Evaluation of Buckeye/LIDAR High-Resolution Data

JGES Experiment 3

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Thanks to the Team!

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  - Maj Martin
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  - Capt Daine
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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

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Purpose of Research Program

- Sponsored by
  - U.S. Army Engineer Research and Development Center (ERDC)
  - U.S. Army Topographic Engineering Center (TEC)
- 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

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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

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What is it?

←Without Buckeye?

Controlled Image Base – 1 meter (CIB1)

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Buckeye Imagery

➔With Buckeye?

Looks like a school ➔

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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.
    - Evaluation vice planning
    - Small unit (platoon) vice battalion or brigade
    - Urban vice open country
- Study Method:
  - Participants participated in three trials evaluating multiple potential sites for Vehicle Control Points (VCP) using CSE:
    (1) With Buckeye/LIDAR data
    (2) With CIB1/DTED2 data
    (3) Second trial scenario with Buckeye/LIDAR data

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Hypotheses

1. Participants who use the ***Buckeye/LIDAR*** would produce output ***more quickly***
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 be able to ***derive information more accurately***
4. The output generated with the ***Buckeye/LIDAR*** will be ***more uniform***
5. There will be ***little or no learning effect*** due to evaluation design
6. ***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 each site as to its potential for establishing a VCP
- Specific tasks :
  - Evaluate the potential of each site on 28 criteria in 6 categories
    - Area Characteristics
    - Requests for additional information (RFIs)
    - Rate the overall quality of each site
    - Rank the three sites relative to one another
    - Rate confidence in the site rankings
  - 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

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

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Rejected Measures

- Area Characteristic
  - Due to variations in terrain there was no objective measure of the quality of each site wrt to a VCP
  - Comparing participants scores for each site to a "ground truth" or consensus score from the SMEs would have controlled for variation in site terrain.
  - SMEs were tasked to generate consensus scores for each site in the 28 criteria and overall
  - The wide range of experiences among the SMEs contributed to varying judgments wrt evaluation criteria.
  - Correlations among the consensus scores of the SMEs were too low for there to be confidence in the consensus scores.

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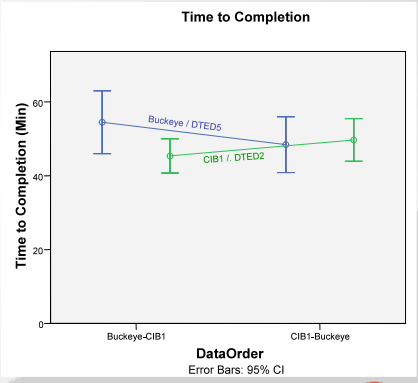
Time to Solution (H1)

- 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]



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

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%**
Q1		62.20%		13.40%
Q2		86.60%		33.40%
Imagery	**71.20%**		**7.80%**	
Q3	75.60%		11.20%	
Q4	66.60%		4.40%	

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Uniformity (H4)

- There is no evidence that participants' evaluations when using Buckeye/LIDAR were more uniform than when using CIB1/DTED2
  - This is probably due to the variety of experiences among the participants

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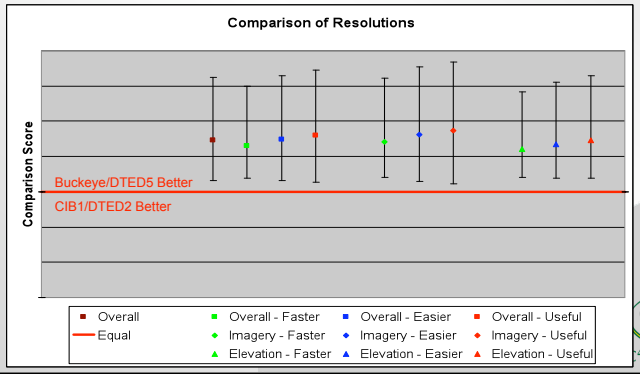
Subjective Perception (H6)

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***



Observations

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