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# SIMULATED MARKSMANSHIP PERFORMANCE METHODOLOGY: ASSESSING LETHALITY, MOBILITY AND STABILITY ACROSS THE PREPARATION, EXECUTION AND RECOVERY STAGES OF A MILITARY FIELD TRAINING EXERCISE

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Marksmanship, a key cornerstone of military training, is one area of military assessment that includes standardized quantifiable measures. However, assessment of marksmanship in a traditional live-fire setting can be costly, time consuming, and dangerous, while frequently only providing rudimentary objective measures of performance. This research created an enhanced combined marksmanship assessment methodology, which builds on earlier static and dynamic methodologies. The successful portions of previous methods, to include static and dynamic shooting with acquisition assessments, were integrated and additional pertinent assessment areas were added (i.e., targets of varying height and increased distance to force gross movements in transitions across engagements), while minimizing execution time and still using a mobile, low-cost weapon simulator. This methodology is executable in any setting, is easy to assemble, provides streamlined metrics on the entire marksmanship process across two critical shooting styles, and can track changes in marksmanship across various performance periods throughout a training cycle.

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# Simulated Marksmanship Performance Methodology: Assessing Lethality, Mobility and Stability Across the Preparation, Execution and Recovery Stages of a Military Field Training Exercise

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**Abstract.** Marksmanship, a key cornerstone of military training, is one area of military assessment that includes standardized quantifiable measures. However, assessment of marksmanship in a traditional live-fire setting can be costly, time consuming, and dangerous, while frequently only providing rudimentary objective measures of performance. This research created an enhanced combined marksmanship assessment methodology, which builds on earlier static and dynamic methodologies. The successful portions of previous methods, to include static and dynamic shooting with acquisition assessments, were integrated and additional pertinent assessment areas were added (i.e., targets of varying height and increased distance to force gross movements in transitions across engagements), while minimizing execution time and still using a mobile, low-cost weapon simulator. This methodology is executable in any setting, is easy to assemble, provides streamlined metrics on the entire marksmanship process across two critical shooting styles, and can track changes in marksmanship across various performance periods throughout a training cycle.

**Keywords:** Human-systems integration · Human factors · Military · Marksmanship · Simulation and training · Test and evaluation · Lethality · Soldier performance · Soldier readiness

## 1 Introduction

Military training replicates operational tasks and missions at various levels in order to focus on skills required to maximize performance, minimize risk and increase probability of mission accomplishment. Marksmanship is one area of military assessment that includes standardized quantifiable measures. Shooting proficiency has been utilized for both training qualifications and assessment of military equipment [1–11].


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However, assessment of marksmanship in a traditional live-fire setting can be costly, time consuming, and dangerous, while frequently only providing rudimentary objective measures of performance such as count of shot hits, misses, and shot group dispersion [12]. Methodologies to assess marksmanship performance have recently been established using the Fabrique National (FN) American simulator systems (formerly Noptel Oy), but most of these methods focus on the effects of clothing and individual equipment (CIE) [13–18]. These methodologies provide a cost effective and efficient alternative to evaluate marksmanship performance, while still being operationally relevant, and allow for objective measures without the safety concerns and risks that are associated with live-fire. Other research has utilized similar simulator systems to assess Soldier performance in a marksmanship scenario while evaluating a variety of physical [19–22], physiological [23, 24], or psychological [25, 26] attributes and conditions in a lab-based setting. All of these systems are limited by their source of recoil (i.e., tethered to a compressed gas tank or power source), thus restricting the methodologies from being transferrable to the field setting. There is a need for a streamlined methodology that is easy to set up, evaluate, and can be utilized in the field where the Soldiers are training and fighting.

This current study was conducted to evaluate a refined marksmanship methodology that combines multiple shooting styles and target distances, and incorporates streamlined metrics that assess the entire marksmanship process in a scenario that can be executed in under five minutes. In addition, this methodology utilizes the FN Expert weapon simulator and a demilitarized M4 (although other weapons can be used), allowing it to be flexible and able to be set up in a field setting. This study assessed the methodology to see if it can detect performance changes over the course of a 72-hour field training exercise. This quick, combined methodology provides the benefit of mobile and dynamic marksmanship assessment in the middle of other active operational field performance tests without any delay or break in testing. Additionally, this enhanced methodology integrates a static self-paced shooting task with a dynamic fast-paced shooting task in order to capture both suppressive and combat shooting requirements in one scenario. This paper reports the initial findings, focusing on the overarching metrics of lethality, mobility, and stability across the all target engagements.

## 2 Methods

### 2.1 Study Participants

Study volunteers consisted of forty-six active duty Soldiers (primarily infantry). These participants were predominantly males (4 females) between the ages of 18 and 37 years ($M$ = 24.5, $SD$ = 4.2). There were five participants who were left-handed (11%), and five who wore glasses (11%). All were qualified "marksman" through the Army Basic Marksmanship qualification process using the M4 carbine. Three (6.5%) were classified as Marksmen (score of 23–29 out of 40 on the standard marksmanship test), three (6.5%) were Sharpshooters (score of 30–35), and the additional forty (87%) were Experts (score of 36+).

## 2.2 Test Apparatus

All testing utilized the FN Expert simulator and associated NOS pro software. The system's optical unit was mounted to the picatinny rail on the right side of the barrel of a de-militarized M4 carbine with an integrated carbon dioxide recoil simulation system manufactured by LaserShot, Inc. A M68 close combat optic (CCO) sighting system was also utilized in this testing scenario. This system was mounted on the picatinny rail section on top of the weapon receiver. The FN Expert optical unit was mechanically zeroed to the CCO, utilizing the standard procedures as laid out in the product manual [27].

Five paper ring targets with diamond graded reflector rings were used in this methodology, four scaled to 75-meters and one 150-meters when placed at an actual distance of 5-meters. These special targets reflect the infrared beam from the FN Expert optical unit, providing x, y coordinates for aiming points and shot locations to the NOS pro software via wireless Bluetooth. The targets were set up as depicted in Fig. 1 below. Pre- and post-mission testing occurred in an enclosed hanger bay facility. Mid-mission testing occurred outside in a level grassy field at the training exercise location.

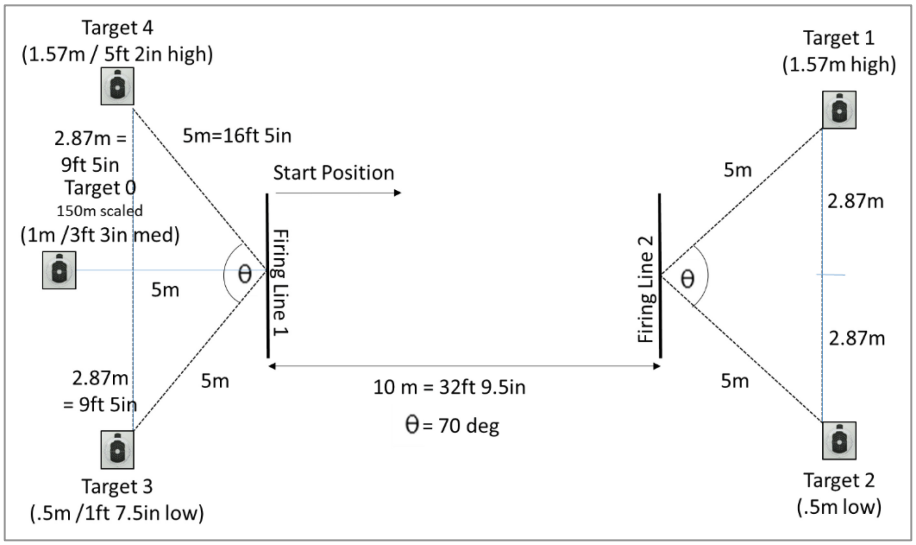


**Fig. 1.** Diagram of the combined static and dynamic marksmanship methodology layout, with distance and heights labeled for each target. Target 0 is 150-meter scaled, while targets 1–4 are 75-meter scaled.

## 2.3 Test Procedures

Marksmanship performance was assessed at three time points across a 2-week training period containing a 72-hour mission exercise (with multiple assessments at pre-, mid-, and post-mission exercise) utilizing traditional measures of lethality (e.g., accuracy).

Supplemental measures of mobility (e.g. acquisition and engagement time) and weapon handling (e.g., stability) were also collected in order to assess the entire marksmanship process of locating, moving, positioning, and engaging the targets.

At the beginning of each testing session, the weapon was mechanically zeroed by the data collector. This acted as gross adjustment and zeroing for the weapon sights, with minor zeroing adjustments for each individual made via the software. The individual software zeroing consisted of shooting 3 shots as accurately as possible at a target in the prone position. The simulator's associated software then moves the shot grouping to the center of the target, adjusting the subsequent shots during the scenario. This process simulates the zeroing process that would occur when using a live weapon and sighting system.

Next, the scenario begins with a static task of firing three series of five shots (15 shots total) at the 150-meter simulated distance target, with a priority on accuracy over speed. Upon completion of the third series of static shooting, the test participant is given a ten-second countdown to initiate part two. The second part of the scenario is a fast-paced dynamic task, requiring the participant to sprint 10-meters to a second firing line, engage two targets spread across a 70° arc with two sets of controlled pair shots (4 shots per target total) at a simulated distance of 75-meter at various heights. Upon completion of engagement, the participant must sprint back to the original firing line, and engage two more targets with the same shot requirements. Order of target engagement was based on the participant's dominant shooting side in order to ensure assessment of a weak-side transition (right handed individuals engage the left target first and move to the right, and left handed individuals engage the right target first and move to the left). Upon completion of the first set, the participant is given a 60 s recovery period and the entire combined scenario is then repeated in a different firing position as randomly assigned (i.e., unsupported standing or unsupported prone). The required table of fires is shown in Table 1 below. Figure 1 shows a diagram of the target placement and heights. This combination of tasks not only quantifies marksmanship performance across the entire marksmanship process from acquisition to engagement and transition, it can also focus in on additional skills such as low to high and high to low transitions.

**Table 1.** Table of fires for combined marksmanship methodology

| Trial no. | | Scenario section | Firing position[a] | No. of trials | No. shots/trial | Total no. shots |
|---|---|---|---|---|---|---|
| I | A. | One target | Standing unsupported | 3 | 5 | 15 |
| | B. | Four targets | Standing unsupported | 1 | 16 | 16 |
| II | A. | One target | Prone unsupported | 3 | 5 | 15 |
| | B. | Four targets | Prone unsupported | 1 | 16 | 16 |

[a]Order of firing position randomized across trial

## 2.4 Measures of Marksmanship Performances

**Lethality.** Shooting lethality was measured utilizing the shot accuracy, or the distance of a single shot to the target center. This is calculated using the Euclidian distance in millimeters of the shot to the bull's eye, or center of mass of the target [28] as seen in Fig. 2.

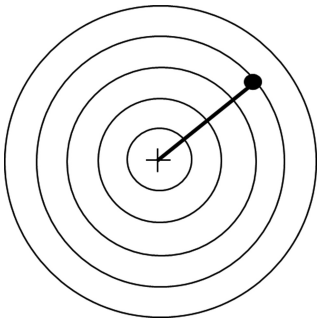

**Fig. 2.** Visual image of shooting accuracy, or distance from shot to the center of the target.

**Mobility.** The marksmanship process includes threat detection, movement, positioning, sighting, aiming, and engagement. The mobility metric utilized here includes the target acquisition (i.e., move, detect, position) and target engagement (i.e., aim, shoot, adjust, shoot, etc.) as depicted in Fig. 3.

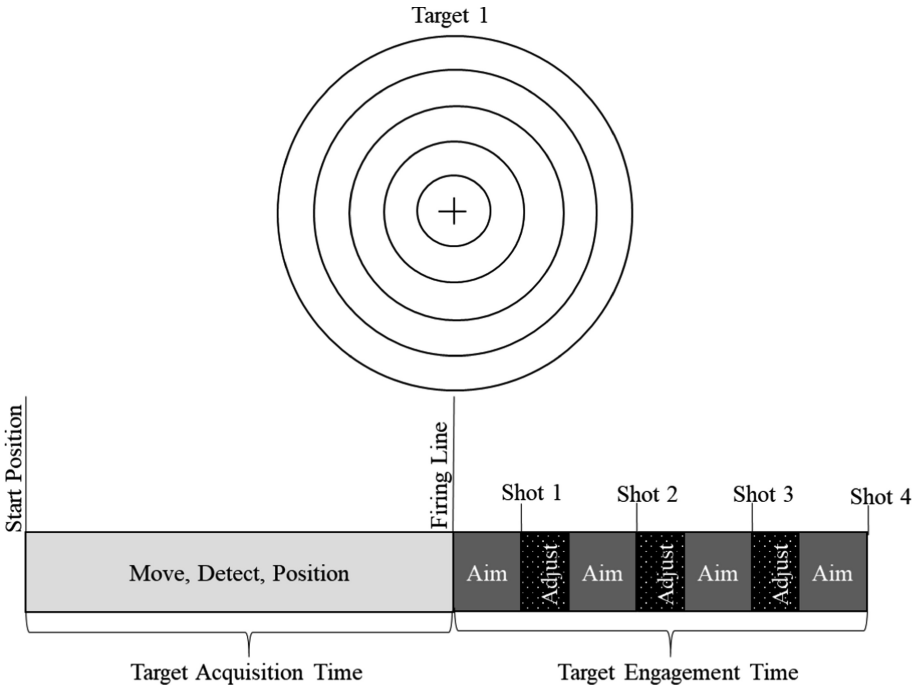


**Fig. 3.** Visual representation of target acquisition (i.e., move, detect, position) and target engagement (i.e., aim, shoot, adjust, aim, shoot, etc.) measurements per target.

**Stability.** Weapon handling and barrel stability describes the aiming and degree of movement prior to shot execution. The FN Expert software records aim trace data points every .15 s prior to shot (up to 2.99 s). Stability is measured here as the area of aiming during the critical aiming window, or the last .60 s to .20 s prior to shot [17], as depicted in Fig. 4.

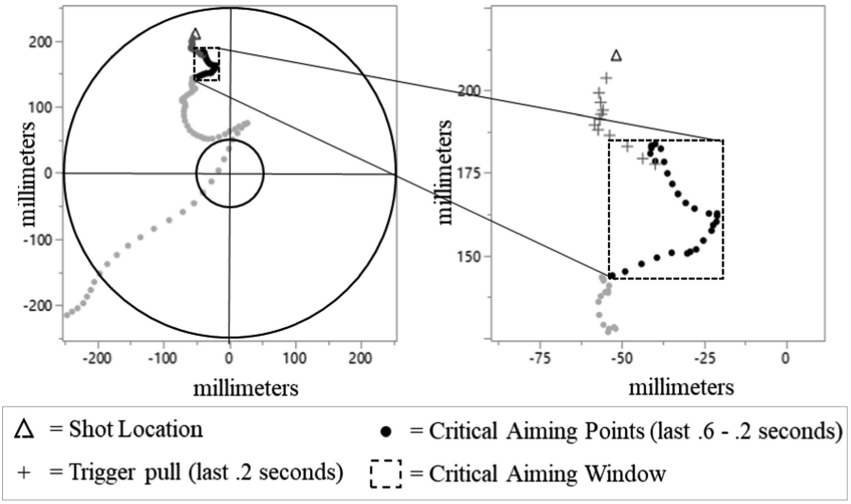


**Fig. 4.** Visual image of overall stability, as measured by the area of movement within the critical aiming window (last .6 to .2 s of aiming prior to engagement)

### 2.5 Data Analysis

The study used a repeated measures experimental design across a 72-h training mission (pre-, mid-, and post-) with counterbalancing to control for order of firing position exposure (i.e., order effects). The statistical analyses were conducted to investigate mean shooting performance across the entire marksmanship process in the areas of lethality, mobility, and stability utilizing within-subjects repeated measures analysis of variance (ANOVAs). Tests of multiple comparisons were conducted using the Tukey Honestly Significant Differences (HSD). Confidence intervals were set at 95% (alpha = .05).

## 3 Results

Significant differences in marksmanship performance were seen across the three mission time points for the lethality, mobility, and stability measures. Lethality and mobility performance declined at mid-mission compared to pre-mission, but rebounded

at post-mission; whereas, stability measures degraded in the post-mission session. These differences indicate that the methodology is able to identify changes in marksmanship performance over time due to mission activities and recovery.

### 3.1 Lethality

Analysis of marksmanship lethality as measured by mean accuracy across all targets revealed a main effect of session, $F(2, 84.1) = 6.365$, $p = .003$. As seen in Fig. 5, the Soldiers had significantly greater shot accuracy during the pre- ($M = 916$ mm, $SD = 202$ mm) and post- ($M = 884$ mm, $SD = 210$ mm) mission test sessions as compared to the mid-mission session ($M = 1021$ mm, $SD = 328$ mm).

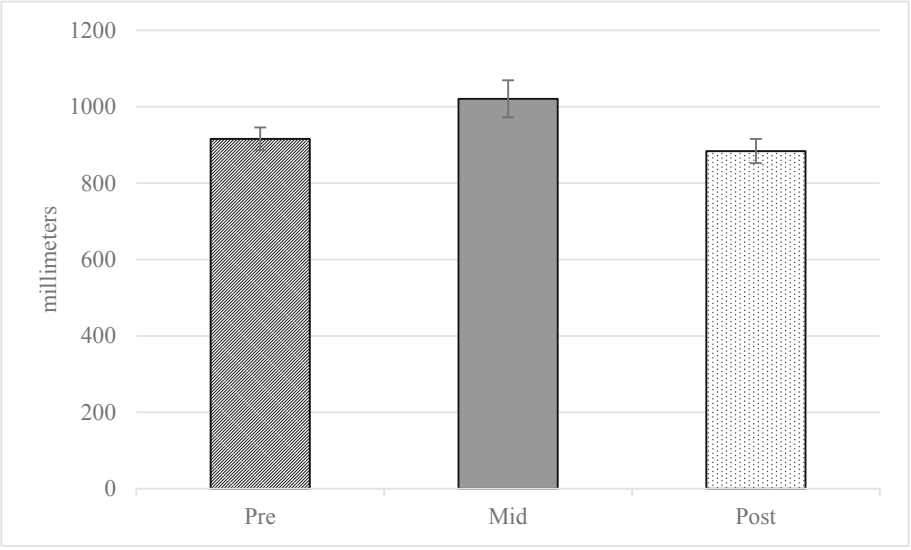


**Fig. 5.** Lethality as measured by shot accuracy across the pre-, mid-, and post-mission time points (error bars represent Standard Error).

### 3.2 Mobility

Analysis of mobility in the marksmanship process as measured by combined mean target acquisition and target engagement across all the targets revealed a main effect of session, $F(2, 85.11) = 3.59$, $p = .032$. As seen in Fig. 6, Soldiers took significantly less

time to acquire and engage the targets during the pre- ($M$ = 6.06 s, $SD$ = 1.27 s) and post- ($M$ = 6.01 s, $SD$ = 1.97 s) mission test sessions as compared to the mid-mission session ($M$ = 6.48 s, $SD$ = 1.32 s).

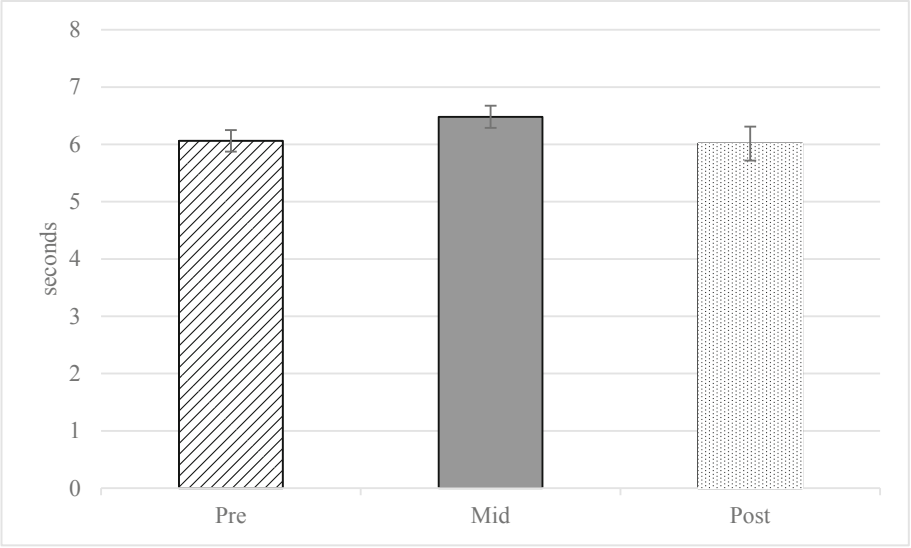


**Fig. 6.** Mobility, as measured by combined target acquisition time and target engagement time, across the pre-, mid-, and post-mission time points (error bars represent Standard Error).

### 3.3 Stability

Analysis of weapon handling stability in the marksmanship process as measured by mean area of aiming movement during the last .60 s prior to shot across all the targets revealed a main effect of session, $F(2, 85.29) = 4.15$, $p = .019$. As seen in Fig. 7, the Soldiers moved more during aiming, covering significantly larger areas and were less stable handling their weapon during the post-session ($M$ = 116890 mm$^2$, $SD$ = 90471 mm$^2$) as compared to the pre- ($M$ = 86092 mm$^2$, $SD$ = 46029 mm$^2$) and mid-mission sessions ($M$ = 83360 mm$^2$, $SD$ = 40660 mm$^2$).

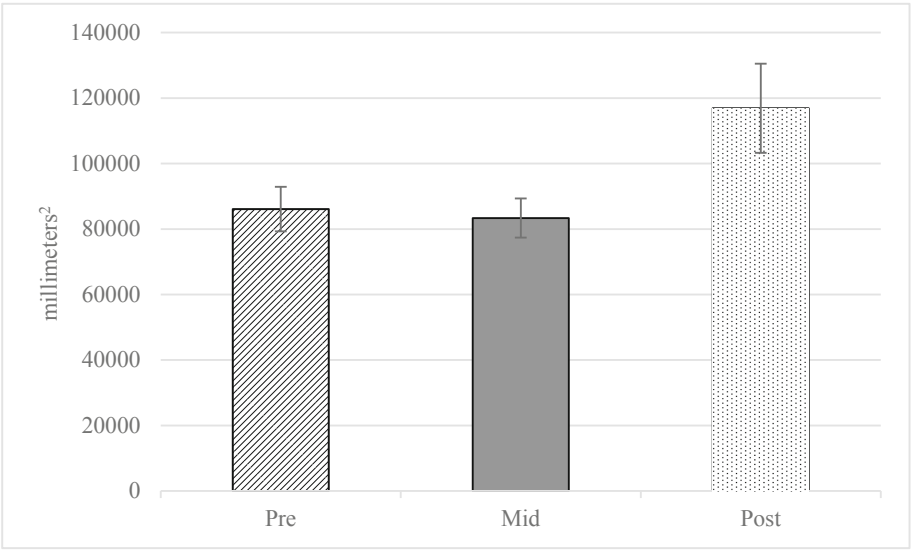


**Fig. 7.** Stability, as measured by the overall area of aiming points, within the last .60 to .20 s of aiming prior to engagement across the pre-, mid-, and post-mission time points (error bars represent Standard Error).

## 4 Discussion

The differences seen across the marksmanship measures of lethality, mobility and stability indicate that the methodology is able to identify changes in marksmanship performance over time due to mission activities and recovery. The ability to streamline three high level outputs of marksmanship performance that cover the entire process from acquisition through engagement is also very important for researchers in order to understand areas of degradation over time and to provide training feedback. However, the differences in performance could have been influenced by a variety of environmental factors which we had limited control over (e.g., time of day during test execution, test location variances, temperature and humidity variances). For example, although the outdoor testing area was flat, level, and hard-packed, it was not as hard and smooth as the cement floors indoors. This could account for the slower target acquisition and engagement times during the mid-mission test session rather than fatigue-related degradations in performance. Future testing of this methodology should utilize identical locations in order to limit the external noise when modeling performance over time.

Additionally, although a simulator system provides many benefits (e.g., flexibility, reduced cost, increased safety), there are limitations to consider as well (e.g., reduced realism and limited recoil effects resulting in potential changes in user behavior and performance). Future applications of this methodology could incorporate live-fire

training with minor modifications while still integrating the various key methodological elements that provide streamlined output metrics in the areas of lethality, mobility, and stability.

This enhanced methodology is fast to execute, yet still provides sufficient information for accurate assessment of mission-related marksmanship performance and fatigue. This methodology is unique as it combines multiple shooting skills as required by the Army, in order to provide a single assessment of marksmanship performance in the areas of lethality, mobility, and stability. Additionally, the design of this methodology allows for additional in-depth analysis to pinpoint the areas of deficiency as necessary (i.e., target acquisition, target transition, transition type, approach shot versus transitional shot, firing position, etc.).

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## References

1. Adams, A.A.: Effects of extremity armor on metabolic cost and gait biomechanics. Master's thesis, Worcester Polytechnic Institute, MA (2010)
2. Bensel, C.K.: Soldier performance and functionality: impact of chemical protective clothing. Mil. Psychol. **9**(4), 287–302 (1997)
3. Bewley, W.L., Chung, G.K., Girlie, C.D.: Research on USMC Marksmanship Training Assessment Tools, Instructional Simulations, and Qualitative Field-Based Research. (UCLA CSE/CRESST N00014-02-1-0179). Los Angeles, CA (2003)
4. Carbone, P.D., Carlton, S.D., Stierli, M., Orr, R.M.: The impact of load carriage on the marksmanship of the tactical police officer: a pilot study. J. Aust. Strength Cond. **22**(2), 50–57 (2014)
5. Garrett, L., Jarboe, N., Patton, D.J., Mullins, L.L.: The effects of encapsulation on dismounted warrior performance. Technical report No. ARL-TR-3789. Aberdeen Proving Ground, M.D: U.S. Army Research Laboratory (2006)
6. Headquarters DOA: Rifle and Carbine. (TC 3-22.9 C1). Washington, DC (2017)
7. Johnson, R.F., Kobrick, J.L.: Effects of wearing chemical protective clothing on rifle marksmanship and on sensory and psychomotor tasks. Mil. Psychol. **9**(4), 301–314 (1997)
8. Johnson, R.F., McMenemy, D.J., Dauphinee, D.T.: Rifle marksmanship with three types of combat clothing. In: Proceedings of the Human Factors Society 34th Annual Meeting, pp. 1529–1532 (1990)
9. Krueger, G.P., Banderet, L.E.: Effects of chemical protective clothing on military performance: a review of the issues. Mil. Psychol. **9**(4), 255–286 (1997)
10. Son, S., Xia, Y., Tochihara, Y.: Evaluation of the effects of various clothing conditions on firefighter mobility and the validity of those measurements made. J Hum. Environ. Syst. **13**(1), 15–24 (2010)
11. Taylor, H.L., Orlansky, J.: The effects of wearing protective chemical warfare combat clothing on human performance. (No. IDA Paper P-2433). Alexandria, VA: Institute for Defense Analysis (1991)

12. Department of the Army: Rifle marksmanship M16-/M4-series weapons (FM 3-22.9). Washington, D.C. (2008)
13. Brown, S.A.T., McNamara, J.A., Choi, H.J., Mitchell, K.B.: Assessment of a marksmanship simulator as a tool for clothing and individual equipment evaluation. In: Proceedings of the Human Factors Society 60th Annual Meeting, pp. 1424–1428 (2016)
14. Choi, H.J., Mitchell, K.B., Garlie, T., McNamara, J., Hennessy, E., Carson, J.: Effects of body armor fit on marksmanship performance. In: Advances in Physical Ergonomics and Human Factors, pp. 341–354 (2016)
15. McNamara, J., Choi, H.J., Brown, S.A.T., Mitchell, K.: Evaluating the effects of clothing and individual equipment on marksmanship performance using a novel five target methodology. In: Proceedings of the Human Factors Society 60th Annual Meeting, pp. 2043–2047 (2016)
16. Brown, S.A.T, McNamara, J., Mitchell, K.B.: Dynamic marksmanship: a novel methodology to evaluate the effects of clothing and individual equipment on mission performance. In: Proceedings of the Human Factors Society 61th Annual Meeting, pp. 2020–2024 (2017)
17. Brown, S.A.T., Mitchell, K.: Shooting stability: a critical component of marksmanship performance as measured through aim path and trigger control. In: Proceedings of the Human Factors Society 61st Annual Meeting, vol. 61, no. 1, pp. 1476–1480 (2017)
18. Brown, S.A.T., Villa, J., Hancock, C.L., Hasselquist, L.: Stance and transition movement effects on marksmanship performance of Shooters during a simulated multiple target engagement task. In: Proceedings of the Human Factors Society 62nd Annual Meeting, pp. 1444–1448 (2018)
19. Baca, A., Kornfeind, P.: Stability analysis of motion patterns in biathlon shooting. Hum. Mov. Sci. **31**(2), 295–302 (2012)
20. Hawkins, R.N., Sefton, J.M.: Effects of stance width on performance and postural stability in national-standard pistol shooters. J. Sports Sci. **29**(13), 1381–1387 (2011)
21. Lawson, B.D., Ranes, B. M., Thompson, L.B.I.: Smooth moves: Shooting performance is related to efficiency of rifle movement. In: Proceedings of the Human Factors and Ergonomics Society Annual Meeting, pp. 1524–1528 (2016)
22. Shorter, P.L., Morelli, F., Ortega, S.: Shooting Performance as a Function of Shooters' Anthropometrics, Weapon Design Attributes, Firing Position, Range, and Sex (No. ARL-TR-7135). Army Research Lab Aberdeen Proving Ground MD Human Research and Engineering Directorate (2014)
23. Tharion, W.J., Shukitt-Hale, B., Lieberman, H.R.: Caffeine effects on marksmanship during high-stress military training with 72 hours sleep deprivation. Aviat. Space Env. Med. **74**(4), 309–314 (2003)
24. Warber, J.P., Tharion, W.J., Patton, J.E.: The effect of creatine monohydrate supplementation on obstacle course and multiple bench press performance. J. Strength Cond. Res. **16** (4), 500–508 (2002)
25. Chung, G.K.W.K., O'Neil, H.F., Delacruz, G.C., Bewley, W.L.: The role of anxiety on novices' rifle marksmanship performance. Educ. Assess. **10**(3), 257–275 (2005)
26. Smith, C.D., et al.: Sleep restriction and cognitive load affect performance on a simulated marksmanship task. J. Sleep Res. (2017). https://doi.org/10.1111/jsr.12637
27. FN Expert: FN Expert Application User's Guide, pp. 9–10. Noptel Oy, Oulu, Finland (2017)
28. Johnson, R.F.: Statistical measures of Marksmanship. (USARIEM Technical Note TN-0 1/2/). U. S. Army Research Institute of Environmental Medicine, Natick, MA 01760-5007 (2001)