Evaluation of Buckeye/LIDAR High-Resolution Data

JGES Experiment 3

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Thanks to the Team!

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  - Mr. Vicklund
  - Capt Daine
  - Cpl Tredo

Background

- Geospatial is focal point of military planning
- Geospatial Decision Support Products are rapidly penetrating all command levels
- Empirical research is needed to:
  - Evaluate military value of emerging products
  - Prioritize future product 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 the value-added of the Buckeye/LIDAR high-resolution imagery and elevation data

Buckeye / LIDAR

- Objective:
  - Provide unclassified high-resolution geospatial data that can be applied to tactical missions
- Products – High Resolution Data
  - Buckeye
    - 10-15 cm (4-6 in) resolution color digital imagery
  - LIDAR
    - Digital Terrain Elevation Data level 5 (DTED5) comparable elevation data
    - Elevation data +/- 1 meter at 1 meter spacing
  - Co-located on helicopter / UAV
- Buckeye/LIDAR products are currently available in theater on the NIPR and SIPR nets
  - 38,000 sq km data on Iraqi urban areas and supply routes

What is it?

➔Without Buckeye?

Controlled Image Base – 1 meter (CIB1)

Buckeye Imagery

➡With Buckeye?

Looks like a school ➔

Current Study

- Study Objective
  - Assess the benefits of Buckeye/LIDAR to military planners in a **complex** and **realistic** scenario
  - To determine the effect of high-resolution data on military decision-making
  - Different approach from two previous experiments (presented at 12th, 13th, 14th ICCRTS)
    - Varied the resolution of data while maintaining computer tools constant.

Study Method

- Mission:
  - Evaluate three potential sites for Vehicle Control Point
  - Infantry platoon
  - Actual in-country urban data
  - Three sites per trial

- Three trials
  1) With Buckeye/LIDAR data
  2) With CIB1/DTED2 data
  3) CIB1/DTED2 trial with Buckeye/LIDAR data

Hypotheses

1. Participants who use the ***Buckeye/LIDAR*** would be able to ***derive information more accurately***

2. Participants who use the ***Buckeye/LIDAR*** would require ***less additional information*** in order to actually establish a VCP

3. Participants who use the ***Buckeye/LIDAR*** would produce output ***more quickly***

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

5. ***Participants will consider using*** the ***Buckeye/LIDAR superior*** with respect to speed, ease of use, usefulness of information and overall

Study Design

- **Within Participants** design with respect to System used:
  - Each subject will evaluate scenarios consisting of three sites in both conditions (with Buckeye/LIDAR data and with CIB1/DTED2 data)
- **Between Participants** design
  - System Order (which system is used first)
  - Scenario Order (which scenario is used first)_
  - 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 (1 hour) and
  - Buckeye/LIDAR (1/2 hour)
  - Sample evaluations (1 hour)

Study Design (cont)

- Participants
  - 15 U.S. Army Personnel
    - In country experience establishing VCPs
    - Experienced varied: command, platoon Sgt, fire team leader
    - Ft. Lewis (11) and Ft. Benning (4).
  - Anonymous
    - Randomly assigned participant numbers
    - Randomly assigned data designators
  - Experience Questionnaire
    - Unable to control for experience
    - Post Hoc analysis
  - Randomly assigned to groups

Experimental Tasks

- Evaluate three sites as to its potential for establishing a VCP
- Specific tasks :
  - Evaluate the potential of each site on 28 criteria in 6 categories
    - Area Characteristics (guidance)
    - Requests for additional information (RFIs)
  - Respond to questions requiring deriving information from the data
  - Respond to a questionnaire designed to obtain the participants perceptions of the potential relative value of Buckeye/LIDAR and CIB1/DTED2
  - Weight categories and criteria
  - Participate in post-trial debrief

Measures - Objective

- Answers to questions requiring analysis of the data (H3)
  - Imagery Questions
  - Elevation Data questions
- Need for additional information - RFIs (H2, H4, H5)
  - Proxy for the value of information contained in the data
  - 28 Criteria in 6 categories
- Time to complete scenario (H1, H4, H5)
  - Significant in prior experiment
- Responses to a questionnaire evaluating subjective perception of Buckeye/LIDAR (H6)
  - 10 criteria
  - Imagery and elevation

Accuracy of Information (H3)

- In all cases participants were able to derive more accurate information from Buckeye/LIDAR data than from CIB1/DTED2 data [$p < 0.001$]
  - Chi-Squared tests on answers to questions

	Percentage of Correct Responses			
	Buckeye	LIDAR	CIB1	DTED2
Overall	72.80%		15.60%	
Elevation		74.40%		23.40%
Imagery	71.20%		7.80%	

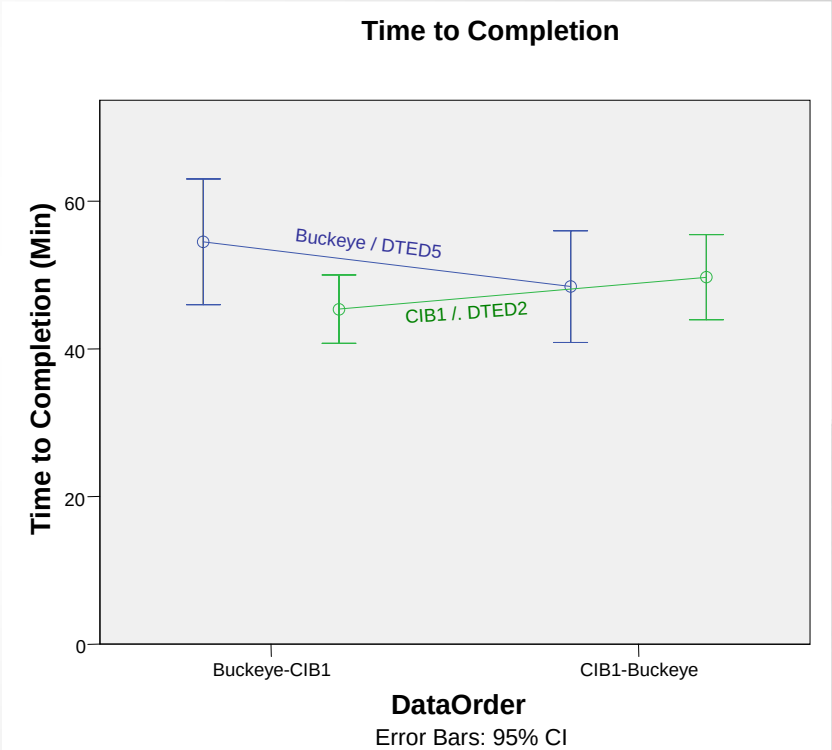
Requests for Additional Information (H2)

- Participants using Buckeye/LIDAR required less additional information [$p < 0.001$], on average, than when using CIB1/DTED2
  - Buckeye/LIDAR RFI score: 4.26
  - CIB1/DTED2 RFI Score: 2.97
- RFIs are an inverse proxy for the value of the information contained in the data.
- As RFI's are costly in time and manpower, fewer RFIs result in increased tactical flexibility, improved force security, and lower demands on intelligence staffs

Time to Solution (H1)

- Average time to scenario completion (H1)
  - Repeated measures ANOVA [$p < 0.001$]
  - Buckeye/LIDAR: 51.67 min
  - CIB1/DTED2: 47.40 min
  - Average difference was only 4 min
  - Higher resolution data required more time to analyze

- Learning effect (H5)
  - Average time to completion was shorter for the second system the participants used [$p = 0.01$]



Subjective Perception (H6)

There is strong statistical evidence [$p < 0.001$] that, when using Buckeye imagery and LIDAR elevation data, participants believe :

- they can produce the required output ***more quickly***
- it is ***easier*** to conduct military evaluations
- the information is ***more useful***

Summary

"This is a game changer"

- Higher resolution imagery and elevation data provides :
  - More information to the military decision-maker
  - Information that is more valuable to the decision-maker
- The reduced costs due to fewer RFIs would probably overshadow the slightly longer analysis time required when using higher resolution data
- Participants believe that higher resolution data improves the process of making military evaluations

Questions?