Supporting Effects-based Operations with Information Technology Tools:

Examining Underlying Assumptions of EBO Tool Development Practices

Mr. William John Wales and Dr. Thomas Triscari, Jr.
Lally School of Management & Technology
Rensselaer Polytechnic Institute
110 8th Street
Troy, New York 12180

William John Wales
walesw@rpi.edu

Thomas Triscari, Jr.
trisct@rpi.edu

The Changing Face of Warfare

	Environment	Models	Battle Space
Past (Cold War)	Stable (U.S.S.R) **Systems Untested**	Many (Behavioral and Technical)	Defined Theater Defined Enemy Motivations/ Values Structure/ Doctrine
Present	Volatile (Access to Knowledge) **Systems Tested**	Many (Technical) Few (Behavioral)	UnDefined Theater UnDefined Enemies Motivations/ Values Structure/ Doctrine Coalition Efforts
Future	Hyper-Competitive **Severe Stress On Systems**	Few (Behavioral & Technical)	UnDefined Theater UnDefined Enemies Accelerated Tempo Global Reach

The Environment is changing,
New threats are emerging,
Systems are being stressed,
Signaling a new era of warfare

Background → Observation → Imperative → Framework → Conclusions

Effects Based Operations

ACC/XP (2002). Effects Based Operations. Langley AFB VA, Air Combat Command

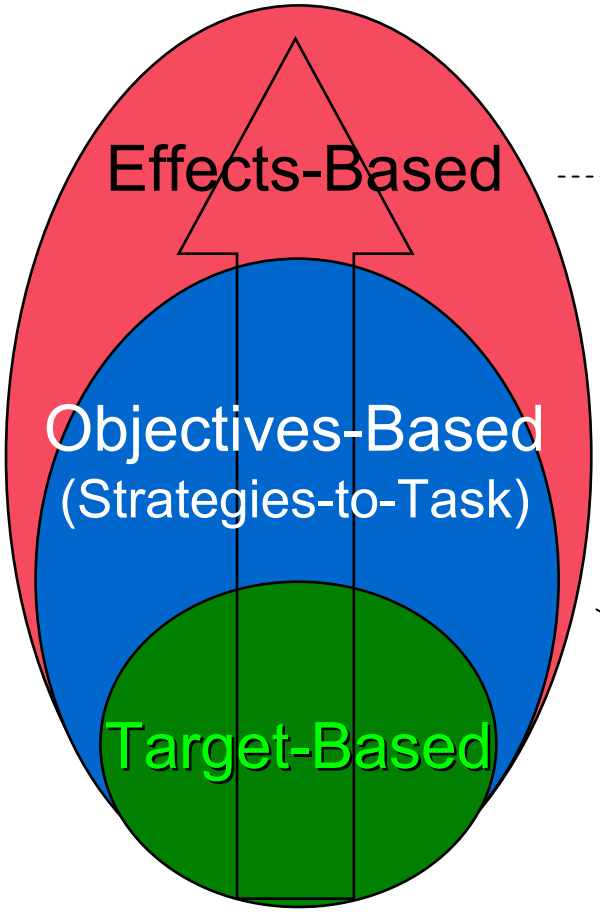
Effects-Based Operations

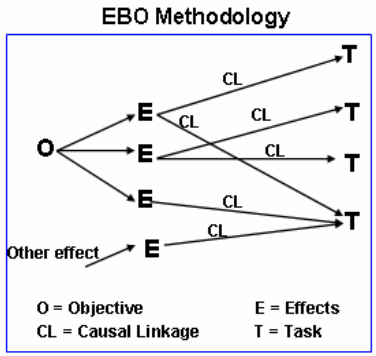
"Actions, taken against enemy systems, designed to achieve specific effects that contribute directly to desired military and political objectives."

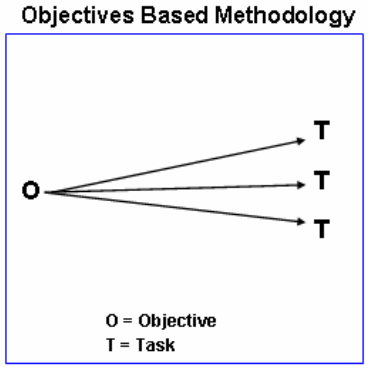
Effects Based Methodology

"A methodology for planning, executing, and assessing operations designed to attain the effects required to achieve desired national security outcomes."

In an era of precision weapons, it makes intuitive sense that precision operations should follow



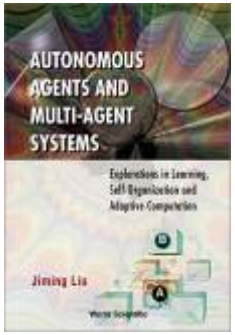


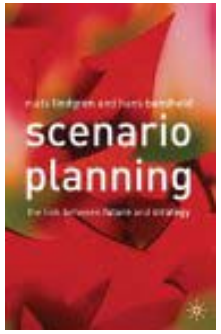


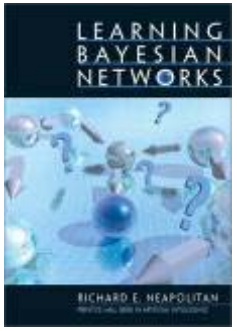
Supporting EBO CoA Generation

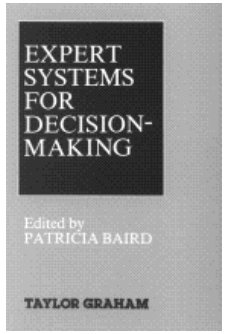
Observation

A wide variety of *approaches* have been used to develop tools that help decision makers generate courses of action (CoA)





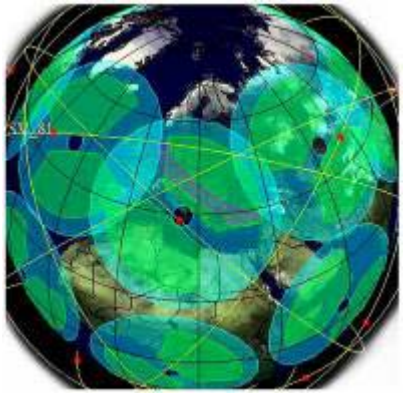




Ex Approaches: Autonomous systems, scenario planning, Bayesian networks, expert systems

The diversity and fundamental differences of these approaches has prompted the need for a basic understanding of the underlying assumptions upon which the approaches are based.

Adverse Unintended Consequences



Hyper-Competitive
Decision Environment
- incomplete data
- uncertain information
- ambiguous goals
- high stakes
- time pressure
- lethality of weapons
- intelligent adversaries

Klein, G., *Sources of Power*. 1999

The way human commanders formulate effects-based strategy will be impacted by the way supporting technology is designed

Inadequate Decision Support Engineering

- With out understanding the assumptions underlying approaches, developers may:
  - employ approaches based only on their merits
  - leave unchallenged the limitations of approaches
  - avoid comparing different approaches
- Fostering convergent vs. divergent thinking
  - Dangerously limited view of evolving situation
  - "Blind spots" in perception of environmental threats
  - Affords commanders a "false" situational awareness

Are we properly addressing decision making in the "real world"?

Decision Support Paradigms

- Although approaches differ, many pertain to a similar “school of thought”
- Decision Support Paradigms
  - Operate at the family level
  - Low resolution method of analysis
  - Classify & subsequently characterize EBO tool development practices
  - Advantages vs. Disadvantages
- Examining Underlying Assumptions
  - Gravitation towards a paradigm
  - Testing and Evaluation of Approaches

Paradigm	Defining Attributes	Example Approaches
Autonomous	Human-less loop	Closed Loop Systems
Directive	Prescriptive	Prototypical Expert Systems
Predictive	Inferential Analysis	Modeling & Simulation
Emergent	Descriptive	Scenario Planning

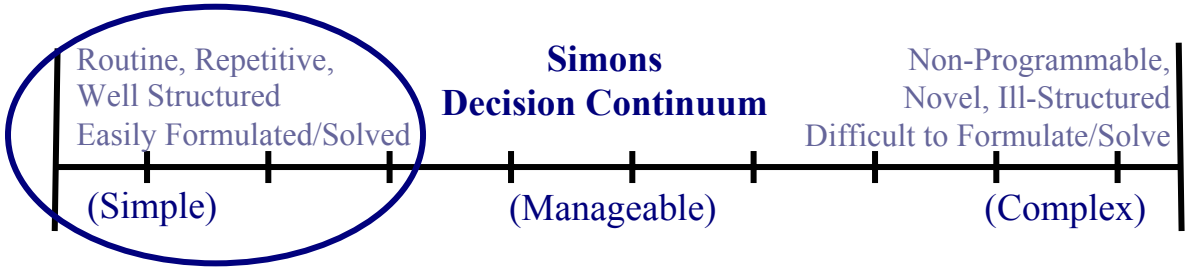
It is imperative that the efficacy of the basic assumptions underlying the approaches are challenged and compared prior to technology being codified and fielded in support of strategic planning.

Autonomous Paradigm

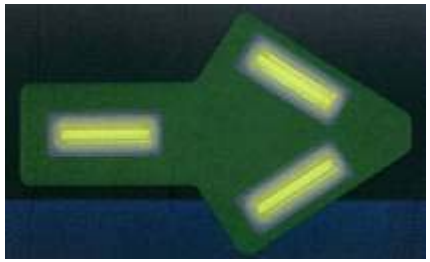
- Central Belief
  - A task or set of tasks may be fully automated thus removing the human from the decision process
- Focus
  - Achieving machine autonomy from the human decision maker, eliminating human error and limitations
  - Developing a set of rules to be applied to data being processed by the decision technology
  - Freeing the human decision maker to focus on more pertinent, strategic higher level decisions.
- Limitations
  - Exceptions to predefined rules may cause disastrous results, with the severity of the mistake dependent upon what information is overlooked, discarded, misinterpreted, or otherwise mishandled
  - Supplanting vs. unintentionally changing human activity
- Example Approaches
  - Autonomous agent technologies

"Often individuals who devote their professional careers to learning and applying decision analysis, artificial intelligence, or some other domain will be understandably reluctant to admit that tools and methods outside their domain may be equally or even more appropriate to solve a given problem"

Hopple, G.W., *Decision aiding dangers: the law of the hammer and other maxims.*
IEEE SMC Nov/Dec 1986



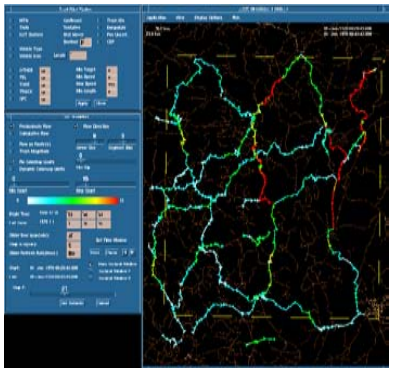
Directive Paradigm



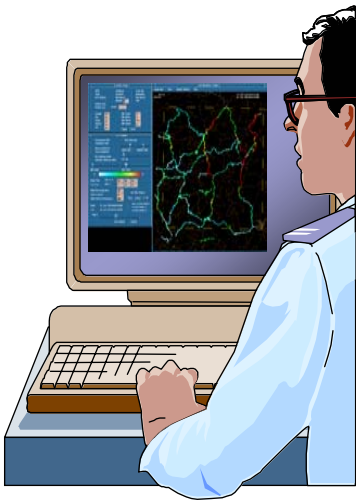
- Central Belief
  - Knowledge engineering may increase the availability, understandability, and survivability of human 'expertise' through limited interaction decision support systems.
- Focus
  - Formulating directive procedural knowledge from available descriptive knowledge about the situation
  - Machine centered guidance of human commanders or other technological components
- Limitations
  - Potential oversimplification of complex environments
  - Non-transferable human cognitive capabilities
  - Affect on mental decision processes: trust, adaptability
- Example Approaches
  - Prototypical expert systems, case-based reasoning

The non-transferability of many human abilities has resounding consequence for the need to encourage the training, development, and validation of expert decision makers.

Predictive Paradigm



- Central Belief
  - World events are dependent, allowing predictive models to be constructed using probabilities that bear a direct and meaningful relationship to eventual event outcomes.
- Focus
  - Assessing predictive probabilistic estimates for each event, outcome, or consequence in a modeled course of action (CoA).
  - Increasing the level of analysis and reasoning commanders must perform over a set of potential CoAs through prediction.
- Limitations
  - Probabilities difficult to assess
    - Human skill in probability estimation
    - Variable stability in events and trends
    - Non-rationality of intelligent adversary
  - Understanding the future by labeling it
    - To improve the model is to improve understanding of the future
- Example Approaches
  - Whiteboard decision support tools to layout & model CoAs



Emergent Paradigm

- Central Belief
  - At a strategic level the future is wildly unpredictable and can not be treated in a logical, predefined formulation.
- Focus
  - Human decision makers understanding of the environment or situational awareness
  - Encourages the discovery, inclusion, and consideration of outlier events
  - Observe & reflect vs. formulate & estimate
  - Generating scenarios => monitoring environment
- Limitations
  - Costly in terms of time, energy, and resources
- Example Approaches
  - Scenario generation, planning, and analysis

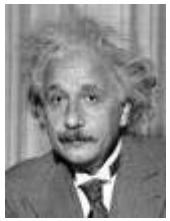
Emergent Tools aid the human decision maker to develop situational awareness, consider the many possible ways a situation may evolve, and ultimately formulate a dynamic, response strategy that incorporates an appreciation for the breadth of possible future scenarios.

Presentation Take-Aways

- Effects-based strategy formulation is inherently a human centric endeavor
- EBO CoA generation supported by a wide variety of approaches
- Approaches represent gravitation to a dominant decision support paradigm
- Failing to examine underlying assumptions of paradigms & approaches will potentially yield adverse unintended consequences
- Need for testing and evaluation of emerging approaches / technologies

There is a need to meticulously question, compare, test, and evaluate approaches prior to technology being codified and fielded in support of strategic planning

Extra Time: Discussion of Concepts



"The problems that exist in the world today cannot be solved by the same level of thinking that created them"
~Albert Einstein

A portion of this research was sponsored by the Air Force Research Laboratory under agreement number F30602-03-2-0088. The views and conclusions contained in this presentation are those of the authors and should not be interpreted as necessarily representing the official policies or endorsements, either expressed or implied, of the Air Force Research Laboratory or the U.S. Government.