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Investigating Young Pilots' Perception, Training, and Reliance on Automation in the Flight Deck

Mary Bender[1], Allysa Hayden[1], Vanesa Miksa[1], and Elizabeth Blickensderfer[1]

Abstract

Automation has existed for decades and has been implemented in many industries, including aviation, and the designs of the future are underway. This technology has changed the roles and responsibilities of pilots, and the current pilots-in-training will be the primary operators of those aircraft. Understanding how these future pilots are learning and using automation may provide insight to future aircraft design teams. Eleven participants, including four Certified Flight Instructors Instrument and seven pilots-in-training, were recruited via convenience sampling from a southeastern university for this study. The participants completed a semi-structured interview which focused on their experiences with automation. Results suggest that first, CFIIs understand the risk of pilots' over-reliance on automation and emphasize manual flight at the instrument rating level. Second, CFIIs seem aware that a pilot's comfortability with automation influences their decision to use it. Third, young pilots tend to rely on automation but feel prepared to hand fly in situations where manual flying is required. Finally, training from CFIIs on automation concepts tends to be inconsistent. The implication of this study includes recommendations on how training on automation concepts can be improved, such as (1) having more time to experience using automation in the simulator or in flight, (2) having dedicated, in-depth lessons either on the ground or in flight on automation concepts, and (3) more consistency from CFIIs when teaching automation.

Keywords

aviation, automation, pilots, CFIIs, reliance, training

Introduction

Automation has existed for decades and has changed the roles and responsibilities of humans in the flight deck. Automation refers to machines performing tasks previously performed by humans (Parasuraman & Riley, 1997) and varies in levels and capabilities. Lower levels of automation require human input, whereas systems with higher automation capabilities require no human input. With the aim to reduce human physical and mental labor, automated technology has been implemented in many industries, including manufacturing, automotive, and aviation (Sheridan, 2002). The design, development, and manufacturing of complex systems (such as an aircraft) that include advanced automation technology begin years, or decades, in advance of their use. In turn, the operators of these future systems will be the current (and future) generation of aviators in training. For aviation, this means the pilots currently in training will be flying the next generation of aircraft. The purpose of this interview study was an initial exploration of how young pilots in training are experiencing automation in flight. Understanding how these future pilots are learning about and using automation may provide insight to design teams working on the aircrafts of the future.

Background

The aviation industry began automating tasks in the flight deck in 1912, starting with the gyroscopic autopilot which controlled the heading and attitude of the aircraft (Hartley, 2024). Over time, the flight deck evolved to include other forms of technology, beginning with the modern "six-pack" of displays: the Altimeter, Airspeed indicator (ASI), Vertical Speed Indicator (VSI), Heading Indicator (HI), Turn Coordinator, and Attitude Indicator (AI). However, a major

[1]Embry-Riddle Aeronautical University, Daytona Beach, FL, USA

Corresponding Author:
Mary Bender, Embry-Riddle Aeronautical University, 1 Aerospace Blvd, Daytona Beach, FL 32114, USA.
Email: benderm@my.erau.edu

transition occurred with the introduction of automated systems such as the G1000 (i.e., glass cockpit) into the flight deck. Currently, new aircraft use a Primary Flight Display (PFD) and Multi-function Display (MFD) combination as well as automated systems, such as autopilot and a Flight Management System (FMS). Autopilot handles tasks related to flying the aircraft (e.g., maintaining heading and altitude) whereas FMS handles tasks related to the navigation and performance of the aircraft. Although this technology has made flying and monitoring the aircraft easier by reducing the pilot's workload, the new technology also has the potential to lull pilots into over-reliance on automation resulting in complacency, decreased situational awareness, and loss of their manual flying skills (Parasuraman, 2000; Parasuraman et al., 2000; Parasuraman & Wickens, 2017; Taylor et al., 2020).

In the late 1990s, Parasuraman and Riley (1997) characterized pilots' approach to automation in the flight deck as *use, misuse, or disuse. Using* automation involves pilots choosing to activate different automated systems during flight, such as autopilot or FMS. The *misuse* of automation involves pilots over-relying on automation during flight, whereas the *disuse* involves pilots neglecting to use automation. A pilots' decision to use automation is influenced by several factors, including mental workload, trust in automation, self-confidence, automation reliability, and potentially, age (Federal Aviation Administration, 1996; Lee, 2008; Parasuraman & Riley, 1997). While many challenges exist in implementing automation in sociotechnical systems, a growing number of research-based guidelines exist (Smith et al., 2025). Furthermore, design teams (including human factors specialists) are working to implement these guidelines in their designs (Ladurini et al., 2024).

Generational Differences

Another key aspect of flight deck design and training on automation is understanding characteristics of the operator, that is, the future pilot. While research-based principles (Smith et al., 2025) broadly affect pilots, generational differences in the adoption, use, and reliance on technology as well as the training pilots receive, may also play a role. Although not aviation specific, a comprehensive literature review by Choudhary et al. (2024) found that Millennials and Generation Z adopt new technology with less hesitation than their predecessors in Generation X. Generation Z, however, are more proficient than Generation X in their use of technology. Furthermore, Generation Z is more dependent (i.e., reliant) on technology compared to Millennials and Generation X (Choudhary et al., 2024). These generational differences in technology use in general may impact future pilots' reliance on automation in the flight deck. In other words, future pilots' experiences with a broad array of technology will be very different from the experiences of older generation pilots.

A key factor to consider for pilot training on automation is the difference in preferred learning/training methods between the generations. Generation Z, commonly referred to as digital natives, have watched videos from a very young age. The videos include a plethora of opportunities to watch, listen, and learn. It is likely that Gen Z adults will expect videos to play a primary role in their training. Indeed, recent studies found that Generation Z tends to prefer learning by observing, such as watching an individual perform a task then replicating their process, or watching videos (e.g., YouTube) over lectures or reading books (Gochenouer et al., 2024; Szymkowiak et al., 2021). In contrast, Generation X tends to prefer more traditional styles of learning, such as lecture-based lessons (Shaikh & Jamal, 2020). Additionally, with the large number of hours viewing videos combined with receiving instant gratification online, Gen Z may be less equipped to pay attention for extended periods of time. In fact, Wolmark (2025) reported that the average attention span of Generation Z is 8 s whereas the average attention span for Baby Boomers is 20 s. It is important to examine these changing perspectives between different generations and consider possible implications for pilots receiving training and interacting with automation in the flight deck.

Due to generational differences in learning styles and reliance on technology, along with concerns about pilots' over-reliance on automation, exploring young pilots' training on, experience with, and use of automation in the flight deck is crucial. Thus, the purpose of this interview study was to begin exploring how young pilots learn about automation in the flightdeck, their early experiences using automation, and flight instructors' views of flight training related to automation.

Method

Participants

Eleven male pilots participated in the study. This included four Certified Flight Instructor Instrument (CFIIs) and seven pilots-in-training, all between the ages of 19 and 27 ($M = 22.17$, $SD = 2.55$). Four pilots held their private pilot certificate, four held their CFII certificate, and three held their commercial certificate. Most pilots were instrument rated ($n = 10$) and one was familiar with flying instrument but not rated ($n = 1$). The flight hours ranged from 158 to 2,500 hr, and the median was 283 hr ($M = 482.64$, $SD = 87.76$). The majority of participants were either undergraduate students or recent alumni of an aviation focused university. Seven pilots completed most of their flight training at a Part 141 Collegiate, two at a Part 61 (Local FBO), and one at a Part 141 Non-Collegiate.

Materials

A demographic questionnaire and a structured interview protocol were used in the study. The study was approved by the

university's institutional review board (IRB) for the protection of human participants.

Demographic Questionnaire. A demographic questionnaire was administered online via Google Forms. It collected the following participant information: age, gender, affiliation, highest certificate, instrument rating status, CFII certification status, flight training organization (Part 61 vs. Part 141), and total flight hours.

Interview Protocol. A research team, including three human factors specialists, one of whom is also a domain expert (CFI/I and a multiengine flight instructor [MEI] with 700 flight hours) developed the list of questions used in this study. Questions were beta tested with an instrument rated pilot with 270 flight hours and revised for clarification. Two interview protocols were used for this study. For pilots-in-training, 12 questions were used which centered around their perspectives on training, challenges faced, areas for improvement, and lessons learned. For flight instructors, 14 questions were used which focused on their automation training approach, difficulty and challenges, and lessons and insights. During the interviews, the researcher used a semi-structured approach by following the structured protocol while also adapting questions as appropriate. The researcher audio recorded each interview.

Procedure

Participants were recruited from a southeastern university via convenience sampling techniques, such as word-of-mouth, flyers, and emails. The individuals who were interested in participating completed an informed consent form and the demographic questionnaire. Following the questionnaire completion, the researcher conducted the individual interviews either in person or online. Each interview lasted approximately 30 to 60 min. Upon completing the interview, the participants received a $10 gift card as compensation. All the participants who signed up completed the study in full ($n = 11$).

Coding

The audio recordings were transcribed by the Voice Memos app and uploaded to a computer. A thematic analysis was used to code the qualitative data (Adu, 2019). A coding team of three human factors specialists reviewed each transcript separately and extracted the main ideas, question by question, for each interview. Next, the coding team met to compare the main ideas extracted and come to consensus on the main idea(s) given by each respondent to each question, respectively. This resulted in a consensus list of main ideas per question. Following this, the coding team re-examined the consensus list of main ideas and extracted the broader themes that appeared across the participants.

Results

The themes for the instructor interviews are presented first, followed by the themes identified in the pilot interviews.

Results from CFII Interviews

Theme 1. Some formal training on automation begins near the end of the private pilot course. Much more formal training occurs in the mid- to late-instrument training. During instrument training, the focus is on teaching autopilot modes, functions, and integration in the G1000.

Theme 2. The major focus during private and instrument training is *manual flying skills*, especially during holds (i.e., a maneuver assigned by Air Traffic Controllers [ATC] that keeps pilots in a protected airspace) and approaches (i.e., the descent). The instructors emphasize that students only use automation during straight and level flight and do not rely on it during bad weather/critical phase of flight.

Theme 3. The instructors teach the prioritization when using/considering using automation as: aviate, navigate, communicate, and automate.

Theme 4. In the instrument course, CFIIs spend 5 to 10 hr teaching automation, although there was no agreement among the interviewees. CFIIs believe the best way to teach automation principles is through demonstration and practice (either in-flight or using simulation). Overall, however, it falls on the student to learn automation.

Theme 5. The difficulties and challenges CFIIs face include, (1) students over relying on automation (i.e., too high of expectations or think they know how to use it), (2) learning how to use automation (i.e., understanding what certain buttons do), and (3) complacency.

Theme 6. CFIIs will measure a pilot-in-training's ability to use automation by the student's capability to program and verify automation correctly, and the student's knowledge of when and where to use it and justification for that decision.

Theme 7. The lessons and insights from CFIIs include, (1) students will embrace automation, (2) their comfortability with automation influences their decision to use it, and (3) the importance of emphasizing manual flying skills.

Results from Pilots-in-Training Interviews

Theme 1. Pilots-in-training perceive their training on automation as balanced, and they feel prepared to handle situations where manual intervention is required.

Theme 2. The challenges pilots-in-training face when learning to use automation in flight include, (1) programming (i.e., knowing what to do and inputting), (2) verifying while in flight, and (3) using different automation in different aircraft.

Theme 3. Pilots-in-training feel overwhelmed when, (1) interacting with automation in flight, (2) programming while also communicating with ATC, and (3) flying the plane.

Theme 4. If the pilots experience difficulties using automation, six out of seven pilots stated that they disconnect automation and hand fly the plane.

Theme 5. The areas of automation training that are not effective include, (1) not receiving formal training, (2) receiving inconsistent training, and (3) not receiving detailed/helpful training.

Theme 6. Pilots-in-training believe automation training could be improved by having more time in the simulator or in flight and having dedicated lessons on automation.

Theme 7. The lessons that help clarify automation concepts for pilots-in-training include observation of instructor/experienced pilot and practice.

Theme 8. All pilots have had a positive experience with using automation in the flight deck.

Discussion

Automation was designed to reduce the physical and mental workload of pilots (Sheridan, 2002) and increase the efficiency and safety of flight (Akay et al., 2007; Borst et al., 2010). However, learning, training, and using automated systems presents challenges. The current study indicates that CFIIs recognize that younger pilots are embracing automation and that these pilots-in-training are using automation in the flight deck earlier than did prior generations. Although increased exposure and use of automation can increase pilots' comfort with using automated systems, it can also lead to an over-reliance on automation, which can ultimately lead to errors (Parasuraman & Riley, 1997). This study provided evidence that CFIIs understand this concern and reduce the risk by emphasizing and prioritizing training manual flight skills at the instrument rating level.

The interviews revealed several trends as to how automation training occurred. For these pilots, automation training tended to occur during ground school, which was separate from their flight training. However, this approach may not be the most effective method since younger pilots prefer using video-based lessons or observing the instructors to learn (Gochenouer et al., 2024; Szymkowiak et al., 2021). Students suggested training could be improved by incorporating more simulation training, having more dedicated flight lessons on automation, and increasing the use of the demonstration-performance method, where the instructor first performs the maneuvers and then the student replicates it. These findings are consistent with the literature that Generation Z tends to prefer learning by first observing and then performing the task (Szymkowiak et al., 2021). Additionally, learning automation can be difficult, and younger pilots face challenges.

The CFIIs reported the most common challenges regarding automation for the young pilots were learning *how* to use the automation (e.g., input sequences, etc.), and students' *complacency* and over-reliance on automation. CFIIs also highlighted the need to address certain misconceptions that students have while using automation, such as a belief that they can "sit back and relax." It is important for younger pilots to remember that although automation can reduce their workload, it is essential for pilots to still take an active, supervisory approach while using automation. To help pilots manage flight tasks effectively and use automation appropriately, instructors reinforce the concept "aviate, navigate, communicate, and automate." For instance, younger pilots unanimously reported they would disconnect automation if they felt frustrated or encountered difficulties while using automation, and focus on manually flying the plane (i.e., aviating).

Although this study provides insights into both pilots and CFIIs perception on the training and use of automation in the flight deck, it has limitations. First, the small sample size limits the generalizability of the results. Second, the potential for interview bias may have influenced the results and decreased the internal validity. Future research should investigate the automation training more experienced pilots (i.e., 1,000+ flight hours) receive and how the more experienced yet younger pilots use and rely on automated systems in the flight deck. Additionally, future research should compare the use and reliance of automation in the flight deck between Generation Z pilots and Generation X pilots.

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