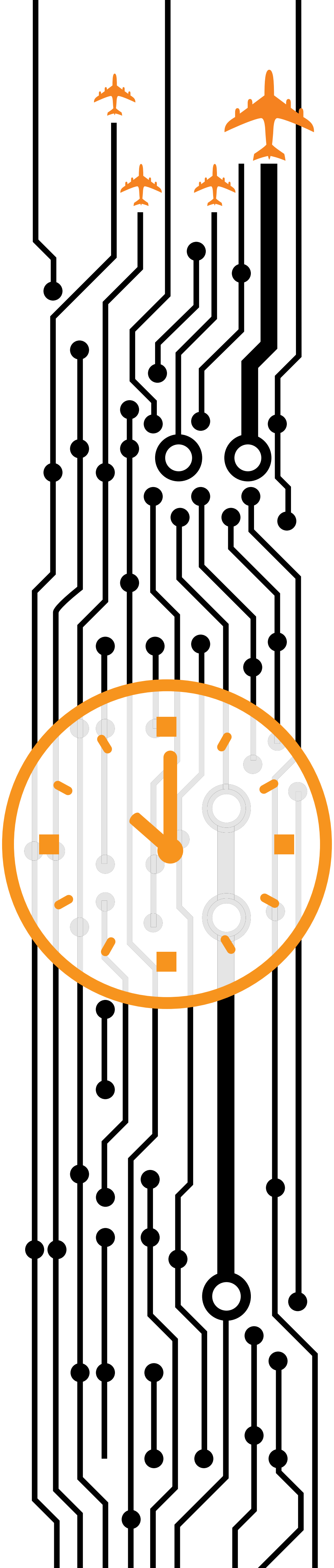


Flying
digital or analogue?

by Captain Pradeep Deshpande

In our increasingly digitised world there is sometimes apprehensiveness and even a little bit of suspicion towards what is not digitally processed and presented. Often we are pleased to see data merely presented in digital form even if it was actually processed by analogue means. Analysts over the years have therefore tried to convert art into science and fed it to the new breed of digitally hungry minds. In my opinion flying has met the same fate too.

Many of today's older pilots have grown up in the analogue world before transitioning to the digital one. I must admit that I owe the inspiration to write this piece to a short video 'Children of the Magenta'[34]. It's not new and many of you may have seen it but if you haven't - , it's a 'must view'!

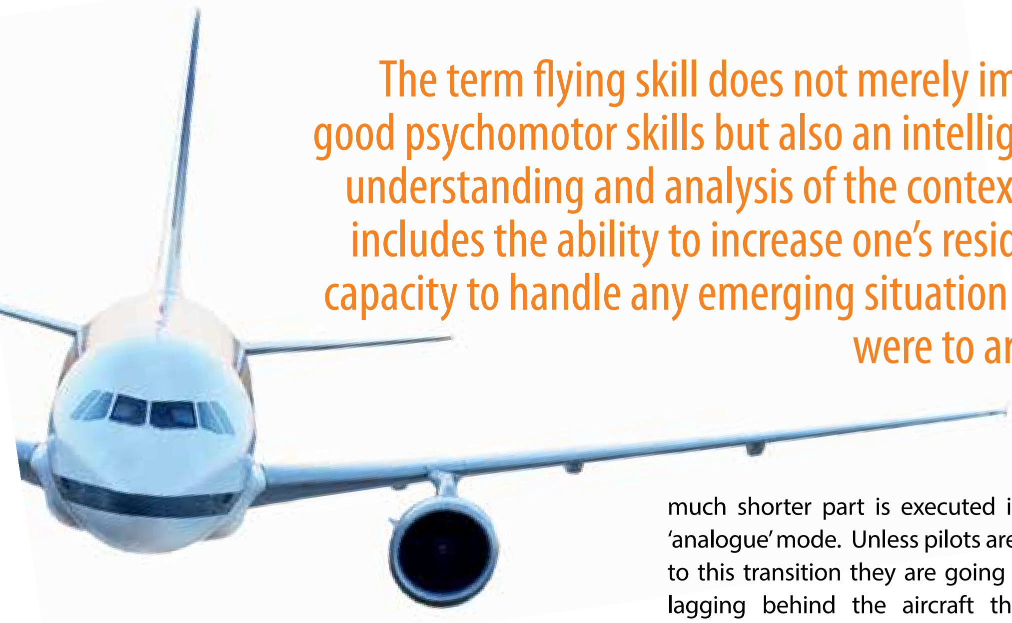
The skill set required for a professional pilot includes good CRM, technical knowledge, weather awareness and adequate psychomotor or hand-flying skills among others. In this article I will focus only on the hand-flying skill part and within that, flying the approach and landing.

Since the spread of commercial aviation as means of travel, accidents related to approaches and landings have been in sharp focus due to the higher vulnerabilities during this phase of flight. This has resulted in the attention being given in two distinct areas – the provision of hardware and the procedures and training of pilots. Hardware improvements have been seen in the landing aids, runway lighting systems, weather prediction and in aircraft systems. Pilot training has seen the ALAR[35] approach which has included the establishment of and strict adherence to defined stabilised approach criteria, the rise of the practice of routine flight data monitoring, the concept of non-punitive go around policies and adjustments to the authority gradient in the flight deck in respect of calls for a go around.

While all the above improvements have shown excellent results, the one area that has been neglected is the maintenance of manual flying skills. One may argue that if the initiatives proposed by the ALAR project and what followed it had been applied, the chances of unsafe landings would have been minimised. I agree. However, there is more to it than that. With stabilised approach criteria, really bad approaches are easy to recognise and deal with; it is the not-so-bad approaches that are more problematic. Those where the crew feel they can

34- View a copy of this video on SKYbrary at: http://www.skybrary.aero/index.php/Automation_Dependency
35- The acronym Approach and Landing Accident Reduction was introduced in work on the subject by the Flight Safety Foundation which began in 1996

Flying – digital or analogue? (cont'd)



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legitimately continue the approach to a landing merely because the aircraft passed the designated stabilised approach gate(s) in compliance with the criteria. What often happens is that they are then unable to execute it because they failed to appreciate the dynamics of a rapidly changing external situation and/or the prevailing energy state of the aircraft.

The term flying skill does not merely imply good psychomotor skills but also an intelligent understanding and analysis of the context. It includes the ability to increase one's residual capacity to handle any emerging situation if it were to arise. It also means the ability to distinguish a good approach from a bad one particularly when it is (or is perceived to be) nominally within the applicable stabilised approach criteria.

Whilst a large part of this would form a part of the innate cognitive skills of an individual, the good news is that a considerable part of the necessary awareness can be developed from that foundation given sufficient focus on the task. This ability to make good – and timely – tactical judgments becomes very important because while most of a typical approach is flown in what I call 'digital' mode, the final and much shorter part is executed in the 'analogue' mode. Unless pilots are alive to this transition they are going to be lagging behind the aircraft thereby increasing the odds of a poor landing or even worse, an unsafe one.

The basis of good transition from digital mode to the analogue mode starts during the preparation for the descent and continues all the way through until the aircraft vacates the active runway. If it is one of those days where the wind velocity is of significance to aircraft control near the ground in terms of its effect on the tail/headwind component during flare, then the ATIS wind may become something of more dynamic concern as the runway gets closer. If ATC provide a sequence of spot winds then it must be recognized that their value is as a context rather than as the wind which will actually prevail in the flare to touchdown. The fact that the distance of the anemometer(s) which ATC are using from the runway TDZ[36] can vary tremendously from airport to airport must also be recognised – although any sequence and the variation in wind speed and direction it shows is valuable. For example if the mean wind reported equates to a headwind component of 10 knots, the pilot must plan to arrive at the runway threshold at the applicable V_{app}[37] plus 5 knots and then set the engine thrust gradually to flight idle as or soon after the flare is commenced. To arrive at this point however, the pilot has to often negotiate a large segment of the approach where the winds may be rather different to the reported airport wind. They may need to adjust the thrust in response to the changes in the Indicated Air Speed in order to maintain the target Vapp which is of course what the auto throttle usually does. During an approach in unstable air, the auto throttle-commanded thrust setting can vary from as much as 69 % to as little as 49 % to adjust for a speed that may be less than 10 knots from the Vapp. This is a digital response and because the auto throttle has the auto pilot to assist in the large trim changes that ensue, the changes involved are not that obvious. But if a pilot was to make such large adjustments during while in manual flying, clearly it will not work. Instead they must use their judgement and anticipation to makes more modest changes in the thrust setting, whilst tolerating some variation about the Vapp in such a way as to progressively reduce the variation from target N1 so as to arrive at the threshold with the aircraft within the acceptable tolerance limits for the applicable landing reference speed.

Pilots need to understand that such tolerances are provided so that they can make coarse corrections when conditions are less than ideal. When landing in strong and gusty winds, the pilot must retain the residual capacity to respond to the unexpected - say a sudden wing drop or unexpected drift in the flare. They must be permitted to accept a speed which is not exactly the prescribed one as they cross the

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36- Touch Down Zone

37- The indicated air speed which should be flown on the approach based on the Estimated Landing Weight (ELW) of the aircraft

threshold. The tolerances are there to allow pilots to slightly reduce their attention on airspeed so as to give more of their attention to controlling the aircraft to achieve a safe touch down within the TDZ. They need to realize that the impact of an additional 5 or 7 knots will in most circumstances make little difference to the landing whereas the consequences of not appreciating drift after flaring or allowing the rate of descent to suddenly increase or decrease can be significant.

So if it is appreciated early on that some superior controlling may be required on an approach due to prevailing weather conditions, the crew must brief and be prepared for greater speed variations. Emphasis must be placed on the mean engine thrust and all variations should be within a couple of percent of this. When what may be quite large changes in indicated airspeed occur, they must be countered with small changes in thrust. What matters is to be patient and watch the changes taking place gradually. Unless one encounters wind-shear (which may well be a go around situation) these changes would be quite adequate to get you on the threshold within the tolerance limits. But the monitoring pilot must beware of inappropriate calls of 'check speed' and the handling pilot of mechanically reacting to speed variation without taking any account of the prevailing wind conditions.

The message illustrated here is that it does not pay to be strictly digital in your thinking. The objective is to execute a good landing and not merely flying the approach at precisely the required speed. Another aspect of 'digital flying' is following the command bars of the Flight Director (FD). In some types of FD, just ensuring that the target is always met does not necessarily mean that the aircraft is on the correct approach path. In this 'V bar' type, the command bars may just be guiding the aircraft towards the correct path after it has drifted from, say, the ILS the glideslope or localizer. In this case, a quick glance at the raw ILS data would reveal where the aircraft actually is and thus indicate what kind of a change is likely to occur once the aircraft arrives back on the correct path. Seemingly minor deviations from the correct path at large distances from the runway very quickly increase as one comes closer to it so that larger control inputs are needed. And in aircraft that use roll spoilers to assist in roll control, an excessive roll command may lead to a significant increase in drag on the down-going wing which causes the airspeed to fall at a potentially critical stage of the approach. Anticipating the implications of flying manually but still using the FD allows the pilot to foresee the control input that is about to become necessary in respect of both the thrust setting and the flight controls as the aircraft regains the correct path. The operative words here are 'about to' and it is this analogue response that the pilot must appreciate. Correcting after the aircraft achieves the correct path would be the 'digital' response and would be 'too little too late'.

The transition from digital (automated) to analogue (manual) flying is relevant to the approach. Subject to aircraft type, 'coming on the controls' just prior to disengagement of automation can represent a lost opportunity to determine, by lightly but firmly holding the controls for a period beforehand, to get the 'feel' of the aircraft. Without the Autothrottle engaged, small changes in thrust are best achieved by 'walking' the thrust lever knobs i.e. making a small movement of one lever and then using that as a reference for movement of the other(s).

The replacement of analogue systems is a huge technical achievement that has made flying simpler in more ways than one. But however capable and reliable it is, it cannot entirely replace what has traditionally been called 'seat of the pants' flying. Appreciating all the implications of operating our digital aeroplanes has the potential to make flying safe and even more enjoyable. But we all must strive to become the 'fathers' rather than the 'children' of the magenta!

EDITORS NOTE

Those readers who are more familiar with the 'digital' area control centre than the 'digital' flight deck may be wondering how much of the piloting talk above is transferable to their environment.

Suggesting that the supervisor occasionally switches off all the aids that make it possible to handle busy traffic periods at a busy time is hardly sensible. But maybe there is an opportunity to provide safe and expeditious ATC service with less than full automation at quieter times as a means to retaining controller 'reversion skills'.

After all, automation is not yet infallible and opportunities to remind oneself how to handle loss of full automation in a training simulator are either not sufficiently frequent or not yet available at all.

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He has approximately 9000 hours from 32 years in aviation.

38- An optional but almost always displayed overlay on the Aircraft Attitude Display – once known as the Attitude Indicator – which provides a target pitch and roll and provides cues to 'fly' the aircraft to comply with the target. With the AP engaged, the set target will always be met.