SUPPORTING BRADLEY A3 ACQUISITION USING SIMULATION BASED TECHNOLOGY

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The Department of Defense (DoD) vision for Simulation Based Acquisition (SBA) is to have an acquisition process that is enabled by robust, collaborative use of simulation technology that is integrated across acquisition phases and programs.

The Army's Bradley Advanced Training System (BATS) is an evolutionary training system that has implemented some of the basic tenets of SBA. The system was initially developed as a training and development tool for the Bradley A3 program. Through partnering between PM Bradley, STRICOM, United Defense and the Bradley Infantry School, the BATS program has grown to an interactive, interoperable training system that provided initial operator training support for the Bradley A3 Limited User Tests. Additionally, the BATS will be used to support the Bradley A3 Initial Operator Test and Evaluation (IOT&E) testing this fall. These initial successes in the program have led to evolutionary changes in the BATS system development, moving from a Gunnery only training system to a multi-purpose role of Gunnery and Maneuver training.

This paper will discuss the application of Simulation and Modeling for Acquisition, Requirements and Training (SMART) tenets through the development and implementation of the BATS program and highlight issues that are currently being addressed with ongoing integration efforts. SMART is defined as the integrator of simulation tools and technologies across acquisition functions and program phases. This paper will also discuss the implications of using SMART for the acquisition of weapon systems and their training systems.

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1. INTRODUCTION

The long-term effect of multiple and continuous deployments and shrinking budgets ultimately translates into less Research and Development (R&D) money to develop new weapons systems. Less R&D money means current weapon system project managers (PMs) must be creative in order to maintain program cost, schedule and performance requirements. Traditionally, PMs wait to develop training devices after system fielding. This frees up shrinking R&D money during critical times to ensure program milestones are met. But, delaying the development of training devices does an injustice to the soldier by forcing him into a new system without adequate familiarization and train-up. Additionally, this delay is a much more expensive development path in the long run.

1.1 Simulation and Modeling For Acquisition, Requirements and Training (SMART)

The Simulation and Modeling for Acquisition, Requirements and Training (SMART) initiative pushes aside the traditional linear life-cycle model of acquisition and relies upon simulation to evolve a weapon system from concept to design, to test, to production, to training, and to the field. It is a strategy for efficiently managing Modeling and Simulation (M&S) as a resource to be exploited by the Project Manager to accomplish acquisition objectives. SMART involves the collaborative use of M&S across the acquisition, requirements and training spectrum. The goal of the SMART initiative is to minimize the resources, risk, and time associated with the acquisition of a weapon system. The U.S. Army and United Defense (UDLP) have formed a partnership to mitigate risk to the Bradley Fighting Vehicle A3 (BFV A3) program to include M&S technology throughout the vehicle's life cycle.

1.2 Application

The Army's Bradley Advanced Training System (BATS) is an evolutionary training system that has implemented some of the basic tenets of Simulation Based Acquisition (SBA) and SMART. The system was initially developed as a training and development tool for BFV A3 program. Through partnering between PM Bradley, STRICOM, UDLP and the US Army Infantry School, the BATS program has grown to an interactive, interoperable training system that provided initial operator training support for the BFV A3 Limited User Tests (LUTs). Additionally, the BATS will be used to support the BFV A3 Initial Operator Test and Evaluation (IOT&E) testing this fall. These initial successes in the program have led to evolutionary changes in weapon systems development.

2. DEVELOPMENT

PM Bradley utilized the Combat Simulation and Integration Laboratory (CSIL), the Bradley Plus Simulator (BPS), Software Common Operating Environment (SCOE) and BATS to gain insight to the vehicle development. These tools were used for build-test-build operations, familiarization and gunnery training in support of the BFV A3 milestone tests (see Figure 1). Because of the work done at the CSIL, and the SBA methodologies applied throughout the BATS program, the Bradley program was able to get LRIP approval without having to go through all the formal testing that had been required of them for past acquisitions.

The SBA methodologies do not end with the Bradley system only. This capability is currently being expanding to support other vehicle platforms such as the Crusader and Grizzly systems.

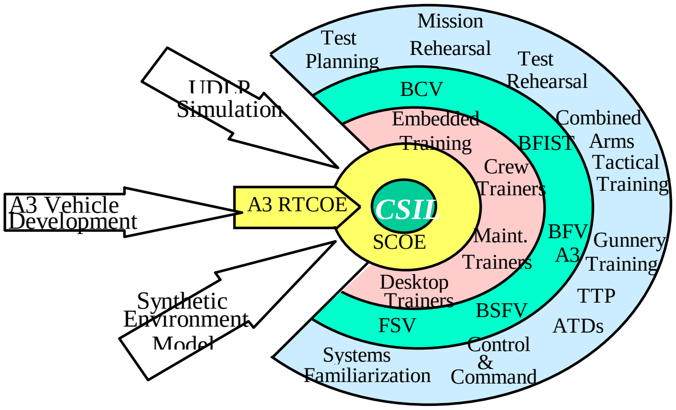

Figure 1. Bradley A3 SBA Concept

2.1 Combat Simulation Integration Laboratory (CSIL)

The CSIL was established to provide a test bed for integrating weapons systems software and hardware in a controlled environment. The CSIL provides models and simulations of tactical systems so that integration of platform components can be accomplished prior to integration on a vehicle platform. The CSIL was instrumental in the development of the Simulation, Emulation, and Stimulation (SES) process. The SES process allows engineers to simulate major components of a tactical system, Emulate the tactical system, and then use a mix of Simulated and real components to Stimulate the entire system. This is an iterative process that allows for the refinement of the tactical system at a much lower cost and it may be accomplished prior to, or in parallel with the tactical system development.

2.2 Simulation Emulation Stimulation (SES) Models

The SES models provide simulations of Line Replaceable Unit (LRU) components to the A3 tactical software. The SES models match the operation characteristics, timing, and interfaces of the various LRUs in the weapon system. This allows the A3 tactical software to run in an environment with any mix of simulated and real LRUs. The SES models also provide a powerful tool for integrating devices, which are not fully developed. The idea of SES was developed by the CSIL and is adopted across all of United Defense Training Systems products.

2.3 Bradley Plus Simulator (BPS)

The BPS was developed by United Defense as a test bed for the development of the A3 variant of BFV. The BPS was a predecessor to the BATS trainer and provided a modeling tool that incorporated bench equipment into a simulated turret and hull. This simulator is used in the CSIL in San Jose as an engineering test-bed for hardware and software. The system utilizes the SES concepts and the actual A3 tactical software/hardware to provide the engineers a platform for conducting Proof of Principle (POP) demonstrations, integration, and test of newly developed concepts and designs. This hardware-in-the-loop simulator utilizes LRUs and vehicle software in an engineering environment where modifications are integrated prior to being incorporated into the final vehicle design.. The build-test-build philosophy performed via the CSIL supports the SMART paradigm

2.4 Software Common Operating Environment (SCOE)

The SCOE was developed to facilitate the reuse of the A3 tactical software in BATS. Through the use of the SCOE, the A3 tactical software is able to run on a Windows NT operating system transparently to the tactical LRUs as well as the operator. The SCOE has been cost effective by avoiding costs normally provided to perform a simulation of the vehicle tactical software. The SCOE has also provided a low cost path forward for future development and integration of tactical systems and software through its reuse in the Bradley Desktop Trainer (BDT). The SCOE is a collection of software services which provide system level functionality to the tactical applications. This layer of software services has been developed so that it is portable across multiple computer platforms. The SCOE has been tailored to encompass multiple tactical applications such as Grizzly and Crusader. The SCOE also provides interfaces unique to the simulation environment.

2.5 Bradley Advanced Training System (BATS)

The BATS prototype was developed through the oversight of STRICOM and was used by PM Bradley primarily for risk mitigation purposes. The BATS is a full fidelity crew-station used in gunnery and maneuver training prior to the BFV A3 milestone tests. By using the BATS as the primary training device prior to these tests, the Bradley PM has ensured that crews are proficient prior to the record test, thus minimizing the time required on the vehicles. This also frees the vehicle for maintenance, instrumentation, and hardware and software upgrades. The BATS development was leveraged from United Defense's investment in the BPS.

The BATS is a high fidelity reproduction of the gunner's and the commander's weapon station (see Figure 2). The crew-station includes the actual vehicle seats, Gunner Hand Station and Commander Hand Station, and LRUs, such as the Commander Sight Control Panel and the System Control Box. Separate sighting subsystems and bi-ocular displays replicate the Gunner's Target Acquisition Sight and Commander's Independent Viewer. The Instructor Operator Station (IOS) is used to create, manage, and score an exercise. The exercise is user generated, the data is electronically logged, and the instructor can monitor and score a crew's performance. The IOS also provides the capability to automatically conduct After Action Reviews and recommend exercises to be repeated. As a part of this monitoring subsystem, the IOS provides a stealth viewer to provide visibility into the exercise.

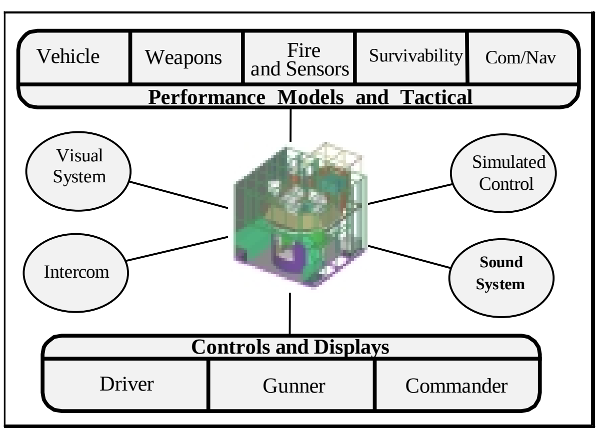

Figure 2. Bradley Advanced Training System

2.5.1 Precision Gunnery

The BATS is a complete gunnery training system that consists of a high fidelity gunner and commander's weapon station, and an IOS to control gunnery exercises, perform pre-brief, and provide AAR. The BATS employs a visual and computational system to provide the target images to develop and sustain gunnery skills for the BFV A3. The computational system also utilizes tactical software that replicates the actual fire-control functions and capabilities of the BFV A3. The BATS was used to train instructors, key personnel, and the test crews in support of the BFV A3 LUT-1 at Fort Benning and LUT-2 at Fort Hood.

3. IMPLEMENTATION

The BPS and BATS have enabled the user, developer, and trainer to collaborate by assimilating data digitally. The three disciplines have been involved in all facets of the BFV A3 and BATS acquisition to ensure that the solution satisfies the required capabilities now, instead of waiting until fielding. This saves time and money and improves military worth.

3.1 User Testing

The BATS was developed to familiarize the user and support the BFV A3 milestone tests. Because of the time that was saved by using the SCOE over simulation, the BATS was available concurrently with the scheduled LUT test. The Bradley program had the advantage of using the BATS to train the users prior to conducting LUT and was further able to provide trained crews for the Synthetic Environment Live Fire (SELF) tests which were conducted after the completion of crew familiarization and gunnery training.

3.1.1 Limited User Tests (LUTs)

The BATS' primary mission was to provide the initial A3 Bradley crew familiarization and gunnery training leading into the BFV A3 LUT. By utilizing the same software for the trainer functionality as was provided on the vehicle, the user was capable of identifying potential problems that may be incurred as well as providing the contractor with early feedback to the system functionality. The actions further enhanced the crew's awareness of the vehicle's capabilities and performance and allowed the crews to better respond to the real world test.

3.2 Synthetic Environment Live Fire (SELF) Testing

In an effort to support the Department of Defense's (DOD) five initiatives for using M&S in Test and Evaluation (T&E), the Synthetic Environment Live Fire (SELF) effort investigated supporting Live Fire Testing (LFT) using a synthetic environment (SE). SELF explored different M&S methodologies applicable to LFT. The near term purpose of the SELF program was to establish a SE capable of replicating BFV A3 live fire tests to generate data comparable to the live fire data. This comparison will be used in assessing the capabilities of the SE to augment test data. The long-term goals of the program include:

1.) Establishing a reusable and reliable test architecture capable of supporting different platforms throughout the acquisition cycle,
2.) Examining the utility of supporting live fire testing in the SE, and
3.) Documenting recommendations for designing and evaluating live fire SE test methodologies.

SELF provided a tool suite capable of augmenting existing T&E methodologies while capitalizing on an existing training device representative of the Vehicle Under Test (VUT).

3.2.1 Bradley SELF LUT-1 Overview

The SELF team successfully completed SELF Bradley A3 LUT-1 in November 1997, at Fort Benning, Georgia. The Bradley A3 SELF LUT-1 was the first in a series of three tests to be conducted in parallel to Bradley A3 milestone Operational Tests. LUT-1 was conducted on the BATS, prior to the actual LUT-1 gunnery exercises. The SELF LUT-1 replicated the gunnery exercises planned for the BFV A3 LUT-1 performed in December 1997. Data was collected to satisfy twenty Measures of Performance (MOPs) that focused on the ability of the BFV A3 to perform target acquisition and munition delivery accuracy.

3.2.2 Bradley SELF LUT-2 Overview

The SELF team completed SELF LUT-2 in September 1998. This was the second in the series of three tests that were conducted in parallel to Bradley A3 milestone tests. LUT-2 was executed on the BATS, at Fort Hood, Texas. The SELF LUT-2 replicated the Table VIII gunnery exercises planned for the BFV A3 LUT-2 performed in October 1998.

3.2.3 SELF Results

The BATS infrastructure was modified to demonstrate its capability to support gunnery testing. The data reliability was excellent with little to no failure incident. The SELF tests also showed that the BFV A3 crews practiced test scenarios and enhanced their skills prior to the actual test events. Additionally, SELF data was collected more efficiently than in the actual test.

The SELF program reaffirms that the BATS (and other gunnery training devices) can provide gunnery training to crews as well as test support to the T&E community prior to a milestone test. It was demonstrated that the SELF infrastructure can provide target acquisition and hit probabilities similar to live fire test results. The training infrastructure can be used to aid in LFT by practicing the live fire test scenario, pre-testing the live fire exercise, and executing the LFT to collect and analyze data. With this additional test support, an enhanced testing process with more robust data can be performed and obtained.

The implications of the results of the SELF LUT-2 tests are significant to the training community. Training devices have the capability of greatly increasing the accuracy, efficiency, and capability of real world range testing, including collection and analysis of live range data. In addition, the use of training devices that allow use of tactical hardware and software, such as the BATS, enables the T&E of weapon system enhancements prior to their introduction into fielded weapon systems, making the training environment an integral part of the weapon system development process.

The third phase of SELF testing is planned for 1999 in support of the BFVS A3 IOT&E.

4. FUTURE

The BATS program is in the planning stages for a phase IV development. Phases I-III were provided for LUT I & II, and IOT&E support as well as familiarization and gunnery training. LUT II provided a basic Proof Of Principle (POP) for interoperability with the Army's Close Combat Tactical Trainer (CCTT). The fourth phase will provide the BATS system as an A3 Bradley

Module immersed in the CCTT training system. The full functionality of a single multipurpose gunnery and maneuver training system will be demonstrated during this phase. PM Bradley, STRICOM, UDLP and the CCTT contractor, Lockheed Martin Information Systems (LMIS), have been coordinating the necessary requirements to perform this final phase effort. Testing is scheduled for the first and second quarters of fiscal year 2000. Successful results will pave the way for additional weapon systems programs to apply the SMART methodology by providing an even more enhanced synthetic environment.

5. IMPLICATIONS

SMART provides the Army with a highly effective engineering and management process for weapon system development and acquisition. From the initial idea to shared characteristic and performance simulation models, to the development of high fidelity simulators, to testing, to rapid prototyping, to initial production, SMART effectively puts better quality systems in the field faster than previous acquisition methodologies. But, the Army must aggressively manage the SMART process in order to prevent unfair competition. The SMART process, based upon sharing of simulation models and other system data, is contrary to proprietary relationships that industry currently practices. The path forward for the acquisition of weapon systems is clear, but requires fair management to protect the luxury of full and open competition.

6. CONCLUSION

The Acquisition Community cannot afford multiple, duplicative simulation development efforts. With the critical importance of interoperability on today's battlefield, we must demonstrate that our systems are effective and capable of operating on an integrated Combined Arms battlefield. The Army's common synthetic environment provides a growing capability that can be reused, saving scarce resources, and to the benefit of all.

SBA and SMART are strategies for change, deliberately intended to satisfy three goals:

1.) Reduces acquisition time, resources with emphasis on total ownership costs, and risk.
2.) Increases quality, military worth, and supportability of fielded systems.
3.) Enables IPPD across the entire acquisition life cycle.

There are difficult cultural, technical procedural challenges to implementing these methodologies. The Army doesn't have to wait until all the challenges are solved to start implementing those parts where value can be extracted.

The implementation of these methodologies and principles has been possible for the BFV A3 program as a result of a collaborative effort between different functional U.S. Army disciplines and industry. The development and accomplishments of the Bradley Advanced Training System proves the efficiency and economics of applying Simulation and Modeling for Acquisition, Requirements and Training to the development of weapon systems and their training devices by mitigating risk to program cost, schedule and performance requirements. The ultimate result is a highly trained soldier with state of the art weapon systems. For Additional information, please contact either of the following:

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