Future aircraft concepts intended to reduce the need for runways

Vertical/short take-off designs could provide the answer to growing problem of air traffic congestion in airports

Several new vertical/short take-off and landing (V/STOL) designs have been unveiled as a result of the NASA-funded Runway Independent Aircraft (RIA) study and in response to renewed interest in relieving airport congestion as traffic recovers towards pre-11 September 2001 levels.

NASA Ames last year awarded Bell, Boeing and Sikorsky study contracts to explore RIA concepts for alleviating national air transport system congestion, to be followed by the selection of a design for further study and refinement. The studies included a detailed performance analysis and identification of key enabling technologies. The hope is that, with rotorcraft research funding reinstated in the NASA budget, there will be money for follow-on work this financial year.

Boeing Phantom Works initially focused on a range of concepts including a stop-and-fold tiltrotor, twin rotor/compound helicopter, tilt-wing, canard rotor wing and conventional tandem-rotor helicopter. Its chosen Advanced Civil Tiltrotor concept offers the lowest operating costs in dollars per seat/kilometre, said Harold Rosen­stein, Phantom Works chief engineer advanced rotorcraft systems, at the American Institute of Aeronautics and Astronautics International Powered Lift Conference in Williamsburg this month.

Boeing's concept features a 20m (66ft)-span "W" wing shaped for stiffness and to minimise the impact of downwash from its twin 15m-diameter five-bladed prop­­rotors. The fuselage would accommodate about 90 passengers in a six-abreast cross-section, in aircraft mode, the Advanced Civil Tiltrotor is designed to fly at a maximum cruise speed of 350kt (650km/h) and lift a 9,000kg (20,000lb) payload, or almost twice that with a 460m take-off run, over a 1,100km (660nm) range.

Sikorsky chose the Reverse Velocity Rotorcraft (RVR) concept, based on a double-ended aerofoil designed to generate lift from the retreating blade, reduce rotor drag by 15% and improve stall margin. The eight-bladed main rotor has a linear 20% taper and individual blade control. The RVR would be powered by three advanced technology turboshafts and use a two-speed transmission optimised for high RPM for vertical lift and reduced RPM for efficient forward flight, with thrust from an aft-mounted, auxiliary-powered vectoring ducted fan.

The 27,000kg-class vehicle is intended to carry 80 passengers over a range of 920km at a speed of 340kt. It is designed for a disc loading of 83kg/m² (171b/ft²). With the extra offloading effect of a 15m-span compound wing, this could be reduced to 78kg/m² as well as saving on fuel and empty weight. "The aircraft basically autogyrates at high speed, with the wing carrying 60-70% of lift," says Sikorsky engineer Dale Ashby.

Bell focused on a 120-seat civil version of its much-publicised Quad Tiltrotor (QTR) concept, building on its experience with the twin-engined V-22 Osprey military tiltrotor and experimental XV-15. Each of these concepts carries the need for further technical study and maturation. For Bell, the main challenge with mounting four engines will be to ensure the forward propwash does not impede the aft two prop­­­­rotors. The US Defense Advanced Research Projects Agency has already spent money on the QTR, but more is needed to tunnel-test the concept at NASA Langley. "Analysis shows it's okay, but we need to do more testing to prove it," says Dick Spivey, a former Bell director for tiltrotor business development and now a consultant.

The RVR requires more work on rotor optimisation, independent blade control flight controls and a two-speed transmission, whereas Boeing identifies its key hurdles as the Advanced Civil Tiltrotor's high aspect-ratio wing and rotor and active aero-elastic controls. Finding development cash will be difficult in the current economic climate. Then there is the cost of buying a 120-seat rotorcraft, expected to be 30% more expensive than a similarly sized airliner.

"You have to look beyond the current downside," says Dennis Eckenrod, American Airlines chief pilot and a tiltrotor proponent, who predicts that within two years the air transport industry will be facing a worse congestion crisis than ever.

**Tackling the congestion crisis**

It is estimated that the USA alone has a cumulative runway shortage of 800km (50 miles) and that delays cost the industry $3,600 an hour — or $1 a second. Runway Independent Aircraft (RIA) operating from V/STOL pads or short stub runways and following simultaneous non-interfering procedures such as steep 6-9° approaches, could increase airport throughput by as much as 50%, say RIA proponents.

They say the benefits will come not just in savings from reduced delays at hub airports, but generating income from new services. RIA vehicles are chiefly aimed at stage length routes averaging 320-480km, which are steadily being abandoned as turboprops are grounded in favour of jets. Tiltrotors and Reverse Velocity Rotorcraft will not only be able to operate faster services than turboprops on short-haul routes, by eliminating the need for time-consuming approaches, departures and holding patterns, but will open up flights into the many thousands of local US airports with runways of 1,220m or less and long ago abandoned by the mainlines carriers.