Modeling Organizational Decision Making in Military Command & Control

Dr. Dennis K. Leedom
Science Advisor, US Army III Corps
Fort Hood, Texas

July 2001

Outline

1. Outline III Corps battle management organizational structure
2. Summarize Army frustration with measuring the ROI of digitization
3. Review of C^2 decision modeling paradigms
4. The multi-tiered decision process within a battle staff
5. Coping with situational ignorance: the need for sensemaking
6. System performance measurement: the need for a paradigm shift
7. Questions / Discussion

III Corps Battle Management Organizational Structure

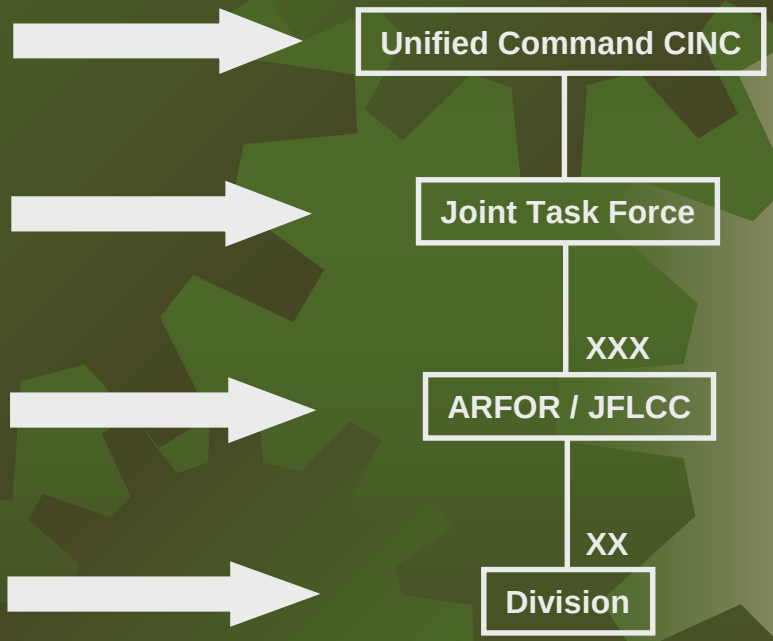
C^2 Relationships for a Corps

A CORPS NORMALLY FIGHTS AS PART OF LARGER FORCE

A CORPS CAN BE ASSIGNED AS A JTF/ARFOR HEADQUARTERS

A CORPS CAN BE ASSIGNED THE ARFOR/JFLCC HEADQUARTERS

A CORPS CAN BE A FORCE PROVIDER FOR OTHER HEADQUARTERS



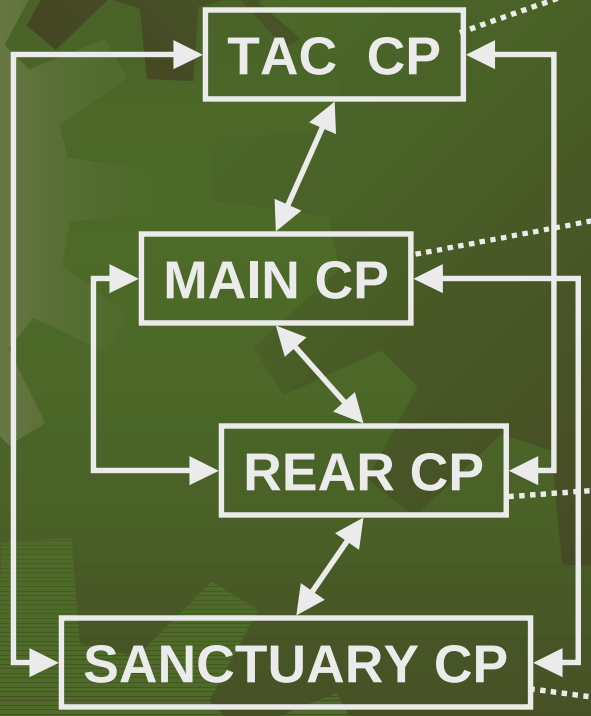
III Corps Combat Power

37% OF ALL U.S. ACTIVE COMPONENT GROUND COMBAT POWER

OVER 25,000 COMBAT VEHICLES AND AIRCRAFT

- Armored Cavalry Regiment
- 2 Heavy Divisions
- 2 Heavy Brigades
- Air Defense Brigade
- Corps Artillery
- COSCOM
- Various Corps Support Units

III Corps Command Posts



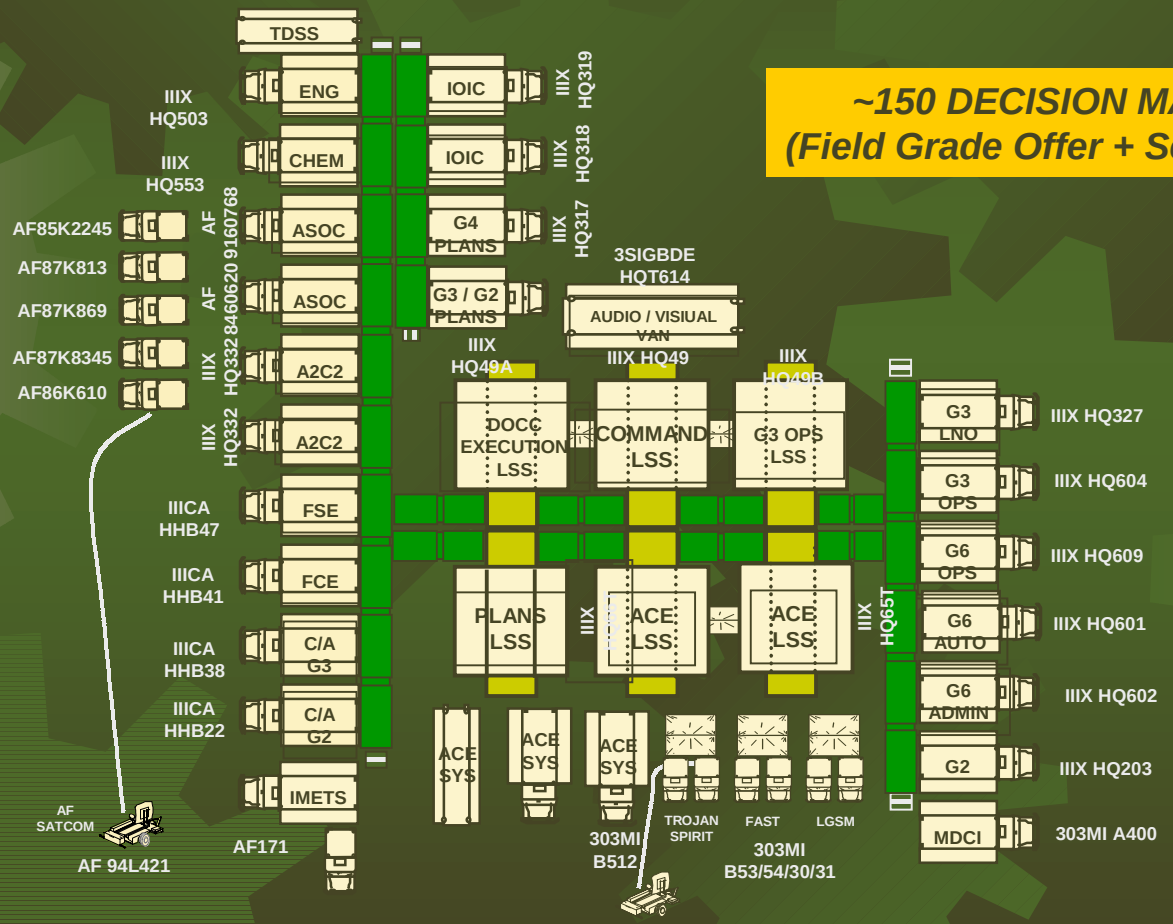
Monitor and control III Corps close operations

Synchronize III Corps combat, CS, CSS operations
Allocate III Corps resources
Monitor and control III Corps deep operations
Plan future III Corps operations

Monitor and control III Corps
- •Sustainment operations
- •Force protection operations
- •Movement operations
- •Terrain management operations
- •C2 operations

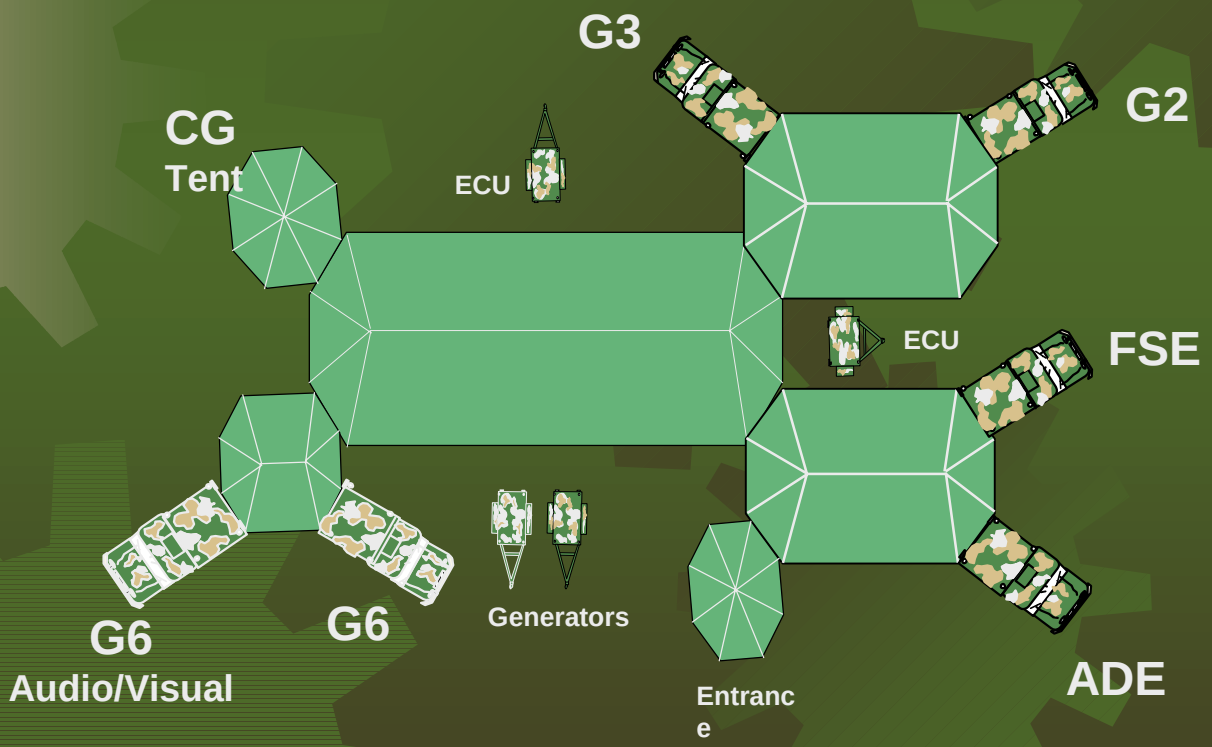
Monitor and control III Corps deployment operations

III Corps Main CP

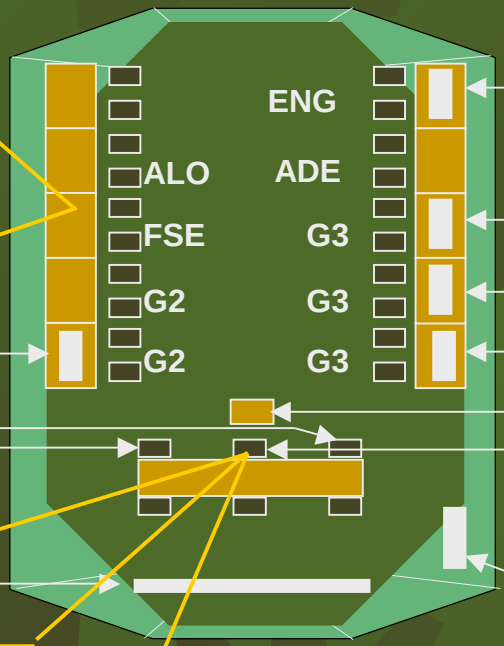


III Corps Tactical CP

~40-50 DECISION MAKERS
(Field Grade Offer + Senior NCO)



Tactical CP Hub



ASAS

RTO

SCREEN

MCS

GCCS

MCS

MCS

BATTLE CPT

VIDEO OPER

VIDEO BANK

Army Frustration With Measuring ROI For Digitization

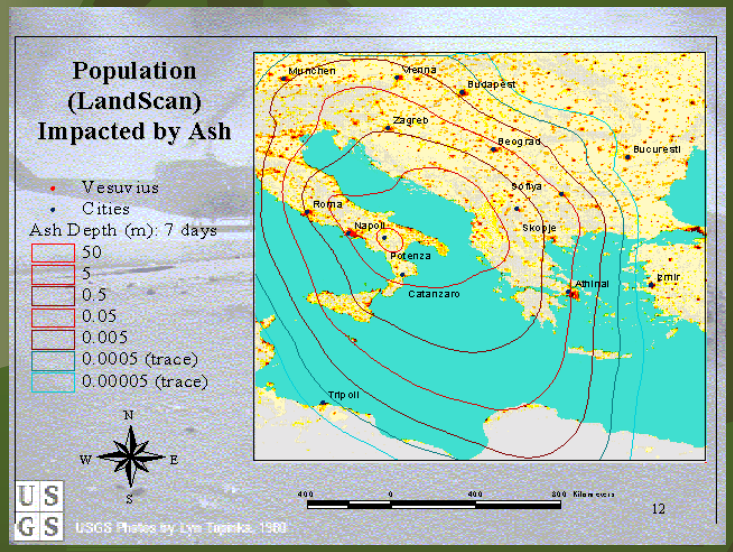
Facilitating Battle Command

(The Technology Component)

Facilitating CA Planning

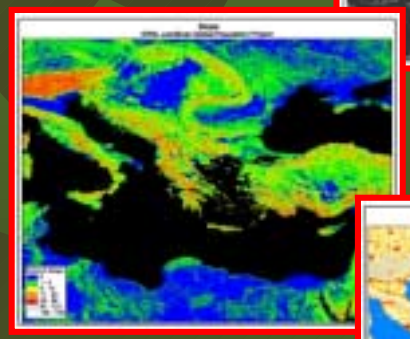
Hazard Prediction and Assessment Capability

Example: Civil impact of Mt Vesuvius eruption



Nighttime Illumination Database

Terrain Slope Database



Population Coefficient Database

Developed by:
Oak Ridge National Laboratories

Realizing the Full Potential of C^3I Technology

"Digital training is more than individual training, and it is additive in nature. It is also essential to train individual skills within the context of a network with the friction of the field environment. Leaders must understand networks, what affects a network's successful functioning, and be trained in the integration of digital functionality—across all the BFAs. Until leaders can understand how to leverage the full integration of Army Tactical Command and Control Systems (ATCCS), we will NOT have achieved the full warfighting potential of digital technology."

COL Robert Cone, Cdr 2BCT
***III Corps Digital Training Seminar*, 3 May 2001**

Individual Operator "Knobology"

MCS
FBCB2
TAIS
AFATDS
ASAS
CSSCS
FAADC2
AMDPCS
DTSS
GCCS-A

PM - Developed New Equipment Training

Integrated Battle Staff Organization & Training

Battle Command "Team Performance"

The Measurement Problem

"The major challenge is that Capitol Hill doesn't understand the power of digitization nor the additive costs associated with it.

…until we have quantifiable results of the digital revolution, it is hard to show goodness of results."

Summary Issues…
***III Corps Digital Training Seminar*, 3 May 2001**

Productivity Paradox

“Research on IT and productivity has been disappointing, not only because it has exacerbated apprehension about the ultimate value of billions of dollars of IT investment, but also because it has raised frustrating concerns with the measures and methods commonly used for productivity assessment. However, only by understanding the causes of the "*productivity paradox*", we can learn how to identify and remove the obstacles to higher productivity growth.”

The Productivity Paradox of Information Technology: Review & Assessment
Erik Brynjolfsson, Communications of the ACM, 1993

Paradox Explanations

SERVICE VS MANUFACTURING	**IT investments have typically contributed more in manufacturing rather than service industries**
DEGREE OF CENTRALIZATION	**IT investments have typically contributed more in decentralized versus centralized organizations**
DEFINITION OF PERFORMANCE	**Organizational inputs and outputs are not being properly defined: hard to measure quality increases**
TIME LAG OF PAYOFF	**Time lags between initial IT investment and productivity increases are often 5+ years**
DECISION MAKER INERTIA	**Decision makers have failed to adapt their decision making processes to the new technology**
COST OF REENGINEERING	**Successful IT investments have typically been accompanied by 10x investments in intangibles**

Need for a Paradigm Shift

The introduction of computers into organizations has been predicated on the assumption that they would become a key instrument in improving organizational problem-solving

- ***Organizational actors analyze data to solve well-structured problems***
- ***Organizational actors employ decision-theoretic, choice-making methods of analysis***
- ***Computers provide organizational actors with formal decision models and fixed pipelines of data***

This view is in contrast to a more active, interpretive, sensemaking image of organizational decision making

- ***Organizational actors are interpreters and enactors of a stream of events***
- ***Information technology should support human inquiry as a subjective sensemaking process***
- ***Information technology must adapt to the needs of today's "pluralistic" context of organizations and their turbulent information environments***

Information Technology and Organizational Change in Turbulent Environments: Exploring Emergent Technology Designs for Sensemaking

Session 195, Ram Tenkasi, Chair
Academy of Management, Chicago 1999 Conference

Facilitating Battle Command

(The Organizational Component)

Commander Skills & Knowledge

Staff Skills & Knowledge

Commander's Intent and Concept of Operation

Present State

Future State

Leadership Force of Will

Visualize Present METT-TC

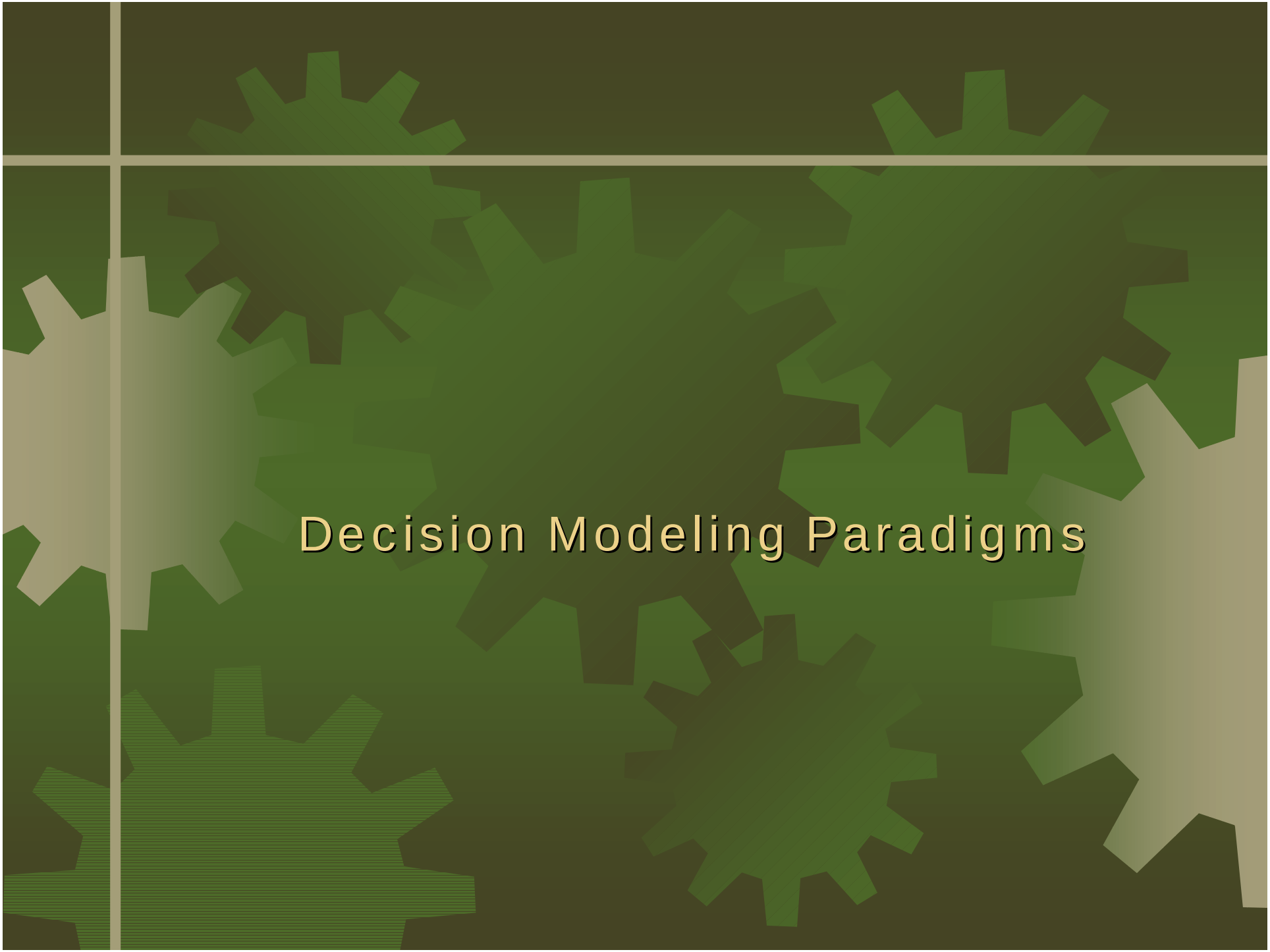
Project Future METT-TC

ENABLE

ENABLE

ENABLE

Battle Staff Teamwork and Synchronization


Decision Modeling Paradigms

Military Decision Making Process

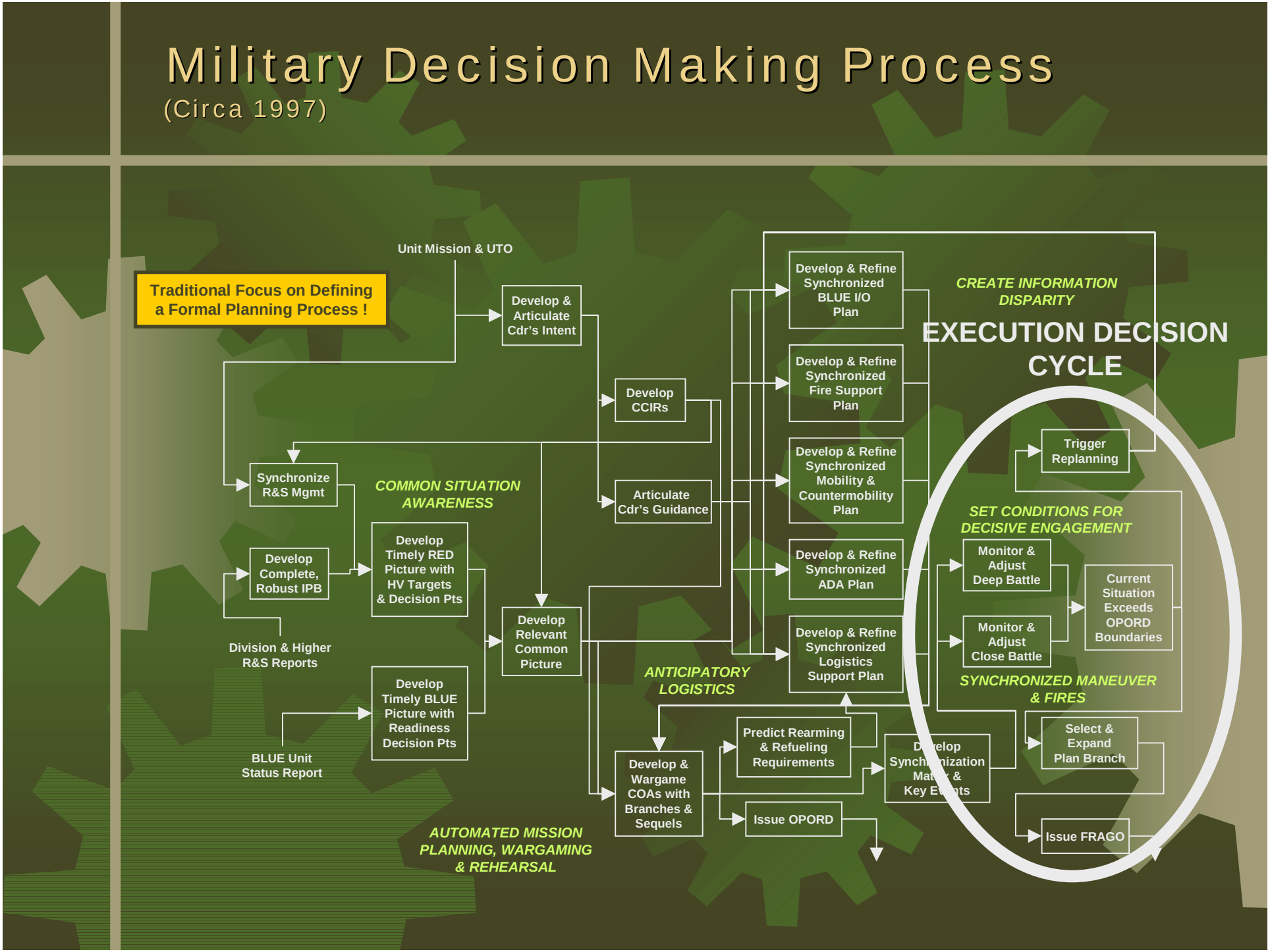
(Circa 1977)

"… in order to win, we should operate at a faster tempo or rhythm than our adversaries or, better yet, get inside the adversary's Observation-Orientation-Decision-Action time cycle or loop."

Patterns of Conflict
COL John R. Boyd

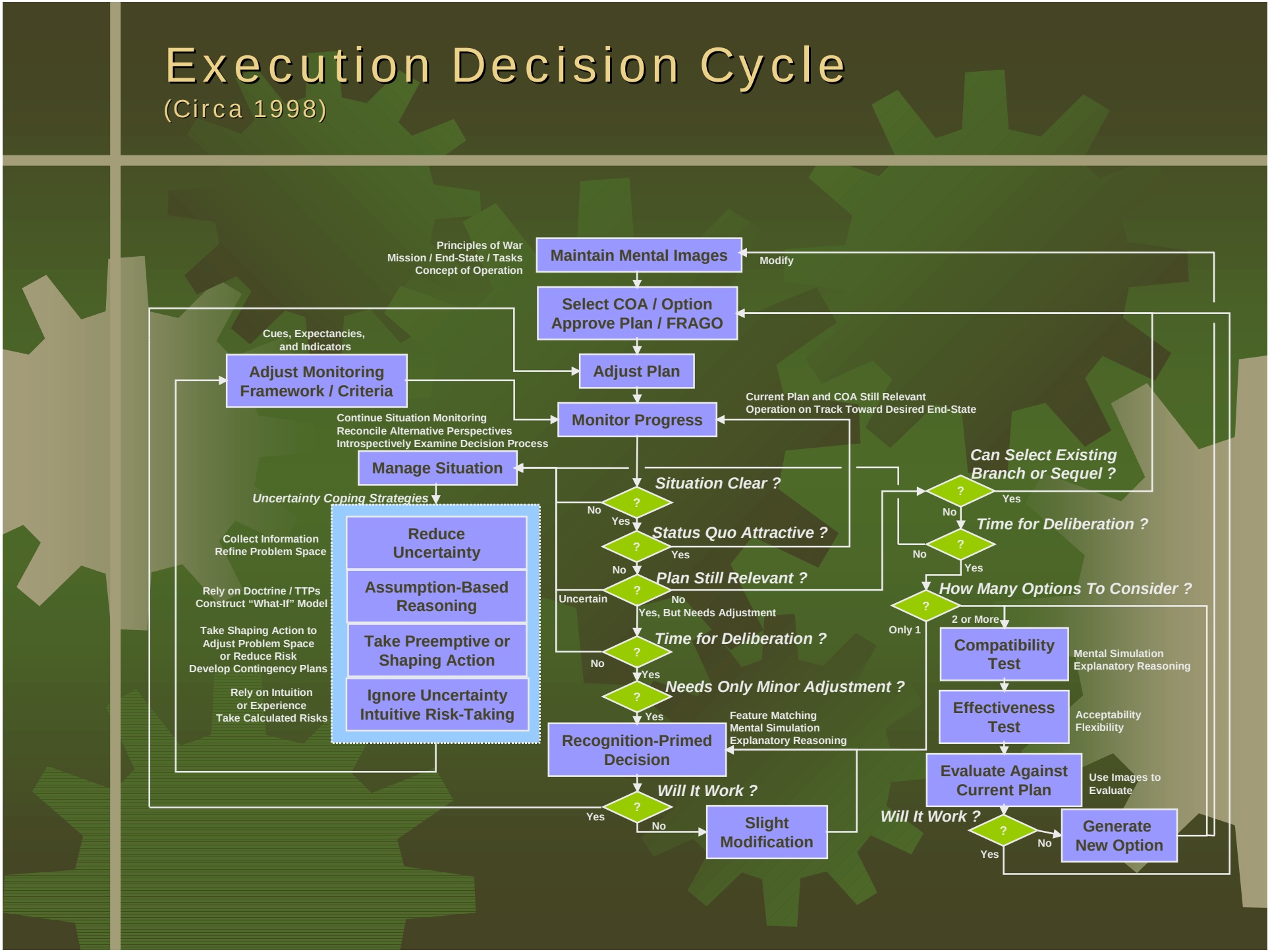
Military Decision Making Process

(Circa 1997)



Execution Decision Cycle

(Circa 1998)



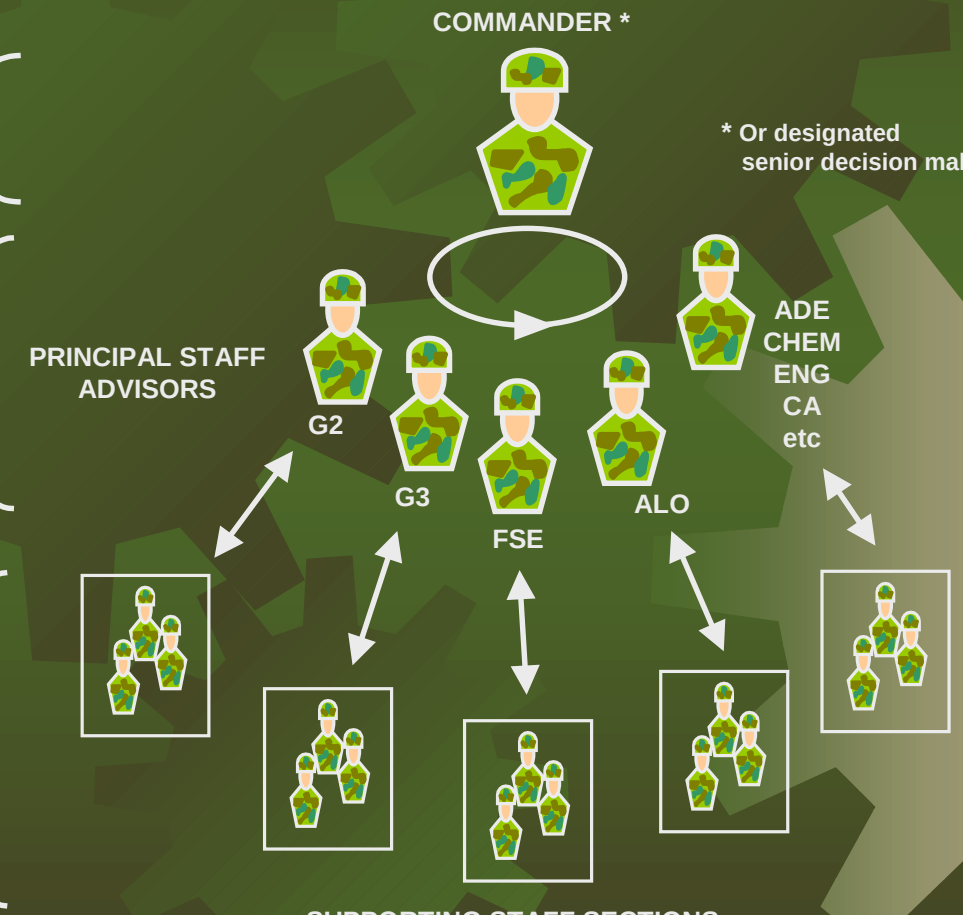
Multi-Tiered Decision Process Within the Battle Staff

Multi-Tiered Decision Making Process

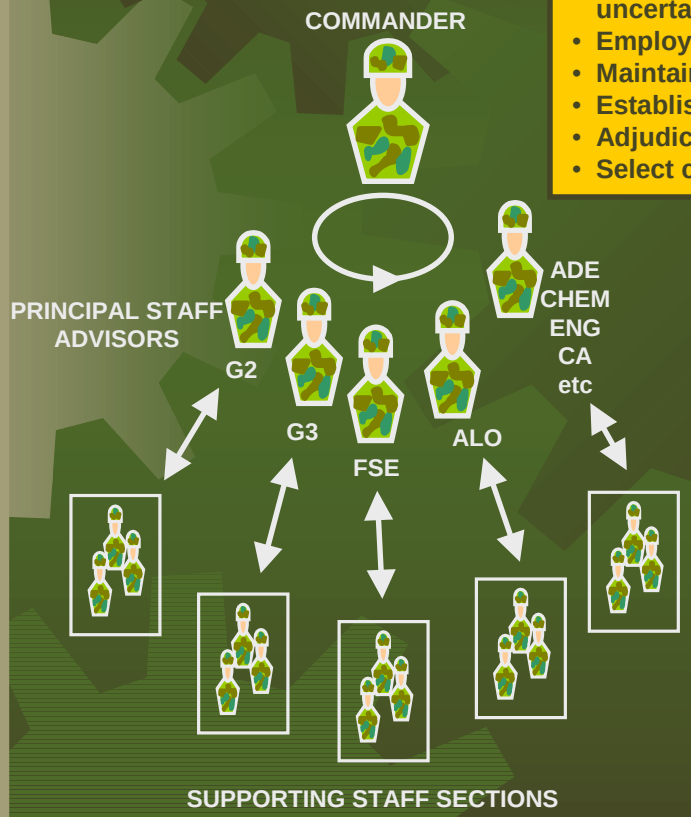
TIER 1

TIER 2

TIER 3



Cognitive Responsibilities



- ***Creativity-oriented:*** **create vision and set goals in response to ill-defined problems**
- ***Action-oriented:*** **enact environment to maintain operational advantage, reduce uncertainty, and shape the "reality" of the battlefield**
- **Employ paradigms and analogies to focus staff attention**
- **Maintain overall situation awareness and scan for decision making opportunities**
- **Establish overall battle rhythm and set information priorities**
- **Adjudicate conflicts between units and/or battlefield functional areas**
- **Select courses of action and approve operational adjustments as required**

- ***Adaptation-oriented:*** **plan and improvise specific battlefield functions within rational bounds set by commander**
- **Monitor functional area of responsibility / project future events**
- **Compare operational progress with current plans and constraints**
- **Provide commander with experience-based assessments**
- **Identify emerging problems and areas of potential exploitation**
- **Shape/articulate windows of decision making opportunity**
- **Articulate courses of action and/or recommend adjustments**
- **Coordinate with other principal staff advisors to insure common understanding and synchronization of functional areas**

- ***Task-oriented:*** **perform specific analytic or information-gathering tasks with little or no discretion**
- **Build integrated picture for specific area of responsibility**
- **Track battle and conduct specified operational analyses**
- **Develop course of action details and test for suitability and feasibility**
- **Build / transmit operational plans, orders, FRAGOs to subordinate units**
- **Coordinate with other staff sections / headquarters to insure consistency of information databases**

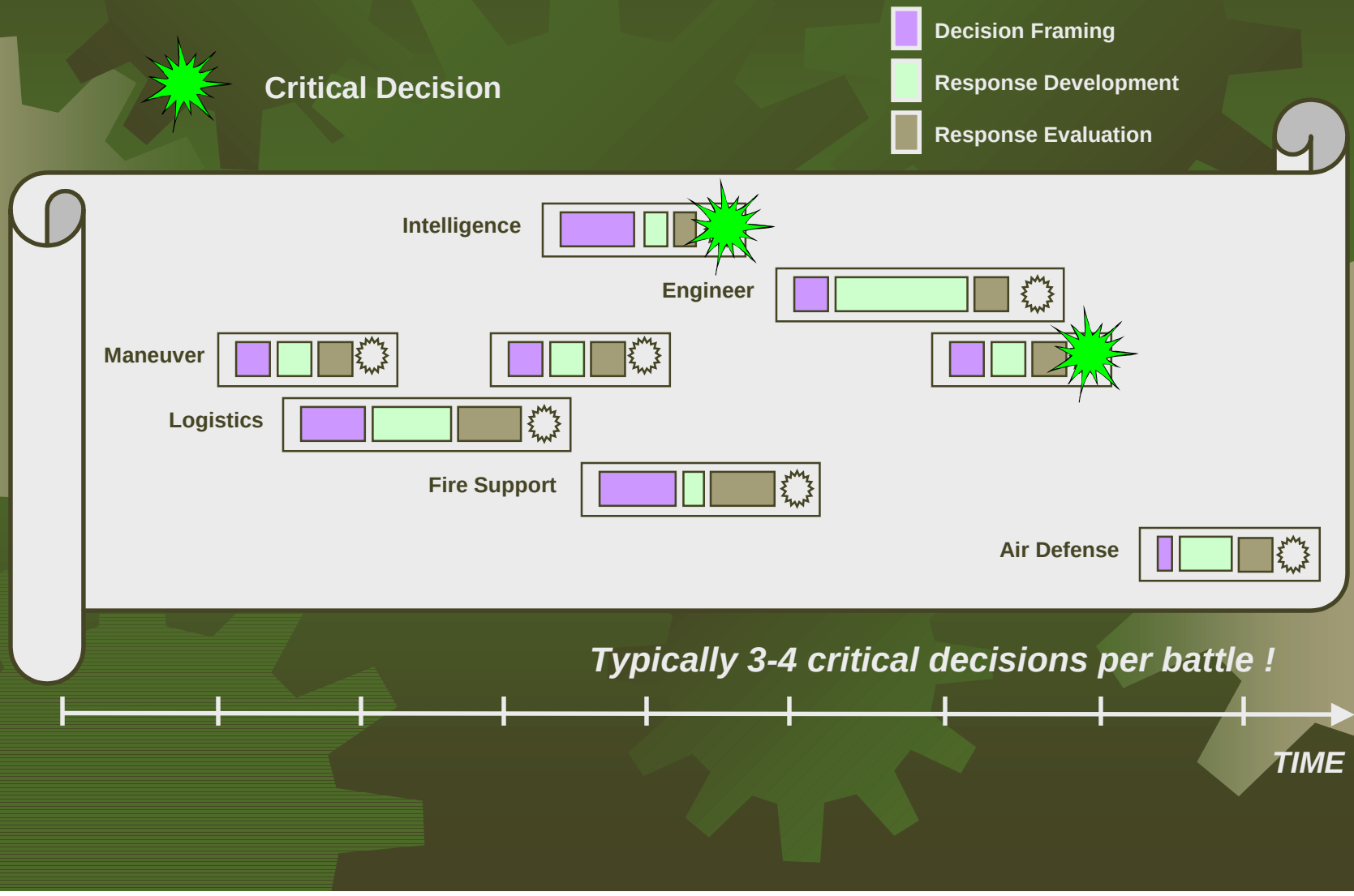
Decision Event

- What aspect of the operation needs attention?
- What is at stake?
- Which paradigms/analogies are appropriate to apply?
- Which operational variables need to be considered?
- Which operational variables can be ignored for the moment?
- How much time is available to make a decision?
- What additional information needs to be collected to clarify the nature of the problem?

- How much is known and understood about the situation?
- What assumptions can be made regarding areas of ignorance?
- Does the situation suggest an obvious response?
- Should/can more than one response option be developed?
- What rule sets are used to generate response options?
- What additional information needs to be collected to develop or response option?
- How much time/resources will it take to collect this information?

- What criteria should be used to judge suitability of responses?
  - Desired effect?
  - Timeliness?
- Which operational constraints are relevant for selecting a response?
  - Effect threshold?
  - Timeliness?
  - Resource availability?
  - Required leadership?
- Is a tentative or incremental shaping decision feasible and appropriate?

Stream of Decision Events



Cognitive Dimensions of Battle Staff Proficiency

(Circa 1999)

Establish Team-Organizational Structure & Process	1. Clarify expected roles and contributions of individuals-teams 2. Establish clear strategy for knowledge management 3. Establish effective information exchange practices 4. Establish supportive behaviors and error monitoring 5. Align decision authority with decision-making capacity
Manage Decision and Analysis Strategies	6. Employ proper mix of decision strategies for each situation 7. Effectively manage the collaborative debate process 8. Sequence and communicate decisions and assumptions 9. Employ proper mix of analysis strategies for each situation
Manage External Situation Awareness Process	10. Balance push-pull of information flow to decision-makers 11. Maintain attentional scanning across multiple decision threads 12. Verify key information inputs & employ proper risk management 13. Manage battlespace images & their cognitive shaping influence 14. Anticipate and prepare for the emergence of complexity
Monitor & Adjust Team-Organizational Process	15. Manage task priority, task sequencing, and information cost 16. Manage process error associated with staff rotation and handover 17. Practice continual self-critique and organizational learning

Establish Team-Organizational Structure & Process

- **Does each individual in the command post clearly understand his/her role and expected contributions within the MDMP?**
- **Is there a strategy for effectively combining the information available from ABCS *(explicit knowledge)* and the expertise available from experienced battle staff personnel *(tacit knowledge)*?**
- **Does each battle staff member practice positive information exchange techniques *(clarity, brevity, verification of meaning)*?**
- **Is each battle staff member anticipating and proactively responding to the information needs of others within the command post?**
- **Is decision making delegated consistent with the availability of critical information and personnel expertise?**

Manage Decision & Analysis Strategies

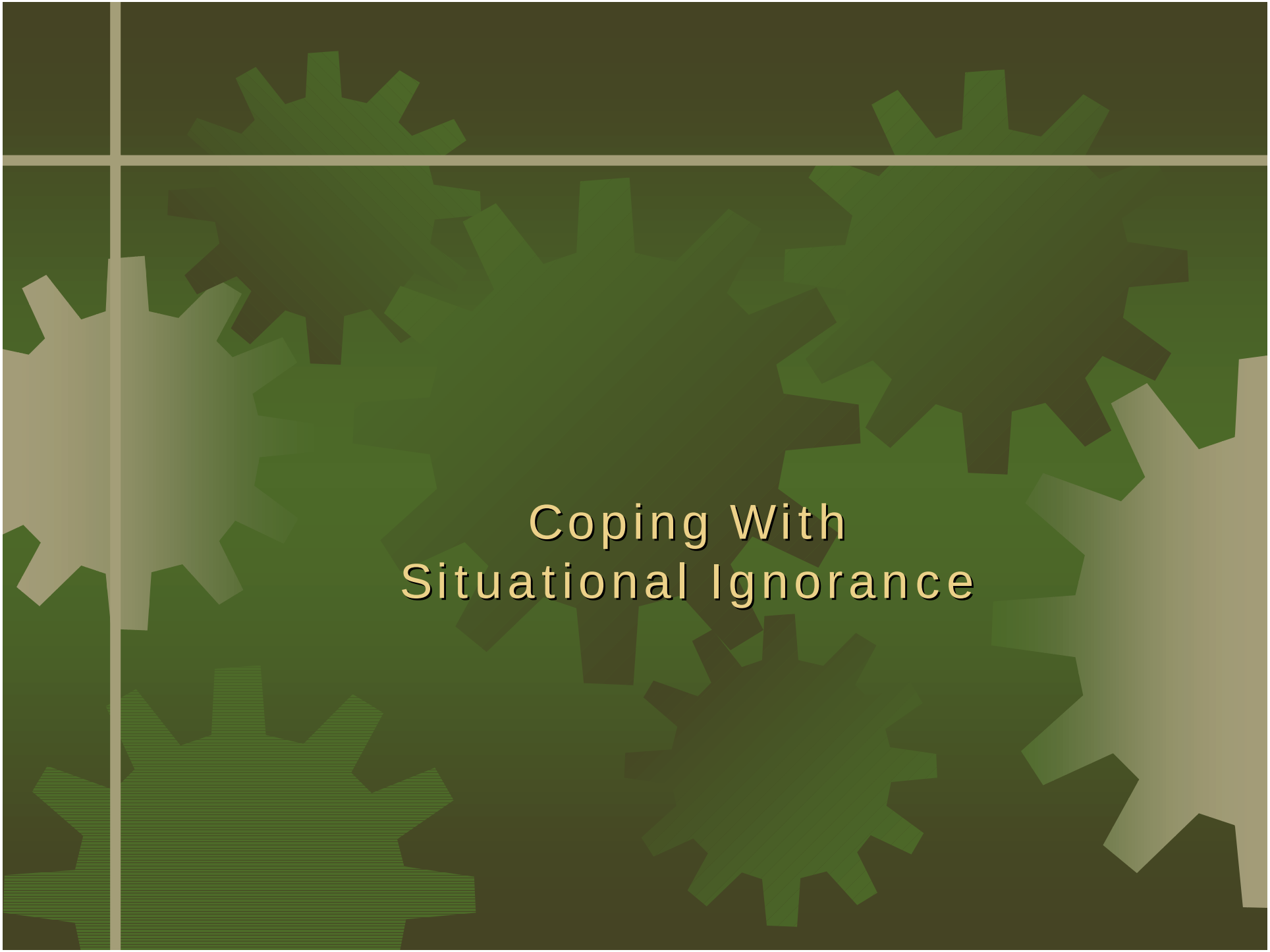
- **Are the senior staff members adjusting their decision making strategy consistent with time stress and information availability?**
  - ***Analytical*: Deliberate, systematic identification and evaluation of multiple options**
  - ***Recognitional*: Intuitive responses developed from "recognition" of familiar situations**
  - ***Situation Management*: Employ risk reduction strategies while clarifying the situation**
- **Are differing BOS viewpoints effectively articulated and reconciled through the deliberate management of key staff huddles and battle update briefings?**
- **Are critical decisions and operational assumptions being developed and communicated across the battle staff in a timely manner?**
- **Is the battle staff appropriately using both deliberate and abbreviated procedures for developing operational plans and orders?**

Manage External Situation Awareness Process

- **Are the senior staff members balancing the “push/pull” of information through effective use of ABCS displays, standard reports, and liaison officers?**
- **Are the senior staff members maintaining attentional scanning across multiple decision threads during high op tempo periods?**
- **Are the senior staff members verifying key information inputs and using situation shaping and risk reduction strategies to cope with uncertainty?**
- **Are senior staff members effectively communicating ROEs, operational themes and intent, desired end states, and COAs to maintain a common mental picture within the command post?**
- **Is the battle staff mentally prepared to anticipate and cope with emerging or unexpected events and METT-TC interactions?**

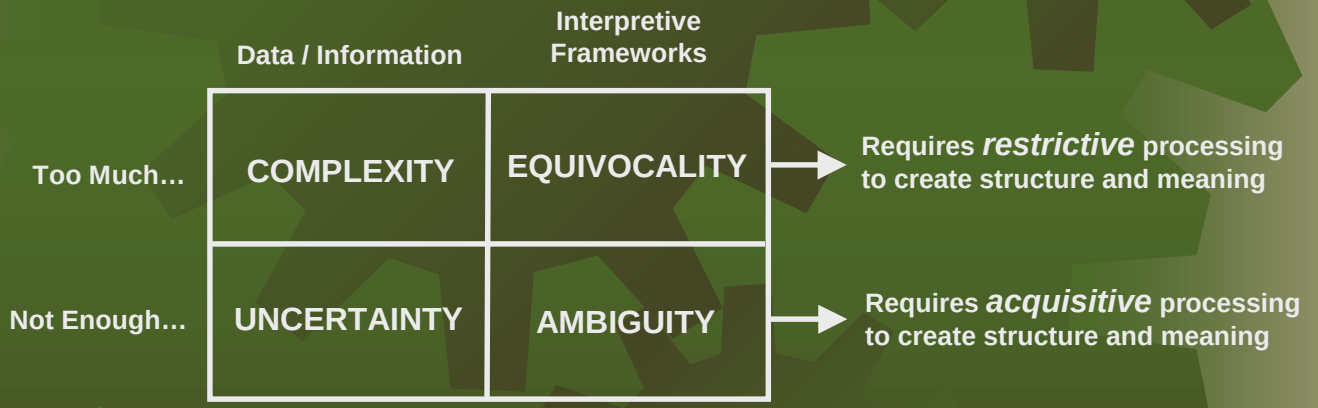
Monitor and Adjust Internal Team-Organizational Process

- **Are the senior staff members appropriately adjusting MDMP task priorities and task sequencing in order to exploit windows of decision making opportunity?**
- **Do the senior staff members understand the cost (*time and resources*) associated with requesting specific pieces of information?**
  - **Do they understand the impact of delaying planning decisions or staff products?**
  - **Do they understand the burden imposed on subordinate staffs or units?**
- **Is the battle staff effectively transferring the required mental picture at critical staff handovers (*e.g., shift change, plans→operations*)?**
- **Is the commander effectively using After-Action Reviews to self-critique and continually improve as a battle staff team?**


Coping With
Situational Ignorance

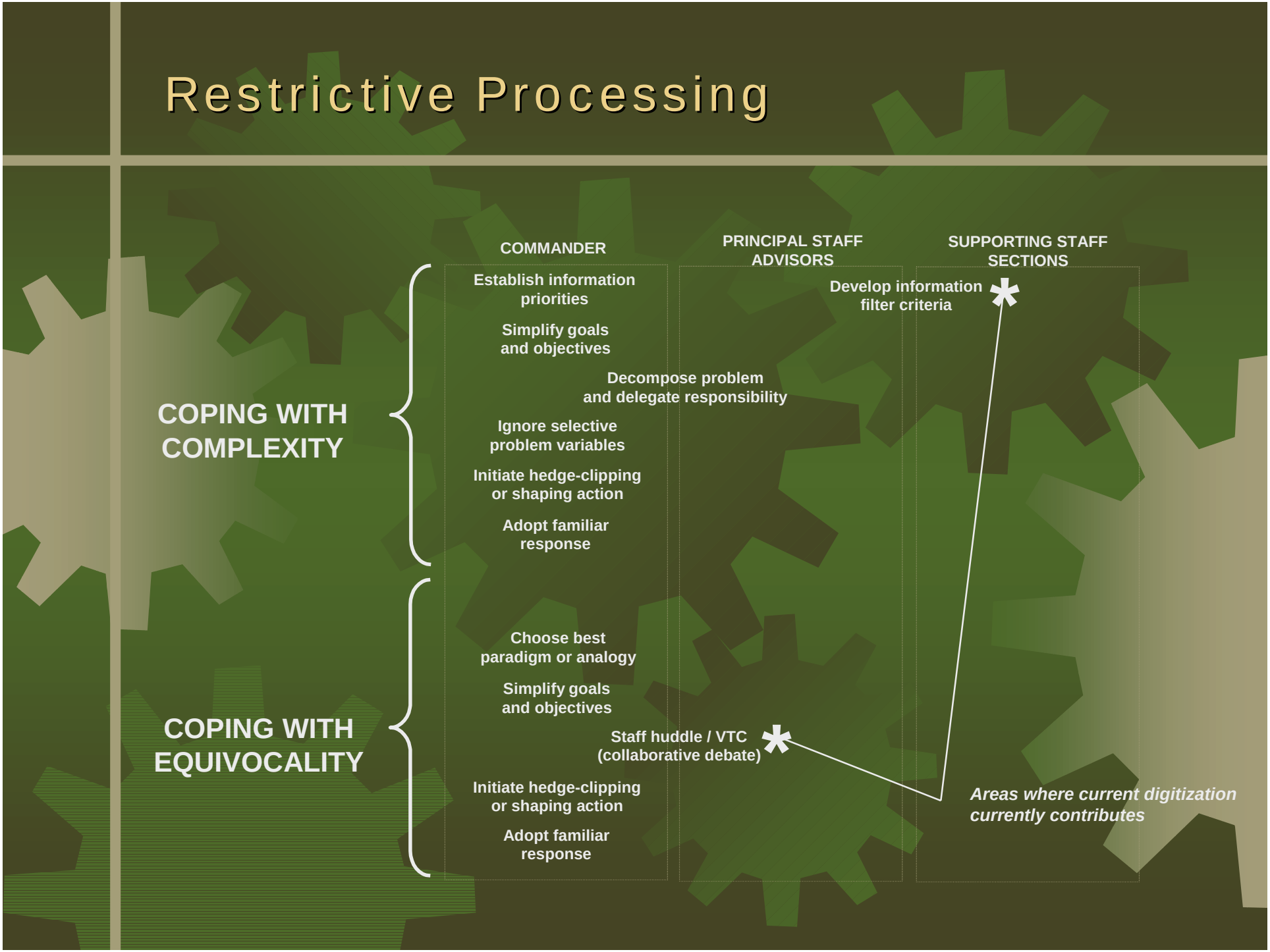
Types of Situational Ignorance

•*UNCERTAINTY*	Not having enough information or lacking confidence in the information
•*COMPLEXITY*	Having more information than can be processed or understood
•*AMBIGUITY*	Not having a conceptual framework for interpreting the information
•*EQUIVOCALITY*	Having several competing or contradictory conceptual frameworks



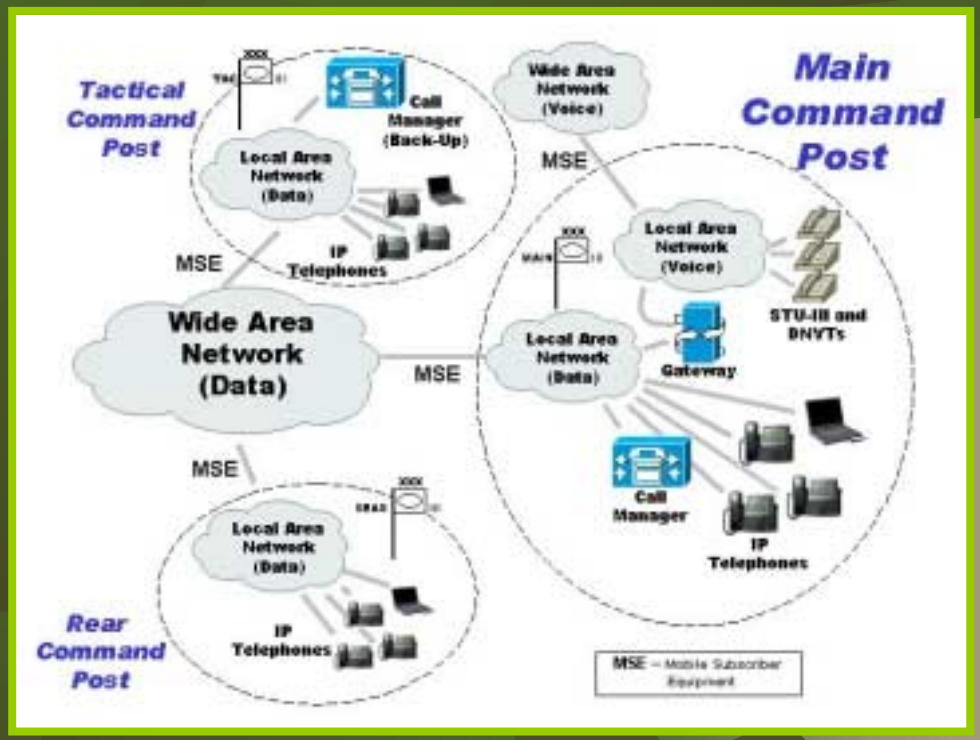
Adapted from
Managing Organizational Ignorance
By Michael H. Zack

Restrictive Processing



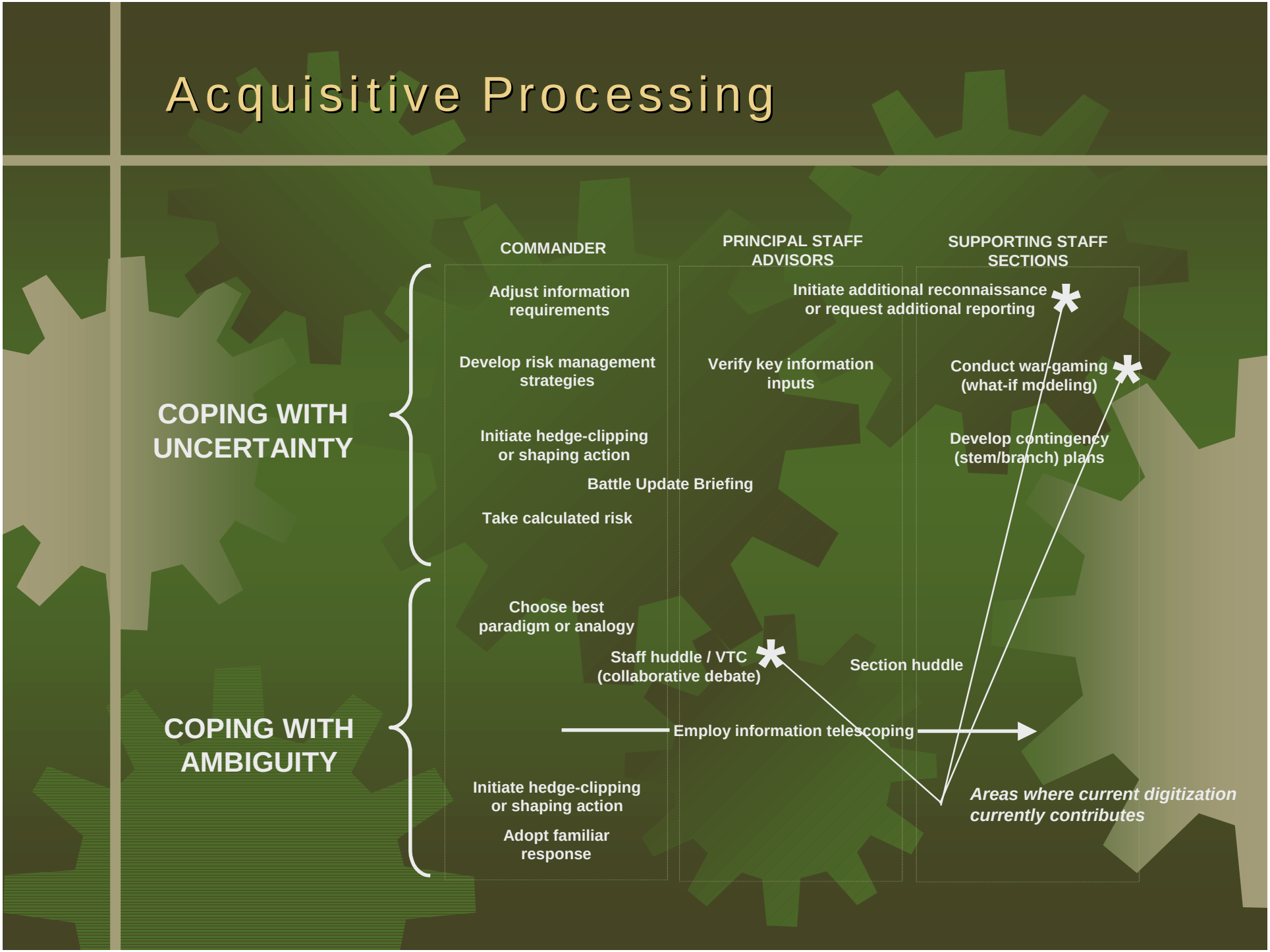
Example: Facilitating Staff Huddles

How can the III Corps Chief of Staff quickly reach out and huddle with key advisors located in another part of the Main CP ?

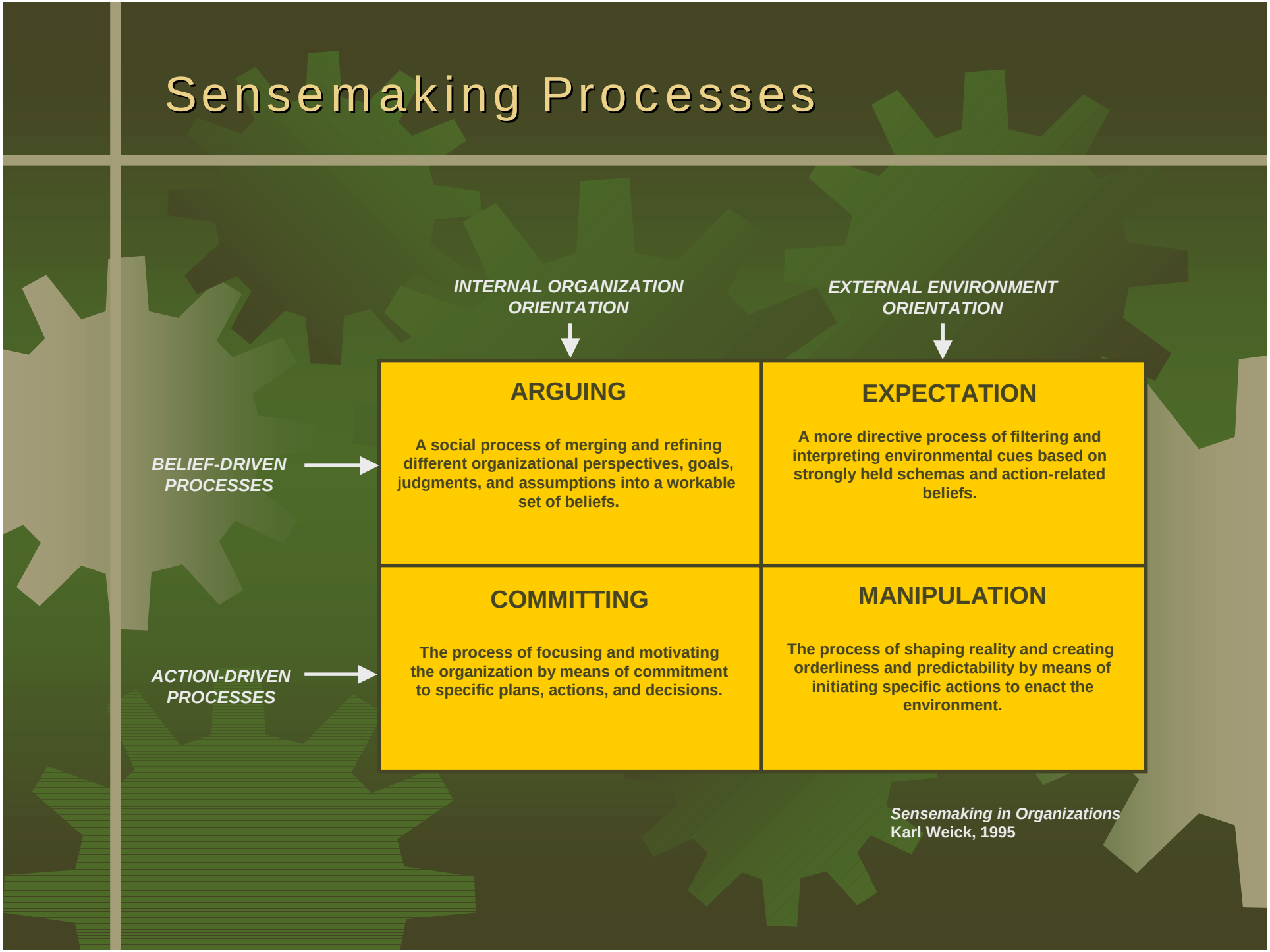


"Hoot-and-holler" multicasting concept adapted from the securities and exchange industry …

Acquisitive Processing

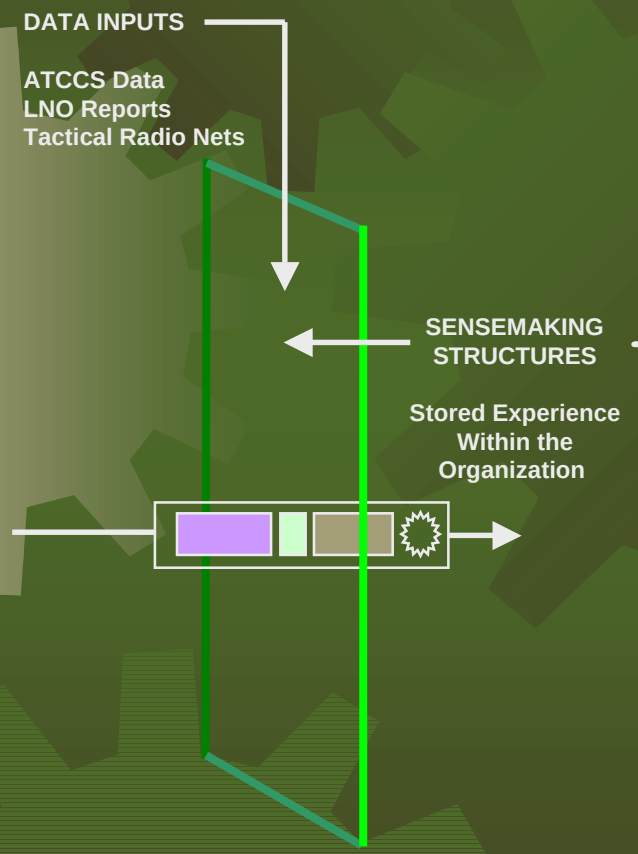


Sensemaking Processes



Sensemaking in Organizations
Karl Weick, 1995

Sensemaking Framework



Sensemaking in Organizations
Karl Weick, 1995

IDEOLOGY
Shared, relatively coherent, emotionally charged beliefs values, norms, cause-effect relationships, preferences for certain outcomes, and expectations that bind the organization together. They provide ready-made interpretation structures for supporting the belief side of sensemaking.

3rd-ORDER CONTROLS
Unspoken organizational premises *(jargon, patterns of uncertainty absorption, unique communication channels, informal procedures, and personnel selection criteria)* that shape the flow/content of information, search for options, focus the definition of risk, and constrain expectations. They act to delimit the belief side of sensemaking.

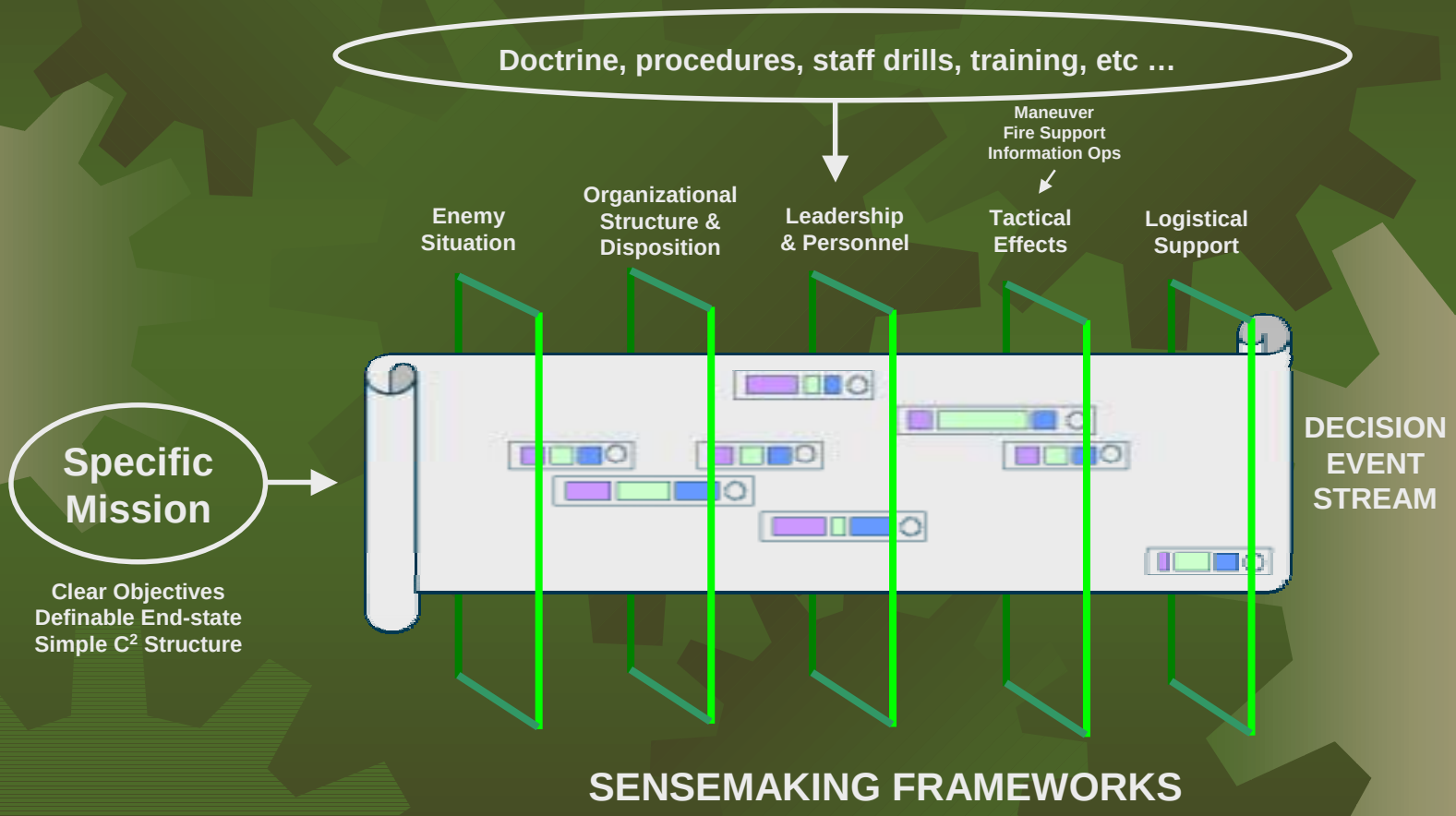
PARADIGMS
Internally consistent sets of simplifying heuristics about important things in the world, how these things act, how they relate to one another, and how they come to be known. They serve as alternate realities for linking belief and action.

THEORIES OF ACTION
Organization-level cognitive structures that filter and interpret environmental signals as triggers for organizational responses. They link perception to shaping action.

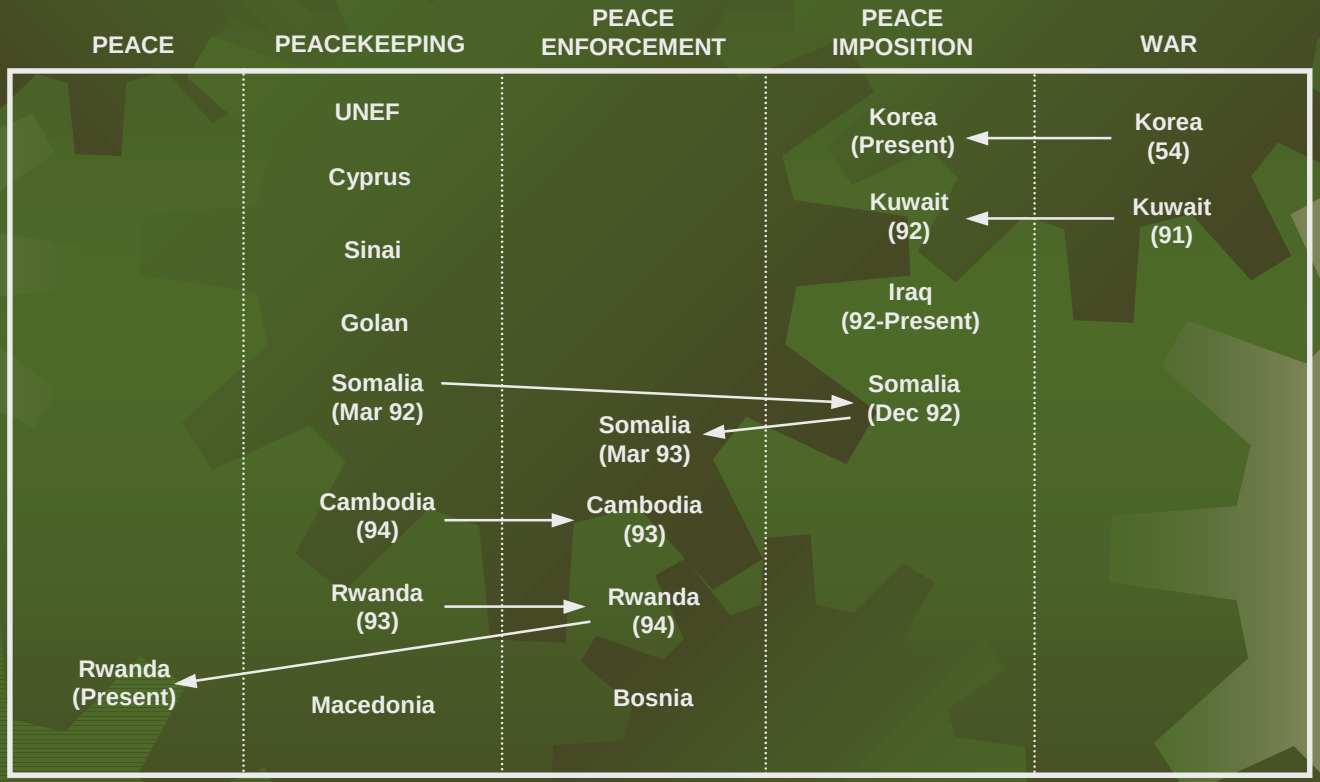
TRADITION
Symbolic mental structures (patterns of action, patterns of means-ends behavior, organizational structures) that facilitate a non-nonsense, can-do, action-oriented stance toward the world. They provide ready-made formulas for action.

STORIES
Narrative structures that represent filtered, ordered, and affected accounts of experience based on a "beginning-middle-end" story sequence. They are used to guide action under conditions of crisis, complexity, and time pressure.

Traditional Combat Domain



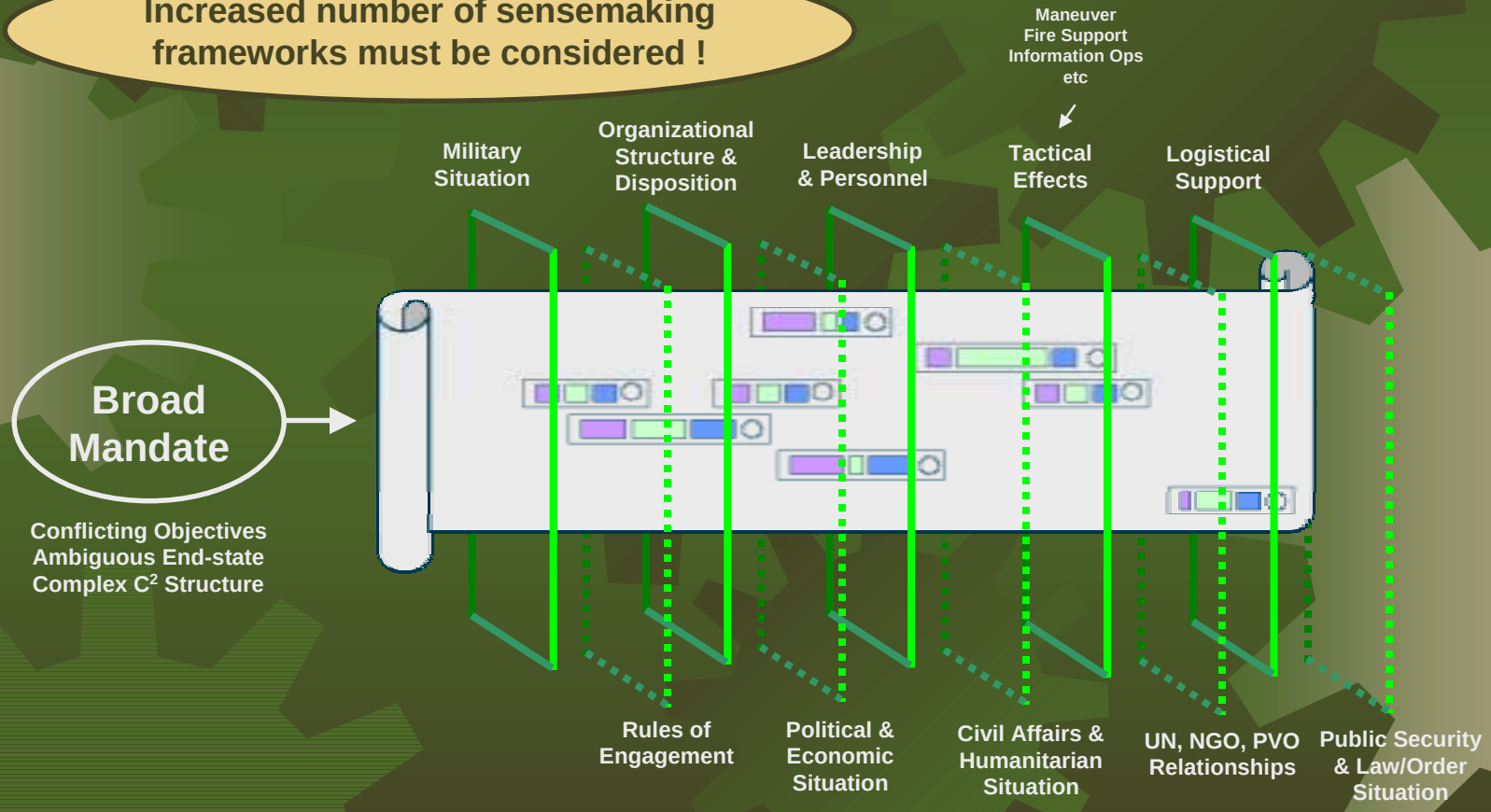
Recent UN Peace Operations



Command Arrangement for Peace Operations
By David S. Alberts & Richard E. Hayes

Complex Contingency Domain

Increased number of sensemaking frameworks must be considered !



Example: Political Structure of Cities

HIERARCHICAL CITIES

- Operate within a broadly accepted rule-of-law
- Citizens assume some level of responsibility
- Consistent set of beliefs, mores, expectations
- Typical of most US cities

MULTICULTURAL CITIES

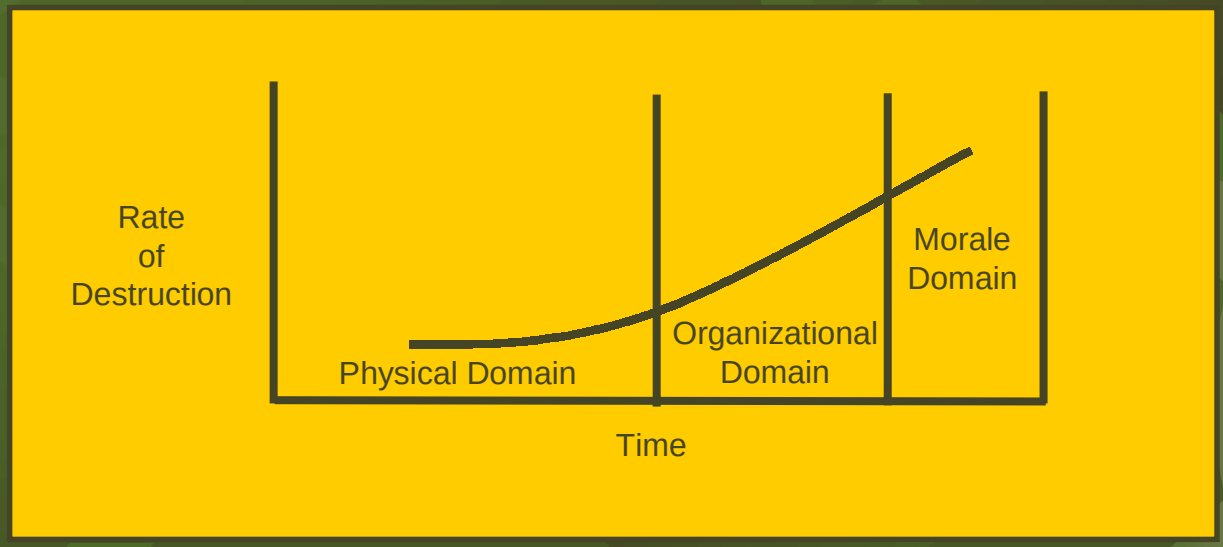
- Characterized by ethnic struggle for dominance
- Government officials supported only by partisan groups
- Other groups exhibit subversion and must be coerced
- Diverse set of beliefs, mores, expectations
- Examples: Jerusalem, Belfast

TRIBAL CITIES

- Blood-based allegiances produce intractible and merciless struggle
- Typically characterized by overpopulation and impoverishment
- Few outward clues of family/clan membership
- Examples: Mogadishu, Kigali, Sarajevo

Situation Understanding in Urban Operations

Need good situation awareness at all levels !



Training for Urban Operations
MG(ret) Grange
Presented at: *Preparing for Urban Operations in the 21st Century*
RAND Corporation, 22-23 Mar 2000

Sensemaking Complexity in Other Venues

Is this an accident or criminal act?
How many casualties?
NBC contamination?
Are there more devices?

DOMESTIC TERRORIST RESPONSE

Response priorities?
Sequencing of response actions?
How do we maintain common understanding?
Command & control relationships?

Preservation of Criminal Evidence

Fire Containment

Scene Security & Crowd Control

Facility & Personnel Decontamination

Incident Management

Protection of First Responders

Public Information

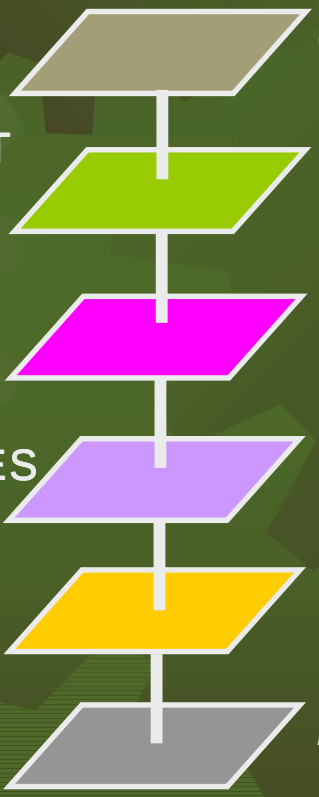
Casualty Triage & Decontamination

Secondary Device Disposal

Federal
State
Local
Private


System Performance Measurement:
The Need for a Paradigm Shift

Levels of C^2 System Measurement



OUTPUT

LATENT VARIABLES

INPUT

CAMPAIGN OUTCOME
e.g., did we neutralize regional influence of rebel force?

BATTLE OUTCOME
e.g., did we improve force exchange ratio?

DECISION QUALITY
e.g., did the C2 system avoid any 0-order blunders?

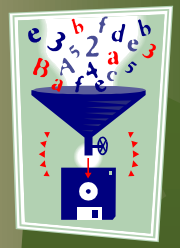
DECISION SUPPORT
e.g., did the C2 organization effectively support sensemaking?

BATTLE STAFF FUNCTION
e.g., how many targeting decisions resulted in target kills?

DEVICE PERFORMANCE
e.g., how many messages / hour did the commo system pass?

Need for a New Measurement Paradigm

OLD



Difficult (if not impossible) to show meaningful correlations or causality

CAMPAIGN OUTCOME

BATTLE OUTCOME

DECISION QUALITY

DECISION SUPPORT

BATTLE STAFF FUNCTION

DEVICE PERFORMANCE

NEW

Contributes to ...

C2 Organizational Performance

Organizational Process

Training / Procedures

Technology Enabling / Disabling Factors

CAMPAIGN OUTCOME

BATTLE OUTCOME

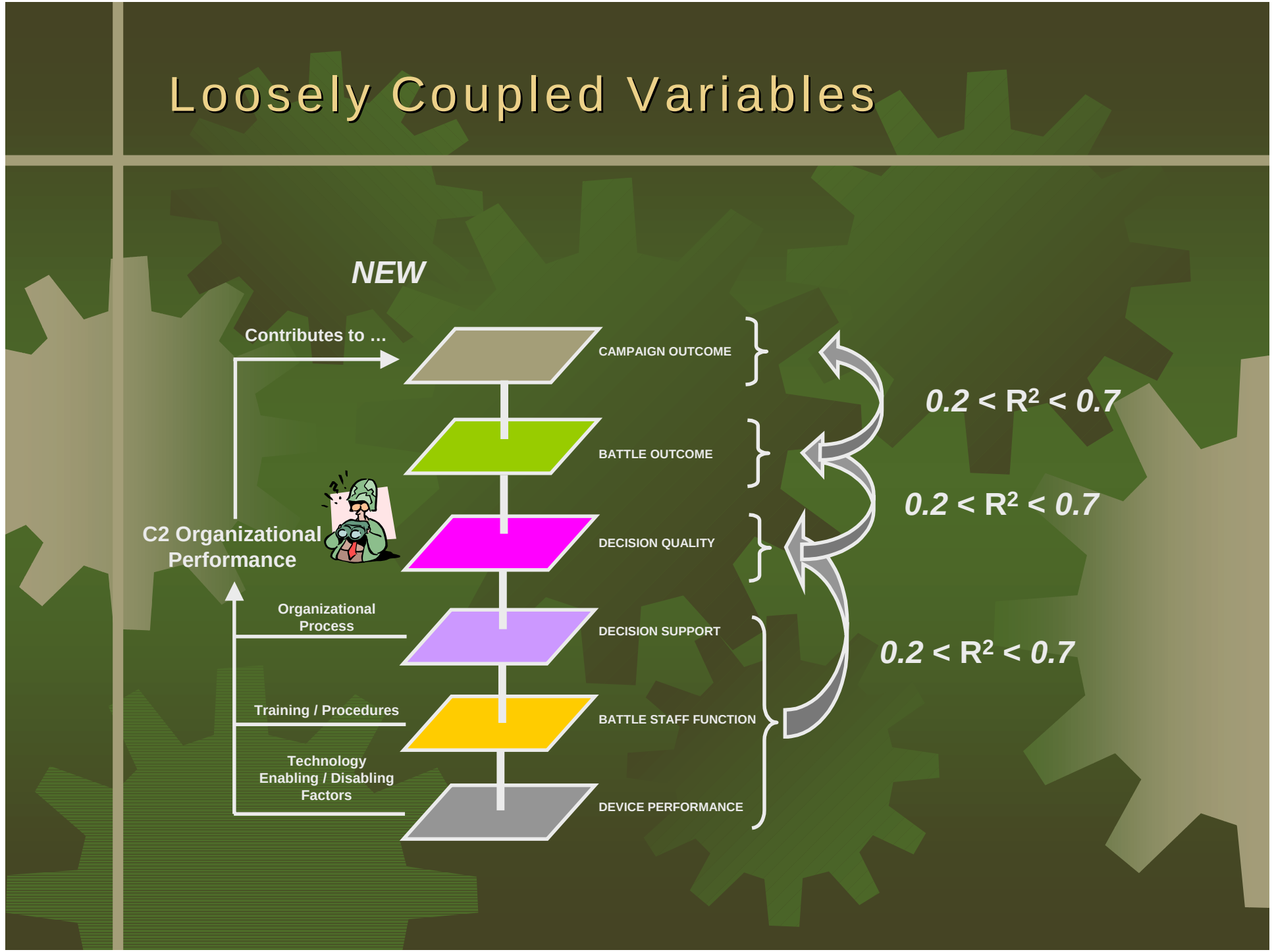
DECISION QUALITY

DECISION SUPPORT

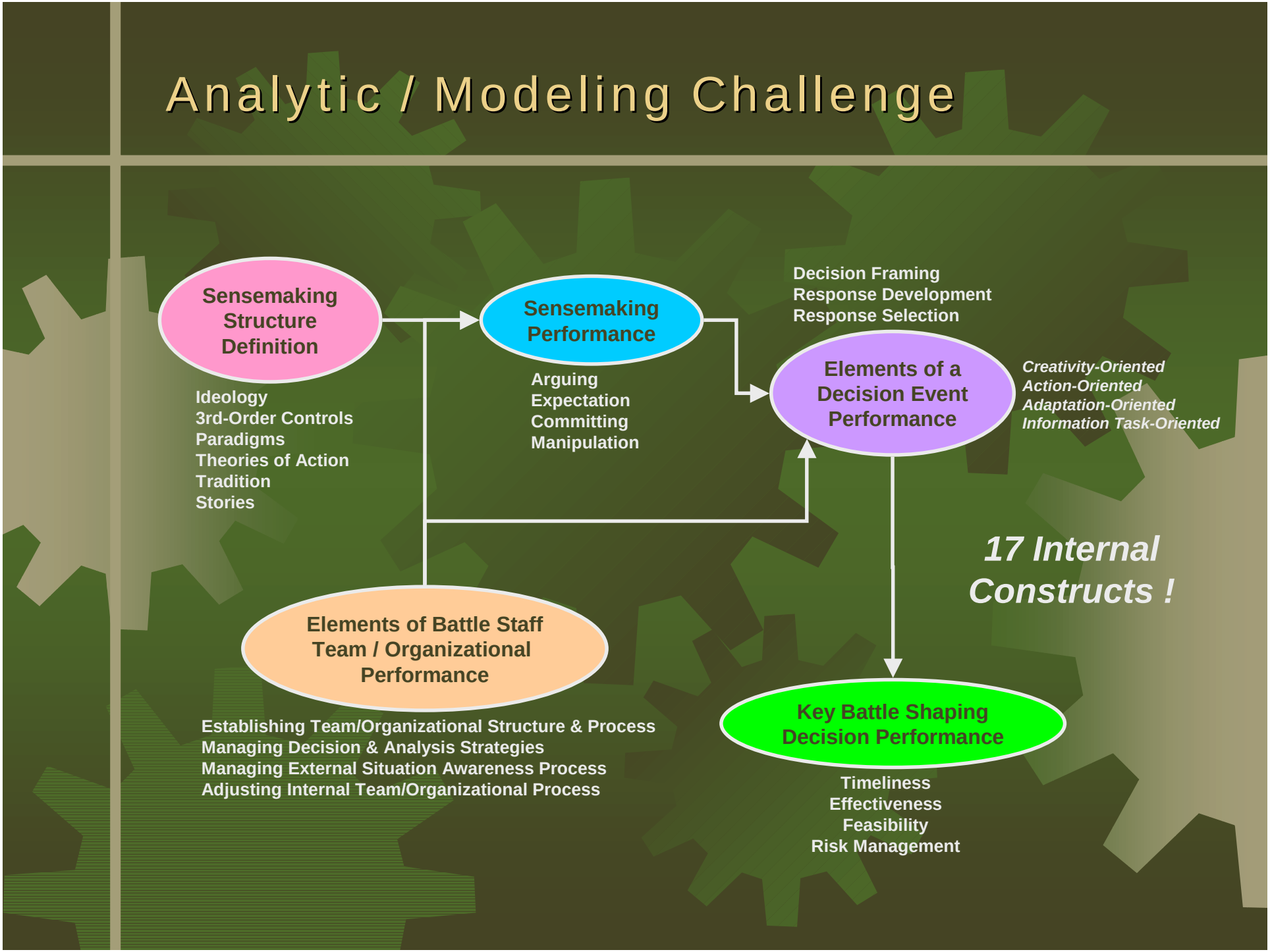
BATTLE STAFF FUNCTION

DEVICE PERFORMANCE

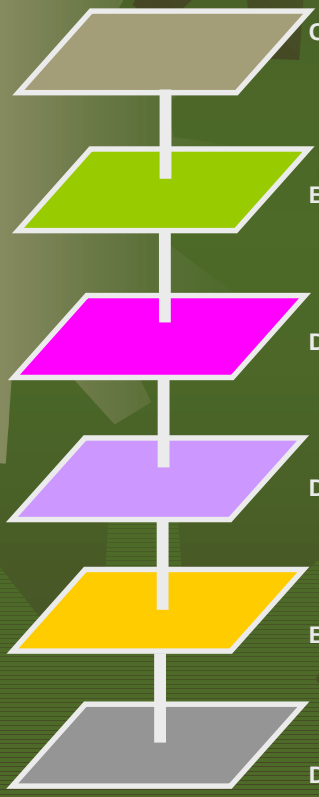
Loosely Coupled Variables



Analytic / Modeling Challenge



Measurement Approach



EXPERIMENTAL DESIGN ENVIRONMENT

Non-linear Processes

Single Trial

Free Play

Emergent Behaviors

N = 20-30 Critical Events / Exercise

Repeated Observation in Emergent Context

Synthetic / Surrogate C2 Process MOEs

Deterministic Behaviors

Replicated Trials

Highly Controlled

Linear Processes

Case Studies

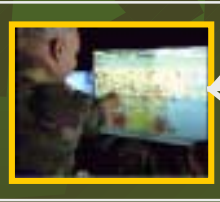
Hybrid Analytical Approach

Statistical Analysis

Synthetic/ Surrogate Measures of C^2 Performance Impact

EXAMPLE:
VOICE-OVER-IP TELECONFERENCING

	KEY BATTLE SHAPING DECISIONS ... 1	2	3	4
Ideology				
3rd-Order Controls		✓		
Paradigms			✓	
Theories of Action	✓		✓	
Tradition				
Stories				✓
Establishing Team/Organizational Structure & Process				
Managing Decision & Analysis Strategies	↑	↑		
Managing External Situation Awareness Process			↑	↑
Adjusting Internal Team/Organizational Process				
Arguing	↑	↑	↑	
Expectation	↑			
Committing				
Manipulation				↑
Decision Framing	↑		↑	
Response Development		↑		
Response Selection				↑



Summary

- Military C^2 will remain a complex, proactive, interpretive organizational process – *particularly at Division and above*
- Attempts by the US Army to show "return on investment" for digitization have encountered same frustrations as private industry *–reflects underlying measurement issues*
- Our understanding of the military C^2 decision making process has evolved over time from the simple OODA model to a more naturalistic model *–one that emphasizes tradeoffs among time available, information available, situation recognition, and risk management*
- It is now time to extend these models further by formally addressing C^2 decision making as a collective sensemaking process heavily influenced by cultural variables and team dynamics
- Assessing the impact of training and technology on C2 system performance will require the development of synthetic/surrogate measures of process performance and a hybrid approach to experiment design


Questions &
Discussion