Dynamic Battlefield Visualization: Knowledge Management in a Complex, Emergent PMESII-PT Battlefield

Paper 162

Dennis K. Leedom, Ph.D., Evidence Based Research, Incorporated
Scott B. Shadrick, Ph.D., U.S. Army Research Institute

14th ICCRTS “C² and Agility”
Washington, DC, 15-17 June, 2009
Visualization can be generally defined as the art and science of developing situational understanding, determining a desired end state, and envisioning how to move the force from its current state to the desired end state.
Visualization Challenge

ANBAR PROVINCE, WESTERN IRAQ

SYRIA

ANBAR PROVINCE

JORDAN

SAUDI ARABIA

100 miles

The operational variables describe the overall operational environment. Upon receipt of a warning order or mission, Army tactical leaders narrow their focus to six mission variables. Mission variables are those aspects of the operational environment that directly affect a mission.
Phase 1: Task Requirements Analysis

Organizational Sensemaking Research

Visualization Process Analysis
Psychological Social Ecological

Stability Ops Analysis

Issues & Emphases

Officer Interviews

Training Support Package

Interview Guide
Visualization Characteristics

Battlespace Visualization

- Purposefully frames actions and links them with understanding and intent
- Is synchronized vertically across the commander and staff
- Balances intuition with deliberate reasoning according to past experience
- Structurally framed by doctrine to provide common ground of understanding
- Matched to the dimensions and levels of operational complexity
- Collaboratively constructed to achieve unity of purpose
- Continuously adjusted to revealed aspects and unpredictable adversary
- Supports and guides a larger planning and execution process
Levels of Visualization Thinking

**PURPOSE**  What am I attempting to accomplish? How do I define my desired

**FOCUS**  Where can the enemy be most effectively influenced to achieve the desired endstate? How do I define the center(s) of gravity?

**SYSTEM EFFECTS**  How do I achieve this influence? What systems and functions support the center(s) of gravity?

**OBJECTS**  What specific units, groups, people, facilities, events do I need to target to defeat or manipulate these systems and functions?

**ACTIONS**  What actions (lethal and non-lethal) do I need to take against these units, groups, people, facilities, and events?

**RESOURCES**  What resources (troops, Joint/Interagency support) do I need to accomplish these actions?

**TIMING**  What is the required timing and synchronization of these resources and actions?
Commander’s Visualization Space
Issues Highlighted in Interviews

• 25 interviews with officers possessing relevant BCT/BTF command and staff experience
• Read-ahead survey form based on initial task model
• 2 hour interviews recorded for post-analysis

• Visualizing effects of non-lethal actions on civilian population (center of gravity) / lack of doctrinal concepts and MOEs
• Reconciling multiple operational perspectives of military forces, interagency organizations, and intergovernmental elements in a common PMESII-PT battlespace
• Reconciliation of short-term operational objectives against short-term tactical actions
• Loss of operational focus during unit rotation / discontinuity of operations during unit handovers
• Managing multiple forms of verbal, written, graphic, and tacit knowledge
Visualization Task Areas

• **Build the Visualization Framework**
  1. Identify tactical problems employing METT-TC and Operational Design frameworks

• **Synchronize the Visualization Framework**
  2. Synchronize the visualization internally across Commander and staff to develop shared understanding
  3. Synchronize the visualization across relevant external players to accommodate multiple stakeholder perspectives

• **Assess the Visualization Framework**
  4. Focus collection of information and identify patterns / trends to discover operational variances and maintain a running estimate
  5. Develop meaningful measures of effectiveness (MOE) based on endstate objectives and 2nd-order consequences

• **Exploit the Visualization Framework**
  6. Target shaping and ISR operations to reduce risk/uncertainty and discover adversary weaknesses
  7. Exploit newly revealed problem elements to seize and maintain operational initiative
Training Development and Testing

- Deliberate practice of expert cognitive behaviors
- Multiple, realistic COE scenarios
- Built-in cues or triggers: ambiguous, critical, useful, irrelevant, and misleading
- Built-in performance measurement supports feedback
- Coaching/feedback via video or avatars of authentic mentors, instructors, and Soldier role models
Introduction to Visualization Training

In this module, you will be introduced to the visualization skill, identify tactical problems using the factors of METT-TC & integrating the Elements of Operational Design.

In this module, you will see:

a. A description of the visualization process for Build 1, with an example, which demonstrates how the trainee uses the Target Performance Criteria as the means to build the visualization.

b. The background situation, with relevant maps, staff updates and situation update.

c. A practical exercise of the Build 1, visualization process with assessment and feedback.
Introductory Materials

Visualization Introduction

Road-to-War Briefing

Battlefield Update Briefing
Training Vignette Features

- Video from Iraq
- Realistic Animations
- UAS Video
- C2 Information Displays
Pre- and Post-Training Assessment

Students review situation

Students perform task skills

Students receive feedback
## CONFIDENCE RATINGS

<table>
<thead>
<tr>
<th>Visualization Skill Domain</th>
<th>Mean Rating</th>
<th>Pre-Training</th>
<th>Post-Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Build</td>
<td></td>
<td>3.89</td>
<td>3.92</td>
</tr>
<tr>
<td>Synchronize</td>
<td></td>
<td>3.96</td>
<td>4.05</td>
</tr>
<tr>
<td>Assess</td>
<td></td>
<td>3.37</td>
<td>3.76</td>
</tr>
<tr>
<td>Exploit</td>
<td></td>
<td>3.04</td>
<td>3.71</td>
</tr>
</tbody>
</table>

## PERFORMANCE ASSESSMENT

- Pre-test ($M = 79.6, SD = 4.6$)
- Post-test ($M = 87.8, SD = 4.9$)

(Wilcoxon’s $Z = 2.533, p < .05$)
Phase 2: Refine the Visualization Model

Research Findings from Phase 1

Knowledge Management Analysis

Issues & Emphases

Doctrinal Alignment

Issues & Emphases

Officer Interviews

Issues & Emphases

Refined MDMP Model
Sensemaking Strategies

KURTZ & SNOWDEN, 2003
Forms of Sensemaking Knowledge

LOGICO-SCIENTIFIC KNOWLEDGE
- Objective: Establish a body of universal truths
- Nature: Empirically validated truths, objective definition
- Method: Formal reasoning using predicate logic and proofs
- Application: Theory-driven, context-free, objective, ahistorical

NARRATIVE KNOWLEDGE
- Objective: Endow experience with meaning and intentionality
- Nature: Plausible explanations, bracketed by experience
- Method: Abductive just-in-time reasoning using story-telling
- Application: Meaning-driven, context sensitive, intentional, paradoxical

BRUNER, 1986
Mapping onto Operational Design

ELEMENTS OF OPERATIONAL DESIGN
(from US Army FM3-0, Feb 2008)

HOLISTIC KNOWLEDGE FRAMEWORK

End State

Conditions

Centers of Gravity

Operational Approach

Decisive Points

Lines of Operation/Effort

Battlespace Artifacts

System Models

Tactical Episodes

Strategic Agendas

Operational Significance and Context

State Variables

Define

Indirectly Modify

Define

Directly Modify

Define

Input to

Transaction Changes

Reveal

Instantiate

Define
Issues Highlighted in 2nd Interviews

- Misuse of intuitive (RPD) reasoning and abbreviated MDMP when it is not supported by relevant operational experience
  - Traditional MDMP viewed as a time-consuming, pro forma exercise
  - Continuous series of FRAGOs cannot substitute for deliberate reevaluation of operational requirements and strategy
- Failure to adequately transfer situation awareness and understanding between rotating units
  - New unit experiences steep learning curve
  - Adversaries learn to exploit operational seams
- Operational objectives poorly articulated
  - Reactive operations consist of disconnected series of tactical engagements and effects (e.g., “Ground Hog Day” syndrome)
  - Consequence management consumes considerable resources

18 interviews with officers possessing relevant BCT/BTF command and staff experience
2 hour interviews recorded for post-analysis
Continuous Visualization Cycle
Flow of Knowledge in Battle Rhythm

Diagram showing the flow of knowledge in battle rhythm with various stages and processes, including identifying key battlefield objects, representing the battlefield, connecting systems in terms of PMESII-PT influence pathways, defining relevant MOEs and synchronizing framework of understanding, assessing the state of the battlefield and level of operational progress, defining endstates and identifying relevant PMESII-PT conditions, identifying the center of gravity systems associated with endstate, designing operational approaches in terms of effects and decisive points, orchestrating operational approaches in terms of lines of operation/effort, refining operational reach, tempo, simultaneity/deep, phasing/transition, culmination, and risk, conducting mission analysis and developing ISR plan, developing course of action (COA) sketches and refined guidance, conducting COA war game and compare COA options, approving COA, refining CCIR, and identifying high-payoff targets, producing operations plan, order, and/or FRAGOs.
Transfer of Visualization between Units

Continuous Process of Knowledge Management and Battle Management
Questions ?