	250 (402)	200 (322)
Top speed, mph (km/h)	130 (209)	132 (212)	170 (273)
Acceleration, 0-60 mph (0-97 km/h), s	5.9	7.1	3.4
Weight, lb (kg)	3100 (1406)	3600 (1633)	3900 (1769)
Length, in (mm)	175 (4445)	175 (4445)	175 (4445)
Height, in (mm)	46 (1168)	46 (1168)	46 (1168)
Width, in (mm)	78 (1981)	78 (1981)	78 (1981)
Ground clearance, in (mm)	4.5 (114)	4.5 (114)	4.5 (114)
Seating capacity	2	2	2

*RTX may be reconfigured with a single, much larger motor for production model

**Based on 220 V



Li-ion Motors has applied for—but has not received—federal funding to help with vehicle development and manufacture, according to a company spokesman. Thus far, private investors have backed the company's R&D activities. And the $2.5 million X Prize winnings offered a financial boost as well.

Testing for government certification has proven to be another considerable challenge. Initially slated for a mid-2011 launch, the Inizio is currently in the process of **U.S. Department of Transportation** certification—"a time-consuming effort" that has caused a delay in the timeline, the spokesman said. Li-ion Motors now expects to begin production by year-end.

Looking far into the future is not necessarily prudent for an automaker that has yet to sell its first car (though the company began accumulating orders for both of its vehicles this past January). A take-things-as-they-come approach has been adopted at Li-ion.

"Ten years down the road? Geez. I'm looking at 10 months down the road," Daigrepont admitted. "The whole industry is moving at a really fast pace. We honestly don't have a lot of projections for the future; we're just kind of reacting to the moment. We'd like to be a shareholder in the marketplace, obviously."

For now, the 11-year-old EV maker is singularly focused on bringing its two existing cars to market.

So, what does an electrified high-performance vehicle cost these days? Pricing starts at $139,000 for the base R model and extends to $249,000 for the top-of-the-line RTX model. Inizio will be available to markets outside of North America.

Production will be limited and based on demand. "Obviously, we're not capable of manufacturing a thousand cars and have them sit there," Daigrepont said. "We're planning to sell them from our facility—not that we're not looking to set up dealer networks. But we're that small company just trying to start and move forward."

Calling motorsports country home, Li-ion Motors is perfectly located to not just move forward—but fast.