Using Formative Evaluations to Assess the Potential Value of Geospatial Decision Support Products During Development

George Mason University

Walter Powell
Ryan Johnson
Leonard Adelman
Kathryn B. Laskey

Army Geospatial Center

Ken Braswell
Vineet Gupta

Viecore FSD

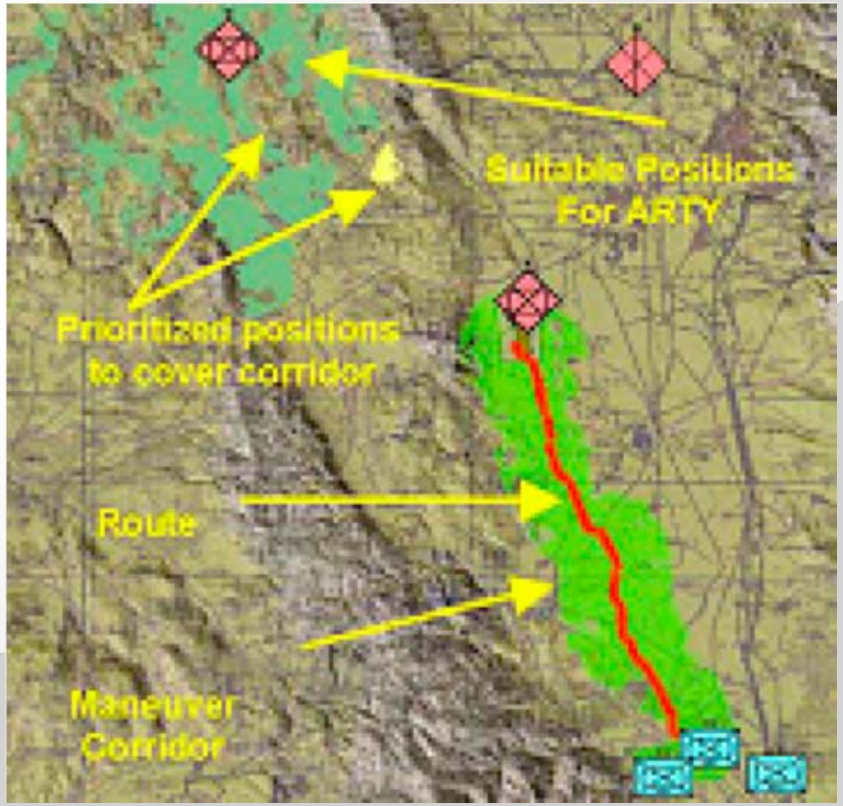
Michael Altenau
Andrew Goldstein

15th International Command & Control Research & Technology Symposium

23 June 2010, Santa Monica, CA

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 Evaluations?

- "Requirements frequently are not linked to the capabilities desired by the Combatant Commanders..."

  —Defense Acquisition Performance Assessment, 2006

- Answer questions:
  - What is the value added for the warfighter?
  - Does the product meet operational needs?
  - How can the product be improved?
- Provide feedback to help focus allocation of resources

Formative vs. Summative Experiments

- Formative evaluation involves systematically working with a few subject matter experts (SMEs) to evaluate the prototype to provide feedback on the product's progress toward meeting the users' needs:
  - ***During*** the design phase
  - Qualitative feedback
  - Fewer participants (3-5)

- Summative evaluation involves conducting a rigorous experiment (or acceptance test) with sufficient users to determine if product actually meets the users needs:
  - Typically near the end of design phase
  - Statistically significant (quantitative) results
  - Well designed experiment requires 16 participants

Research Program Overview

Sponsor:

- U.S. Army Geospatial Center (AGC), a part of U.S. Army Engineer Research and Development Center (ERDC)

Purpose:

- Assess the contribution to military decision making of the Battlespace Terrain Reasoning and Awareness – Battle Command (BTRA-BC) suite of geospatial reasoning tools
- Provide feedback to tool developers

Participants:

- Experienced Military personnel as SMEs

BTRA-BC

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: Tactical Spatial Objects (TSOs)

- Computationally light weight objects that transform geospatial data into geospatial information relevant to the tactical mission or task
- Capture integrated terrain and weather effects
- Based on doctrine

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

Evaluated TSOs

Assembly Area

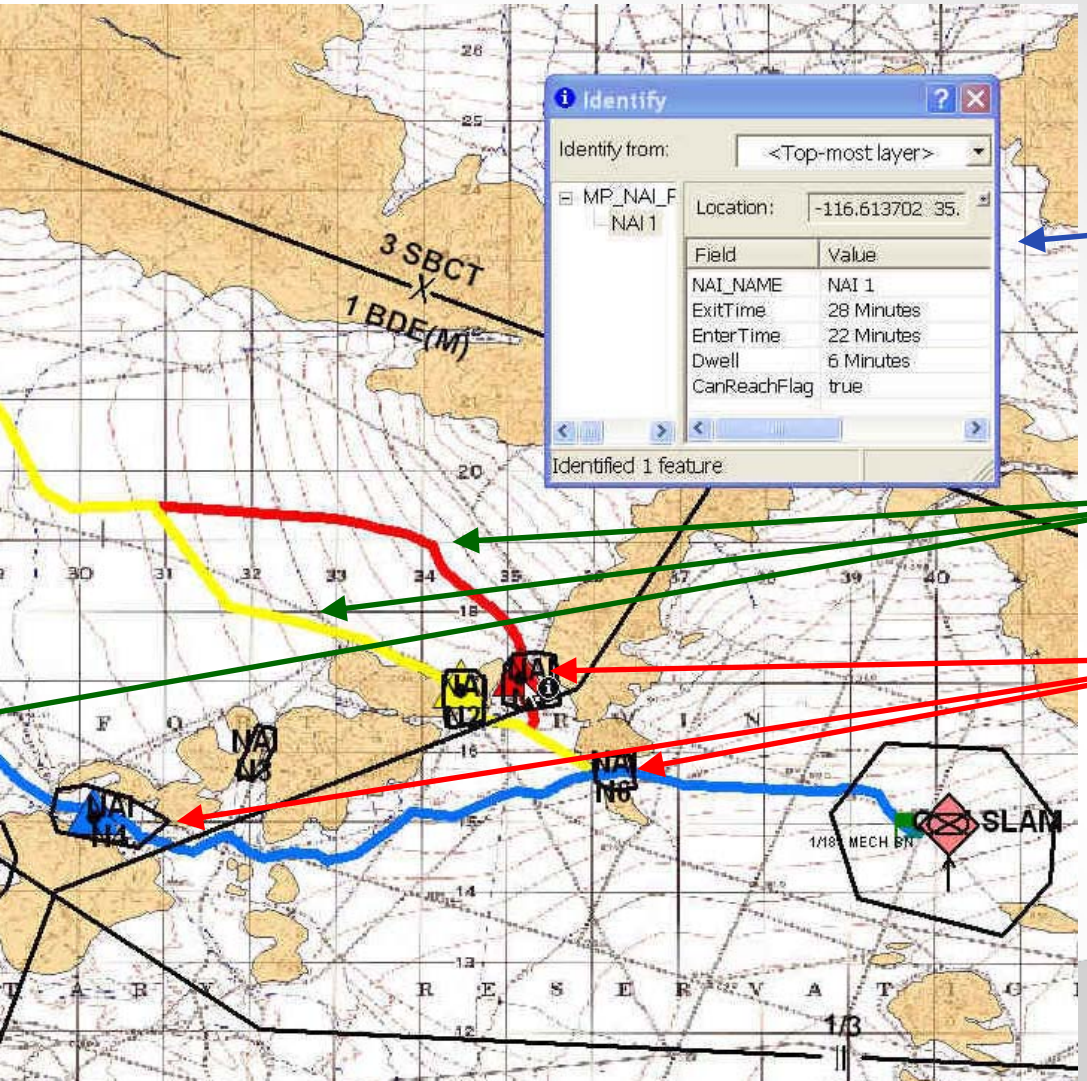
- Open Terrain
- Closed Terrain

Choke Points

Engagement Area

- **Movement Projection**
  - Weighted Costs
  - Route Options
  - Time-Constrained
  - Time- and Objective-Constrained
  - Force-on-Force
  - Named Area of Interest (NAI)
  - Capacity Flow
  - Multi-Constrained

Movement Projection: NAI TSO



NAI Detail

Routes

NAIs

Hypothesis Generation

Evaluation team identified many criteria of value for the TSOs

SMEs vetted the criteria

Criteria were grouped into concise hypotheses

Hypotheses covering the majority of criteria were used to generate the questionnaires

Hypotheses and questions specific to each TSO were addressed during post-TSO hot wash discussions

Hypotheses

Using the TSOs to complete the task would improve the quality of the participants' solutions

Using the TSOs would make completing the task easier

Using the TSOs would save the participant time

The functions and setting of the inputs would be easy to understand

Adjusting the inputs would provide additional information about the effect of terrain on the task

The TSOs would highlight the terrain information most important to completing the task

The participants would elect to use the TSO to complete the task instead of, or in addition to, currently

Study Design

Environment

- BTRA-BC C2 Test and Demonstration Application (TDA)
- Developmental C2 system with features representative of fielded systems

Training prior to trials

- TDA (1 hour) and
- General BTRA-BC (1 hour)
- Per TSO (0.5 hours each)

Participants: 2 – 4 experienced military planners

Study Design (con't)

Operation Order

- Mission
- Commander's Intent
- Concept of Operations
- Vignettes

Value Questionnaire – 5-point Likert scale

Pre-evaluation technical walkthrough and pilot test

Post-evaluation hot wash discussion

aphic User Interface (GUI) Concerns

TSOs will be provided to Commercial Joint Mapping Tool Kit (CJMTK) Program Of Record (POR)

Evaluated BTRA-BC TSO engines not TDA GUI

Impossible to completely divorce evaluation of TSO engines from GUI

Fielded systems which implement will have specifically designed design GUIs

GUI comments noted and provided with TSO engines

Examples of Specific Feedback

Movement Projection:

- Weighted Costs: 4 of 4 participants would use the TSO
- Force-on-Force: 2 of 3 participants would not use the TSO
- Implementing with urban terrain would be useful
- The ability to adjust maneuver / formation speed would be useful

AA: Population and building density would be useful as additional inputs

NAI: TSO would be useful for both offensive and defensive missions including generating multiple friendly Courses of Action (COAs).

Summary of Results

Most TSOs were valuable in their current form and participants would use them if they were available

Their initial confidence in the TSOs would be enhanced if:

- It were easier to see the data on which the TSO outputs were based
- The participants better understood the process for generating output graphics and tables

Participants were enthusiastic about most of the Movement Projection TSO options, but found little utility for the Force-on-Force option

Summary (con't)

Current version of the Engagement Area (EA) TSO was not ready to be fielded

- It did not provide any information beyond than that available from the Choke Point TSO
- Additional information was needed, such as size of units; weapons, observation, fire support, & battle positions; and the commander's desire about where to engage the enemy
- The EA TSO should be developed at a more mission-specific level

GUI and Other Concerns

Addressing GUI issues would allow participants to better understand the potential value of the TSO engines

It was difficult to access information other than that presented as graphics

There was concern that in order for these TSOs to be used in the field, significant preparation by topographic experts would be needed to prepare the data

Conclusions

Informative feedback can be obtained from a well-formulated evaluation using a small number of participants

Feedback obtained early in development can test the viability of underlying concepts

Formative evaluations have become part of the TSO developmental cycle

- FE II evaluated 5 TSOs in December 2009
- FE III evaluated 6 TSOs in May 2010
- FE IV is tentatively scheduled for Fall 2010

Questions?