

12TH ICCRTS: Adapting C2 to the 21st Century

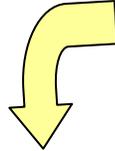
Macrocognition in Complex Team Problem Solving



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OPERATIONAL DOMAIN

- Agile, quick-response teams
- Power to the edge
- Coalition teams
- Special Ops
- Knowledge Interoperability



Develop the ability to make sense of and use information (e.g. converting data to knowledge) within the cognitive domain.

Improve Decision making – enhanced situational awareness through collaborative engagement and remote monitoring to compress the Observe-Orient-Decide-Act loop

..... Adm James R Hogg, Director CNOSSG

2006 Quadrennial Defense Review (QDR)

.... a substantial 15 percent increase in U.S. Special Operations Forces (SOF)

"SOF will increase their capacity to perform more demanding and specialized tasks, especially long-duration, indirect and clandestine operations in politically sensitive environments and denied areas,"

"SOF will have the capacity to operate in dozens of countries simultaneously" and will deploy for longer periods to build relationships with "foreign military and security forces"



Military Requirements / Drivers

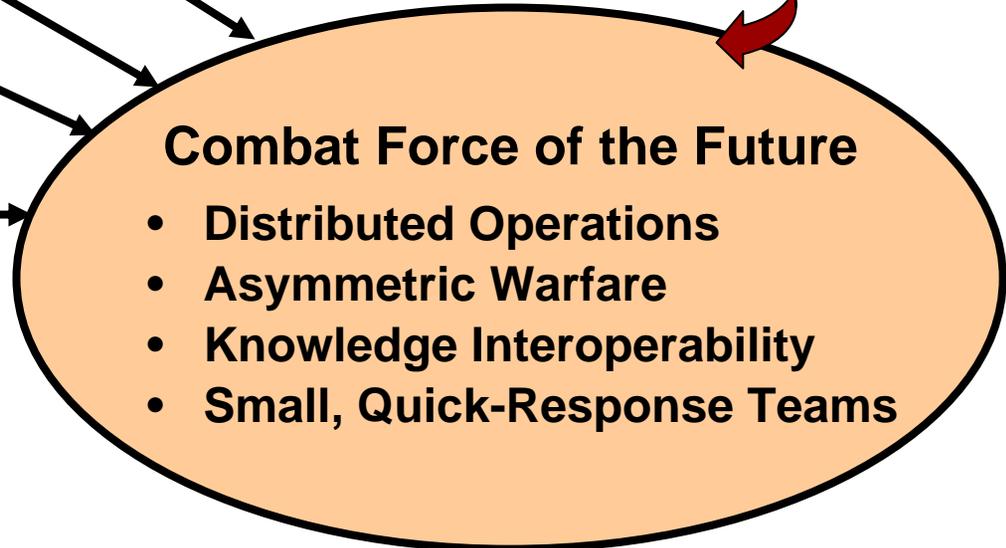
Naval S&T Focus Area
Maritime Domain Awareness
Information, Analysis and Communication
Operational Environments
Asymmetric & Irregular Warfare
Distributed Operations
Assure Access and Hold at Risk
Power Projection
Survivability and Self-Defense
Naval Warrior Performance and Protection
Platform Mobility
Fleet/Force Sustainment
Affordability, Maintainability, and Reliability
Power & Energy



Operational Concepts & Missions

Warfighting & Support Functions

Strong requirement in CNOs SSG XXVI "Cyberspace and Maritime Operations in 2030"



Capabilities Required

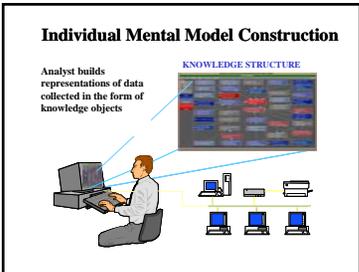
- **Rapid Team Analysis of Large-Volume, Uncertain Data**
- **Knowledge Interoperability in Coalition Ops**
- **Measures of Team Situational Awareness**
- **Accelerated Team Synchronization**
- **Improved Heterogeneous Team Performance**
- **Develop Team Collaboration Performance Metrics**
- **Superior Speed of Command and Course of Action Selection**
- **Cultural/Language/Experience-Free Representation and Transfer of Meaning**
- **Computational Models of Subjective Reasoning/Course of Action Selection**

Collaborative Cognition in Practice



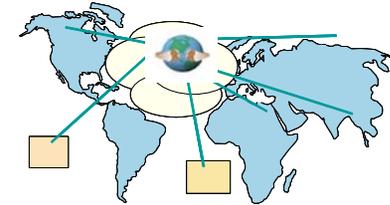
Collaboration and Knowledge Interoperability (CKI) Program

Individual Knowledge Building



Developing Knowledge Interoperability

Work by teams whose members are separated by space and time.



Program Objective

Understand the cognitive processes underlying team decision making in order to aid and improve team performance in quick-reaction, NDM-type problem solving.

Attaining Shared Understanding



Team Consensus Development





Office of Naval Research

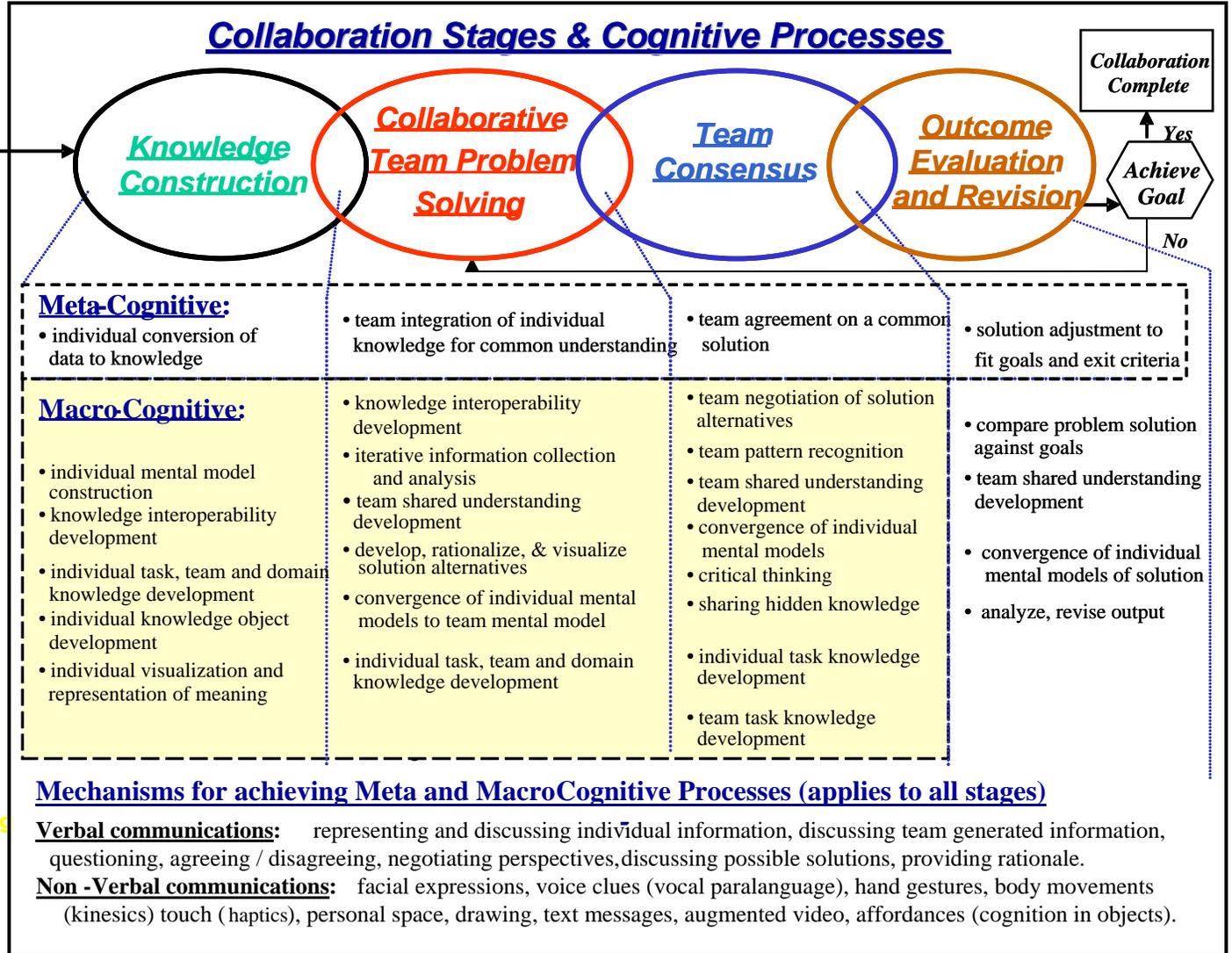
Collaboration and Knowledge Interoperability (CKI) Program

MODEL OF TEAM COLLABORATION

Focus on Macro-Cognition

Problem Area Characteristics

- Collaborative Situation Parameters:
- time pressure
 - information/knowledge uncertainty
 - dynamic information
 - large amount of knowledge (cognitive overload)
 - human-agent interface complexity
- Team Types
- asynchronous
 - distributed
 - culturally diverse
 - heterogeneous knowledge
 - unique roles
 - command structure (hierarchical vs. flat)
 - rotating team members
- Operational Tasks
- team decision making, COA selection
 - develop shared understanding
 - intelligence analysis (team data processing)



Objective: Present a taxonomy of team collaboration stages and associated macrocognitive processes and sub-processes. The taxonomy will serve as a starting point toward achieving a better understanding of the cognitive aspects of team collaboration

Impact: Understanding team macrocognition will produce more effective team collaboration tools resulting in more timely and accurate mission decisions from C2 down to individual warfighter. Tools will also improve intelligence analysis and mission planning.



CONUS Reachback



SOF tactical unit





Team Collaboration Taxonomy

Collaboration Stages and Macrocognitive Processes



	Team Collaboration Stages			
Major Macro-cognitive Processes	Knowledge Construction	Team Problem Solving	Team Consensus	Evaluation and Revision
Individual Knowledge Building				
Team Knowledge Building				
Developing Shared Problem Conceptualization				
Team Consensus Development				
Outcome Appraisal				



Team Collaboration Taxonomy

Collaboration Stages and Macrocognitive Processes



	Team Collaboration Stages			
Macro-cognitive Sub-Processes	Knowledge Construction	Team Problem Solving	Team Consensus	Evaluation and Revision
Individual Knowledge Building				
<i>Iterative Information Collection</i>				
<i>Individual Task Knowledge Development</i>				
<i>Individual Mental Model Development</i>				



Team Collaboration Taxonomy

Collaboration Stages and Macroognitive Processes



	Team Collaboration Stages			
Macroognitive Sub-Processes	Knowledge Construction	Team Problem Solving	Team Consensus	Evaluation and Revision
Team Knowledge Building				
<i>Pattern Recognition and Trend Analysis</i>				
<i>Team Mental Model Development</i>				
<i>Recognition of Expertise</i>				
<i>Sharing Unique Knowledge</i>				
<i>Uncertainty Resolution</i>				
<i>Knowledge Interoperability</i>				



Team Collaboration Taxonomy

Collaboration Stages and Macrocognitive Processes



	Team Collaboration Stages			
Macro-cognitive Sub-Processes	Knowledge Construction	Team Problem Solving	Team Consensus	Evaluation and Revision
<i>Developing Shared Problem Conceptualization</i>				
<i>Visualization and Representation of Meaning</i>				
<i>Building Common Ground</i>				
<i>Knowledge Sharing and Transfer</i>				
<i>Team Shared Understanding</i>				



Team Collaboration Taxonomy

Collaboration Stages and Macrocognitive Processes



	Team Collaboration Stages			
Macro-cognitive Sub-Processes	Knowledge Construction	Team Problem Solving	Team Consensus	Evaluation and Revision
<i>Team Consensus Development</i>				
<i>Critical Thinking</i>				
<i>Mental simulation</i>				
<i>Intuitive Decision Making</i>				
<i>Iterative Information Collection</i>				
<i>Solution Option Generation</i>				
<i>Storyboarding</i>				
<i>Team Pattern Recognition</i>				
<i>Negotiation of Solution Alternatives</i>				



Team Collaboration Taxonomy

Collaboration Stages and Macrocognitive Processes



	Team Collaboration Stages			
Macroognitive Sub-Processes	Knowledge Construction	Team Problem Solving	Team Consensus	Evaluation and Revision
Outcome Appraisal				
<i>Feedback Interpretation</i>				
<i>Replanning</i>				
<i>Team Pattern Recognition</i>				

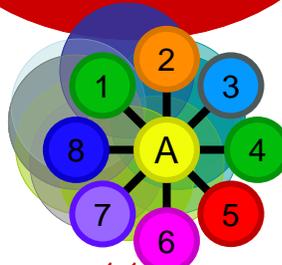
Task: Outcome, Evaluation and Revision



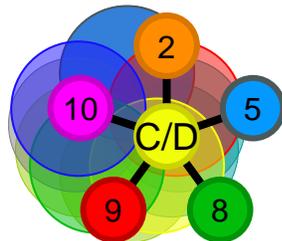
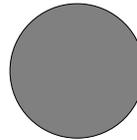
Macro-Cognitive Processes:

1. Individual mental model construction
2. Individual task knowledge development
3. Individual visualization & representation of meaning
4. Knowledge interoperability
5. Iterative information collection & analysis
6. Team shared understanding
7. Develop, rationalize & visualize solution alternatives
8. Convergence – Individual to team mental model
9. Team agreement on a common solution
10. Team negotiation
11. Team pattern recognition

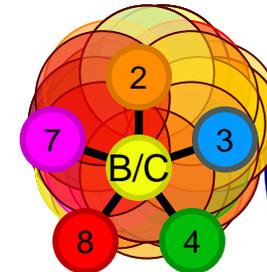
Task: Knowledge Construction



Macro-cognitive Processes



Task: Team Consensus



Task: Team Problem Solving

Summary

- **Multidisciplinary Research in Macrocognition poses Terminology Challenges**
 - ✓ Terminology will often be domain specific
 - ✓ Multiple meanings of terms will likely exist
 - ✓ Multidisciplinary contributions add complexity to functional relationships
 - ✓ Granularity of the processes must be defined (nesting of processes)
 - ✓ A new Ontology may be needed

- **Future Research Issues**
 - ✓ Macrocognition is an understudied construct within team cognition
 - ✓ Macrocognition is a key factor in team performance in ad-hoc, problem solving teams
 - ✓ Macrocognition consists of several macrocognitive processes consistently present in collaborative team activity

QUESTIONS ?