

FVL on Four Fronts

Future Vertical Lift pursues fast rotorcraft and flexible architectures for multi-domain operations.

By Frank Colucci

According to the US Army field manual, aviation operations are inherently multi-domain operations (MDO) to synchronize the right forces at the right place and time. The Army-led Future Vertical Lift (FVL) initiative continues four signature modernization efforts to increase rotorcraft speed and range and harness converging command and control technologies to dominate MDO. The Future Long Range Assault Aircraft (FLRAA), Future Attack Reconnaissance Aircraft (FARA), Future Unmanned Aircraft System (FUAS) — which includes Future Tactical Unmanned Aircraft System (FTUAS), Advanced Unmanned Aircraft System (AUAS) and Air-Launched Effects (ALE) — and Modular Open-System Approach (MOSA) are expected to provide first units equipped in 2030. All four efforts are intended to integrate new capabilities quickly and without costly “vendor lock” on original equipment manufacturers. Notably, the Army’s Project Convergence 20 at Yuma Proving Ground last year saw 20 of 27 demonstration technologies integrated on the fixed-wing Gray Eagle unmanned aircraft system (UAS) without reliance on the manufacturer, General Atomics.

Bell’s tiltrotor and Sikorsky-Boeing’s compound helicopter Joint Multi-Role Technology Demonstrators (JMR TDs) have provided flight test information on platforms for FLRAA competition in fiscal 2022. Sikorsky and Bell are expected to fly FARA competitive prototype helicopters in fiscal 2023. Imminent competition is meanwhile revealing industry ideas about production FVL technologies. Northrop Grumman cites its UH-60V avionics architecture as an example of a software-defined, hardware-enabled MOSA for FVL platforms. A recent Collins Aerospace webinar suggested antennas and systems integrated into aerostructures can combat weight and drag to maximize FVL speed and range. Multiple sensor functions in a single aperture or antennas combined with lights likewise reduce drag. Next-generation health management systems could cut wiring weight 40% with a shared connective network.

Collins suggested braided composites and resin pressure-molded thermoplastic composites could make lighter, less costly FVL structures. Bell flew the Valor JMR TD with thermoplastic tail surfaces that would save weight and assembly costs versus familiar composites. Which technologies earn their places in FARA and FLRAA production will be determined by competitive prototyping efforts.

FLRAA

FLRAA — modeled by the JMR TDs — is made to give the Army a fast, long-range squad carrier, now expected to augment rather than replace the Black Hawk in tactical assault, medical evacuation and special operations. MDO dictates a networked, optionally manned platform readily adapted to changing threats. The Bell V-280 Valor advanced tiltrotor completed its extended 215-hour flight test program in April, having exceeded 300 kt (555 km/h). The Sikorsky-Boeing SB-1 Defiant compound helicopter has been slow to accumulate flight hours but generated relevant data with its transmission system testbed, systems integration lab and ground runs, backed by flight tests of the smaller Sikorsky S-97 Raider.

Neither of the 30,000-lb (13.6-metric-ton)-class, fly-by-wire JMR TDs is a true FLRAA prototype. At the end of March, the Army announced that both companies were moving into the second phase of FLRAA competitive demonstration and risk reduction (CD&RR) work. Phase II calls for Bell and the Sikorsky-Boeing team to begin the preliminary designs of major FLRAA subsystems and the entire weapons system, in parallel with the programmatic source selection activities, with a downselect to a single team in 2022. The Phase II work also supports preliminary analysis of requirements for Special Operations Command, as well as the medevac mission and exportability features.



The Bell V-280 Valor tiltrotor completed its JMR Technology Demonstrator flight test program in April, and provides one possible approach to a Future Long Range Assault Aircraft. (Bell)



The Bell Model 360 Invictus is one of two FARA Competitive Prototypes meant to launch its own Air-Launched Effects and team with unmanned aircraft systems. (Bell)

The winner will then complete air vehicle and weapons system preliminary design reviews in less than a year for the Army to make an accelerated Milestone B decision on FLRAA engineering and manufacturing development (EMD). The Army said that a quick Milestone B decision promises more time to complete the detailed design, build and test the prototype air vehicles. It also mitigates the risk of losing the company's specialty industry workforce going from development to production.

Bell involved real air assault soldiers and Army maintainers in the Valor demonstration program and had Army experimental test pilots fly its tiltrotor JMR TD. The demonstrator also integrated enough autonomy to fly hands-off. A survivable, crashworthy production version is still supposed to cruise at 280 kt (520 km/h), hover-out-of-ground-effect at 6,000 ft and 95°F (1,800 m and 35°C), and cover combat ranges to 800 nm (1,480 km). It also has to be affordable. Bell has long talked about a simplified approach to building the blade, wing, cabin with composite broad-goods rather than small pieces of thermosetting prepregs. Induction-welded thermoplastic ruddervators also reduced part weight by 10% compared to thermoset parts.

The Sikorsky-Boeing team has not discussed manufacturing technology for a Defiant X production FLRAA. Drawings show a Comanche-like inverted shelf on the empennage that may

dissipate telltale exhaust and an F-35-like nose sculpted to deflect radar returns. Defiant X capabilities are being tested in a digital combat environment. Meanwhile, Sikorsky earlier this year demonstrated autonomous takeoff, landing and simulated obstacle avoidance with a Black Hawk optionally piloted vehicle aiming to transition the technology to a production FLRAA.

Missing from the FLRAA picture is a new 5,000–6,000 shp (3,730–4,475 kW) engine with the necessary low specific fuel consumption for deep operations. The accelerated development schedule dictates some modification of an off-the-shelf engine for early production FLRAA. The logical starting points remain the GE T408 now qualified for the Marine Corps CH-53K King Stallion and the Honeywell T55-GA-714C proposed for the CH-47F Chinook (see sidebar, “Honeywell Plans Chinook Engine Upgrade”).

FARA, FTUAS and ALE

Abrupt retirement of the OH-58D Kiowa Warrior robbed Army Aviation of an armed scout helicopter. Air cavalry squadrons today collect information and destroy, defeat, delay, divert or disrupt enemy forces with the 20,260-lb (9.2-t) AH-64D/E attack helicopter and unarmed RQ-7B Shadow UAS. The 14,000-lb (6.4-t) FARA is a fast, fresh start on the mission, able to penetrate contested airspace and control its ALE from internal stowage or control UAS systems in manned-unmanned teaming.

Honeywell Plans Chinook Engine Upgrade

Though Honeywell Aerospace will not comment on engine offerings for FLRAA, the company is continuing development of its 6,000-shp (4,500-kW) class T55-GA-714C upgrade for the CH-47F Chinook. The -714C upgrade centers on a state-of-the-art compression system for higher engine cycle pressure with greater efficiency and promises 22% more power and greater than 8% better specific fuel consumption than the 4,800-shp (3,600-kW) -714A now in the CH-47F.

According to T.J. Pope, Honeywell senior director, military turboshaft engines, -714C compressor rig testing exceeded expectations, and design of the new engine is complete. Honeywell is buying and instrumenting engine hardware aimed at ground and CH-47F flight testing in 2022. Honeywell is partnering with the Army on a cooperative research and development agreement (CRADA) for the flight test program.

The T55-714C aims for a 25% improvement in overall engine reliability. According to Pope, “...our design features a substantially reduced parts count, addresses leaks and other issues associated with the gearbox, and has features to improve erosion robustness in sand/dust environments. We kept the turbine temperatures low — below the melting point for sand — to assure robustness in sandy environments and long time on wing.”

Performance and durability improvements are accomplished without expensive new alloys or exotic materials. Pope explained, “Our objective is to provide a significant improvement in power through an overhaul upgrade, for only slightly more than the cost of a normal overhaul, and to not compromise the T55’s low sustainability cost.” The proposed

upgrade makes maintenance items more accessible with accessories relocated in a top-mounted gearbox.

Like the -714A engine, the -714C has dual-channel full authority digital engine (FADEC) controls. Minor FADEC changes accommodate the new compressor and associated control limits. Pope noted, “We carefully limited this scope for two important reasons: we wanted to keep the overhaul kit cost low, and we wanted to minimize the impact to the helicopter installation; both criteria help assure that these improvements can be incorporated affordably.” To control cost and simplify aircraft integration, the upgraded Chinook engine has no new health and usage monitoring features.

In March, Honeywell received a follow-on Army contract for new-production and spare T55-GA-714A engines to support fielded aircraft and new CH-47F Block 1 production through 2024. The last three CH-47F Block I helicopters for the US Army will be delivered this year. The Block II CH-47F with high-lift rotor blades and drivetrain, fuel and electrical improvements remains in engineering and manufacturing development with production plans to be determined. Block II MH-47Gs in production for Army special operations aviation use the -714A engine.

The Army, Boeing and GE Aviation last year began tests of a Chinook with the GE T408 engine with the stated goal of risk reduction for a CH-47 with more powerful engines. With no program of record to develop and field a new 5,000 to 6,000 shp (3,730–4,475 kW) engine, the 30,000-lb (13.6-t)-class FLRAA Future Vertical Lift platform will also fly, at least initially, with a modified version of one of the currently available engines.



Sikorsky's scalable X2 technologies are the basis for both the Defiant X FLRAA and Raider X FARA. (Lockheed Martin)

Under a competitive prototyping effort scheduled to flight test two FARA helicopters by fiscal 2023, Bell is building the Model 360 Invictus in Amarillo, Texas, and Sikorsky is assembling the Raider X at West Palm Beach, Florida. The tandem-seat Bell Invictus uses an articulated rotor, fixed lifting wings, a supplemental power unit and a ducted tail fan to achieve the required minimum 180 kt (232 km/h). The Sikorsky Raider X with side-by-side cockpit is a compound helicopter with coaxial rigid rotors and an integrated tail thruster for level acceleration and deceleration and an expanded maneuver envelope. Sikorsky took the S-97 Raider — 80% scale of the Raider X — to Redstone Arsenal in April to demonstrate the agility of its X2 technologies for the Army.

Both FARA prototypes are designed around the 3,000-shp (2,200-kW) GE T901 improved turbine engine, being developed for the AH-64E Apache and UH-60M Black Hawk. GE is expected to deliver the first T901 engine to test in the fourth quarter this year. First flight of the FARA competitive prototype in fiscal 2023 aims at low rate initial production around 2028.

FARA competitive prototypes will also be designed around the 20 mm XM915 cannon designed by the Army Combat Capabilities Development Command Armaments Center at Picatinny. Test plans call for the weapon to begin flight tests on a Black Hawk at Project Convergence 21 this fall. ALE extends the reach of FARA with expendable unmanned vehicles. ALE technology maturation ends this year to help choose a single air vehicle maker, two payload suppliers and a control integrator for a prototype in fiscal 2024.

FARA is meant to team with the runway-launched Gray Eagle and the runway-independent FTUAS, which will replace the RQ-7B Shadow in ground maneuver brigade combat teams. The Army expects the quiet, new FTUAS to integrate encrypted datalinks, interchangeable sensors and other payload options with the open system architecture adopted by FLRAA and later FARA. To provide a knowledge base for FTUAS requirements, Army Brigade Combat Teams tested four non-developmental unmanned aircraft systems, and Army Futures Command concluded an FTUAS Rodeo at Fort Benning in March. Twenty-three industry sources responded to an Army request for FTUAS information, and a requirements document should be approved this July.

MOSA and More

Like the other pieces of FVL, MOSA builds on a science and technology effort. The mission systems architecture demonstration (MSAD) concluded last year to investigate process, tool and standards to specify, design and qualify MOSA. Industry

collaborators executed complex demonstrations to implement an open system architecture using common standards, model-based engineering and an architecture centric virtual integration process.

The definitive FLRAA request for proposals this July will include a MOSA annex to be implemented with standardized tools and some government-furnished equipment. A winning contractor will begin FLRAA engineering and manufacturing development in the summer of 2022. MOSA lessons learned on FLRAA will be applied across FVL platforms.

Bell credits an open architecture digital backbone with the ability to use currently fielded mission system equipment on the Valor and Invictus prototypes. In principle, the same architecture allows for quick, cost-effective new technology integration. The same principles using open standards accommodate rapid, cost-effective upgrades and tailored mission systems.

Early on, the FVL family of systems with its five capability sets (CS) assumed derivatives that could replace Marine Corps UH-1Y utility and AH-1Z attack helicopters. Marines continue to play in Army FLRAA simulation activities. Navy and Coast Guard plans have guessed at Seahawk and Jayhawk replacements based on some FLRAA. A navalized version of the 30,000-lb (13.6-t) CS 3 FLRAA remains too big for Navy frigate decks currently hosting the 22,000-lb (10-t) MH-60R/S. FVL, nevertheless, remains a joint-service program, and the Naval Air Systems Command in April issued a request for information on an "FVL (Maritime Strike)" analysis of alternatives. The analysis runs through 2022 and aims at a replacement for manned MH-60R/S Seahawks and unmanned MQ-8C Fire Scouts in the mid-2030s.

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