Experimental Evaluation of Advanced Automated Geospatial Tools

Kathryn Blackmond Laskey
Walter Powell
Leonard Adelman
Michael Hieb
Martin Kleiner

George Mason University C4I Center

ICCRTS 2007
Thanks to the Team!

• U.S. Army
  – Michael Powers, Technical Director
  – Daniel Visone, Program Manager
  – Kenneth Braswell, BTRA-BC Subject Matter Expert

• GMU Team
  – Shiloh Dorgan, Graduate Research Assistant
  – Ryan Johnson, Research Assistant

• NGA University
  – CW3 Martinez, Chief Instructor
  – Participants in pilot and main experiment
Background

• Map is focal point of 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
Purpose of Research Program

• General Purpose:
  – Assess the value-added to Military Decision Making from use of Advanced Automated Geospatial Tools (AAGT)

• Specific Purpose:
  – Evaluate contribution of the Battlefield Terrain Reasoning and Awareness – Battle Command (BTRA-BC) suite of geospatial reasoning tools
BTRA-BC

- Research program sponsored by U.S. Army Engineer Research and Development Center (ERDC)

- 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
  - 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 terrain technicians in performing terrain analysis

• **Study Method:**
  – Perform experiment to compare performance with and without BTRA-BC
  – Participants were students in Advanced Topographic Analysis Course (ATAC) trained as terrain technicians
  – Participants performed two trials of a military planning task:
    (1) With BTRA-BC, and
    (2) DTSS without BTRA-BC
Primary Hypotheses

1. Subjects who use BTRA-BC will produce a military planning output more quickly

2. Subjects who use BTRA-BC will produce a higher quality partial MDMP output

3. Subjects who use BTRA-BC 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 will be more uniform

5. There will be little or no learning effect due to evaluation design

6. Participants will consider BTRA superior with respect to speed, quality, understanding, usability, and overall
Study Design

- Environment: DTSS with and without added BTRA functionality

- Subjects: 18 ATAC students (mid-grade military terrain analysts)

- Within subjects design:
  - Each subject solved problem in both conditions (with and without BTRA)
    - Two near-identical scenarios with similar terrain
    - Design was counterbalanced on scenario order and system order
  - Training was conducted on BTRA-BC (1-2 hours) immediately prior to BTRA-BC trial
Experimental Tasks

• The evaluation scenario began with analysis of specific terrain and continued to the point of generating potential AAs.
• Specific tasks:
  – Generate Combined Obstacle Overlay (COO) (automated, but different process in the two conditions)
  – Identify Mobility Corridors (MC)
  – Categorize Mobility Corridors by size
  – Group Mobility Corridors to form potential Avenues of Approach
  – Plan routes for 3 types of vehicles
  – Identify Choke Points on Avenues of Approach
  – Calculate travel times
  – Recommend subordinate echelon Areas of Responsibility
  – Answer questions to assess terrain understanding
  – Answer questions to assess subjective experience with system
Combined Obstacle Overlay
Mobility Corridors
Potential Avenues of Approach
Choke Points
Battalion Boundaries
Measures

- Time to complete scenario (H1, H5)
- Quality of solutions as judged by expert evaluators (H2, H4, H5)
- Scores on a questionnaire evaluating subject understanding of the problem (H3, H5)
- Scores on a questionnaire evaluating subjective perception of BTRA (H6, H5)
Initial Results: Time to Solution

- Average time to scenario completion (H1)
  - BTRA: 1.1 hours
  - DTSS: 3.1 hours
  - >99.99% confidence that average times are different

- Learning effect (H5)
  - Average time to completion on DTSS was shorter for subjects who used BTRA first (3.6 hours vs 2.6 hours)
  - >99% confidence that average times are different
Hypothesis Tests: Subjective Perception

There is strong statistical evidence that:

1. Subjects believe they can produce the required output *more quickly* with BTRA-BC than with DTSS
2. Subjects believe they can produce an output of *higher quality* with BTRA-BC than with DTSS

The results provide no evidence against the hypothesis that:

3. Subjects believe they have *as good an understanding* of the impact of the given terrain on military planning when using BTRA as when using DTSS
Preliminary Conclusions

- BTRA-BC dramatically speeds performance on terrain reasoning tasks
- Experience with BTRA-BC may help speed terrain analysis using DTSS
- Terrain technicians believe BTRA-BC speeds performance and improves accuracy without degrading understanding of the terrain
Project Status

• Analysis of data from experiment continues
  – Results for solution quality
  – Results for other hypotheses
  – Additional analyses of questionnaire data

• Planning is underway for a follow-on experiment
  – Intelligence or operations officers perform a planning task using the Commander’s Support Environment (CSE)
    • With access to BTRA-BC products
    • Without access to BTRA-BC products
  – Experiment will evaluate speed, performance, subjective perceptions

• Future experiments will assess effect of geospatial tools on collaborative planning
Questions?