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— Lt. Col. Eric “Chappy” Chapital, former F-15E weapons systems instructor, North Carolina

# The *virtual* sky

No longer a tool used just for flight training, simulators create a realistic experience for warfighters

By Jay Spenser

As a pair of F-22 Raptors streak through the skies, their pilots coordinate with other F-22s and an Airborne Warning and Control System (AWACS) aircraft to complete the operation—despite enemy fighters and surface-to-air missiles.

But only the two F-22s are in the air. The crews of the other Raptors and the AWACS aircraft are participating in this exercise from simulators at various U.S. Air Force training centers in the United States. As for the enemy fighters and missiles, they appear real on cockpit displays but are computer-generated.

A decade ago, the role of military flight simulators was to help crews transition to new aircraft types, hone their basic flying skills and practice emergency procedures.

“Today it’s a different world,” said Mark McGraw, vice president for Boeing’s Training Systems and Services in Defense, Space & Security. “Even the most complex air combat or air mobility operations can be simulated with fidelity, letting warfighters train just as they might someday be called on to fight.”

All manned aircraft programs in Defense, Space & Security benefit from these new simulator capabilities. And Boeing is leveraging the growing sophistication and fidelity of flight simulation to further benefit its military customers.

“We’re helping our military customers reduce their costs and risks even as they increase the readiness of the warfighter,” said Randy Deidrick, director of the Capability Center Shared Integrated Product Team within Training Systems and Services.

“With budgets tight, our customers need to offload time spent in the air with simulator time,” he added. “To meet this requirement, we at Boeing have collaborated with our customers and suppliers to develop a truly immersive training environment.”

It’s a training environment that:

- Familiarizes crews with real-world operations and threats
- Acquaints crews with new locations
- Allows crews to deal with emergencies not safely practiced in the actual aircraft
- Spares crews from having to fly all the way to a target and back
- Lets crews fire more missiles than an aircraft actually carries
- Concentrates the learning

After a simulator mission, the crew and instructor review the training session at a debriefing station that is essentially a miniature theater, where the crew’s

**PHOTO:** A pilot is shown using an F-15E simulator—a major component of Boeing’s three F-15E Mission Training Centers. RON BOOKOUT/BOEING

decisions, control inputs and communications are reviewed with visual aids.

"Instructors can have students fly a complex mission, offer performance feedback during a quick debrief and then have the students re-fly the same mission to assess their improvement," said Kay Grabanski, program manager for Boeing's three F-15E Mission Training Centers at Seymour Johnson Air Force Base, N.C.; Mountain Home AFB, Idaho; and Royal Air Force Lakenheath, United Kingdom.

Lt. Col. Eric "Chappy" Chapital was until recently an F-15E weapons systems instructor at Seymour Johnson Air Force Base in North Carolina. "The Boeing-produced Strike Eagle simulators are actually changing how we instruct because they let us teach at a higher level and perform more of the training in the simulator," Chapital said. "This saves time, fuel and dollars while delivering better results to the Air Force."

Improvements over the years to visual display systems help make this realistic training possible.

"Four jet-fighter simulators fit today in the space occupied by just one 20 years ago, when visual systems required a 40-foot-diameter [12-meter] dome," said Rob Lechner, chief engineer for Training Technologies with Boeing Defense, Space & Systems.

Last December, Boeing unveiled a dramatic leap forward in simulation capability. The Constant Resolution Visual System (CRVS) combines greater simplicity with lower costs and visuals that approach reality.

"CRVS is unique because it offers the same high resolution throughout the entire viewing area, providing an uninterrupted field of view and unvarying target acuity," said Boeing's McGraw. "It makes virtual training missions and other simulations more immersive and effective."

Progress in networking and integration likewise is transforming today's flight training. A decade ago, Boeing experts in St. Louis implemented the U.S. Air Force Distributed Mission Operations Network, a virtual environment in which simulator crews at different mission training centers can fly and train together. What started with the F-15C Eagle is today a collaborative battlespace that can accommodate many different aircraft types, as well as what's known as "constructive threats"—computer-simulated enemy weaponry and actions.

The F-22 Raptor Mission Training Center at Langley, Va., connected to this network last November, and three more Raptor training centers are joining in the next three years.

The Distributed Mission Operations Network is the "premier virtual training environment" for combat aircrew in ground-based simulators, said Boeing's Barry Cossel, an F-22 training manager.

The capability to fly virtual missions alongside actual aircraft in the sky is a key element of what's known as Integrated Live, Virtual and Constructive training, or I-LVC. It eliminates the geographical constraints of having to train over existing ranges. This technology represents the ultimate in military flight training, and Boeing is leading the way with I-LVC.

Boeing also is supporting various U.S. Navy programs with its simulator expertise, including the F/A-18 Super Hornet, the EA-18G Growler and the new P-8A Poseidon maritime patrol aircraft, which is a military derivative of the Next-Generation 737 commercial jet.

Crew training for the P-8A will be in Operational Flight Trainers that are based on the Next-Generation 737 full-flight simulators. Featuring full motion and visual systems, these Operational Flight Trainers replicate the Poseidon's unique flight deck. The first of these trainers is scheduled to become operational at the Naval Air Station in Jacksonville, Fla., in late 2011.

Poseidon crews also will train on another simulator known as the Weapons Tactics Trainer, which replicates the aircraft's cabin with its state-of-the-art control and display systems. In the simulator, Poseidon crews will be trained

**PHOTO:** Boeing's Mission Training Center at Langley Air Force Base, Va., includes F-22 simulators such as this one. BOB FERGUSON/BOEING

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in the aircraft's anti-submarine warfare, anti-surface warfare, and intelligence, surveillance and reconnaissance systems and capabilities.

"The Poseidon program is very important to the Navy and United States," said Tom Lavender, manager of P-8 Training Systems for Boeing. "We're pleased that our Navy customers chose us to also provide Poseidon training support."

As many as 20 of the P-8A Operational Flight Trainers and 15 of the Weapons Tactics Trainers could eventually be in operation at several locations, he said.

Boeing-developed simulators also are being used to train U.S. Army pilots to fly the company's Apache AH-64D Longbow helicopter. These training devices provide so much value that one Longbow Crew Trainer is assigned to each battalion in Iraq and Afghanistan.

"The Army says its in-theater Longbow Crew Trainers save lives," said Ken Bloms, program manager for Boeing's Apache Training Systems. "They do this by allowing combat crews to practice more than 280 simulated emergencies, including engine and transmission failures and hits from enemy fire."

Apache pilots also can preview missions and even practice brownout landings, a disorienting situation that occurs when the main rotor kicks up a blinding swirl of desert sand while landing.

"Without a doubt, training systems like the Longbow Crew Trainer not only prepare our pilots well for combat but also provide the opportunities to make mistakes and learn," said U.S. Army Lt. Col. John Vannoy, product manager for Apache Sensors at Redstone Arsenal, Ala. "The system is clearly, in my mind, the 'best of the best' training devices in the field today."

Boeing C-17 Globemaster III crews also rely on simulators to develop and sustain their readiness for a variety of missions. Each C-17 Weapon System Trainer combines a C-17 flight deck with the aft loadmaster station so crews can practice typical operations such as airdrops, where C-17s deliver supplies by parachute.

"As many as six crews at a time can practice formation airdrops in our networked simulators," said Tracy Mead, C-17 Aircrew Training Systems program manager and a former U.S. Air Force C-17 pilot. "For maximum realism we also include additional C-17s that are virtual, as well as a host of constructive threats." ■

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**PHOTO:** Robert Heiman, Training Systems & Support electrical engineer, in the P-8A Poseidon simulator in St. Louis. BOB FERGUSON/BOEING



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— Mike Saladin, senior manager with Simulation Engineering at Boeing Training & Flight Services

# Dreamscape

## Learning to fly the 787

While military jet-fighter simulators feature ultra-realistic visuals of aerial combat scenes from the cockpit, commercial pilots being trained to fly the new 787 Dreamliner also are getting breathtaking virtual views, whether it's the Tokyo skyline or snow-covered Mount Rainier near Seattle.

For the 787 suite of training devices, this includes higher-resolution, crisper visuals produced by state-of-the-art content and projection technology.

And the 787 simulation devices have all the new technology that's part of the 787 itself, including dual Electronic Flight Bag displays that replace bulky paperwork and dual head-up displays that let pilots see flight data overlaid on the view ahead.

Flight training begins on desktop trainers that display virtual cockpits on standard computer monitors. Later, students move on to flat-panel trainers, with large LCD pilot displays with the same resolution as in the actual flight deck, and finally to a full-flight simulator, where pilots experience not only the realistic visuals but also the motion resulting from their control inputs.

Ascents and descents, pitches and rolls are created by a new electric and hydraulic mechanical system that provides a faster response time and uses only 20 percent of the electricity of previous full-flight motion systems.

Students can prepare for and review their full-flight sessions at a nearby station that provides a time-based audio and video recording of their training session.

Pilots spend up to 20 days learning to fly a 787. If they already are certified to fly a 777, they need only five days of training due to the commonality between the two models.

Maintenance training uses desktop trainers that feature a virtual airplane and various maintenance scenarios. Students can troubleshoot and fix simulated faults in the virtual airplane.

There are eight training suites at five Boeing Training & Flight Services locations in Tokyo, Singapore, Shanghai, Seattle and outside London. The training suites were built by Thales (pronounced *tal-lis*), a leading provider of onboard and ground systems for the civil aerospace market.

“We worked in close collaboration with Thales to develop training devices and environments that meld its technical capabilities with our training requirements,” said Mike Saladin, senior manager with Simulation Engineering at Boeing Training & Flight Services.

— Kathrine Beck

**PHOTO:** Vincent Eckelkamp, instructor pilot, Boeing Training & Flight Services, in a Thales 787 full-flight simulator in Seattle. GAIL HANUSA/BOEING