Experimental Evaluation of Advanced Automated Geospatial Tools

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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 Geospatial Center (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

Mobility Corridors
Route
Chokepoints
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?