MORE FARA COMPETITORS REVEAL CONCEPT AIRCRAFT

The concept art of the Bell 360 Invictus attack reconnaissance helicopter. **Bell Image**

The competition for the U.S. Army's Future Attack Reconnaissance Aircraft (FARA) is heating up, with four of the five contenders now having revealed concept aircraft.

Earlier this year, the Army awarded competitive prototype contracts to Bell, Boeing, Karem, Sikorsky, and a team from AVX Aircraft and L3. AVX and L3 were the first to reveal their concept, a compound coaxial helicopter design featuring a wing for lift during high-speed forward flight, plus two ducted fans that provide forward and reverse thrust. The fly-by-wire aircraft also features a side-by-side cockpit "optimized for pilot efficiency," the companies said.

Bell revealed its tandem-cockpit FARA concept, called the 360 Invictus, on Oct. 1. It features a single main rotor with a hub and rotor blades that have been "ported over" from the Bell 525 Relentless program, but which will be scaled to fit the Invictus, according to Keith Flail, vice president of advanced vertical lift systems at Bell. Where the 525 has five main rotor blades, Invictus will have four. Invictus also will use a version of the 525's fly-by-wire flight control system and modular, open-systems avionics provided by Collins Aerospace.

In cruise flight, two "lift-sharing" wings will offload half the burden from the 360's fully articulated main rotor system. Horizontal stabilizers controlled by the fly-by-wire system will keep the aircraft trimmed in the lowest drag position at high speed. The ducted tail rotor is canted to reduce drag and provide additional lift, Flail noted. Invictus will carry munitions internally and features retractable landing gear to further reduce drag at high speed.

In mid-October at the Association of the U.S. Army's annual conference (AUSA) in Washington, D.C., Sikorsky unveiled the Raider X, a sleek, beefed-up version of its S-97 Raider coaxial compound helicopter. The new concept retains the Raider's basic coaxial main rotor configuration with an aft pusher propulsor, but is 20 percent larger than the S-97.

Raider X increases the weight of the aircraft from about 12,000 to 14,000 pounds (5,445 to 6,350 kilograms), according to Sikorsky's FARA program director, Tim Malia. The design features a side-by-side cockpit, which also widens the fuselage to increase its internal weapon storage. Sikorsky chief test pilot Bill Fell said Raider has already flown 207 knots in level flight and 250 in a shallow dive, and the larger, more powerful Raider X should be able to fly faster than that — well above the Army's 180-knot requirement.

Meanwhile, Karem Aircraft has teamed with Northrop Grumman and Raytheon on a concept called the AR40, which has been revealed to be a winged compound helicopter with a rear propulsor and an actively controlled main rotor.

The only competitor so far declining to show a concept is Boeing. According to Boeing FARA program manager Shane Openshaw, a concept exists and the Army is "fully aware" of where Boeing is in the initial design phase of the competition, but the company's approach is "not to necessarily be out in the public sphere pumping our chest. . . . We will gradually go public and start revealing the nuances of our design when it makes sense for us to do so if we can," Openshaw said.

Dan Parsons contributed reporting to this story.

Sikorsky's Raider X is a beefed-up version of its S-97 Raider. **Sikorsky Image**

ITT ENIDINE ADAPTS ITS 'ADAPTIVE' DAMPING

BY ERIC TEGLER

Sometimes the project you embark on takes you somewhere you didn't intend. That's essentially what happened with an effort to address vibration in the variable-speed rotor helicopters now coming to market.

Buffalo, New York-based ITT Enidine develops and implements vibration absorption technology for commercial and defense markets. In 2017, the company initiated a project targeting in-cabin vibration hot spots for helicopters with multi-rpm rotors. ITT Enidine has a long-standing relationship with Bell, providing cabin vibration damping in the latter's 505 Jet Ranger X and 525 Relentless, which has a multi-rpm main rotor.

The company's principal engineer, Mark Ott, explained that his team was looking to develop a simpler, less costly vibration attenuation approach than current fully active systems, which use force generators. They turned to the time-tested Frahm damper, patented by Hermann Frahm in 1911.

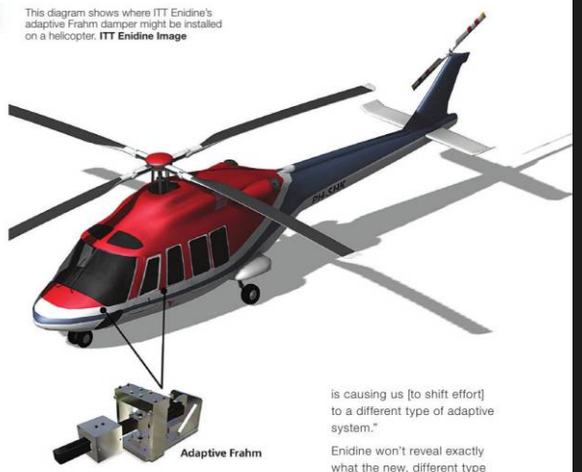
The simple mass/spring system attaches to a vibrating structure and is tuned to resonate 90 degrees out of phase with the input source. It dampens vibration at a given frequency, but can't effectively attenuate vibrations at the various frequencies which multi-rpm rotors create.

ITT Enidine sought an "adaptive" Frahm damper, able to alter its behavior to attenuate vibrations at two specific frequencies representative of 100 percent rotor rpm and 90 percent rotor rpm. The system isn't as quick to respond or as flexible as a fully active damping system, but is cost-effective — offering cabin vibration damping where it's wanted most, in long duration forward level flight rather than quick transients.

Engineers essentially developed a controlling algorithm to locate the damping mass of a conventional configuration Frahm in near-real-time (generally within five seconds rather than the milliseconds of a fully active system response).

"We're calling it adaptive because we're actually changing the characteristics and behavior of the isolation device to react to whatever it's sensing," Ott said. "That takes a little bit of time."

This diagram shows where ITT Enidine's adaptive Frahm damper might be installed on a helicopter. **ITT Enidine Image**



The system is also novel in that it uses a single vibration sensor located on the input side of the adaptive Frahm, Ott noted. "Most of the time people look at vibration input versus the frequency response and those two have to be 90 degrees out of phase for attenuation to work. Ours is a little bit different. We're doing it with only one sensor."

ITT Enidine bench tested the quarter-scale system, which showed the ability to achieve an average of 70 percent attenuation for both frequencies of interest. The successful test was reason enough to continue further development, but then something unexpected happened.

"What happened," Ott explained, "was we were talking with an OEM and we displayed this [system] with them [at a trade show]. The interest that that generated is causing us [to shift effort] to a different type of adaptive system."

Enidine won't reveal exactly what the new, different type of adaptive vibration system is or who they're developing it for. The goal is similar, reducing or isolating in-cabin vibration at specific points, like at the pilot's feet, below a cockpit seat, or near electronic systems/sensors. A Frahm damper is not used, but the capabilities — a controlling algorithm and single vibration sensor — demonstrated with the Frahm project will be employed.

Mark Ott put it this way: "Although this new application is different in scope, our proven capabilities to adapt a system's behavior will be used to improve performance on an unspecified platform."

ITT Enidine already has a name for the new damping system, though Ott won't share that, either. He did say that bench testing is expected to be complete by mid-2020, with installation on a flying aircraft by early 2021.

ITT Enidine plans to return to the adaptive Frahm damper once this project is done. For now, they're adapting to the market.