



**U.S. Army Research Institute
for the Behavioral and Social Sciences**

Research Report 1928

**END STATE – Commander’s Visualization at the
Company Level: Training Refinement and Transition**

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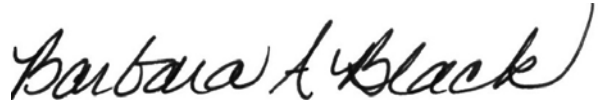
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**U.S. Army Research Institute
for the Behavioral and Social Sciences**

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END STATE – COMMANDER’S VISUALIZATION AT THE COMPANY LEVEL: TRAINING REFINEMENT AND TRANSITION

EXECUTIVE SUMMARY

Research Requirement:

Success in modern military operations depends on the ability of commanders to visualize an increasingly complex and unpredictable operational environment. Visualization is the process of developing situational understanding and envisioning how to move the force from its current state to the desired end state. It is a critical command skill that must be acquired earlier in a leader’s career than ever before given the current operational challenges that small units confront. However, junior leaders must all too often develop their visualization skills through a trial and error process during collective training. Training is needed that will improve commander’s visualization through deliberate reflection and practice coupled with performance assessment and expert feedback and guidance.

Procedure:

To meet this requirement, the U.S. Army Research Institute for the Behavioral and Social Sciences researched and developed a training product called END STATE – Commander’s Visualization at the Company Level. This report focuses on follow-on research conducted to refine and transition the END STATE training product to the U.S. Army’s junior leaders. The research addressed the following objectives: improve the set of 74 learning assessments embedded throughout END STATE’s 14 training vignettes; improve access to, and the utility of, learner performance data as well as expert guidance and feedback; extend END STATE’s potential training audience to include both individuals and groups; and refine and evaluate END STATE’s pre- and post-training tests to ensure their comparability for conducting training effectiveness evaluation. To meet these objectives, the research involved iterative reviews of training and test materials by active duty and recently retired subject matter experts to refine the relevance and generality of END STATE’s principles and practices for visualizing small unit operations in counterinsurgency (COIN) environments. Product revisions were made to support on-line collection of learner performance data and comments. Additional product refinements broadened END STATE from a lock-step individual trainer to an open-ended training tool for small group professional development. Test evaluations with over 150 junior leaders including captains, lieutenants, senior non-commissioned officers (NCO), and cadets assessed the tests’ comparability and ability to discriminate the visualization skills of inexperienced versus experienced junior leaders.

Findings:

Refinements to END STATE’s learner assessments should substantially enhance their effectiveness as thought prompts and diagnostic indicators. Extensive revisions were made by subject matter experts in response to junior leader recommendations for improving END STATE and recent doctrinal guidance on counterinsurgency. The refinements made to improve the availability and utility of expert guidance will help ensure END STATE provides relevant and timely feedback to learners as well as training management data to trainers. The refinements made to performance assessment enable on-line collection, storage, and dissemination of learner performance data and comments. By including an “un-locked” trainer profile in END STATE, the product can now be used in group settings to

stimulate and guide leader development and professional discussion. Refinement and subsequent evaluation of END STATE's pre- and post-tests found that the tests are sufficiently comparable for training effectiveness evaluation and able to discriminate significant differences in the visualization skills of junior leaders with, versus without, deployment experience.

Utilization and Dissemination of Findings:

During prior formative evaluations, 48 captains, lieutenants, and senior NCOs concluded that the END STATE training product is relevant, effective, and worth using. Given the additional refinements and findings reported here, the authors conclude that END STATE is a relevant learning tool that will help junior officers and NCO leaders develop the visualization skills needed to understand and adapt to the challenges of today's COIN environments. The product's centralized storage of training data supports Army-wide training management and training effectiveness evaluation. END STATE's potential training audiences include all junior leaders, both officers and NCOs, across a broad range of training venues. The product's DVD format readily accommodates training delivery options ranging from a lieutenant with a laptop to a group in a battalion-level NCO professional development (NCOPD) session. END STATE's self-paced design and instructorless expert feedback is a powerful tool for individual professional development. With the addition of a knowledgeable trainer and a theater-style set-up, END STATE becomes an exceptional tool for both unit professional development and the formal classrooms of the officer and NCO educational systems.

END STATE – COMMANDER'S VISUALIZATION AT THE COMPANY LEVEL: TRAINING
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Introduction

In today's counterinsurgency (COIN) environment, the Army's junior leaders conduct some of the most complex and challenging small unit operations in military history. As always, the ability to visualize operations requires that these junior leaders develop situational understanding and envision how to move their force from its current state to the desired end state. However, the challenges and "costs" of visualizing are severely compounded in COIN environments. The challenges include unpredictable and asymmetric threat forces, foreign people and cultures, dense and dysfunctional urban infrastructures, turbulence in unit personnel, emerging technical threats and opportunities, the complexities of joint, interagency, multinational, host-nation operations, and particularly, far from decisive end states.

The development of visualization expertise, like any other higher-order skill, requires highly structured and focused learning methods that include repetition, emphasis on challenge areas, and performance feedback (Ericsson, 1996; Shadrick & Lussier, 2004). A leader's ability to visualize is a human performance requirement developed through education, training, practice, and experience (Department of the Army [DA], 2003; Sanderson & Akerley, 2007). To improve commanders' visualization skills, the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) conducted a program to research and develop visualization training for company and battalion commanders (Leedom, et al., 2007; Lickteig, Cianciolo, Silverman, Menaker & Stroupe, 2009; Lickteig, et al., 2009; Shadrick, Leedom, Bell, Manning & Lickteig, 2008; Sidman & Garrity 2007).

END STATE – Commander's Visualization at the Company Level is an instructorless, interactive training product to help junior leaders develop the visualization skills needed to understand and adapt to today's operational environments (Lickteig, et al., 2009). It employs instructional strategies that ARI has successfully applied to developing leader cognition in a variety of domains (Lussier, Shadrick, & Prevou, 2003; Schaefer, Shadrick, Beaubien, & Crabb, 2008). An overview of END STATE's training methods and design features are provided in Figure 1.

END STATE's training vignettes feature a company commander and his unit conducting a series of missions in Kirkuk, Iraq. These vignettes immerse learners in the complex physical and human terrain and the ambiguous enemy situations that typify COIN environments. The product also includes a pre-test and post-test to assess the visualization skills of junior leaders. In particular, END STATE provides expert guidance and feedback that stresses the need to adapt solutions to the complexity and uncertainty of COIN and promotes the principles of how to visualize small unit operations and how the principles apply in every operational environment.

The training audiences for END STATE potentially include all junior leaders, both officers and non-commissioned officers (NCO), across a broad range of training and development venues. The product's client-side, DVD-based format readily accommodates training delivery options ranging from a lieutenant with a laptop to a group in a battalion-level NCO professional development session. END STATE's self-paced design and instructorless expert feedback is a powerful tool for individual professional development. With a knowledgeable trainer and a theater-style set-up, END STATE becomes an exceptional tool for professional development and the formal classrooms of the officer/NCO education system.

Overview of END STATE Training

Training

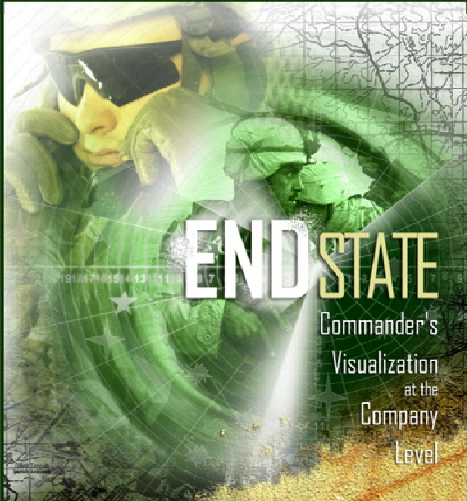
- Interactive multi-media on DVD
- Middle East scenarios
- Instructorless coaching
- Proactive role model
- Reflect-act cycle

Evaluation

- Over 70 checks-on-learning
- Multiple choice with three attempts
- Objective and quantitative results
- Expert guidance and feedback
- Pre- and post-tests

Support

- Quick Start Guide
- Navigational prompts in blue
- Training status in green, amber and red
- Introduction, Road to War, Battle Update Briefs, Maps, and Bookmarks



Nested with battalion version of End State

Figure 1. Overview of END STATE’s training methods and design features.

During prior research by ARI on the initially developed version of END STATE, 48 junior officer and NCO participants in a formative evaluation concluded that END STATE was relevant, effective, and worth using (Lickteig, et al., 2009). On the strength of that Soldier support, ARI conducted follow-on research to refine and transition END STATE to better prepare the Army’s junior leaders. This report documents that follow-on research that primarily addressed the following research objectives:

- Revise checks-on-learning to enhance their effectiveness as thought prompts and as diagnostic indicators of performance.
- Add features that enhance END STATE's usability and accessibility to training audiences.
- Revise and evaluate pre- and post-training tests to ensure test comparability for assessing training effectiveness.

The ultimate goal of this research was to deliver refinements that will facilitate END STATE’s transition to the Army and improve the visualization skills of junior leaders. The purpose of this final report is to describe and document the current version of END STATE which is available in a companion research product (ARI, in preparation). This report concludes with recommendations for conducting training effectiveness evaluation of END STATE and for the implementation of END STATE across a broad range of training venues.

END STATE Learning Objectives

The Observe-Orient-Decide-Act (OODA) cycle (DA, 2003) was adopted as the organizing framework for END STATE. A series of cognitive task analyses (Lickteig, et al., 2009) focused on the challenges of COIN (DA, 2006) and concluded that the OODA cycle provides a proactive framework for visualization that enables and reinforces the rapid tempo of small unit operations. Conceptualizing command decision making as an OODA cycle underscores that visualization integrates perception, cognition, and action. Successful commanders repeatedly:

- **Observe** the situation and proactively collect information.
- **Orient** their unit and external players with situational understanding.
- **Decide** what to do and how to do it.
- **Act** to exploit opportunities and deter threats.

As shown in the Figure 2, END STATE stresses that the OODA cycles of the friendly force “stay inside” the OODA cycles of the enemy force. The figure also reflects the complexities of COIN, particularly the need to orient the many external players that directly impact the operations of small units, such as civilians, tribal leaders, host nation security forces, coalition forces, and government and non-government agencies. This representation of the OODA cycle highlights the need to align interdependent visions and to coordinate multi-player action cycles.

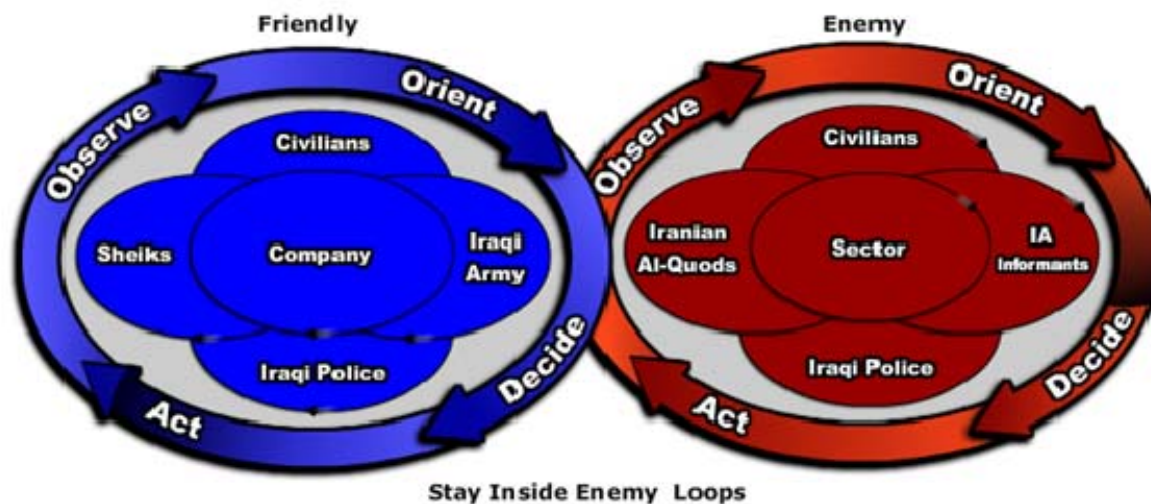


Figure 2. Overlapping friendly and enemy OODA cycles with external players.

Anchored to the OODA cycle, a set of eight visualization skills were identified that serve as END STATE's terminal learning objectives. The first two visualization skills, for example, relate to the Observe segment of OODA. Users of END STATE initially learn to observe and envision how the space and time factors of their Area of Operations (AO) might impact maneuver, action, and coordination. Next, users observe and envision how their AO might impact Mission, Enemy, Terrain & Weather, Troops & Support, Time Available, and Civilians (METT-TC) factors as they refine their visualization to match their unit's mission, task, and purpose. The complete set of visualization skills addressed by END STATE is as follows:

1. Observe and envision the AO in 2D, 3D and 4D.
2. Observe and envision the AO's METT-TC factors.
3. Orient the unit for maneuver, action, and coordination.
4. Orient external players for maneuver, action, and coordination.
5. Decide what information is needed for current and future action.
6. Decide what actions are needed for current and future situations.
7. Act on emerging threats.
8. Act on emerging opportunities.

Each visualization skill is associated with multiple performance criteria, which provide targets for learner interaction with the training program and performance assessment. The complete set of performance criteria for the eight visualization skills is provided by Lickteig, et al. (2009). As an example, the performance criteria for the first visualization skill, Observe and Envision the AO in 2 Dimensional (2D), 3 Dimensional (3D), and 4 Dimensional (4D), are provided below:

- Estimate the relative distance and time required by troops, assets, and the enemy to travel from one point to another in the operational environment at different times of day, days of the week, points in the year, under different weather conditions, and using different modes of movement.
- Comprehend the implications of physical terrain, including terrain elevation, urban elevation, and line-of-sight.
- Judge the orientation, dispersion, and visibility of target points in the field from reference points in the field.
- Comprehend the implications of human terrain for friendly and enemy action.

END STATE Overview

This section provides a brief overview of the current END STATE training product, particularly the product refinements made to meet the research objectives previously listed. A more complete description of END STATE's design, development, and formative evaluation is available (Lickteig, et al., 2009) as well as the current END STATE training product (ARI, in preparation).

Soldier Summary

After initially starting END STATE and creating a new user profile, the user is presented the Soldier Summary depicted in Figure 3. The Soldier Summary provides a brief description of END STATE and its goals: training junior leaders to visualize small unit operations and coaching them to apply those skills on a full-spectrum battlefield. The summary stresses that END STATE is a tool designed to guide professional development and discussion that can be used in either institutional or unit settings. The summary also informs the user that although END STATE is set in Kirkuk, Iraq, the training's principles on how to visualize and conduct small unit operations apply in any COIN environment.

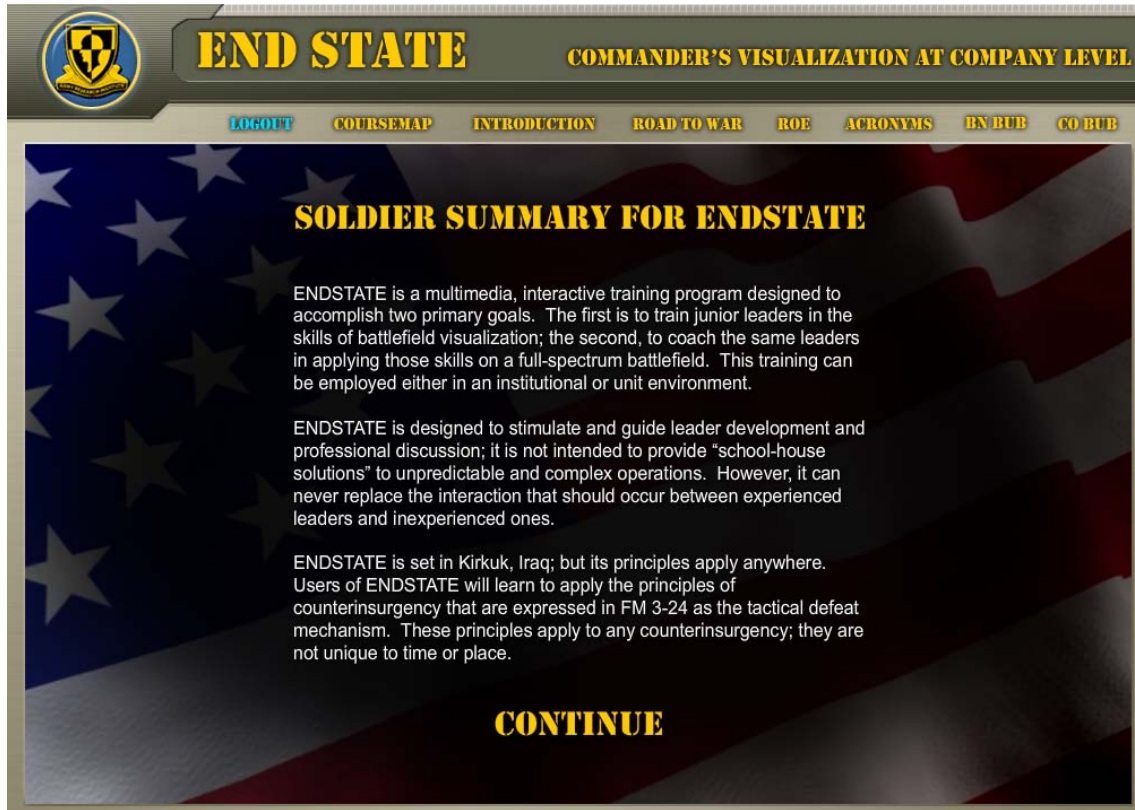


Figure 3. Soldier Summary.

Course Map

After a user selects the Continue button on the Soldier Summary page, the Course Map depicted in Figure 4 is presented. END STATE's Course Map is the centralized location where users can access all elements of the training product including the training vignettes, the tests, and the training support materials. Ideally, the user begins by reviewing the Quick Start Guide, located at the left side of the Course Map. The Quick Start Guide notes the lock-step nature of END STATE which requires that individuals with "user" profiles complete the 16 vignettes in order: the pre-test vignette, the 14 training vignettes, and then the post-test vignette. Notably, END STATE now includes a "trainer" profile that unlocks the vignettes and allows small-group trainers to select any vignette or visualization skill, as desired, in order to stimulate and guide professional discussion and development.

Access to the training support materials, including tactical and instructional information, is available via the "tool bar" across the top of the Course Map. Clicking on the name of each support resource, such as the Introduction or the Road to War, takes the learner directly to the requested training support material. "Blue" navigational prompts are provided to aid progression on the Course Map and throughout the course. When the learner begins the course, for example, a blue highlight surrounds the pre-test titled "Attend AAR" module located directly below the top toolbar.



Figure 4. END STATE's Course Map.

As the user progresses through END STATE, the navigational prompts advance to the next step. For example in Figure 4, the notional user has completed the pre-test and the first six training vignettes, so a blue highlight (in color versions of the figure) surrounds the next training vignette titled “4a Extend Presence” under the Orient segment of the OODA cycle. As the user completes each vignette, its padlock icon is replaced by an information icon by which users can view feedback on their responses to each test item and training thought prompt.

The legend at the lower left of the Course Map provides a course synopsis on how the training is structured into pairs of “a” and “b” vignettes which are labeled Prepare and Execute, respectively. The Quick Start Guide reinforces the training program’s reflection-action cycle by stating: “Each ‘a’ module helps PREPARE you to EXECUTE the mission in the ‘b’ module.” The legend at the lower right of the Course Map shows status indicators of green (in color versions) for “Trained,” amber for “Practice Needed,” and red for “Untrained.” After each vignette is completed, the Course Map updates and displays the user’s current status on all completed vignettes.

Training Support Materials

Quick Start Guide. As described previously, the Quick Start Guide provides a brief set of instructions on how to use the training system. It appears as shown in Figure 4 (above) when the learner visits the Course Map for the first time. On subsequent visits, the Quick Start Guide is not shown, but may be accessed by clicking the Quick Start Guide button.

Course Introduction. The Course Introduction provides a brief self-paced, illustrated text overview of the components of the END STATE program. This overview also includes frequently asked questions about how the system functions.

Road to War. The Road to War is a self-paced multimedia presentation of country-level background information on Iraq, the setting of each of the END STATE vignettes. The presentation includes information on Iraq's population, economy, and culture as well as a high-level description of recent political events in the area.

Rules of Engagement (ROE). The ROE are a text presentation of 10 notional rules of engagement for conducting operations in Iraq. The ROE have been enhanced to reflect the realities of a sovereign Iraq. Specifically, they contain rules for "sharing the road" with Iraqis and for warrant-based detention operations.

Battle Update Briefs. END STATE features two multimedia update briefs: one at the battalion level and one at the company level. Both briefs use a combination of still images and 3D-animated presenters to convey the information in an engaging and realistic fashion. Information in each of the briefs includes intelligence on people, places, and tactics at an echelon-specific level of analysis.

Training Vignettes and Thought Prompts

The storyline of END STATE features a 3D avatar called Captain Dukes of A/2-5 IN conducting full-spectrum operations with his unit in Kirkuk, Iraq. Beginning with his unit's relief-in-place during the first four training vignettes, Captain Dukes learns to carefully observe his AO and especially the area's human and physical terrain and the enemy's deceptive patterns of operation. During the next four training vignettes, Dukes repeatedly orients his unit and key external players for coordinated action by sharing his understanding of the current situation and its desired endstate. The next four vignettes examine how Dukes decides what actions his unit will need to take to achieve the desired endstate. In the last two training events, Dukes and his unit repeatedly act to exploit emerging opportunities and deter emerging threats in their AO. The 14 training vignettes are organized into seven complementary pairs, as shown in the Course Map, in which Dukes considers relevant principles for visualizing and conducting the upcoming mission and then applies the principles during execution of the mission.

Throughout the training and testing vignettes, a 3D avatar called Major Harris serves as Captain Dukes' virtual mentor. Major Harris, Dukes' former small-group instructor in the Captains' Career Course, repeatedly appears during internal dialogues in which Harris guides Dukes' thoughts and decision-making. Major Harris also presents the 74 thought prompts that challenge Dukes and the learner to apply their visualization skills to each mission and then receive Harris' explanatory feedback in the form of expert considerations to all user responses. Coupling the thought prompts with explanatory feedback is designed to stimulate and reinforce the reflective thought and deliberate practice needed to ingrain visualization principles and skills. Figure 5 shows an example thought prompt with explanatory feedback.

Pre- and Post-Tests

The pre- and post-tests were developed to assess the value of END STATE's training. In addition, the tests may increase learners' motivation to improve their visualization skills when, for example, they discover their pre-test performance is inferior to that of experienced junior leaders.

The storyline of the pre- and post-tests extends the story of Captain Dukes to include the incoming and outgoing After Action Reviews (AARs) for his unit's deployment in Kirkuk, Iraq. Test items are embedded in AAR discussions. For the pre-test, the discussion is led by the outgoing company commander that Captain Dukes is replacing; for the post-test, the discussion is led by Dukes for his incoming replacement (see Attend AAR and Conduct AAR in Figure 4). Each test comprises 16 questions, structured by the visualization skills required to See First, Understand First, and Act First and their direct relation to the OODA cycle (DA, 2003). The AARs are conducted in the 3D world of END STATE with Major Harris introducing each test item, as appropriate to the ongoing AAR discussion. In contrast to the thought prompts during training, learners are given only one chance to answer each test item and do not receive immediate feedback after submitting their response to a test item. However, test performance summaries and item-level results are available to learners after the completion of each test via the information icons shown on the Course Map for each test.

The pre- and post-tests now included in END STATE are the result of extensive research, testing, and refinement in collaboration with more than 200 Soldiers, including nearly 80 for test revision and more than 150 for test evaluation. The results of that research are briefly summarized below; more detailed documentation of the pre- and post-test revision and evaluation are provided in Appendix B. In the test revision phase, all test items were individually completed and reviewed by nearly 80 junior leaders with deployment experience. Based on Soldier reviews of what were labeled Test A and Test B forms, many of the test items were revised by the research team led by a co-author recently deployed to Iraq and now a retired lieutenant colonel. Item modifications ranged from relatively minor changes (e.g., clarification of question stems), to more accurate and current stimulus materials and terminology, to entire replacement of item content. In the test evaluation phase, the revised versions of the Test A and Test B forms were administered to more than 150 junior leaders including cadets, captains, lieutenants, and senior NCOs. After filling out a brief demographic survey, the Soldier participants completed both test forms in paper-and-pencil format. The order of test form administration was counterbalanced across Soldier participants. In the analysis phase, the resulting test scores were examined for differences between test forms and for differences between experienced and inexperienced junior leaders, operationally defined as with, versus without, deployment experience, respectively.

The revised test forms were found to be sufficiently comparable to enable training effectiveness evaluation with overall average means of 67% and 69% for the pre- and post-test, respectively. The corrected correlation between the two test forms was .85, and differences in average scores across the two test forms were statistically non-significant.

The revised test forms were found to discriminate between junior leaders with and without deployment experience, as shown in Figure 6. Performance differences between inexperienced and experienced leaders on both test forms were significantly different, with large effect sizes (>1). Statistical results are provided in Appendix B.

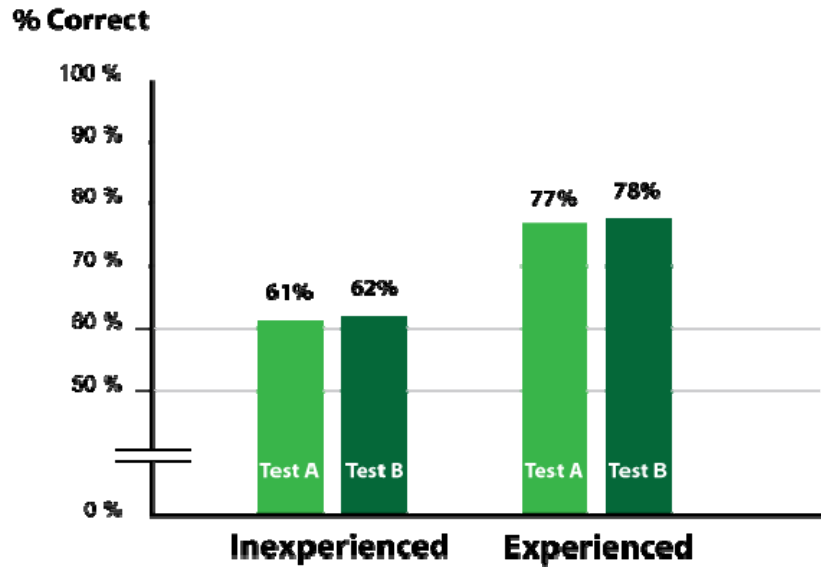


Figure 6. Test performance by test form and junior leader experience.

Training Data Presentation

Learner Data

As noted, an objective of the research was to improve access to, and the utility of, learner performance data. Revisions to END STATE now enable learners to more readily review their status on each test and training vignette. The purpose of these updates was to provide learners with the opportunity to more readily and precisely track their training and test status in detail and to maximize the learning benefit of reflective thought and deliberate action with repeated access to expert considerations and explanations.

At the completion of any vignette, the learner is automatically returned to the Course Map where the learner’s status color for the vignette is updated (green, amber, or red¹) and its padlock icon is replaced with an information icon (see Figure 4). After clicking on an information icon, learners are presented their overall score for that vignette as well as color-coded status feedback on their performance for each test item or thought prompt in the vignette, as shown in Figure 7.

For additional feedback on thought prompts, learners can click any “View” button on the right side of Figure 8 to review the Answer Key for any thought prompt. The Answer Key presents the thought prompt as it appeared during training with the addition of correct and incorrect response indicators and expert explanatory feedback. After reviewing the feedback, learners can go back and re-take vignettes to enhance their training status. For the pre- and post-test vignettes (Attend AAR and Conduct AAR) feedback options and formats are similar, however, no Answer Key is provided.

¹ green = 85%+ correct; amber = 70-84% correct; red = less than 70% correct

END STATE COMMANDER'S VISUALIZATION AT COMPANY LEVEL

LOGOUT COURSEMAP INTRODUCTION ROAD TO WAR ROE ACRONYMS BN BUB CO BUB

← Back **Vignette: 2b Escort Convoy**

Your Overall Vignette Score = 70

COL #	Check on Learning (COL)	
22	Select the two most likely obstacles in this urban scene.	View
23	What is the best action when reacting to this IED?	View
24	Match each action with its two most likely results.	View
25	Select the two most likely obstacles in this scene.	View
26	What five results does the enemy desire from a friendly convoy encountering an IED?	View
27	Rank these actions from best to worst to assist Mr. Smith.	View
28	Select the key terrain along this route from the areas identified.	View

Click [View](#) to View Answer Key.


Trained = Practice Needed = Untrained = ← Back

Figure 7. Sample feedback to learner on a completed training vignette.

END STATE COMMANDER'S VISUALIZATION AT COMPANY LEVEL

LOGOUT COURSEMAP INTRODUCTION ROAD TO WAR ROE ACRONYMS BN BUB CO BUB

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 **Rank these actions from best to worst to assist Mr. Smith.**

Drag the letter for each option to the correct location.

- A Setup a perimeter and post guards until Smith's security force. ✓ **A (Best)** *This may be the best option, however you are not prepared to conduct this for an extended time.*
- B Ensure that Smith has a way to contact you and head back to the ✓ **C** *This option will at least help Smith make his site less vulnerable.*
- C Walk the perimeter with Smith and move his equipment into a ✓ **B** *Smith can call if things turn ugly and you can respond.*
- D Leave a couple of soldiers to guard the power station and parts. ✓ **D** *Leaving two soldiers to guard a site would be asking for an insurgent attack.*
- E Change you patrol schedule to commit all your forces to guarding ✓ **E (Worst)** *Don't compromise your entire mission. If you cannot handle this new requirement, ask battalion for help.*

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Figure 8. Sample answer key for a thought prompt.

Trainer and Researcher Data

For trainers and researchers, more quantitative data are captured by END STATE and stored in a format that can be readily imported into most spreadsheet applications (e.g., Microsoft Excel). In the present effort, updates were made to data collection and storage in order to make it easier for researchers to analyze the data in a variety of ways. Specifically, END STATE records the following data elements based on learner performance, each in a separate data field:

- A unique user identification number.
- The user's initial score on each thought prompt or test question.
- The user's final score on each thought prompt (not applicable to test questions).
- The number of attempts made to answer the question correctly (not applicable to test questions).
- Date and time the data were submitted.

Product Transition Status

Visualization training must be available anytime and anywhere in order to support the demanding schedules of today's junior leaders. For this reason, END STATE was implemented as a client-side application that can run anywhere a learner has computer access. Installation is a simple matter of running a DVD, and program use requires no other special applications or plug-ins.

The current research included efforts to enable the storage of training data in a central repository on an Army server. Centralized data storage would enable Army-wide training effectiveness evaluation. Although learners can run the END STATE application on any computer, Internet connection and common access card (CAC) authentication is required to submit data to this central repository.

Recommended Future Directions

During earlier development research and formative evaluation, nearly 50 experienced junior leaders concluded that the END STATE was relevant, effective, and worth using (Lickteig, et al., 2009). In the current research reported here, data from more than 150 Soldiers indicated that END STATE's pre- and post-training tests are comparable and able to identify significant differences in the visualization skills of inexperienced versus experienced junior leaders.

The natural next step in END STATE's transition is a comprehensive training effectiveness evaluation that assesses changes in knowledge and skill as a result of exposure to the learning content (Kirkpatrick, 1994). Such an evaluation would further strengthen the product by revealing areas where refinement could improve achievement of the visualization learning objectives. Advanced training effectiveness evaluation could then address behavior changes in the operational environment and broader organizational impact.

Training effectiveness evaluation might begin by determining if there are significant differences in the pre- and post-test performance of junior leaders after completing END STATE's approximately 6.5 hours of training. Evaluation might also compare performance differences on the post-test between learners who completed the training vignettes and those who did not. Ideally, participants in the evaluation should be representative junior leaders without deployment experience to ensure

generalizable results. Future evaluations should assess the training effectiveness of *END STATE* on job-related performance metrics.

Evaluating training effectiveness using segments of the training could reveal the minimum number of vignettes necessary to achieve a significant impact on visualization knowledge and skill. It would also provide data that leaders could use to judge their return on investment in the *END STATE* training. That is, the data could show how much improvement in visualization knowledge and skill the average leader could expect after investing a certain number of hours in the training. The data might also be useful to small-group trainers for selecting the most useful vignettes and visualization training, as needed, to stimulate and guide professional discussion and development.

Conclusions

END STATE's potential training audiences include all junior leaders, both officers and NCOs, across a broad range of training venues. The product's DVD format readily accommodates training delivery options ranging from a lieutenant with a laptop to a group in a battalion-level NCOPD session. *END STATE* is a relevant, flexible, and effective tool that will enable junior leaders to develop visualization skills through their own effort, not at the expense of Soldiers on the ground. By preparing young leaders to visualize the challenges of COIN using virtual training like *END STATE*, the U.S. Army can maximize their success.

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Appendix A

Acronyms

2D	2 Dimensional
3D	3 Dimensional
4D	4 Dimensional
AAR	After Action Review
AO	Area of Operations
ARI	U.S. Army Research Institute for the Behavioral and Social Sciences
CAC	Common Access Card
COIN	Counterinsurgency
DA	U.S. Department of the Army
METT-TC	Mission, Enemy, Terrain & Weather, Troops & Support, Time Available, and Civilians
NCO	Non-commissioned Officer
NCOPD	NCO Professional Development
OODA	Observe, Orient, Decide, Act
ROE	Rules of Engagement

Appendix B

Pre- and Post-Test Refinement and Evaluation

Initial Test Form Revisions

Refinement of the pre-and post-tests began with comprehensive subject matter expert review and modifications to the original test forms described in Lickteig, et al. (2009). Modifications addressed comments made during the user review process and reviews made by the independent consultant on the current effort. Revisions ranged from changes to relatively minor elements of the assessment items (e.g., clarification of question stems) to updates of visuals and terminology to entire replacement of item content. Although individual assessment items were revised, sometimes substantially, the overarching format (“Army Qualities of Firsts”) and storyline (Attend/Conduct an AAR) of the original test forms were retained. Modified test forms were then subjected to evaluation by a new sample of military subject matter experts located at Fort Campbell ($N = 31$) who were instructed to complete one of the two test forms, then provide evaluative ratings for each assessment item. A copy of the evaluation form is provided in Appendix C. The test forms were revised based on the data from Fort Campbell, and then subjected to further analysis and revision as described below.

Participants

One hundred fifty-nine participants from two different installations provided test form performance data. Thirty-eight percent ($N = 60$) of the participants were commissioned officers (72% were captains, 27% were lieutenants and there was one major), 4% ($N = 6$) were non-commissioned officers (all but one were sergeants first class), and the remaining 58% were cadets. The highest level of military education achieved by 43% of the commissioned officers ($N = 26$) was the Officer Basic Course, with the remaining officers having completed the Officer Advanced Course ($N = 33$) or the Pre-Command Course ($N = 1$). Of the six enlisted Soldiers, two reported having completed the Basic Non-Commissioned Officers’ Course, three reported having completed the advanced course, and one participant reported having not yet completed any courses in the non-commissioned officer education system (this participant was a specialist, E-4). Eighty-three percent of commissioned officers reported having command experience. Thirty-eight percent of participants reported having done a tour in Afghanistan or Iraq, with 20 participants having served on multiple tours (2-4 tours). Two participants were removed from analyses for having not completed both the pre- and post-tests, reducing the sample size to 157.

Materials

To enable rapid, flexible administration of the training assessments in the context of minor content and format changes, paper-and-pencil format was used. Like the original test forms, those forms used for final evaluation each contained 16 items that assessed the eight visualization skills taught in END STATE. Also consistent with the original test forms, the format of the assessment items included multiple choice, matching, and select all that apply. Participants were given only one chance to answer each item and overall performance scores were calculated as the average percent correct for each item. Every effort was made to balance the number of multiple-choice items across the two test forms in order to standardize the expected performance scores, however, there were slightly more multiple choice items in the post-test. Given that some revisions were made to the test forms during the

data collection process, not all participants received exactly the same test form. In the pre-test, 13 of the 16 test questions were exactly the same or functionally equivalent across all participants. In the post-test, 9 of the 16 questions were exactly the same or functionally equivalent.

Procedure

All participants began by filling out a brief demographic survey. Next, they were administered both test forms back-to-back via a counterbalanced research design (i.e., half received the pre-test first and half received the post-test first). Twenty-five participants evaluated the pre-test and eighteen evaluated the post-test using the evaluation form shown in Appendix C. None of the participants received any END STATE training.

Results and Discussion

Initial analyses were conducted to determine whether the final form of the pre- and post-tests (containing all 16 items across participants) could be considered functionally equivalent to its corresponding “abbreviated” form (containing only those items that were the exactly the same or trivially different across participants). Functional equivalence must be demonstrated in order to investigate the adequacy of the final test forms for assessing pre- and post-training performance. The correlations between the abbreviated and final test forms were found to be substantial (.95 for the pre-test and .89 for the post-test), indicating that the final test forms measured the same (or very highly similar) constructs as their corresponding abbreviated forms, despite differences in some test questions. Moreover, the average overall scores across final and abbreviated test forms, although statistically significantly different, were not practically different; the effect sizes of the differences were very small and overall average scores differed by only one percentage point. The average scores on the pre-test were 66% and 67% for the abbreviated and final forms, respectively [$t(156) = 2.045, p = .04, d = .05$]. Similarly, the average scores on the post-test were 70% and 69% for the abbreviated and final forms, respectively [$t(156) = -3.155, p = .002, d = .12$]. Together, these findings suggested that the final test forms could be used for further analysis despite differences in exact format across participants.

Test Form Sensitivity

The descriptive statistics for the pre- and post-tests are shown in the table below. As can be seen in the table, the reliability of each assessment form is moderate, appropriately reflecting the multifaceted nature of operational visualization. Also shown in the table are the differing average scores for participants who had been deployed at least once and those who had never been deployed. *t*-tests were conducted on the pre- and post-test scores to evaluate the significance of these performance differences. For both assessment forms, these differences were found to be significant and effect sizes quite large [$t(155) = 6.66, p = 0, d = 1.14$ for the pre-test; $t(155) = 7.36, p = 0, d = 1.15$ for the post-test]. These results clearly indicate that the pre- and post-tests designed to assess visualization are indeed sensitive to differences in actual operational experience with employing visualization. It is possible that deployment experience did not produce perfect average scores on the pre- and post-tests because the participants who had been deployed were still junior officers and members of the END STATE target training audience.

Table 1

Descriptive Statistics for Each Test Form

Test Form	Scale Reliability	Overall (<i>N</i> = 157)	Mean (SD) % Correct	
			Inexperienced (<i>N</i> = 96)	Experienced (<i>N</i> = 61)
A	.66	67 (17)	61 (16)	77 (12)
B	.65	69 (15)	63 (14)	78 (12)

Test Form Comparability

In order to ensure that performance differences between pre- and post-testing reflect experience with the training content, the two test forms must be comparable with regard to the constructs they assess and the average overall scores that they produce. To investigate the comparability of the pre- and post-tests, their inter-correlation was analyzed, as well as the difference in their average overall scores. The correlation between test forms was .56. When corrected for attenuation due to the moderate reliabilities of the test forms, the estimated correlation was .85, suggesting that the pre- and post-test forms assessed similar underlying constructs. A *t*-test indicated that the average overall scores across test forms did not significantly differ [$t(156) = -1.209, p = .23$]. Together, these results suggest that for the purposes of conducting training effectiveness evaluation the test forms may be considered comparable.

Learner Ratings

Using a scale of 1 to 4 (Strongly Disagree to Strongly Agree, with no “neutral” or “no opinion” ratings) participants rated each test question on the characteristics of confidence (of one’s own accuracy), relevance, adequacy (of information provided), clarity (of the test question stem and of the response options), accuracy (of content), and realism (see Appendix C). In addition, participants were asked to rate each test question for the degree of expertise (operationalized as educational level and operational experience) required to answer it correctly. Ratings of the level of expertise required served as an indicator of difficulty of each item that was independent of actual performance. To analyze learner ratings on these dimensions, only questions from the abbreviated test forms were used. The questions on the final test form that were not administered across all participants were not rated. Consistent with performance scores, however, it is expected that the difference in learner ratings between the abbreviated test forms and the final test forms would be trivial.

Test form quality. An overall item quality score was created for each test question by averaging the learner ratings received on each of the seven dimensions described above. Test form quality scores were then created for the pre- and post-tests by averaging the overall item quality scores. The pre-test earned a quality score of 3.14 (SD = .40) and the post-test earned a score of 3.30 (SD = .42), out of a maximum possible score of 4. An independent samples *t*-test was performed on these learner ratings and was found to be non-significant [$t(41) = -1.271, p = .21$]. These results indicate that on average users agreed with positive statements about the quality of the test questions and that the test forms were comparable in their perceived quality.

Test form difficulty. Two overall difficulty scores were created for each test form. The first score was created by taking the average frequency of user ratings (across test questions) of the amount of deployment experience required to answer the question correctly (no deployment experience, one deployment, or two or more deployments). The second score was created by taking the average frequency of user ratings (across test questions) of the amount of professional education and leadership experience required to answer the question correctly (ranging from cadet training and no leadership experience to advanced coursework with company command experience).

On average, 68% of reviewers of the pre-test indicated that no deployment experience was required and the remaining 32% indicated that one deployment was required. On average, 52% of post-test reviewers indicated that no deployment experience was required and 44% indicated that one deployment was required.

On average, 95% of pre-test reviewers indicated that a junior level of professional education (i.e., the Advanced Officers' Course or Advanced Non-Commissioned Officers' Course or lower) and leadership experience (i.e., platoon-level) were required to answer the test questions correctly. On average, 98% of post-test reviewers indicated that a junior level of professional education and leadership experience were required.

These findings suggest that pre- and post-test difficulty is well calibrated to the characteristics of the END STATE target audience. They also corroborate the performance differences between experienced and inexperienced participants. That is, the rated difficulty level of the pre- and post-tests should differentiate participants with and without deployment visualization experience, and this is exactly what they did. In addition, the test forms appear to be comparable in difficulty ratings, as well as overall average scores.

Appendix C

Test Form Quality Rating Survey

Directions: For the test item on the left page, rate your agreement with the statements below using the scale provided. Place a check in the box that best reflects your opinion.

		Strongly Disagree	Disagree	Agree	Strongly Agree
		1	2	3	4
1. Confidence	When I answered this test item, I was confident that I answered correctly.				
2. Relevance	This test item and problem set is relevant to company level visualization.				
3. Adequacy	This test item and problem set provide adequate information.				
4. Clarity	The wording of this question is clear.				
5. Clarity	The wording of each response choice is clear.				
6. Accuracy	The answer scored as “correct” is accurate.				
7. Realism	The visuals used in this test item reflect the operational environment.				
8. What level of education/experience would a Soldier need to answer this test item? Circle your response.					
	<ul style="list-style-type: none">• Cadet/officer candidate/WLC graduate - no unit leadership experience.• BOLC III/BNCOC Graduate - new platoon leader/squad leader.• CCC/ANCOC graduate - experienced platoon leader/platoon sergeant.• CCC/ANCOC graduate - experienced company commander/1SG.				
9. What is the minimum level of operational experience required to answer this test item? Circle your response.					
	<ul style="list-style-type: none">• Prior to first deployment.• After first deployment.• After two or more deployments.				
10. How would you improve this item? Please indicate here, or feel free to mark suggestions on the question and responses on the left side of this page. Your improvements might address issues such as the test item’s relevance, difficulty, adequacy, clarity, accuracy, and realism or any other suggestions including alternate items to replace this item.					

