

The Virtual Employment Test Bed: An immersive synthetic environment allows engineers to test and evaluate material solutions

Robert DeMarco, MSBME; Gordon Cooke, MEME; John Riedener, MSSE.; Elizabeth Mezzacappa, PhD

U.S. Army - Target Behavioral Response Laboratory
Research, Development and Engineering Command
Armament Research, Development and Engineering Command
Quality Engineering and System Assurance Sciences Division
Picatinny Arsenal, NJ 07806
973-724-9175
robert.m.demarco.civ@mail.mil

Keywords:

Virtual, Simulator, Immersive, Behavioral Science, Human Performance, Measurement and Automation

ABSTRACT: *The Virtual Employment Test bed (VETB) allows engineers to test and evaluate material solutions in a realistic combination live/virtual environment, as well as the associated user performance characteristics. This program brings together current, state-of-the-art, ARDEC capabilities to form a user performance evaluation test bed where ARDEC designs will be evaluated under operational scenarios at any point in the system lifecycle.*

1. Introduction

There is always a desire to gather user test data early in the product development life cycle in order to avoid the larger costs of changing a design later. The DoD has encouraged the use of modeling and simulation as a way of achieving early insight to the capabilities or improvements of a new design.

The Virtual Employment Test bed (VETB) allows engineers to test and evaluate material solutions in a realistic combination live/virtual environment, as well as the associated user performance characteristics. This program brings together three current, state-of-the-art, ARDEC capabilities to form a user performance evaluation test bed where ARDEC designs will be evaluated under operational scenarios at any point in the system lifecycle.

2. Live Virtual Constructive Testing at the Target Behavioral Response Laboratory

Since its inception in 2004, the Target Behavioral Response Laboratory (TBRL) at Picatinny Arsenal has conducted comprehensive Live-Virtual-Constructive (LVC) studies under controlled laboratory experimentation. Construction of the live experiments is grounded in behavioral science. Human behavioral science requires close attention to the critical issues inherent in human experimentation, such as internal and external validity, experimental controls, subject

selection and protection issues, and statistical power (Cooper 2012).

Behavioral scientists strive to configure the laboratory situation to systematically manipulate and capture the most relevant and fundamental factors determining behavior of the subjects. This task involves constructive simulations of the external environment of physical structures and spaces.

To create an operational environment, the capabilities of the Gaming & Interactive Technologies Multimedia (GITM) group were used to fashion an immersive synthetic environment. This environment is used to create scenarios that test a design with respect to the users' requirements.

3. The Virtual Employment Test Bed

The Virtual Employment Test Bed (VETB) provides a 180 degree wrap around environment where any ARDEC (and PM) system can be evaluated. VETB provides engineer and user jury feedback, in an operational environment to capture more realistic performance measurements. Once users have completed an exercise, their performance data, such as accuracy and reaction time, will be immediately available. System adjustments can be made and tests rerun rapidly. The VETB offers flexibility and can be altered for specific systems if necessary.

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 03 APR 2014		2. REPORT TYPE Conference Proceedings Article		3. DATES COVERED 00-00-2012 to 00-00-2014	
4. TITLE AND SUBTITLE The Virtual Employment Test Bed: An immersive synthetic environment allows engineers to test and evaluate material solutions Excerpted from the Proceedings of the 23rd Annual Behavior Representation in Modeling & Simulation (BRIMS) Conference, April 1-4, 2014, Washington, DC				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Robert DeMarco; Gordon Cooke; John Riedener; Elizabeth Mezzacappa				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Army, ARDEC, Target Behavioral Response Laboratory, RDAR-EIQ-SD, Building 3518, Picatinny Arsenal, NJ, 07806-5000				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT The Virtual Employment Test bed (VETB) allows engineers to test and evaluate material solutions in a realistic combination live/virtual environment, as well as the associated user performance characteristics. This program brings together current, state-of-the-art, ARDEC capabilities to form a user performance evaluation test bed where ARDEC designs will be evaluated under operational scenarios at any point in the system lifecycle.					
15. SUBJECT TERMS Virtual, Simulator, Immersive, Behavioral Science, Human Performance, Measurement and Automation, Target Behavioral Response Laboratory					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Public Release	18. NUMBER OF PAGES 4	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

4. Virtual Adversaries

While the typical first person shoot simulations are usually used for training, the TBRL utilizes virtual adversaries to conduct testing of the design and function of equipment. The VETB is an integration of several systems that creates a full scale targeting measurement system. The VETB is configured for data collection, including video recording equipment and motion capture cameras and sensors on guns to record trigger pulls. The test bed also includes computer control systems, video recording, motion capture (MOCAP) (Figure 4.1), audio/visual equipment, and flexible integration of stimulus devices; x, y, z location coordinates are captured in real time. This real time information allows the TBRL to test system characteristics. These methods also allow the TBRL to test the impact of platform characteristics on weapon effectiveness, for example slew rate, speed of targeting, rate of fire, etc. This capability is most useful in examining the parameters determining the effectiveness of weapons fire.

In the current configuration of the test bed and experimental design, the adversary placement is designed to evaluate the impact of changes to the Gunner Protection Kit (GPK) on targeting for convoy protection (Figure 4.1). The test bed consists of a wrap around screen that displays an immersive game simulation (Figure 4.3). Subjects are placed in the GPK; both person and gun are outfitted with motion capture sensors (Figure 4.4). Paintball guns fire at the subject from angles that correspond to the adversary fire displayed on the screen. The adversaries are positioned onscreen so that the subject will be required to swing the gun through a spectrum of angles and speeds in order to accurately aim at adversaries in the simulation. The set-up is instrumented to record time to acquire target, time to get gun on target, accuracy of aim, number of bullets expended, latency to fire, and time to acquire next target. The combination of live subjects operating a real GPK and a 50-caliber gun shooting air bullets against Virtual Adversaries allows testing of the full range of targeting functions and weapon performance.

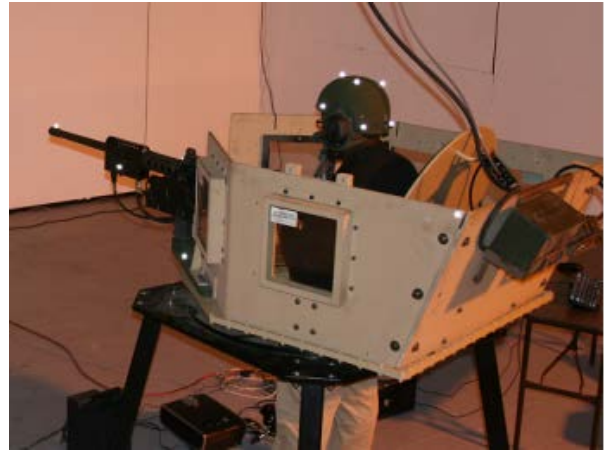


Figure 4.1: The Virtual Employment Test Bed with the GPK. The glowing spheres allow motion capture of subject and gun movement by the cameras mounted on the tops of the wall.

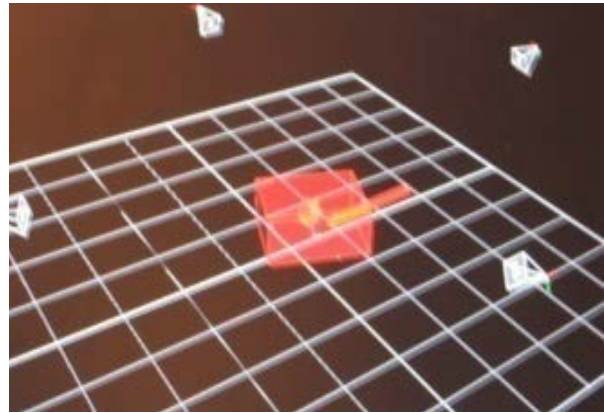


Figure 4.2: Motion capture coordinates.

5. VETB and Decision Support

The VETB experiment is constructed to allow TBRL to collect data that is analyzable—including experimental control over conditions, same comparable conditions, repeated measures, number of subjects with sufficient statistical power, and comparison baseline conditions. The LVC data collected allow for statistical analyses and data-based decisions for acquisition, training, doctrine, and commander decisions. Standard benchmarks can be created and alternative options can be compared using numbers and statistics. These quantitative analyses can then serve as a basis for support for decisions across DoD. The production of quantitative data for appropriate decision-making is the greatest benefit for the use of LVC methods for testing. The VETB data also can be used in developing decision support modeling and simulation tools (Mezzacappa, et al, 2012; Riedener & Mezzacappa, 2012).

UNCLASSIFIED



Figure 4.3 The Virtual Employment Test Bed with the GPK. Subjects target adversaries displayed on video projections upon the wrap around screens. Trigger pulls and aim on the screen are recorded. Live fire paintball guns are mounted on top of the walls. Picture by Todd Mozes.

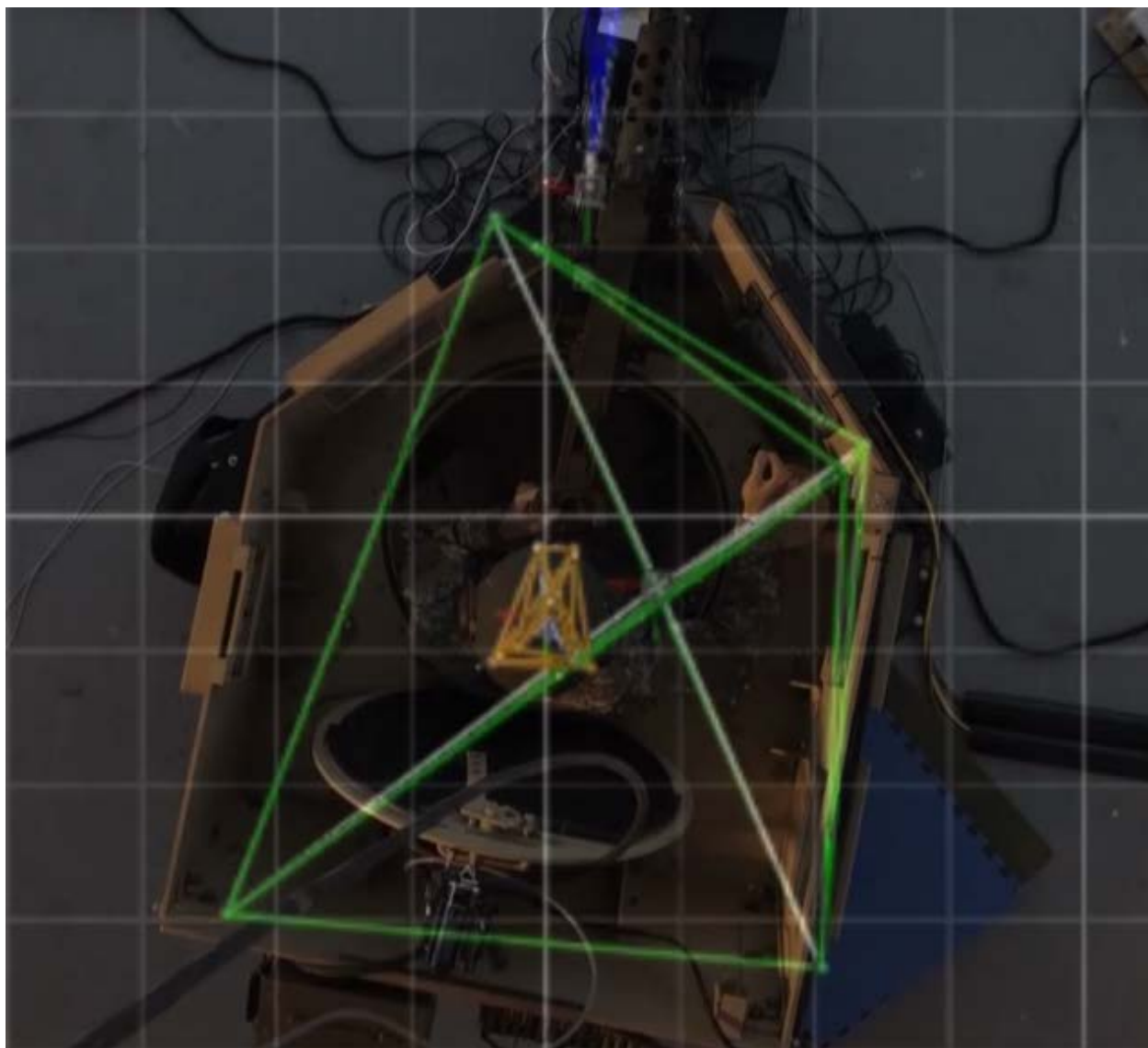


Figure 4.4: Motion capture coordinates overlaid over a video recording of a gunner in the GPK.

UNCLASSIFIED

6. References

- Cooper, H. (2012). APA Handbook of Research Methods in Psychology. Washington, DC: American Psychological Association.
- Mezzacappa, E.; Cooke, G.; Reid, G.; DeMarco, R.; Sheridan, C.; Riedener, J. (2012). Data-Driven Modeling of Target Human Behavior in Military Operations. Proceedings of the 21st annual Behavior Representation in Modeling & Simulation (BRIMS) Conference, March 12-15, 2012, Amelia Island, FL.
- Riedener, J.; Mezzacappa, E. (2012). Data-Driven Modeling of Human Behavior in Military Operations. Proceedings of the 21st annual Behavior Representation in Modeling & Simulation (BRIMS) Conference, March 12-15, 2012, Amelia Island, FL.

Author Biographies

ROBERT DEMARCO, MSBME, is a Project Lead Engineer and Certified LabVIEW Associate Developer.

GORDON COOKE, MEME, is a Principal Investigator at the TBRL. He was also a Chief Engineer, USMA, 11th Armored Cavalry Regiment stationed at the National Training Center, Fort Irwin, CA and served a one-year tour in Mosul, Iraq as the Deputy Division Plans Officer for Multi-Nation Division North-West.

JOHN RIEDENER, MSSE, is the Technical Director of the TBRL. He is a Certified Lean/Six Sigma Black belt with a focus on Design of Experiments and Statistical Analysis of Test Results.

ELIZABETH MEZZACAPPA, PhD, is a Principal Investigator at the TBRL with expertise in social psychology, stress, and human behavior modeling and simulation issues.