Diversity in design

Boeing offers 2 of 5 development options in rotorcraft program

By Marc Sklar

Boeing is offering two alternatives for assessment of future rotorcraft needs to support the U.S. Army's Joint Heavy Lift program

Experience in programs like the battle-tested and modernized CH-47 Chinook and the advanced V-22 Osprey give Boeing the ability to present the customer two concept designs: the Advanced Tandem Rotor Helicopter, and the Quad TiltRotor being developed by a Boeing/Bell Helicopter team. The ATRH concept has the outward appearance of the Chinook; the QTR concept looks like a V-22 with four tiltrotor engines—two engines forward and two aft.

"The maturity and knowledge we bring is unmatched," said Pat Donnelly, director of Advanced Rotorcraft Systems with Advanced Systems at Integrated Defense Systems. "They asked contenders to bid within three speed bands (low, medium and high). So Boeing offered up an Advanced Tandem Rotor Helicopter configuration for the low-speed band and, teamed with Bell Helicopter Textron, a Quad TiltRotor for the high-speed band."

The concepts are among five contracts for Conceptual Design and Analysis awarded by the Army's Aviation Applied Technology Directorate at Ft. Eustis, Va., in 2005. The Advanced Rotorcraft Systems team that won the contracts for Boeing was then part of Phantom Works. Now, the team is part of Advanced Systems in IDS.

"The customer gave us the missions in terms of payload and range and said, 'You tell us what it needs,'" Donnelly said. "We think our concepts, including the variations from baselines we'll present, will offer the capabilities they want."

As the teams prepare for submittals in late 2006, *Boeing Frontiers* looks at these capabilities and how the Boeing teams are drawing on cross-company expertise to greatly enhance their designs.

Advanced Tandem Rotor Helicopter

A quick glance at the ATRH will remind people of the workhorse CH-47 Chinook. But that would be deceiving. ATRH, in additional to being substantially larger than the Chinook, also will incorporate advances in aerodynamics, avionics, drive systems, rotor technology, materials, weapons systems, communications and networking.

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> —Pat Donnelly, director of Advanced Rotorcraft Systems, on the two concept designs Boeing is proposing for the U.S. Army's Joint Heavy Lift program

"Overall, the tandem rotor is a very efficient lifter," said Bob Derham, ATRH program manager. "Some of the loads being considered are growing, and we can readily accommodate that. Also, we're incorporating advanced aerodynamic features that make us 40 to 50 percent faster than current helicopters."

The ATRH team also is applying Lean+ techniques to the development of the helicopter concept and to the processes that would be used to build it. "We're using the CATIA V.5 design system, which is a Boeing best-practice design tool," Derham said. "We're also tapping into C-17 team techniques in Long Beach [Calif.] and getting help from teammates in Huntington Beach [Calif.] for the cargo-handling and operations analysis, and from Seattle engineers for some of their advanced landing gear designs."

To ensure the concept will truly be "joint"—work for more U.S. services than just the Army—the team also took a 1/72 scale model of the ATRH to the Shipboard Suitability Center of Excellence in St. Louis, which has the models of ships in the same scale.

"We proved [it] could move around on a Navy aircraft carrier or the latest, newest class of U.S. Navy amphibious assault ships," Derham said. "We looked at maintenance operations, moving around on deck and elevators, and what a typical flight profile would be like. This is unusual for a conceptual design but was very informative. By electronically shipping its design to a Boeing rapid-configuration facility in Mesa, Ariz., that used stereo lithography to build the models, the team was quickly able to get what it needed for the testing.

"Using great development tools, processes and teams from around Boeing, we've designed a concept we feel is the most affordable to deliver with the capabilities the customer is looking for," Derham added.

Quad TiltRotor

Like its cousin the V-22, the Bell Boeing Quad TiltRotor can offer customers the best of both worlds.

"Our primary advantage is the capability to carry significant payload at high speed from unprepared fields," said Dave Poling, Boeing QTR program manager. "The payload is in the ballpark of a C-130 transport plane."

The QTR team, too, is drawing on the best of Boeing for its design. "We are looking at Lean+ as we design the airframe, and what we can get in avionics, electron-

Meet the contenders

Here's a look at the two alternatives for assessment of future rotorcraft needs Boeing is offering the U.S. Army to support its Joint Heavy Lift helicopter program.

Bell Boeing Quad TiltRotor

- Four-engine tiltrotor with large fuselage and rear loading ramp
- Ability to take off and land vertically and fly with turboprop speed
- Evolution of technology proven on the V-22 Osprey
- Represents Bell Boeing's proposal for the high-speed category of JHL—vehicles flying 250 knots (288 miles per hour or 463 kilometers per hour) or faster

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Advanced Tandem Rotor Helicopter Concept

- Large tandem rotor helicopter with rear loading ramp
- Front and rear rotors spin in opposite direction
- Flies like traditional helicopter
- Proven, affordable capabilities enhanced by advanced avionics, systems and aerodynamics
- Represents Boeing's proposal for the lower-speed category of JHL—vehicles flying between 160 and 200 knots (184 and 230 miles per hour 296 and 370 kilometers per hour)

BELL BOEING GRAPHIC

ics, crew systems and human systems interfacing from within the company," Poling said. "We're particularly drawing from areas with leap-ahead technologies. Using Boeing resources, like the C-17 experts in cargo handling, is key to providing the capability and keeping our costs down."

A Bell Helicopter–funded one-fifth-scale model of a QTR completed wind-tunnel testing at NASA's Langley Research Center in Virginia this summer. The test objectives were to investigate the aeroelastic effects of the wake of the front rotor on the aft rotor and wing of the aircraft, as well as how its overall structure responded to flight conditions. These tests, along with tests on individual components of the QTR, are being compared with results of similar V-22 tests to ensure performance is as expected.

"The QTR could speed the deployment, replenishment and removal of troops in ways that give the customer greater capabilities on the battlefield," Poling said. "When we submit our study, we will show the advanced technologies that make this concept a realistic option."

The final concept reports will be submitted in early 2007. Next will come a component technology demonstration that could include full-scale component testing and possibly subscale model testing.

"Our concepts are to help the customer make the decision on the value of speed and other capabilities and what they are willing to pay for those," Donnelly said. "With the ATRH and the QTR, we'll be in a position to compete whichever speed category they pick." ■

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