A330neo cockpit – commonality with A350 innovations

The A330neo, Airbus' newest widebody airliner, was developed at a time to be able to benefit from the technologies introduced on the A350. Moreover, when designing the A350, one of Airbus' goals was to achieve a balance between commonality coming from the original A330, and innovations from the A380. For example, the A350 and the A380 employ the same side-stick and digital fly-by-wire flight control philosophy with envelope protection – which was first introduced on the A320 and A330 airliners and is now standard across the Airbus product range. Another standard Airbus feature is the 'dark cockpit' concept whereby lights only show on the overhead systems management panel to indicate where an action is required. Overall the A330neo and A350 cockpits share a similar layout. The most noticeable difference is that the A350 has larger screens and an On-board Information System (OIS) display. On the A330neo most of the content can be used on an Electronic Flight Bag (EFB) laptop or tablet.

In short, the continuous and systematic cross-fertilization and circular "feedback" between *all* Airbus airliners has allowed state-of-the-art innovations to be infused into the A330neo's DNA, bringing this aircraft *'en par'* with the A350 in many key areas, including the following:

- Trajectory and energy management displays for the pilot on a new Harmonized-PFD.
- '4D' satellite-based navigation for the most efficient real-time flight paths and optimum trajectories.
- Safety-enhancing flight-ops functions including new Airborne Situational Awareness (ATSAW) system; Runway Overrun Prevention (ROPs); automated traffic avoidance (AP-TCAS) system; Global Navigation Satellite System (GNSS) -based landing (eg. Ground-Based Augmentation System - GBAS and Satellite-Based Augmentation System - SBAS); and airport on-ground navigation functions.
- Real-time aircraft data on pilots' EFBs plus Skywise on-board diagnostics and health monitoring.
- Digital air traffic communications for pilots and mission-management features, automated checklists, and wireless EFBs.
- Optional dual head-up-displays (HUDs) for pilots.
- Very high, bypass ratio (10:1) Trent turbofan engines – conferring double-digit reductions in CO_2 emissions.
- Enhanced 3D span-wise aerodynamics, from wing-root to wing-tip with CFRP weight-saving materials.
- Airspace cabin with full-colour LED lighting, larger bins, in-flight satellite connectivity and wireless IFE for passengers.

Focus on the cockpit

As part of a series on the A330neo, we focus on how this aircraft's cockpit embodies new technology, ergonomics and commonality to complement the larger A350 in an airline's fleet mix. To guide us through this topic, we spoke with two Airbus experts: test pilots Captain Jean-Michel Roy and Captain Shaun Wildey.

It should be noted that while each of the items listed above and relating to the cockpit are individually beneficial, the real value is realised when these are combined to form a 'bigger picture' for pilots, which is summed-up by five pillars: "Fly"; "Navigate"; "Communicate"; "Manage Aircraft Systems" and "Manage Mission".
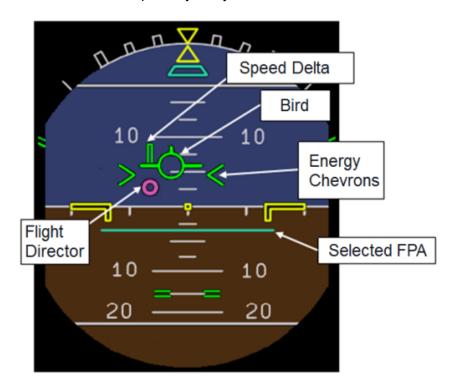
1. Fly the aircraft

"The first category 'Fly', has evolved significantly for the A350," explains Roy. "On the original A330, and on all other Airbus aircraft at the time, the piloting core symbology has centered on the traditional concept of 'pitch and thrust'. The new approach on the A350 introduces new intuitive parameters for pilots to fly the aircraft, namely **'trajectory'** and **'energy'**."

To reinforce this change of mindset, new symbology was introduced onto the HUDs which is now mirrored on a new **'harmonized Primary Flight Display' (hPFD)**. The latter is an enhancement of the traditional 'head down' PFD which provides the trajectory and energy guidance information. For conveying the *trajectory*, or 'flight path vector', the bird symbol is

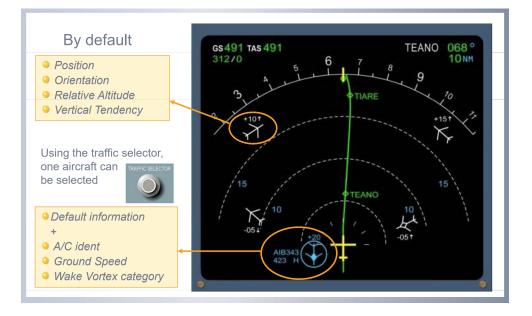**Follow us**   [f] [twitter] [in] [instagram] [youtube]

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presented on the hPFD, which is now complemented by the *energy* conveyed to the pilot, depicted as chevrons relative to the bird.

"Following its successful introduction on the A350, we decided to make the new HUD and hPFD displays – with their new trajectory and energy symbologies – available for the whole fleet, including the A320 and A330neo, so it's really the A350 which brought this new innovation into the A330neo cockpit," says Roy.

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Test pilot Shaun Wildey points out some of its potential advantages in operation: "On approach, when using the HUD, the bird with the circle and horizontal aircraft wings shows where the aircraft is going and in reference to the runway threshold. One of the benefits of this trajectory presentation is that the pilots know that the aircraft is aiming at the correct touchdown point on the correct slope."

"With the previous flight directors showing the pitch on the PFD, the aircraft may be nose-high while it is actually descending. The new hPFD flight director symbology will show the actual trajectory of the aircraft alongside the energy cues. This allows the pilots to better understand the flight path."

2. Navigate

Another example of technology infusion from the A350 cockpit into the A330neo's is 'Airborne Traffic Situational Awareness' (ATSAW). "This shows other surrounding traffic on the pilot's Navigation Display (ND), which existed already with TCAS, and now provides additional information including each aircraft's *identification,* as well as the direction in which it is heading," explains Roy.

"Prior to ATSAW there was only positional information and a diamond symbol, but that didn't indicate if other traffic was coming towards you, or moving away. Now with ATSAW we can see a small symbol of an aircraft heading towards us, and we can see a caption with its flight number – which can be quite important in a busy area. So this is new and coming from the A350 development."
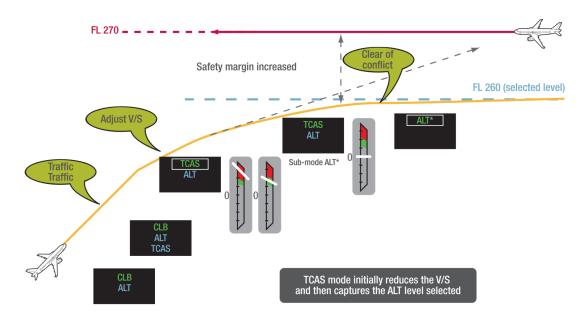

"The A330neo cockpit also features 'Autopilot / Flight Director Traffic Collision Avoidance System' (AP/FD TCAS) mode. This is an enhancement whose timeline is associated with these new airliners. So for pilots in an A330neo, if they have traffic venturing close, then the automation can help them to proactively avoid it. The resolving manoeuvre

can either be performed by the autopilot if the latter is engaged, or via the flight director markers which can guide the pilot to safely perform it manually."

Wildey notes: "The AP/FD TCAS is a big step forward because pilots nowadays have less opportunity to practice aircraft handling at high altitude, and as an instructor we sometimes see less efficient manoeuvres, even 'over-control', if they use the previous Standard Operating Procedures (SOPs), which requires them to turn off the flight directors. So using this technology developed in the A380 and A350 and putting it back into the A330neo is an enormous step in the right direction for safety and efficiency."
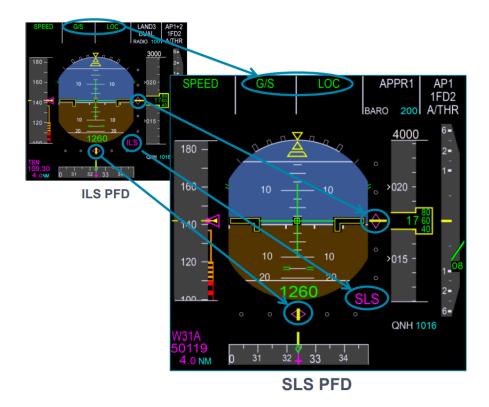

For *en-route navigation*, thanks to an upgraded on-board Multi-Mode Receiver (MMR) unit, A330neo pilots will be able to use a new '**Satellite-Based Augmentation System' (SBAS)** function which will be increasingly needed and obligatory by 2025 throughout North American airspace. This GPS augmentation is accomplished with a regional infrastructure such as Wide Area Augmentation System (WAAS) over the US, and the European Geostationary Overlay Service (EGNOS) over Europe etc. En-route navigation using this method provides ATC with an accurate alternative to traditional ground-based Secondary Surveillance Radar (SSR).

The A330neo is further 'future-proofed' by incorporating **'FANS-C'' 4D Trajectory-Based Operations'**, whereby the aircraft will offer '**Automatic Dependent Surveillance Contract' (ADS-C)** capability to transmit automatically or on-demand the aircraft's complete predicted four-dimensional aircraft trajectory (3D + time) to the ATC controller. In parallel, the aircraft's CPDLC equipment facilitates the digital uplink of ATC orders and clearances. The benefits of FANS-C include more accurate flight plans, more optimised trajectory computation and acceptance processes, better alignment of airlines' and ATM planned trajectories, enhancement of aircraft traffic predictions and improvement of demand/capacity network calculations. For FANS-C capability the aircraft is also fitted with a new data link Air Traffic Services Unit (ATSU), an upgraded Flight Management System (FMS) and a Datalink Control and Display Unit (DCDU).

For the subsequent *approach* phase, A330neo pilots will welcome another important cockpit development which was originally designed into the A380 and A350: the concept of standardizing the approaches around the concept of the "xLS".

"Essentially this allows pilots to fly most of the approaches as if they were using a regular ILS procedure," explains Roy. "This is made possible via different xLS modes: **'Satellite Landing System' (SLS)** and **'GBAS Landing System' (GLS)**, both using positional information from GPS low-earth-orbit (LEO) constellations and reinforced respectively by SBAS augmentation (mentioned above for *en-route* navigation), or via fixed **'Ground-Based Augmentation Systems' (GBAS)** stations at the destination airport."
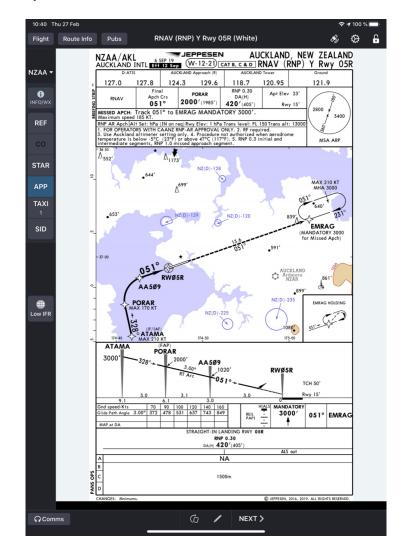

ILS PFD

SLS PFD

In the case of SLS, its particular capability is that it enables pilots to fly GPS satellite-based approaches, providing lateral and vertical guidance, into airports which are neither equipped with a GBAS ground station nor any functioning radio-based ILS infrastructure. The other xLS mode is the **'FMS Landing System' (FLS)** which uses real-time data from the FMS. In short, these xLS approaches allow the pilot to fly 'straight-in' non-precision approaches in the very same manner as they would for a traditional VHF radio-beam ILS approach since they present the same familiar ILS-like symbology."

The A330neo's systems also allow pilots to perform precision *curved* approaches, called '**Required Navigation Performance – Authorization Required' (RNP-AR)**. This function enables the aircraft to follow precise three-dimensional curved flight paths through congested airspace, around noise sensitive areas or through difficult terrain.
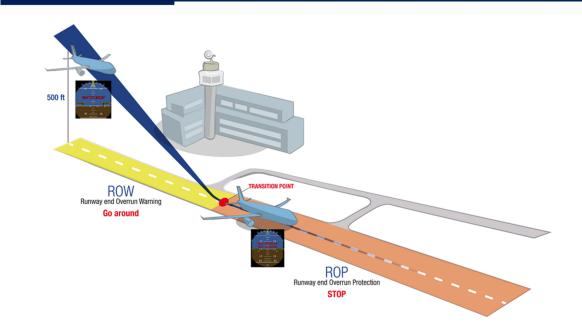
"Together these xLS and RNP approach capabilities mean that the A330neo – like the A350 – is able to fly all the approaches in the world using a very simple classification for precision and non-precision straight-in approaches – with xLS, as well as curved approaches – via RNP-AR," notes Roy.
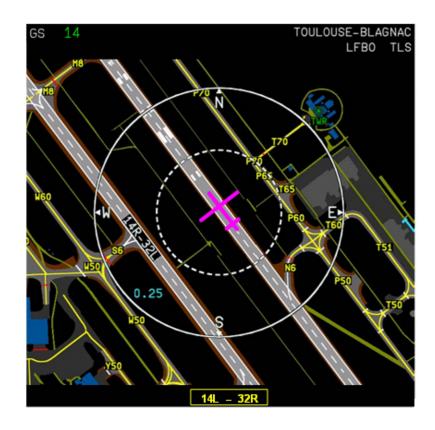
After the approach segment of course, there is the landing phase to consider. "Airbus' **'Runway Overrun Prevention System' (ROPs)**, first introduced on the A380, is standard on the A350 and now is being distributed on the A330neo," says Roy.

"ROPs alerts the crew if they are coming in to land with too much energy, should they be too high or too fast, and take into account whether the runway is "wet" or "dry". Such early warning allows the pilot to make a safe go-around decision, before the landing is committed. Or if the pilot decides to continue with the landing then the system will, on touchdown, help the pilot to achieve maximum deceleration either automatically, or manually by reminding him to do so by clear voice calls," he explains.

Once the pilots turn onto the taxiway, the **'On-board Airport Navigation System' (OANS) -** which was introduced on the A350 and is now available on the A330neo - presents the pilot with a map of the airport apron, its runways and all the taxiways, showing the aircraft's exact location in real time.

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"This for sure enhances safety because it can be challenging to taxi large aircraft, especially at large airports and when the weather is not what we would like it to be," says Roy. "With this technology pilots have a much better understanding of where they are and where they should go – whether to reach the required takeoff position, or to reach the gate after the taxi-in."

"The authorities are pushing the industry to adopt this type of airport navigation system. They recognize that ground traffic is a real issue for safety, efficiency and for comfort - especially on some routes where the ground phase presents an increased workload at large or complex airports."

Wildey adds: "Pilots can visually see on their Navigation Display exactly where the runways are, reducing the risk of runway incursion. Overall OANS really enhances their situational awareness, which reduces the workload in the cockpit and improves crew-resource management (CRM). This in turn improves operational efficiency for the airline because pilots can optimize their task-sharing and carry on taxiing."
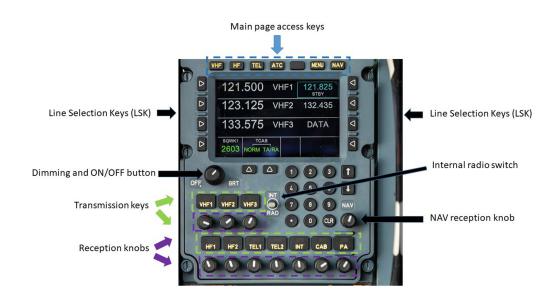

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3. Communicate

Pilots flying the A330neo will also appreciate the very latest in ATC communication features. "For voice communication we will implement a new panel to control the radio management: We are switching over from the older A330 analogue radio system, to a new **'Digital Radio and Audio Integrating Management System' (DRAIMS)** which is very similar to the digital audio system for the A350."

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DRAIMS, which features new audio management avionics and new user control panels with a large modern digital display, multifunction keys and a numeric keypad, handles all cockpit communication tasks. The system facilitates clearer communication between pilots, cabin crew and the ground to ensure flight safety, answer to air traffic control, or prepare for ground operations. Of course, both A330neo and A350 pilots can still communicate with ATC via written messages using **'Controller Pilot Data Link Communications' (CPDLC)** – which remains unchanged and is common with the A350. So here there is commonality on the datalink, and innovation on the voice. "This is another good example of the balance in the A330neo between commonality with previous aircraft and the latest innovations," comments Roy.

4. Manage Aircraft Systems

In terms of managing the aircraft systems, the emphasis for the A350 has been on keeping a very high level of commonality on the overhead panel – the interface of the systems management – with the popular overhead panel that has featured on the A330ceo and A320ceo for many years.

"The A330neo's overhead panel is almost the same as the A350's," says Roy. "We were so happy with the original design, and the consequence is the 'dark cockpit' concept where if all the lights are out, then the aircraft is ready to fly."

"We not only continue to have the same overhead panels, but we also have the core of the monitoring, the **'Electronic Centralized Aircraft Monitor' (ECAM)** screens on the centre panel between the pilots, where for the 'sensed' failure scenario we stay with the same concept. So in this regard the two aircraft are fairly equivalent. From a pilot's perspective, the methodology of our training is exactly the same in terms of how you manage a failure in the cockpit."

"You could even introduce a pilot from an A350 to the A330neo cockpit, who had never flown in the latter – or vice versa – and they would be able to manage an emergency or failure in exactly the same way using the ECAM," he adds.

5. Manage Mission

For the last category, "Manage Mission," pilots in either aircraft cockpit can use **'Electronic Flight Bags' (EFBs)** to receive and display on-board aircraft navigation data (flight plans, aircraft position etc.) from the FMS, or perform takeoff performance calculations, or even transmit diagnostic maintenance data to the ground.

"This facility is incorporated in the A350 cockpit via a dedicated laptop docking station. Whereas on the A330neo, thanks to its secure wi-fi router and maintenance connectivity solution – known as the **'Flight Operations and Maintenance Exchanger' (FOMAX)** – A330neo pilots can also connect a portable EFB tablet device to the aircraft," says Roy.

"The FOMAX router is a very big step forward allowing A330neo pilots to communicate with the open world and with the aircraft avionics (as they can on the A350 using its docking station), however in this case by connecting their hand-held (or dashboard mounted) EFBs via wi-fi."

Wildey notes: "It particularly helps with regards to efficiency by being able to connect the EFB to the aircraft via the A330neo's FOMAX wi-fi. In the past, A330 pilots would have had to load the flight plans into the FMS directly, then if they wanted to see the information on their EFB, they would separately have to enter it again into that tool. Having the EFB linking to the FMS now avoids repeating data entry and greatly reduces workload on the ground and in the air."

Working with **Checklists** is another 'Manage Mission' activity which has been greatly enhanced by the capability on the A330neo to link pilots' EFBs into the aircraft's avionics

and FMS. By using the connected EFB concept, Airbus has transformed the former typically laminated card based checklists of the A330ceo into electronic checklists – referred to as the **'electronic Quick Reference Handbook' (eQRH)**. Action-items can either be sensed by the aircraft or by the pilot. Items which need attention are highlighted in blue, while the completed actions are green. This blue/green logic is now common with the A350.

Wildey points out: "With these interactive checklists you can quickly determine from the colour-codes which items have been completed versus those not yet done. This reduces the chance of missing a step, say, if the process has been interrupted for any reason."

With the A330neo's eQRH, the checklist labels, text, and user interactions are the same as, or intuitively equivalent to those on the A350. For example, the way to tick in the EFB's eQRH function will be performed with a manual tick on the EFB's touchscreen, while on the A350 the pilot will use the Cursor-Control Unit (CCU) to place the tick on the built-in checklist screen.

"Whereas previously we used the paper checklists; with innovation on the A350 we went with the integrated checklists; and now we are bringing that back into the A330neo, giving pilots the very same 'look and feel', thanks to the eQRH," explains Roy.

A330neo & A350 training commonality

By all design and by all standardized procedures, operators value the commonality between the two aircraft – A330neo and A350 – which have been approved under a single-pilot license endorsement. Consequently, pilots flying one aircraft can also fly the other, after undergoing some 'differences-training' (pilots still have to learn the major system changes, air pressurisation limitations, operating weights etc.). Importantly this differences training does not need to include rental sessions in a full-flight-simulator (FFS), so overall it takes only eight days, after which pilots receive a single stamp in their license stating that they can fly both the A330neo and A350 from one day to the next – and be totally at home in either cockpit.