2026 NDIA MICHIGAN CHAPTER
GROUND VEHICLE SYSTEMS ENGINEERING
AND TECHNOLOGY SYMPOSIUM
MODELING, SIMULATION, PROTOTYPING, AND VALIDATION
(MSPV) TECHNICAL SESSION
AUG. 11-13, 2026 - NOVI, MICHIGAN

CREW OPTIMIZATION AND AUGMENTATION TECHNOLOGIES (COAT) SOLDIER TOUCH POINT 5 (STP5) FIELD EXPERIMENT

Rachel Anderson[1], Andrew Hoelscher[1], Jeffrey Schultz[1], Victor Paul[1], Ryan Wood[1], Alexander Reid, PhD[2], Steven Ratka[2], Kaitlyn Roose, PhD[2], Lauren Grant, PhD[2], and Sumit Shrestha[2]

[1]US Army DEVCOM GVSC
[2]DCS Corp, Sterling Heights, MI

ABSTRACT

Ground Vehicle Systems Center (GVSC) conducted a Soldier Touch Point (STP) in the field comparing the use of Vitreous User Interface (UI) on a Helmet Mounted Displays (HMD) to a Soldier Machine Interface (SMI) on Vehicle Mounted Displays (VMD). Soldiers drove a Stryker Vehicle equipped with 360-degree indirect vision through a series of mobility obstacles at Camp Grayling. No significant differences were found in Soldier performance between the UI conditions, however, a significant performed better maneuvering through obstacles on the right-hand side of the vehicle in comparison to the left. This is a continuation of simulation only work previously presented at GVSETs 2023.

Citation: R. Anderson, A. Hoelscher, J. Schultz, V. Paul, R. Wood, A. Reid, S. Ratka, K. Roose, L. Grant, S. Shrestha "Crew Optimization and Augmentation Technologies (COAT) Soldier Touch Point 5 (STP5) Field Experiment," In *Proceedings of the Ground Vehicle Systems Engineering and Technology Symposium* (GVSETS), NDIA, Novi, MI, Aug. 11-13, 2026.

.

1. INTRODUCTION

Helmet Mounted Displays (HMDs) represent a rapidly evolving technology with the potential to revolutionize situational awareness (SA) and operational effectiveness for ground vehicles. These systems aim to fuse data from advanced sensors—including LiDAR, infrared, and AI-powered computer vision—creating a real-time 3D understanding of the surrounding environment that surpasses current capabilities. Applications include Closed-hatch indirect vision 360 SA, automated route planning around detected threats, collaborative targeting with other vehicles, and enhanced reconnaissance via augmented reality overlays of unmanned aerial vehicle (UAV) feeds.

However, realizing this potential presents significant challenges. While HMDs promise increased awareness, maintaining stable

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited. OPSEC #10799 visual perspectives, cognitive overload and integration into legacy systems present significant obstacles to HMD adoption in military ground vehicles. The DEVCOM Ground Vehicle Systems Center (GVSC) Crew Optimization and Augmentation Technologies (COAT) program is actively addressing these challenges, seeking to identify the conditions under which HMDs can enhance ground vehicle crew performance.

COAT's program Project Vitreous has partnered with the Army Research Laboratory (ARL) to develop an HMD User Interface (UI) specifically for closed-hatch, indirect vision systems [1].

Research has previously investigated the use of HMDs in various applications, building a foundation for the work underway in the COAT program [2, 3, 4].

The purpose of this Soldier Touch Point is to build upon GVSC's previous work utilizing the latest state-of-the-art HMDs, head tracking, and Spatial UIs to re-evaluate the utility of the technology in ground vehicle applications.

2. METHOD

2.1. Participants

Eight active-duty Soldiers of the U.S. Army who have training within or experience with the operation of a Stryker vehicle were recruited for this study. Soldiers were from the 11B Infantryman career field within the 1-2 Stryker Brigade Combat Team (SBCT) of the 7th Infantry Division, Joint Base Lewis-McCord, WA. All Soldiers were volunteers and the Soldier Touch Point was conducted in accordance with Institutional Review Board (IRB) oversight. Four Soldiers participated in the first week of evaluation and four Soldiers participated in the second week of evaluation. Day 1 of each week was utilized for safety training, course familiarization, and vehicle training. Days 2-4 of each week were utilized for data collection.

2.2. Equipment

STP5 was a field evaluation looking at Soldier's driving performance differences between two UIs. It compared the use of a Soldier Machine Interface (SMI) on Vehicle Mounted Displays (VMD) to the Vitreous UI (VitReal) on a Varjo XR-3 HMD (Figure 1). A modified Stryker Infantry Carrier Vehicle (ICV) (Figure 2) was outfitted with a drive-by-wire system that enabled Soldiers to control the vehicle from a customized crew compartment in the vehicle. Seven external vehicle cameras were installed on the vehicle to provide a near 360-degree visual view around the vehicle for indirect vision drive. The left crew station (used to evaluate driving) had a seat, three screens for displaying camera feeds from cameras mounted on the exterior of the vehicle, a user interface (VitReal vs SMI), a bilateral control device (yoke) for steering, and foot pedals for acceleration and braking (Figure 3).

Figure 1: Helmet (left) and Varjo XR-3 HMD (right)


Figure 2: COAT Stryker Vehicle with the Safety Driver Hatch Open


Figure 3: Advanced Vehicle Crew Stations Inside the COAT Stryker


Figure 4: Soldier Machine Interface

While Driving, Soldiers utilized one of two UIs for driving from the left crew station. The Soldier Machine Interface (SMI) was displayed on the VMDs for the first condition (Figure 4). The second condition utilized the VitReal UI which was displayed on the HMD for the second condition(Figure 5).

2.3. Location

Camp Grayling Joint Maneuver Training Center located in Grayling, MI was used by


Figure 5: VitReal UI

GVSC as it provided a variety of areas for vehicle maneuvers, including primary roads, secondary roads, and cross-country terrain. A route (Figure 6) was laid out that consisted of these roads and included a series of driving obstacles for Soldiers to complete. Jersey barriers and barrels were used to lay out different driving maneuvers/obstacles.

2.4. Obstacles

Six obstacles were identified/created to evaluate Soldier driving performance. These included:

1. FOB Entracne (Figure 7) - This maneuver mimics a FOB entry point and is a low speed turning maneuver requiring the participant to move the vehicle through a tight, angled corridor made of six jersey barriers. Drivers had to avoid hitting the jersey barriers. Measures for this maneuver were time to complete and number of barrels/barriers hit.

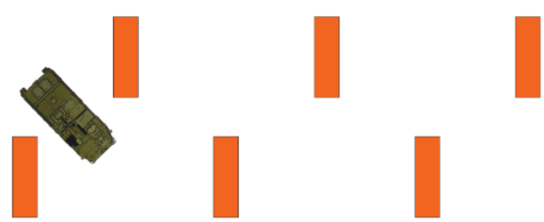
Figure 7: FOB Entrance

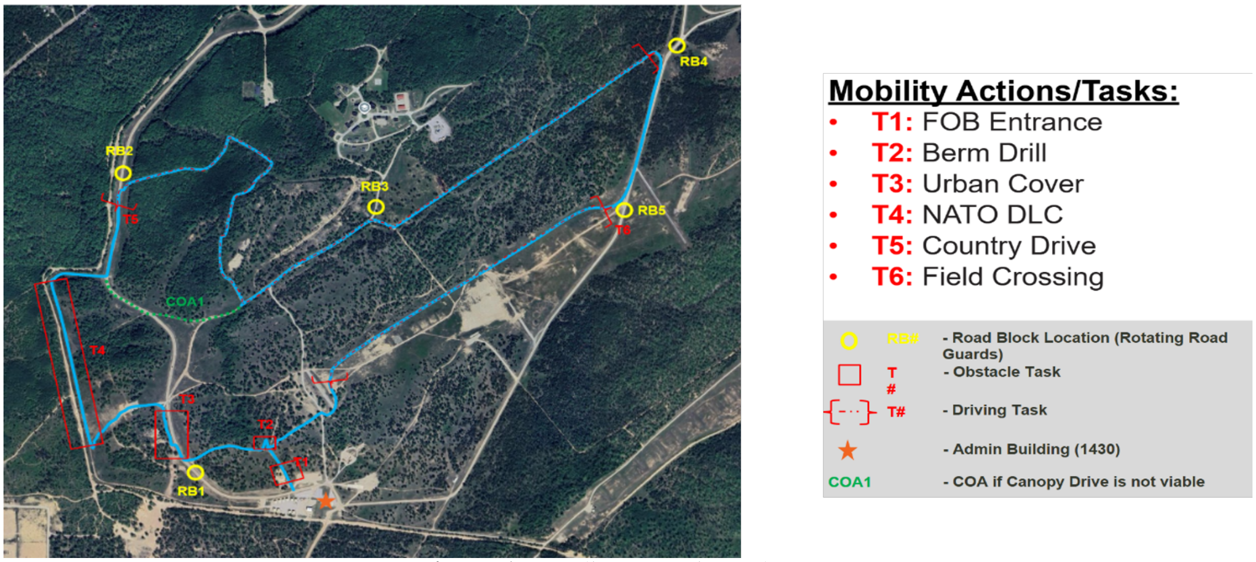

Figure 6: Grayling Test Site and Route

2. Berm Drill (Figure 8) - This maneuver mimicked moving the vehicle in and out of a prepared firing position. During this maneuver, (1) Soldiers pulled in and moved to the beginning or cover position (first set of barrels) and communicated “Ready position”. (2) Soldiers then moved as close to the end of the berm as possible (without hitting barrels) and stop stating that they are “in position”. (3) Soldiers will then move back to the cover position and state when they are there and stopped. Soldiers will then repeat (2) & (3). Once that is complete, Soldiers will back out of the position and proceed to the next berm. There will be a total of 2-3 berms for this maneuver. Measures for Berm Drill will be total time to complete, distance from “Ready Position”, and distance from the front of the berm and barrels/barriers hit.

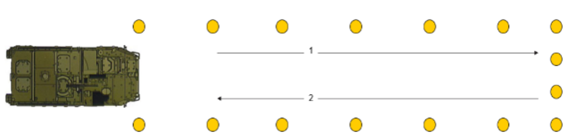

Figure 8: Berm Drill

3. Urban Cover (Figure 9) - This maneuver mimics moving in an urban area. In this maneuver, shipping containers were placed on alternating sides of the vehicle pathway . Soldiers were instructed to move their vehicle to the first container and stop such that the front of their vehicle is lined up with the end of the box where they will stop and communicate “Ready position”. Soldiers then slowly moved their vehicle forward until they could see the target (barrel) that was hidden by the Connex. They were then instructed to stop their vehicle, communicate “Target Spotted”, press the timestamp button, and then move to the next Connex on the opposite side of the pathway. The measures for this maneuver were overall time to complete, distance to edge of each Connex at the ready position, and distance to the edge of each Connex when the target is spotted.

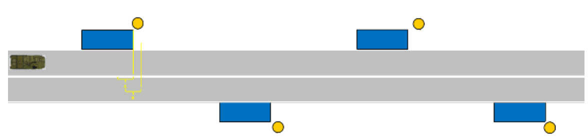

Figure 9: Urban Cover

4. NATO Double Lane Change (Figure 10)

- This is a standard maneuver for testing the dynamic stability of vehicles. For this maneuver, Soldiers drove their vehicle through "gates", made up of barrels, changed lanes, stabilized their vehicle and changed lanes back. This was repeated twice based on the space available. Measures for this maneuver were time to complete and number of barrels/barriers hit.

Figure 10: NATO Double Lane Change

5. Country Drive (Figure 6, T5) - Soldiers drove their vehicle on a dirt road through a canopy of trees. They were instructed to complete this portion of the drive as quickly as possible.

6. Field Crossing (Figure 6, T6) - Soldiers were instructed to maneuver their vehicle across a field as quickly as they can. Measure for this maneuver was time to complete

2.5. Questionnaires

Questionnaires that were given once, before the start of the week for each group, included:

- A Motion-Sickness Screening Questionnaire was administered to participants before the study as participant screening to understand how susceptible Soldiers would be to motion-sickness.

- A demographics questionnaire was administered after Soldiers were consented into the study and before the first trial. It allowed us to gather details about their background and experience

Questionnaires that were given after each trial included:

- Modified NASA TLX [5]: allows Soldiers to subjectively rate their overall workload for the trial.

- Situational Awareness Questionnaire: allows Soldiers to subjectively rate their overall Situation Awareness of the trial.

- Simulator Sickness Questionnaire [6]: a standard instrument administered immediately after a trial and used to discover whether a participant is experiencing motion-sickness or other

Questionnaire that was given at the end of the week after all trials concluded:

- Usability Questionnaire: obtained quantitative feedback on each UI's usability for driving.

- After Action Review - Group Discussion about what Soldiers liked/didn't like and what they thought could be improved based on their experiences.

3. RESULTS

To evaluate participant performance, we looked at task completion time, number of barriers hit, and Urban Cover stopping position. We also gathered overall subjective ratings of situation awareness and obstacle workload.

Course completion time was broken down by UI Conditiion and then by obstacles(Figure 11). We found that there was no significant difference in Course Completion Times between UI conditions among the different obstacles. Even though there was no difference between completion times, it is important to note that Soldiers were able to complete each obstacle at the same pace with both UIs. The max speed on the range was set at 35mph.

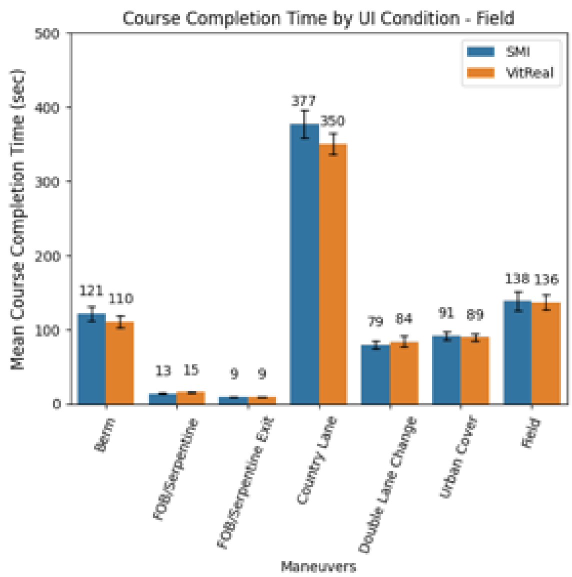

Figure 11: Course Completion Time by UI Condition

Regarding obstacles hit, Soldiers hit significantly less obstacles on the right side of the vehicle in comparison to the left (Figure 12). This was likely due to the front camera position being mounted right of center on the vehicle. Soldiers did have guidelines on the SMI and VitReal to help with navigation of potholes and rough terrain. However, VitReal's guidelines were a green color similar to terrain, therefore making them difficult to see in certain terrain. It was noted that it would be beneficial to change their color in VitReal for later studies.

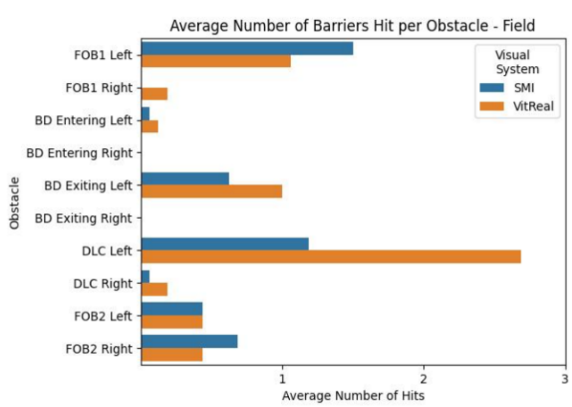

Figure 12: Average Number of Barriers Hit Per Obstacle

A right-side bias was also found in relation to vehicle alignment during Urban Cover (Figure 13). Soldiers more consistently aligned their vehicle to the front of the containers when approaching the containers on the right-hand side. We assert that this occured due to the front camera position being right of center causing the Soldiers to adjust their steering.

Additionally, Soldiers stopped short from the front of the containers more frequently using the HMD. They also only passed the front of the container when using the VMD. We assert that the display position and the alignment with a user's head position caused this.

Both conditions showed an increase in short or far stops on the left side. With the VMD, the displays are farther away from the user's head and the user is using more of their peripheral vision to align with the container; whereas, with the HMD, the display is directly on their head and the user is turning their head more to algin with the container.

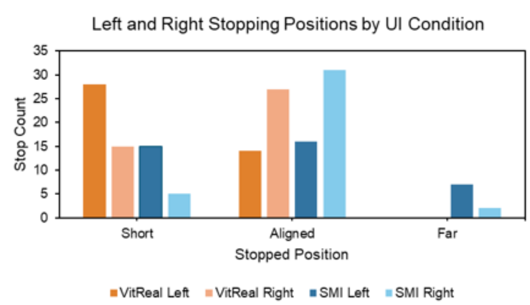

Figure 13: Left and Right Stopping Positions by UI Condition

SA ratings indicated no difference in SA between UI conditions (Figure 14). SA task was Urban Cover barrel detection. Additionally, the only differences in workload were noted under the frustration and temporal workload categories, with VitReal being rated higher than SMI (Figure 15).

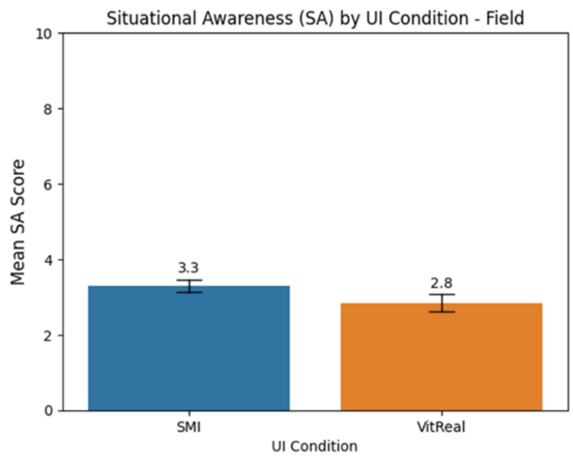

Figure 14: Field SA Ratings

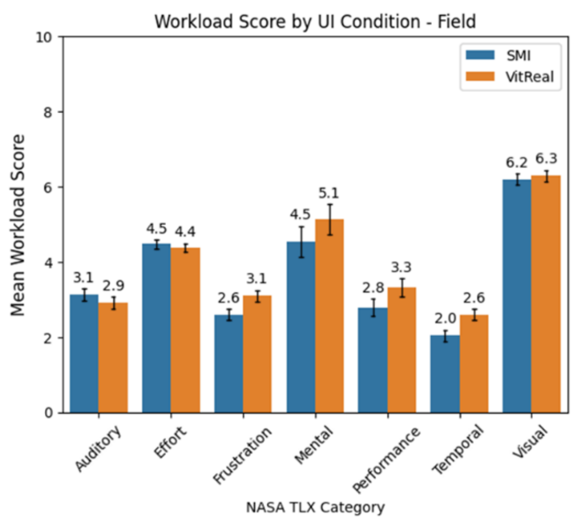

Figure 15: NASA TLX Scores Across Maneuvers and UI Condition

4. CONCLUSION

Overall, Soldiers were able to drive the vehicle at speed when utilizing either of the UIs. Some significant differences in driving performance between UI conditions was noted; Soldiers hit more obstacles on the left side of the vehicle in comparison to the right. We also noted that during Urban Cover, Soldiers stopped the vehicle short of the containers more frequently during VitReal trials and stopped the vheicle far more frequently during SMI trials. However, due to confounding variables (display location and front camera position) we could not determine if there was a correlation caused by UI type, such as camera position and UI placement on the displays. Lastly, Soldiers also rated their SA similarly across UI conditions. During workload conditions, Soldiers indicated that the SMI UI is more helpful during mobility related tasks and the VitReal UI is helpful with tactical tasks.

5. REFERENCES

[1] J. Hansberger, R. Wood, T. Conner, J. Hansen, et al., “Designing an Interactive Mixed Reality Cockpit for Enhanced Soldier-Vehicle Interaction,”, Proceedings of the Ground Vehicle Systems Engineering and Technology Symposium (GVSETS), Novi, MI, 2023.

[2] A. Meldrum, A., V. Paul, K. McDowell, C. Smyth, “CAT-ATD/RMS Driving FOV Experiment: Preliminary Results and Lessons Learned”, journal of Archaeology,” (IVSS-2004-MAS-01). 4th Annual Intelligent Vehicle Systems Symposium and Exhibition, Traverse City, MI, 2004.

[3] T. Mikulski, T. Ferris, P. Green, R. Anderson, ”Usability Study I for Crew Optimization & Augmentation Technologies,” Ground Vehicle Systems Center, Warren, MI, 2021.

[4] T. Mikulski, T. Ferris, P. Green, ”Engineering Evaluation Test II for Crew Optimization & Augmentation Technologies,” Ground Vehicle Systems Center, Warren, MI, 2021.

[5] S. G. Hart and L. E. Staveland, ”Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research,” in Human Mental Workload, P. A. Hancock and N. Meshkati, Eds. Amsterdam: North-Holland, 1988, pp.139-183.

[6] R.S. Kennedy, et al., "Simulator Sickness Questionnaire: An Enhanced Method for Quantifying Simulator Sickness," in The International Journal of Aviation Psychology 3.3, pp. 203-220, 1993.

6. CONTACT INFORMATION

Rachel Anderson
Human Factors Engineer
U.S. Army DEVCOM GVSC
6501 E 11 Mile Rd
Warren, MI
Rachel.e.anderson46.civ@army.mil

7. ACRONYMS

ARL	Army Research Laboratory
EET	Engineering Evaluation Test
FOB	Forward Operating Base
HMD	Helmet Mounted Display
ICV	Infantry Carrier Vehicle
GVSC	Ground Vehicle Systems Center
GVSL	Ground Vehicle Simulation Laboratory
SA	Situational Awareness
SMI	Soldier Machine Interface
UI	User Interface
VMD	Vehicle Mounted Displays