The Boeing Sikorsky SB>1 Defiant uses the company's X2 compound helicopter technologies to achieve FLRAA range and speed. (VFS staff)

Mixing Modernization

As Future Vertical Lift pursues transformational technologies, the US military modernizes its legacy helicopter fleet.

By Frank Colucci

Even with timely development and production, the advanced helicopters or tiltrotors of Future Vertical Lift (FVL) will share missions and technologies with legacy Apaches, Black Hawks and Chinooks. The VFS "Pre-Forum 76 Special Session" webinars in May gave an update on FVL and ongoing helicopter improvements. Army Program Executive Officer (PEO) Aviation Patrick Mason reported his organization is shifting focus from individual platforms to coordinated capabilities. FVL nevertheless remains a family of flying machines meant to go farther and faster than today's helicopters and defeat near-peer threats. Deputy PEO Aviation and FVL program executive officer (now) Brig. Gen. Robert Barrie summarized, "We look to have an affordable platform that we can achieve reach, lethality and survivability with."

FVL has four signature modernization efforts. Future Attack Reconnaissance Aircraft (FARA) competitive prototypes should fly by fiscal 2023. Joint Multi-Role Technology Demonstrators (JMR-TD) are reducing risk for a Future Long Range Assault Aircraft (FLRAA) program of record. Future Unmanned Aircraft Systems (FUAS) demonstrations include a Future Tactical UAS (FTUAS) and Air Launched Effects (ALE) ultimately operated by a Scalable Control Interface (SCI). A Modular Open Systems Architecture (MOSA) for all FVL platforms will leverage the capstone JMR Mission System Architecture Demonstration this year.

FARA Fight

The FARA competitive prototyping (FARA CP) effort now calls for the Bell Model 360 Invictus and Sikorsky's scaled-up S-97 Raider — the Raider X — to fly around November 2022 and give the Army an advanced scout-attack helicopter. Army FARA product manager Col. Greg Fortier noted, "This is not your grandfather's acquisition program by any stretch." Competitive prototyping gives industry design attributes rather than hard requirements to allow trades for affordability. "It should be crystal clear, if we can't deliver an affordable FARA, then we've failed the mission," said Fortier.

FARA attributes will mature into an Army requirements document fleshing out a 14,000-lb (6.4-metric ton) helicopter with a 40-ft (12.2-m) diameter rotor to fit urban landing zones and attain cruise speeds not less than 180 kt (333 km/h). Analyses trimmed five industry performers to two, and Fortier observed, "You couldn't get two more different platforms." The Bell Invictus is an articulated rotor helicopter with tandem cockpits, fixed lifting wings and ducted tail-fan. The wingless Sikorsky Raider X with two crew abreast leverages the company's X2 Technology: stacked, coaxial rigid rotors and an integrated tail thruster.

Government furnished equipment shared by both includes the 3,000-shp (2,240-kW) class improved turbine engine (ITE), a 20 mm cannon and an integrated munitions launcher. The General Electric T901 ITE completes critical design review in July, and a first engine to test is expected in the fourth quarter of fiscal 2021. Also government-furnished will be MOSA information from an architectural collaboration working group (ACWG) to lay out avionics in both FARA platforms.

By the late May, the tandem-seat Bell Invictus was past subsystem design and moving to preliminary design. Bell subsequently announced an industry team including Collins Aerospace for cyber-hardened avionics, Parker Lord for active vibration control and L3 Harris for the WESCAM MX-15D multi-sensor, multi-spectral imaging and targeting system. Sikorsky's compound Raider X passed preliminary design review en route to final design later this year and — like the much bigger Sikorsky-Boeing Defiant — benefits from flight testing of the 12,000-lb (5.4-t) Raider. Plans call for the competing final designs to support a go/no-go decision to build two prototypes later this year for first flights around November 2022. A downselect to a single platform should give the Army a FARA first unit equipped in fiscal 2030.

One casualty of the FARA CP downselect was the compound coaxial helicopter (CCH) proposed by AVX Aircraft. AVX chief operating officer Kendall Goodman described the coaxial, soft-in-plane rotorcraft proposed for both FARA and FLRAA, the smaller scout powered by a 3,750 shp (2,800 kW) growth version of the ITE. "Our approach was the body would be a lifting body at high speeds," Goodman explained. "What we quickly learned was we were not able to achieve the lift we needed without a wing." Wind tunnel tests varied wing chord, span and location until, at high speeds, the CCH got half its lift from rotors and half from the wing.

The Bell V-280 Valor JMR technology demonstrator offers a tiltrotor path to a program of record for a Future Long Range Assault Aircraft. (VFS staff)

FLRAA Formulation

The Bell V-280 Valor and Sikorsky-Boeing SB>1 Defiant JMR demonstrators are not production prototypes of a 30,000-lb (13.6-t) class FLRAA to replace the Black Hawk. They have nevertheless reduced risk for a formal competition between an advanced tiltrotor and a compound helicopter. Army FLRAA product manager Col. David Phillips said, "Competitive acquisition is one of the best ways we can achieve the Army's goals."

In addition to the JMR technology demonstrators, Karem Aircraft has begun single-rotor tiedown tests of a FLRAA-sized optimum-speed tiltrotor nacelle with individual blade control (IBC) and efficient two-speed transmission. "You've got this rotor that works not only in one small band of rpm but over a huge band," explained Karem president Dr. Thomas Berger. The rigid rotor with IBC also promises high control power. "There sometimes has been the thought that tilt rotors are not that maneuverable. We certainly have not seen that to be the case in our analysis."

Col. Phillips told the VFS webinar audience that JMR-TD work will inform FLRAA draft requirements, a system specification and a weapon system specification in fiscal 2021. "We're really getting down to what systems we're allocating to what requirements." A FLRAA low-rate initial production decision in fiscal 2028 would field a first unit equipped in fiscal 2030. According to Army Futures Command, the projected schedule most likely dictates a FLRAA with a modified, currently available engine. Future increments would introduce a more efficient and reliable powerplant. In early June, Honeywell announced a 6,000 shp (4,475 kW) T55-GA-714C engine for the Chinook and next-generation applications.

Bell believes its V-280 Valor demonstrator provides a low-risk transition to the FLRAA program of record. From first flight in late 2017 to late May 2020, the advanced tiltrotor had logged 171 hours in flight and 318 hours with rotors turning. It demonstrated high-speed efficiency and low-speed agility. Bell program director Ryan Ehinger said, "We're talking about Level 1 handling qualities or demonstrating Level 1 quickness." Bell established its own key performance parameters at the start of Valor development and has shown the aircraft can exceed 280 kt (520 km/h) and hover at 6,000 ft (1,500 m) and 95°F (35°C). According to Ehinger, "Affordability is the number one priority as well." The Valor systems integration lab exercised the tiltrotor hydraulics, electrical systems and software. "We tried to look at qualification level testing not only for safety of flight but how those technologies would be appropriate to the next program."

Sikorsky JMR-TD chief engineer Steve Weiner reviewed FLRAA risk reduction testing done by the Sikorsky Boeing SB>1 Defiant. The big compound helicopter had flown just 18 times for 14 hours by his time of the presentation, but its propulsion system testbed had logged more than 100 ground test hours. The PSTB enabled Defiant engineers to fix acoustic-driven resonance in the engine exhaust with swirl vanes tested first on the ground. The Defiant rotor system also "flew" more than 400 hours in the National Full-Scale Aerodynamic Complex (NFAC) wind tunnel in California. "We have the distinction of being the fastest edge-wise rotor ever tested in NFAC," said Weiner. "We've gotten over 250 kt." The Defiant also draws on flight test data from the smaller Raider. The S-97 has hit 200 kt (370 km/h) airspeed and 60 degrees of bank, and demonstrated ADS-33 handling qualities. Wiener told the VFS audience, "Everything that Raider aircraft has done, the Defiant will be doing in the coming months."

Figuring Out FUAS

"We're at a critical junction with our current UAS portfolio," acknowledged Army unmanned aircraft system product manager Col. Scott Anderson. Today's unmanned fleet is rooted in 1990s technology, and the bigger Shadow and Gray Eagle aircraft remain tied to runways. Anderson also noted, "We're going to be facing contested, congested battlespace." Army Futures Command has nested three different initiatives under the Future Unmanned Aircraft System (FUAS).

The Future Tactical UAS (FTUAS) is meant to replace the RQ-7B Shadow in brigade combat teams with a rapidly deployable, runway independent air vehicle with reduced acoustic signature. Last year, the Army issued demonstration contracts to Textron, L3Harris, Martin UAV and Arcturus, and by May had conducted 60 flights at Fort Riley, Kansas. Demonstrations culminate in fiscal 2021 to help formulate a requirements document. "We're not picking a winner from the demonstration, that's not the intent," said Anderson. "We're collaborating to gain feedback from soldiers."

Air Launched Effects (ALE) envisions a UAS launched and controlled from the AH-64E initially — and later from FARA or FLRAA — to extend the reach of Army aviators in reconnaissance, security and attack missions penetrating enemy air defenses. Tests at Yuma Proving Ground, Arizona, in February and March launched the Area-I Altius 600 UAS from a Black Hawk to evaluate separation characteristics in forward launches from a hover. The FVL Cross-Functional Team will continue ALE flight trials into the fourth quarter of fiscal 2021 to transition to the next phase of the program.

The Scalable Control Interface (SCI) for ALE, FTUAS and all future Army unmanned aircraft will enable a single operator to control multiple UASs. The Army awarded an SCI software integration contract to Leidos in February 2020; rapid prototyping will put SCI capability on the MQ-1C Gray Eagle and AH-64E Apache in fiscal 2021, and on an ALE and a FARA rotorcraft around fiscal 2024. SCI aims for an intuitive human-machine interface, and Col. Anderson told the VFS audience, "I can envision a day... when you don't have trained operators."

The Bell Model 360 Invictus is one approach to FARA and uses a fixed wing to attain higher speed and greater range than legacy helicopters. (Bell)

The Sikorsky Raider X stretches the S-97 Raider experience to the FARA competition. (Sikorsky)

MOSA and More

MOSA aims to build and upgrade FVL mission systems without expensive proprietary interfaces. New capabilities from a choice of developers will adapt to emerging threats. The mission system architecture demonstration (MSAD) has awarded six contracts to avionics vendors to develop MOSA tools and rules. A capstone demonstration wraps-up this December 2020 and will generate a final report and provide guidance for FARA, FLRAA and FUAS architectures.

MOSA flexibility and economy come to legacy helicopters with the Aviation Mission Common Server (AMSC), which transitions the legacy fleet from single-purpose/single-vendor architectures to more adaptable modules and components. Non-proprietary, government-controlled, open system standards interface new software applications without going to each platform maker for integration. According to Col. John Frasier of the PEO's Aviation Systems Project Office, AMCS hardware and software can be

employed on all aircraft as a gateway or digital backbone to integrate new capabilities with operational flight programs. He said, "It's simply a necessity, not only for speed at which threat is evolving but for cost."

Legacy Links

While FVL drives a new family of interoperable rotorcraft, legacy helicopters are gaining capability. Apache modernization product manager Lt. Col. Matt Peterson noted the latest AH-64E V6 with common processor gives the Apache crew improved cognitive decision aids and fully integrated LINK 16 connectivity. The joint air-to-ground missile (JAGM) will give the attack helicopter a next-generation weapon with infrared seeker. The interim Spike non-line-of-sight missile will extend standoff ranges beyond 15 nm (28 km). Apache V6 software will meanwhile migrate through the Apache fleet while an improved tail rotor blade and tail rotor drive enhance agility and safety.

Black Hawk modernization continues on two fronts. The UH-60M with integrated cockpit continues in production and will be upgraded with the ITE, crashworthy external fuel system and other refinements. "The 60M is a very formidable aircraft today but it does have a challenge with the proprietary cockpit," said utility helicopter deputy product manager Steven Kelley. The recapitalized UH-60V with Northrop Grumman glass cockpit and government-owned architecture offers a new open system for faster, more cost-effective upgrade. Compared to the UH-60M, new UH-60V capabilities can be fielded in weeks rather than months. Ten UH-60L-to-V conversions are in low-rate initial production at Corpus Christi Army Depot. The first UH-60V unit should be fully equipped in fiscal 2021. Studies are underway to develop a requirement and a path for a similar H-60M open architecture using current Mike-model hardware.

The CH-47F Block 1 Chinook with a Collins common avionics architecture system — CAAS 9.4 delivered in June — has given Army cargo helicopter crews Blue Force Tracker situational awareness and automated tactical approaches through its digital automatic flight control system. It also introduces elements of an open architecture to accommodate third-party software without significant change in the Operational Flight Program. The CH-47F Block II with Block 10 CAAS, new high-lift rotor blades, and improved drive, electrical and fuel systems wraps up testing at Boeing Mesa in October. Limited user testing next year aims for a low-rate initial production decision. The first Block II MH-47G special operations aircraft will be delivered in August. Block II opens the door to automated approaches to GPS points and the active parallel actuator system with tactile cueing.

All of the changes in US Army helicopters have natural appeal to international customers. They also mirror the concerns and objectives of the other US armed services, and they bridge the gap to a new generation of FVL.

About the Author

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