Experimental Evaluation of Advanced Automated Geospatial Tools

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Thanks to the Team!

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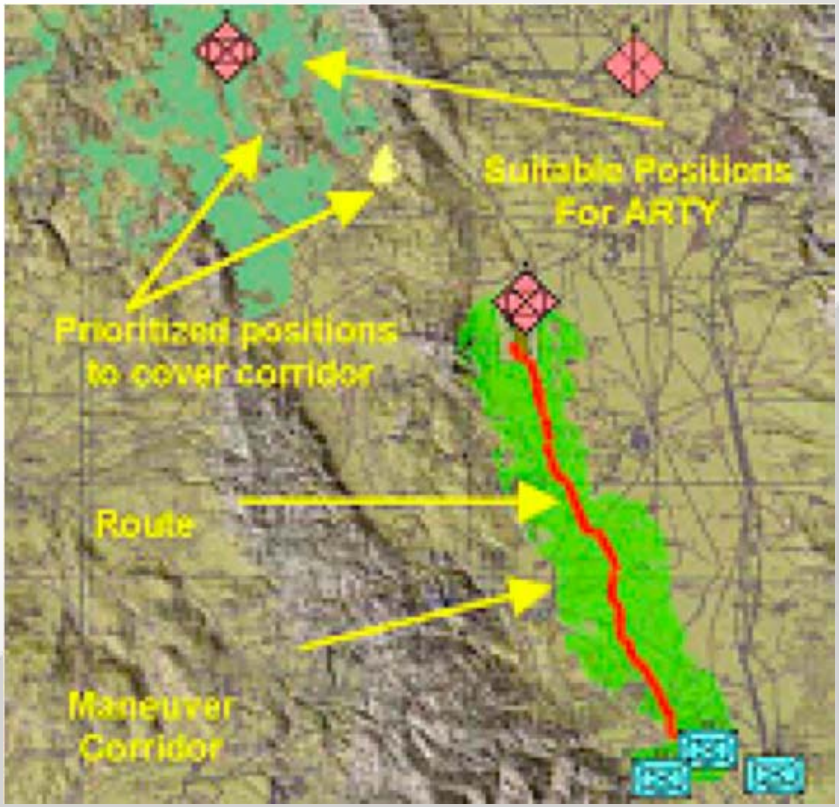
Background

- Map is focal point of the command post
- Automated geospatial support tools are rapidly penetrating all command levels
- Empirical research is needed to:
  - Evaluate military value of emerging tools
  - Prioritize future tool development



Why Conduct Experiments?

- Most military R & D tests to requirements
- Hypothesis driven to test value-added
- Statistically significant results
  - Quantitative not just qualitative feedback
- Answer questions:
  - What is the value added for the warfighter?
  - Does the product meet operational needs?
  - How can the product be improved?

Purpose of Research Program

- Sponsored by
  - U.S. Army Engineer Research and Development Center (ERDC)
  - U.S. Army GeospatialCenter (AGC)

- Purpose:
  - Assess the value-added to Military Decision Making from use of Geospatial Decision Support Products (GDSPs)
  - Evaluate contribution of the Battlespace Terrain Reasoning and Awareness – Battle Command (BTRA-BC) suite of geospatial reasoning tools

BTRA-BC II

Objective:

- Empower commanders, soldiers, and systems with **information** that allows them to **understand** and **incorporate** the impacts of terrain and weather on their functional responsibilities and processes

- Products
  - Information and knowledge products that capture integrated terrain and weather effects
  - Tactical Spatial Objects (TSOs) - Predictive decision tools that exploit these products

- Some BTRA-BC products have been fielded in the U.S. Army's Digital Topographic Support System (DTSS)
  - Used by U.S. Army for terrain analysis

Current Study

- Study Objective
  - Assess the benefit of BTRA-BC tools to military planners in a **complex** and **realistic** scenario
  - Expand on results of previous experiment (presented at last year's ICCRTS)
    - COA generation vs. AA recommendation
    - Planners vs. terrain analysts
    - More complex scenario and tasks
    - More complex decision-making

- Mission:
  - Move to seize an objective in the presence of the enemy
    - Analyze actual terrain data
    - Plan a Course of Action (COA)
    - Mechanized Battalion

Primary Hypotheses

1. Participants who use BTRA-BC TSOs will produce military planning output ***more quickly***
2. Participants who use BTRA-BC TSOs will produce a ***higher quality*** plans
3. Participants who use BTRA-BC TSOs will display ***as good an understanding*** of the impact of the given terrain on military planning
4. The quality of the output generated with BTRA-BC TSOs will be ***more uniform***
5. There will be ***little or no learning effect*** due to evaluation design
6. ***Participants will consider using BTRA-BC TSOs superior*** when producing a plan with respect to speed, quality, ease and overall

Study Design

- Environment
  - Commander's Support Environment (CSE)
    - Developmental C2 system
    - Originally a DARPA initiative

- Three independent variables
  - **System used** (with and without BTRA-BC TSOs)
  - **System Order** (which system was used first)
  - **Scenario Order** (Which of two near identical scenarios was used first)

Study Design

- **Within Participants** design with respect to System used:
  - Each subject will solve a planning scenario in both conditions (with and without BTRA TSOs)
- **Between Participants** design with respect to
  - System Order
  - Scenario Order
  - Design was counterbalanced on scenario order and system order
- Study design will maintain the required statistical power and minimize the number of participants
- Training prior to trials
  - CSE (4 hours) and
  - BTRA-BC (2 hours)

Study Design (cont)

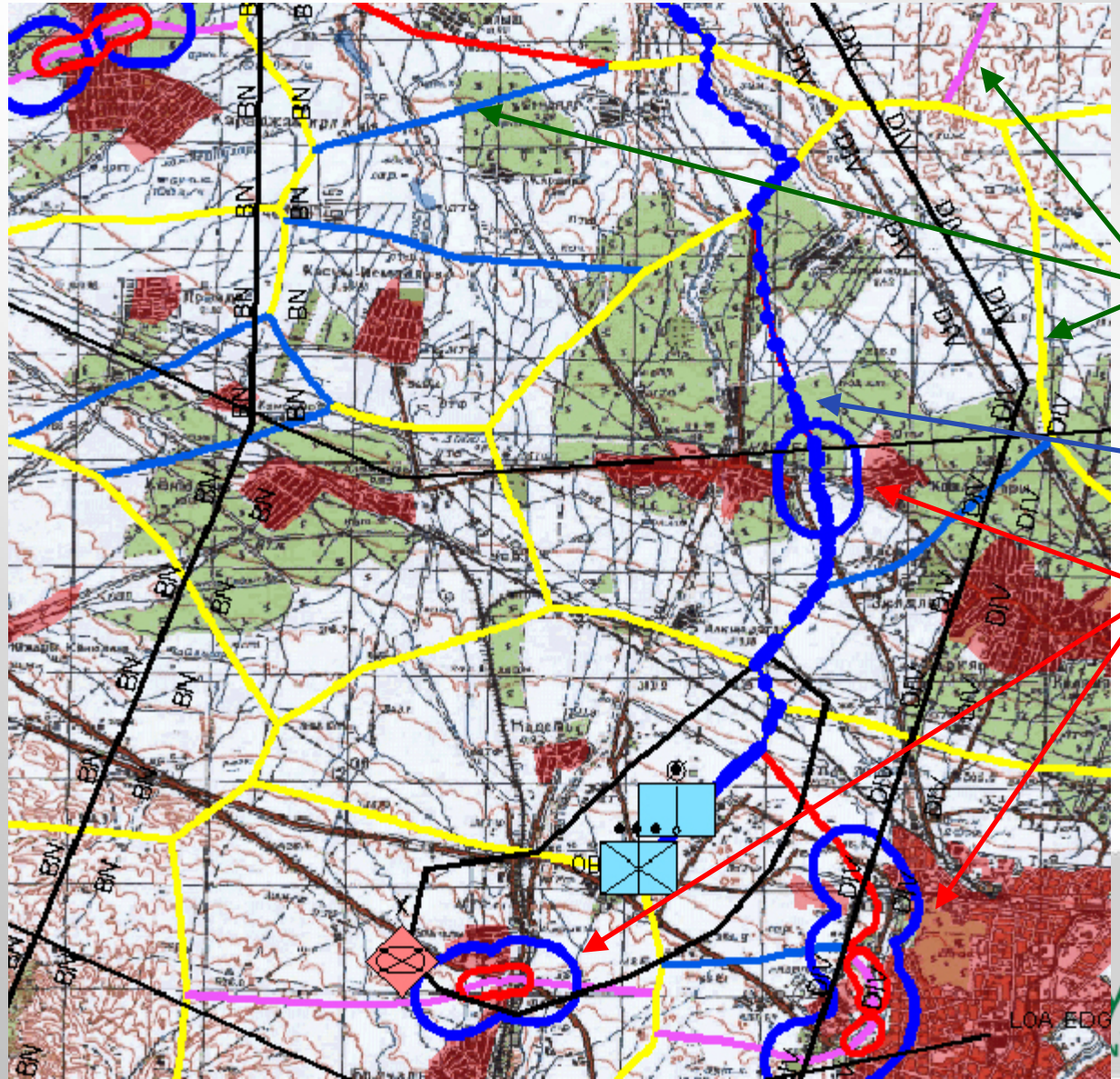
- Participants
  - U.S. Army Majors, Lt. Colonels, Colonels
    - Planning experience
    - Comfortable with digital systems
  - Experience
    - Questionnaire
    - Ranked and grouped by experience
    - Randomly assigned to groups
  - Anonymous
    - Randomly assigned participant numbers
    - Randomly assigned data designators

Experimental Tasks

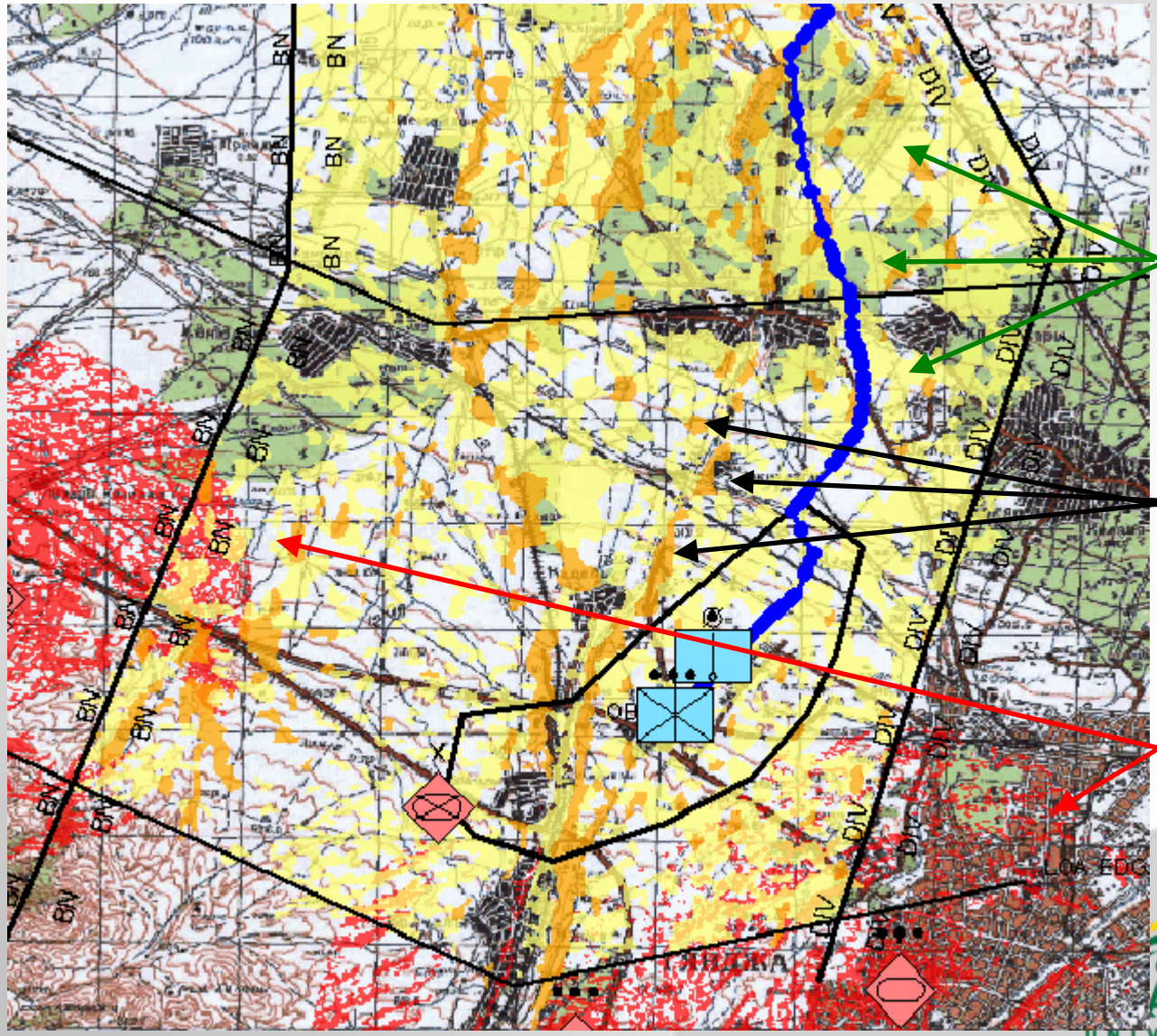
- The evaluation scenario began with analysis of specific terrain and continued to the point of generating a plan of movement and a Course of Action (COA).

- Specific tasks :
  - Digital Plan
    - Plan movement
      - Identify Mobility Corridors (MC)
      - Categorize Mobility Corridors by size
      - Group Mobility Corridors to form potential Avenues of Approach
      - Identify Choke Points on Avenues of Approach
      - Calculate travel times and coordinate simultaneous arrival
    - Identify Engagement Areas
    - Identify Battle Positions
    - Identify Ambush Sites
    - Identify Named Areas of Interest (NAI)
    - Generate battalion graphics including subordinate echelon Areas of Responsibility

BTRA-BC Tier 1 TSOs



BTRA-BC Tier 2 TSOs



Battle Positions

Hide Positions

Engagement Area

Experimental Tasks (cont)

- Specific tasks (cont)
  - Operation Order
    - Commander's Intent
    - Concept of Operations
      - Explanation of graphics
      - Impact of terrain on mission
  - Terrain Understanding Questionnaire
  - System Comparison Questionnaire

Measures

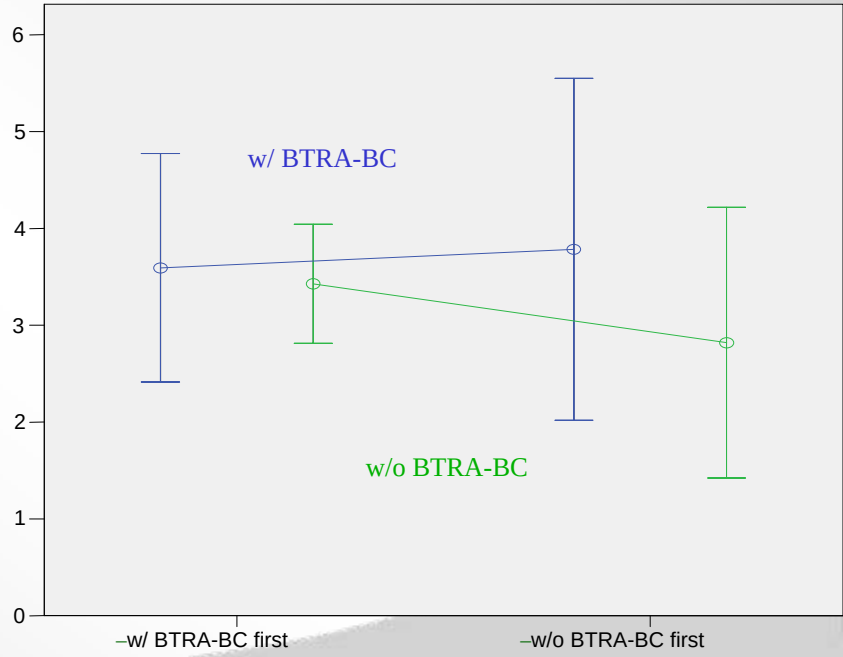
- Time to complete scenario (H1, H5)
  - Objective
  - Significant in prior experiment
  - Possibly less significant in more complex planning
- Quality of solutions as judged by expert evaluators (H2, H4, H5)
  - Subjective
  - 45 criteria in 15 categories
  - Independent SMEs
- Scores on a questionnaire evaluating subject understanding of the terrain (H3, H5)
- Scores on a questionnaire evaluating subjective perception of w/ BTRA-BC (H6)
  - Scale Normal and Reversed

Preliminary Results: Plan Quality (H2)

- There is statistical evidence that:

  Participants produced a ***higher quality*** output using CSE w/ BTRA-BC [F(1,4) = 5.35, p = 0.08]

- Performed a repeated-measures ANOVA on the average of all 13 measures of plan quality
- Approached traditional 0.05 significance level
- No other effects appeared significant.



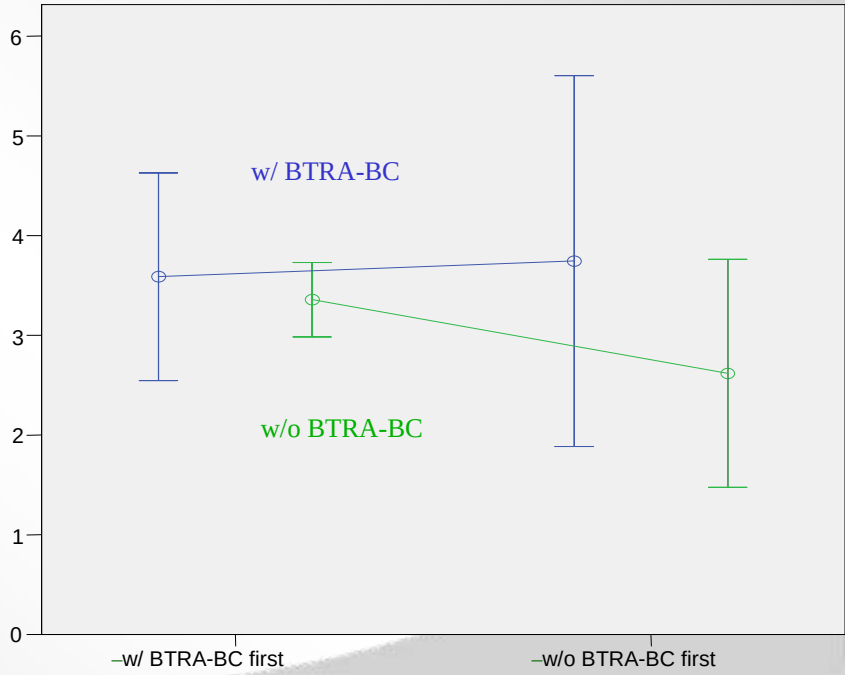
Preliminary Results: TSO-related Measures (H2)

- Participants produced a ***higher quality*** output using measures directly related to BTRA-BC TSOs [F(1,4) = 12.62, p = 0.02]

- Performed a repeated-measures (ANOVA) on the average of the TSO related measures

- Possible learning effect for CSE w/o BTRA-BC [p = 0.08](H5)

- No other significant effects

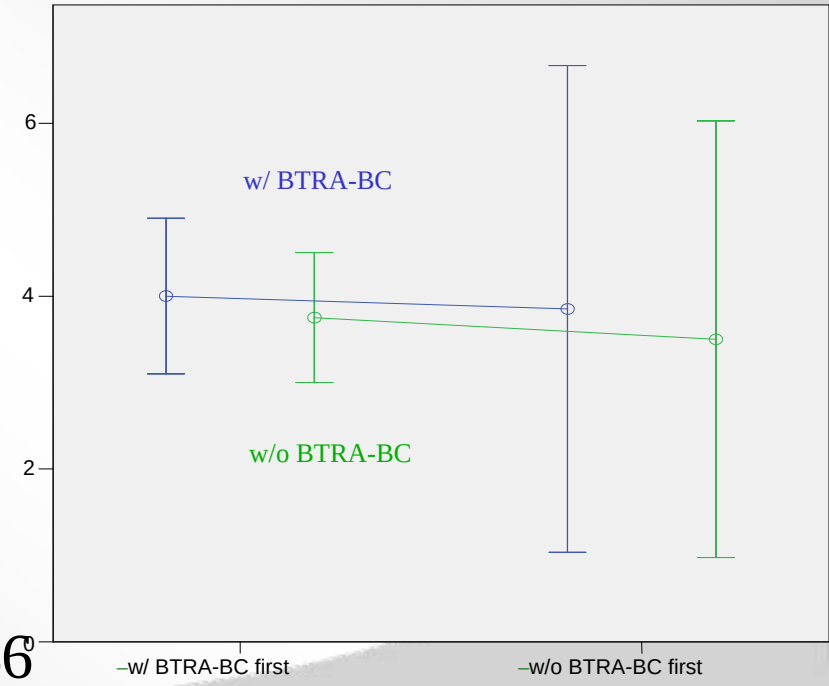


Preliminary Results: Terrain Understanding (H3, H4)

- There is no statistical evidence that participants ***knowledge of the impact of the given terrain on military planning*** differed when using CSE w/ BTRA-BC (H3)

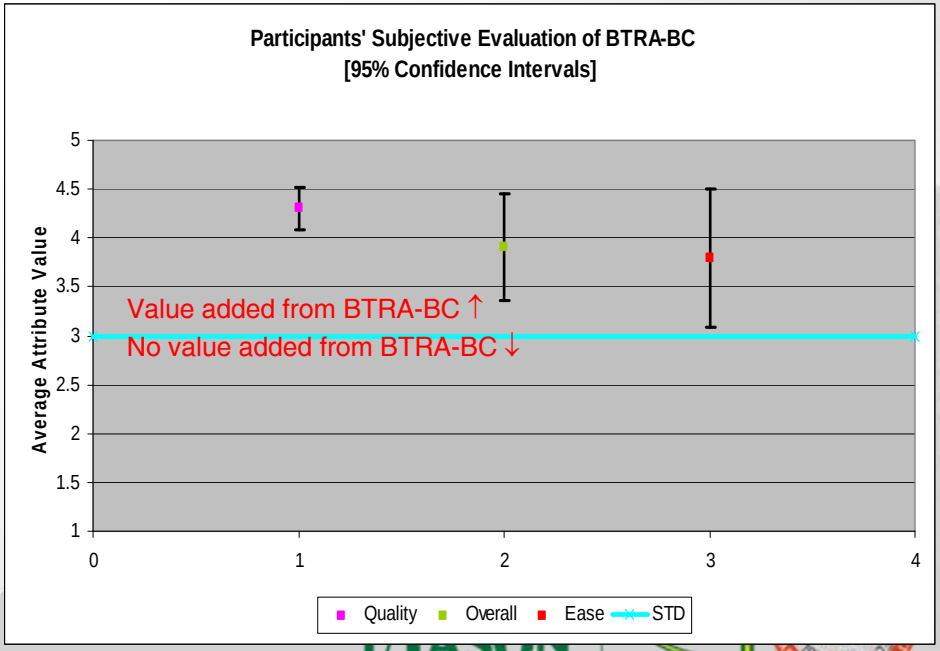
- Participants who used CSE w/ BTRA-BC first had ***significantly less variance (more uniformity) in measures of their terrain understanding*** than those who used CSE w/o BTRA first [F(1,7) = 0.10, p = 0.00] (H4)

- CSE w/ BTRA-BC first Var = 0.25
- CSE w/o BTRA-BC first Var = 2.46



Preliminary Results: Subjective Perception (H6)

- There is strong statistical evidence that:
  1. Participants believe they can produce an output of ***higher quality*** w/ BTRA-BC than w/o BTRA-BC
  2. Participants believe that overall CSE with BTRA-BC was ***superior*** to CSE w/o BTRA-BC
- The results provide marginally significant evidence producing a plan using CSE with BTRA-BC TSOs was *easier* than with BTRA-BC TSOs.
- No effect for *speed*



Summary (1 of 2)

- Preliminary results are encouraging
- BTRA-BC TSOs improved the planning process
  - Participants produced a ***higher quality*** output using CSE w/ BTRA-BC when all measures are considered
  - Participants produced a ***higher quality*** output using measures directly related to BTRA-BC TSOs
  - Participants who used CSE w/ BTRA first had ***significantly less variance (more uniformity) in measures of their terrain understanding***
  - There is a ***learning effect*** in that participants who used CSE w/BTRA-BC first produced ***higher quality*** output when they used CSE w/o BTRA-BC

Summary (2 of 2)

- Participants believe they can produce an output of ***higher quality, more easily*** and that overall CSE with BTRA-BC was ***superior*** to CSE w/o BTRA-BC
- Participants did not generate the output more quickly
- Participants ***knowledge of the impact of the given terrain on military planning*** was not degraded

- These results will be strengthened when data from the full set of 16 participants is analyzed.

Next Experiment in the Series

- Object: Assess the value of Buckeye's 4-inch resolution imagery and DTED 5 elevation data
- Examining accuracy of data vice effectiveness of tools
- Experimental Design
  - Platoon / reinforced squad
  - Iraqi city where CIB1 and Buckeye data are available
  - Planning task: Evaluation of potential sites for Vehicle Control Point (VCP)
  - Environment CSE
  - Participants: 16 infantry E6-E7 or O2-O3 with experience in-country

Questions?