Automation in the flight deck, blessing or curse?

by Captain Dirk De Winter

One thing is certain, there are definitely new challenges ahead.

Back in the mid 1980s, the arrival of the B737-300 at my airline brought a new level of automation on the flight deck. New functionalities such as Auto Thrust (A/T), a digital version of the autopilot (AP), a flight management computer (FMC) and electronic flight instrument displays (EFIS) significantly reduced pilot workload. This was favoured by many pilots, especially those who had previously been flying the B737-200.

No more reading of the thrust setting placards and manually adjusting the thrust setting every couple of thousand feet in the climb. Just dial in the desired speed and the auto thrust system will command the thrust required to maintain it. No more unfolding of en-route charts and calculating an approximate heading when given a direct routing to a navigation aid, which was still out of reception range. Just select the aid in the FMC and through the AP the aircraft is guided to the navigation aid. Searching for a diversion airport? Increase the scale of your Navigation display, select 'airports' on the EFIS control panel "et voila".

Of course, this advance in flight deck technology required a change in skills. The focus on basic flying skills shifted to system operation and monitoring skills. Initial and recurrent training evolved accordingly.

B737-200 Auto Pilot control panel

B737-300 Navigation Display

B737-300 Auto Pilot control panel

And cooperation with ATC also improved. Even before the pilot monitoring had made the read back of an ATC instruction, the pilot flying had dialled in the required speed, heading or altitude changes on the AP control panel, selected the appropriate AP modes and the aircraft followed them. Or to be more precise, tried to follow them. Unlike today's version of the digital AP, the aircraft still had to obey aerodynamic and inertial laws. When a small speed increase was requested, the A/T system would not command full thrust to achieve the change but used basic ▸▸

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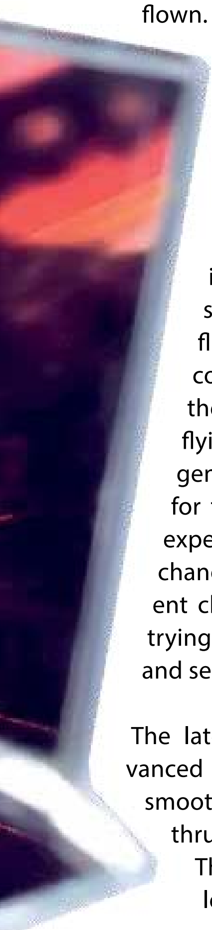
algorithms which ensured that only a gentle increase in thrust followed a requirement for a small speed increase and reduced it gently to the required new thrust setting once the new speed had been reached.

However it was also the case that when a large speed change was requested, the A/T might increase the thrust more quickly and so disturb passenger comfort. Descents could be performed using various modes. The most common mode was a descent in which the A/T commands idle thrust and the AP adjusts the pitch to follow the speed commanded by the pilot or set by the FMC. Any large change in speed then meant a large change in pitch and rate of descent. To soften the level off, pilots would often reduce the speed to reduce the rate of descent or change the AP mode to command a reduced rate of descent, typically 1000 ft/minute. But this meant that the A/T which had previously set idle needed to increase the thrust to that required to maintain the selected speed and this change might not be very smooth.

While monitoring of automation modes is essential, some recent accidents have indicated that when automation capability is degraded or its use in less familiar ways attempted, the pilot has not necessarily appeared to have had sufficient knowledge to achieve the desired flight path.

Whilst such adjustments might occasionally disturb passenger comfort it's a blessing for TMA controllers. The high climb performance of twinjets has often caused nuisance TCAS alerts because the normal altitude capture mode of the AP allows high rates of climb when approaching the selected altitude. This high closure rate can cause a nuisance alert to an aircraft flying 1000ft above. The flight crew can anticipate this and select a reduced climb rate of maximum 1500 ft/minute for the last 1000ft instead of the normal altitude capture mode. This increases the flight crew workload but when well managed avoids nuisance alerts and stabilises the traffic in the TMA.

A350 FMA on the top of the Primary Flight Display



Another surprise generator is the use of the cost index (CI). This parameter represents the ratio between the time and fuel cost for the airline or for the specific flight. When entered in the FMC, it determines the climb, cruise and descent speeds which should be flown. Whilst before aircraft of a particular type could be expected to fly the same speeds for the same flight phase, now there is considerable variation. High fuel cost will result in a low cost index and slower speeds. Changing flight level for the same cost index will also change the cruise speed. So whilst flying optimised cost index generates fuel efficiency for the airlines, slower than expected or unpredictable changes in speeds can present challenges for controllers trying to maintain traffic flow and separation.

The latest APs have more advanced algorithms, which try to smooth out the effects of both thrust and pitch changes. This allows the pilot to select any speed, heading or altitude and AP mode without having to monitor the pitch and thrust. But they still have to monitor the Flight Mode Annunciator (FMA) in order to verify the correct engagement of the A/T and the lateral and vertical AP modes.

While monitoring of automation modes is essential, some recent accidents have indicated that when automation capability is degraded or its use in less familiar ways attempted, the pilot has not necessarily appeared to have had sufficient knowledge to achieve the desired flight path. And the situation has been made worse by failure to adequately monitor the 'basic parameters' of pitch and thrust which would have ensured that the flight path could have been stabilised. That would have left more time for troubleshooting and even recovery of the desired level of automation. In some accidents, full automation was available to the pilots but unfortunately the A/T modes used were not appropriate for the flight phase and this was neither observed nor properly understood by the pilots. Monitoring of the thrust setting would have shown that it was not aligned with the speed requested by the AP and the position of the aircraft.

Proficiency requirements for licensed professional pilots in Europe currently include an annual demonstration of manual flying skills and a demonstration of manual flying without the A/T at 3 yearly intervals. Modern flight operations make extensive use of automation and rarely require or even allow extended manual flying especially with manual thrust setting. To counteract any degradation in manual flying skills, many airlines include additional manual flying in their recurrent training.

This should be promoted, as improved manual flying skills will improve the knowledge of the basic pitch and thrust settings. It will also encourage cross checking of basic pitch and thrust settings as part of normal monitoring of the flight instruments and the FMA. In the rare case of a complete loss of automation, this will enable the stabilisation of the flight path and buy time to diagnose what has gone wrong and recover.

Captain Dirk de Winter

has over 11,000 hours flying time gained over the last 22 years. He started as a cadet pilot with SABENA in 1987 flying Boeing and Airbus aircraft. Before starting his flying career Dirk obtained a Masters degree in Electronic Engineering from the University of Brussels. Since January 2009 Dirk has been working part-time at EUROCONTROL.