Distributed Testing at Redstone

Sharing Data in "Real Time" to Support Development of Javelin and Other Weapons

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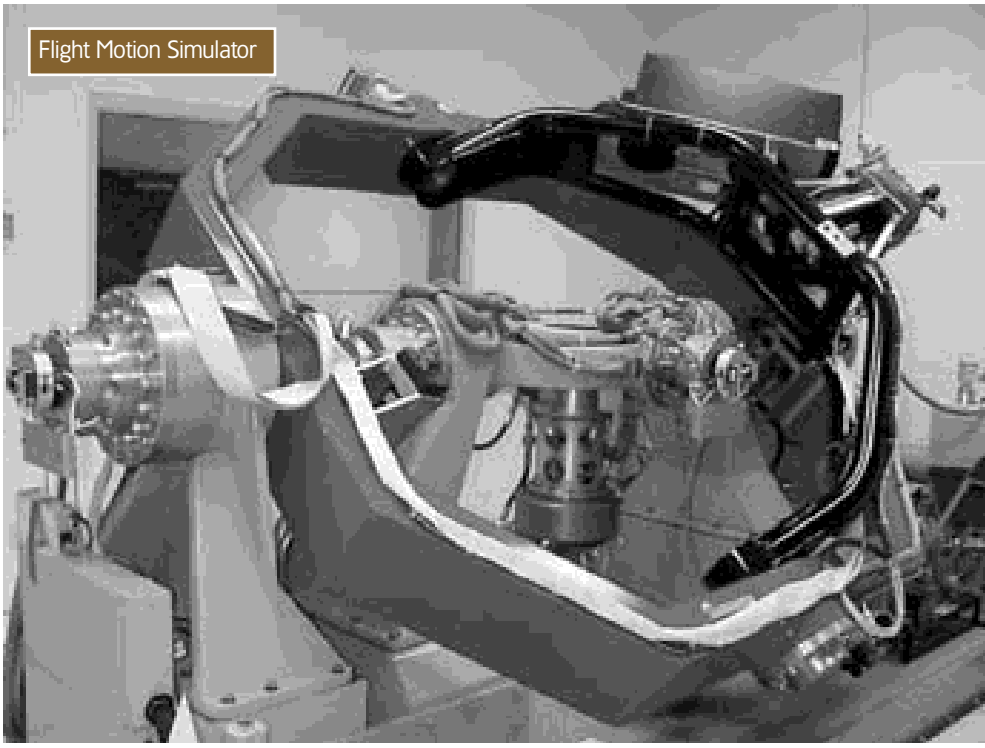
As the Army transforms itself and develops lighter and more mobile forces that are also lethal and versatile, it is acquiring more sophisticated, lightweight weapons. Developers are providing the Army with a variety of new systems such as the Javelin, a fire-and-forget antiarmor weapon that allows a soldier to lock onto a target, fire, and then seek cover or move to another position while the missile is in flight.


Flight Motion Simulator

Redstone Technical Test Center

The Army's Redstone Technical Test Center (RTTC) at Redstone Arsenal, Ala., is an important player in acquiring such weapons, putting them through a variety of rigorous tests. Though a system such as the Javelin still must be fired on a test range to prove its accuracy and lethality, the Army is also investing in new technologies at RTTC and other test sites, to conduct a full spectrum of realistic tests through computer modeling, simulation, and other nondestructive means.

The RTTC is also improving its ability to "distribute" tests, said Lloyd Brooks of the center's Test Management Division, explaining that RTTC uses fiber-optic communications links on Redstone Arsenal and high-speed network connections to other locations to link them into tests at the same time and share data in "real time." Distributed testing saves time and resources, he said, and enables defense contractors and acquisition program managers to make critical decisions and design changes earlier in the process of producing and fielding their systems.

Javelin Test Program

For weapons such as the Javelin, that means using state-of-the-art simulation technologies to test these systems in a "hardware-in-the-loop" mode. A specially designed laboratory at RTTC, the Electro-Optical Sensor Flight Evaluation Laboratory (EOSFEL), provides the means to test missile guidance and control systems in a nondestructive and simulated environment. The proximity of this laboratory to the Electro-Optical Target Acquisition System Evaluation Laboratory, linked to EOSFEL by high-speed fiber-optic cable, allows closed-loop, nondestructive testing of target-acquisition sensors and fire-control subsystems with the missile's subsystems. The Defense Research and Engineering Network (DREN), a high-speed wide-area network connection, links RTTC to other test sites and enables them to participate in distributed tests.

Javelin Command Launch Unit

One hardware-in-the loop trial, for example, involved having a soldier at White Sands Missile Range, N.M., use a Javelin Command Launch Unit (CLU) linked to RTTC, some 1,200 miles from White Sands. When the soldier powered up the CLU, he was actually seeing a simulated battlefield scene generated by the laboratory at Redstone. When he locked onto the target and pressed the trigger, he saw a live mis-

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Photos courtesy RTTC

sile-seeker video and the round going down range to strike the target. He didn't notice a delay in response due to the high speed of communication between RTTC's lab and White Sands.

"We took the functionality of the Javelin CLU, just in software, and gave it to White Sands," explained Kenneth LeSueur, a senior electronics engineer at RTTC who oversees the work at the EOSFEL facility. "The gunner did the 'switchology' where he was actually looking on the range, and we inject that into the tactical hardware here. The Javelin seeker video was piped from this lab over the DREN back to the gunner at White Sands. We were getting round-trip latencies on the order of 80 milliseconds, so the DREN is very successful for us."

Early Involvement

LeSueur said the trial at White Sands was preceded by a test that linked a gunner on one of RTTC's test ranges to the EOSFEL, some three-and-a-half miles away.

"Our goal was for the gunner to not know there wasn't a real round on his shoulder until he pulled the trigger," LeSueur said. "The band width and the latency of the fiber-optic connection to the test area from the lab was such that a human could not perceive a delay. Actually, the weapon system in this case could not perceive any difference."

"We are trying our best to take the Virtual Proving Ground effort and bring it to where the customer is leading us," Brooks said. "The test community is driving us toward this way of doing business – getting the soldier involved more quickly while involving developers so they can determine more quickly if they are meeting the user requirements placed on them. We're able to help them make material changes and refocus the design strategy before they get into producing large numbers of hardware."

A Javelin missile is fired at the Army's White Sands Missile Range, N.M.

Virtual Environment

"We can merge a weapon system into a virtual environment and perform nondestructive testing that we can repeat in any given scenario," LeSueur explained. "We can simulate differing weather patterns and conditions, differing types of ranges, countermeasures, [and] temperature extremes. With missile systems in particular, any time you do a live test you are going to destroy hardware. So when you come into a laboratory and do repeatable, nondestructive tests on very expensive assets, there is a financial payoff as well as an engineering advantage. We can also push the edge of the envelope in here and not be limited by the safety and environmental constraints of live fire."

LeSueur said additional improvements to support distributed testing are planned.

Central Hub Planned for Developmental Testing

"In the coming two or three years, we will be bringing a Test Command and Control Center online," he said. "It will be kind of a central hub for all distributed testing. You can compare it to a NASA command center, because it will have all types of communications – voice, computers communicating over the DREN, big-screen TVs, and a big tie-in to the fiber-optics infrastructure here at RTTC. We will be able to bring in a representative of every player in a

distributed test, and they will be able to communicate with their personnel and coordinate the test from a central location."

He said RTTC is also planning to link through the DREN to the Raytheon plant in Tucson, Ariz., to support future tests.

William Wilkinson, RTTC's lead engineer for the Javelin test program, said this program spurred RTTC in developing some of its laboratory facilities and test tools. These high-tech facilities do not just test the operation of missile sensor guidance and control systems under normal operating conditions, he explained. They also simulate various functional problems so testers can see how the systems respond.

"You can input certain faults to look at how a missile would react in flight," Wilkinson said. "This is done using tactical hardware, not just bread-board components in a lab. We have a system that can introduce a control-actuator problem such as a fin that sticks, and we can simulate the missile going bad in flight. We can then determine what the flight characteristics would be in that case. You can load different types of tracker software into a guidance system and play it against different scenarios without having to do captive-carry flights."

A "captive-carry" flight uses aircraft to carry missiles down range to the target and test their guidance systems, he explained.

Wilkinson first became involved with the Javelin test program during production-verification testing for the initial low-rate production design in 1995, and he has seen the system undergo some improvements and changes that lower production costs. As Raytheon and Lockheed Martin introduced new materials or made alterations to Javelin subsystems, a variety of tests at RTTC helped the program manager determine if these changes affected system performance. RTTC testers also subject systems to a variety of dynamic and climatic environments.

Testing to Extremes

"The Javelin is a fairly robust system because we do some rigorous dynamics tests," Wilkinson explained. "During a qualification test, we drop the bare round from three feet, at various angles, onto reinforced concrete. We also drop it housed in its container, from several different angles. That is all done at different temperatures – extremes you would see in the field."

Dynamics testing for the missile system includes subjecting it to the type of vibration it would experience when transported in a tactical wheeled vehicle, a two-wheel trailer, and a Bradley Fighting Vehicle. RTTC has used data from the field to create simulations on a shaker table. Soon a vibration test that replicates transport in a HMMWV will be introduced, Wilkinson added.

RTTC has upgraded some of its other facilities to improve testing.

Bottom Line – Improved Firing Capability

"Over the past several years, we have improved our firing capability at Test Area 6 with facilities upgrades," Wilkinson said. "The Javelin Environmental Test Set that we built for the program office has become one of our primary instrumentation keys. We are able to do functional tests on rounds in chambers at varying temperatures, varying humidity, etc. We can power up the round and go through some functional tests, while actually looking at a target. We can fire a round with a derivative of this family of test sets.

"We've bought some new dynamic equipment. The [Javelin] program office provided funds for us to complete a dual captive-flight system, providing the capability to compare the performance of two identical guidance systems running two different versions of tracker software during a single captive flight."

Editor's Note: The author welcomes questions or comments on this article. Contact him at *castm@dtc.army.mil.*

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The DAU Virtual Campus, also known as the Online Schedule System (OSS), no longer serves as a registration system for any DAU course. The Acquisition Training Application System (ACQTAS) will be the sole registration system for all DAU courses. Civilians from DoD agencies other than the Army, Navy, and Air Force can access ACQTAS at the following Web site *https://www.atrrs.army.mil/channels/acqtas*. The OSS will continue, however, to serve as the delivery platform for all Web-based training courses (ACQ 101, BCF 102, CON 237, IRM 101, LOG 101, LOG 203, PQM 101, SAM 101, TST 101) and "A" sections for DAU hybrid courses (ACQ 201, BCF 211, PQM 201).

When a student registers for an online class in ACQTAS, the data entered into ACQTAS for each student (SSN, name, address, organization, etc.) will be the data of record; this data will then be forwarded to OSS. If the student already has an account in OSS, the user name/password for that student will remain the same. If the student does not have an account in OSS, OSS will provide the student with a user name/password he or she can use to enter OSS for the purpose of completing Web-based training courses.

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