

Former Boeing Engineers Say Relentless Cost-Cutting Sacrificed Safety

The failures of the 737 Max appear to be the result of an emphasis on speed, cost, and above all shareholder value.

By

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The simulators in which pilots train to fly airliners are engineering marvels in themselves. Picture a squat pod raised 10 feet in the air and mounted on spider legs that let the whole contraption move up, down, left, right, forward, and back. To meet Federal Aviation Administration requirements, the pilots sitting inside must be shown a realistic representation of what they'd see outside a real cockpit, so images are projected onto a curved mirror. Many simulators use cinema-quality sound to create a cacophony of alerts and warnings. Each machine costs as much as \$15 million, and airlines pay hundreds of dollars an hour for pilots to use one.

As [Boeing Co.](#) developed the 737 Max, the newest version of its most profitable and now most infamous plane, engineers repeatedly invited FAA officials to look over their designs in one of the company's Seattle simulators—an even more realistic mock-up incorporating pieces of actual aircraft. One purpose was to find out how to ensure that pilots switching to the new plane from previous 737 models never had to get inside one for what's known as Level D training. “We showed them all these scenarios, and then we'd ask, ‘Would this change equal Level D?’” recalls former Boeing engineer Rick Ludtke.

Boeing got what it wanted: Pilots moving from a 737-800 to the 737 Max would need at most Level B training, which they could complete in an hour or two on an iPad. That let airlines deploy the \$120 million plane more quickly. For Boeing, it was an important selling point that gave customers one less reason to defect to its European rival [Airbus SE](#).

Since the crashes of two Maxes within five months—a [Lion Air flight last October](#) and an [Ethiopian Airlines flight this March](#)—the pressure and maneuvering around simulator training has struck Ludtke as essential to understanding how an emphasis on costs twisted a process that's supposed to produce the best, safest planes. “They could have done better and should have done better, but better wasn't an option,” says Ludtke, who started at Boeing in 1996 and holds two U.S. patents for flight crew alerting systems. Federal investigators probing the Max recently interviewed Ludtke for hours about the connection between simulator requirements and the new software system linked to the crashes, known as the Maneuvering Characteristics Augmentation System, or MCAS.

Managers didn't merely insist to employees that no designs should lead to Level D training. They also made their desires known to the FAA team in charge of 737 training requirements, which was led by Stacey Klein, who'd previously been a pilot at now-defunct Skyway Airlines for six years. "She had no engineering background, her airplane experience was very limited," Ludtke says. "It was just an impossible scenario." FAA spokesman Greg Martin says the position Klein occupies, "while substantial," is primarily that of "an organizer, facilitator, and executor of the FAA policy and guidelines," and that in her role she calls on experts from multiple organizations.

In a statement, Boeing says, "The 737 Max was certified in accordance with the identical FAA requirements and processes that have governed certification of previous new planes and derivatives. The FAA considered the final configuration and operating parameters during Max certification, and concluded that it met all certification and regulatory requirements."

Yet somehow a company renowned for its meticulous engineering installed software that drove the aircraft into the ground while the pilots searched desperately for answers.

The crisis, according to more than a dozen interviews with former employees and FAA inspectors and hundreds of pages of internal emails and records, is best understood as part of a larger drama that's played out as Boeing has reshaped its workforce in an all-consuming focus on shareholder value. The push for efficiency has only accelerated under Dennis Muilenburg, who since becoming chief executive officer in 2015 has demanded price concessions from suppliers, heaped more cost demands on engineers, and cut the workforce about 7 percent while making many more planes.

Adam Dickson, a manager of fuel systems engineering for the 737 Max, retired in November after almost 30 years at Boeing—in part, he says, because of dismay over performance targets that risked sacrificing safety for profits. "It was engineering that would have to bend," he says. The company's priorities were expressed in annual performance reviews in which engineers were measured in part on how much their designs had cost. "Idea's [sic] are measured in dollars," as a manager put it in one engineer's annual evaluation. Boeing rejects the suggestion that it prioritizes cost. "At no time did our performance targets reward or encourage a trade off against safety," the company says.

Ludtke was laid off just after the Max was certified in March 2017. Employment on his team, known as flight crew operations, had been cut in half, from 30 to 15, he says. The workers managed how pilots interacted with the plane's software and controls—the very issue suspected of flummoxing crews in the Lion Air and Ethiopian Airlines tragedies. The constant shuffle helps make sense of missteps that have since come to light. Pilots first complained they hadn't been told about the MCAS software. It was tied to a sensor suspected of malfunctioning. Then Boeing disclosed on May 5 that a cockpit light warning of the sensor's malfunction wasn't turned on in every Max, as buyers had been assured—something the engineers realized months before the first plane went down, but didn't pass on to customers or the FAA.

Ludtke has embraced a role as a kind of gadfly, speaking frequently to reporters about the pressures he and others faced at Boeing. “They were targeting the highly paid, highly experienced engineers,” he says. “Over time that’s eroded the company’s ability to successfully design and manage programs. They do it strictly by cost, and they do it more so with every airplane.”

The crisis marks a profound test for Muilenburg, himself a former engineer who first worked at Boeing as a summer intern in 1985. At the company’s annual meeting in Chicago in April, family members of crash victims stood outside in a driving rain, holding up photos of loved ones and signs reading, “Prosecute Boeing & execs for Manslaughter” and “Boeing’s Arrogance Kills.” Inside, Muilenburg apologized. “We own it,” he said of the accidents, while also insisting there was no “technical slip or gap.” Investors so far stand behind him—the stock is up 11 percent this year, though it dips with each revelation about the crashes—and the FAA may bless Boeing’s software update for the Max as soon as late May. That would be the first step toward getting the 387 planes already in customers’ hands back in the sky this summer.

Even if that happens, there are congressional inquiries, a Justice Department criminal probe, lawsuits from victims’ families, airlines to mollify, and regulators in multiple countries to satisfy. In short, Muilenburg must navigate unfamiliar skies: Boeing, the pride of American manufacturing, the epitome of engineering excellence, now operates under a cloud of suspicion and skepticism. The company hopes that its next plane, the 777X, will begin commercial flights in 2020. Ludtke’s group worked on that plane, too. Boeing is again seeking FAA approval for a plane as an update of an existing model, in this case the 25-year-old 777.

One curiosity about Boeing is that even its white-collar workforce is unionized. For decades, the largest of the engineers’ unions, the 23,000-member Society of Professional Engineering Employees in Aerospace, had a mostly cordial relationship with management. Some Boeing CEOs had themselves been members. But in 2000 the engineers walked out for 40 days, all but halting aircraft production. Soon after, the company moved its headquarters from its historic base in Seattle to Chicago. In time it began shifting work to states less friendly to unions, notably South Carolina.

A new Boeing strategy had been launched a year before the strike at a retreat in the California desert for 280 senior managers. Phil Condit, then the CEO, was the architect of the purchase of McDonnell Douglas, a move that shifted the company’s center of gravity from commercial jetliners to military programs such as the F-15 fighter. It wasn’t going well—costs rose, production lines bottlenecked—and Condit had tapped the former McDonnell Douglas CEO Harry Stonecipher to fix operations. What managers heard at the retreat was a kind of a scared-straight message. Condit told them the stock price was so depressed that Boeing could face a takeover. Chief Financial Officer Deborah Hopkins underscored the importance of benchmarks such as return on net assets, one of Stonecipher’s favored metrics.

The relentless message: Shareholders would henceforth come first at Boeing. The important thing was not to get “overly focused on the box,” Hopkins said in a 2000 interview with Bloomberg. “The box”—the plane itself—“is obviously important, but customers are assuming the box is of great quality.” This was heresy to engineers, to whom the box was everything. The strike that year was formally over wages and benefits, but workers described it as a referendum on management.

“It was pretty intense low morale because of all the layoffs—constant, grinding layoffs, year after year”

Meanwhile, the competitive threat from Airbus was escalating. In 2003 the European manufacturer surpassed Boeing in deliveries for the first time. When Boeing, by then run by Stonecipher, embarked the following year on the 787 Dreamliner, it handed much of the work to outside suppliers in an attempt to keep down costs. The plane instead entered service three years late and billions of dollars over budget.

The next CEO, James McNerney, a former General Electric Co. executive, vowed no more “moonshots” in aircraft development. After costly strikes by machinists in 2005 and 2008, he also challenged unions head-on. In 2009, Boeing said it would open its first jetliner assembly line outside the Seattle area, shifting some production of the 787 to a plant in North Charleston, S.C., formerly owned by a supplier that made much of the fuselage for the plane. The workers there were unionized, but they voted to abandon the union to help secure the new work.

At the time, some executives at Boeing were pushing for an update of the 737, a 1960s-era design that analysts considered ripe for replacement. It might have entered service late this decade. But in December 2010, Airbus surprised Boeing by announcing the development of the A320neo—as the name suggests, an update of an established model. It quickly gathered orders, and Boeing responded in 2011 by announcing its own update: the Max.

In part by dangling the threat of shifting production of future aircraft to South Carolina, Boeing secured long-term contracts with its two major unions, the engineers and the machinists. In July 2014, McNerney, who was approaching 65, was asked on a conference call with journalists if he planned to retire that year. He was feeling confident enough to joke, “The heart will still be beating, the employees will still be cowering.”

They were. It was a climate that didn’t reward people willing to buck managers, says Mark Rabin, who worked in a flight test group that supported the Max and was laid off in 2015 after a 17-year Boeing career. “It was pretty intense low morale because of all the layoffs—constant, grinding layoffs, year after year,” he says. “So you really watched your step and were careful about what you said.”

Managers also felt heat to hit ambitious cost targets, says Dickson, the former supervisor of fuel systems engineering for the Max. The sales team would sell planes for delivery four years out at prices the company couldn’t yet hit from an engineering standpoint—creating immense pressure throughout the organization to drive down

costs. In 2016, Boeing started asking for specific time and cost reductions as part of managers' performance evaluations, Dickson says, and by 2018, his superiors warned in "very directly and threatening ways" that pay was at risk if the targets weren't met.

(Muilenberg and McNerney had personal reasons to emphasize productivity and cost-cutting. Boeing's incentive pay plans for executives and rank-and-file employees have for years emphasized profitability, with revenue, cash, and share performance playing a role more recently. Boeing has beat its targets every year since 2012, contributing to the \$209 million in total pay the two CEOs received since then.)

Shop floor workers reported similar demands on schedule and cost. In 2016, William Hobek, a quality manager at Boeing's 787 plant in South Carolina, filed suit in federal court claiming he'd been fired after repeatedly reporting defects up the chain of command. When he complained, a supervisor replied, "Bill, you know we can't find all defects," according to the suit. Hobek called over an inspector, who quickly found 40 problems, the suit claims. (It was later settled; Hobek declined to comment for this story, citing settlement terms.) Al Jazeera in 2014 sent a hidden camera into the plant and caught some employees on tape saying they'd never fly on the planes because of shoddy workmanship.

Some of Boeing's machinists are determined to reestablish union representation at the plant, and last May they scored a big win when a unit of flight readiness technicians voted 104 to 65 to join the union. Boeing responded by saying it was a "micro-unit" barred by federal law and appealed to the National Labor Relations Board to void the election. The union says the company has since fired six of the technicians, and it's filed several complaints on their behalf. ("Boeing terminated these individuals based on well-publicized, long-standing, and objectively obvious safety, compliance, and conduct policies," the company says.) In April a number of current and former workers at the plant vented to the New York Times for a front-page exposé of production problems. They described defective manufacturing, debris left on planes—wrenches, metal slivers, even a ladder—and pressure not to report defects.

Scrutiny of the Max has also exposed the almost fraternal relationship between Boeing and its regulator, the FAA. The 1958 act that established the agency allowed it to hand off many aspects of the certification process to Boeing and other manufacturers. In 2009 the system was expanded further, allowing Boeing to directly choose and supervise the employees who vouch for safety as authorized FAA representatives.

Boeing began putting more junior employees into the roles, and some employees believed that was because they'd be more willing to listen to managers and less likely to dig in their heels, Dickson says. "How long do you want to keep polishing that apple?" was a phrase managers often used with engineers who wanted to keep testing, he says. The message: It's fine, let's keep things moving. The FAA's Martin says the agency regularly reviews the workers Boeing and other manufacturers put in certification roles "to determine if there is any information that indicates that the individual has

demonstrated a lack of care or judgment, or a lack of integrity, or is otherwise unsuitable.”

Now Boeing is seeking FAA approval for the 777X as an update of an existing model, the 777. Internal tensions about this approach are being exposed in the proceedings of a wrongful termination suit brought by a former Boeing engineer, Michael Neely, who claims he was fired in 2016 after citing design and safety problems.

Neely had been working for Boeing’s space and defense operation in Alabama when he was brought to the Seattle area to help define a plan to adapt an electrical load management system from an earlier model of the 777. Disagreements escalated as a deadline approached for Boeing to send plans for the system to the electrical contractor, a GE unit. Neely argued that reusing the previous system, essentially an enormously complicated and computerized version of a fuse box, wasn’t adequate for the new design and didn’t meet FAA standards, according to emails filed in the suit. Within months, GE, too, had objected, saying the system would need to be significantly expanded.

Of course, friction and intense disagreements are common in every aircraft program. Such programs are an industrial undertaking like no other, involving tens of thousands of people and taking years to complete. But with the Max’s grounding in March, Boeing has now had two airplanes taken out of the air by the FAA in six years, following battery fires on the Dreamliner in 2013. (There were no fatalities.) The last model the FAA grounded was the McDonnell Douglas DC-10, in 1979.

It isn’t assured that the Max’s prospects will recover as fast as Boeing and investors expect, Barclays Capital analyst David Strauss wrote on May 7, citing a survey of fliers suggesting that almost half will be unwilling to fly on the Max for a year or more. The same day, Carter Copeland of Melius Research wrote to investors that the most consequential outcome of the Max crisis might be the end of a system that’s helped save both Airbus and Boeing time and money—the FAA’s approval of “heavily modified” aircraft as extensions of previous designs. If the agency were forced to consider them as “clean sheets,” he wrote, it would add long as two years (and additional cost) to their development timelines.

The evidence suggests that what Boeing needs is a full-throated commitment to safety and engineering over cost. Muilenburg would seem perfect for the job—he’s a Boeing lifer who’s said his ambition as a young man was to become “the world’s best airplane designer.” In his public comments about the 737 Max, though, he has shown an extremely limited range of vocabulary, and he frequently boils his plan down to this: a software update. He insists that the design and certification process for the Max went exactly as planned.

On March 27, Boeing invited 200 airline representatives, regulators, and pilots to Seattle for a first look at the changes it had made to the MCAS software. A day before, a group of engineers was summoned to a session with Muilenburg and Kevin McAllister, head of the commercial airplanes business. McAllister spoke emotionally, and a staffer wept in the background. Then Muilenburg fielded five or six questions with the same

artfully vague responses he's provided reporters. A company spokesman says Muilenburg was greeted warmly. An engineer present had a different take: It was, he told colleagues, "a nothingburger."

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