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The Need for Two Pilots in Modern Aircraft

Kim Valeriy Aleksandrovich
Type Rating Instructor, 2 Flight Division of the Flight Service Department of "UZBEKISTAN AIRWAYS" JSC
Tashkent, Uzbekistan

Abstract: The issue of the need for two pilots on board modern aircraft is an urgent topic in the aviation industry, especially in the context of the rapid development of technology and automation. Despite significant advances in this field, such as the introduction of high-tech control systems and autopilots, there remains a need for two pilots to ensure reliable control and control of the aircraft, especially in emergency situations. Two pilots contribute to more balanced and expeditious decision-making, workload distribution and improvement of overall flight safety. The study of this topic is important not only from a theoretical but also from a practical point of view for the sustainable development of aviation. This work is aimed at analyzing and justifying the need for two pilots in modern aircraft.

Keywords: Pilots, co-pilot, finding two pilots, aircraft, piloting aircraft, the need for two pilots.

1. Introduction

The necessity of having two pilots on board aircraft is one of the most significant and relevant topics in the aviation industry. With the advancement of technology and the increase in flight automation, there is a need to reassess traditional crew size requirements, linked to opportunities for improving the efficiency and cost-effectiveness of air transport. Modern aircraft are equipped with high-tech control systems, autopilots, and diagnostic tools that significantly reduce the impact of human factors on flight safety. However, despite these advancements, the need for two pilots on board remains, driven by the necessity of providing reliable control and management of the aircraft in emergency situations that exceed the capabilities of automated systems. Additionally, the presence of two pilots allows for the distribution of workload, contributing to more balanced and prompt decision-making in complex and unforeseen circumstances.

The issue lies in finding the optimal balance between leveraging technological advancements associated with process automation and meeting safety requirements. In this context, the investigation of the necessity of having two pilots is not only theoretically significant but also practically important for ensuring the sustainable and safe development of the aviation industry. The aim of this work is to examine the necessity of having two pilots in modern aircraft.

2. General Theoretical Issues of Aircraft Management

The process of managing an aircraft is a complex and multifaceted activity, encompassing a wide range of technical and operational tasks aimed at ensuring the safety and efficiency of the flight. This process begins long before takeoff with meticulous preparation, including route planning, calculating the necessary amount of fuel, assessing weather conditions, and other factors that may affect the flight [1]. The aircraft commander is fully responsible for the safety of the flight, crew, and passengers. They must perform all necessary checks at every stage of the flight: pre-departure, during flight, and post-landing. Typically, their duties include analyzing meteorological conditions, carrying out safety control procedures, creating a flight plan, and ensuring the successful delivery of the aircraft to its destination. During the flight, pilots must report any problems or changes, monitor messages from air traffic controllers, and make adjustments to the route as needed.

The copilot also plays a crucial role in the aircraft management process, performing many important tasks and responsibilities that complement and support the work of the captain (commander) of the crew [2]. The primary duties of the copilot are illustrated in the table below.

Table 1. Duties of the Copilot [3].

Duty	Description
Flight Preparation	The copilot assists in checking all documents, including the flight plan and technical logs.
Aircraft System Check	Before takeoff, the copilot conducts an external inspection of the aircraft and checks the condition of its systems and equipment. They also assist the captain with pre-flight checks inside the cockpit, verifying the operation of avionics, navigation systems, hydraulics, and other critical systems.

Aircraft Management	During the flight, the copilot's duties include managing the aircraft when the captain is performing administrative tasks or resting, monitoring instruments, and performing necessary maneuvers.
Navigation and Communication	The copilot is responsible for maintaining communication with air traffic controllers, receiving and transmitting instructions. They also assist in navigation, following the route, and adjusting the course as needed.
Flight Monitoring	The copilot continuously monitors the operation of all aircraft systems, oversees fuel indicators, engine parameters, and other critical data.
Safety Assurance	In the event of an emergency, the copilot takes actions to resolve the issue or minimize its consequences. They assist the captain in making decisions and carrying out necessary procedures to ensure flight safety.
Landing and Taxiing	The copilot helps the captain with landing procedures, either piloting the aircraft or performing auxiliary tasks. After landing, they assist in managing the aircraft on taxiways and in preparing for the next flight.

Thus, the copilot is an integral part of the crew, making a significant contribution to the safe and efficient management of the aircraft. Their participation and professionalism provide additional levels of control and safety assurance at all stages of the flight [3]. From the above, it can be noted that the roles of the captain and the copilot are largely similar, as both require a high level of skill and qualification. The main difference lies in rank and responsibility: the captain is the senior pilot and is responsible for the entire flight, whereas the copilot follows the commander's orders. The captain, with greater experience and responsibility, receives a higher salary and wears four stripes on their uniform, as opposed to the three worn by the copilot [4].

3. Issues Surrounding the Presence of a Copilot on Board an Aircraft

Currently, discussions are emerging regarding the necessity of having a copilot on an aircraft[6]. Airlines, striving to keep up with rapid technological advancements, have begun actively integrating artificial intelligence technologies at various stages of operation. The use of AI algorithms in autopilot work allows for controlling speed, altitude, and other parameters with high precision, almost without human intervention. However, takeoff, landing, and control in turbulent conditions remain the pilots' responsibilities. In the future, a fully automated control system may be developed, where a single pilot will oversee the flight with the help of AI.

AI technologies, such as deep learning, can create multisensory models for predicting weather conditions and suggesting optimal routes. Companies like Airspace Intelligence are developing models that predict airspace dynamics and recommend optimal routes. This technology saves pilots time by eliminating the need to manually select the best route [19].

For widespread implementation, improvements in the human-machine interface are necessary. Feedback suggests that the control indicator could be more intuitively understandable. "The possibility of earlier intervention and interpretability by pilots demonstrates how AI can work with humans, enhancing trust and safety," adds Stephanie Gil from Harvard. The study was partially funded by the US Air Force, Boeing, and the Office of Naval Research. The obtained results do not necessarily reflect the views of the US government [20].

However, currently, autonomous systems lack the emotional intelligence to make real-time decisions, which can lead to severe consequences in case of errors. Experts also pointed out the risks associated with losing control of the aircraft if the sole pilot becomes incapacitated. Oleg Prikhodko, Vice President of the Flight Crew Union, stated[5] that replacing the copilot with artificial intelligence in the coming decades is impossible, as it would jeopardize the safety of passenger transport and undermine the pilot training system.

Igor Delduzhov, President of the Sheremetyevo Flight Union, also emphasized [5] that the experience gained as a copilot is necessary for future aircraft commanders. Amid these issues, discussions about replacing the copilot with AI technologies raise concerns among potential pilots, which may lead to a long-term shortage of personnel in the industry [5,6].

One of the main problems of replacing pilots is the multitude of unpredictable situations that require high qualifications and skills to resolve. Moreover, this would require the installation of a large number of expensive fail-safe sensors[7]. However, the use of autopilots in civil aviation would significantly reduce the need for a large crew, such as flight engineers and navigators. It would also optimize flight paths, reduce fuel consumption, and effectively use runways. Since modern automatic onboard control systems (ABCS) control all major components of the aircraft, automating routine tasks and increasing the safety and efficiency of flights.

These systems can predict optimal points for ascent and descent to save fuel and maintain optimal speed and course [8,9].

The advantage of the neural network approach lies in its ability to identify patterns in data and generalize them, meaning it can extract knowledge from the data. However, this approach also has its drawbacks: the complexity of forming representative samples, a large number of training cycles, and the risk of forgetting old examples. Additionally, it is challenging to visually represent the functional dependence between the input and output data of the studied object [10].

Nevertheless, more than forty countries, including Germany, the United Kingdom, and New Zealand, have approached the United Nations organization responsible for aviation standardization with a proposal to implement and ensure the safety of single-pilot flights. The European Union Aviation Safety Agency (EASA) is also collaborating with aircraft manufacturers to develop and approve regulations for such flights. According to EASA, the implementation of these services could begin as early as 2027 [11].

Tony Lucas, captain of an Airbus SE A330 crew at Qantas Airways Ltd. and president of the Australian and International Pilots Association, expressed concern that a sole pilot might find themselves in a critical situation before anyone could assist them [12]. He emphasized that "when a problem arises, it develops very quickly." The following examples highlight the necessity of having a second pilot:

1. Air France Flight 447: On June 1, 2009, en route from Rio de Janeiro to Paris, the crew began receiving incorrect speed readings due to iced-over sensors while on autopilot. Ninety seconds after the incident began, the captain returned to the cockpit, but the plane was already in a stall from which it did not recover. All 228 people on board perished in the crash.
2. US Airways Flight 1549: On January 15, 2009, a US Airways aircraft collided with a flock of geese, losing power in both engines. Thanks to the combined efforts of Captain Chesley Sullenberger and First Officer Jeffrey Skiles, the plane was successfully landed on the Hudson River with no loss of life. This event became known as the "Miracle on the Hudson" [10].
3. Gimli Glider: On July 23, 1983, a Boeing 767 of Air Canada, flying from Montreal to Edmonton with an intermediate stop in Ottawa, encountered an unusual situation. At 12,000 meters altitude, it was discovered that the fuel quantity data from the onboard computer was incorrect. This incident occurred during Canada's transition to the metric system, causing confusion among ground staff who miscalculated the fuel load using pounds instead of kilograms, resulting in underfueling.

As a result, the aircraft ran out of fuel mid-flight, and the engines stopped. The engine failure led to the loss of the main electrical system, leaving the pilots with only backup instruments powered by an auxiliary power unit. The captain, Robert Pearson, who had experience with gliders, managed to handle the situation. Realizing they would not reach Winnipeg, First Officer Maurice Quintal suggested using the Gimli Industrial Park Airport, a former airbase where he had previously served, for an emergency landing. Unbeknownst to him, the base had been converted into a racetrack with a partitioned runway.

On the day of the incident, a local car club was holding a race on the track, which was equipped with a barrier. Despite this, Captain Pearson successfully landed the plane, stopping less than 30 meters from spectators. A fire broke out during the landing, which was quickly extinguished by car enthusiasts using handheld fire extinguishers [21].

Based on these examples, the necessity of having two pilots in the cockpit has been demonstrated. The arguments for and against replacing the second pilot with artificial intelligence or other technological tools are presented in Table 2 below.

Table 2. Arguments for and against having a copilot on an aircraft [13]

Arguments For	**Arguments Against**
Reduction of Pilot Shortage: The global aviation industry is facing a severe shortage of qualified pilots. Over the past three decades, the number of licensed pilots has decreased by approximately 30%. Thousands of new pilots are expected to be needed in the coming years. Some airlines are already being forced to limit or cancel flights due to staff shortages. Reducing the number of pilots in the cockpit can mitigate this problem.	Inadequate Automation: Incidents with B737 Max aircraft have shown that human interaction with automatic systems is not always error-free. Issues with automation can lead to serious consequences, including a decline in piloting skills and a lack of situational awareness for the pilot.

Cost Savings for Airlines: Reducing the number of pilots means significant savings on their salaries, as pilots are among the highest-paid employees in airlines. This will reduce operational costs and possibly lower ticket prices, benefiting passengers.	Increased Workload for the Pilot: In the cockpit, the captain and first officer work together, sharing tasks and checking each other. This increases safety, as the presence of a second pilot allows for the timely detection and correction of errors. In crisis situations, the second pilot plays a crucial role in decision-making and supporting the captain.
Development of New Technologies in Aviation: Simplifying pilot requirements will open up new opportunities for innovation in aircraft design. Automation can take on more functions, as has happened with the disappearance of flight engineer positions. Modern automation systems already manage most stages of flight, and their role will only grow.	Health Risks for the Sole Pilot: Eliminating the second pilot increases the risks associated with the health of the sole pilot. If the captain loses consciousness or faces another serious health issue, the aircraft would be left uncontrolled. Even ordinary fatigue can become critical, as studies show that pilots often fall asleep during flight [13].

Thus, the use of artificial intelligence in aviation is a promising area of development that can bring significant benefits to both the aviation industry and passengers. The implementation of AI in automated control systems for civil aviation is a necessary step for improving the industry and ensuring its sustainable development [14].

4. Future Trends

Numerous aviation experts predict that by 2030, civil aircraft will be piloted by just one person [15]. This innovation is expected to reduce operating costs for aircraft. To alleviate the burden on the sole pilot, the concept of a "virtual copilot" is planned to be introduced. At the opening of the MAKS-2021 airshow, the President of the Russian Federation emphasized that unmanned systems, robotics, and artificial intelligence would become key areas of development for Russian aviation. These trends are already actively being implemented in military aviation, but the civilian sector lags in the application of artificial intelligence.

Existing automation, by performing routine tasks, significantly eases the work of pilots, and it is now hard to imagine a modern aircraft without these technologies. However, the concept of a "virtual copilot" represents a fundamentally new stage of development based on artificial intelligence technologies, differing from the traditional autopilot used in modern airliners.

Experts from the State Research Institute of Aviation Systems (GosNIIAS), working within the National Information Center (NIC) "Zhukovsky Institute," note [16] that modern autopilots perform a limited range of tasks related to stabilizing flight parameters. Meanwhile, the crew's functions expand to include navigation, assessing the current state of the aircraft and weather conditions, and situational awareness tasks. The development of computational capabilities and artificial intelligence technologies makes the creation of a "digital copilot" possible [17].

When it comes to implementing modern technologies that allow for the replacement of the copilot in an aircraft, this represents a comprehensive process based on advancements in artificial intelligence (AI) and automation. One of the key areas is the development of systems like Air-Guardian, developed at the Massachusetts Institute of Technology (MIT). These systems use eye-tracking technologies and saliency maps to analyze and predict pilot actions, enabling the machine to make decisions in critical situations. Such technologies significantly improve flight safety by providing more accurate and faster responses to potential risks.

Another important aspect is the development of AI advisors, such as the system being created by Merlin Labs for the US Air Force. This system is designed to interact with air traffic controllers at a level comparable to human pilots. Machine learning algorithms enable the AI to perceive and respond to controller commands in real time, ensuring continuity and safety in aircraft management even in challenging conditions.

Additionally, integrating AI into educational programs, like Microsoft Copilot, helps prepare future specialists to use such technologies. These programs foster critical thinking and provide students with tools for effective learning and data analysis. Thus, they support the transition to more automated and technologically advanced management systems in aviation and other industries [18].

Modern AI technologies allow for enhanced interaction between humans and machines, where AI acts as a copilot, ensuring a higher level of safety and efficiency in flights. Implementing such technologies requires

significant efforts in development and certification but promises substantial benefits for the aviation industry in the future.

5. Conclusion

In conclusion, the examination of the necessity for having two pilots on board modern aircraft has shown that, despite significant advancements in automation and the implementation of high-tech control systems, the human factor remains critically important for ensuring flight safety. Technical systems can effectively handle routine tasks and improve flight control, but in extreme and unforeseen situations, only the experience and professionalism of two pilots can ensure adequate and timely decision-making, as evidenced by numerous incidents and accidents in aviation history.

The presence of two pilots on board allows for the distribution of workload, which reduces fatigue levels and improves concentration, especially during long flights. This contributes to more balanced and prompt responses to unexpected changes in flight conditions. Examples such as the emergency landing on the Hudson River, the incident with Air France Flight 447, and the landing of an airliner on a racetrack demonstrate the importance of the coordinated work of two pilots in preventing disasters and minimizing risks.

Therefore, maintaining two pilots on board modern aircraft is a necessary condition for sustaining a high level of safety and reliability in air transportation. The implementation of artificial intelligence technologies and automated control systems should be seen as a supporting tool that complements but does not replace the human factor. This approach will ensure the sustainable development of the aviation industry while maintaining high standards of safety and flight efficiency.

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