Winds of Change

Ryan Ellison discusses how flight management system technology can be optimised to achieve significant improvements in air traffic management

Unless you are directly involved in the concepts being developed within future ATM planning such as NextGen and SESAR, it might be hard to believe anything will happen to unlock the constraints found in our airspace systems.

Today's ATM environment lends itself to so many operational inefficiencies that many people have developed the 'it is never going to change' or 'I'll believe it when I see it' attitude. Aviation history may justify this thinking, to a point, change is happening and early benefits can and are being obtained by early adopters.

Operational improvements such as Time and Trajectory based operations as well as the overarching concept of performance based operations hold many of the keys within airspace optimisation programmes and are pillars of NextGen and SESAR. However these concepts rely heavily on the equipment available in the air and ground as well as the accuracy this equipment is capability of providing. Fact is, the smartphone sitting on my desk has much more computing power than the FMS flight management system found within modern aircraft coming off the line today and the WiFI in the back of the aircraft is capable of handling much more data than the ACARS in the front.

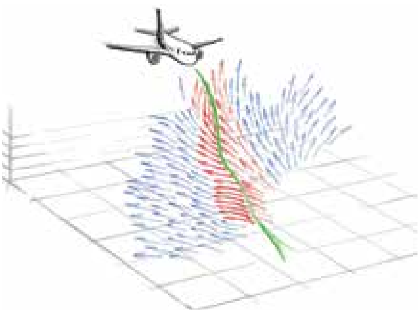
It's hard to believe that just a few years ago Southwest Airlines was ordering 737NGs with glass displays made to look similar to Classic 737s. Since 2007, the airline has invested millions in aircraft modernisation and crew training to create an organisational culture that embraces technology.

This early adopter attitude was focused on gaining operational efficiencies found with existing hardware and utilising concepts found within NextGen and SESAR. The first step was embracing the FMS and all it has to offer. While today's FMS may have the computer capacity of a 1980's video game, its capabilities, when used correctly and in harmony with the aircraft's automation, can have a tremendous effect on individual aircraft efficiency and can contribute to a gain in ATM performance.

Southwest's original goal with technology upgrades was to utilise RNP procedures across its route network in order save time and fuel. This admirable and ambitious plan put Southwest on the map as a technology leader and set the stage for early wins within NextGen. As these concepts continue to develop, the importance of trajectory operations should eventually lead to a full system wide implementation of Performance Based Operations (PBO).

For this vision to become reality, the importance of knowing where and when an aircraft will be at any given time and in any given space cannot be overstated. The FMS will play one of the biggest roles for air service providers, airlines and industry stakeholders accomplishing their goals over PBO. However the FMS is still a computer and produces an output only as good as its inputs allows.

Southwest recognised this a number of years ago and sought ways to improve FMS performance. This led to a focus on weather, particularly wind and temperature data input to the FMS. As wind is a critical factor in an aircraft's ability to meet a required time of arrival and calculate an accurate four-dimensional trajectory, it became clear that the most up-to-date, accurate, and tailored weather would be essential for operations within the future ATM system.



As an aircraft commences its descent through the atmosphere it goes through an ever changing environment of wind shifts and temperature changes. While each FMS is different, today's typical FMS only has room for three to five winds during the descent phase of flight, not a lot considering the constant change of wind direction and speed with descending. Multiply this with the fact that the FMS needs to have accurate wind data to plan an optimum trajectory and accordingly time predictions to comply with an RTA - if used - prior to top of descent one might see the efficiency problems emerging.

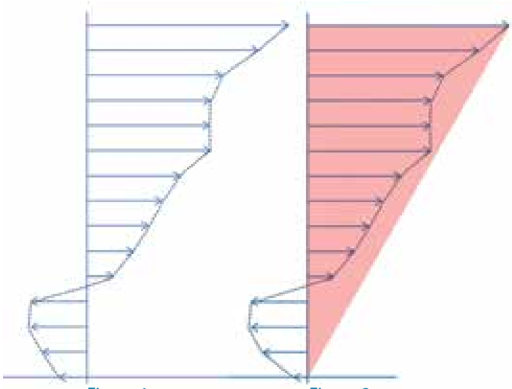


Figure 1 *Figure 2*

The image above (Figure 1) represents a typical headwind/tailwind profile which could be encountered on any day, at any location around the world. The image beside it (Figure 2) shows how the FMS will interpret winds if no winds are inserted in to the FMS, generally speaking. The diagram shows that even though 'no winds' are inserted in the FMS, the system still interpolates the wind at the current altitude and assumes zero winds at the surface. This can lead to a large wind error within the FMS thus leading to inaccurate descent calculations within the computer.

To overcome this large error many airlines currently encourage their crews to select winds from the weather information they currently possess or send them descent winds from their flight planning systems. While this may be an improvement over not inputting winds at all it does come with a cost.

Most aviation weather products have significant delays in update rates and have large scale granularity within their models. While this may suffice within an enroute environment it makes forecasting the descent, where an aircraft is descending through a number of layers quickly challenging. Additionally, on long haul flights, flight crews weather data may be anywhere from eight to 18 hours old.

Flight planning services help eliminate some of this latency by utilising the most up to date information available and selecting winds and preset fixed levels and sending this to the flight deck. This aids the crew with some automation and standardisation across the system. Fixed levels selection also has its draw backs, however. Figure 3 shows the winds error in our example and how it might compare with our given atmosphere. There clearly can be an improvement over a 'no wind' type selection however one must remember that the level selection will always be fixed thus some days the computed wind error maybe less, others it may be more. This leads to variation within the system. As pilots, from flight to flight will have little knowledge of how accurate their descent profile calculation will be, trust in the system can be compromised.

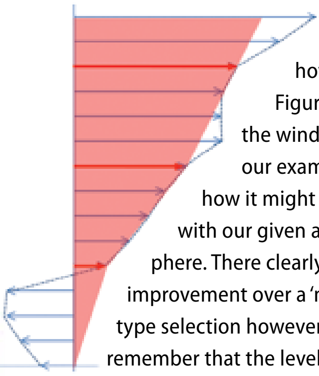


Figure 3

To overcome this, AVTECH has designed the Aventus NowCast Descent system, which incorporates two independent features. First, AVTECH worked with industry leading MET providers to secure the very best in meteorological forecast models. Not only do these models incorporate high resolution grids they also incorporate aircraft sensed data from AMDAR and TAMDAR sensors. This allows for a very accurate model in a very tight space, updated often.

The second, a level selection algorithm which tailors each wind uplink to each aircraft's trajectory, performance and given wind forecast creating one of the first performance based tools on the market today. The Aventus NowCast system automatically communicates with the FMS prior to Top of Descent requesting all the necessary data from the FMS then, a few moments later provides the FMS with a tailored wind uplink prior to descent trajectory calculation.

The next image (Figure 4) shows the wind error with a tailored wind selection compared with the atmospheric profile. One can see, by making small changes in level selection large changes in wind error can be obtained.

The Aventus system establishes a 4D trajectory for every flight based on data from the FMS either from the trajectory bus on the Boeing 737 or calculated based on FMS generated data. For the Aventus application the 4DT is being used to establish the wind profile for that specific flight using the Aventus algorithms but it could also be used for a number of other applications such as flow management, wake vortex applications, performance based separation setup to name a few.

The system demonstrates that efficiency gains can still be obtained today utilising new algorithms, enhanced forecasting and existing aircraft technology. But it's not the only benefit, utilising automated systems such as Aventus shrink operational variance within an airlines operation, reduce pilot workload all while saving fuel. Operational trials within SESAR as well as independent trials conducted by AVTECH have shown fuel benefits ranging from 20 to 80kg depending on size of aircraft, complexity of airspace and activity of the local weather systems.

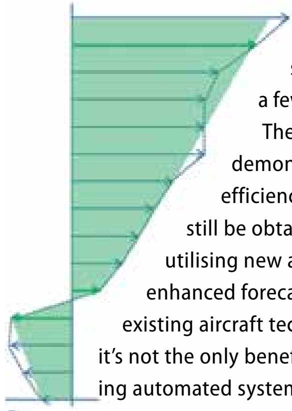


Figure 4

On July 11, AVTECH announced Southwest Airlines as their US launch customer for the Aventus NowCast Descent wind system. Keeping true to their focus on utilising technology to enhance operations, Southwest is implementing Aventus throughout its entire route network.

The Aventus system has an excellent operational track record and is the first application where aircraft and ground computers are connected providing an optimised solution and direct benefits. Aventus can also be expanded to the full, end-to-end environment offering optimised wind forecasting for pre-flight, climb, cruise and descent.

But what about the future benefits? Without the accurate trajectory predictions which come from a system like Aventus, many of the concepts found within SESAR and NextGen will not be possible. Time Based and Trajectory based operations need exact predictions in order to ensure proper flow and confidence within the system. As the system is tailored to the performance of each aircraft subscribing to it creates an environment that facilitates the performance based concept. ATM

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