P3I BAT Preplanned Product Improvement

A Simulation-based Acquisition That Meets the Army's 2020 Vision

DEBORAH PINKSTON

Meeting the Army's 2020 Vision of "doing more with less" in today's changing environment places a challenge on the project/product manager (PM), who is developing a major acquisition system. How can a PM provide increased, reliable requirements with less money? How can a PM do this while maintaining the cost, schedule, and performance of a major acquisition system?

BAT — picture taken by a lipstick camera on a gun tube.

Modernizing Existing Systems

The Army Deputy for System Management and Horizontal Technology Integration, at the Army Management Staff College emphasized on July 7 that the Army needs to "recapitalize" legacy systems encompassing a number of platforms. Modernization of existing Army systems to technical levels capable of achieving combat readiness is critical not only to meet current Army needs, but also to achieve the Army's 2020 Vision of its weapon systems as a strong, objective force for the soldier. The Army can no longer waste budgets on items to be replaced; it cannot afford the lead times and budgets required to develop new systems.

One method to reach the Army goal of increased capability, increased reliability, and increased equipment life span is to upgrade existing (legacy) Army systems with preplanned product improvements (P3I). Developing a major acquisition system such as an ACAT ID program requires extensive testing and evaluation to "prove out" a system. This can cost millions of dollars if conventional or traditional tactical testing is pursued. For example, a typical captive flight test (CFT) of a major acquisition program can cost as much as $1-2 million each. These tests are developmental in nature and verify and validate the system's performance.

The Army test and evaluation community (Army Test and Evaluation Agency, Army Materiel Systems Analysis Activity, Office of the Deputy Chief of Staff for Operations, and the Training and Doctrine Command) want the PM to prove out the maximum capability of the developed system. This is prior to providing the system as an objective force for the Commanders-in-Chief and, certainly, for the soldier who uses the end item.

The Chief of the Army Tactical Missile System-BAT Project Office (ABPO), Test Division, and the P3I BAT test engineer indicated that the system can require as many as 10-20 CFTs, 6-8 Live Fire Tests, and some 10-15 Operational Tests.[1] A total cost for this range of testing can be as much as $30-50 million, or more. This estimate would include successfully completing a program's exit criteria, getting an Acquisition Decision Memorandum, or obtaining approval by the Sec-

Pinkston *is a member of the Army Acquisition Corps Competitive Development Group (CDG). She is an Acquisition Management Specialist working for the P3I BAT Product Office, Redstone Arsenal, Ala.*

Photo Courtesy Northrop Grumman Electronic Sensors and Systems Sector (NGESSS)

retary of Defense to enter the production phase of the system's life cycle. Not included in this estimate is consideration/impacts for the sustaining base or deployment needs of the system in light of increased requirements, but reduced funding.

Some other challenges exist outside the PM's immediate control that impact the program. The PM has to satisfy concerns of not only the Army cost, schedule, and performance requirements, but also any industry-based impacts, and any political or congressional impacts that come with these changes. The "Iron Triangle," pointed out by the Army Deputy for System Management and Horizontal Technology, requires innovative and astute business and leadership qualities of the PM, while at the same time a certain degree of political prudence.

Simulation-based Acquisition Modeling

One method of meeting these challenges is using simulation-based acquisition modeling for development and production/deployment. Using this method can reduce the number of tests and save as much as one-fourth to two-thirds of the cost of conventionally testing a system. Additional savings can also be obtained with fielding and deploying the system by using the simulation-based research and development special tooling and special test equipment for acceptance test procedures.

An example of this application is the U.S. Army Program Executive Office-Tactical Missiles, ABPO P3I BAT program. This program is nearing a significant milestone in a simulation-based acquisition product development project for the Army Tactical Missile System TACMS-P3I BAT Brilliant Anti-Armor submunition. The ABPO, the manager of the P3I BAT program, is developing a unique Hardware-in-the-Loop (HWIL) simulation as a primary means of qualifying P3I BAT for developmental testing and production.

In 1995, the Missile Research, Development, and Engineering Center of the Army Aviation and Missile Command (AMCOM) began development of the P3I BAT HWIL simulation facility. In December 2000, the HWIL simulation laboratory becomes operational and begins full-scale support of the P3I BAT program. According to the P3I BAT Product Manager, the P3I BAT HWIL facility costs approximately $10 million to build, and is the only facility capable of "flying" a single aperture, dual-mode sensor submunition in the Army.[2] It tests the P3I BAT over the full spectrum of weather conditions, ensuring that long-range fire support is available to support the full spectrum of operations. Use of the HWIL furthers the acquisition initiatives of using state-of-the-art simulation to reduce the cost of testing and improve system reliability throughout the life cycle of the system.

> **"The Army can no longer waste budgets on items to be replaced; it cannot afford the lead times and budgets required to develop new systems. Modernization of existing Army systems, therefore, is critical to meet Army needs."**

The P3I BAT

The P3I BAT is a state-of-the art submunition that uses highly advanced technology to improve the basic BAT capability and expand the target set to include cold, stationary armor; surface-to-surface missiles (SSM), including transporter erector launchers (TEL); and multiple rocket launchers (MRL).

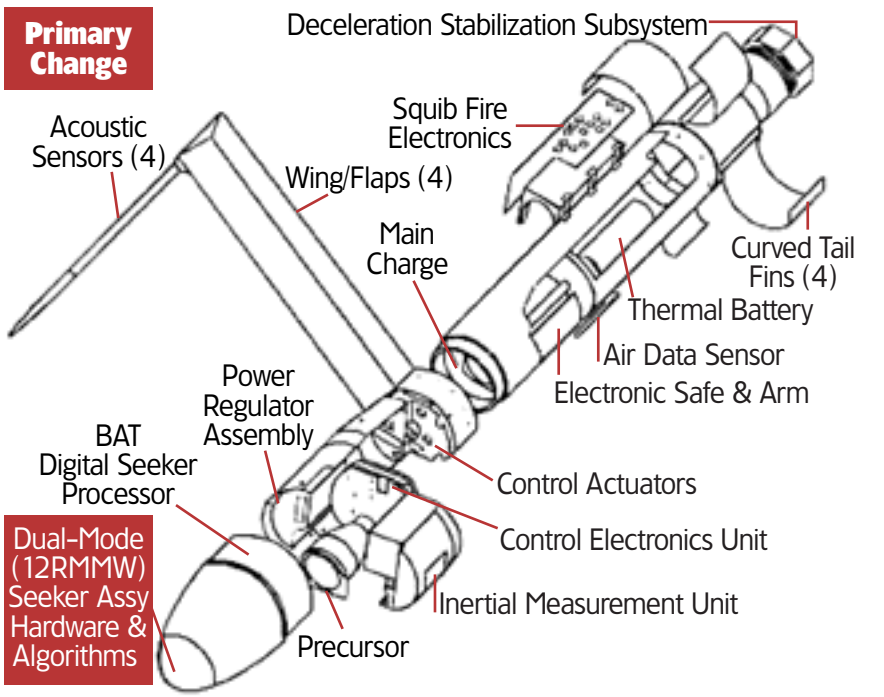

FIGURE 1. **View of the P3I BAT**

Like its basic BAT predecessor, the P3I BAT is a deep-strike weapon autonomous submunition once launched from the Multiple Launch Rocket System M270A1 launcher, and dispensed from the Army TACMS Block II missile in the proximity of known concentrations of enemy vehicles.

To determine the location of the hostile formations, the P3I BAT submunition, a tri-sensor system, uses acoustic, imaging infrared (I2R), and millimeter-wave (MMW) sensors. The new single aperture dual-mode seeker [I2R and MMW] autonomously searches for, detects, acquires, recognizes, tracks, and guides the submunition to impact independent of an acoustic signal. The P3I BAT submunition suite of sensors also provides the robustness to defeat a variety of countermeasures during engagement.

The MMW radar has excellent target acquisition capability at relatively long range, and can search a large area due to an inherently large field-of-view, and is not disabled by most weather conditions. The I2R sensor has excellent terminal accuracy and provides imagery that is useful for target classification. When used together in the P3I BAT submunition, target acquisition is significantly increased.

The P3I BAT, can attack both hard and soft targets [an improvement over the base BAT, which only attacks hard targets] making it an excellent weapon to defeat such targets as SSM MRLs and TELs at long ranges. Figure 1 shows an exploded view of the P3I BAT, reflecting the 80 percent commonality with the base BAT, including the airframe and most of the internal components. The unique portion of P3I BAT is the dual mode seeker.

Testing a Tactical Submunition

The engineer responsible for the P3I BAT HWIL from the AMCOM Research, Development and Engineering Center and SimTech, his support contractor, emphasized that the technical sophistication of the sensors and the autopilot software mandated an approach to testing.[3] The HWIL simulation provides the means of exercising the actual P3I BAT hardware and tactical software in a full, simulated flight. The acoustic, MMW, I2R sensors, and the inertial measurement unit are provided with input signals to make the system behave as though it is flying a real engagement.

High-speed, real-time computers are used to control the target, environment, and countermeasure signatures and battlefield scenarios. A six degree-of-freedom (6 DOF) flight dynamics simulation determines the flight trajectory. The HWIL test items, therefore, provide a true representation of the tactical system consisting of tactical hardware and the operational software used in an actual combat operation.

The functional diagram of the facility (Figure 2) identifies the major components of the facility, which are the anechoic chamber; flight table; antenna array and MMW signal generation hardware; I2R projector with optics; Computer Image Generator (CIG); dichroic beam combiner; and acoustic signal and aerodynamic data signal generators. The anechoic chamber provides a reflection-free environment, with the antenna array and MMW signal-generation chain simulating the radar return. The radar-transmitted pulse is modulated with the target and clutter signature, and transmitted from the antenna array across the anechoic chamber at the correct angle-of-arrival, where it is received by the radar and processed.

Simultaneously, the IR scene is computed by the CIG and projected into the seeker via the relay optics. The dichroic beam combiner is a dielectric that functions as a mirror for the IR while allowing the MMW signal to pass. The flight table moves the submunition seeker in pitch, yaw, and roll to simulate flight motion. A 6 DOF submunition airframe and aerodynamics simulation resident on the facility simulation computers continuously updates the relative geometry. A data collection system captures the real-time simulation data from both the submunition and facility for display during simulation execution, post processing, and archiving.

Simulation-based Testing and Production

According to the P3I BAT PM, the HWIL is a pertinent tool for the PM's use in removing much of the risk driven by design maturity. The HWIL uses test hardware over and over again, mitigating the need for producing more prove-out hardware to achieve the required level of verification and validation data. He cautioned, however, that the HWIL is not a replacement for full operational or end game, impact testing.

The HWIL supports the P3I BAT Continued Development (CD) program by validation of the submunition digital models, support of the production cut-

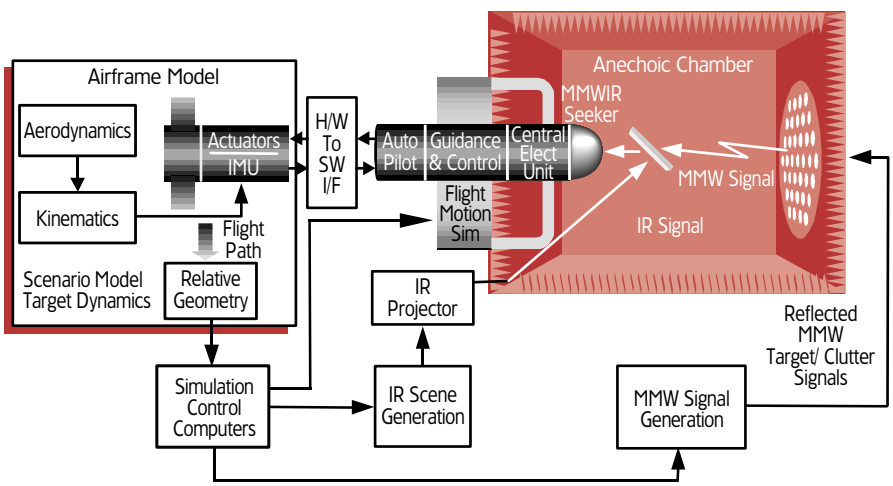

FIGURE 2. **HWIL P3I BAT Diagram**

in and full-rate production decisions, product improvements, and software maintainability. According to the P3I BAT simulation and systems engineer of the ABPO and AC, Inc. (the P3I BAT support contractor), during the CD program the HWIL supports seeker tactical software development and submunition performance assessment.[4] This includes the following:

- Hit point analysis.
- Pre-flight predictions.
- Post-flight reconstruction.
- Countermeasure analysis development and assessment of sensor fusion algorithms.
- Limited user readiness test and evaluation simulation support.
- Assessment and analysis of the effectiveness of the P3I BAT submunition against Operational Requirements Document-derived mission requirements.

The HWIL also reduces the costs associated with tactical testing of a major system prior to seeking a Defense Acquisition Board milestone decision. As an upgrade to an existing system, the HWIL is particularly appropriate with an 80 percent commonality with base BAT. Verifying and validating the peculiar components, software, and algorithms in the HWIL is very cost effective when compared to captive flight tests, drop tests, and other developmental testing normally required for a major acquisition system. The common components of the system are already qualified with no need to retest. Use of an HWIL streamlines the validation process of the unique seeker and saves range costs, target expense, and eliminates range variables.

Finally, the HWIL will be a valuable acquisition and sustaining base tool used during the production phase, eliminating the need to build a separate P3I BAT Simulation Test Acceptance Facility (STAF). On May 16, the Acting Assistant to the Project Manager for System Integration of the ABPO explained that checking out the complete tactical round using the HWIL special tooling and special test equipment will make the P3I BAT STAF facility a unique and essential acceptance test procedure (ATP). This ATP will sustain the life of the system.

"The HWIL supports the P3I BAT Continued Development (CD) program by validation of the submunition digital models, support of the production cut-in and full-rate production decisions, product improvements, and software maintainability."

Final Thoughts

The P3I BAT HWIL simulation facility is a life cycle tool that provides many benefits to the PM who experiences added program requirements with limited funding. Since P3I BAT is a near all-weather system, simulation is the only cost-effective method to assess the diverse battlespace scenarios in multivariable environments. Including the systems contractor, the test community, and the user as integrated product/process team (IPT) players when planning the use of the HWIL facility, is essential in getting their acceptance of the simulation-based acquisition concept.

A summary of important benefits to be gained from an HWIL simulation-based acquisition follows:

- A cost-effective means of verifying system performance.
- Comprehensive flight-test hardware and software readiness evaluation.
- Thorough post-test data analysis and test failure analysis.
- Full system integration, including functional verification of tactical hardware and software.
- Reduction in the number of flight tests required for system development.
- Closed loop tactical software development, checkout, and upgrades .
- Precise system performance assessment over flight envelopes and countermeasure scenarios.
- Thorough evaluation of system design and performance prior to production commitment.

These benefits meet the Army 2020 Vision of "more with less." An effective IPT effort, where the systems contractor, the test community, and the user work jointly to capitalize on this cost, schedule, and performance simulation-based capability, will provide the sustaining base life cycle of the system. It will also provide the Army, the Department of Defense, and members of Congress the rationale and importance of simulation-based modeling as a cost saving/cost avoidance method of keeping a system not only viable, but also a strong objective force for the soldier.

Editor's Note: The author welcomes questions or comments on this article. Contact her at **Debby.Pinkston@msl.redstone.army.mil**

ENDNOTES

1. Conversations between Chief of the Army Tactical Missile System – BAT Project Office, Test Division, and P3I BAT test engineer, May 2000.
2. Conversations between the author and P3I BAT PM, June 29, 2000.
3. E-mail message sent to the author from the P3I BAT HWIL engineer, AMCOM RDEC, and his support contractor, SimTech, Oct. 27, 1999.
4. Personal interview between the author and P3I BAT Simulation and Systems Engineer, ABPO, May 2000.