CV-22 Osprey
Lt Col Jim Peterson – USAF 7th Special Operations Squadron, RAF Mildenhall
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This was an absorbing presentation that included a brief history of the challenges posed by tilt-rotor aircraft development, an overview of the US programmes that led to the introduction of aircraft into service, and the experience accumulated subsequently. The majority of V-22 aircraft, about 350, are operated by the US Marine Corps (USMC), but the UK-based contingency (7th Special Operations Squadron) is a component of the US Air Force (USAF) fleet of about 50 aircraft. Their operations are worldwide, and an oversight of front-line deployment capability was included in the presentation.

Compound aircraft (tilting wings or engines/rotors) are a genre that designers long believed could deliver vertical take-off and landing with cruise speed and range capabilities that would be between conventional fixed and rotary wing operations. Lt Col Peterson reviewed 1930 and 1942 projects, which were far-reaching but unsuccessful, and acknowledged the partial success of a US project which flew in 1954 but failed to complete a full transition. This was soon followed by the Bell XV-3 that flew on 1 August, 1955, and between 1958-62 it demonstrated 110 successful transitions. It was the seed from which progressively more capable US compound aircraft projects evolved. By 1976 the Bell XV-15, supported by NASA and US Army funding, was flown and transitions were demonstrated in 1978. Attributed research outcomes were better understanding of 'prop whirl' – the high gyroscopic precession effect of the large counter-rotating rotors – and its reconciliation with handling qualities using fly-by-wire (FBW) technology. The US DoD initiated the JVX programme in 1981 and contracted Bell/Boeing to develop a demonstrator two years later. The first of the V-22 lineage flew in 1989, crew training by the USMC commenced in 2000, and in 2007 and 2009 aircraft began to enter service with the USMC and USAF respectively.

The speaker gave a detailed introduction to the aircraft covering the crew, its overall capabilities and its systems. The aircraft carries four crew members, two pilots and two flight engineers. The pilots occupy the flight-deck and the commander role can be performed from either seat. They take prime responsibility for flying and navigation, and the execution of the sortie. The flight engineers, seated behind the pilots, are tasked to manage the aircraft's internal systems and to handle all non-routine communication and surveillance. They perform information-gathering duties and ensure that data from on-board sensors and military tactical sources is inserted into the tactical displays used by the flight crew – this can include long-range battle-related data relayed via satellite. The rest of the fuselage is devoted to payload, and loads can be up to 20,000lb (9,070kg), or 24-32 troops, or a lightweight armoured vehicle. All payload can be loaded through a rear ramp door, which also allows deployment either in-flight, from the hover, or when on the ground.

The baseline avionics systems he described are those on the current CV-22 Block10/B airframes – it is a Mil-Std-1553 based configuration which will be replaced by an open-architecture system, offering much greater data-transmission capacity in due course. The flight control system (FCS) is a three-channel fly-by wire (FBW) system with controls that mimic collective and cyclic controls (helicopter-style) in low-speed modes and conventional throttle and column controls (fixed-wing) in cruise modes, and is configured such that the aircraft is flyable if only one channel of the flight control system is operable. He stressed the great value of FBW in providing harmonised control responses that in terms of pilot 'feel' were seamless between flight phases. The aircraft has counter-rotating propellers which in transition and hover modes turn into high disc-loaded helicopter rotors. Each three-bladed rotor is about 2,200lb (1,000kg) mass, and being tip-mounted on the wings (relatively thick section and slightly swept-forward, constant chord, in plan) they need to react in a differential manner when the aircraft is manoeuvred in transition and hover. On a block schematic diagram of the lateral FCS system control laws he illustrated how differential cyclic creates instinctive responses to control inputs: e.g.: banking the aircraft as it is commanded left or right in the hover. The aircraft has a high-pressure, 5,000psi (340bar) three-channel (two main and one auxiliary) hydraulic system with titanium lines. The engine exhausts are deflected outwards by a flow-entrainment system that uses rotor downdraft energy to minimise hot-gas ingestion, and hot-spots on the landing surface. There are also on-board oxygen and inert gas generation systems (OBOGS and OBIGGS) that replenish supplies on demand, and the aircraft is de-iced (rubber-boots on flying-surface leading edges) and anti-iced (electrical deicing on engine intakes, etc.). A failure case he cited was that associated with the nacelle-tilt system. If it fails in the cruise position, causing the rotor blades to touch the ground before the aircraft on landing, the composite blades disintegrate in a manner that ensures there is tendency for the aircraft to tip nose-up or down.

The aircraft's mission systems support its front-line military tactical role, with a navigation system that draws information from inertial navigation and satellite-based systems. High-accuracy position data is derived using software-based Kalman filtering, and along with other mission-related data is overlaid on electronic data displays. Terrain-following uses modified F-16 Lantirn pod sensors faired onto the fuselage nose to allow the aircraft (cruising at 210-250kts, depending on altitude) to operate in low-visibility conditions. The aircraft can fly at low-level using terrain shielding, and has low noise and infra-red signatures that minimise the chance of detection. He acknowledged that once into transition and hover the rotor noise is considerable. If it is detected the aircraft has an extensive array of defensive aids to alert the crew, and that will automatically deploy chaff and flares if necessary. There is a 7.62mm (alternatively a 12.7mm) gun mounted at the rear, and operable by one of the two flight engineers. Additional gun locations are possible.

Operations were not detailed, but the presentation made clear that the aircraft is regarded as ready for detachment to any theatre of activity: rescue and humanitarian as well as military missions. The European squadron at the present time has 7 out of 10 planned aircraft and can be deployed in the Middle East and parts of Africa. He showed slides that reflected brochure performance data: 879n.m. (1,627km) range, 390 n.m. (722km) combat radius and 1,940n.m. (3,590km) ferry range with auxiliary internal fuel tanks.

This was a well-paced presentation that packed a lot of information. It was delivered congenially and proved to be as thought-provoking as it was informative. Audience questions were numerous and wide-ranging too, and the thanks expressed by Daniel Nutt were heartily supported by the 160 or so people present.

A striking view from beneath of an XV-22 Osprey in the hover as it was conducting training at RAF Sculthorpe, Norfolk (USAF)

Two regular meeting attendees took the speaker by surprise when they arrived with a K'NEX model of a V-22 Osprey. They demonstrated its powered rotors, and tilting engine nacelles. The photograph below shows Giles and Joss Davis with their splendid model.