Arkansas Law Review

Volume 77 | Number 1 Article 6

April 2024

Two Heads are Better than One: Single Pilot Operation Threatens the Safety of the Friendly Skies

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TWO HEADS ARE BETTER THAN ONE: SINGLE PILOT OPERATION THREATENS THE SAFETY OF THE FRIENDLY SKIES

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I. INTRODUCTION

Twelve minutes elapsed from the time Lion Air Flight 610's wheels lifted off the runway to when it crashed into the Java Sea, ending the lives of all 189 people onboard the Boeing 737 MAX aircraft.[1] This was not the only fatal Boeing 737 incident; five months after the Flight 610 crash, Ethiopian Airlines Flight 302 suffered the same fate.[2] The Flight 302 accident claimed all 157 lives of those onboard and occurred only six minutes after takeoff.[3] Mourning and devastated friends and family of the deceased passengers were left with one question: What happened?[4] Quindos Karanja, who lost his mother along with his sister and her three children, recalled that Boeing responded by blaming the foreign pilots.[5] Dennis Muilenburg, Boeing's CEO at the time, linked "pilot inexperience and lack of training" to the crashes.[6]

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* J.D. Candidate, 2024, University of Arkansas School of Law. This Comment is in honor of my father, retired Airbus A300 Captain Walter Rook III. I am eternally grateful for his life-long dedication to our family, unconditional support of me, and willingness to be my go-to resource for this Comment. I would like to express my utmost gratitude to my mother, Cassandra, and brother, Walter IV, for their support and encouragement throughout my entire law school experience. Much appreciation also to Amanda Beth Hurst for her mentorship and invaluable advice.

1. Andrew J. Hawkins, *Everything You Need to Know About the Boeing 737 Max Airplane Crashes*, THE VERGE (Mar. 22, 2019, 8:00 AM), [https://perma.cc/W6WA-HZUX].

2. *Id.*

3. *Id.*

4. *See* Patrice Taddonio, *In 737 Max Crashes, Boeing Pointed to Pilot Error—Despite a Fatal Design Flaw*, PBS (Sept. 14, 2021), [https://perma.cc/LM9V-J559].

5. *Id.*

6. *Id.*

Further investigation led to the common denominator of the crashes: automated piloting.[7] Boeing's Maneuvering Characteristics Augmentation System ("MCAS"), an automated piloting system, is only supposed to handle aircraft operations in very specific circumstances.[8] The MCAS is designed to activate itself automatically during manual flight when a plane's wing flaps are up and its nose is angled unusually high.[9] Currently, Boeing reports that in the case of these two crashes, the MCAS was inappropriately activated when one of the two sensors—used to determine if a MCAS-triggering condition is occurring—produced incorrect data, leading to the repeated, wrongful activation of the MCAS.[10]

However, Boeing could have prevented these tragic crashes from happening in the first place. When the MCAS was originally being tested in simulators—which is industry custom—a test pilot recognized that there was a disastrous incident while he was trying to respond to MCAS activation during active flight.[11] That incident would have likely caused the airplane to go down in a real flight.[12] Determined to keep morale and profits high, Boeing did nothing with the information received about MCAS's danger.[13] Boeing kept quiet because of financial concerns and controversy with the Federal Aviation Administration ("FAA"), as well as wanting to reduce costly pilot training for MCAS.[14]

Despite devasting results with MCAS, Boeing has another automated piloting system on the horizon that poses even more grave risks: Single Pilot Operation ("SPO"). Boeing—along with Airbus[15]—wants to replace one of the pilots in the cockpit of commercial airline flights with the new SPO technology it is

7. *Id.*; *MCAS*, BOEING, [https://perma.cc/B3X9-JGLA] (last visited Feb. 3, 2024).
8. *MCAS*, *supra* note 7.
9. *Id.*
10. *Id.*
11. Taddonio, *supra* note 4.
12. *Id.*
13. *Id.*
14. *Id.*
15. This Comment predominately addresses Boeing because it is the most prominent American plane production company. Airbus is also working to develop SPO but is based in the United Kingdom. Aviation law outside of the United States is beyond the scope of this Comment.

developing.[16] The FAA should not allow SPO technology to be implemented because it is premature, motivated by financial gain to the detriment of safety, and ignores the importance of professional judgment in the cockpit.

II. BACKGROUND

A. Cockpit History

Over time, the amount of cockpit crew required on a commercial airline flight has decreased.[17] A team of five people—the flight engineer, radio operator, navigator, first officer, and captain—typically comprised a commercial aircraft crew in the 1950s.[18] As aviation technology developed, the need for crew members reduced.[19] With new communication technology emerging, the radio operator position became obsolete.[20] The navigator position was replaced with inertial navigation systems.[21] The introduction of the Boeing 737 aircraft deemed the flight engineer unnecessary in 1969, but some jets still utilized the position.[22] In the 1980s, the Airbus A300 and Boeing 767 completely eliminated the flight engineer.[23]

Until today, the gradual decline in the amount of crew members has not posed much, if any, burden to pilots or passenger safety, as the now-obsolete positions did not require the crew members to exercise as much judgment as the remaining positions.[24] The new technology vastly reduced the amount of manual work needed for the safe operation of the flight, so much so that the two pilots onboard could absorb the responsibilities

16. Jacopo Prisco, *Why Airplanes Might Soon Have Just One Pilot*, CNN (Jan. 13, 2022, 6:34 AM), [https://perma.cc/BVY3-YS9U].

17. Karl D. Bilimoria et al., *Conceptual Framework for Single Pilot Operations*, NASA 2 (2014), [https://perma.cc/9FSD-DVRV].

18. *Id.*

19. Helwing Villamizar, *From Five to None? Evolution of the Flight Crew*, AIRWAYS (Apr. 23, 2022), [https://perma.cc/XZ8S-CBJT].

20. Bilimoria et al., *supra* note 17, at 2.

21. *Id.*

22. Villamizar, *supra* note 19.

23. *Id.*

24. Bilimoria et al., *supra* note 17, at 2.

between themselves.[25] Importantly, the crew transitions preserved the safety that the now-obsolete positions offered.[26] The new equipment and technology could complete the work that the crew members performed without adding any new risks.[27]

B. Purpose of Each Pilot

Today, commercial aircraft use dual pilot flight ("DPF").[28] A few types of aircraft are flown with just one pilot in the cockpit, but, by and large, most commercial airlines are required by law to have two pilots operating flights: typically one captain and one first officer.[29] This is called DPF because there are two pilots onboard.[30] One pilot takes on the pilot flying ("PF") role and the other serves in the pilot monitoring ("PM") role.[31] The captain sits in the left seat and has the final decision-making authority for the operation of the plane.[32] Hence, the captain is in charge of deciding what tasks he or she and the first officer will have during the flight, such as assigning the task of PF or PM.[33] The first officer, also called the right-seater, aids the captain in the operation of the aircraft.[34] Both pilots have the same licensure, an Airline Transport Pilot Certificate, and receive the same initial training.[35] Through additional training and experience, a first officer can upgrade and become a captain.[36]

Both pilots have an integral role in the safe operation of a commercial aircraft.[37] Typically, the PM handles the radio communications with air traffic control ("ATC") in all phases of the flight while the PF focuses on the actual flying and settings

25. *Id.*
26. *Id.*
27. *Id.*
28. *The Importance and Benefits of Utilizing Dual Pilot Operations*, GRAND VIEW AVIATION, [https://perma.cc/6MBJ-SURX] [hereinafter GRAND VIEW AVIATION].
29. Bilimoria et al., *supra* note 17, at 1-2.
30. GRAND VIEW AVIATION, *supra* note 28.
31. *Id.*
32. 14 C.F.R. § 91.3 (2019).
33. *Airline Captain and First Officer Explained*, ATP FLIGHT SCH., [https://perma.cc/2E8A-JVT3] [hereinafter ATP FLIGHT SCHOOL].
34. *Id.*
35. *Id.*
36. *Id.*
37. *See id.*

located inside the cockpit.[38] The captain's main responsibility is to "manage risk and resources (both human and automation)."[39] Even when the two pilots are performing their respective duties at the same time, they still communicate and collaborate to help each other during flight.[40]

Having two pilots onboard is especially essential when a problem arises during a flight, such as tumultuous weather or engine failure.[41] In emergencies, the first officer will normally be the PF while the captain uses his or her expertise to solve the problem at hand.[42] The pilots can switch roles at any time during the flight.[43] Four major reasons for allowing the first officer to act as the PF instead of the captain are: (1) to alleviate fatigue on long trips or multiple flights in the same day; (2) to utilize the captain's expertise in better ways; (3) for the first officer to gain experience under the guidance of a seasoned pilot; and (4) in crisis, to allow the captain to work on a solution rather than be the PF.[44]

C. Explanation of SPO

In contrast to DPF, SPO is "flying a commercial aircraft with only one pilot in the cockpit, assisted by advanced onboard automation and/or ground operators providing piloting support services."[45] SPO is currently being researched by a number of institutions including NASA and the Advanced Cockpit for the Reduction of Stress and Workload.[46] Specifically, the research focuses on the concept of operations for SPO.[47] A system's Concept of Operations is a document that is frequently updated with data gathered on the security analysis performed by the

38. ATP FLIGHT SCHOOL, *supra* note 33.

39. Bilimoria et al., *supra* note 17, at 3.

40. Mark Finlay et al., *The Difference Between a Captain and a First Officer*, SIMPLE FLYING (Dec. 27, 2023), [https://perma.cc/36JE-F9QY].

41. *Id.*

42. *Id.*

43. AIR LINE PILOTS ASS'N, THE DANGERS OF SINGLE-PILOT OPERATIONS 6 (2019), [https://perma.cc/C6UX-8NT8] [hereinafter ALPA].

44. Finlay et al., *supra* note 40.

45. Bilimoria et. al., *supra* note 17, at 1.

46. *Id.*

47. *Id.*

technology developer.[48] This means that researchers are evaluating the feasibility of SPO based on reports of how it has functioned while tested.

Automated piloting systems are normally and regularly used in DPF-operated commercial airline flights.[49] Generally, automated systems in commercial aircraft "can augment or even replace pilots' performance, manag[e] engine power, [and] control[] and navigat[e] the aircraft."[50] Ground-based operators assist the onboard pilot by providing information about conditions, system errors, and may intervene with the flight if needed, as they can assume control of the aircraft from their base.[51] However, ground-based operators only assist DPF on an as-needed basis.

Unlike DPF, captains would have to totally rely on ground-based operators to monitor and assist SPO flights. In theory, the onboard autonomous system and ground-based operators—who can control the airplane—would collaborate with and support the onboard pilot, offsetting some of the workload.[52] Since the FAA currently requires the DPF approach, the autonomous systems have been implemented in aircraft with two human pilots onboard.[53] These onboard autonomous systems have increased the level of safety at which commercial aircraft operate, but they cannot replace the expertise of a human pilot.[54]

Besides death and taxes, one more thing is guaranteed in life: technological malfunction. The autonomous systems used in commercial aircraft are no exception.[55] Ground-based operators assisting SPO flights would monitor multiple aircraft at the same time.[56] NASA has determined that having to deal with issues on

48. *Develop CONOPS and Preliminary Security Requirements (b)*, FED. AVIATION ADMIN., [https://perma.cc/5VPD-MBEE].

49. *Autopilot Systems—Aircraft Instrument System*, AERONAUTICS GUIDE, [https://perma.cc/V5SP-QGSL] (last visited Feb. 4, 2021).

50. Stephen Rice & Scott Winter, *The Future of Aviation? Even More Automation*, FAST CO. (Mar. 26, 2019), [https://perma.cc/W7LK-25ND].

51. Bilimoria et al., *supra* note 17, at 4.

52. ALPA, *supra* note 43, at 10.

53. GRAND VIEW AVIATION, *supra* note 28; *see also* ALPA, *supra* note 43, at 3.

54. *See* ALPA, *supra* note 43, at 5.

55. *Id.* at 20-25.

56. *Id.* at 8.

multiple planes is not a feasible workload; one ground-based operator cannot handle multiple complications at once.[57]

D. Current Regulations

For SPO to be implemented, its safety level must be equal to that of having two pilots in the cockpit.[58] The FAA requires that the minimum flight crew "must be established so that it is sufficient for safe operation, considering—(a) [t]he workload on individual crewmembers; [and] (b) [t]he accessibility and ease of operation of necessary controls by the appropriate crewmember."[59] It also requires two pilots for all large aircraft, which are those weighing 12,500 or more pounds.[60] Commercial airplanes vary in weight, but as a group, they are unequivocally the heaviest planes.[61] Commercial airplanes can weigh anywhere from 30,900 to 127,000 pounds, making them all susceptible to the FAA's two-pilot regulation, even without considering the weight of passengers and luggage.[62]

Part 121 of the Federal Aviation Regulations—requiring DPF—currently stands in the way of the implementation of SPO in the United States.[63] Part 121 provides the operating requirements for "Air Carriers and Operators for Compensation or Hire."[64] Kentucky Representative Brett Guthrie introduced the FAA Reauthorization Act of 2018 to Congress.[65] The Act is substantial and covers a wide variety of topics, but, if modified by the FAA Reauthorization Act of 2023, its SPO objective would radically change air travel in the upcoming years. One purpose of the new act is to change Part 121 to allow SPO—first in cargo planes (think FedEx and UPS, for example)—where there are no

57. *Id.* at 5.

58. Bilimoria et al., *supra* note 17, at 1.

59. 14 C.F.R. § 25.1523 (2023).

60. 14 C.F.R. § 91.531 (2023).

61. Joe Haygood, *How Much Does a Plane Weigh?*, SKYTOUGH (Aug. 30, 2022), [https://perma.cc/TK45-8FA7].

62. *Id.*

63. *See* 14 C.F.R. pt. 121 (2023).

64. 14 C.F.R. § 121.1 (2023).

65. *See* FAA Reauthorization Act of 2018, H.R. 302, 115th Cong. (2018); Peter Greenberg, *Airlines Are Lobbying for a Change to Federal Regulations that Could Put One Pilot in the Cockpit*, CBS NEWS (Dec. 8, 2022, 11:33 AM), [https://perma.cc/9K5G-LQGC].

passengers.[66] In a cargo plane using SPO, the only person onboard would be the captain. Eventually, the technology would be expanded to commercial airline flights in the United States.[67]

III. ANALYSIS

This Part is divided into four Sections: (A) why SPO technology is not ready to be used; (B) how monetary motivation outweighs safety concerns; (C) how commercial flights rely on professional judgment from two trained and certified pilots to ensure safe operation; and (D) how SPO should be regulated in the future.

A. Too Much Too Soon

SPO technology is far too premature to use on commercial airline flights considering (1) NASA's study on SPO's current feasibility, (2) comparison to self-driving cars, and (3) outcomes of SPO malfunction.

1. NASA Calls It a No-Go (For Now)

SPO is not currently feasible because NASA research shows that the technology needs significant improvement before implementation.[68] For SPO to be viable enough to implement, the flight must be able to operate with the same safety level as if it had two pilots onboard.[69] A recent NASA study concluded that much more research and development needs to be done to assess the feasibility of SPO.[70] However, NASA further explained that (in theory) SPO could be feasible and that it is worth exploring the possibility.[71]

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66. Greenberg, *supra* note 65; *see also* FAA Reauthorization Act of 2023, S. 1939, 118th Cong. (2023).

67. *See* FAA Reauthorization Bill of 2018, H.R. 302, 115th Cong. (2018).

68. Richard Mogford et al., *NASA's Single-Pilot Operations Technical Interchange Meeting: Proceedings and Findings*, NASA 103 (Apr. 2013), [https://perma.cc/ZN23-KFK7].

69. *Id*. at 33-34.

70. *Id*. at 103.

71. *Id.*

One reason that SPO is an intriguing idea is that human pilot error is a causal factor for 60% of aviation accidents.[72] This statistic is often used as evidence that removing a human pilot would improve safety.[73] However, this interpretation is a "complete fallacy" because it only considers the forensic evidence, rather than also looking at how often pilots prevent accidents.[74] Those data are not kept.[75] To truly understand pilot error data, the public would need evidence of how flight crews deal with, prevent, and solve incidents during flight.[76]

After running a baseline experiment using SPO, NASA concluded that the "present-day automation design paradigm is not sufficient."[77] The onboard pilot would have to serve in a PM capacity, which is not ideal for the human pilot, and his job would be made more difficult by the SPO.[78] Even though a human pilot serves as the PM in DPF, when there is only one pilot onboard, their expertise is much better utilized by acting as the PF because they would actually be in control of the aircraft.[79] Further, the onboard pilot's role is critical when operating in off-nominal conditions.[80] Most strikingly, NASA's data definitively showed that SPO technology as it is now is "not nominally acceptable due to the significant task demands and workload."[81]

In conclusion, NASA is currently unwilling to accept SPO and needs proof of significant improvement in efficacy before thinking about implementing it at all, especially on aircraft carrying large numbers of passengers.

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72. Randall E. Bailey et al., *An Assessment of Reduced Crew and Single Pilot Operations in Commercial Transport Aircraft Operations*, NASA 1 (2017), [https://perma.cc/KQV6-P7R3].

73. *Id.*

74. *Id.*

75. *Id.*

76. *Id.* at 1-2.

77. Bailey et al., *supra* note 72, at 12.

78. *Id.* at 12-13.

79. *Id.* at 13.

80. *Id.*

81. *Id.*

2. Autonomous Automobiles

SPO and self-driving cars share similar characteristics that make them dangerous and currently unfit for use. Self-driving cars are a mechanism like SPO, in that they both rely on autopilot systems.[82] Although cars historically have had only a single driver whereas commercial planes have had two pilots, the implementation of the autopilot system is similar because they are both using a comparable type of technology.[83]

As drivers are starting to use and trust the autopilot systems to guide them safely on the roads, the main problem is that the driver becomes disengaged and inattentive, which leads to enormous safety risks.[84] Like commercial airline pilots, car drivers can react much quicker to emergency situations than any computer system currently can.[85]

A striking issue with the implementation of SPO is the same as the disengagement of the driver in an autonomous car: As pilots rely more on technology, they are less likely to pay full attention to their flight duties.[86] Not only does that make the flight less safe, it also erodes pilot skills because less practice leads to less muscle memory reaction in response to an emergency.[87] Whether operating a motor vehicle or flying a plane assisted by an SPO, complacency decreases the likelihood that an operator will resolve an emergency situation before a disaster occurs and decreases the overall skill of the operator.[88]

Furthermore, just as self-driving cars are susceptible to cyberattacks, where a threat actor is able to hack into the system and control the vehicle,[89] the same is true for SPO.[90] In a controlled experiment with a real driver on real roads, hackers

82. Eugenia Akhim, *This Is Why Self-Driving Cars Are a Step in the Wrong Direction*, HOTCARS (July 28, 2022), [https://perma.cc/64BC-E6EK].

83. Shuai Chen, *Autonomous Driving—Airplane vs. Automobile*, MEDIUM (Nov. 21, 2019), [https://perma.cc/JK6C-5HWD].

84. Akhim, *supra* note 82.

85. ALPA, *supra* note 43, at 3-4.

86. *Id.* at 4.

87. *Report: Automation Erodes Pilot Skills*, AVWEB (Apr. 12, 2019), [https://perma.cc/XR5U-UWPB].

88. *Id.*

89. Akhim, *supra* note 82.

90. ALPA, *supra* note 43, at 4.

were able to commandeer a self-driving Jeep Cherokee.[91] By using code, hackers accessed the Jeep's entertainment center and could send commands to the audio system, air conditioning, and, more importantly, the steering, brakes, and transmission.[92] Because this was simply an experiment, the hackers did not command the Jeep to do anything that would threaten the life of the driver, but it showed that hackers have the ability to force thousands of vehicles to steer off the road, slam on or disable the brakes, and take many other actions that could seriously endanger the driver and others on the road.[93] Simply put, automated systems can be taken over in mere seconds to produce deadly results. Although developers claim that encryption can prevent cyberattacks on SPO, that has not been proven true.[94]

In terms of safety, autonomous cars "currently have a higher rate of accidents than human-driven cars, but the injuries are less severe."[95] Data show that for every million miles driven, autonomous cars have 9.1 accidents, while human-driven cars have 4.1 accidents.[96] In 2017, U.S. drivers drove about 11 billion miles a day in the aggregate.[97] That means that on any given day, self-driven cars would produce 100,100 accidents, while human-driven cars would have less than half that amount at roughly 45,100. The difference between these statistics shows a huge risk in using autonomous cars. While the injuries may be less severe, the alarming accident rate for autonomous cars proves the technology is unsafe for the roads.

Notwithstanding injuries, more than doubling the number of road accidents every day places an undue burden on the stress of drivers and first responders having to dispatch to accident scenes. It would also deplete resources of emergency responders as they would have to spend significantly more time on accident

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91. Andy Greenberg, *Hackers Remotely Kill a Jeep on the Highway—With Me in It*, WIRED (July 21, 2015, 6:00 AM), [https://perma.cc/5LTD-EU88].

92. *Id.*

93. *Id.*

94. ALPA, *supra* note 43, at 4.

95. Clifford Law, *The Dangers of Driverless Cars*, NAT'L L. REV. (May 5, 2021), [https://perma.cc/G9EC-CLC6].

96. *Id.*

97. *National Household Travel Survey Daily Travel Quick Facts*, BUREAU TRANSP. STATS. (May 31, 2017), [https://perma.cc/X4NG-99M4].

response, making them slower to respond to other emergencies that may be more time-sensitive than a wreck unless the staffing is increased.[98]

This is not to say that autonomous cars, or SPO for that matter, will never be safe enough for widespread use, but rather it merely means that the technology is so infantile that it needs decades of refinement. Therefore, because SPO is susceptible to the same dangers as self-driving cars, the risks of implementing this premature technology are too high to accept.

3. Bugging Out: SPO Malfunction

The main reason that SPO technology is too dangerous for public use is the overwhelming possibility of malfunctions. The Air Line Pilots Association ("ALPA") notes that as with all technology, as SPO "grow[s] more complex, as [it] inevitably will, the probability of errors will increase, possibly to the point of negating any benefits [it] might otherwise provide."[99] While it is true that automation technologies have made flying safer (and the safest form of travel), system malfunction is the cause of a growing number of in-flight incidents.[100] Further, industry commentators contend that "automation and the autoflight system is simply an obedient subordinate of the pilots" and "can only do what it is told to do."[101] Therefore, in order for SPO technology to effectively replace the first officer, it must be able to act in response to the captain like another human pilot would.[102] Whether SPO can replicate human cognitive ability is the root of

98. *See, e.g.*, Nathaniel Weixel, *Ambulance, EMT First Responders Face Crippling Workforce Shortage'*, THE HILL (Oct. 27, 2021, 6:00 AM), [https://perma.cc/QHM8-MYKR].

99. ALPA, *supra* note 43, at 13.

100. Tim Culpan, *Airliners Need More Than One Pilot and a Digital Dog*, BLOOMBERG (Nov. 23, 2022, 1:00 PM), [https://perma.cc/L8DD-BGLH]. Flying is "estimated to be 10,000 times safer than automobile travel and is often cited as the world's safest mode of travel." Bailey et al., *supra* note 72, at 2.

101. Mohamed Anas Maaz, *Single Pilot Operations: The Risks and Challenges*, SIMPLE FLYING (Dec. 1, 2022), [https://perma.cc/96HS-MW5E].

102. *Id.*

the issue.[103] Evidence shows that SPO is not developed enough to meet human cognitive ability at the necessary level.[104]

Commercial airline flights are not the place to test out such a dangerous technology. Even if first tested in cargo planes, lives are still at stake. Cargo planes not only transport boxes, but they also transport animals and other living matter, plus the pilot.[105] Although companies like Apple can quickly roll out system updates for bug fixes on the latest iPhone, the stakes are low in comparison to what could happen if an SPO flight had a bug. When hundreds of lives are at stake, it is imperative that the technology is impeccably reliable. Furthermore, if an issue arises during flight, it will increase the workload of the pilot.[106] Unless pilots are properly trained on how to respond to system malfunctions, there is no guarantee that any issue can be resolved, especially if advanced IT skills are needed. And what is the result of an unresolved SPO bug? Only a catastrophic incident can tell.

B. It's All About the Safety Until It's All About the Money

Boeing and Airbus are far more concerned about the profit opportunities of implementing SPO than the safety of passengers as shown by (1) Boeing and Airbus' profit projections, (2) commercial airlines' cost savings of cabin crew, (3) the current pilot shortage, and (4) Boeing's profit-oriented criminal history.

1. Forecast: It's Raining Cash

Big companies are always searching for ways to become leaner and save money; commercial airlines are no exception.[107] During the COVID-19 pandemic, it is no surprise that commercial

103. *Id.*

104. Bailey et al., *supra* note 72, at 13.

105. *Chartered Air Freight Delivery*, FEDEX, [https://perma.cc/V4D3-XTCK] (last visited Feb. 11, 2024). Air freight companies often transport animals to transfer them between zoos, or even horses competing in the Kentucky Derby, the Olympics, or other big competitions. And yes, even the famous inhabitant of SeaWorld, Shamu, was flown in a 5,000-gallon pool. *Sea World Loads Whale for Ohio Trip*, ORLANDO SENTINEL (Feb. 13, 1990, 5:00 AM), [https://perma.cc/5MM7-SCCB].

106. *See supra* Sections II.C-D.

107. Matt Driskill, *VIEWPOINT: Single-Pilot Operations: Just Say No*, ASIAN AVIATION (June 20, 2021), [https://perma.cc/B2FE-9R7J].

airlines scrambled to find ways to stay profitable while their business—keeping hundreds of people confined in a small area with recirculated air to travel to another city—was practically banned.[108] This created the perfect storm to introduce SPO to commercial airlines since they were experiencing economic distress.[109]

Even before the COVID-19-era economic pressures, Boeing hid the issues with the MCAS system to avoid additional training requirements.[110] The onerous training requirements were a significant hinderance because they prevented Boeing from "earn[ing] millions of dollars when selling the [impacted] plane."[111] Boeing was able to capitalize on the low training requirements because the airlines were willing to pay a much higher price per plane when they would not have to spend incredible sums of money on training their pilots to use the new aircraft or having technology installed into existing aircraft.[112]

How an airline replaces airplanes is very similar to how the average person replaces their personal vehicle. An aircraft is purchased, used for a period of time, and replaced with a newer model. While some technologies can be upgraded in an existing car, a new car has greater capabilities. The same is true for aircraft. While existing planes can integrate technologies to a certain degree, it cannot match what a new plane could offer. Thus, while it is possible to integrate SPO into existing planes, it would take batches of new aircraft to fully roll out SPO at its highest degree of functionality.

The business of selling aircraft is extremely lucrative. From 2014 to 2018, Boeing sold between 723 and 806 planes per year.[113] After having steady sales for years, Boeing only sold 157

108. *See id.*; Niraj Chokshi, *American Airlines Posts a $931 Million Loss as the Industry Struggles to Recover*, N.Y. TIMES (Jan. 20, 2022), [https://perma.cc/3NVS-S4Y6].

109. Driskill, *supra* note 107.

110. *See infra* Section III.B.4; Paul Cassell, *Judge O'Connor Rules That the Boeing 737 MAX Crashes Victims' Families Represent Protected "Crime Victims" and Can Seek Boeing's Prosecution*, VOLOKH CONSPIRACY (Oct. 24, 2022, 1:40 PM), [https://perma.cc/2ZH4-F5C3].

111. Cassell, *supra* note 110.

112. *Id.*

113. *Boeing's Aircraft Deliveries from 1998 to 2021*, STATISTA (Aug. 23, 2023), [https://perma.cc/P8WK-DHPL].

planes in 2020 due to the pandemic limiting commercial air travel, a drastic decline in its status quo.[114] Sales picked back up slightly in 2021 with 340 total aircraft sold but in no way returned to the volume Boeing was accustomed to pre-COVID-19.[115] With the sharp decrease in airplane sales post-COVID-19, the motive to sell an enticing new product to commercial airlines is extraordinary.

A base model Boeing 737 retailed for $89.1 million in March 2022.[116] That is the least expensive model.[117] The MAX 10, the highest-grade 737, sells for $134.9 million.[118] Airbus' equivalent to the Boeing 737 is the A320.[119] 516 Airbus A320s, listed at $101 million apiece, were delivered in 2022, and Airbus delivered 661 commercial planes in total that year.[120] It is important to note, however, that the listed prices for these aircraft are not necessarily what the airlines will actually pay for them.[121] The actual purchase price will likely be reduced for bulk ordering based on the number of aircraft ordered and the business relationships between the airline and manufacturer.[122] If Boeing and Airbus can convince the FAA and airlines that SPO is beneficial, they can guarantee themselves a substantial amount of orders for SPO planes, funneling in a plentiful profit.

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114. *Id.*

115. *Id.*

116. *Average Prices for Boeing Aircraft as of March 2022, by Type*, STATISTA (Aug. 23, 2023), [https://perma.cc/X2QY-Q2NU].

117. *Id.*

118. *Id.*

119. Youssef Yahya, *The Boeing 737 MAX vs. Airbus A320neo*, AVIATION FOR AVIATORS (Dec. 23, 2022), [https://perma.cc/7RT8-EE5A].

120. *Airbus Reports 2022 Commercial Aircraft Orders and Deliveries*, AIRBUS (Jan. 10, 2023), [https://perma.cc/22XT-J3PJ]; *see also* Jake Hardiman & Dr. Omar Memon, *What Are the Hourly Operating Costs of the Airbus A320 Family's Variants?*, SIMPLE FLYING (Dec. 25, 2023), [https://perma.cc/ZPY5-2TCQ].

121. Pranjal Pande & Tatenda Karuwa, *How Much Do Airbus Aircraft Cost?*, SIMPLE FLYING (June 28, 2023), [https://perma.cc/WLS8-9MYQ].

122. *Id.* To put the orders in perspective, Delta Airlines ordered 100 Boeing 737 MAX 10s with an option for thirty more in 2022, with delivery set for 2025. Leslie Josephs, *Delta Buys 100 Boeing Max Planes, Its First Major Order with the Manufacturer in More than a Decade*, CNBC (July 18, 2022, 5:54 PM), [https://perma.cc/EFK5-522N]. However, this is the first time Delta has ordered new airplanes from Boeing in over a decade. *Id.* Delta's order is worth more than $13.5 billion, but the airline did not disclose what the purchase price will actually be. *Id.* Delta is the only top four U.S. commercial airline (the others being American, Southwest, and United) that has not ordered new aircraft in recent years. *Id.*

2. Banking on Savings

SPO systems are being marketed to commercial airlines as a cost-saving solution.[123] Through SPO, commercial airlines and other air transport companies could cut the costs of personnel expenses, benefits, and salaries by $8.3 billion because they would effectively be cutting pilot personnel needs in half.[124] Although this seems like a substantial savings, it only represents 5% of the companies' non-fuel expenses.[125] The real financial incentive is therefore held by Boeing and Airbus because of how many new planes they could sell.

Further, SPO requires that someone be responsible for the flight from the ground; these people are referred to as ground-based operators.[126] They are supposed to be responsible for the safe execution of the air travel alongside the onboard captain.[127] For it to be cheaper for the airlines to use SPO instead of DPF, the ground-based operators would need to be working for multiple flights at the same time.[128] Currently, ground-based operators have to assist about twenty flights at a time, in various phases of flight and located all over the country or world.[129] Furthermore, if SPO is to be widely used, insurance companies will likely place substantial increases on their premiums to hedge their risk in protecting the commercial airlines that hope to save money by using this emerging technology.[130] Therefore, the implementation of SPO technology will have, at most, a nominal savings impact on commercial airlines.

3. Staffing Shortages in the Sky

Another reason SPO may be tempting is that it would eradicate, or at least reduce, problems that have arisen from the

123. *See* ALPA, *supra* note 43, at 1.
124. *Id.* at 24.
125. *Id.*
126. *Id.* at 11.
127. Bilimoria et al., *supra* note 17, at 3-4.
128. ALPA, *supra* note 43, at 11.
129. Bilimoria et al., *supra* note 17, at 4.
130. Culpan, *supra* note 100.

current pilot shortage.[131] The United States is currently experiencing a shortage of about 8,000 pilots, and this is projected to increase to 30,000 by 2032.[132] The shortage started with the baby boomer generation of pilots retiring.[133] Additionally, pilots have mandatory retirement at age sixty-five in the United States.[134] Further, less pilots are entering the civilian workforce after being trained in the military, where a substantial number of commercial pilots originate.[135] It is also extremely time consuming and costly for individuals to put themselves through flight school, which people must do if they are not trained in the military.[136] It is projected that by 2032, 80,000 more pilots will be needed in the workforce worldwide.[137]

It would unquestionably be convenient to reduce the number of pilots needed for commercial flights as the demand for flights continues to increase and the outlook on the pilot shortage is grim at best. However, SPO is still too dangerous to implement.[138] Further, several professions are experiencing shortages.[139] For example, the United States is predicted to have a shortage of up to 124,000 physicians by 2034.[140] One main reason cited for this shortage is how long it takes to properly train doctors and the expense of becoming a doctor.[141] Likewise, time and money are also barriers that people face in becoming pilots.[142] Just because we have a pilot shortage does not mean that we should replace them with computers, just like we should not replace doctors with

131. *See* Andy Agouridis, *Top 6 U.S. Industries with a Talent Shortage*, CAREER HIGHER (Aug. 1, 2023), [https://perma.cc/5VNZ-5AGV].

132. Geoff Murray & Rory Heilakka, *The Airline Pilot Shortage Will Get Worse*, OLIVER WYMAN, [https://perma.cc/GBZ8-JZ2B] (last visited Feb. 10, 2024).

133. Joseph Coughlin, *Filling Empty Seats: Why Baby Boomer & Gen X Retirement May Leave Millennials Coming Up Short*, FORBES (May 20, 2022, 8:24 AM), [https://perma.cc/U39A-PYYT].

134. Murray & Heilakka, *supra* note 132.

135. *Id.*

136. *See infra* Section III.C.2.

137. Murray & Heilakka, *supra* note 132.

138. ALPA, *supra* note 43, at 30-31.

139. Stephanie Ferguson & Makinizi Hoover, *Understanding America's Labor Shortage: The Most Impacted Industries*, U.S. CHAMBER OF COMMERCE (Jan. 9, 2024), [https://perma.cc/PP7G-VM8L].

140. Andis Robeznieks, *Doctor Shortages Are Here—and They'll Get Worse if We Don't Act Fast*, AM. MED. ASS'N (Apr. 13, 2022), [https://perma.cc/3P7D-J297].

141. *Id.*

142. *See infra* Section III.C.2.

software just because we need more of them—automation is not the solution to these kinds of problems.

4. Troubled Waters: Boeing's Lies Lead to Criminal Guilt

Boeing lying about the safety of its aircraft for profit, even with knowledge of deadly consequences, is nothing new; thus, it cannot be trusted to report the safety of SPO either. In October 2022, Judge Reed O'Connor of the U.S. District Court for the Northern District of Texas decided that the families of the victims of the two Boeing 737 crashes were "crime victims."[143] Boeing's criminal conduct was misrepresenting the MCAS system to the FAA and concealing knowledge of the improper activation, ultimately leading to the loss of 346 lives.[144] In the course of its investigation, the FAA determined the reason Boeing lied about the MCAS system "was to secure less onerous training requirements for pilots transitioning to fly the MAX from other older 737 models."[145]

Through secret negotiations with the Justice Department, Boeing admitted to criminal conspiracy but refused to plead guilty,[146] showing no effort to take responsibility for the event. The victims could sue Boeing because the secrecy of the negotiations with Boeing and the Justice Department violated the Crime Victims' Rights Act.[147] This ruling required the prosecution to honor the crime victims' reasonable right to confer about the case and any agreements.[148] However, the real problem was that Boeing and the Justice Department reached a settlement deal mandating Boeing to make payments of $1.7 billion to Boeing's airline customers, $500 million to the crime victims' families, and a $243 million fine.[149] Critics highlighted that Boeing was already contractually obligated to pay out the $1.7 billion amount.[150]

143. *See supra* Part I; Cassell, *supra* note 110.
144. Cassell, *supra* note 110.
145. *Id.*
146. *Id.*
147. *Id.*
148. *Id.*
149. Cassell, *supra* note 110.
150. *Id.*

Expert testimony revealed Boeing's direct criminal guilt in the two fatal crashes.[151] "But for" causation linked three actions that caused the crashes: (1) the FAA would have required comprehensive simulator training for American carriers on "how pilots should respond to improper MCAS activation" if Boeing had not lied; (2) foreign carriers would also have complied with the FAA's simulator training requirements; and (3) the pilots of the crashed planes would have been able to land them if they were properly trained in the simulator.[152]

Judge O'Connor's ruling and the supporting evidence showed that Boeing was directly responsible for the two fatal flights, and that they were preventable.[153] Boeing demonstrated a refusal to accept responsibility for the events and a willingness to lie to the FAA, airlines, and the public regarding the safety of their products.[154] SPO is now set to make Boeing and Airbus incredible sums of money, and Boeing has shown what lengths it will go to protect its profit margin.

C. Leave it to the Professionals

Without the professional judgment of two trained, certified, and continually evaluated pilots, the safety of commercial airline flights is greatly reduced. The need for two professional pilots onboard is evidenced by (1) realistic situations pilots face in the ordinary course of flying that require the judgment of more than one trained professional and (2) the experience required to become a commercial airline pilot.

1. That's Not Going to Fly: Hypothetical Flight Situations

The professional judgment of two pilots is necessary for the safe operation of a commercial airline flight in many situations.

151. *Id.*
152. *Id.*
153. *Id.*
154. Cassell, *supra* note 110.

A few of these situations include (a) incapacitation, (b) cyberattacks, and (c) suboptimal conditions.[155]

a. Incapacitation

One substantial hurdle that SPO has yet to overcome is pilot incapacitation.[156] Pilot incapacitation is "the inability of a pilot, who is part of the operating crew, to carry out their normal duties because of the onset, during flight, of the effects of physiological factors."[157] Incapacitation is assumed to occur one time for every one million flight hours.[158] A joint study conducted by the FAA and NASA in 2017 rendered the conclusion that if pilot incapacitation occurred with a flight supported by SPO, the results could be "catastrophic."[159] Events that can cause incapacitation include hypoxia (not having enough oxygen), food poisoning, falling asleep, attack by a passenger or crew member, heart attack, stroke, or seizure.[160] If only one pilot is incapacitated on a flight where there are two pilots, it is unlikely that the event will end in significant harm; however, the same cannot be said for when the only human pilot on the plane is no longer able to operate the aircraft.[161]

Proponents of SPO claim that the technology is advanced enough to handle a situation in which the single on-board pilot is incapacitated.[162] They also say that the odds are too low to really consider incapacitation as a big issue.[163] To ease the minds of the wary, however, the advocates argue that pilot incapacitation would be a "declared emergency" that ATC would be able to handle from the ground.[164] This would require that the ground

155. Other situations certainly exist but are beyond the scope of this Comment.

156. ALPA, *supra* note 43, at 5.

157. *Pilot Incapacitation*, SKYBRARY, [https://perma.cc/Q5FT-9VZB] (last visited Feb. 10, 2024).

158. Bailey et al., *supra* note 72, at 3.

159. ALPA, *supra* note 43, at 4.

160. SKYBRARY, *supra* note 157.

161. *Id.*

162. Bilimoria et al., *supra* note 17, at 4.

163. *Id.* at 3.

164. *Id.*

operator assisting from a control center take control of the flight and potentially land the plane.[165]

NASA conducted an experiment under these conditions and concluded that ground operators experience significant difficulty in handling issues on different aircraft at the same time.[166] If multiple situations in which an on-board pilot needs assistance are occurring simultaneously, one ground operator will not be able to dedicate their full attention where it may be required, endangering not just the flight in crisis at that moment, but also the other flights the ground operator is managing.[167] Further, incapacitation might not be the only reason a flight needs ground operator assistance in each situation. The operator may frequently have to assist with common issues such as weather updates and fuel status, keeping them busy regardless of whether there is an emergency on one of their assigned flights.[168]

One well-known, real life example of incapacitation—albeit engine failure, not human incapacitation—was portrayed by the movie *Sully* where a bird strike resulted in dual engine failure.[169] The captain of the flight, Captain "Sully" Sullenberger, made the decision to land the plane on the Hudson River.[170] Captain Sully had a mere 208 seconds to decide how to save the lives of his passengers and crew members.[171] He was assisted by his first officer.[172] Together they were able to land the plane safely by using their expertise, teamwork, and brainstorming.[173] During these 208 seconds, the two pilots had to communicate with the passengers and crew, try to coordinate a plan with ATC, and most importantly, figure out how to land the plane when they could not make it to an airport.[174] If Captain Sully had been alone in the

165. *Id.*

166. ALPA, *supra* note 43, at 11.

167. *Id.* at 13.

168. *Id.* at 3.

169. *Biography*, SULLY SULLENBERGER, [https://perma.cc/2BWT-4CBD] (last visited Feb. 10, 2024).

170. *Id.*

171. Emmett Pena, *The Miracle on the Hudson: The 208 Seconds That Defined Captain "Sully" Sullenberger's Career*, STMU RESEARCH SCHOLARS (Nov. 19, 2020), [https://perma.cc/87Y3-SQK5].

172. *Id.*

173. *See id.*

174. *Id.*

cockpit assisted only by SPO, his workload would have been unmanageable, likely ending in catastrophe. Because there were two pilots to address the situation, the first officer could inform the passengers and crew of the situation and Captain Sully could talk to ATC, all while the two pilots simultaneously worked together.

More recently, in November 2022, a captain became medically incapacitated soon after takeoff.[175] The first officer was able to control the airplane, speak with ATC, and plan a route to safely land the plane.[176] Had the captain been the only pilot onboard, there would not have been enough time for an SPO system to kick in, given encryption and signal delays, and for a ground operator to gain control of the flight and coordinate with ATC before the plane would have crashed.[177] Therefore, because incapacitation of the pilot or the aircraft can end catastrophically without a second pilot onboard, the risk of implementing SPO is too excessive to accept.[178]

b. Cyberattacks

By implementing SPO, commercial airlines are also accepting the risk of software cyberattacks.[179] The best way to prevent cyberattacks is to encrypt the software.[180] However, encryption hampers the effectiveness of the SPO technology because it can cause signal delays.[181] In situations where time is

175. *Copilot Turns Plan Around After Pilot Suffers Medical Emergency on Plane from O'Hare*, CBS NEWS (Nov. 22, 2022, 10:51 PM), [https://perma.cc/YME2-7P73].

176. *Id.*

177. *See infra* Section III.C.1.b.

178. In 2015, one of the pilots on a Germanwings flight intentionally crashed the plane, killing 150 people in total. *Germanwings Crash: What Happened in the Final 30 Minutes*, BBC NEWS (Mar. 23, 2017), [https://perma.cc/V3AQ-XXDV]. The pilot accomplished this by locking the other pilot out of the cockpit. *Id.* It is true that the second pilot in this situation was useless in preventing the crash. *See id*. However, if there is another pilot onboard, it is much more difficult for a pilot to complete a suicide mission because the second pilot must be incapacitated, whether that be medically or otherwise, than if he were alone in the cockpit. Situations such as this prove that when a flight is in crisis, it is imperative to have two pilots on the flight. Although tragic situations like this have occurred, they are exceedingly rare.

179. ALPA, *supra* note 43, at 23-24.

180. *Id.* at 4.

181. *Id.*

of the essence, much like what happened to Captain Sully,[182] delays can be the difference between safety and disaster. Although delays likely take less than a minute, in the interim, the SPO ground operator may not have access to control the system.[183] This means that there can be a lapse in time where no one is in control of the aircraft. Additionally, when operating flights with service to international destinations, some countries have banned encryption, leaving the system vulnerable to cyberattack.[184]

Further, if a cyberattack occurs, a threat actor could have complete control over the plane. Commandeering the plane renders the pilot and ground operator unable to complete any flight duties.[185] Although a second pilot would be of no use when the plane is being controlled remotely by a hacker, the SPO technology being implemented is what allows the possibility of cyberattacks in the first place. Current technology used on commercial aircraft does not give the possibility for cyberattacks.[186] Therefore, because SPO technology opens flights up to cyberattacks and encryption—which cannot be used everywhere and can cause signal delays where the flight is not controlled—SPO should not be used on commercial airline flights, especially with foreign destinations.

c. Off-Nominal Conditions

One very common situation to consider is when conditions—mainly weather-related—are off-nominal during a flight. Unexpected changes in weather, rain, ice, lightning, engine fire, air pressure, and "uncoordinated interactions" with other aircraft all represent off-nominal conditions.[187] ALPA has found a "clear inverse relationship between pilot workload and safety, particularly during off-nominal conditions."[188]

182. *See supra* Section III.A.1.
183. ALPA, *supra* note 43, at 8-9.
184. *Id.* at 9.
185. *Id.*
186. *See id.*
187. *Id.* at 6-7.
188. ALPA, *supra* note 43, at 3.

Current research proves that during off-nominal conditions, the workload is too demanding for both the pilot and ground operator in SPO.[189] Furthermore, having a ground operator would not lessen the workload of the captain.[190] NASA's data clearly show that SPO technology is not acceptable, especially in off-nominal conditions, because of the workload it demands of the onboard pilot.[191] The question therefore is whether a ground operator can safely take on tasks, reducing the workload of the onboard pilot.[192] Tasks such as take-off, approach, and landing are higher-workload than other situations pilots handle during flight.[193]

In NASA's experiment, the pilots who were assisted by SPO could not complete all tasks when their workload became too high, even in nominal conditions.[194] This led to error.[195] That issue was even more prevalent in off-nominal conditions where "[t]he data show a statistically significant increase in workload for the SPO condition" compared to DPF.[196] From the pilots' safety perspective, SPO was intolerable even during nominal conditions.[197] Unsurprisingly, the pilots thought that the use of SPO during off-nominal conditions was "completely unacceptable," prompting researchers to conclude that "[t]he SPO condition was clearly not well appreciated by the flight crew."[198]

The other pressing issue with off-nominal conditions is the lack of communication. In considering the relationship between the pilot onboard and the ground operator, "[a] primary concern is the ability (or inability) to know what the other pilot is doing."[199] This lack of situational awareness is cause for concern. If there were two human pilots in the cockpit, each would know

189. *Id.* at 5.
190. *Id.*; *see also* Bailey et al., *supra* note 72, at 12-13.
191. *See supra* Section III.A.1.
192. Bailey et al., *supra* note 72, at 2-3.
193. *See id.* at 2.
194. *Id.* at 6-7.
195. *Id.*
196. *Id.* at 7.
197. Bailey et al., *supra* note 72, at 9.
198. *Id.* at 10.
199. *Id.* at 3.

what was happening and have immediate access to the controls and other necessary equipment.

Non-verbal cues are a significant way that onboard pilots communicate.[200] In DPF, the pilots can non-verbally gather information from each other in a natural and quick way that only human brains can understand.[201] If both aircraft operators (the ground operator and onboard pilot in SPO) are not physically in the same place, coordination suffers.[202] Confusion and workload also rise because replacing non-verbal communication with verbal communication causes the addition of "an impractical number of tasks to the pilot's workload."[203]

In conclusion, because of deadly implications of incapacitation, cyberattacks, and disjointed communication, SPO technology introduces significantly more problems than it fixes and should not be incorporated into aircraft.

2. Preparing to be a Pilot

SPO is an inadequate substitute for a human pilot because the intensity of the training shows how hard a human's expertise is to replace. Becoming a pilot involves a significant investment of time, energy, rigorous training, and a high degree of knowledge, making pilots some of the most highly trained professionals society has.[204] The requirements ensure that only people who are highly competent can fly; it is a dangerous job. There are two general ways to become a commercial pilot: through the military or by private training.[205]

To become a pilot in the military, regardless of branch, the person must first obtain an officer commission.[206] A bachelor's degree, preferably in science, with a minimum grade point

200. ALPA, *supra* note 43, at 8.

201. *See id.*

202. *Id.*

203. *Id.* at 4.

204. *See Airline and Commercial Pilots: Occupational Outlook Handbook*, U.S. BUREAU LABOR STATISTICS (Sept. 6, 2023), [https://perma.cc/CG4G-XKAN].

205. *See The Decision: Military or Civilian*, FUTURE & ACTIVE PILOT ADVISORS (Feb. 1, 2023), [https://perma.cc/ZK5N-BGT8].

206. *A Complete Guide to Military Pilot Salary & Requirements*, MYBASEGUIDE, [https://perma.cc/WV2A-9QY7] (Feb. 10, 2024).

average of 3.4 is required before someone can even be considered for an officer commission.[207] An officer must also meet a host of other requirements to secure a pilot spot, non-exhaustively including: not being overweight, no laser eye surgery, no allergies or asthma past age twelve, vision 20/50 or better uncorrected, and passing qualifying tests and flight school.[208] It takes a highly exceptional person to meet these arduous requirements. Not including the bachelor's degree or Officer Candidate School, it can take up to two years to become a military pilot.[209]

If a person elects civilian training, they start their training by enrolling in flight school.[210] They will also need to pass a strenuous medical exam with an Aviation Medical Examiner.[211] Before earning a commercial rating, a private pilot's license is required.[212] Next, the student pilot must earn a Student Pilot Certificate and begin ground training school.[213] In ground training school, students are taught about weather conditions, flight instruments, and ATC.[214]

Once ground school has been completed, student pilots can start learning how to operate an aircraft by working with a certified flight instructor in a simulator.[215] This allows students to become acquainted with the aircraft and learn how to use its instruments before venturing into navigable airspace.[216] Furthermore, the flight instructor can simulate emergency and off-nominal circumstances to teach the student how to handle

207. *Id.*; *Officer Candidate School*, U.S. ARMY, [https://perma.cc/6X2M-YCBR] (last visited Feb. 10, 2024).

208. *A Complete Guide to Military Pilot Salary & Requirements*, *supra* note 206.

209. *See* ATP FLIGHT SCHOOL, *supra* note 33.

210. *Id.*

211. *FAA Medical Certificates*, ATP FLIGHT SCH., [https://perma.cc/JUT5-ABE2] (last visited Feb. 10, 2024).

212. Tom Grupa, *How Much Do Flying Lessons Cost?*, LESSONS.COM (Oct. 19, 2022), [https://perma.cc/XX7B-ZHD6].

213. *Become a Pilot*, FED. AVIATION ADMIN., [https://perma.cc/B7ZB-VQAC] (last visited Feb. 10, 2024).

214. *Ground School vs Flight School: What's the Difference?*, PILOT INST. (Aug. 20, 2019), [https://perma.cc/DLJ2-7JSC].

215. Marcel Bernard, *Real Learning through Flight Simulation*, FAA SAFETY BRIEFING, Sept./Oct. 2012, at 8, [https://perma.cc/VWC5-Y8EJ].

216. *Id.*

these situations.[217] Once the flight instructor is comfortable with the student's simulator performance, the student can fly an actual plane.

Forty hours of flight time is required for a private pilot's license.[218] A minimum of 250 flight hours are required to get a commercial pilot certificate.[219] It can take upwards of two years to accumulate that many hours.[220] Additionally, flying lessons cost up to $240 an hour.[221] That means that flying lessons alone can cost over $37,000. Hours earned towards a private pilot's license are credited against the hours needed for a commercial license.[222] All of the requirements for a private pilot's license show that it takes an immense amount of time and dedication to become qualified to work in this field. Pilots, just like physicians, lawyers, and engineers, are tested in a way to produce only very capable individuals that can be trusted with monumental responsibilities.

To be able to fly for a major American airline, a pilot also needs to get an instrument rating and a multi-engine rating.[223] Those hours can also count towards the required commercial hours.[224] Passing the FAA Practical Flight Test is the final step in earning a commercial license.[225] In conclusion, no matter how an individual chooses to become a pilot, it is a very intensive program requiring a large amount of training and education. The aviation industry is highly regulated for a reason; the FAA

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217. *Emergency Procedures Training*, FED. AVIATION ADMIN., [https://perma.cc/HS7H-RD96] (last visited Feb. 10, 2024).

218. Rachel Miller, *How Much Does It Cost to Become a Pilot? Private, Instrument, Commercial, CFI*, FL AVIATION CTR. (Feb. 22, 2023), [https://perma.cc/DU7U-BRFV].

219. *How Do I Get a Commercial Pilot License (Certificate)?*, FED. AVIATION ADMIN., [https://perma.cc/J77M-F75L] (last visited Feb. 10, 2024).

220. *See How Long Does It Take to Become a Commercial Airline Pilot?*, ATP FLIGHT SCH. [https://perma.cc/AVT6-RA6N] (last visited Feb. 10, 2024).

221. *How Much Do Flying Lessons Cost?*, *supra* note 212.

222. *See* Miller, *supra* note 218.

223. *How to Become an Airline or Commercial Pilot*, SCHOLARSHIPBUDDY, [https://perma.cc/C27H-SN32] (last visited Feb. 20, 2024).

224. *Id.*

225. Valerie Smith, *Commercial Pilot Requirements: A Beginner's Guide*, REDBIRD FLIGHT SIMULATORS (June 24, 2021), [https://perma.cc/GW3A-YYBH]. The test has both a check ride and an oral component. *Id.* The requirements listed here are non-exhaustive and only a sample of standards pilots must meet.

requires such strict standards because of how dangerous the implications of an unqualified pilot are.

D. Regulatory Options & Recommendations

If SPO is ever to be implemented in commercial airline flights, it must be regulated to ensure the safety of passengers and crew. Before Part 121 is amended, there must be (1) an extended timeframe for SPO implementation and (2) extensive simulator trials. After the preventable tragedies endured just a few years ago,[226] Congress should decline to amend Part 121 at this time.

1. Public Acceptance & Extended Timeframe

As a matter of public policy, polling data show that the general public is not ready to accept the SPO idea.[227] Even if Congress were to allow SPO, the product is likely unmarketable at this point. The European Union Aviation Safety Agency ("EUASA"), in contrast, has said that SPO could be introduced on commercial airline flights as early as 2027.[228] A 2017 NASA study concluded that without significant societal change in opinion of the SPO, it will never become a reality.[229] That includes commercial airline passengers being unwilling to buy a ticket for a flight with only one human pilot, as well as the pilots themselves being unwilling to operate an aircraft on their own.[230]

Moreover, while SPO could be implemented in the United States for domestic flights and countries regulated by EUASA, some jurisdictions ban the use of such technology in their airspace.[231] This means that flights to these countries or just over their airspace during flight would have to use DPF. Other entities, such as ALPA, have been pushing back on SPO with fervor.[232] While ALPA, a pilots' union, certainly has a vested interest in

226. *See* discussion *supra* Part I.

227. ALPA, *supra* note 43, at 4.

228. *Bizarre and Dangerous . . . Aviation Regulators Pursue Single Pilot Part 121 Ops*, AERO NEWS NETWORK (Nov. 23, 2022), [https://perma.cc/UDD7-R3TX].

229. Bailey et al., *supra* note 72, at 13.

230. *See id.*; ALPA, *supra* note 43, at 18-19.

231. Culpan, *supra* note 100.

232. *See* ALPA, *supra* note 43, at 31.

protecting pilot jobs, it is not the only group that can apply pressure to stop the amendment of Part 121.[233]

One way to capitalize on this negative public opinion and limit successful SPO implementation is for consumer protection agencies to require airlines to disclose SPO use when consumers are buying flights.[234] If a consumer knows about SPO—which is an important caveat—he or she is likely to be reluctant to trust the safety of that aircraft.

The power of the individual cannot be underestimated in a situation like this.[235] Enough pushback from the general public could persuade Congress to regulate against the use of SPO.

Advanced and intricate technology cannot be developed quickly.[236] Although there is no clear timeframe for when SPO development began, the most current NASA studies conclude that SPO technology, though not necessarily infeasible, needs much more time for research and development.[237] Even as lobbyists push for Congress to amend Part 121 to allow SPO, it is clear that now is not the time. Not only are there gaping holes in safety, but pilots are also uncomfortable using the technology.[238] Furthermore, the funding for aviation development is limited, and polls of industry experts revealed that there are more important issues that need research funding than SPO, which, theoretically, only benefits the private sector and not the general population.[239] SPO lobbyists and developers are pushing too far by trying to introduce this technology to the market too quickly. The risks are too prominent at this point for Congress to amend Part 121 and allow SPO.

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233. Culpan, *supra* note 100. Other pilot groups such as the International Civil Aviation Organization, the European Cockpit Association, and the International Federation of Air Line Pilots' Association have opposed SPO. Steven Walker, *Pilot Associations Team Up Calling Single Pilot Ops "A Threat to Safety"*, SIMPLE FLYING (Mar. 27, 2023), [https://perma.cc/2BHU-G5DP]. These groups represent over 150,000 pilots worldwide. *Id.*

234. Culpan, *supra* note 100.

235. *Id.*

236. *See* Matt Clancy, *How Long Does It Take to Go from Science to Technology?*, NEW THINGS UNDER THE SUN (Aug. 13, 2021), [https://perma.cc/YWW2-WTZE].

237. *See* discussion *supra* Section I.A.

238. *See* discussion *supra* Section III.A.1.

239. ALPA, *supra* note 43, at 5.

2. Simulator Trials

Boeing has a harrowing past of refusing to conduct the necessary simulator trials and pilot training on their technology.[240] Simulator trials and training are integral to the aviation industry. Pilots are trained and tested in simulators, and new technology is introduced in the same setting.[241] Pilot training on new technology is time-consuming and expensive. However, if SPO is to be brought to general usage, that is a cost that both the commercial airlines and developers must accept.

The best way to gain confidence in SPO from both the public and pilots is to put it through extensive simulator trials. First, the hypothetical situations that create the most concern about SPO could all be tested in the simulator.[242] The pilot and ground operator would be able to test how fast the plane could be controlled during pilot incapacitation or appropriate program activation in sudden onset lightning storms. As one issue with the use of SPO is the deterioration of pilot skills, simulator training can augment actual flying hours to maintain the necessary levels of competency. If commercial airlines want their pilots to fly with SPO, they need to require the pilots to train in the safe environment of the simulator.

If the developers commit adequate resources to proving that this technology is safe and effective, the feasibility of the product increases greatly. Large experiments will need to be done with numerous trials on all currently foreseeable issues. Only after that proof is adequate should commercial pilots be trained to use SPO. Until then, it is unfathomable that Congress has enough evidence to amend Part 121 allowing this technology.

IV. CONCLUSION

Boeing took 346 lives in the span of five months when it knowingly allowed planes that could crash to nevertheless take flight.[243] Boeing and Airbus are now back on the same trajectory

240. *See* discussion *supra* Part I.
241. *See* discussion *supra* Section III.D.2.
242. *See Emergency Procedures Training*, *supra* note 217.
243. *See* Cassell, *supra* note 110.

as they push for the implementation of SPO despite knowledge of its many pitfalls and possibility of devastating malfunctions. Part 121 of the Federal Aviation Regulation, keeping the skies safe by requiring two human pilots onboard, is threatened by the Congressional FAA reauthorization bill allowing implementation of SPO.

The risk is that airplanes—currently the world's safest mode of transportation[244]—will lose their safety as they lose a human pilot. SPO manufacturers rely on financial and efficiency arguments, while casting aside NASA research showing that the technology is premature, the deadliness of similar technology tested in cars, and the importance of having two highly trained professionals onboard when things go wrong during flight. Hypothetical situations like cyberattack and pilot incapacitation have not been addressed in a way that keeps aircraft safety at the same level with SPO as it does with two human pilots onboard. For these reasons, Congress should keep Part 121 intact and reject the reauthorization bill.

244. ALPA, *supra* note 43, at 6.