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Tesla Motors' electric vision

Martes, 26 julio 2011

Dan McCue

When the word "transition" is used in the lead of a business news story, no doubt the expectation in the reader's mind is that the subject of the piece is somehow on the ropes, and more than likely, one management team is being replaced by another.



But that's not so when it comes to Tesla Motors Inc., the Silicon Valley-based firm currently best known as manufacturer of Tesla Roadster, a high end, all-electric sports-car blessed with the ability to go from zero to 60 miles per hour in just 3.7 seconds and a range greater than 200 miles on a single charge.

Since its debut in early 2008, more than 1,650 Roadsters have been sold in the US, Canada, Europe and Asia – a very respectable total for a boutique firm selling a cutting-edge vehicle with a price tag starting at \$109,000.

By the end of this year, the trail-blazing auto will be sold out in North America, with deliveries slated to continue through the end of the 2012 in Europe and Asia.

Taking its place on Tesla's product sheet is the Model S, a zero-emission premium sedan that will be built in a 5.5 million square-foot facility in Fremont, Calif., that was formerly owned as a joint venture by Toyota and General Motors.

Production of the Model S, which will retail in the US starting at \$49,900 after a federal tax credit and will cost slightly more elsewhere, will require Tesla Motors to dramatically increase its workforce while exponentially ramping up its production activities.

According to Tesla spokeswoman Camille Ricketts, the company will produce 5,000 of the new sedans in 2012 alone, and ultimately will expand production to about 20,000 vehicles a year.

"Our co-founder [and current CEO] Elon Musk is famous for saying that he's not going to stop until every car on the road is an electric vehicle," Ricketts.

"We've always had a vision that was broad and ambitious, and I think what's really happening here is that we're growing into that vision at this point," she continued. "Given the styling of the Roadster, which features a body custom built for us by the Lotus Group, and its price tag, it kind of targeted its own market.

"The Model S is going to be different," Ricketts said. "It's going to be for families and a more mid-market type of audience, and I think it is representative of the very, steady growth that we've experienced as a company."

"I don't think it's a matter of our culture really changing," she said to an inevitable early question. "I think since our founding in 2003 we've always been about being hard working and being ambitious. However, I think what you will see in the months ahead, is our inviting more and more talented people to come work with us, so that we can remain as fast and nimble as we possibly can."

Extraordinary gentlemen

When Tesla was founded by a group composed mostly of mechanical engineers in the early 2000s, the startup's audacious business plan could essentially be broken down into three chapters: First, they wanted to develop a high-performance sports car that dazzled the imagination and prove that electric vehicles were at least as viable – and frankly, a whole lot better – than hybrids like the Chevy Volt or Toyota Prius.

Second, they wanted to roll out a luxury sedan that could compete on an equal footing with such well-known brands as Mercedes and BMW.

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Lastly, they wanted to produce hundreds of thousands of electric vehicles at a price-point that would encourage the embrace of the masses.

"A lot of Tesla's early employees came from Stanford and came from this community, but they weren't a bunch of Silicon Valley software guys, if you know what I mean," Ricketts said. "At the same time, I don't think you could really describe them as automotive industry veterans.

"What they were, were guys who shared a powerful vision, who understood how batteries worked and, mechanically, how cars operated," she said.

What they were in fact was a kind of league of extraordinary gentlemen.

The South African-born Musk for instance, made his fortune as co-founder of Pay Pal -- the e-commerce web site that allows payments and money transfers through the internet -- and built his reputation as an engineer, entrepreneur and philanthropist through a myriad of endeavors that include not only Tesla Motors, but also SpaceX, a privately funded space transport company seeking to replace NASA's now-retired space shuttle, and SolarCity, a provider of solar energy system design, financing, installation and related services.

SolarCity, incidentally, also builds charging stations for electric vehicles.

Then there was JB Straubel, Tesla Motors' chief technical officer, who earlier had co-founded Volacom, a company that collaborated on a high altitude aircraft platform using a novel, hydrogen-powered electric power plant, and who had also developed a new hybrid vehicle drivetrain based on a micro turbine and a high-speed flywheel.

Named "2008 Innovator of the Year" by the Massachusetts Institute of Technology's Review of Young Innovators Under 35, Straubel told *Renewable Energy Magazine* that he was drawn to the team of like-minded collaborators at Tesla Motors by the chance to "really commercialize some of the advances in electric vehicle storage capabilities and batteries".

"For me, my involvement stemmed from a real love of the technology side of this," Straubel said. "I think at the time of Tesla's founding, the technology for electric vehicles had come a long way -- a lot farther than a lot of people thought -- and it was also much closer to being commercially-viable than many people believed.

"And that was another exciting thing about the beginning of Tesla... our sort of realizing these things as a company before any of the other companies in the world did. As a result, we were about to get a product to market -- the Roadster -- that was ahead of the conventional wisdom in many respects."

Barely able to suppress a smile, Straubel added, "That was great fun."

But why all-electric rather than trying to take what many would consider the easier route of developing a new hybrid?

"Well, I think the more deeply I got into hybrids myself, the more I thought of it as a great technology, but a transitional technology," Straubel said. "So much [of that technology] rides on an evolution from an internal combustion engine infrastructure. And I think fuel cells are probably in the same category.

"You know, hybrids are leveraging the whole fueling infrastructure and a lot of the same vehicle systems as a conventional vehicle today, and that makes a lot of sense as a transition," he said. "But most people don't argue that we'll all be driving a hybrid car 100 years from now.

"I think if you look into the more distant future and say, 'Well, where do you want to spend your time and where will you be doing the most relevant research and development,' it's obvious that the answer is in the realm of the pure electric vehicle."

Straubel continued by acknowledging that the road less taken is surely marked by many challenges, "but in the long, long term, most people and most car companies acknowledge that there's an evolutionary pathway that we are heading down".

"So that, in a long answer to your question, is why pure EVs instead of hybrids," he said. "We see EVs as a really interesting end point."

Tesla Motors other co-founders were Martin Eberhard -- a sports car enthusiast who had co-founded and founded startups Network Computing devices Inc. and NuvoMedia (manufacturer of the Rocket ebook), respectively -- Marc Tarpenning and Ian Wright, all of whom have since left the company.

Wright has since founded Wrightspeed and is endeavoring to create his own high performance vehicles to compete with Ferrari, Lamborghini and Porsche.

Early adversity gives way to success

Although all of the founders have their own versions of the Tesla Motors creation story, each of their accounts share at least two themes: That they all shared a concern about climate change and were disenchanted with the internal combustion engine, and that the early days of the company were difficult.

In an August 2009 speech at IBM's Almaden Institute in San Jose, California, Tarpenning described the first years of Tesla Motors as a constant cycle of developing the car, hitting a milestone, and then seeking fresh venture capital to support continued advances.



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The company's big breakthrough was designing a durable and powerful battery pack that is often likened to the lithium-ion cells used in conventional laptop computers.

Straubel said that characterization somewhat misses the mark.

"It's a similar chemistry to that pioneered and developed for the consumer electronic industry -- not just laptops -- but I think the comparison has been generalized quite a bit," Straubel said. "It's probably most appropriate to talk about them as small format cells that really leverage the investment that the portable electronics industry made in lithium ion as a technology.

"It was because of the demand for better portable consumer electronics that lithium-ion got so much traction in the early years; it certainly wasn't being researched initially for cars," he said. "Almost nobody was thinking about that then.

"Today, of course, it's actually shifted fairly substantially, to the point that most of the lithium-ion research that is going on now is actually for transportation versus portable electronics," he added.

But even with the spadework done by the consumer electronics industry, the initial leap to employing the technology in full-blown car wasn't easy. Lithium-ion batteries can explode when overheated. To prevent this from happening, Tesla Motors' engineers came up with an innovative cooling system that circulates water and anti-freeze in sealed tubes throughout the battery array.

"It was just a lot of good, hard engineering," Straubel remembered. "It wasn't like we were coming up with a massive new invention or a fundamental breakthrough; what we needed to do was a lot of solid engineering on how to take some existing technologies and advances that had happened in multiple different industries and put together a system and a product that works."

Straubel said to get where they needed to be, Tesla Motors' engineers looked at a lot of different concepts.

"We looked at air cooling. We looked at liquid cooling," he said. "Ultimately we settled on liquid cooling because we found it to be much more efficient and able to be done within a much tighter architecture. Once we settled on that, the next stage was going through a lot of different methods on how to build it most cost-effectively."

"A lot of work went into it, and there's a lot of work that's still ongoing on reducing the cost of the manufacturing and how to produce this in volume," he said.

Tesla Motors' moment of reckoning came in its sixth year as a company, at almost the same moment the world was reaching the depths of the global financial crisis. In his comments before a crowd of IBM engineers, Tarpenning described a transmission failure that occurred during durability testing at that time in dark terms, explaining that the failure basically chilled needed investment.

Other accounts of the period describe Musk traveling to a far-flung supplier's facility only to discover workers there didn't have the tools they needed to fashion the Roadster's very precise components.

But engineering and supply chain issues weren't the only bumps in the road when it came to producing the first viable electric car of the modern era.

According to a September 2010 profile of Tesla Motors in *Wired* magazine, an internal audit performed by the company just weeks before the Roadster went into production found that the cost of building the vehicle had risen from an anticipated \$65,000 to \$140,000 -- making it a money loser before even one had been delivered.

The situation was born in part from another challenge the company faced: The fact that Tesla didn't own its own manufacturing facility. Many of the manufacturing processes were outsourced, and the cars were initially assembled, one by one, in a garage behind the Tesla Motors showroom in Menlo Park, California.

Determined to keep the company alive and a complete believer in the technology, Musk struck important deals to sell electric powertrain components, including lithium-ion battery packs, to Daimler and Toyota.

To seal his sales pitch to Daimler, Musk turned to Straubel to take one of the German manufacturer's Smart cars, and convert it to an electric vehicle using the Roadster's technology.

As Musk saw it, pulling off the conversion would validate Tesla Motor's technology in the eyes of the world. The only problem was Smart cars weren't sold in the US at the time. To get started, Straubel and his engineers had to tap the company's tight resources and travel to Mexico to buy one.

Once back in California, he and the team removed the Smart car's 83-horsepower gas engine, and replaced it with a customized Roadster battery pack.

According to *Wired* magazine's account of what happened next -- an account that has since morphed into company lore -- an exhausted Straubel climbed behind the wheel after five-and-a-half weeks of work, and, stepping down on the accelerator, rocketed out of the garage and into the parking lot.

Emboldened, Straubel proceeded to floor the accelerator, an act that caused the front wheels to lift off the ground and the back wheels to leave tire marks on the asphalt.

"Straubel called Musk and told him the car was ready for the Germans," *Wired*

's Joshua Davis wrote.

Within days, a skeptical Herbert Kohler, Daimler's head of advanced engineering, would visit California for a meeting with Musk. It wasn't going well. Then, Musk played his trump card, inviting Kohler to drive the newly electric Smart Car.

The two companies have been in business ever since. In fact, Tesla Motors now supplies electric powertrains for two Daimler vehicles, the Smart car and the Mercedes A class. Both are available in Europe.

Tesla Motors is also currently working on the powertrain for Toyota's new electric Rav4 SUV, which is set to debut in 2012.

"You couldn't ask for better partners," Ricketts said. "They are two of the biggest, most efficient and most respected car makers in the world."

From that point forward, Tesla Motors, and its Roadster, were on a major roll.

In January 2010, Tesla Motors and battery cell maker Panasonic announced they would jointly develop nickel-based lithium-ion battery cells for electric vehicles.

Then, after years of pursuing venture funding, the company went public in June 2010 bringing in \$238 million and, in the process, becoming the first American car company to complete an initial public offering since Ford Motor Company in 1956.

Only a month earlier, Musk had closed the deal for the Fremont car factory, which had been known as the Nummi facility during its joint venture days. It opened its doors as the Tesla Factory on 27 October 2010.

A diverse customer base

If sales figures are any marker, Germans, with their penchant for speed, love the Roadster; so too do drivers in Italy, where sports cars are a cultural value. Sales have also been good in Belgium, Luxembourg and the Netherlands, where petro prices are high and the people are well-known for the environmental consciousness.

But, and perhaps not surprisingly, most of the Roadster's sales have occurred on Tesla Motor's home turf in North America, where its big markets are the San Francisco Bay area, Los Angeles, the Pacific Northwest and the Northeastern US.

"Our customers are a really diverse group," Ricketts said. "A lot of people assume that they are just a bunch of eco-conscious millionaires, but by and large, that's not who our customer base is right now."

"We have people who buy the car because they are sports car enthusiasts; Collectors who see the Roadster and can't not have it," she continued. "And then there are the people who are very environmentally conscious. A lot of people here in the Bay area, for instance, or in Seattle, are very green-minded, and the Roadster is of value to them on that level."

"But we've also got people who are really passionate about energy independence and getting America off fossil fuels, and then there are the tech buffs, who are really 'gadgety,' and who see the car as the next wave in a series of technologies that are going to change the way people behave and want to be part of that revolution."

Helping to stoke that diverse fan base is the nature of the battery pack itself, which is essentially a climate-controlled box that guarantees performance whether the Roadster is being driven in the California desert or deep in the pine forests of Northern Europe.

"It boils down to the fact that the cells are liquid cooled," Ricketts said. "That allows us to control the environment around the fuel cells very precisely, regardless of the conditions of the car's external surroundings."

A much-anticipated new model

Tesla Motors unveiled its Model S sedan design on 26 March 2009, and has since booked more than 2,000 orders for the vehicle the company is positioning as an alternative to the BMW 5 Series, the Audi A6, and the Mercedes-Benz E-Class.

Despite the success the company has enjoyed with the Roadster, Straubel said anticipation of the Model S has "forced a lot of rethinking about how we assemble the car and how we build everything".

Behind the scenes, he explained, the company is adding robots, automation and work cells to its new manufacturing facility in Fremont. It is also working out new types of "production processing" to build the battery packs and other parts faster and with greater efficiencies than they have in the past.

"The Roadster was very much a hand-built vehicle that was always anticipated to be in low volume production, and those factors drove the cost of that vehicle," Straubel said. "Our goals for the Model S are quite different and require us to scale up our volume of production dramatically."

"In order to achieve the dramatic cost reductions we're targeting, and to do so while producing ten to 20 times the number of vehicles we're building per year, we've had to reinvent the entire manufacturing line," he said.

Straubel said while the battery that will be used in the Model S has an energy density that's about 40 percent higher than

the fuel cells used in the Roadster, the biggest change will be to its architecture, which is actually being built in the floor boards of the new vehicle.

"It's going to be integrated with the chassis in a very efficient, structural way," he explained. "The layout is completely different from the one we employed with the Roadster, and if you saw them side by side, they actually look like completely different batteries."

Asked why the new approach was taken, Straubel said it all came down to vehicle-level optimization.

"With Model S we designed the entire vehicle from the ground up as an EV, so we were able to look at where to locate the battery pack to better optimize the handling and usable space of the vehicle," he said.

"By comparison, with the Roadster, I think we had less of an ability to change around the whole car," Straubel continued. "We kind of came into it replicating the volume and space of where an internal combustion engine and a fuel tank might have been."

Unlike those who argue that electric cars won't really catch on until there's a revolution in battery technology, Straubel believes such a revolution is unnecessary.

"The batteries that are available today are better than most people understand, both in terms of cost and overall energy density," he explained. "We can build cars today with 200 to 300 miles of range on a single charge, and that's really not too different from the range of internal combustion cars on a single tank of gas. So from a range and performance point of view, I'd say we are already where we need to be.

"Now, from a cost perspective, I think there's a lot more room to improve, but that said, at the moment, batteries are not even the biggest cost driver, at least, in terms of the vehicles we are creating," he said. "They are actually more cost-effective than most people realize."

"Frankly, I think new technology always takes it on the chin when it comes time for placing blame for high costs, but what I say to people is, "Then why is the Ferrari so expensive," Straubel laughed. "The technology isn't in there, yet it costs as much as the Roadster.

"The issue is no one is producing electric vehicles at the high volume at which internal combustion cars are being produced, and it's the low volume nature of the thing that is still driving the price," he said.

Straubel said he sees battery technology continuing to improve, but on an incremental basis, the rate of improvement scaling up as the market for electric vehicles improves.

"Right now, I think we are a little bit past a tipping point where you are going to soon see pretty massive amounts of EVs entering the market – even with today's battery technology" he said. "It just hasn't quite gained momentum yet and reached the point where we have lots of models on the market from different manufacturers."

Think different

What's holding them back? Some would suggest a critical factor is the improving, but still spotty allocation of electric vehicle charging stations, particularly in a large country like the US. Straubel is not in that camp.

"Personally I don't think charging stations are an obstacle," he said. "It gets talked about a whole lot, but as an EV driver myself I can tell you that once you've lived with one of these vehicles for a while, charging stations are not something you really think about or focus on.

"And we've seen this with a lot of data that we've collected from Roadster drivers," Straubel added.

"The reality is, people typically charge at home and at work, and that ends up being 95-plus percent of all the charging stops," he continued. "Where I think infrastructure becomes more relevant is when you want to take a car on a road trip, or when you want to leave the city you live in and travel to a neighboring city or across the state or to another state entirely – going outside the vehicle's range.

"To address that, Tesla today is focusing more in intra-city travel, and helping to install rapid charging stations along major transportation corridors," he said.

Ricketts said that as the public becomes more accustomed to electric cars, their changing mind-set will be just as critical to the technologies success as any improvement in range.

"People think that they need to drive electric cars differently, but we are out to prove that you don't need to," she said. "Today, it is completely feasible to take a road trip.

"For instance, we just had a bunch of customers drive the entire perimeter of Hong Kong on a single charge, and we ourselves have taken the Roadster from Los Angeles to Detroit, Michigan, charging it along the way at public charging stations," Ricketts said.

"So it's really just a matter of educating the public at this point and proving, again and again, that you can rely on electric cars to get you anywhere a car with an internal combustion engine can get you," she said.

"The other interesting thing, and something people don't discuss enough, I think, is the relative cost of owning an electric car, which is so low that you really do wind up recouping your investment in the end," Ricketts continued.

"Not only do you avoid all oil changes, all smog checks, and all stops at the gas station, but charging the Roadster right now, from an absolutely empty battery, which you hardly ever have, costs you \$8 and takes you 245 miles," she said. "Compare that to a \$50 tank of gas these days and the savings are pretty clear at that end.

"The other thing is the simplicity of Roadster – its powertrain is really just the battery, the motor and the power-electronics module, which is sort of the thinking brain of the car, and it is such a simple configuration that there is not a whole lot that breaks on these things.

"Most of our customers only ever get serviced when they are in for yearly inspections or if they need a firmware upgrade, so the amount of money you save by not having an internal combustion engine sort of whirling around and getting extremely hot in your vehicle is really significant in the end," she said.

Among the subjects that is now intriguing Straubel is the concept of solar charging for electric vehicles.

"I think ultimately, we are going to end up in a place where almost everyone is driving electric vehicles power by solar energy," he said. "How does Tesla play into that? Well, typically, the customers who are early adopters of EVs are also fairly well educated about their energy usage and their carbon foot print and a lot of other, kind of -- I don't know if you'd call them "advanced topics" -- but they are a little more sophisticated energy topics than those on the minds of the typical Wal-Mart shopper.

"We see people who are very interested in putting solar PV on their homes or on their garage when they buy a Roadster or when they buy a Model S, so we help to facilitate that and make sure that it is a seamless interaction or integration between the vehicle and the house," he said.

"It's a little different energy profile when you add the charging of an electric vehicle to your average energy usage, and you need to know how to size the PV system to match the profile of both the energy use in the home and the car," Straubel continued.

"And there are some neat things you can do when it comes to solar charging," he added. "For instance, we have built in the car the ability to time when it charges. While you might think you'd want to charge you car during the day, it's actually better to export you excess daytime solar energy back to the grid, and then pull clean and cheap energy back from the grid at night.

"You wind up with a better cost advantage, a better CO2 advantage, all of the above," he said.

A new generation of stores

As it prepares to ramp up its production capabilities for the Model S, Tesla Motors is also preparing to roll out a new generation of stores in which to sell them.

The company's retail model is completely different from franchise model that dominates the traditional automotive industry. In Fact, at Tesla Motors, they don't even call them dealerships. Think of them as more like an Apple store than a dealership with rows of available cars, balloons and garish signage.

"Our stores are completely vertically integrated into the Tesla organization, and they only employ Tesla employees," Ricketts said. "We believe it's very important for us to have our own product specialists on the floor, engaging with customers every day."

Currently Tesla has 18 stores around the world. In April, it launched a new retail strategy in San Jose, Calif. That strategy entails located Tesla Motors stores at malls and other high traffic areas where even people who are not currently shopping for a car will be exposed to the technology.

"It's a plan to get the technology in front of as many eyeballs as possible," Ricketts said. "We want people to have every opportunity to come in and learn why EVs are advantageous and catching on, and why they are the wave of the future. We'll be opening new stores this fall to accelerate that strategy."

No matter how many new employees Tesla Motors hires or how many stores it opens, both Straubel and Ricketts said they expect the company to remain somewhat outside the corporate mainstream of the automotive industry.

Asked to describe Tesla Motors' internal culture, the first word Straubel came up with was "entrepreneurial"; the second was "scrappy."

"It's definitely a place that's very fast moving," he said. "It's a company with quick decision processes. We're not worrying about the perfect way to do something, but rather, the best way to do something quickly. And we're also looking for innovative solutions to problems, rather than simply doing things the way others in the industry have always done them."

When it was suggested that it almost sounded like Tesla Motors is an auto company with a tech-company personality, Straubel said that was a decent description.

"We've kind of blended the culture by bringing in some automotive talent and also hiring people who have worked for tech companies in the past or, frankly, are right out of school," he said.

"We work hard to hire the best and the brightest people, people who are very flexible and super passionate about the problems they are solving, whether it revolves around an environmental challenge, how to build a better EV, or how to couple it with other forms of renewable energy, you name it," Straubel continued.

"So what you see inside Tesla Motors is a lot of very young engineers who are just starting their careers and are super excited about what they are doing, and then there are the people we've attracted from the traditional car companies who are a different breed unto themselves," he said.

"They are the kind of people who like to shake things up a little bit, the people wanted to implement change, fight the inertia of the establishment and who were kind of bursting at the seams at their previous organizations.

"We like people who think of the automotive establishment as too slow and too conservative, and there are a lot of those people here, for sure," Straubel said. "Tesla takes on that culture in a big way, and as a result, we wind up with a lot of those folks here – people who are trying to effect change internally, inside the company, and for the entire industry and in terms of technology.

"Those are the type of people who usually fit in best here," he said.

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Slee1150@live.com Why can't auto makers install mini wind turbines to produce energy while the car is in motion. To supplement the battery charge from conventional means. Implement conventional solar means with wind power in order to supplement the charge of a direct plug in power vehicle? Free energy!

Brian The former NUMMI facility is 5.5 million square feet, not 350,000sqft.

Charles Great article and research. Thank you

Ross Do your research; Elon Musk is not a Tesla Co-Founder; He came along later.

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