Anticipatory Understanding of Adversary Intent: A Signature-Based Knowledge System

Paper 163

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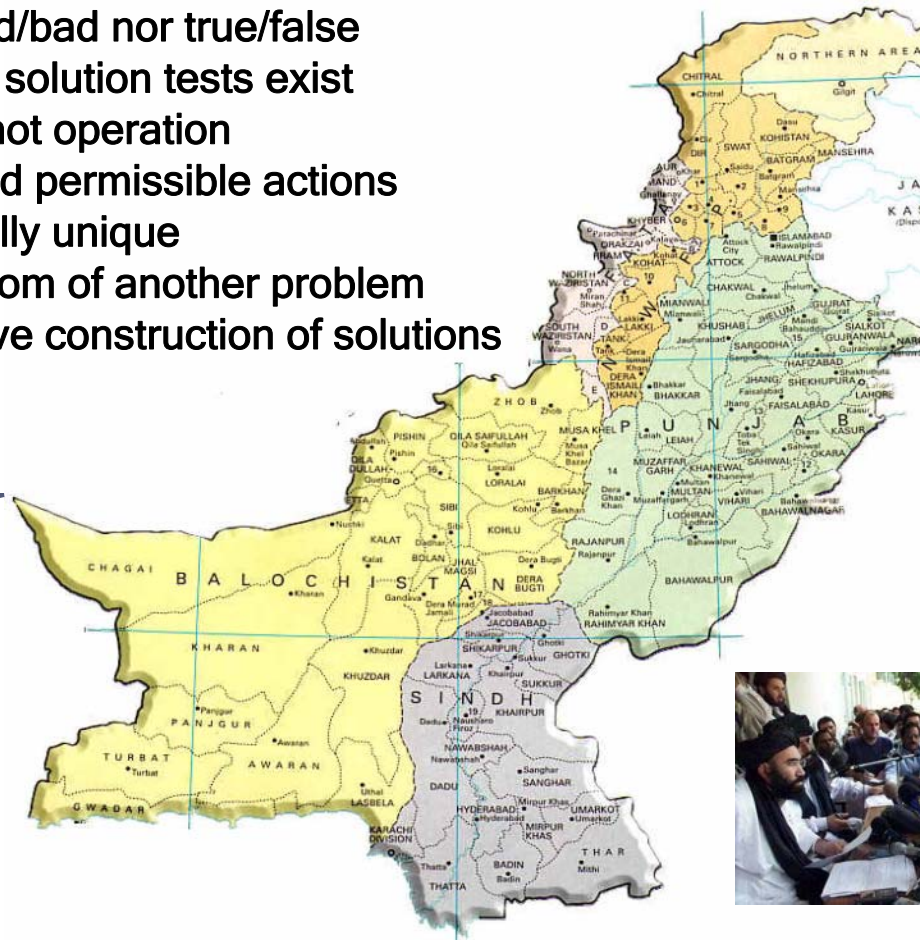
Wicked Operational Problems

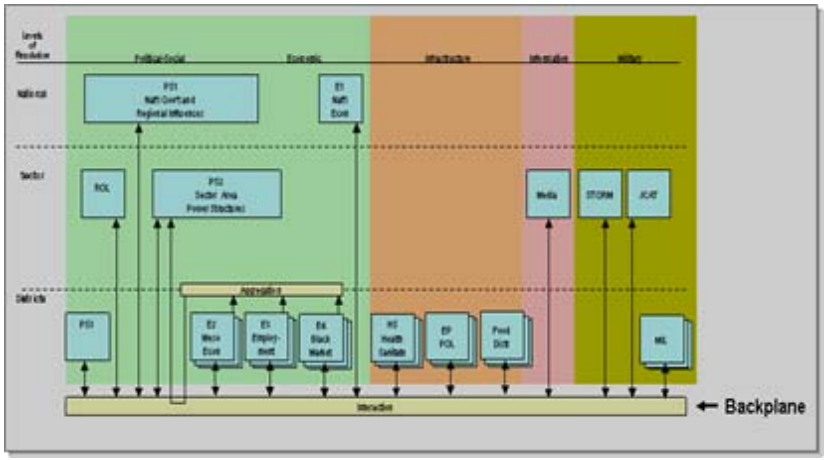
1. No definitive formulation of the problem
2. No stopping rules
3. Solutions are neither good/bad nor true/false
4. No immediate or ultimate solution tests exist
5. Every solution is a one-shot operation
6. Infinite set of solutions and permissible actions
7. Every solution is essentially unique
8. Every problem is a symptom of another problem
9. Problem explanations drive construction of solutions
10. No right to be wrong



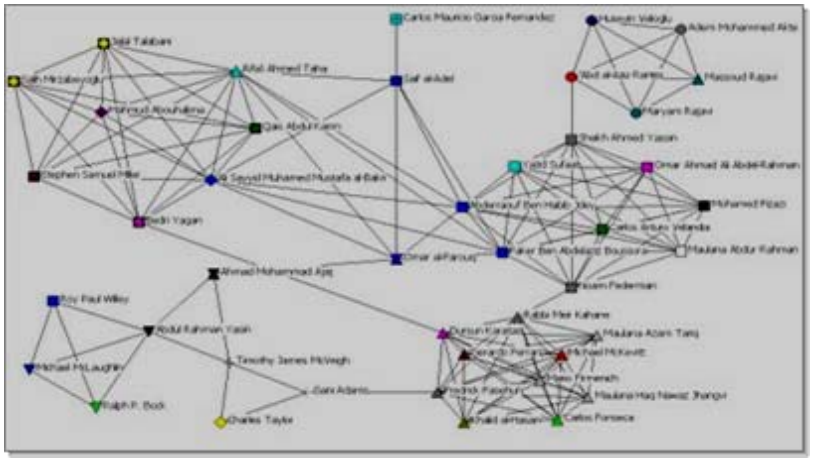
MODELING REPRESENTATION ?

Existing Analytical Paradigms

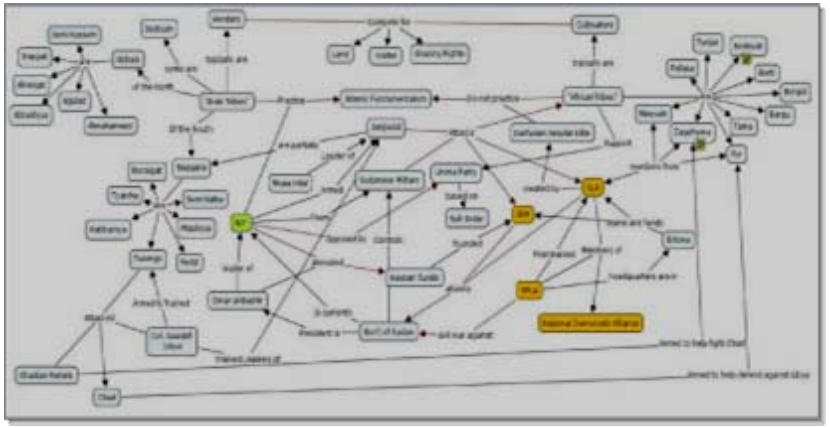
System Dynamics Models



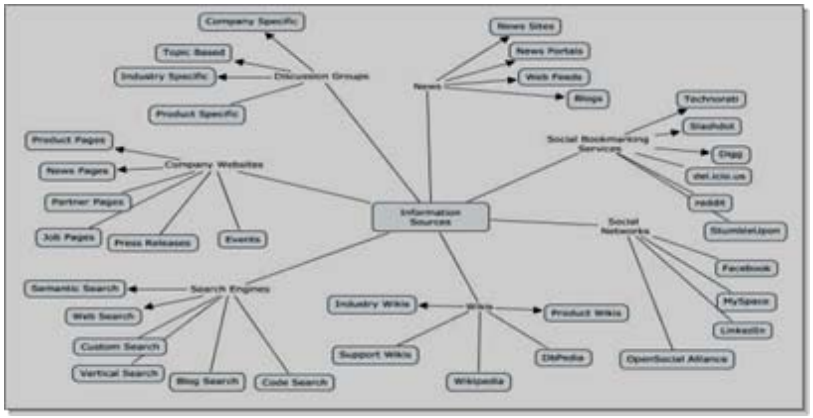
Social Network Models



Agent-Based Models

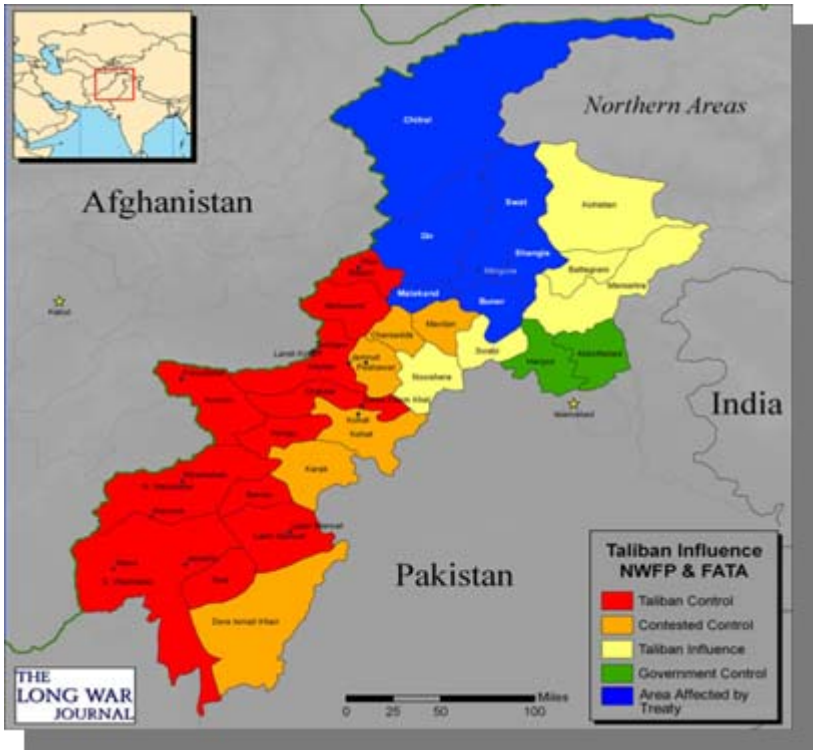


Information Mining Models

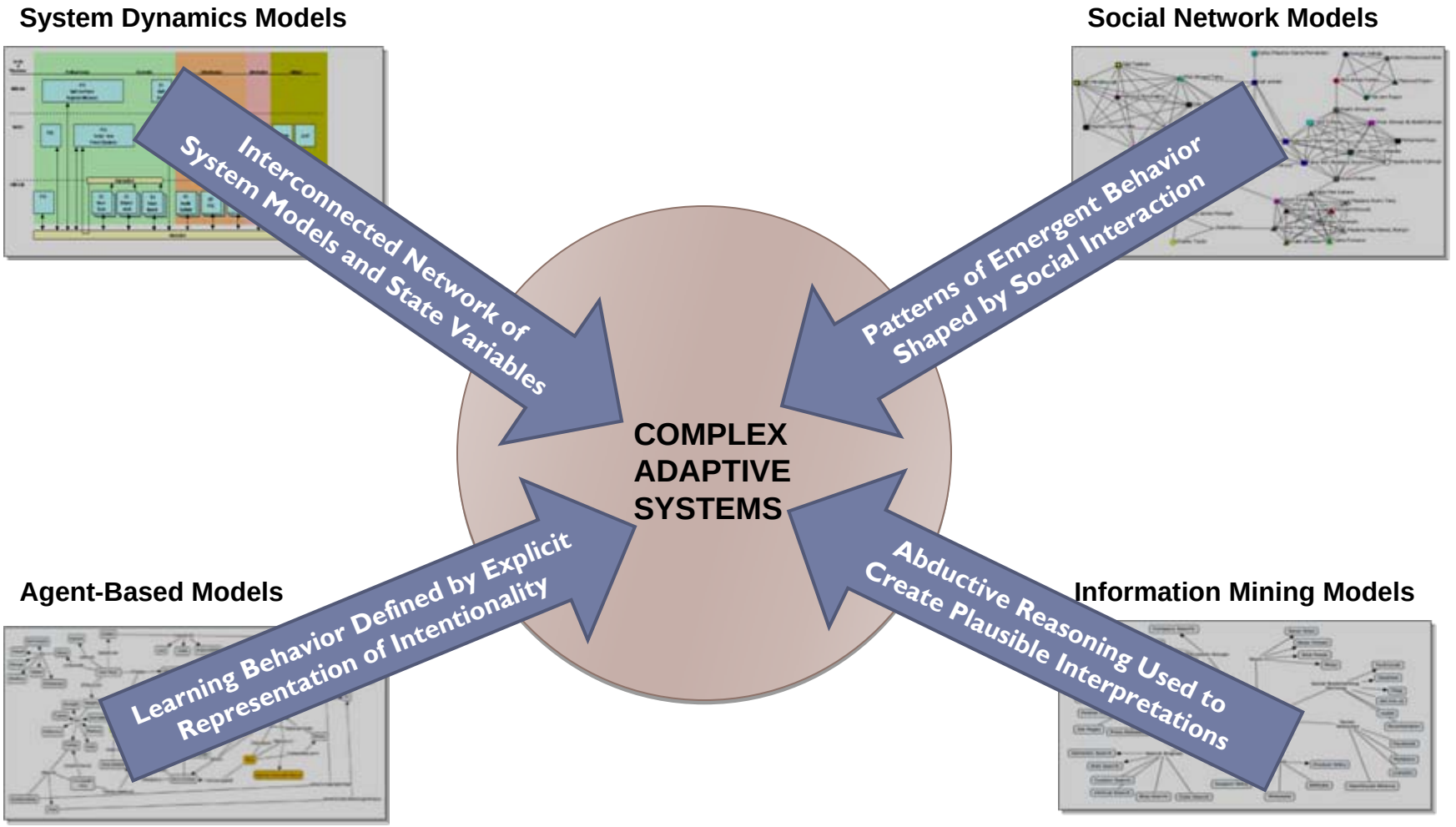


Complex Adaptive Systems

Complex	*Comprised of diverse, interconnected elements and actors*
Adaptive	*Capacity to change and learn from operational experience*
System	*Organized to achieve a cohesive, strategic purpose*

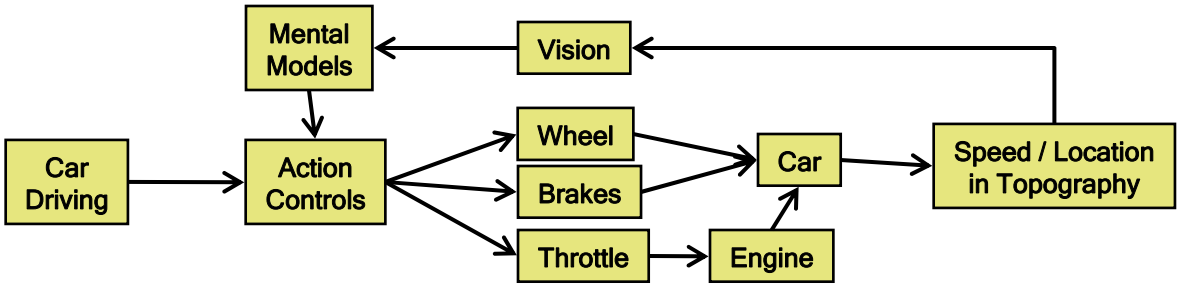


New Modeling Approach



Motivation: Work Abstraction Theory

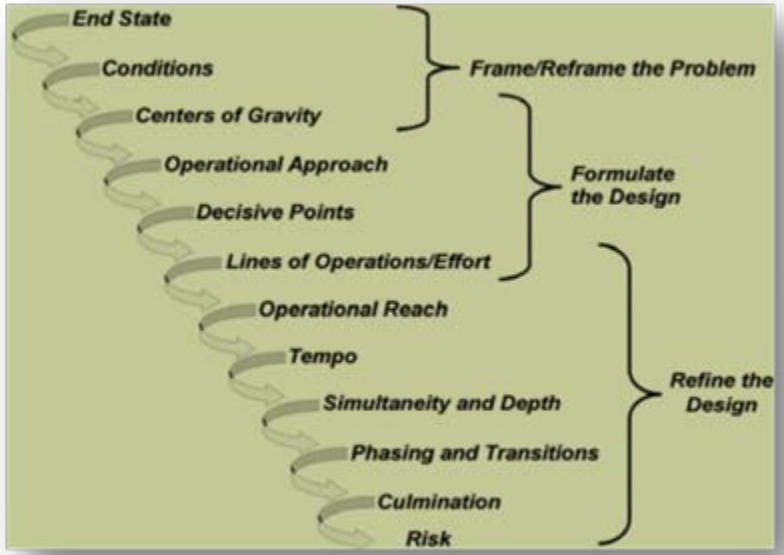
WORK DECOMPOSITION *(Industrial Age Paradigm)*

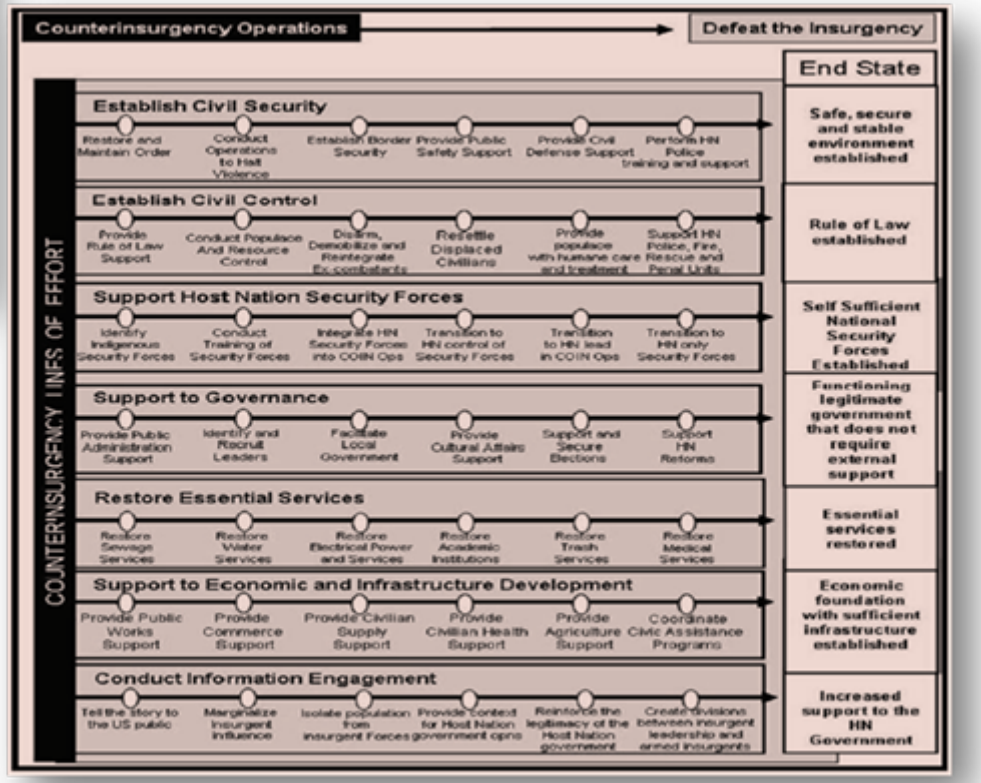


WORK ABSTRACTION *(Knowledge Age Paradigm)*

	Knowable Environments	*Wicked Environments*
Goals, Purposes, and Constraints	→ *Organizational Intentions*	→ *Multiple stakeholders / perspectives*
Definitions of Value/Progress	→ *Environmental Transformation*	→ *Adaptive / opportunistic organizations*
General Functions and Effects	→ *Cause-Effect Mechanisms*	→ *Unintended consequences*
Physical Work Processes	→ *Work Capabilities*	→ *Multiple (PMESII) work dimensions*
Physical Object Characteristics	→ *Environmental Artifacts*	→ *Selective attention / interpretation*

Motivation: Operational Design Doctrine





Motivation: Narrative Knowledge Theory

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

BRUNER, 1986

→ RATIONAL ENGINEERING MODELS

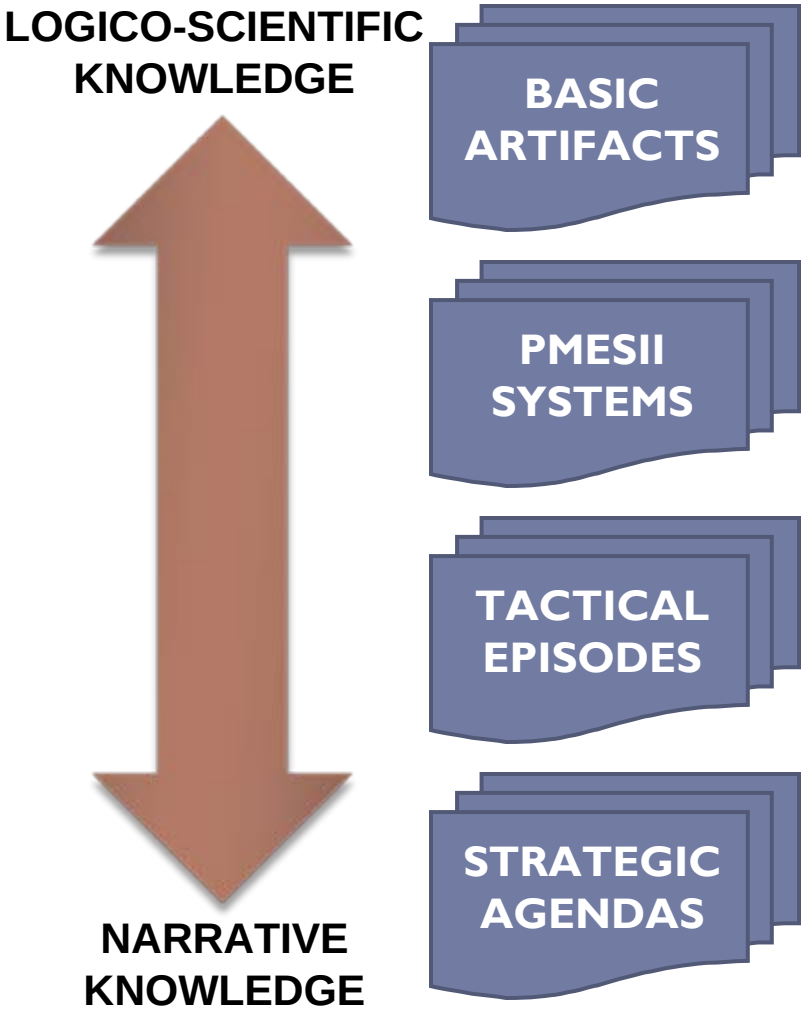
NARRATIVE KNOWLEDGE

- 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

→ ACTION/EFFECTS LINKED WITH MEANING

Complementary, but irreducible !

Four Basic Elements of Knowledge



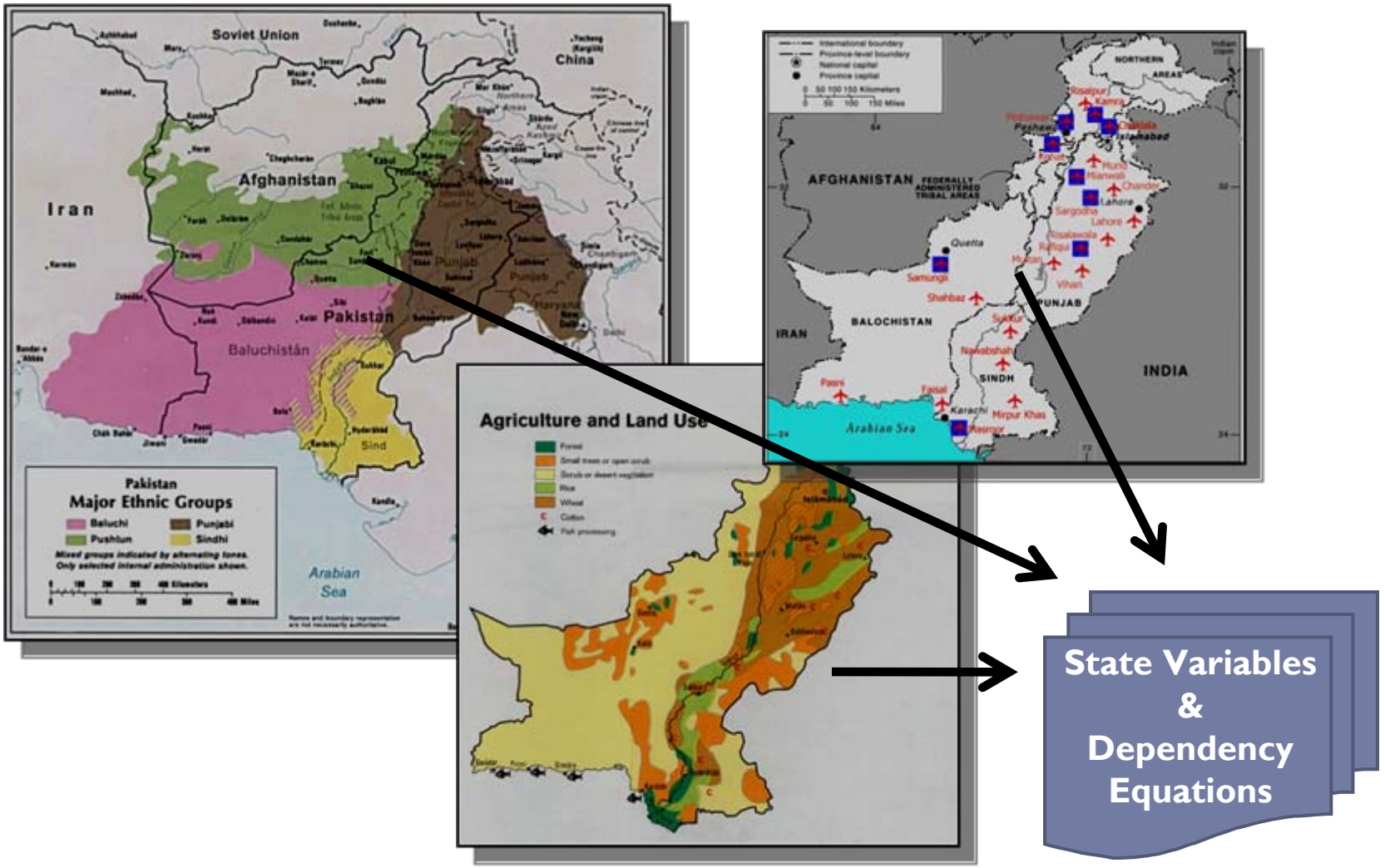
- Defines key objects and features of the region in terms of basic characteristics and state variables
- Represents the decomposition of the region into work-related abstraction

- Structurally composes basic artifacts into meaningful PMESII models and organizational work systems
- Functionally links state variables via system dynamics equations *(used to propagate 2nd-order effects)*

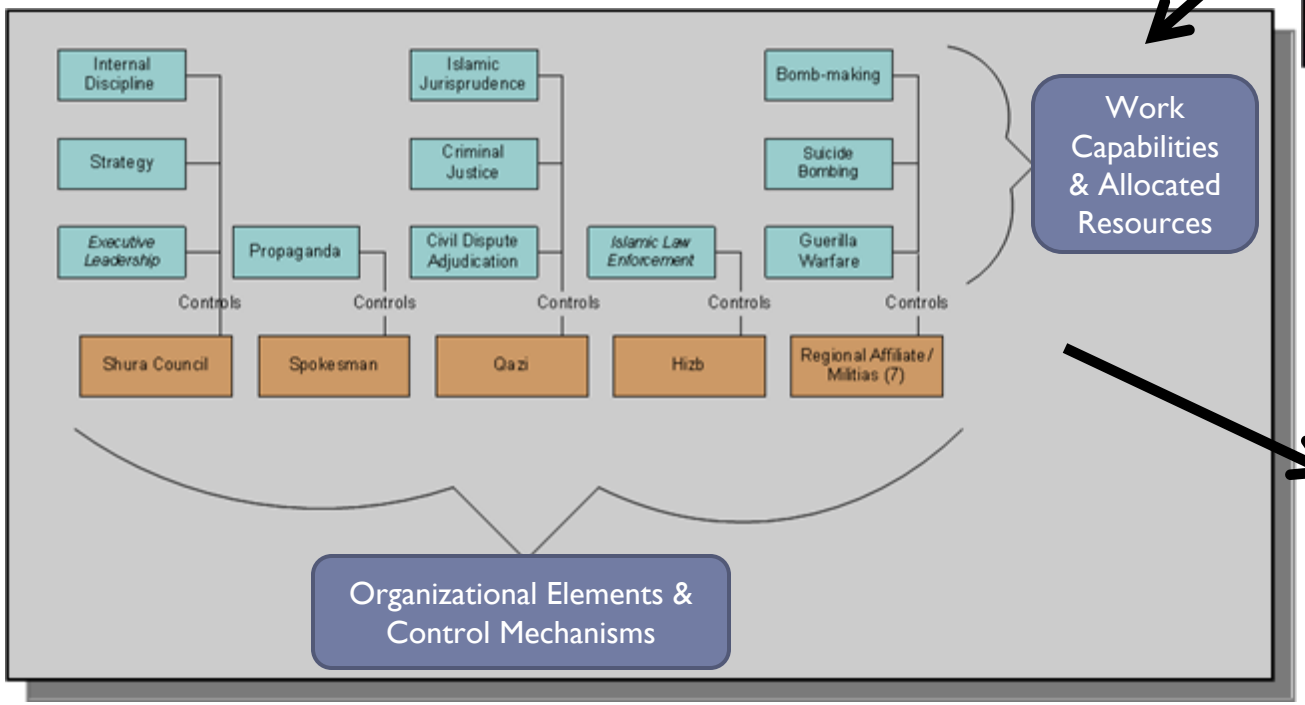
- Associates actions, events, and emergent conditions with PMESII systems and strategic agendas
- Triggers state variable changes in the form of direct effects *(2nd-order effects arise via PMESII models)*

- Connects a line of effort hypothesis with a center of gravity (PMESII system) and objective (state variables)
- Enables tracking of operational progress and contextual assessment of operational relevance)

Constructing Artifacts & Systems



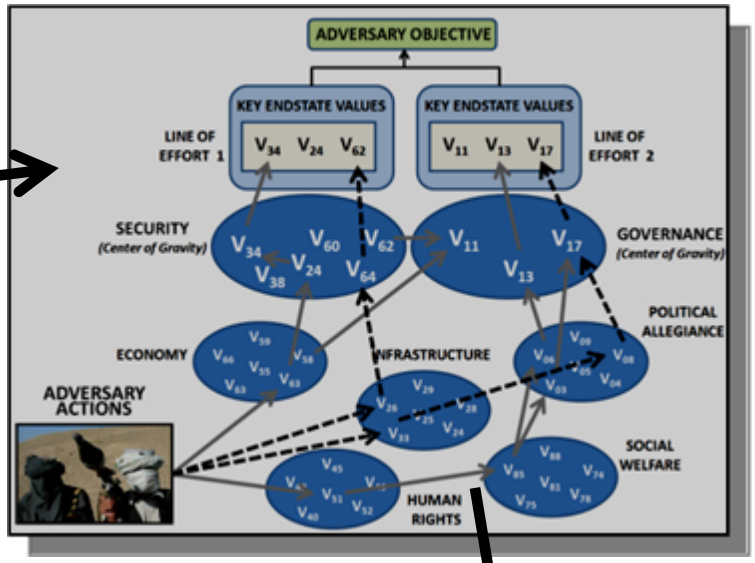
Constructing Adversary Work Systems



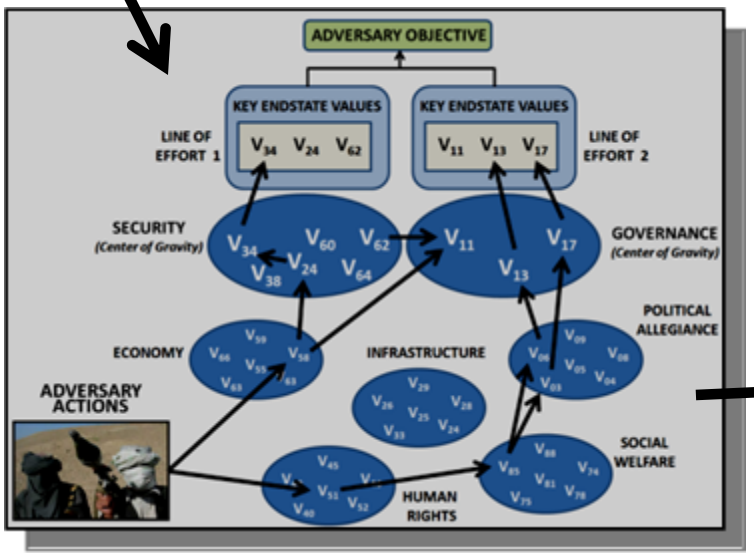
Work Capabilities & Resources

Constructing Tactical Episodes

Time t_2



Time t_1

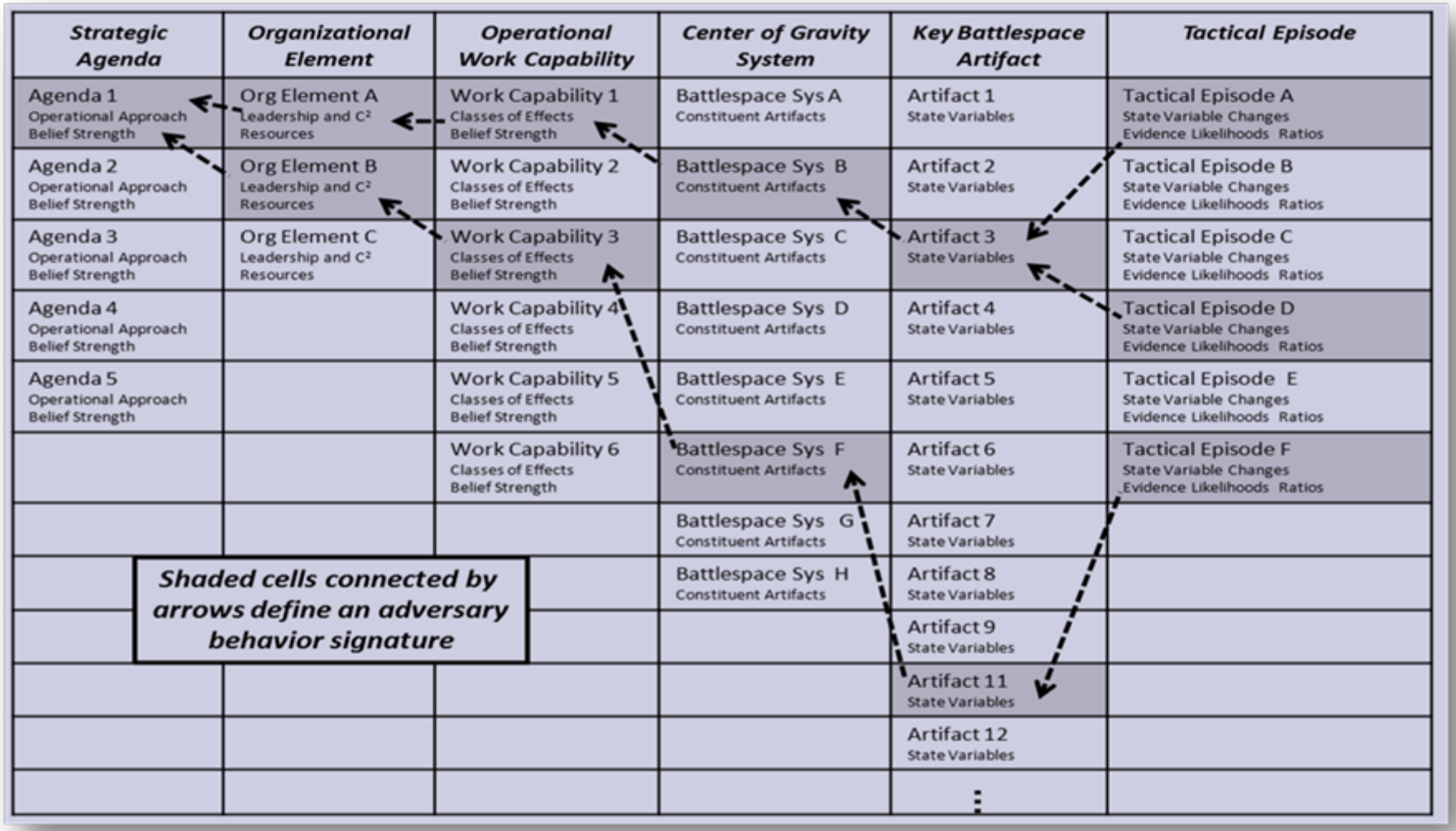


Direct Effects & 2nd-Order Consequences

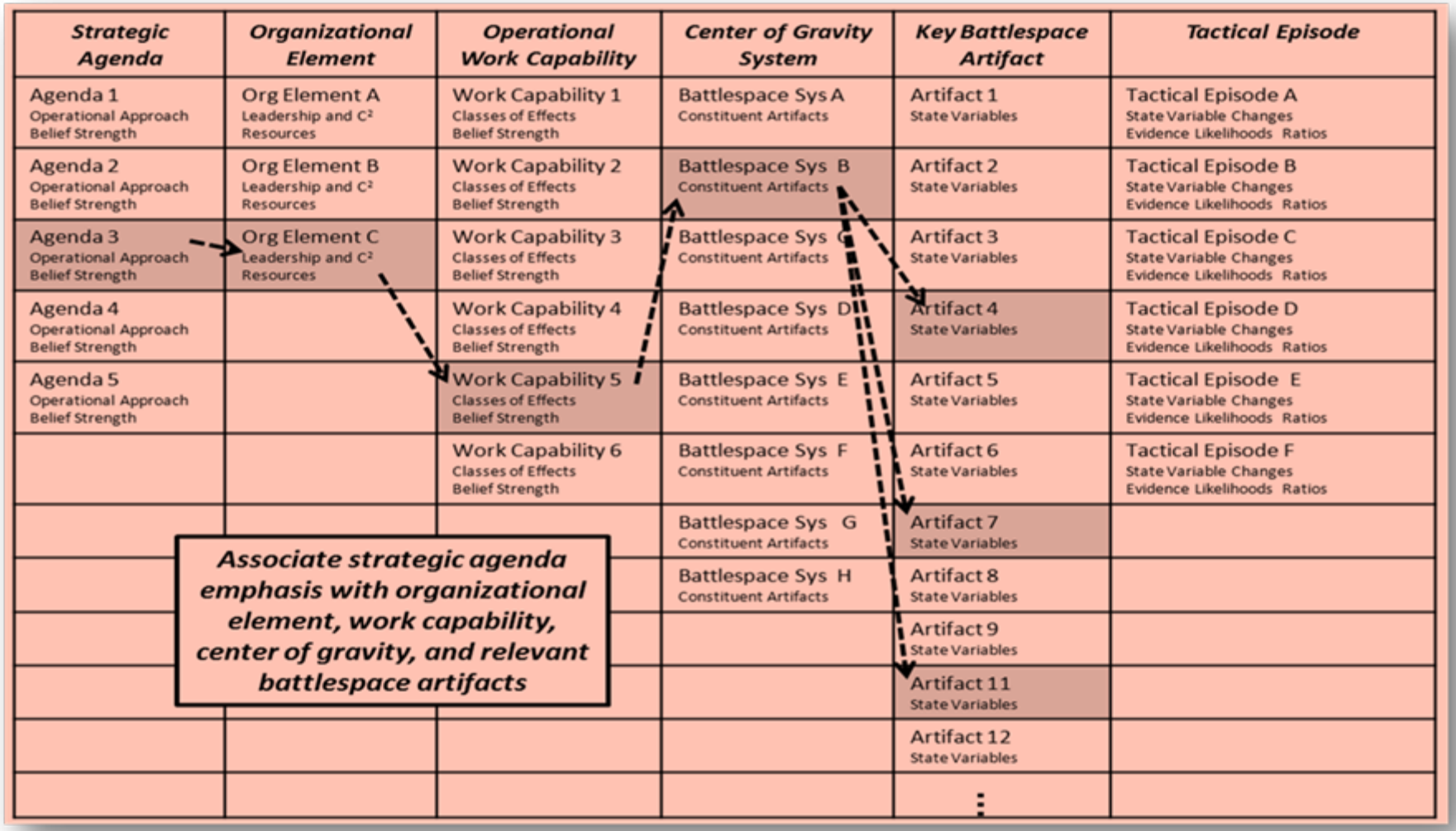
Behavior Signature

A behavior signature is a ***dynamically constructed narrative*** that uniquely characterizes an adversary at a given point in time in terms of a ***hypothesized strategic agenda*** that is (1) organizationally supported by a ***defined work system***, (2) functionally associated with ***systemic cause-effect relationships*** within the battlespace ecosystem, and (3) instantiated over time by a series of ***observable tactical episodes***. A behavior signature enables the anticipation of future adversary intentions and actions to the extent that the contextual framework of knowledge underlying its construction remains valid over time.

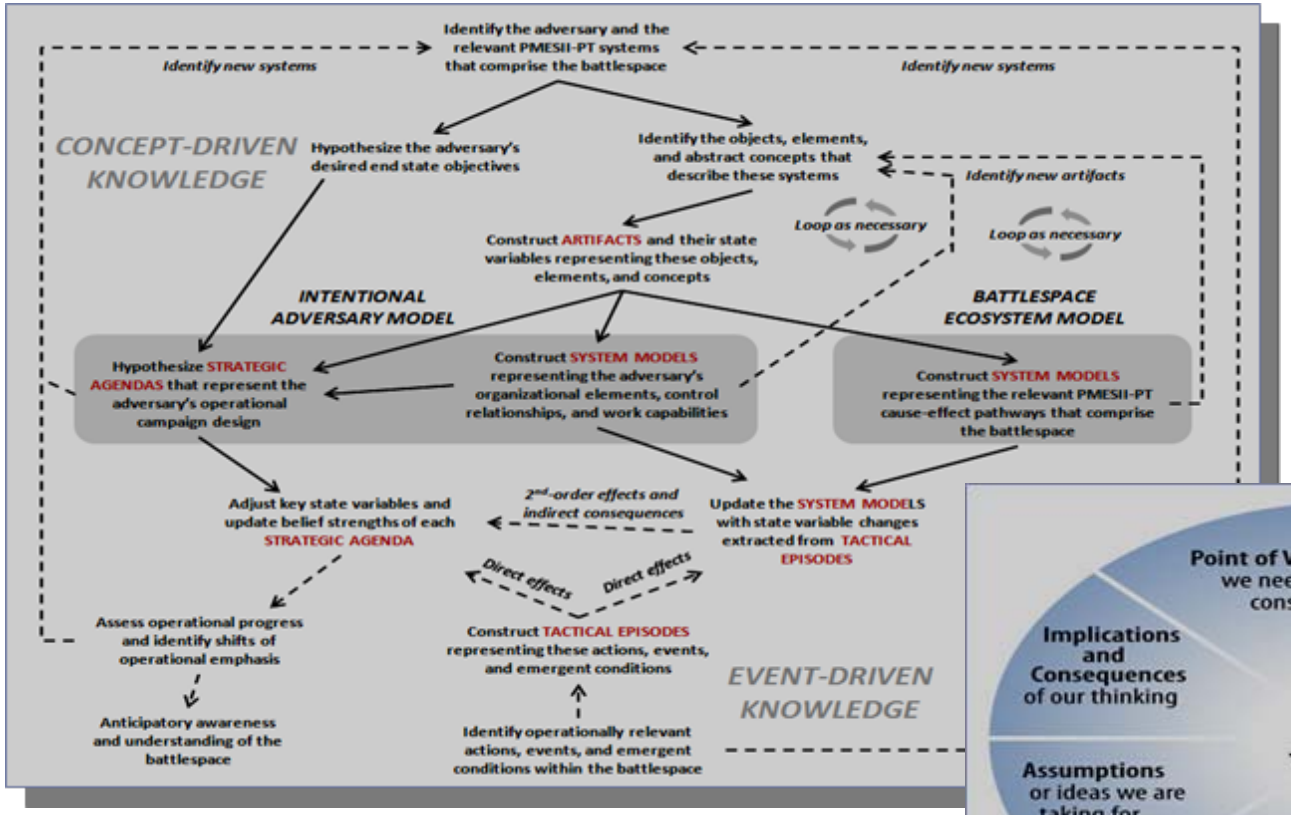
Use of Morphological Tables



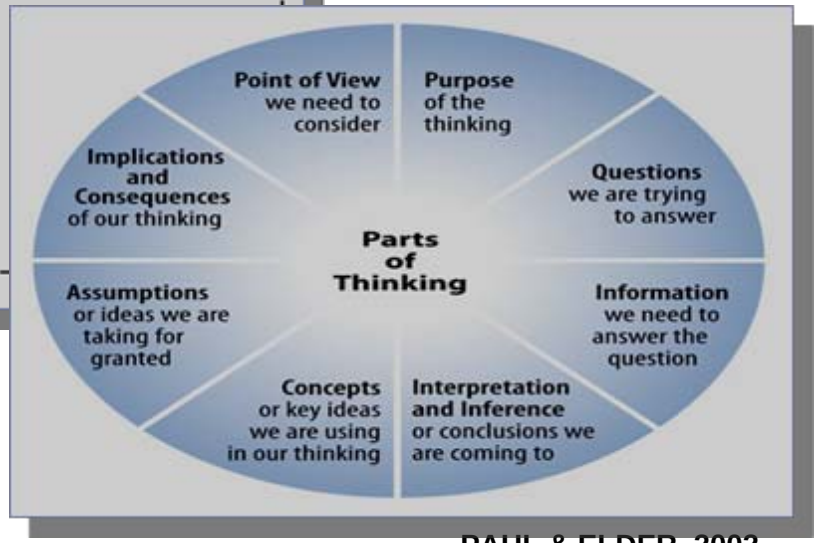
Anticipating Future Actions and Events



Building Frameworks of Understanding



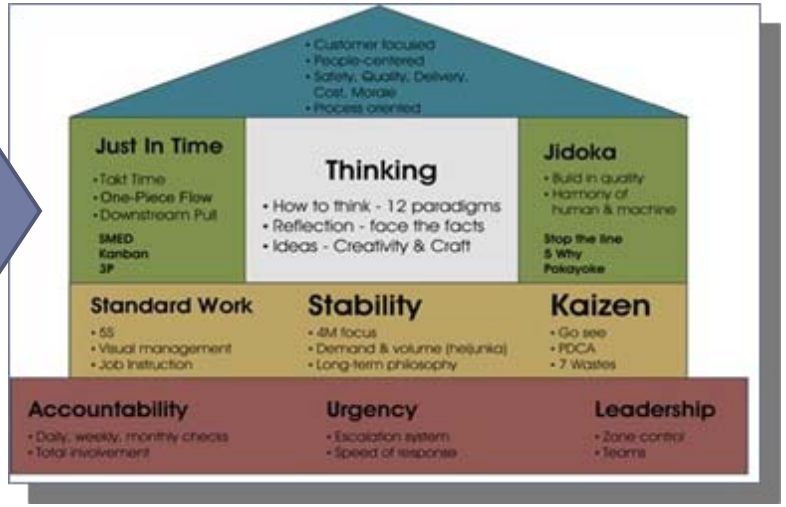
LEEDOM & EGGLESTON, 2009



PAUL & ELDER, 2002

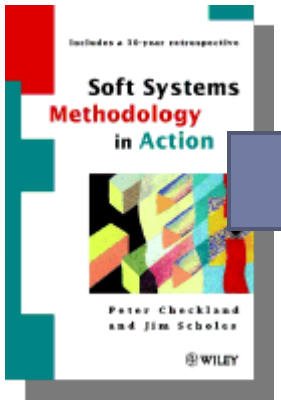
Motivation: Conceptualization Strategies

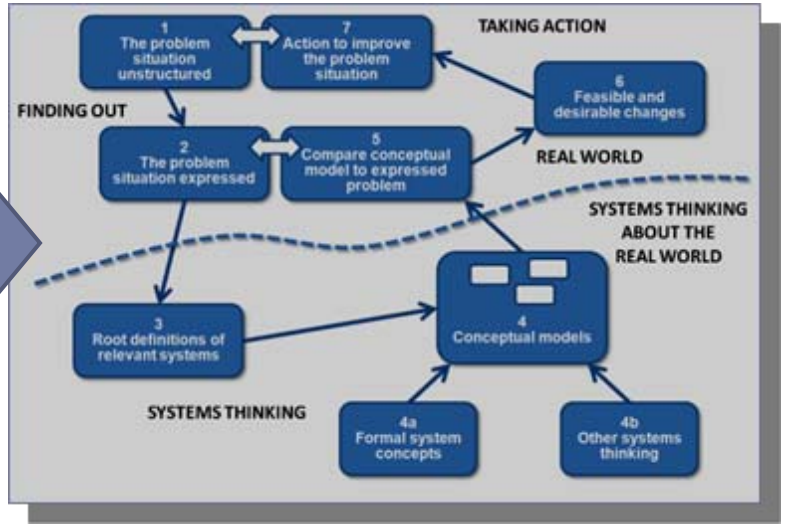
TAIICHI OHNO



HOLISTIC, CONTINOUS LEARNING

CHECKLAND, 1999





ITERATIVE, CONCEPTUAL MODELING

Conceptual Shaping Tasks

DIAGNOSTIC TASKS

1. Key assumptions check
2. Quality of information check
3. Indicators or signposts of change analysis
4. Analysis of competing hypotheses

CONTRARIAN TASKS

5. Devil's advocacy analysis
6. Team A / Team B analysis
7. High-impact / Low-probability analysis
8. "What if?" analysis

IMAGINATIVE TASKS

9. Brainstorming
10. Outside-in thinking
11. Red team analysis
12. Alternative futures analysis

Taming Hard System Problems

Hard Modeling Paradigm

- Construct well-formed, stable system representations
- Assume problem representations are universal
- Model predicts future states → action recommendations
- Focus externally on utility of model to end user

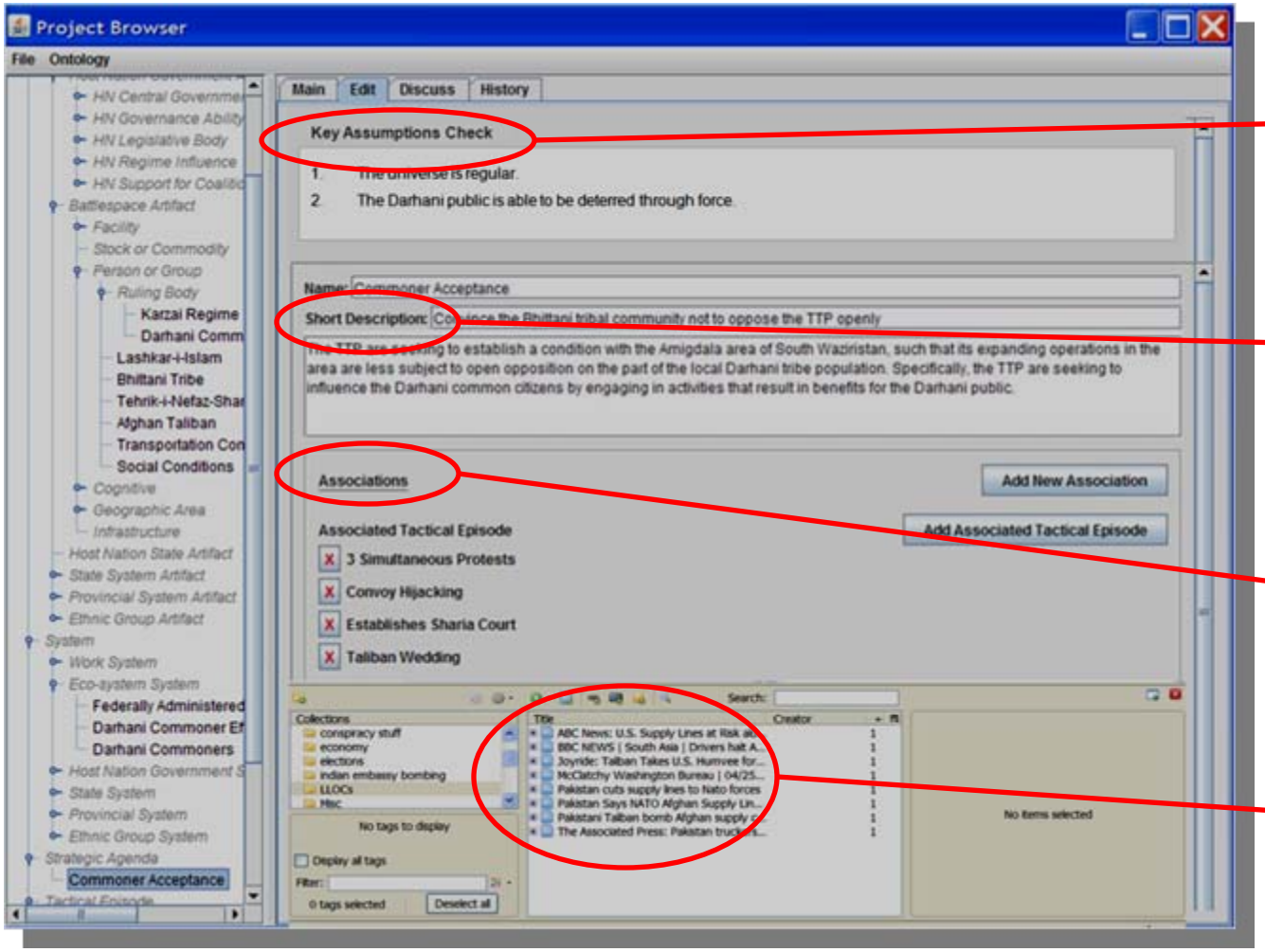
Brittle, cannot account for adaptive behavior
Requires fitting questions to model structure
Lacks end user trust and support

Soft Modeling Paradigm

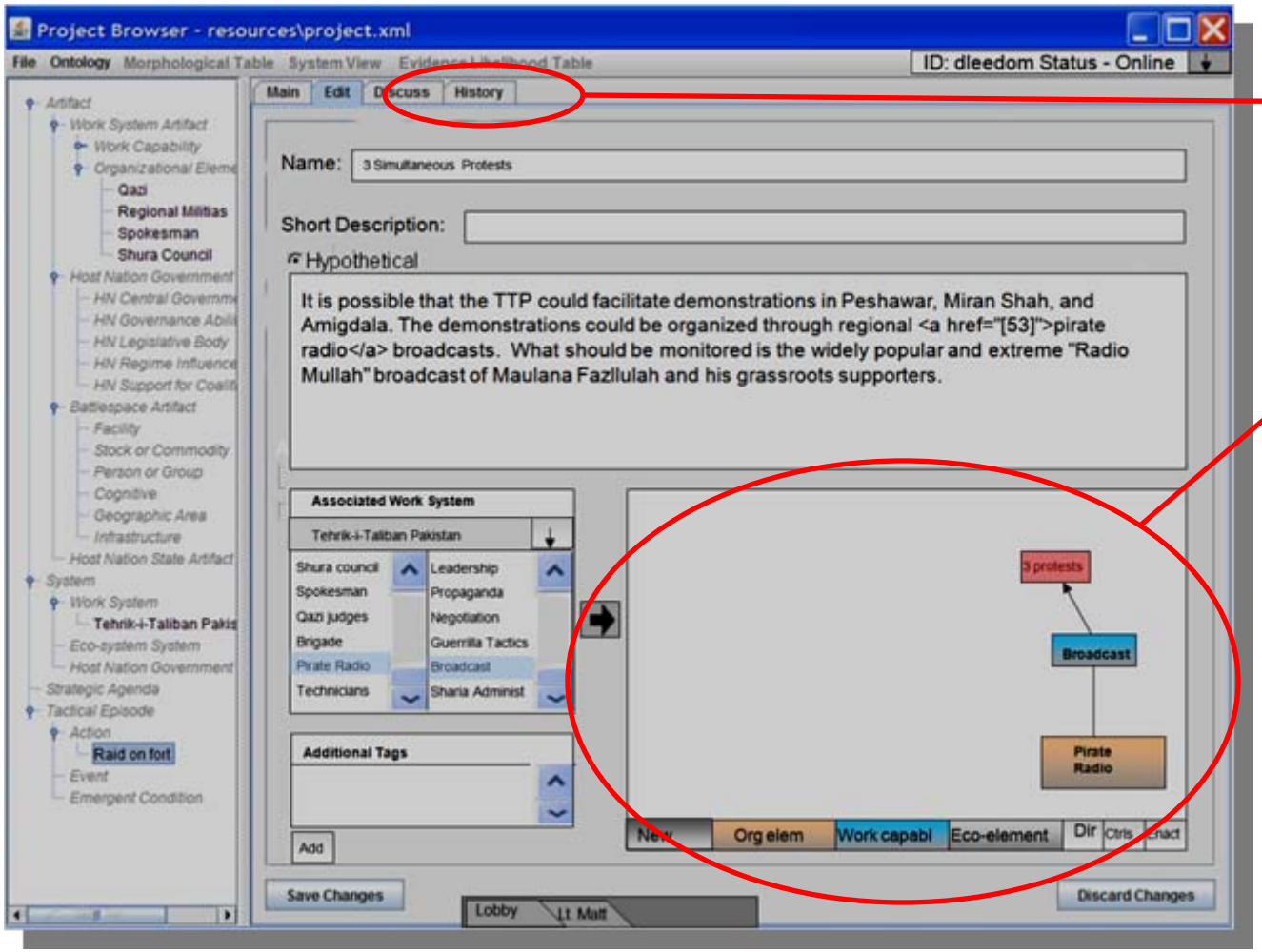
- Create flexible modeling environment with standard grammar
- Evolve problem framework to match operational questions
- Model supports learning → increased problem understanding
- Focus internally on model refinement and adaptation

Flexible, places behavior in intentional context
Fits model structure to operational questions
Involves end user in model management

User Interface Facilitates Collaboration



Interactive Model Adaptation



Historical Analysis

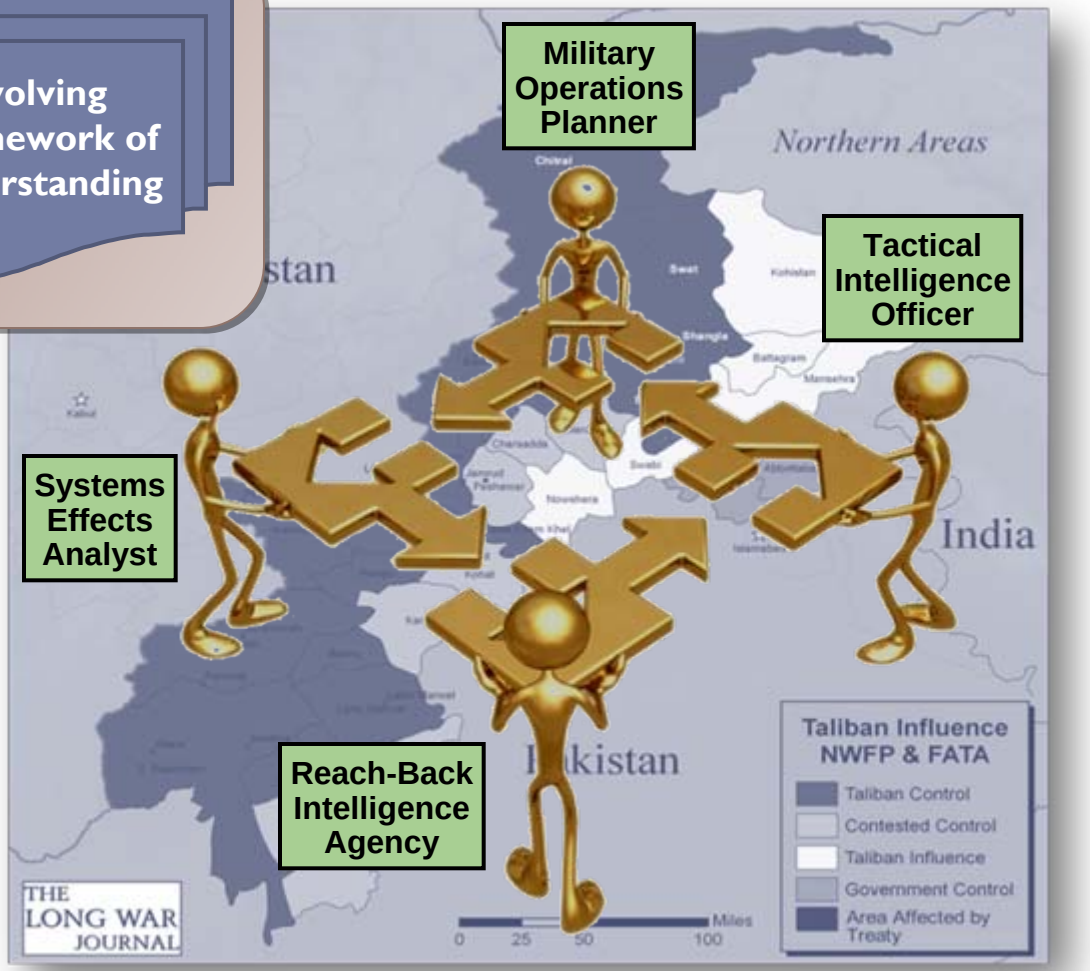
"What If?" Hypothesis Analysis

Summary

Formal Knowledge Grammar
Dynamic Association Graphs
Abductive Reasoning Tools
Behavior Signature Framework
Wiki Interface for Collaboration
State Variable Backplane

Evolving Framework of Understanding

Soft Systems Approach to Modeling Complex Adaptive Adversaries



Questions ?