

# Hell for Elon Musk Is a Midsize Sedan

The Model 3 production line. PHOTOGRAPHER: BALAZS GARDI FOR BLOOMBERG BUSINESSWEEK

Will the Model 3 make Tesla a real car company?

By Tom Randall , Josh Eidelson , Dana Hull , and John Lippert rom

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On July 1, Elon Musk went home to sleep. The chief executive of Tesla Inc. had been camping out at his electric car factory in Fremont, Calif., for much of the past week. He'd been sleeping on a couch, or under a desk, as part of a companywide push to get out of what he calls "production hell" by manufacturing at least 5,000 of Tesla's new Model 3 sedans in a week. "I was wearing the same clothes for five days," Musk says in an interview with Bloomberg Businessweek. "My credibility, the credibility of the whole team," was at stake.

Musk initially promised as many as 200,000 Model 3s by the end of 2017. To get there he planned an unprecedented investment in factory robots, calling the production line "the machine that builds the machine." He'd said it would look like "alien dreadnought"—a manufacturing process so futuristic, unstoppable, and cost-effective that it would seem extraterrestrial.

It hasn't worked out that way. Tesla ended 2017 having made not quite

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2,700 Model 3s. As of the end of June it had turned out about 41,000, and some analysts express doubts about whether it will ever be able to show a profit on the car, and Tesla hasn't even started selling the \$35,000 base model.

Making matters worse, Tesla has \$10 billion in debt and suffered a credit downgrade in March. It's spent about a billion dollars more per quarter, on

average, than it has taken in over the past year, and the cost of a recently announced factory in China is still unknown. Tesla is running out of cash at a time when competition is heating up—Volkswagen, BMW, Daimler, and others plan to release dozens of electric car models.

In early June, at Tesla's annual meeting, Musk tried to project calm, but at times seemed close to tears. "This is like—I tell you—the most excruciatingly hellish several months that I have ever had," he said, before noting that Tesla's assembly lines were being further upgraded, making the company "very likely" to hit the weekly goal of 5,000. He also revealed he'd asked employees to build a third general assembly line that would be "dramatically better than Lines 1 and 2." That sounded even more alien-dreadnoughty.

A week later, Musk posted a picture of the new facility on Twitter. There were no fancy robotic systems, nor fixed walls, even—just a large tent outside the factory built from scrap from the other lines. The automotive world winced. "Insanity," said Max Warburton, an analyst with Sanford C. Bernstein & Co., in an email to Bloomberg News. "I don't think anyone's seen anything like this outside of the military trying to service vehicles in a war zone."

The tent sufficed. "I think we just became a real car company," Musk wrote in a July 1 email to employees announcing that Tesla had made 5,031 Model 3s the previous week. Even so, it's unclear whether Musk has put Tesla on a path to lasting greatness or just staved off collapse. The company is the most shorted U.S. stock, and a higher percentage of Wall Street analysts give TSLA a sell rating than for all but one stock on the S&P 500. The story of Tesla's sprint to release the Model 3, based on interviews with 20 members of Tesla's design and engineering teams, suppliers, and dozens of current and former workers, is a case study in brilliant design and unbelievable hubris.

The prize for Musk is enormous: If he gets the Model 3 right, he will remake a trillion-dollar industry and do more to reduce carbon emissions than any person on the planet. But it may turn out that mass-producing cars is the one challenge that simply defies him.

In early 2015, Musk convened a meeting of his top engineers in a windowless conference room at the factory. There were 12 people, including experts in batteries, design, chassis, interiors, body, drive systems, safety, and thermodynamics. Musk had gathered them to figure out what the Model 3 would be.

Over the course of the meeting, the engineers filled a whiteboard with dozens of requirements, including a range of at least 200 miles and an affordable price. The last of these criteria made the project especially daunting. Even scarier, Tesla would begin selling it in mid-2017, giving the company 2 ½ years to design, test, and build a new vehicle, compared with about five years at a traditional automaker.

Creating a low-cost electric car is about maximizing range in every possible way. For instance, Tesla's designers added plastic covers, costing \$1.50 each, to hide four pads on the underside of the car where a jack goes. The decision reduced wind resistance and improved the car's range by 3 miles. They also opted for four-piston monoblock caliper brakes, which are usually reserved for more expensive cars. But since the brakes are lightweight, they lower the car's battery requirements and overall cost. "Every single decision like that was put back into the context of an electric car," says Doug Field, a former Apple vice president Musk recruited as a top engineer in 2013. In other words, electric cars require new ways of thinking about cost and performance.

Musk decreed that the Model 3 would have a single central screen for all controls and information, which would both cut costs and allow Tesla to push the front seats forward to allow for more rear legroom. Tesla's design chief, Franz von Holzhausen, spent the 2015 Christmas holiday figuring out how to design a car interior without a traditional dashboard.

Musk declared he didn't want visible air vents. "I don't want to see any holes," von Holzhausen recalls him saying. Von Holzhausen paired engineer Joseph Mardall with designer Peter Blades to figure that one out. Blades's sketch called for a recessed gap across the entire width of the car from which the air would flow, with a long strip of wood instead of the dash. Mardall pointed out that to make the approach work, the entire ventilation system would need to be redesigned. "Are we serious about this?" he recalls asking.

Musk was serious, but a second problem soon appeared: The wooden strip, just below the air gap, worked like an airplane wing, sucking cold air down and shooting it into the driver's lap. Mardall, an aerodynamics specialist, proposed adding a second, hidden gap from which air would shoot straight up, lifting the main blast of cold air above the piece of wood and away from the driver's crotch. "It was one of those eureka moments," Blades recalls, still in awe of the elegance of the solution. "The spine still tingles."

The system Blades and Mardall designed combines all the components of a standard HVAC system into a single basketball-size glob of molded plastic

tucked under the hood, which Tesla calls the Superbottle. The glob is stamped with a logo of a bottle wearing a superhero cape.

Chassis marriage on the Model 3 assembly line. PHOTOGRAPHER: BALAZS GARDI FOR BLOOMBERG BUSINESSWEEK

Blades and  
Mardall relay all  
this with pride. “I  
had to negotiate  
with my wife: I’m

going to do seven days a week for the next half-year,” Blades recalls. “And that’s not just me—everybody’s wives or partners—it’s just part of the story of Tesla. At this company if you don’t ask those silly questions and ask to do something crazy, then it’s not really the right place for you.”

If such loyalty seems extreme, it’s partly the result of Musk’s reputation for defying odds (and, some would say, common sense). He was mocked in 2002 when, as a 31-year-old software entrepreneur with no aerospace training, he founded SpaceX. It now launches more rockets a year than any other company.

Mass-producing a car isn’t rocket science; in some ways, it’s harder. Rockets can essentially be built and checked by hand; a perfect car must come off the production line every minute or so if you have any prayer of keeping pace with the world’s leading manufacturers. Cars are composed of tens of thousands of individual parts and have to withstand snow, potholes, and highway speeds, performing flawlessly for years. They are the largest purchase most people make besides a home, and they’re also heavily regulated lethal weapons that contribute to more than a million deaths each year.

At a typical plant run by Toyota Motor Corp., widely seen as the most capable carmaker, a new car requires about 30 hours of labor. Even with all the robots, Tesla spends more than three times that number of hours on each car, says Michelle Hill, a manufacturing expert at management consulting firm Oliver Wyman. And Toyota would never, as Musk has, try a new manufacturing system and all-new workforce on a never-before-built car. Successful carmaking is “the orchestration of so many things that have to play together in unison,” she says.

### **Market Cap Per Vehicle Produced**



Data: Compiled by Bloomberg

Musk's disregard for precedent, of course, is part of his appeal. In the weeks before the March 2016 public unveiling of the Model 3 design, employees took bets on how many prospective buyers would pay a refundable \$1,000 deposit to reserve one. The most optimistic prediction was around 200,000; the actual number was twice that. Field recalls opening his staff meeting the following week with a warning: "You are now working at a different company," he said. "Everything has changed."

According to one supplier, Tesla had said it expected to spend 28 months to reach large-scale mass production, but after seeing demand for the car, Tesla moved up the timeline by 15 months. It had previously said it would build 500,000 cars per year by 2020, a goal skeptics called outlandish. But in May 2016, Musk said the plan was to do that in 2018.

In an unconventional move, Musk restructured Tesla, assigning the engineers who designed the Model 3 to invent its manufacturing process. He put Field in charge of the factory and gave him the budget to automate as much of the car assembly as possible. Tesla bought two robotics companies, Grohmann Engineering in Germany and Perbix in Minnesota. Field's team invented dozens of industrial processes. One involved a tool called the golden wheel, an apparatus that automatically breaks in suspensions and aligns cars in one step without humans.

The "golden wheel." PHOTOGRAPHER: BALAZS GARDI FOR BLOOMBERG BUSINESSWEEK

Automakers generally rely on thousands of suppliers, from windshield wiper makers to electronics manufacturers. But Musk has long argued that the traditional supplier model led to cost overruns and mediocrity. Starting in 2015, he told employees he wanted to make even the thorniest parts of his supply chain in-house. In late 2015 he appointed a recently hired car interiors expert, Steve MacManus, to build a seat factory near the main plant in Fremont. Seat assembly is labor-intensive and is outsourced by every major

car company to the lowest-paid workers they can find. “Your job is to get us out of seat hell,” MacManus recalls Musk telling him during their first conversation after he’d started.

And so, in one area of MacManus’s Model 3 seat line, more than a dozen robots rapidly piece together the front seats, including tiny motors, hinges, heaters, and frames. Tesla claims this is the world’s first front seat assembly line in which no humans are involved at all. The plan is eventually to use Musk’s tunnel-digging venture, the Boring Co., to dig an underground passageway to bring seats to and from the main Fremont factory, about 2 miles away. They already have a spot in mind.

Musk keeps trying to bring other parts of Tesla’s supply chain in-house. In an [email to employees](#) this spring, he also announced he would fire all contractors and consultants unless a Tesla employee personally vouched for them. “We’re going to scrub the barnacles,” he said during the company’s earnings call in May. “It’s pretty crazy. We’ve got barnacles on barnacles. So there’s going to be a lot of barnacle removal.”

To critics, Musk’s description of [contractors](#) as parasitic crustaceans is revealing. He is maniacally committed to Tesla’s mission of saving the world from global warming, but at times Tesla has seemed to fall short of more prosaic obligations, such as making sure its workers are safe. On Nov. 18, 2016, eight months before Model 3 production began, a factory employee heard a scream coming from just outside the main building at the Fremont plant. He saw a colleague, quality-control lead Robert Limon, writhing on the blacktop and grabbing at his leg, which was “bleeding like crazy,” the worker says. The specifics of this incident haven’t been previously reported.

Limon’s co-workers gathered around him. Someone used a belt to tie a tourniquet around his leg. The witness, who declined to be named out of concern for adverse consequences from Tesla, says management offered counseling for people who had seen what happened—and the witness took the company up on it, because it was traumatic.

Limon later told this co-worker he’d been hit by a forklift driver who’d been doing doughnuts on the property for fun. Limon didn’t respond to requests for comment for this story, but according to people who saw and spoke to him in the following days, and as depicted in photos seen by Bloomberg Businessweek, the injured leg was amputated.

Tesla says that both Limon and the forklift driver were fooling around in an inappropriate way that isn’t representative of the automaker’s safety

culture. Afterward, Tesla says it fired the driver and held factorywide safety meetings on each shift. The company suggests Tesla's enemies disclosed the episode to damage its reputation. "Nothing is more important to us than the safety of our employees," a spokesperson says. "This is not to say that there aren't real issues that need to be dealt with at Tesla or that we've made no mistakes with any of the 40,000 people who work at our company." The spokesperson says Tesla's goal is to "have the safest factory in the world by far."

The state agency Cal/OSHA, which fined Tesla \$800 in connection with the injury, described it as an ankle fracture. But agency documents show it did not interview Limon. Tesla says it tried repeatedly to arrange an interview. A few months later, Justine White, a Tesla safety official, sent a resignation letter to Musk that was recently reported by the Center for Investigative Reporting. White said she had made "repeated safety recommendations" about "informing employees of forklift hazards in a timely manner after an employee's lower leg was amputated when run-over." Tesla disputed White's claims.

Dozens of current and former Fremont workers, many of whom requested anonymity, say there's a larger pattern in which a company hellbent on making lots of cars tolerates unsafe conditions. A 2017 analysis by Worksafe Inc., a nonprofit, said that serious injuries at Tesla's plant in 2015 and 2016 were well above industry averages. Tesla, which is a nonunion company that has been targeted by the United Auto Workers, points out that Worksafe has ties to labor. It says injury rates in 2017 fell 25 percent and were about the same as the industry average. In June, Musk said Tesla's 2018 injury rates so far were 6 percent below the average, even as Model 3 production increased.

Tesla's safety records were questioned again earlier this year when the Center for Investigative Reporting reported that Tesla had misclassified work-related injuries as personal medical issues, which made the plant seem safer than it is. Tesla argued that the report was "an ideologically motivated attack by an extremist organization," but it retroactively added 13 injuries from 2017 to its safety logs, according to a subsequent article. Tesla says it routinely updates safety logs to ensure accuracy.

"An important error that Tesla has made is simply ignoring the extensive experience of the last 50 years in the auto industry," says Harley Shaiken, a

University of California at Berkeley professor who chaired a state commission that warned against the 2010 closure of the Fremont plant, which previously had been operated by Toyota and General Motors Co. as a joint venture. Tesla sought, Shaiken continues, “to start from scratch in a way that has resulted in meltdowns and near-meltdowns.”

Tesla says automation on the Model 3 line is making the factory safer. But when robots break down, employees have to pick up the slack. For instance, an enormously complex robotic conveyance system for bringing parts to the line had to be removed, and teams of human workers wound up doing the work. (Parts of the conveyance system, which had included 500 machines to lift parts, were used to build the new manual production line under the tent.)

Today, Tesla has about 10,000 workers at its Fremont plant. GM and Toyota had less than half that and produced more than 400,000 cars at the plant’s peak in 2006. Tesla argues that a larger workforce is justified given that more of the car is manufactured in-house, but interviews with workers suggest the company has stretched to ensure that there are enough workers on the floor. Current and former employees describe 12-hour shifts as common, with some going as long as 16 hours.

To battle exhaustion, employees drink copious amounts of Red Bull, sometimes provided free by Tesla. New employees develop what’s known as the “Tesla stare.” “They come in vibrant, energized,” says Mikey Catura, a Tesla production associate. “And then a couple weeks go by, and you’ll see them walking out of the building just staring out into space like zombies.”

Four current employees say the pressure they felt to avoid delays forced them to walk through raw sewage when it spilled onto the floor. Dennis Duran, who works in the paint shop, says that one time when workers balked, he and his peers were told, “Just walk through it. We have to keep the line going.” Tesla says it’s not aware of managers telling employees to walk through sewage and that plumbing issues have been handled promptly.

Musk and many Tesla employees dispute that workers are unhappy or unsafe. “There’s always going to be challenges from a safety standpoint and from a production standpoint—that’s all manufacturing,” says Dexter Siga, who started as a technician in 2011 and is now a manager. He adds that Tesla has “had our fair share of challenges” as a young and rapidly growing company, but it treats safety as “an overriding priority.”

For his part, Musk says Tesla demands hard work, but that’s because it’s the only way to survive as a U.S. car manufacturer. “I feel like I have a great debt to the people of Tesla,” he says, his voice cracking with emotion. “The reason I slept on the floor was not because I couldn’t go across the road and



be at a hotel. It was because I wanted my circumstances to be worse than anyone else at the company. Whenever they felt pain, I wanted mine to be worse.

“You know,” he continues, “at GM they’ve got a special elevator for executives so they don’t have to mingle with anyone else.” (“Typical Elon, deflecting from the real issue, which is the ability to mass-produce at scale and with quality,” says GM spokesman Ray Wert.) “My desk is the smallest in the factory, and I am barely there,” he says. “The reason people in the paint shop were working their asses off was because I was with them. I’m not in some ivory tower.”

Quality inspector Eli Johnson works on the body assembly line. PHOTOGRAPHER: BALAZS GARDI FOR BLOOMBERG BUSINESSWEEK

In July 2017, Musk delivered the first Model 3 sedans at a raucous party in Fremont. The car was celebrated by reviewers (“[Driving Tesla’s Model 3 Changes Everything](#)” was Bloomberg’s take), but it was almost immediately apparent that Tesla could never deliver it in the numbers Musk promised.

The first problem involved the batteries. Tesla and Panasonic Corp., which jointly operate a battery factory in Nevada, had designed cells that were slightly larger than the standard 18650 cells used in previous Teslas. The new batteries were better, but the automated manufacturing line for packing thousands of them together didn’t work, and the task had to be done by hand for a time. A new system, made by Grohmann, was eventually built and flown in.

In November, Musk told analysts he was “really depressed” but doing his best to fix the battery-packing issue. Other problems emerged, and Tesla had to shut down the Fremont plant for five days in February. In retrospect, Musk says, trying to automate so much of Tesla’s factory at once was overly ambitious. “We thought it would be good, but it was not good,” he says. “We were huge idiots and didn’t know what we were doing.”

This April, Musk took over manufacturing engineering personally. “I’m back to sleeping at factory,” he tweeted. “Car biz is hell.” Field, who’d been in charge of the factory, took a leave of absence the following month; he later left the company. In mid-June, Tesla announced it was laying off 9 percent of its workforce, more than 3,000 people.

A Model 3, fresh off the line. PHOTOGRAPHER: BALAZS GARDI FOR BLOOMBERG BUSINESSWEEK

Musk turned 47 in late June, during the final sprint to make 5,000 cars a week. “First bday I’ve spent in the factory,” he tweeted, “but it’s somehow the best.” On the Friday before the deadline, Musk seemed giddy with excitement about what he expected would be a spike in Tesla’s stock price. He tweeted a music video of the 1958 single Short Shorts, by the Royal Teens. On Sunday he announced that Tesla had hit the milestone and proclaimed his love for his employees. Tesla’s stock price gained 5 percent on Monday morning.

The exuberance was gone by lunchtime, and Tesla’s stock finished the day down 2 percent. It lost 7 percent on Tuesday. The “short burn of the century” that Musk had predicted had failed to come to pass, as skeptics pointed out that Tesla’s wild sprint would be unsustainable.

Musk projected confidence during an interview with Businessweek on July 8. “The past year has been very difficult, but I feel like the coming year is going to be really quite good,” he said. He still had “one foot in hell.” He said manufacturing hell will be over in a month.

At present,  
the Model 3 is  
selling more

units in the U.S. than any comparably priced midsize sedan, including those offered by Mercedes-Benz, BMW, and Audi. It’s fast and fun to drive. When you stomp the accelerator, the Model 3 stomps back, and Tesla’s designers tried to replicate the feeling of instantaneous acceleration in every aspect of the driving experience. “Point and shoot,” says Lars Moravy, Tesla’s director of chassis dynamics. “There’s no overshoot, and there’s no delay. That’s the essence of the electric motor and our name.”

Of course, quick acceleration isn’t unique to the Model 3; it’s true of all electric cars. But the fact that there even is a market for these vehicles is to a large extent Musk’s doing. He set out to teach the world that consumers would pay for zero-emissions cars in huge numbers. Whatever happens to Tesla, he’s succeeded in that. Tesla is, as Musk says, “a real car company.” That’s glorious, and it’s also hell. —With Sohee Kim