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THOUGHT LEADERSHIP

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Considerations for Aircraft Trim Control

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Overview of Trim Systems

While aircraft trim has received extensive news coverage in recent months, the trim system concept is not new. Even very old and simple airplanes have an adjustment to enable the pilot to maintain the desired pitch altitude (e.g., nose up or down) without the need to continuously apply a force. Most piston-powered aircraft feature a mechanical wheel by the pilot's knee that can be manually rotated to adjust the trim. Many large aircraft, including those with mechanical and fly-by-wire control systems, also include trim wheels. Trim systems frequently include an electrically actuated electric or hydraulic motor that enables pilots to control the system with a simple switch. This switch is commonly mounted by the pilot's thumb on the aircraft yoke for ease of access.

Pilots frequently adjust the trim to pitch the aircraft up or down during flight. Some more automated aircraft types allow a computer to adjust the trim system and ease pilot workload; others use the trim motor as an actuator for the autopilot. Typically, whenever the trim is moving there is a visual indication accompanied by a mechanical noisemaker, a voice annunciation, or both.

Considerations for Trim Control

While adding a motor to a trim system can provide important safety and convenience benefits, it can also introduce the potential for a malfunction called "runaway trim." Runaway trim occurs when the Trimmable Horizontal Stabilizer (THS) or other trim device on the aircraft tail fails to stop at the desired position and continues to deflect up or down. Runaway trim can have several causes, including but not limited to a bad switch, a short circuit, or a software failure.

All aircraft with powered trim—from the simplest single-engine trainer, to the original 737 introduced 50 years ago, to the fly-by-wire aircraft produced today—have published runaway trim procedures with which pilots must be familiar. These procedures are often called "memory items," meaning that pilots should be able to implement them without referring to a flight manual. If a pilot receives an indication that the trim position is moving without intent, he or she can follow a procedure to override the system. On most aircraft, there is still a trim wheel by the pilot's knee that can be turned to manually adjust the trim. The trim wheel moves when anything else changes the trim setting.

The 737 Max includes the Maneuvering Characteristics Augmentation System (MCAS) as an additional trim input for the aircraft. While the MCAS system on the 737 Max can change the trim by using the same motor that other electric trim sources on the aircraft use, the MCAS system is intended to only move the trim wheel in very specific and unlikely conditions. The motor makes the mechanical trim wheel rotate in a manner that a trained pilot can clearly observe. The pilot can then respond by 1) readjusting the trim manually; 2) readjusting the trim with electric switches; or 3) disabling the electric motor that controls the trim system. All 737 aircraft, including the Max versions, have two large switches next to the trim wheel and near the engine fire handles that will disable all electric trim movement. After disabling this system, trim can still be adjusted using the manual trim wheel.

Evolution of Operator Training

On any airplane with or without an MCAS or similar system, the trim may runaway for any number of reasons. The addition of MCAS can be considered as another branch in the system that controls the airplane's trim. Some aircraft hazards can be overcome operationally; other hazards are more complex and cannot be easily eliminated. Because runaway trim is a well-understood failure mode for aircraft, pilots prepare for this occurrence and extensively practice corrective procedures during flight training. Aircraft operators and pilots are also continuing to change the way they prepare for trim runaway occurrence as well as other types of failures. For example, after an investigation determined that the vertical stabilizer separated resulting in the crash of American Flight 587 in 2001, the pilot aircraft specific training was changed to reduce the likelihood of excessive rudder input and overloading of the vertical stabilizer.

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