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Structural Redesign of Pilot Training and the Automated Aircraft

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ABSTRACT

Flight skill loss due to the overuse of automation has become an industry concern. Aircraft accidents have been attributed to pilots' inability to manage their aircraft in manual flight resulting from unexpected changes in automation and loss of situation awareness. While aviation experts have associated these accidents to diminished stick and rudder skills from the overuse of automation, the problem may be attributed to how pilots are trained in automated aircraft. The FAA has encouraged pilots to manually fly to improve skills; however, limited opportunities for manual flight exist in the current international environment, with potentially less opportunities in the future due to NextGen compliance. A critical view of pilot training identifies how airlines could train pilots in modern day aircraft to maximize safety. The benefit of computer-based training to teach operating procedures, fixed based simulators versus level D full flight simulators, redesigning training programs to improve pilots' understanding through cognitive load theory, and the power of repetition will be addressed.

KEYWORDS

Automation, Aviation, Fixed Base Simulation, Learning, Nextgen, Performance, Pilot Training, Pilot, Recurrent Training, Repetition, Safety, Simulators, Training

INTRODUCTION

Pilot training for multi-crew aircraft has been plagued with economic and safety challenges. While advancements in technology has made the flying job easier, mechanization has made the job of learning complex systems more challenging.

In the early years of flight training, loss of equipment and life, combined with operational costs of training pilots in an airplane, encouraged simulator manufacturers to focus on building training devices that would replicate aircraft. With great success, pilot training and checking events moved into a level D full flight simulator (FFS) eliminating the need for an airplane during the training process, notably reducing training expenses while improving safety. This economic advantage saved airlines millions in training costs.

Training curriculums have also changed over the years. A Boeing 727 pilot was required to diagram an electrical system, diagnose malfunctions during flight, and problem solve while navigating the aircraft. Alternate landing gear was manually extended with a crowbar type lever, a third pilot assisted with systems backup and navigation, and pilots manually trimmed control surfaces for stability.

Today, that three-person cockpit crew has turned into a two-person flight deck. Crewmembers who once *flew* round-dial aircraft now *manage* automated aircraft systems. An automated aircraft refers to an airplane with an auto-flight system to include an autopilot, autothrust, and a flight management computer system that enables pilots to control the aircraft by programming a computer.

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Many automated aircraft self-diagnose malfunctions and list procedural steps via computer screens. Airline pilots are no longer required to attend a formal ground school; therefore, they train themselves at home. Alternate landing gear is extended with the flip of a switch, navigation occurs via global positioning systems (GPS), and the aircraft trims itself for coordinated flight.

The job of flying automated aircraft for commercial operations has shifted from skill-based to cognitive, but training has not followed suit. While pilots once flew with skill to achieve coordinated flight, today complex aircraft manage coordination with automatic self-trimming features, where pilots program computers to achieve operational performance. During manual flight, the pilot does not necessarily have complete control of the automated aircraft. In the Airbus, for example, the pilot points the airplane in a direction they want to fly, and the aircraft determines the most aerodynamically efficient way to bring about results, to include automated trimming. With this shift from flying with skill, to management with cognition, *how* pilots are trained and checked should shift too. While airlines are utilizing highly automated simulators, these devices may not be the best tools for the desired outcome of learning automated aircraft.

Due to the reliability of automated aircraft and ease of flying, airlines, in conjunction with Federal Aviation Administration (FAA), programs such as Advanced Qualification Procedures (AQP), a train to proficiency program introduced in 1990, have reduced training footprints (FAA, 2017). While simulators have kept up with emulating aircraft, training has fallen short of operational necessity by reducing the training footprint with an assumption that the more automated the aircraft is, the less training is required. The economic decision of training reduction has not come without cost. Deficient aircraft management skills with ensuing missed approaches, early configuration changes, and ground mishaps are expensive. Despite insurance, no price can be placed on loss of life.

The aviation industry is growing rapidly and heading full speed into NextGen, where pilots will be responsible for aircraft separation, perform satellite-based landing procedures, and taxi with moving maps. With added complexity and additional tasks, reduced situation awareness (SA) will be open for human error. SA is defined as perception of the environment, understanding the meaning of that experience, and the ability to project that status into the future (Endsley, 2010). Pilots must master current technology via the science of learning, making room in the working memory for additional responsibilities of flying NextGen operations safely. A shift in pilot training, utilizing appropriate training devices and cognitive based learning techniques, should theoretically improve pilot performance and eliminate future catastrophes and realize improved economies.

This article identifies the science of learning, to include the importance of the working memory, assimilation, repetition, the necessity of understanding versus rote memorization, and matching experience to the training event. Confidence is imperative to performance and must be included in the learning equation. The tools necessary to train will be addressed, identifying the benefits of non-motion versus motion simulators. Knowledge assessment is also essential to aviation safety; yet may be falling short under checking methodologies.

Note: The author is a Boeing B777 pilot with 33-years airline experience; type rated on the A330, B777, B747-400, B747-200, B767, B757, B737, aircraft; 21-years instructing in simulators on Boeing aircraft, while flying the line; authored numerous airline flight training programs; author, speaker, and is a doctoral candidate in aviation, with Embry-Riddle Aeronautical University.

AUTOMATION CHALLENGE REVIEW

Pilot error occurs because pilots are human. However, pilot error due to limited knowledge of aircraft operating systems and procedures is inexcusable when cost effective opportunities are available to