JMR Fast-Rotorcraft Demonstrators Begin to Take Shape

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In a step toward the biggest prize in military rotorcraft, replacing the U.S. Army's large fleet of Sikorsky UH-60 Black Hawks, Bell Helicopter has mated the wing and fuselage of its V-280 Valor tiltrotor. Later this year, in a rival step, the Sikorsky/Boeing team will begin final assembly of its SB-1 Defiant coaxial rigid-rotor compound helicopter.

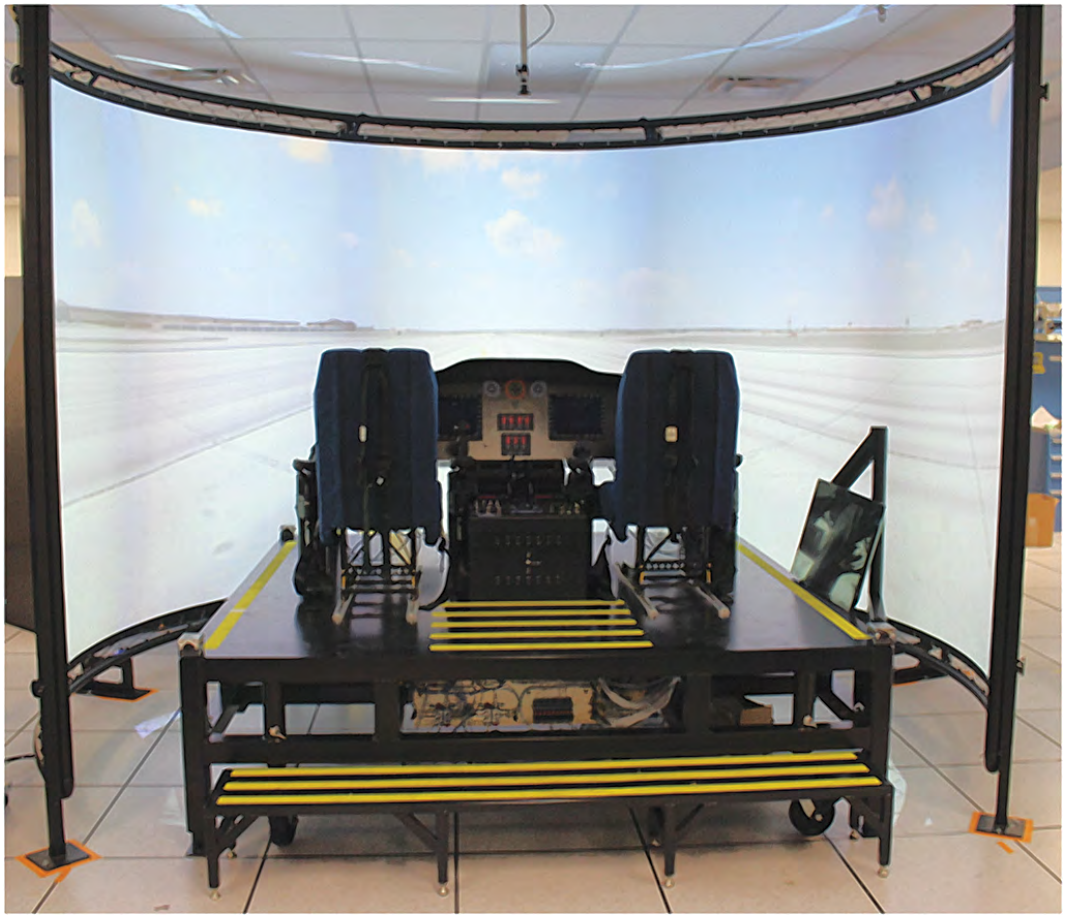
Both advanced rotorcraft are on schedule to fly late in 2017 under the U.S. Army's Joint Multi-Role (JMR) technology demonstration, precursor to the planned Future Vertical Lift (FVL) initiative to replace all of the Pentagon's helicopter fleets.

The Army is scheduled to make a decision in October to launch a two-year analysis of alternatives for the first FVL vehicle. The Army has not said which of the five identified FVL Capability Sets will be first, but industry says indications are the service will stick with its plan to begin with the medium-utility UH-60 replacement—Capability Set 3.

SB-1 scales up Sikorsky's X2 coaxial rigid-rotor configuration to the 30,000-lb. class. Credit: Boeing

The 280-kt. V-280 and 250-kt. SB-1 are being built to demonstrate the benefits of higher speed and longer range for missions now performed by the Black Hawk. Additionally, Bell aims to showcase the V-280's hover performance and prove a tiltrotor can be produced at significantly lower cost than the Bell Boeing V-22. Sikorsky/Boeing wants to highlight the advantages of the SB-1's low-speed agility and high-speed maneuverability in medium missions.

Bell has completed the wing, installing instrumentation before closing it up, and mounted the nacelles on the wing, which was scheduled to be mated to the fuselage on April 21. "It looks like an aircraft," says Vince Tobin, vice president for advanced tiltrotor systems at Bell. To reduce cost, the wing is made from large-cell carbon core composites, eliminating stiffeners and fasteners. The fuselage, built by Spirit AeroSystems, is also largely composite.



Bell's V-280 systems integration lab features a cockpit simulator and complete flight-control system that includes actuators. Credit: Andy Woodward/Bell Helicopter

The wing is simpler than the V-22's to reduce weight as well as cost. Instead of rotating nacelles, the engines are fixed and only the proprotors and gearboxes tilt. The forward sweep also has been eliminated, making a straight wing that is easier to manufacture, with few splices, broadgoods layup and continuous bonded skins for reduced parts count. Proprotor hubs and blades are similar in design to the V-22's, but more manufacturable, says Tobin.

The V-22 has forward sweep because of concerns the blades would flap in airplane mode and strike the wing, but flapping proved not to be an issue, allowing a straight wing. At the same time, Bell has doubled the allowable flapping on the V-280 to increase control authority in the hover. "The V-22 is very maneuverable, but we have gone beyond that for FVL," he says. The V-280's available yaw and roll authority exceeds what most pilots can use, he adds.

A Bell Boeing V-22 is in the background as the V-280 goes through wing mating in Amarillo, Texas. Credit: Mike Calcote / Textron Photos

As it assembles the demonstrator, Bell is completing the build-out of its V-280 systems integration laboratory (SIL). This enables end-to-end testing of the tiltrotor's digital flight control system from pilot inputs to hydraulic actuators "to go after the risk," says Tobin. The lab includes up to six flight control computers and calibrated loads that accurately represent forces at the control surfaces. "It is up and running and ready to move the actuators," he says.

"We feel as good as you can feel when developing fly-by-wire," Tobin says. "We have had software releases when we need them. Now we need to go test them. This is one you don't count as done." The V-22 is fly-by-wire, as is Bell's Model 525 medium commercial helicopter, now in flight test.

The SB-1 team completed its critical design review earlier this year—with no issues, says Doug Shidler, Sikorsky program director—and parts manufacturing for the demonstrator is in full swing. The SIL is operational and "the hydraulics will be online shortly," he says.

The V-280's engines will be installed in the fixed nacelle structures that are already mated to the carbon-fiber wing. Credit: Mike Calcote

The SIL has a fully operational cockpit simulator, all flight controls and electrical systems. "Hydraulics is the only part we don't have yet," says Pat Donnelly, Boeing program director, who adds that hydraulics are only used to control the main rotors, as the propulsor and active tail have electric actuators. Once the SB-1 flies, Shidler says, the SIL will be used to support testing as with previous fly-by-wire aircraft including Sikorsky' S-97 Raider and CH-53K King Stallion now in flight testing.

"We are reusing a lot of software from legacy programs, so there is not a whole lot of risk," says Donnelly. The flight control system is that used in the CH-53K and UH-60MU while the mission computer is from Boeing's AH-64E Apache. In addition to the SIL at Stratford, Connecticut, there will be a propulsion system testbed (PSTB) at Sikorsky's development flight center in West Palm Beach, Florida, where the SB-1 will be assembled and flown.

The PSTB will comprise the engines, transmission, main rotors, propshaft and propulsor. “The SIL is risk reduction for the electronics and software; the PSTB is risk reduction for the dynamics,” Donnelly says. Tobin notes that Bell is looking at the degree to which it can perform testing on versus off the aircraft, which will be influenced by when it will have assembled gearboxes and tested engines ready for installation. Both teams emphasize that they are on track to fly in 2017.