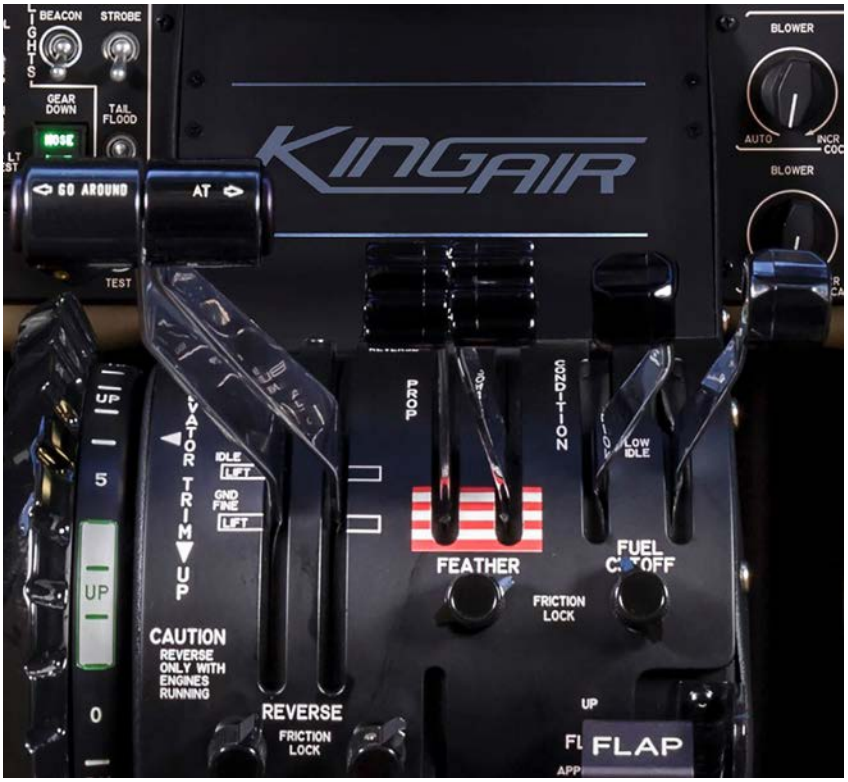
Turboprop Autothrottle and Emergency Autoland Systems

by **Matthew McDaniel**



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While I have loved flying in sunny skies for 45 years, sometimes (as all pilots know), the sun can be a bit too bright and hot. This includes operations on the ground since even air-conditioned aircraft have challenges in hot and humid environments.

Autothrottle systems are not new. They've been around almost as long as commercial jetliners have transported passengers from A to B at previously unheard-of speeds. Granted, the early analog versions were rudimentary compared to the precision today's digital technology offers. They were also bulky, requiring heavy mechanical motors, clutches, and hardware. Yet, old or new, analog or digital, autothrottle technology remained available only within the large turbojet market for decades. The more complex operating mechanics of turboprop engines, with their multiple lever engine controls and mechanical fuel control units, proved incompatible with autothrottle technology. Thus, the turboprop pilot was left to be the sole source of throttle settings and speed control. While this kept such pilots more practiced in those particular airmanship skills, it also kept their workloads higher than their contemporaries flying turbojet aircraft. That was especially true in the takeoff, approach, and landing phases.

A New Millennium

As the 21st century dawned, digital avionics technology achieved new lows, as in low-weight, low-bulk, and low-cost. With the advent of ever-increasing capabilities combined with ever-decreasing size, digital avionics soon began to make inroads into general aviation. Electronic Flight Instrument Systems (EFIS), including Electronic Attitude Indicators (EAI) and/or Electronic Horizontal Situation Indicators (EHSI), had only begun to appear in business jets and turboprops in the early 1990s. While these increased instrument versatility and capability, they weren't exactly revolutionary developments. However, throughout the first decade of the 2000s, companies like Avidyne and Garmin began to capitalize on rapidly advancing computer software and hardware capabilities to create full-featured Primary Flight Displays (PFD), Multi-Function Displays (MFD), and even Flight Management Systems (FMS) for use in light jets, turboprops, and even piston-engine aircraft. It didn't take long for this new technology to find acceptance among those who craved the latest and greatest for their aircraft's flight deck. As a result, many older, cabin-class aircraft now fly with retrofitted, thoroughly modern instrumentation, navigation, and engine management equipment. In many cases, the value of that new digital avionics package can exceed that of the aircraft itself.

The future had arrived, and technology on the flight decks of cabin class aircraft began advancing faster than most owner/pilots could keep up with. Radio stacks of navigation and communication equipment (even those with LCD displays and early digital technology) that were all the rage in the '70s and '80s began to get replaced with units that combined GPS and ground-based navigation, and communication needs, into a single unit. Moving maps quickly evolved from monochrome to full color

and grew in size and presentation detail. Autopilots were upgraded from rate-based analog units to attitude-based digital units. Then, in the mid-2000s, WAAS-capable GPS units were made available to the masses, and digital glide paths into runways big and small, moved from fantasy to reality. Nevertheless, while autothrottle technology improved dramatically across this same timeline, it only did so in large turbojet aircraft, leaving cabin class pilots clutching and tweaking their throttles in the same way they'd been doing for the previous 50 years or more.

Dreaming in Digital

Through the 2010s, digital avionics and autopilots got smaller, better, faster, and more feature-rich. Their use soon became the norm in production aircraft and was sweeping through the retrofit market. Retrofit companies began offering the latest technologies in comprehensive upgrade packages, which included improved engines, techy cabin enhancements, and complete flight deck makeovers. None of those packages had a turboprop autothrottle system, but it was being developed behind the scenes. As digital hardware became smaller and smaller, the feasibility of squeezing autothrottle components into the crowded spaces of cabin-class cockpits began to seem realistic. Meanwhile, software advances made the complex task of automating turboprop power manipulation possible. The time had finally arrived for turboprop pilots to join their jet counterparts and enjoy the enhancements autothrottles could bring to flight safety and efficiency.

Like so much in aviation, change can be slow, even during times of rapidly advancing technology. This is a good thing too. New technologies need vetting, testing, and detailed scrutiny. When applied to certified aircraft, they must be proven to be safe and reliable. That process takes time measured in years, not days, and mountains of capital investment. Thus, while turboprop autothrottles were spoken of often throughout the 2010s, it was in the late 20-teens that news of certifications began to break. Initially, those certifications were retrofit systems only. However, several companies are now offering new production turboprops with autothrottle systems, too.

Pseudo FADEC

Another technology that has been around for decades now is Full Authority Digital Engine Control (FADEC). It allows pilots to move power levers as the situation demands without fear of exceeding engine limitations (torques, temperatures, pressures, etc.). The computer "reads" the pilot's throttle "command" and provides the closest engine output to that command without exceeding any operational limits. Like autothrottle, though, FADEC has primarily been limited to turbojet engines. One of the principal challenges of developing and certifying a turboprop autothrottle system is getting that system to work without the input of FADEC data. The Pratt & Whitney PT6A turboprop engine is far and away the most common in cabin-class turboprop aircraft today. What it is not, however, is digital. It operates via decades-old analog/hydromechanical technology. Highly reliable and versatile as it may be, strapping an autothrottle to a PT6A was a complex matter of tapping into the FADEC to utilize its data and software capabilities since no such FADEC existed.

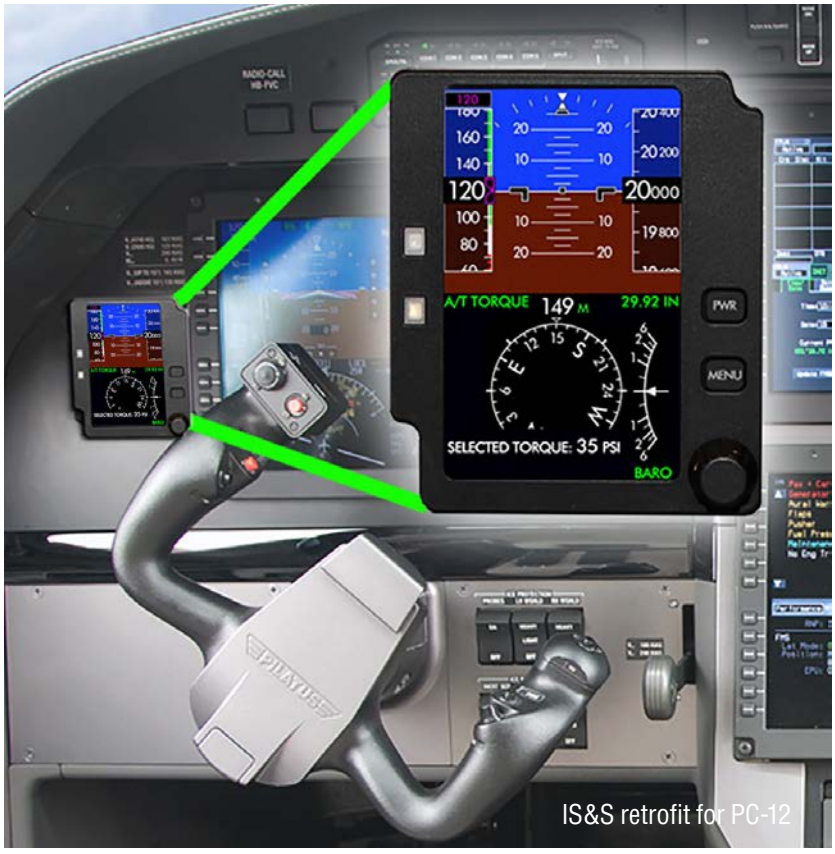
The not-so-secret sauce is provided by linking electromechanical components that control power output to hardware and software that constantly monitor engine parameters and trends. Along with this comes the equally safety-enhancing abilities to select and hold a desired indicated airspeed (IAS) and envelope and stability protection features that will kick in if a distracted pilot allows IAS to reach low or high-speed limits that could potentially cause a stall or structural damage. Additional safety features allow for speed protection in turbulent air or the automatic setting of maximum range or maximum endurance power. Of course, all this must also communicate with the autopilot systems to couple autothrottle adjustments to achieve the IAS, Altitude, Vertical Speed, and Navigation commands input by the pilot. In multi-engine aircraft (such as King Air variants), the autothrottle system must be capable of helping to manage an engine failure situation by adjusting power on the operating engine to achieve safe performance parameters and to assist in avoiding (or recovering from) a Vmca situation, for instance.

Retrofittable

In 2018, Innovative Solutions & Support (IS&S) achieved certification and began delivery of an autothrottle system for the Pilatus PC-12 (image page 22). Dubbed "ThrustSense," the system is retrofittable in two ways, depending on the cost the buyer can justify and other enhancements they might desire. Simply adding autothrottle capabilities requires the addition of IS&S's Integrated Standby Unit (ISU), which can replace any existing standby instruments. The ISU provides the software and control panel necessary to control the PT6A engine. Or, the owner could bundle the addition of autothrottle and ISU with a complete panel upgrade via IS&S's NextGen 3015 system. The 3015 includes dual PFDs, a large central MFD/Engine Display, WAAS, ADS-B In/Out, VNAV, RNP & LPV, electronic charts, TAWS, SynVis, radar, satellite weather capabilities, etc. Similar upgrade paths to ThrustSense are available from IS&S for the King Air 200 and 300 series. ThrustSense retrofit options for other cabin-class turboprops are in development, as well.

Factory Installed

First to market with an autothrottle system for a cabin-class turboprop was Daher, which introduced autothrottle capabilities to its TBM lineup with the TBM-940 model in 2019. All autothrottle control and programming are handled via the Garmin 3000 avionics suite and its requisite assortment of sensors and software. As of this writing, the TBM-960 is the Daher flagship, still sporting the G3000 and autothrottle. Piper followed soon after



IS&S retrofit for PC-12

with its flagship M600 model. The M600 is essentially the Meridian fuselage but with a newly designed wing and the G3000 avionics suite. At Swiss plane-maker Pilatus, the PC-12 NGX is the current model with an autothrottle option available. Their Honeywell avionics suite is dubbed ACE (Advanced Cockpit Environment) and includes SmartRunway and SmartLanding systems and advisories, along with all the other technology typical to current generation glass avionics suites. Finally, in the twin-engine ranks, the King Air 260 and 360 models feature IS&S ThrustSense as standard equipment.

Emergency Autoland Capabilities

The latest in wow-factor avionics technology innovations are the emergency autoland systems. These systems could not be possible without autothrottle capabilities, as they allow for fully automated control from cruise flight through touchdown, rollout, and shutdown. These are not certified autoland systems, like airline ILS Category

III operations. Instead, they are last-ditch emergency systems that can take control of the aircraft in the event of pilot incapacitation or total loss of situational awareness. This emergency mode is activated with the push of a single button (for manual activation) or via automatic activation (should the pilot fail to interact with the avionics systems in a timely or appropriate manner). Upon doing so, control is removed from the pilot, and the aircraft will climb/descend as necessary and divert to the nearest suitable airport via a terrain-aware navigation route. ATC and the passengers will also be advised of what is happening automatically. The aircraft will fly the most appropriate instrument approach procedure, extending landing gear and flaps when appropriate, then land, roll to a complete stop, and shut down.

Piper led the pack to market by introducing their "HALO" emergency autoland system on the M600/SLS in 2020. This milestone represented the first FAA-certified emergency autoland system within general aviation. Cirrus followed quickly with the "SafeReturn" system on their second-generation SF-50 VisionJet. That marked the first turbojet-powered aircraft certified with such a system. Daher dubs their system "HomeSafe," on the TBM-960, built upon the foundation of the autothrottle system they introduced on the prior TBM-940 model. Regardless of the specifically branded name for the system, all are based on the Garmin G3000 avionics suite hardware, software, data inputs, and autopilot/autothrottle control.

Conclusion

These new and emerging technologies are indeed game changers in the world of cabin-class turbine aircraft. Autothrottles significantly lower pilot workload during critical phases of flight while providing greater precision. With envelope & stability protection software, synthetic vision displays, terrain awareness, and crew alerting systems, autothrottle could be life-saving. Taken a step further into full emergency return/autoland capabilities, the technology goes beyond even what large bizjets and airliners currently offer. Especially in terms of emergency return and autoland capabilities, the cabin-class turbine world is presently leading all other segments of general aviation and paving a path for such technologies to trickle upstream and down. T&T

Matthew McDaniel *is a Master & Gold Seal CFII, ATP, MEI, AGI, & IGI and Platinum CSIP. In 32 years of flying, he has logged over 20,500 hours total and over 5,700 hours of instruction given. As owner of Progressive Aviation Services, LLC (www.progaviation.com), he specializes in Technically Advanced Aircraft and Glass Cockpit instruction since 2001. He's a Boeing 737-series Captain, holds 8 type ratings, and has flown over 120 aircraft types. Matt has earned the Master CFI designation for 10 consecutive two-year terms. He can be reached at:* **matt@progaviation.com** *or* **414-339-4990.**