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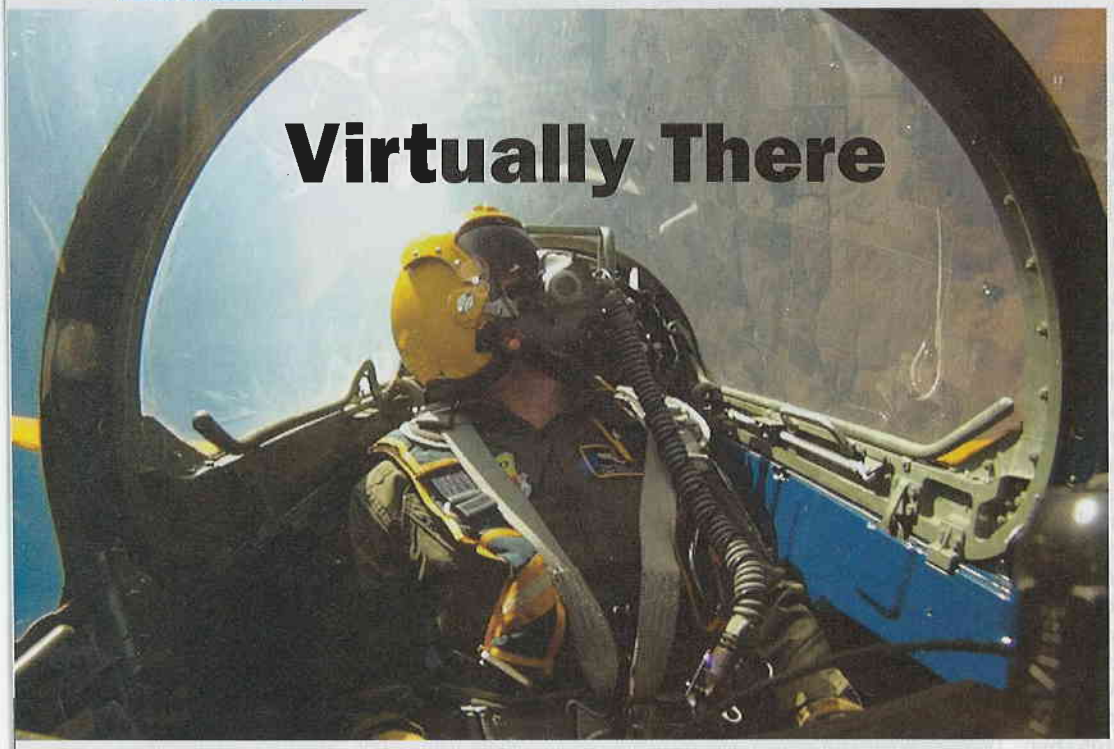

UNIVERSITY OF IOWA PHOTOS

Rockwell Collins is preparing to test LVC simulation using a University of Iowa L-29 Delfin.

The U.S. military targets live, virtual, constructive simulation for fighters

John Croft Sterling, Va.

Cost-effective readiness training for fifth-generation fighter aircraft is driving new simulation technologies that will change the way military pilots are trained within five years.

"A 2011 Rand report clearly states that shrinking resources and expanding mission requirements are jeopardizing the ability to meet proficiency standards to accomplish wartime missions," notes Rockwell Collins in an analysis published in early December. Rand Corp. is a global nonprofit research and analysis "think tank." "Data compiled by Rand indicate that the high costs of training are largely driven by the need to ensure that these red forces are effective."

"Red forces" refers to aggressor squadrons that act as airborne adversaries for fighter pilot training. The sensor and weapons capabilities of fifth-generation fighters such as the Lockheed Martin F-22 and F-35 are such that the number of red forces for a given training missions has expanded dramatically.

"Say there are four F-22s that take off on a training mission with the goal of protecting the East Coast of the U.S.," says Lou Olinto, business development lead for flight-training programs for Lockheed Martin Global Training and Logistics. "The expectation would be that those four aircraft would go up against 24 [red force] aircraft to maintain their readiness levels. If we can give them a [simulated] picture of 70-80% of those aggressors, we provide the cost savings of 20 virtual aircraft."

Rand estimates that the cost of live, faux adversaries needed for such F-22 missions would add up to $63 million a year for T-38 aggressors, $132 million for F-16 aggressors or $593 million for F-22 aggressors, above and beyond current training requirements. The needs will increase further with the introduction of the F-35.

Moving more training to ground-based simulators is not cost-effective. "The [Rand] report also cautions that reducing the number of flight hours and increasing the number of simulated missions only shifts the expense to the simulator environment because the value (fidelity) of training must be maintained," states Rockwell Collins.

Though the F-22 and F-35 have embedded simulation capability built into the onboard avionics, Olinto says the technology has "certain limitations" including the number of aggressor aircraft that can be shown to a particular two- or four-ship training mission and the requirement that the simulation must be pre-planned on the ground (no live link to the aircraft).

A long-term solution the U.S. military is investigating is known as live, virtual and constructive (LVC) simulation, a capability that Lockheed Martin and Rockwell Collins are in the early stages of developing and demonstrating. With LVC, simulated and constructive threats are injected into a live aircraft in real-time from ground stations through data-link connections.

"The operational community has to get used to using the [simulation] technology in a way they never have before," says Olinto. "[Previously], the challenge to industry was to make simulators exactly like the aircraft. Now senior officers in the Air Force and other services say the challenge to industry is to take the capability from the simulation and give it to the live aircraft."

Lockheed Martin is performing the research and development work for the Air Force Research Laboratory (AFRL) and Olinto says "there is no particular timetable" for the project to go operational. "We're working with AFRL in the R&D phase until the technology is proven and we develop the concept of operations (Conops) for how it would be used operationally," says Olinto, adding that Conops has to cover daily training as well as large deployment exercises like Red Flag.

When Lockheed Martin's LCV version goes live, it will most likely be in a fourth-generation fighter—the F-16—rather than a fifth-generation aircraft. In addition to a large installed base of F-16s, a key a reason for starting with the fourth-generation fighter is that it is easier from an avionics standpoint. "One of the challenges of anyone working in this area is security," says Olinto. "It is easier to solve security challeng-

es on the F-16 rather than F-35 or F-22." He says more than 25 countries are flying more than 4,500 F-16s worldwide. "I anticipate initial operating capability (IOC) for LVC in the F-16 first, followed by the F-22," he says, adding that IOC for the F-16 should be in 2-3 years and "definitely" in five years for the F-22.

Lockheed is planning a laboratory demonstration of LVC in March or April 2013, followed by a flight demonstration in an F-16 in September or October, says Olinto. While Link 16 has been used for demonstrations by Lockheed Martin and competitors, he says, the live demonstration next year will "go beyond" Link 16. "Everything we are doing is to make sure the system is operational domestically and internationally."

Olinto says the F-22 and F-35 avionics have the "hooks in place" for LVC, with an architecture that will allow for "increased capability" over time via software upgrades. "There will be specific lines of code that are integrated into the aircraft's operational flight programs (OFP) that will allow this capability to be used by the pilot," he says.

"With the Lockheed Martin solution, there will be one-time integration of our capability into the OFP that will allow for LVC," he says. "In competitor approaches, they have to do substantial modifications to the OFP that are very complex. The advantage of being the OEM (original equipment manufacturer) is that we can do this with the least intrusion into the aircraft."

Two key competitors that Olinto is referring to are: Cubic, lead systems architecture for another AFRL LVC project; and Rockwell Collins, an avionics manufacturer conducting LVC research and development work for the Office of Naval Research.

Rockwell Collins is preparing for LVC flight tests using an Aero Vodochody L-29 Delfin single-engine jet trainer owned by the University of Iowa's Operator Performance Laboratory.

A key focus for Rockwell Collins is providing onboard simulation capability through the certified flight-deck avionics, a path that could eventually allow for the technology to cross over into the commercial aviation realm. "This research system demonstrates a partitioned architecture for embedded training functionality to be injected into flight displays in a manner with a credible path to certification," the company states.

The avionics integration approach differs from Cubic's. "The [Combat Air Force] project is currently in the process of making significant modifications to the OFPs of several F-15 and F/A-18 aircraft," states Rockwell Collins. "While significant OFP upgrades will most likely prove to be an effective solution, it is likely that it will also prove to be an expensive solution when retrofitting currently fielded aircraft and recertifying them for flight."

This L-29 cockpit has been retrofitted with glass to inject real-time virtual adversaries for air-to-air and air-to-ground scenarios.

Rockwell Collins initially tested prototype systems in the L-29 using laptop computers in lieu of avionics displays. "Our current focus is getting that functionality embedded into the aircraft," says LeAnn Ridgeway, vice president and general manager of simulation and training solutions for Rockwell Collins. "Then it comes full circle—using the aircraft as a training media."

Rockwell Collins is also working with the Navy to answer some critical questions about human factors in the LVC environment in terms of knowing what is live and what is virtual. "You can degrade training if you tip people off," says Ridgeway. "What do we have to do to the virtual side to make it look real in terms of the physics model?"

Lockheed Martin is investigating the same issue for the AFRL. "If the pilots in live-fly aircraft were to know that the enemies they see on their sensors are virtual, would they ever be heads-up or would they be heads-down and on the sensor too much, knowing that if they look up, the enemy wouldn't be there?" asks Olinto. "Our engineers are studying the issue as part of the Conops."

Rockwell Collins is planning a three-phase test program for LVC. Phase 1, completed in August, demonstrated basic avionics and training functionality with a single live L-29 aircraft with virtual wingmen against "a combination of virtual and constructive aggressor forces in air-to-air intercept scenarios, as well as constructive targets and additional participants in air-to-ground close-air support scenarios," the company states.

Phase 2, which is ongoing, will bring in additional virtual and constructive entities as well as additional live wingmen in both air-to-air and air-to-ground scenarios.

"The potential third phase will examine incorporating the second live aircraft as a red force in air-to-air engagement scenarios, pending a full risk assessment," states Rockwell Collins, adding that the flight test would be self-funded.

"Once the phased assessment of the LVC capabilities is complete, the architecture will be utilized to examine the human factors implications of pilots participating in these distributed training exercises," the company states.