

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



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

THE SQUAD PERFORMANCE TEST BED

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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

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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





Headquarters, Department of the Army





ARDEC's Role













RESEARCH

DEVELOPMENT

PRODUCTION

FIELD SUPPORT

DEMILITARIZATION

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







Performance Evaluation at TBRL



• Performance of individual Soldiers using ARDEC systems



• Performance of Non-Lethal Weapons against targets





- 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





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





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









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





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





- 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









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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









• 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







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- Capturing behaviors of interest
 - Noldus Observer XT
 11.5 behavior coding
 - Behavior codebook
 - Import multicamera views
 - Code behaviors of interest
 - Perform analysis

| ding Scheme | | | | | | | | | | | | |
|------------------------------------|------|---|---------------------------------|-------|------|-------------|--|----------------------|-----------------------------|------------------|--------------------|-----------|
| Check 🗋 Settings | | | | | | | | | | | View S | ettings 👻 |
| x Add Subject | | Behaviors Add Behavior group Add Behavior | | | | | Modifiers Add Modifier group Add Modifier | | | | × | |
| | | | | | | | | | | er | | |
| bject Name | E SA | Behavior Name | | Start | Stop | Behavior | Modifiers | Mo | difier Name | | | 10 |
| Continuous Sampling | | 🖃 Communicate (Sta | rt-Stop) | | | | | | Rating Officer Evaluation | (Inactive) (Mut | ually exclusive, N | umeric, |
| Officer 1 | q | Talk out Loud | | L | L | State Event | Rating Officer Evaluation | | from -3 to 3 | | | |
| Officer 2 | w | Talk into Radio | | R | R | State Event | Rating Officer Evaluation | Ξ | Omitted Error Ratings | (Nominal, Option | al) | |
| Officer 3 | e | Using Hand Sign | als | н | н | State Event | Rating Officer Evaluation | - | Communication Omitted Error | | | с |
| Officer 4 | r | Muzzle Discipline | (Start-Stop) | | | | | Muzzle Omitted Error | | | | М |
| Officer 5 | a | Pointing Muzzle | at another | М | М | State Event | Rating Officer Evaluation | 1 | Shooting Omitted Error | | | s |
| Officer 6 | s | walking in Front | of a muzzle | W | w | State Event | Rating Officer Evaluation | | Other Omitted Error | | | 0 |
| Officer 7 | d | 😑 Weapon Usage (S | tart-Stop) | | | | | Ξ | Target (Nominal, Optio | nal) | | |
| Officer 8 | f | Firing a Weapon | | F | | Point Event | Rating Officer Evaluation | | Team Member | | | T |
| Officer 9 | z | Generic Presence | (Mutually exclusive) | | | | | - | Student/Staff | | | t |
| Officer 10 | x | Present | | P | Ρ | State Event | <click add="" here="" modifi<="" td="" to=""><td>1</td><td>Injured Victim</td><td></td><td></td><td>I</td></click> | 1 | Injured Victim | | | I |
| Officer 11 (Inactive) | c | Absent | | A | A | State Event | < Click here to add Modifi | | Perpetrator | | | Ρ |
| Officer 12 (Inactive) | V | 😑 Generic Locomotion | Generic Locomotion (Start-Stop) | | | | | Hostage | | | | н |
| Officer 13 (Inactive) | g | Go Toward | | G | G | State Event | Officer Target | | Dispatch | | | D |
| Officer 14 (Inactive) | h | Disperse | | D | D | State Event | Officer Target | | Whole Team | | | W |
| Officer 15 (Inactive) | j | Behavior of Note (Start-Stop) | | | | | Unknown/Unidentified | | | | U | |
| Officer 16 (Inactive) | k | Notes | | N | Ν | State Event | Rating Officer Evaluation | | Other Officer | | | h |
| Officer 17 (Inactive) | b | Errors of Omission | (Start-Stop) | | | | | Ŧ | Officer Target (Nomina | l, Optional) | | |
| Officer 18 (Inactive) | n | Omission | | 0 | 0 | State Event | Omitted Error Ratings | - | | | | |
| Officer 19 (Inactive) | m | Shot Received (M | utually exclusive, Exhaustive | e) | | | | | | | | |
| Officer 20 (Inactive) | | Unharmed | | U | | Initial Sta | <click add="" here="" modifi<="" td="" to=""><td>1</td><td></td><td></td><td></td><td></td></click> | 1 | | | | |
| Unknown/Unidentified Officer | 0 | Shot | | S | | State Event | < Click here to add Modifi | | | | | |
| Team as a whole | 1 | | | | | | | 1 | | | | |
| Radio Dispatch | 2 | | | | | | | | | | | |
| Generic Staff/Student | 3 | 1 | | | | | | | | | | |
| Generic Injured Victim | 4 | | | | | | | | | | | |
| Generic Deceased (non-perpetrator) | 5 | | | | | | | | | | | |
| Generic Perpetrator | 6 - | | | | | | | | | | | |







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



Behavior Coding Process – Video Synchronization





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







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







Summary

- 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



Conclusion

- ✓ Preliminary building and testing of indoor and outdoor test bed to compare performance of Soldiers and squads
 - \checkmark Determine location tracking system sensor configuration
 - \checkmark Test video recording systems
 - \checkmark Acquire materials and gear for soldier testing
 - \checkmark Acquired safety and environmental approvals
- \checkmark Evaluation of team and individual behaviors using codebook
 - \checkmark Development of a behavioral codebook for battle teams
 - \checkmark Behavior coding of teams and individuals
 - \checkmark 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





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- 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



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Individual Frequency Plot



Behavior Directed Toward: 6





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Individual Duration Plot









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