

# Self-Driving Push Divided Tesla Ranks --- Some engineers warned on safety, resigned

[Dugan, Ianthe Jeanne](#); [Spector, Mike](#) [Author Information](#) . [Wall Street Journal](#), Eastern edition; New York, N.Y. [New York, N.Y.]25 Aug 2017: A.1.

PALO ALTO, Calif. -- Tesla Inc. Chief Executive Elon Musk jolted the automotive world last year when he announced the company's new vehicles would come with a hardware upgrade that would eventually allow them to drive themselves.

He also jolted his own engineering ranks.

Members of the company's Autopilot team hadn't yet designed a product they believed would safely and reliably control a car without human intervention, according to people familiar with the matter.

In a meeting after the October announcement, someone asked Autopilot director Sterling Anderson how Tesla could brand the product "Full Self-Driving," several employees recall. "This was Elon's decision," they said he responded. Two months later, Mr. Anderson resigned.

In the race to develop autonomous vehicles, few companies have moved faster than Tesla, an electric-car pioneer that this year surpassed General Motors Co. as the nation's most-valuable auto maker.

Behind the scenes, the Autopilot team has clashed over deadlines and design and marketing decisions, according to more than a dozen people who worked on the project and documents reviewed by The Wall Street Journal. In recent months, the team has lost at least 10 engineers and four top managers -- including Mr. Anderson's successor, who lasted less than six months before leaving in June.

Tesla said the vehicle hardware unveiled in October will enable "full self-driving in almost all circumstances, at what we believe will be a probability of safety at least twice as good as the average human driver." The self-driving feature is subject to software development and regulatory approval, and "it is not possible to know exactly when each element of the functionality described" will be available, Tesla noted.

A Tesla spokeswoman attributed the turnover in the Autopilot group -- which has more than 100 people developing hardware and software -- to fierce competition for talent at large technology companies, conventional auto makers and startups. Tesla has hired more than 35 people to join its Autopilot group so far this year, and brought on more than 50 in 2016.

In an email, Mr. Musk said he was unhappy with previous Journal articles on the company. "While it is possible that this article could be an exception, that is extremely unlikely, which is why I declined to comment," he wrote.

The hurdles to putting self-driving cars on the road on a mass scale are huge, but so are the potential rewards. Advocates say autonomous cars will help minimize congestion and pollution -- and would likely make automobile travel much safer. Human error causes 94% of crashes, according to government statistics.

Companies working on self-driving technology -- ranging from Ford Motor Co. and GM to Alphabet Inc.'s Waymo LLC and ride-hailing firms such as Uber Technologies Inc. -- are dealing with a tricky balance. If they make their technology too proficient, drivers may be tempted to stop paying attention or take their hands off the wheel. Automobiles that drive themselves under all circumstances face more testing and government review.

Tesla decided to introduce semiautonomous technology rather than wait because "when used correctly, it is already significantly safer than a person driving by themselves and it would therefore be morally reprehensible to delay release simply for fear of bad press or some mercantile calculation of legal liability," Mr. Musk said last year.

Mr. Musk has positioned himself as a disruptive force across industries. The South African-born engineer, who made more than \$100 million on an early investment in PayPal Inc., is chief executive of Space Exploration Technologies Corp., or SpaceX, which aims to colonize Mars. He said he is building a "Hyperloop" that will whisk commuters from New York to Washington in 29 minutes. In July, Mr. Musk announced Tesla is building the world's largest lithium-ion battery storage project in Australia.

"Elon's world is a tough world, and that's fine with me," said Ross Gerber, chief executive at Gerber Kawasaki Wealth & Investment Management in Santa Monica, Calif. "They're hard-charging, trying to change the world. That's why I invest in them."

Tesla's board includes James Murdoch, the chief executive of 21st Century Fox, which shares common ownership with Wall Street Journal parent News Corp.

Mr. Musk, who is 46 years old, became chief executive of Tesla in 2008, the year the startup produced its first electric sports car, the Roadster. He gained a reputation for working around the clock, sometimes spending the night on the factory floor.

In October 2014, Tesla introduced hardware and later added software updates that enabled capabilities such as automatic emergency braking and a collision-warning system -- features some rival car makers had also begun incorporating.

Tesla engineers were already hard at work on a breakthrough intended to propel the company closer to the industrywide Holy Grail: putting a driverless car on the road.

Tesla dubbed its project "Autopilot," after the technology that aids airplane pilots. In 2015, Tesla hired Robert Rose, a former software engineer at SpaceX, to run the Autopilot group.

The pressure was high to get testing done. In a 2015 email, Mr. Rose urged engineers to get started on validating the technology, or to proving it works in tests, "RTFN" -- right the f--- now.

Some engineers and suppliers pushed back. Issues they debated included the amount of time a driver would be given to retake the wheel if a car's autonomous driving features stopped working; mechanisms to keep drivers engaged; and whether the technology should be allowed on all roads.

Weeks before the October 2015 release of Autopilot, an engineer who had worked on safety features warned Tesla that the product wasn't ready, according to a resignation letter circulated to other employees and reviewed by the Journal.

Autopilot's development was based on "reckless decision making that has potentially put customer lives at risk," the engineer, Evan Nakano, wrote.

Tesla declined to comment specifically on Mr. Nakano. "We actively encourage development teams and suppliers to highlight concerns and issues so that they can be comprehensively addressed during development," a spokeswoman said.

Tesla said it based its design on millions of miles driven by employees and other early testers, followed by performance validation. It said Autopilot has been tested over more than 1 billion miles.

At least one early test drive was harrowing. In May 2015, Eric Meadows, then a Tesla engineer, engaged Autopilot on a drive in a Model S from San Francisco to Los Angeles. Cruising along Highway 1, the car jerked left toward oncoming traffic. He yelled and steered back on course.

On the same trip, he said police pulled him over for suspected drunk driving. He said he was sober and shot an email warning colleagues, "Do not use Autopilot this weekend."

Mr. Meadows said he was later dismissed for what he was told were "performance issues." Tesla declined to comment on Mr. Meadows but noted that the incident happened months before the release of the technology, giving the company plenty of time to work out problems that had been discovered during test drives.

As the team ironed out the technology, some enlisted the help of suppliers to settle disagreements. One engineer contacted Mobileye NV, the Israel-based company that made Autopilot's cameras, and expressed fear that the equipment could be unsafe if used by drivers who weren't fully engaged, according to people familiar with the matter. Mobileye Chairman Amnon Shashua contacted Tesla in May 2015 and was reassured that the technology would be deployed safely, according to a Mobileye securities filing.

As the release approached in October 2015, however, a Tesla engineer reported to Mobileye that the product was being released in a way that would allow the car to drive itself without hands on the wheel. Mr. Shashua flew to California and suggested precautions, a person familiar with the matter said.

Mr. Musk said "activation of Autopilot would be 'hands-on,'" Mobileye said in the securities filing. "Despite this confirmation, Autopilot was rolled out in late 2015 with a hands-free activation mode."

Tesla said drivers were "responsible for, and ultimately in control of, the car," when it rolled out Autopilot.

Tesla owners' manuals describe Autopilot as a collection of "driver assistance features" and note that motorists are responsible for staying alert, maintaining control of the vehicle and driving safely. The initial version of Autopilot warned drivers to retake the wheel if their hands weren't detected.

Debates raged industrywide, as car makers and tech companies balanced technological advances that boost safety with the potential for dangerous misuse by drivers.

"This is the worst subject in the world to be adventurous with," said Scott Keogh, Audi AG's top U.S. executive, in an interview.

Alphabet's Waymo decided its autonomous system should be free from human interaction partly after its own employees using automated-driving technology became overconfident, engaging in dangerous behaviors such as taking their eyes off the road.

"They were just human," said John Krafcik, Waymo's chief executive, speaking at a January automotive conference. "They began to trust the technology."

Shortly before the release of Autopilot in October 2015, Mr. Rose left the company. Tesla said Mr. Rose's departure wasn't due to any disagreement involving Autopilot but declined to elaborate further.

Mr. Anderson stepped into the job. A Ph.D. from Massachusetts Institute of Technology with a string of patents on autonomous technology, he had helped launch the Model X.

In May 2016, Joshua Brown, a former Navy SEAL, activated the Autopilot system in his Tesla Model S while driving on a Florida highway. Autopilot didn't see an 18-wheel truck crossing the road against a brightly lit sky, Tesla said. The vehicles collided and Mr. Brown was killed.

The following month, U.S. National Highway Traffic Safety Administration officials alerted Tesla that they were about to publicly disclose they were investigating Autopilot.

In September 2016, Tesla upgraded the system. It disabled automatic steering, preventing reactivation until the vehicle is parked, if a driver ignores repeated warnings to keep hands on the wheel. Mr. Musk said the update's enhanced radar likely would have prevented the crash.

Mobileye and Tesla parted ways and Mobileye made public its concerns. Tesla said Mobileye had promoted the technology until Tesla began building competing equipment in-house, an account Mobileye disputes. Intel Corp. reached a \$15.3 billion deal to buy Mobileye earlier this year.

In January, U.S. traffic safety regulators closed their investigation into the May 2016 fatal crash, noting: "A safety-related defect trend has not been identified at this time and further examination of this issue does not appear to be warranted." The probe found the truck should have been visible to Mr. Brown for at least seven seconds before the collision, and that Tesla made an effort during the design process to prevent drivers from misusing Autopilot. The investigation also found the rate of Tesla vehicles crashing had fallen nearly 40% since the company installed its automatic steering feature.

Still, regulators expressed worries about how automated-driving technologies are being marketed.

"We are concerned about drivers operating these vehicles having a good understanding of the capabilities and limitations of the systems," then-NHTSA spokesman Bryan Thomas said at the time. "It's not enough to put it in an owners' manual and hope that drivers will read that and follow it."

In October 2016, Tesla announced an upgrade of Autopilot. All new vehicles were being built with eight cameras that provide 360-degree visibility at up to 820 feet of distance. Tesla vehicles previously featured just one forward-looking camera, as well as a forward radar and 12 long-range ultrasonic sensors positioned to see 16 feet around the car in every direction.

The new cars still come with just one radar sensor, but it has enhanced processing to provide additional data about the driver's surroundings. The radar can see through heavy rain, fog, dust, and even a car in front of it, according to Tesla.

Tesla also said it updated the cars' 12 ultrasonic sensors to improve the distance at which they can detect hard and soft objects.

For \$5,000, Tesla customers can buy an option called "Enhanced Autopilot." That, Tesla said, would give them access to four of the car's eight cameras as well as the radar, 12 sensors, and the new onboard computing system.

For another \$3,000, drivers get the right to activate the rest of the cameras when Tesla enables a full self-driving system. Customers could wait to buy the option, but it would be more expensive.

The marketing was a factor in the decision by Mr. Anderson and at least two other engineers to leave the company, according to people familiar with the matter.

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Lisa Schwartz and Jim Oberman contributed to this article.

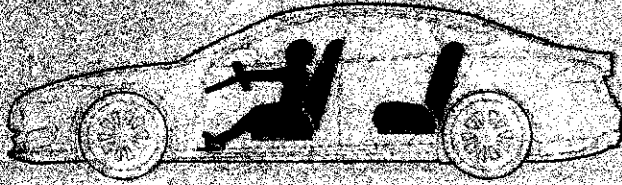
Credit: By Ianthe Jeanne Dugan and Mike Spector

# The Six Stages of Automation

Tesla and other companies are working on automated-driving systems that would eventually allow cars to drive themselves.

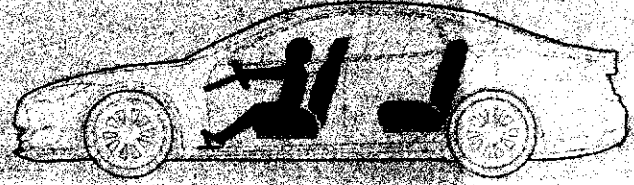
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## Level 0: No Automation



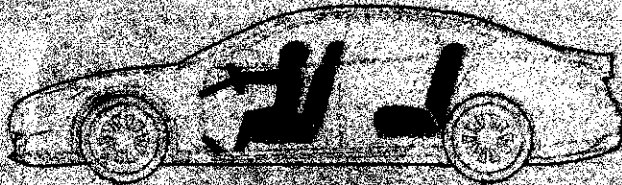
A human controls all the critical driving functions.

## Level 1: Driver Assistance



The vehicle can perform some driving functions, often with a single feature such as cruise control. The driver maintains control of the vehicle.

## Level 2: Partial Automation



The car can perform one or more driving tasks at the same time, including steering and accelerating, but still requires the driver remain alert and in control.

## Level 3: Conditional Automation

Under Development



The car drives itself under certain conditions but requires the human to intervene upon request with sufficient time to respond. Here, the driver isn't expected to constantly remain alert.

## Level 4: High Automation

Under Development



The car performs all critical driving tasks and monitors roadway conditions the entire trip, and doesn't require the human to intervene. But self-driving is limited to certain driving locations and environments.

## Level 5: Full Automation

Under Development



The Holy Grail. The car drives itself from departure to destination. The human is out of the loop. The car is as good or better than a human and steering wheels and pedals are potentially unnecessary.

Sources: SAE International; National Highway Traffic Safety Administration

THE WALL STREET JOURNAL

Mr. Musk, who is 46 years

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