Can the FVL Strategic Plan Come Together Like 1, 2, 3?

With the initiation of the US Army's Future Attack Reconnaissance Aircraft and the US Navy's interest in a Seahawk replacement, is the FVL Strategic Plan finally coming together?

By Alan Graham

In response to Congressional direction, the Pentagon officially established the Future Vertical Lift (FVL) initiative ten years ago — on Oct. 25, 2008. The "DoD Future Vertical Lift (FVL) Strategic Plan" formulated a family of systems from small to heavy lift, codified by the Future Vertical Lift (FVL) Family of Systems (FoS) Initial Capabilities Document (ICD) and was validated by a Joint Requirements Oversight Council Memorandum (JROCM) in July 2013.

Originally settling on Light, Medium and Heavy rotorcraft classes, requirements refinement led to five Capability Sets, approved in January 2015 with Light aircraft class being designated Capability Set (CS) 1, the Medium class broken down into Capability Sets 2, 3 and 4; and Heavy becoming CS5. Each Capability Set had specific missions associated with it to meet joint service needs (see "JMR Technology Demonstration Update: The Road to Future Vertical Lift," *Vertiflite*, Jan/Feb 2016, at **www.vtol.org/FVL**). Current FVL developments, however, appear to be focusing on service-specific solutions.

CS1: FARA Comes into Focus

The US Army has launched the competition to develop its Future Attack Reconnaissance Aircraft (FARA), with plans for a prototype flyoff in early fiscal 2023 that is intended to lead to a new advanced armed scout rotorcraft becoming operational in 2028.

FARA is described in the solicitation as the "knife fighter" of future Army Aviation — a small, optionally-piloted, high-performance platform and the centerpiece of a team that will breech the integrated air defense systems (IADS) of peer and near-peer adversaries to provide the Army with "freedom of maneuver in a multi-domain battle." The Army has set a $30M flyaway unit cost goal.

"The Army currently lacks the ability to conduct armed reconnaissance, light attack and security with improved stand-off and lethal and non-lethal capabilities with a platform sized to hide in radar clutter and for the urban canyons of mega cities," says the Broad Area Announcement (BAA) for the FARA Competitive Prototype (FARA CP) program.

The BAA was released on Oct. 3 on behalf of the FVL Cross-Functional Team, part of the Army's new Futures Command. The Army's FVL CFT — which includes FARA, the medium-size Future Long-Range Assault Aircraft (FLRAA) and a companion Advanced Unmanned Aircraft System (AUAS) — is one of six modernization priorities established by the Army.

Under the Pentagon's FVL initiative, FARA fills some of the missions of Capability Set 1, but its primary driver is the anti-IADS role. In addition to becoming the Army's armed scout, FARA could also be adapted for other military services' missions.

FARA is the Army's fifth attempt in three decades to procure a new armed scout. After winning the Light Helicopter Experimental

(LHX) program, Boeing and Sikorsky were awarded a contract in 1991 to develop the stealthy RAH-66 Comanche to replace the Bell OH-58 Kiowa Warrior. But the Comanche was cancelled as unaffordable in March 2004 after $7B had been spent.

In the wake of the Comanche cancellation, Bell won the Armed Reconnaissance Helicopter competition with the ARH-70A Arapaho, a derivative of its commercial Model 407 with a more powerful Honeywell HTS900 turboshaft. This too was cancelled, in 2008, after development was significantly over budget and behind schedule.

The Army tried again in 2012, formulating the Armed Aerial Scout (AAS) program to either acquire a new commercial off-the-shelf helicopter or upgrade the OH-58D to the OH-58F. Several bidders offered new helicopters, but the Congressionally-imposed sequestration budget cuts killed AAS in 2013.

The OH-58F Cockpit and Sensor Upgrade Program followed AAS on to the chopping block early in 2014, and the Army decided to retire the OH-58D rather than extend its service life. Instead, under the Aviation Restructure Initiative, Boeing AH-64E Apache attack helicopters teamed with Textron RQ-7B Shadow tactical unmanned aircraft took over the Kiowa Warrior's armed reconnaissance mission.

After all these false starts, the Army is taking a different tack this time. Where FLRAA is on a deliberate path to becoming a program of record in fiscal 2021, FARA CP will be conducted as a rapid prototyping effort. FLRAA is following the formal US DoD Instruction 5000-series acquisition process, while FARA will use streamlined "other transactions authority for prototype" acquisition rules to speed things up.

According to the BAA, FARA CP will have four phases. In Phase 1, four to six teams will each be given $15M and nine months to develop preliminary designs. Contract award is planned for "around June 2019," according to the BAA. After initial design and risk reviews in fiscal 2020, the Army plans to downselect to two teams for Phase 2 — awarding each $735M to design, build and test a single prototype.

This second phase is split into two. In Phase 2a, the BAA states, competitors will complete final design and risk reviews in November 2020, leading to first flights in November 2022. After contractor tests are completed, the prototypes are to be handed over the Army for government testing under Phase 2b.

Phase 3 is an evaluation of the outcome of the competitive prototype program and a decision on whether to select one contractor to proceed into "subsequent full system integration, qualification and production," or Phase 4 — the Army is not calling it engineering and manufacturing development (EMD) as it anticipates continuing the "other transactions" approach into the procurement of up to 500 FARA rotorcraft.

To speed things up, the prototypes are to be fitted with a modular open systems architecture "digital backbone," but not a full mission system, which is to be developed during the subsequent integration phase. The Army plans to provide competitors with the 3,000 shp-class (2,200 kW-class) Improved Turbine Engines (ITEs) to power its prototypes, with the existing General Electric T700-701D as the backup. The competition between GE and ATEC (the joint Honeywell-Pratt & Whitney Advanced Turbine Engine Company) to develop the ITE is due to be decided early in 2019.

CS2: Replacing the Seahawk

Facing the need to begin replacing its Sikorsky MH-60R/S Seahawk shipborne helicopters by the early 2030s, the US Navy plans to begin the process in fiscal 2019 to acquire an advanced rotorcraft under FVL CS2.

While the US Army leads the light-attack CS1 and medium-assault CS3 efforts under FVL, the Navy is the lead service for CS2. This describes a rotorcraft that can operate from Navy warships and replace not only the anti-submarine MH-60R and search-and-rescue MH-60S but also the Northrop Grumman MQ-8B/C Fire Scout shipborne UAS.

"We are currently going through requirements validation," Navy Commander Chris 'Jean Luc' Richard told an Oct. 16 meeting of the VFS Federal City Chapter. Richard is the MH-60R Requirements Officer and Rotary Wing Requirements Branch Head in the air warfare division of the Office of the Chief of Naval Operations.

The US Navy intends to replace its Seahawks and unmanned Fire Scouts with a CS2 aircraft. (US Navy photo)

The Navy needs greater endurance, range and speed to support distributed operations, he explained. It also needs manned-unmanned teaming, better connectivity, passive sensors, open-architecture software, resilience in denied environments and modular payloads so one type can replace both the MH-60 Romeo and Sierra.

The MH-60S fleet strength will begin to decline in the mid-2020s, Richard said, becoming a problem by 2028. The newer MH-60R fleet will become an issue by 2033, exacerbated by plans for more warships that carry these helicopters as the US builds up to a 355-ship Navy.

A combination of service life extension programs for the MH-60R/S and procurement of new FVL CS2 rotorcraft beginning in fiscal 2031-33 is expected to offset the inventory shortfall and meet requirements for additional aircraft, Richard said.

The Navy's acquisition timeline calls for a Material Design Decision and Analysis of Alternatives (AoA) in fiscal 2021, he said, leading to a Milestone A decision in fiscal 2024 to begin a competitive, three-year technology maturation and risk reduction phase.

A Milestone B decision in fiscal 2028 will launch a four-year EMD

The Sikorsky S-97 Raider was designed as a light scout for the US Army, about 25% smaller than the FARA requirement. (Sikorsky image)

Raider Races Past 200 Knots

Sikorsky's S-97 Raider has joined a short list of edgewise rotorcraft that have passed the 200 kt (370 km/h) speed mark in level flight. The second prototype of the coaxial rigid-rotor compound helicopter achieved 202 kt (374 km/h) on Sept. 21 at the company's development flight center in West Palm Beach, Florida.

Sikorsky is now working to further reduce drag and vibration as it pushes towards its target of exceeding 220 kt (407 km/h). The second Raider first flew on June 19, taking over from the first prototype, which flew first in May 2015 and had reached 150 kt (278 km/h) before being damaged in a hard landing in August 2017.

The 11,000 lb (5 t) gross-weight S-97 has a coaxial lift-offset rigid rotor system. Lift is generated some distance out from the hub on the advancing side of one rotor and balanced by lift generated on the advancing side of the counter-rotating rotor. Instead of an anti-torque tail rotor, a variable-pitch propeller provides thrust. At high airspeeds, rotor rpm is slowed to avoid the advancing-blade tips going supersonic. So far, this has been done manually, the pilot "beeping" down rotor rpm as airspeed increases. This is being automated, said experimental test pilot Bill Fell, so that rotor rpm reduces as a function of the tip Mach number.

The S-97 is undergoing envelope-expansion flight testing "and we go faster on every flight," said Fell. Raider is designed for a maximum speed of 230 kt (426 km/h) clean and 220 kt (407 km/h) with external stores. "We are on a path to go to 220 kt in level flight," said Fell. "We could go above 220 kt, but to where is hard to predict."

The non-compound Boeing-Sikorsky RAH-66 Comanche achieved 205 kt (380 km/h), "but that was in a dive," said Fell. "Exceeding 200 kt in level flight is a different thing." In 2010, Sikorsky's much smaller X2 Technology Demonstrator reached 252 kt (467 km/h) in level flight and 262 kt (485 km/h) in a shallow dive using the same coaxial-rotor/pusher-propulsor arrangement as the S-97.

As Sikorsky pushes the Raider to higher speeds, drag reductions "will make it a bit slicker," said Fell. Hub fairings, the de-rotated sail fairing between the coaxial rotors, antennas and gaps around the doors are all being looked at "in part to understand the sensitivity to change," he added.

Sikorsky is also adjusting the location of force generators for the Raider's active vibration control (AVC) system in an effort to reduce vibration in the cockpit. AVC is a key part of the X2 technology suite and, for both crew and aircraft systems, reduces the vibration caused by the rigid rotors at high forward speeds.

"So far the 1/rev and 4/rev [vibration] numbers we have for critical components are looking really good," said Fell. "Now we are trying to move the vibration down a little further in the cockpit." The rigid rotors, meanwhile, provider a quicker and crisper control response with less lag, he said.

In addition to increasing airspeed, Sikorsky is expanding the S-97's maneuver envelope to higher load factors and steeper bank angles. At slow speeds, the helicopter has been flown to its full G capability and in steep turns up to a 60-degree angle of bank.

The Raider recently broke 200 kt in testing at Sikorsky's West Palm Beach, Florida, Development Flight Center. (Sikorsky image)

Maneuverability testing will continue through the end of the year at progressively higher airspeeds. "We have not fully expanded the envelope and done some of the extreme maneuvers," said Fell. "That's what the future holds."

program, leading to a Milestone C production decision in fiscal 2020 and initial operational capability for the Navy's FVL CS2 in fiscal 2032.

CS3: JMR Accelerates

The sudden emergence of FARA contrasts with the Army's deliberate approach to FLRAA. As per DoD 5000, the FLRAA AoA is now underway and scheduled to be completed in early 2019. Requirements are being informed, meanwhile, by the Joint Multi-Role Technology Demonstration (JMR TD), under which Bell is flying the V-280 Valor tiltrotor, while Sikorsky-Boeing hopes to fly the coaxial-rotor compound SB>1 Defiant by year-end.

On current plans, FLRAA is to enter a competitive Technology Maturation and Risk Reduction Phase in fiscal 2021, following a Milestone A decision to launch the program. This is planned to lead to a downselect for EMD and production, with initial operational capability not expected until 2034. Industry is telling the Army it can move faster because of the progress made under JMR TD; but for the Army to afford to accelerate FLRAA and acquire FARA would require a major increase to the service's total obligation authority for aviation or require a significant reduction in other Army Aviation accounts, such as current model production.

Bell's V-280 Valor advanced tiltrotor has achieved new speed, range and maneuverability milestones. The aircraft has achieved 250 kt (422 km/h) true airspeed at 80% rpm, the rotor speed for most efficient cruise, said Bell. The V-280 has also completed a 2.1 h flight, covering more than 320 nm (595 km), with two flight-test engineers on broad in addition to two test pilots. The long sortie was a dry run for the Valor's subsequent ferry flight from Bell's assembly plant in Amarillo to its flight test center in Arlington, Texas, closer to Army Futures Command in Austin, where the FVL Cross-Functional Team is based.

With almost 70 h of flying accumulated by mid-October, the V-280 had achieved 45° angle of bank at up to 200 kt (370 km/h), 4,500 ft/min (23 m/s) climb rate at 160 kt, exceeded 200 kt (370 km/h) with less than 50% torque, and reached a peak load factor of 1.9G in a banked turn in cruise mode, with rotors fully down.

The rival Sikorsky-Boeing team is also reporting progress after overcoming delays manufacturing the rigid carbon-fiber blades for its SB>1 Defiant coaxial-rotor compound helicopter demonstrator, powering up the propulsion system test bed (PSTB). The Defiant team is running the engines and transmissions on the PSTB, essentially a ground-based Defiant, at its West Palm Beach, Florida, development test center. Testing with blades attached was expected to begin by the end of October.

The flight demonstrator is almost complete, said Sikorsky, and its engines, fuel, hydraulic and electrical systems, avionics and actuated flight-control surfaces have been tested. Ground runs will begin once blades are available, aiming for first flight by year-end.

Meanwhile, however, the US Marine Corps still needs an armed escort for its existing V-22 Osprey assault aircraft. Although the Army dropped consideration of an attack variant to replace the Apache from its CS3 AoA, the Marines want a common platform for its attack and utility missions, like it currently operates with the UH-1Y Venom and the AH-1Z Viper. Notably the Marines require shipboard compatibility with their LHD ships, which is absent from the Army's requirements for FLRAA.

The Sikorsky-Boeing Defiant CS3 concept. (Sikorsky-Boeing image)

So far, industry is downplaying any threat to the long-awaited FLRAA program from the emergent FARA. Bell and Sikorsky-Boeing, along with their supplier teams, have invested as much as $1B in JMR TD — four times the Army funding — and industry will be required to contribute a third of the FARA prototyping cost, the BAA said. Sikorsky, its parent Lockheed Martin, and industry partners have already invested significantly — reportedly $300M — in the S-97 Raider. Although originally seen as a competitor for the Capability Set 1 scout/attack requirement, the FARA objectives call for an aircraft about 25% heavier than the Raider.

If both programs stay on their current schedules, executives believe FARA truly can be fit in before the heavy spending on the FLRAA ramps up later in the 2020s. But industry's concern is not the overlap. If the Army's budget for modernization and its appetite for an armed scout push back the larger medium-assault program after a decade of development, then the return on industry's investment would be at risk, they admit. Major deviations from current FLRAA plans — or failing to reach production at all — could sour industry on investing for future Army programs altogether.

About the Author

Alan Graham is an aeronautical engineer who has been tracking the development of aerospace technology for nearly a half century.