U.S. Army Armament Research, Development and Engineering Center

THE SQUAD PERFORMANCE TEST BED

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Distribution Statement A - Approved for Public Release
ARDEC, the parent organization of the Target Behavioral Response Laboratory seeks to provide devices to improve Squad lethality, survivability, and mobility, in order to improve Squad-level function. It is well recognized that these three functions can be mutually exclusive in that devices that increase lethality may also decrease survivability (alternatively situational awareness) or decrease mobility. However, there exists no method to conduct critical trade-off analyses of candidate solutions to optimize Squad level performance. The Squad Performance Test Bed consists of both an outdoor and indoor test bed. The outdoor Squad Performance Test Bed consists of a large geographic area that will be instrumented to capture behaviors of collectives (Fire Teams, Squads, Platoons, etc) during outdoor Warfighter Battle Drills. The outdoor SPTB is approximately 700 x 500 meters, over hilly, grassy, and wooded terrain, including roads and a helipad. The outdoor test bed is configured for future data capture during the Battle Drill scenario React to Contact. In this scenario, the Squad receives enemy fire and must react (e.g., seek cover and return fire). The indoor SPTB is configured to simulate the environment appropriate to Close Quarters Battle (CQB) consisting of several rooms in order to conduct testing of the room entry and clearing scenarios. A reconfigurable room was built in order to conduct the task, Room Entry and Clearing. In this scenario, the Squad must come from outside the building, enter a room, shoot enemy found in the room, spare others, and move through other rooms in the same way, without being killed. At this point in time, both the outdoor and indoor Squad Performance Test Beds have undergone preliminary building and testing, under the supervision of Subject Matter Experts in Soldier training. When completed and tested, the Squad Performance Test Bed will give ARDEC and others a unique capability for testing and evaluating materiel and personnel solutions in order to enhance Squad lethality, survivability, and mobility.
15. SUBJECT TERMS
- Squad
- Human Test Facility
- Indoor Test bed
- Outdoor Test bed
- Testing and Evaluation
- Soldier Performance
- Motion Capture
- Behavioral Coding
- Close Quarters Combat
- React to Contact

16. SECURITY CLASSIFICATION OF:

<table>
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<tr>
<th>a. REPORT</th>
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17. LIMITATION OF ABSTRACT

Public Release

18. NUMBER OF PAGES

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19a. NAME OF RESPONSIBLE PERSON

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Overview

• Introduction
  – ARDEC
  – Performance Evaluation at TBRL
• The SQUAD Performance Test Bed
  – Environment
  – Instrumentation
• Measuring Performance
  – Behavior Coding Process
  – Behavior Codebook
  – Behavior Analysis
• Summary
• Conclusions
Advanced Weapons:
Line of sight/beyond line of sight fire; non line of sight fire; scalable effects; non-lethal; directed energy; autonomous weapons

Ammunition:
Small, medium, large caliber; propellants; explosives; pyrotechnics; warheads; insensitive munitions; logistics; packaging; fuzes; environmental technologies and explosive ordnance disposal

Fire Control:
Battlefield digitization; embedded system software; aero ballistics and telemetry

ARDEC provides the technology for over 90% of the Army’s lethality and a significant amount of support for other services’ lethality
Introduction

**Military Need for Squad Performance Evaluation**

- ARDEC seeks to improve Soldier/Squad; lethality, survivability, and mobility
- Trade-off analysis are necessary to produce the most effective Soldier
- Group-level metrics are desired to measure squad performance
- Materiel evaluation will help to achieve optimum squad performance
Introduction

Performance Evaluation at TBRL

• Performance of individual Soldiers using ARDEC systems

• Performance of Non-Lethal Weapons against targets
Goals for Squad Performance Test Bed (SPTB)

- Operationally relevant metrics for squad and individual Soldiers
  - Measures of Effectiveness (MoE)
  - Measures of Performance (MoP)
- Incorporate metrics and measures into modeling and simulation
- Human factors that impact candidate materiel solutions
- Squad-level behavioral response to candidate materiel
- Paradigm to test, record, and assess effects of psychosocial variables in personnel
  - Situational Awareness
  - Leadership
  - Training
  - Cohesiveness
The Squad Performance Test Bed

Outdoor SPTB - Environment

- 700 x 500 meters over hilly, grassy, and wooded terrain
- Configured for React to Contact Battle Drill scenario
- Instrumented to capture behaviors of collective teams
- Location tracking
- Battlefield effects simulation
The Squad Performance Test Bed

**Outdoor SPTB - Instrumentation**

- **Location Tracking System**
  - Ubisense Real-Time Location Tracking System (RTLS)
    - Ubisense Series 7000 sensors & tags
    - Tags worn by team members as the maneuver test bed
    - Computer system
      - Displays & 2-D or 3-D graphs of Soldiers path as traveled
      - Records X,Y,Z coordinates of each Soldier
The Squad Performance Test Bed

Outdoor SPTB - Instrumentation

• **Video recording systems**
  - IP cameras & computer system
    - Display & record Soldiers within the test bed
  - Personal worn cameras
    - Record communicable behaviors & first person perspective

• **Battlefield effect simulation**
  - Machine-gun enemy fire simulated using pyrotechnics
    - COPAS Micro Pyro System
  - Controller Unit, Launcher, and Pyrotechnic rounds
The Squad Performance Test Bed

Outdoor SPTB - Instrumentation

- **Weapon system & rounds simulation**
  - Real weight replicas of squad hand-carried weapons
  - Airsoft Automatic Electric Guns (AEG)
- **LabVIEW software**
  - Triggering & recording events
    - Synchronize target presentation
    - Synchronize battlefield effects
    - Shooter performance
The Squad Performance Test Bed

Indoor SPTB - Environment

- Flash-bang range, two rooms and a courtyard for room entry scenarios
- Simulate Close Quarters Battle (CQB)
- Modular room to test right, left, and center fed rooms
- Motion capture technology
The Squad Performance Test Bed

**Indoor SPTB - Instrumentation**

- **Motion capture system**
  - Uniquely configured Retro-reflective markers
  - Vicon MoCap cameras
  - Computer system that displays and records Soldier location data with 6 degree of freedom
**Indoor SPTB - Instrumentation**

- Video recording systems
  - IP camera system
  - Personal worn cameras
- Weapon system & rounds simulation
  - Airsoft AEG weapons
- LabVIEW software
  - Triggering & recording events
    - Synchronized target presentation
    - Shooter performance
Capturing behaviors of interest

- Noldus Observer XT 11.5 behavior coding
- Behavior codebook
- Import multi-camera views
- Code behaviors of interest
- Perform analysis
Measuring Performance

SPTB – Behavior Codebook

• Deriving behaviors of interest
  – Gain understanding of most relevant behaviors
    • Interviews with Soldier trainers
    • Examining training doctrine of battle drills
    • Group list of behaviors in categories
    • Subject matter expert confirmation
SPTB – Behavioral Coding

• Example behaviors of interest
  – Response to simulated attack of enemy forces
    • Locomotive behaviors
      – Formation during cover & advancement
      – Distance between Soldiers
    • Communicable behaviors
    • Use of force
  – Room entry & clearing
    • Locomotive behaviors
      – Movement to designated area of rooms
      – Movement in side and center fed doorways
    • Communicable behaviors
    • Interaction with hostile and non-hostile targets
    • Use of force
Measuring Performance

Behavior Coding Process – Video Synchronization
Behavior Coding Process – Event Log

• Recording behaviors of interest
  – Event Log tracks all coded behavior on a timeline table
  – Visualization graph displays behavior coded per category

Use the Event Logs to get more detail about the Visualizations. Match the “Relative Time” of the start of the behavior box to the “Time Point” on the Event Log.
Measuring Performance

Behavioral Analysis Example

• Analyzing behaviors of interest
  – Team analysis focusing on Communication, Muzzle Discipline and Weapon Usage
  – Produce timeline visualization of behaviors
  – Descriptive statistics with plots or results
  – Export data for qualitative analysis
• Similar testing conducted with police teams show successful development and evaluation of MoP using location tracking system, video recording systems, and behavioral coding techniques

• Preliminary testing at the TBRL SPTB allowed assessment of the development and testing process which led to refinement of the test bed design plans

• Lessons learned from preliminary testing and police testing are being incorporated in the SPTB test plan

• Future plans include completion and full testing of the SPTB

• Upon completion of the SPTB, ARDEC and other groups will be able to evaluate MoP & MoE for individual Soldiers and squads
✓ Preliminary building and testing of indoor and outdoor test bed to compare performance of Soldiers and squads
  ✓ Determine location tracking system sensor configuration
  ✓ Test video recording systems
  ✓ Acquire materials and gear for soldier testing
  ✓ Acquired safety and environmental approvals

✓ Evaluation of team and individual behaviors using codebook
  ✓ Development of a behavioral codebook for battle teams
  ✓ Behavior coding of teams and individuals
  ✓ Behavior analysis of teams and individuals

• Test and evaluate change in performance with and without candidate materiel solutions to enhance squad lethality, survivability, and mobility
References

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4. http://www.bing.com/maps/#Y3A9NDAuOTM3MzAyfi03NC41ODM2MDMmbHZsPTQmc3R5PXImcT1QaWNhdGlubnkIMjBBcnNlbmFsJTJDJTlwTmV3JTlwSmVyc2V5JTJDJTlwVW5pdGVkJTIwU3RhdGVz. 01/31/2013
5. http://www.airsoftatlanta.com. 05/05/2014
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• Virtual Employment Test Bed: Operational Research and Systems Analysis to Test Armaments Designs Early in the Life Cycle
• Method and Process for the Creation of modeling and Simulation Tools for Human Crowd Behavior
• Squad Modeling and Simulation for Analysis of Materiel and Personnel Solutions
• The Squad Performance Test Bed
• Crowd Characteristics and Management with Non-Lethal Weapons: A Soldier Survey
• Effectiveness Testing and Evaluation of Non-lethal Weapons for Crowd Management
• Effects of Control Force Number, Threat, And Weapon Type on Crowd Behavior
Questions?

US Army - Target Behavioral Response Lab

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BACKUP SLIDES
Team Frequency Plot

Behavior Directed Toward:
- Dispatch
- Injured Victim
- Other Officer
- Perpetrator
- Student/Staff
- Team Member
- Unknown/Unidentified
- Weapon
- Whole Team

Number of Times Behavior was Performed

Where Behavior was Performed
Individual Frequency Plot

Behavior Directed Toward:
- Dispatch
- Injured Victim
- Other Officer
- Perpetrator
- Student/Staff
- Team Member
- Unknown/Unidentified
- Weapon
- Whole Team
Individual Duration Plot

Behavior Directed Toward:
- Dispatch
- Injured Victim
- Other Officer
- Perpetrator
- Student/Staff
- Team Member
- Unknown/Unidentified
- Weapon
- Whole Team
## Behavior Summary Table

<table>
<thead>
<tr>
<th>Officers</th>
<th>Observations</th>
<th>Behaviors</th>
<th>Modifiers</th>
<th>Duration (s)</th>
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