Workload management in a 2-man flight deck: when automation increases the workload...

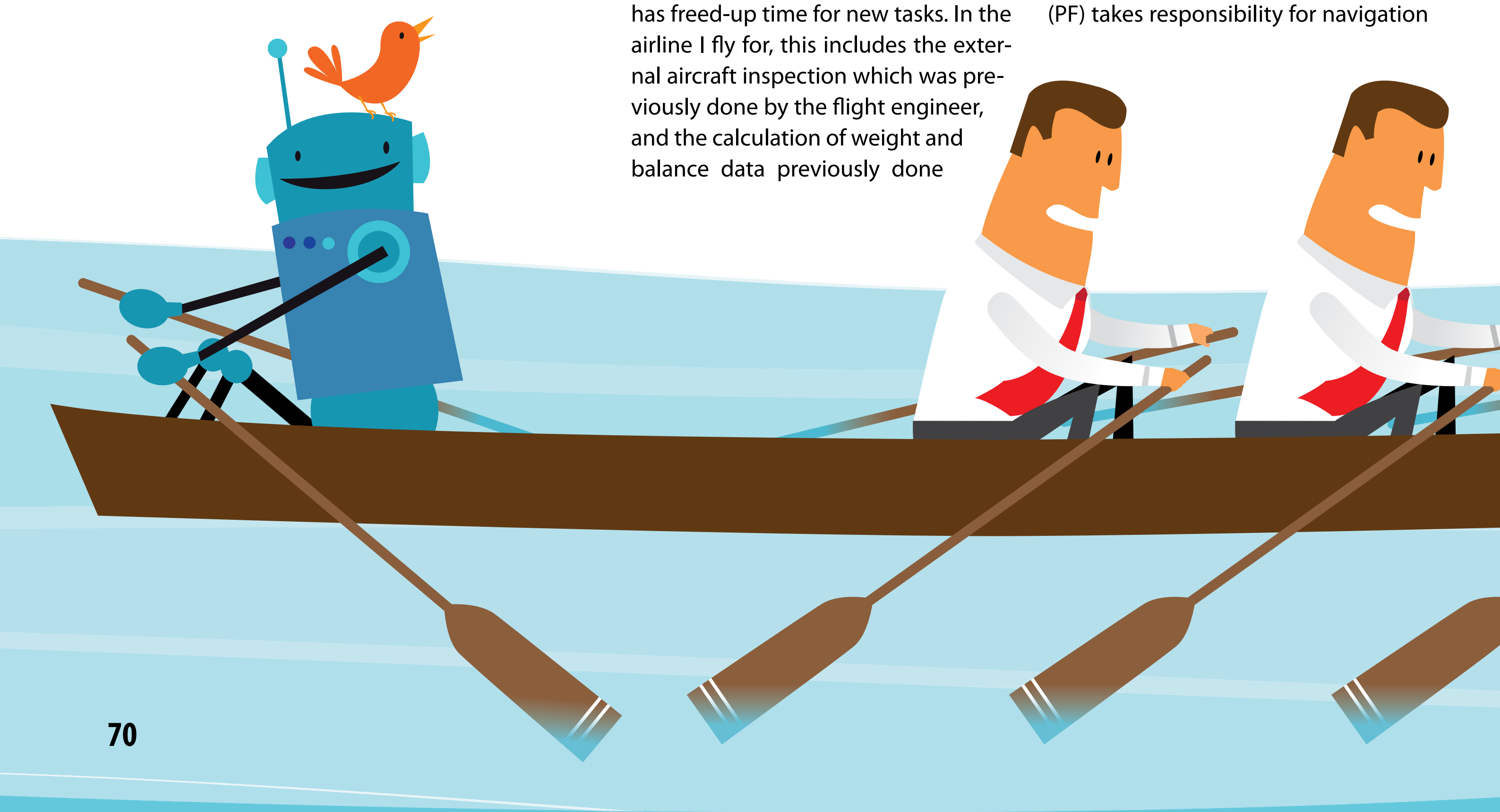
by Captain Dirk De Winter

While the flight deck of first generation passenger jet aircraft hosted a 3 to 5 man crew, modern versions need only a 2 man crew and transport many more passengers. The knowledge and skills of the navigator are replaced by a few keystrokes on the keypad of a Flight Management System (FMS)...

The now digital VHF radios are easily operated by the pilots and aircraft systems have become extremely reliable, digitally controlled and much more automated. Navigating, communicating and system operation have become so "easy" that these tasks can now be combined with the primary aircraft control tasks of the two pilots without any other flight deck occupant. However these two pilots are not working in the same way as the larger crews used to.

During the pre-flight cockpit preparation, new technologies such as datalink allow the uploading of the flight plan straight into the FMS, thus avoiding the time consuming and error-prone process of manual entry. The use of computer programs on the electronic flight bag (EFB) to calculate the take-off performance data instead of the old manual process relying on a paper "weight book" has certainly made this process more efficient. However the time saved by these new technologies has freed-up time for new tasks. In the airline I fly for, this includes the external aircraft inspection which was previously done by the flight engineer, and the calculation of weight and balance data previously done by the despatcher who also sent various flight data such as the fuel uplift, passenger numbers and delay codes to the Company. In the flight preparation phase, the type of tasks undertaken may have changed, but the time required to complete them all has remained very similar and this is reflected in the flight and duty time limitations.

Once in the air, in addition to their aircraft control tasks, the Pilot Flying (PF) takes responsibility for navigation



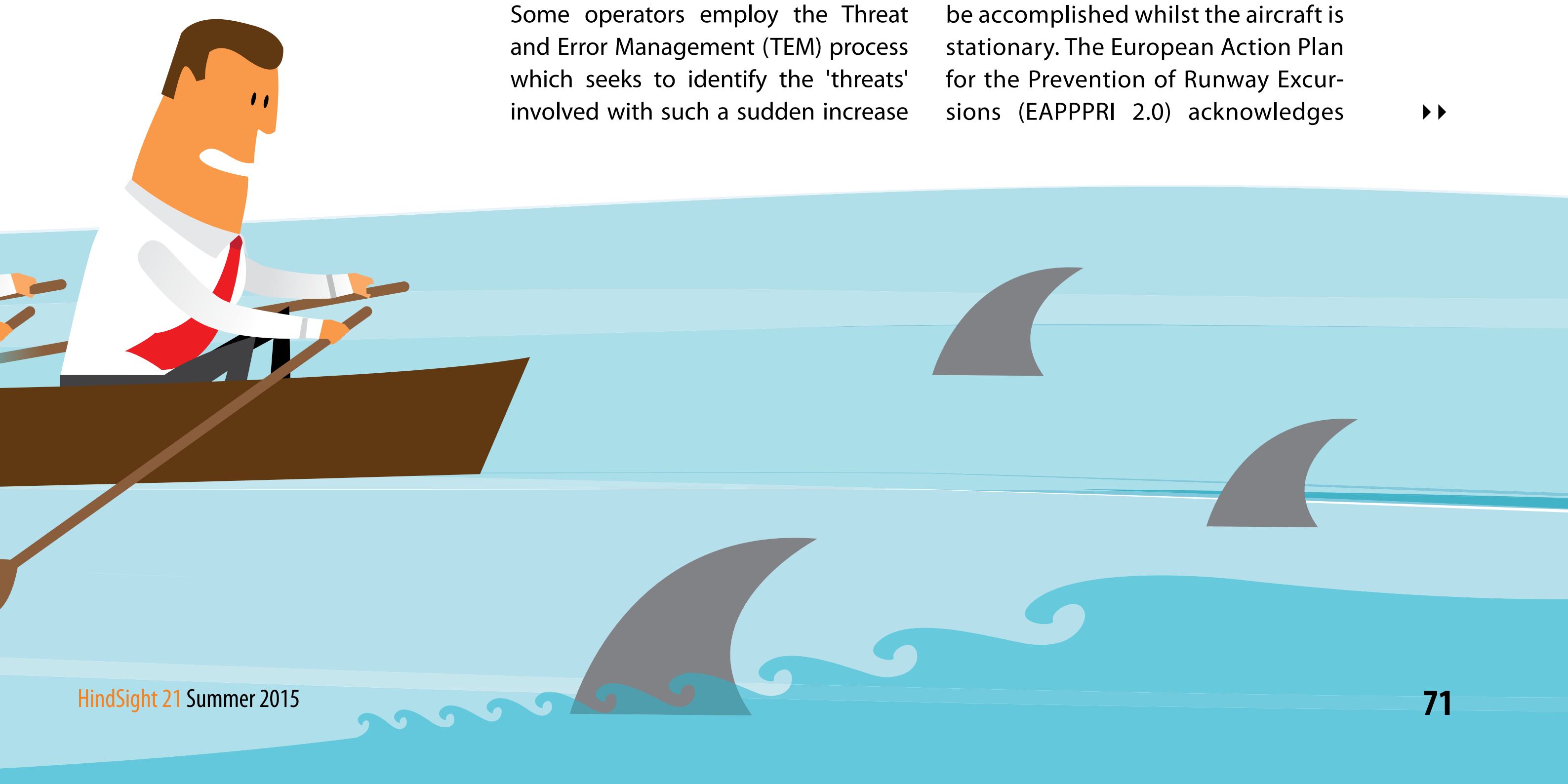
and the Pilot Monitoring (PM) takes responsibility for communication and systems operation. During normal operations, the procedures and tasks for the PF and PM in the various flight phases are well described and evenly distributed. With good use of the available automation, the level of workload is such that spare capacity to maintain situational awareness is available.

However if an unexpected situation occurs which requires extra attention, the workload can increase considerably. A good example is a runway change during the taxi-out phase. Many airlines perform single engine taxi on their twin-jets and these are slightly more complex and change the order of set-ups and checklists because these aircraft were originally designed to taxi on two engines. Adding a taxi out runway change to this significantly increases the flight crew workload. After the PM has verified the new taxi routing and confirmed this with the PF, he needs to stop his primary task – guiding and monitoring the PF – to make the changes to the departure routing in the FMS, select the corresponding chart from the EFB and then cross-check the routing in the FMS against the routing on the chart. Next, the PM needs to go to the take-off performance module in the EFB to recalculate the performance data for the new runway and enter these into the FMS. Afterwards the PF must cross-check these entries and re-brief the changes to the departure routing. An initially normal taxi phase suddenly turns into a high workload phase where errors such as an incorrect taxi routing could lead to a runway incursion or errors in the performance calculation or FMS data entry could lead to a tail strike or even a runway excursion.

Some operators employ the Threat and Error Management (TEM) process which seeks to identify the 'threats' involved with such a sudden increase in workload and offer mitigation measures such as bringing the aircraft to a full stop and remaining stationary so the PF can more effectively monitor the PM as they complete every step of the change process.

Controllers have a “big picture” view of the airport and are trying to optimise the aircraft movements both on the ground and in the air which is one reason why they sometimes change departure runways or departure routings. Changing weather conditions are another. Whilst this is likely to also be beneficial for the flight involved, controllers should consider the time needed by the flight crew to make the necessary changes in the FMS and re-brief the new runway or departure routing. Additionally they might offer an opportunity to stop the aircraft en route to the new runway so that all consequences on the flight deck can be accomplished whilst the aircraft is stationary. The European Action Plan for the Prevention of Runway Excursions (EAPPPRI 2.0) acknowledges

▸▸



Workload management in a 2-man flight deck: when automation increases the workload... (cont'd)

this issue and proposes recommendations for flight crew (REC 1.4.10) and air traffic controllers (REC 1.5.17).

1.4.10	During taxi departure or during approach, Pilots should not accept a runway change proposal if time to re-programme the FMS / re-brief is not sufficient. This includes a change of departures intersection.

Figure 1: EAPPRI 2.0 – Recommendations for Aircraft Operators

1.5.17	When planning a runway change for departing or arriving traffic, consider the time a pilot will require to prepare / re-brief.

Figure 2: EAPPRI 2.0 – Recommendations for Air Traffic Controllers

The same principle applies to approaches. Paris Charles-de-Gaulle airport; one of the busiest airports in Europe, has two pairs of parallel runways with the terminal buildings in between the Northern and Southern runway pairs. The two inner runways are usually used for takeoff and the two outer runways are usually used for landing. This means that once landed, aircraft often have to hold short of the inner (departure) runway to await crossing clearance from the tower controller. To optimise the arrival sequence, controllers sometimes change the approach from the Northern to the Southern runway or vice versa. Like a change in departure runway, this generates a high workload for the flight crew with the major difference that the aircraft position can't be frozen to allow for a change of the landing runway in the FMS and a review the approach and go-around procedure. Some aircraft have a FMS functionality called "secondary flight plan" to store the routing for the approach and go-around procedure for an alternate runway. This "secondary flight plan" can be set up and briefed during the cruise and if required activated with just a few keystrokes making it easier for the crew to accept a runway change. Unfortunately crews often choose to enter the inner (normally the take off) runway into the "secondary flight plan" because in low traffic situations they could request a 'side step' to land on the inner runway and thereby reduce taxi-in time. Also, in anticipation of a short turnaround, the next sector might have already been loaded into the "secondary flight plan". So even if the aircraft is equipped with this secondary flight plan functionality, it's far from sure that it will contain the amended approach and landing runway which the controller has in mind. So the sooner the flight crew is advised of this runway change, the more chance there is that the flight crew will be able to complete a successful stabilised approach and landing. In my view, practical guidance for a straight-in approach is that the landing runway should not be changed once the aircraft is within 20 track miles of the threshold or beyond a late downwind position abeam the landing threshold. This case shows that automation assists in reducing pilot workload but that when there is a change to the original plan; automation creates extra workload that requires careful mitigation.

In recurrent training, workload management is analysed and trained as part of the crew resource management (CRM). Traditionally, the focus is on how the two pilots cooperate. However the way they cooperate with the cabin crew and ATC should also be part of the training process. Here a Training Captain would simulate normal cabin manager or air traffic controller behaviour and not facilitate the flight crew to complete the exercise. A few weeks ago, I had a flight crew under training who requested a hold on a 10 mile final to a major airport in order to investigate a minor technical problem. Whilst this makes the navigation task of the flight crew easier and places the aircraft in an ideal position to start the approach if the situation deteriorates, it is not necessarily an optimal position for the controller who has to manage his arrival sequence. Consequently, there's little chance a controller would authorise such a request without the prior declaration of a PAN or MAYDAY. In lesser situations, controllers are trained to assist flight crew and facilitate the navigation by offering suitable holding fixes or radar vectoring so that the flight crew can swiftly begin the failure management process.

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.