Flying the Osprey
Pilots assigned to fly the V-22 are likely to enjoy the experience. Flight's simu-lator demonstration of the Osprey's flying qualities at Bell showed the aircraft to be extremely versatile, with plenty of potential once pilots become accustomed to tilt-rotor capabilities. The demonstration, carried out within
a 3,600 miles2

generic gaming area con-
tained in the CT6 visual database was flown by Bell test pilot Roy Hopkins, and took the form of a carrier landing followed by some land-based work. Approaching the carrier, Hopkins used the thumbwheel on the power lever to move the Osprey's nacelles from 84° to 90° as we slid over the carrier deck, bringing the aircraft quickly to zero forward airspeed. Still working the nacelles, he then manoeuvred the aircraft slowly from one end of the deck to the other before landing vertically by moving the power lever aft.

Applying full power, the nacelles were set to 63° for a rolling take-off. Before long, the Osprey was flying at 230kt. "It feels like a typical large commuter air-craft in fixed-wing mode," says Hopkins. "I think it will be very easy for both fixed- and rotary-wing pilots to convert to the V-22." Pilots will be helped, he adds, by the automatic flight control system, which will prevent operation outside the conversion envelope.

Now flying at 279kt, Hopkins demon-strated conversion to vertical flight. Backing off on the power lever, he lost speed until the V-22 was flying at 200kt, at which point he increased rotor r.p.m. to 100 per cent by clicking the thumb-wheel. Once down to 200kt, conversion is initiated at a rate governed by how much the thumbwheel is moved from its spring-centred position. The conversion time is 12sec.

Deceleration is fast, because the nacelles have considerable drag in the vertical position. It is even faster if the nacelles are put to the fully rearward position, at 98°.
"Full aft nacelle is useful for other things, too," says Hopkins. "Suppose I want to shoot a steep approach. At 50kt, I put the pylon full aft, and push the stick forward a little, so that the nose points down. Airspeed is very low, and I can adjust the rate of descent with power. Visibility is great, and I can shoot an approach into a confined area." Using the nacelle tilt, Hopkins showed how the Osprey can be three-point-landed on slopes—a unique capability. Normally, slope landings will be nose-up, says Hopkins ("I can land every day on a 20° slope, nose up"), but with full aft nacelle they can be done on a shallow (about 5°) downslope as well.
With one engine out the XV-15 could

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Differential Longitudinal cyclic

Rightrotor] /

Left rotor ~^f<

Control
Pitch (cyclic lever)

Thrust
(Power Lever)

-0
Roll (cyclic lever)

Lateral translation
mode
(Power lever button)

V

Yaw (pedals)

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Aeroplane"
Elevator

Throttle command

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still fly at 170kt. The V-22 single-engine speed is "much-greater", says Hopkins. "The penalty comes in vertical lift, when you're carrying the extra weight of the wing". The V-22 will hover, but with no useful load aboard. The solution, says Hopkins, is to come home and shoot the approach, as normal, except with a slight roll-on landing. "We've done that at gross weights up to 60,0001b, although normally you'd dump some fuel first."

The V-22 will have autorotation capa-bility, although procedures are different from those with a helicopter, because rotor blade inertia is less. A full landing was not attempted in the XV-15 because of the need to preserve the aircraft. "But we simulated a dual engine failure in fixed-wing mode, then did a power-off reconversion, but with the nacelle full back, entered autorotation, and flared, just to show that we could slow up the rate of sink," says Hopkins. The V-22 will sink at about the same rate as CH-53 or CH-47, he adds. "But where we're better is in the airplane mode, where we have a much greater glide ratio because of the wing."

Flight control of the Osprey is carried out via a triple-redundant, all-digital fly-by-wire system built by General Electric. One of the goals of the Osprey flight control system was to ensure that the pilot gets similar response out of the aircraft in both vertical and horizontal flight. Another was to design a system that satisfied both the helicopter and fixed-wing communities—a subject that generated considerable controversy, but which appears to have been elegantly resolved.

With the current system, the tilt-rotor pilot flies the aircraft using a cyclic lever, a power lever, and rudder pedals. He also has a spring-centred nacelle-tilt thumb-wheel, with nacelle position presented on the cockpit displays. The same thumb-wheel is also used to switch rotor r.p.m.

according to the flight mode.
With the pylons vertical, moving the cyclic lever to and fro tilts both rotor discs forwards or backwards to achieve forward or rearward flight. In fixed-wing mode, this control behaves like that in an ordinary aircraft by acting on the elevators to provide pitch control. Moving the cyclic control sideways when in helicopter mode produces "differential collective pitch", increasing the lift vector on one side and decreasing it on the other, resulting in a rolling moment. In forward flight, the same movement operates the flaperons.

The power lever has a fore/aft motion and acts in a similar way to the collective on a helicopter, except that it is hinged below the pilot.
Moving the lever forwards in helicop-ter mode increases lift by increasing the angle of attack of the rotors. Engine power is added automatically to main-tain constant rotor r.p.m. In forward flight, the power lever still acts on rotor pitch, resulting in increased forward speed. The difference between the modes, however, is that when horizontal the rotor spins only 84 per cent as fast as when it is lifting the aircraft.

Also located on the power lever is the switch which gives lateral cyclic control. This is operated to move the aircraft sideways, or to stabilise it in a crosswind. Finally, the rudder pedals provide yaw in both modes by giving "differential longitudinal cyclic" (i.e. tilting one rotor disc forwards, the other back) to rotate the aircraft about its vertical axis when the aircraft is in vertical flight. The pedals act normally through the rudders when flying forwards.
Washing-out of the vertical flight functions begins as the nacelle tilts beyond about 70°. In the XV-15, this was all carried out mechanically, whereas in the Osprey the mixing is carried out elec-tronically.

FLIGHT INTERNATIONAL, 14 May 1988