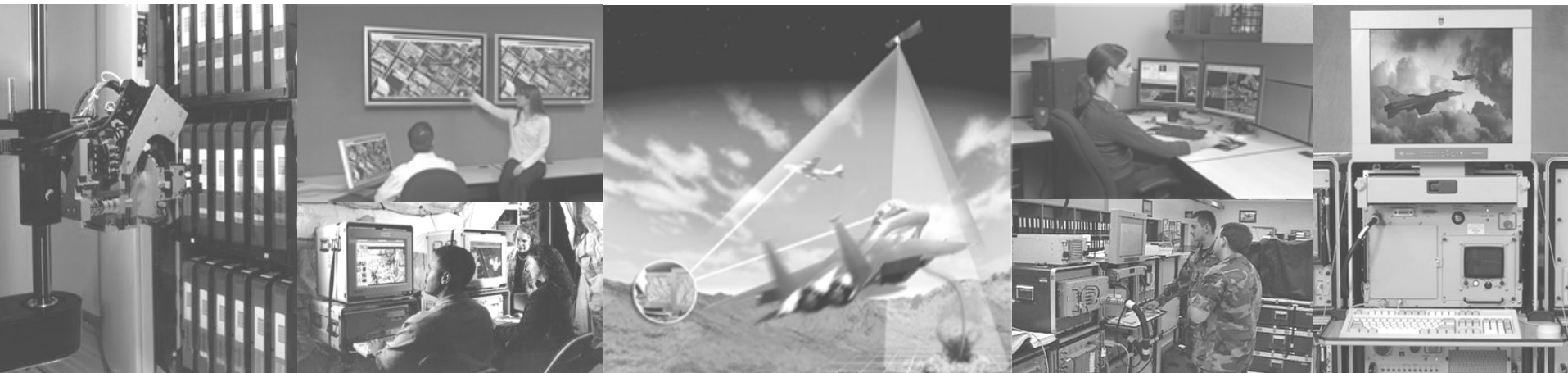


# Synthesizing Information for Senior Policy Makers using Simulation: Addressing EBO problems with System Dynamics

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13th ICCRTS  
Seattle, Washington



# Overview

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- Effects-Based Operations (EBO)
  - That is, Political-Military (POL-MIL) planning
  - Department of Defense (DoD) perspective
    - As opposed to State Department/foreign policy perspective
      - i.e., the problem
  - Working through an EBO example using System Dynamics (SD)
    - As opposed to explaining how SD applies to EBO
      - i.e., the proposed methodology or technical solution

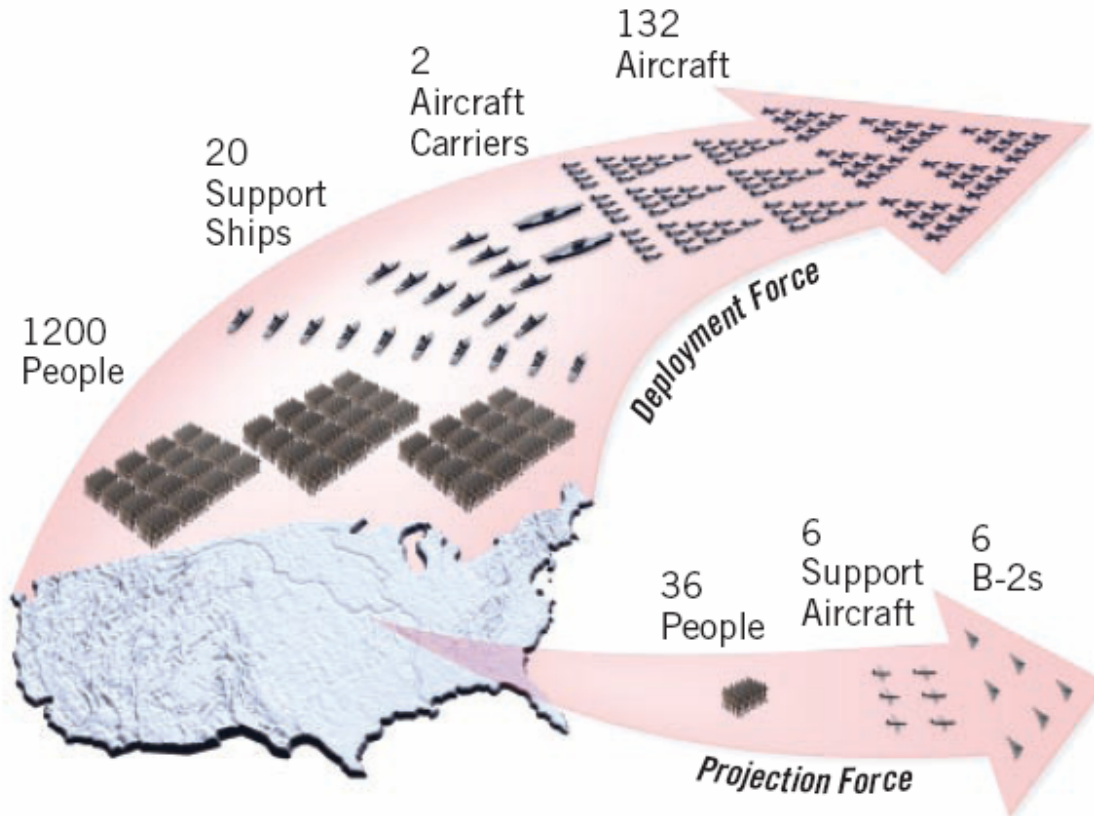
# EBO & POL-MIL planning

- The DoD perspective (Deptula 2001)
  - Gulf War I
  - Rapid Decisive Operations (RDO)
    - Precision Guided Munitions (PGM)
      - High technology
    - Operationally cleaner
      - Less collateral damage
    - More accomplished in less time
      - Quicker operational tempo
    - Fewer casualties
    - Focus on *effects*, not destruction
      - In the service of both *political* and *military* goals
    - Focus on new thinking & organization
      - Focus on airpower, “going light”
    - Revolution in Military Affairs (RMA)



# Executing RMA – a “smaller footprint”

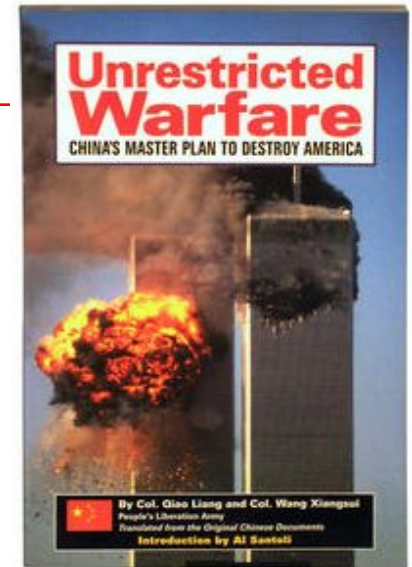
A Libyan-Style Raid: 120 Tons of Ordnance  
4500 Miles from CONUS



- “Surface forces will always be an essential part of the military, but massing surface forces to overwhelm an enemy is no longer an absolute prerequisite to impose control over the enemy.”
- “Only new organizations and doctrine aiming to exploit effects-based operations can fulfill the full potential of this concept.”

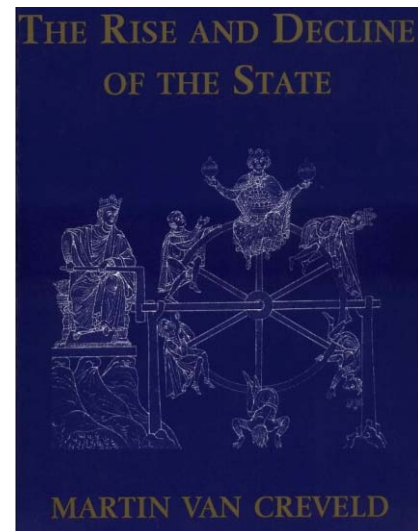
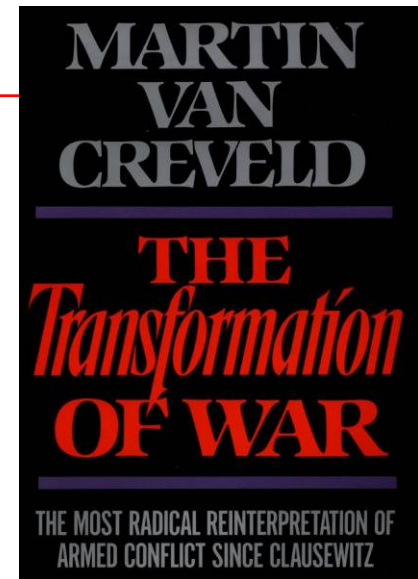
# Response to Gulf War 1

- US forces made the world sit up and take notice
- PRC Cols Qiao Liang & Wang Xiangsui (1999)
- How China can defeat a technologically superior nation through a variety of means (i.e., *effects*)
  - Atomic, Diplomatic, & Financial warfare
  - Conventional, Network, & Trade warfare
  - Bio-chemical, Intelligence, & Resources warfare
  - Ecological, Psychological, & Economic aid warfare
  - Space, Tactical, & Regulatory warfare
  - Electronic, Smuggling, & Sanction warfare
  - Guerrilla, Drug, & Media warfare
  - Terrorist, Virtual (deterrence), & Ideological warfare
- Takeaway: Chinese also focus on effects
  - And get off the battlefield ('cuz it's dangerous there!)



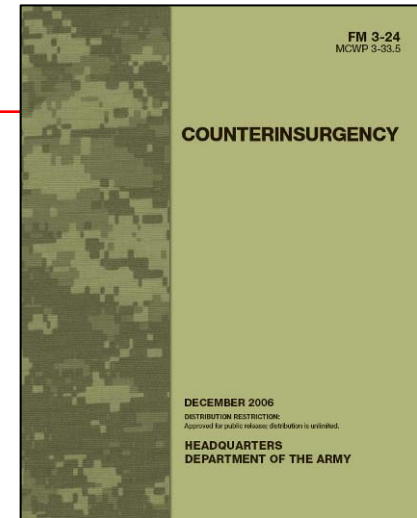
## Van Creveld 1991 & 1999

- Gulf War 1 success dependent on the core four:  
1) POL (oil), 2) Logistics, 3) Electricity, and 4) COM
  - But political, non-technical systems are key, PMESII
  - Gulf War the opposite of Vietnam, but Vietnam-style conflicts will return
- State losing monopoly on violence
  - Insurgents and non-state actors increasingly potent
    - High technology
  - Clausewitzian trinity of state, military, population
- In the modern world, for some people, war is not a rational means to a end, it *\*IS\** the end.
- This is a conflict that the United States can lose
  - History shows that great powers usually lose to insurgents
  - “failed states” are increasingly prevalent on the international stage



# The Iraq experience: terrorism & insurgency

- FM 3-24 “Counterinsurgency” (Dec. ‘06)
  - The “graduate school” of warfare (per Lt. Col. John Nagl on NPR)
  - Counterinsurgency is **counterintuitive**
  - Understanding of complex, long-term effects is key
  - Argues for systemic thinking
- Incorporate counterinsurgency (COIN) insights (May ‘06)<sup>†</sup>
  - **Integrate** DIME elements in support of US policy
  - Illuminate complex, **counterintuitive** policy outcomes
  - Support planning (e.g., pol-mil planning)
  - Transform data, knowledge, and expertise into foresight
  - Identify investments for intelligence and force overmatch
  - Account for time as it influences freedom of action
  - Recognize the importance of perception
  - **Acknowledge that perseverance must be resourced**



<sup>†</sup>Hix, William C. 2006. “Intervening Successfully in the 21st Century – The Campaign in Iraq: Prospects for success and strategic lessons for future decision makers.” Master’s Thesis, Hoover Institution, Stanford University, Stanford, CA 94305.

## Van Riper's EBO criticisms (Dec. '05)

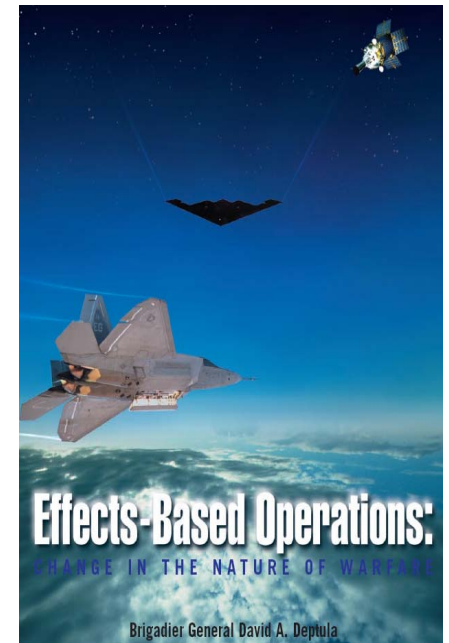


- EBO insights valuable, but incorrectly executed
  - Current EBO operational concepts and tools confuse more than they clarify
    - The database oriented Operational Net Assessment (ONA) is not working
  - There is a methodological difference between structural or *detail* and interactive or *dynamic* complexity
    - ONA addresses the former, but policy and thus EBO entails the latter
    - Modeling and Simulation (M&S) generally, and System Dynamics (SD) specifically, address dynamic complexity
- Political systems (e.g., Iraq COIN) are more analytically intractable (i.e., complex) than technical systems (e.g., the Gulf War's core four)
  - No amount of new technology will ever change the basic nature of war, which is a "terrible, uncertain, chaotic, bloody business."



# Conclusion

- Effects-Based Operations (EBO)
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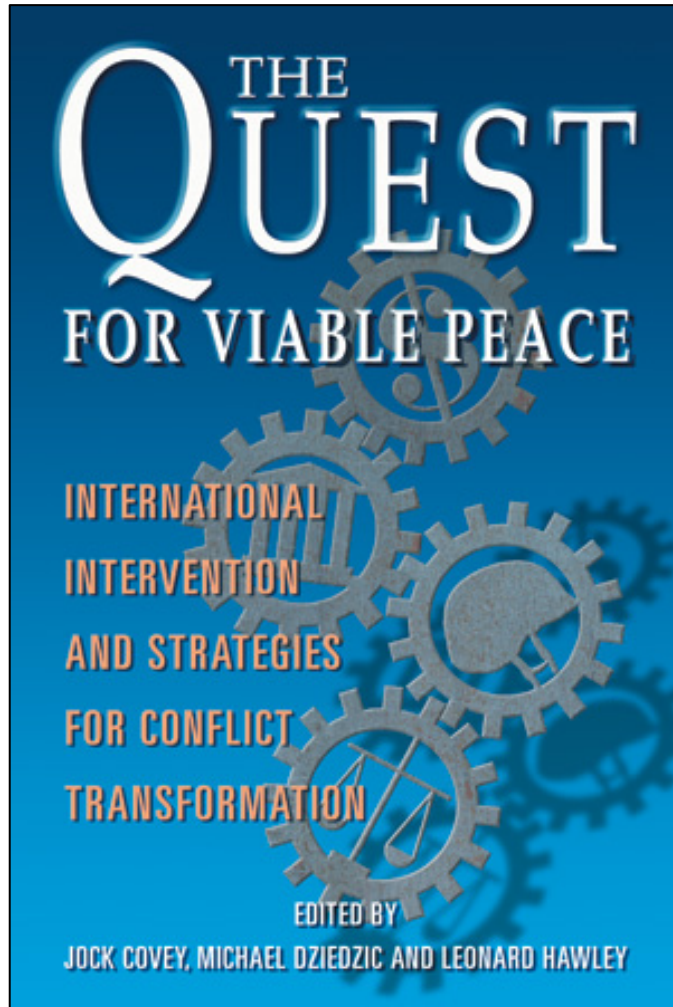


# Policy (that is, dynamic complexity) analysis methodologies contrasted and compared

- **HBS Written Analysis of Case (WAC)**
  - (non-computer aided)
  - What is the problem?
  - What Courses of Action (COAs) are possible or available?
  - Discuss their relative merits
  - Pick one
  - Defend your choice
- **Military Decision Making (MDM)**
  - (semi-computer aided)
  - Mission analysis
  - COA development
  - Wargame
  - COA decision
  - OPORD
- **System Dynamics (SD) reference mode (MIT)**
  - (explicitly computer aided)
  - Articulate the problem
  - Identify required additional expertise and knowledge
  - Define the time frame
  - Choose  $7 \pm 2$  central variables
  - Graph them over time frame
  - Postulate causal connections
  - Create the simulation
  - Iterative development:
    - Research the problem,
    - Modify the simulation, and
    - Test model and repeat



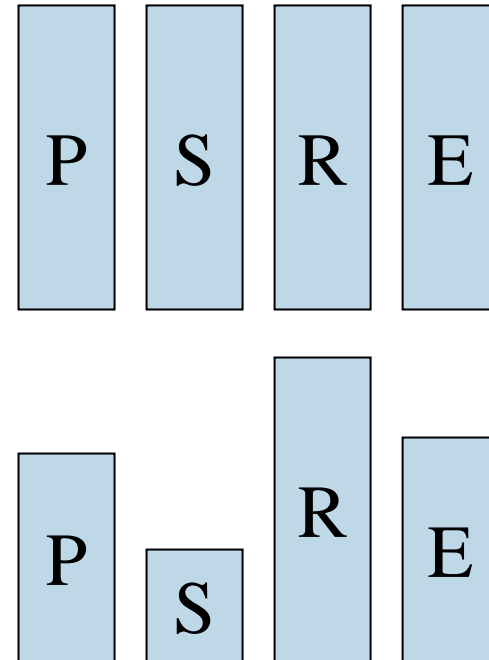
# Failed states & nation building



- Political strategy
- Security strategy
  - i.e., DoD
- Rule of Law strategy
- Political-economic strategy
  - i.e., State Department

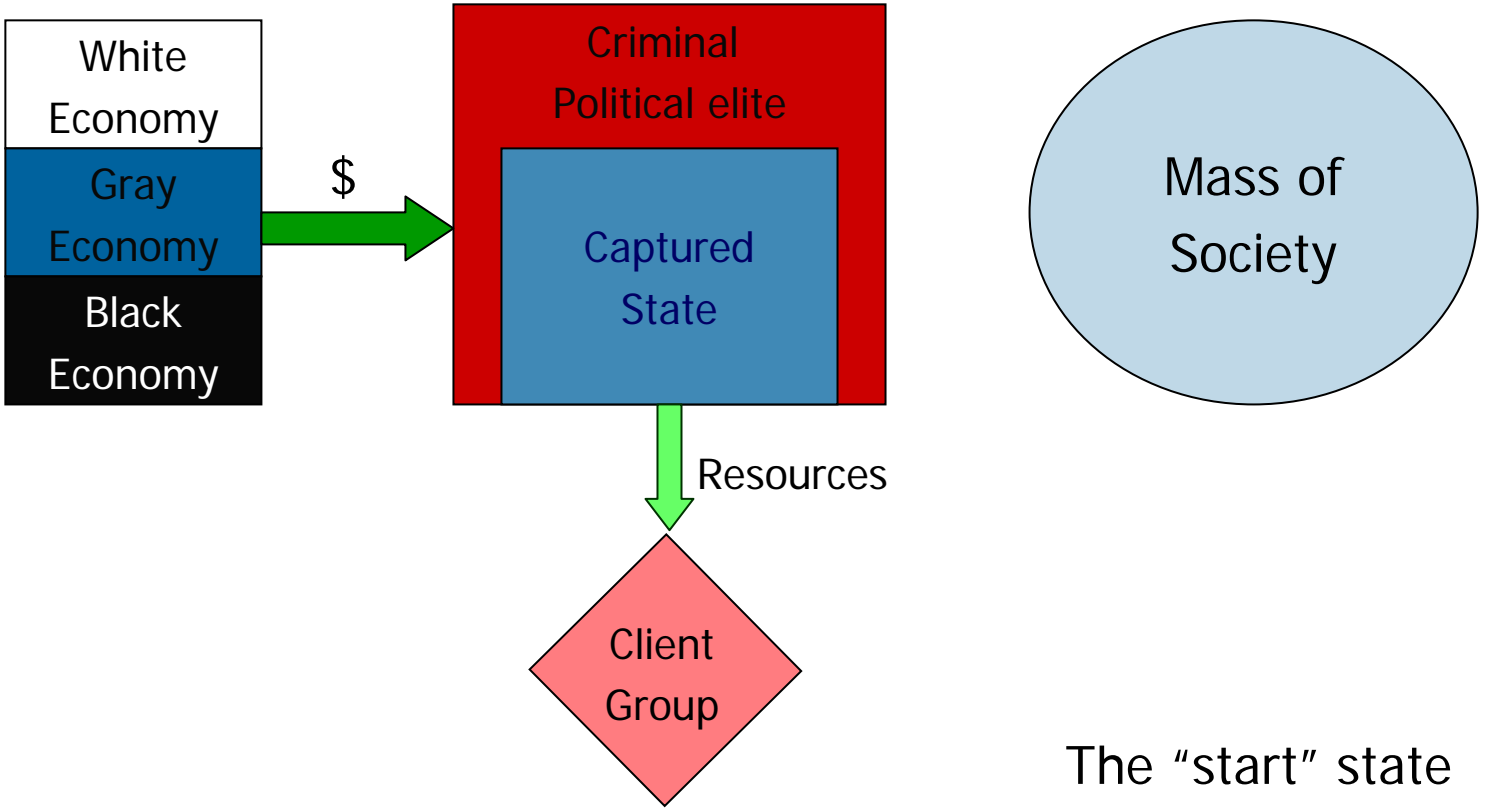
# Kosovo example

- Policy
- Security
- Rule of law
- Economic



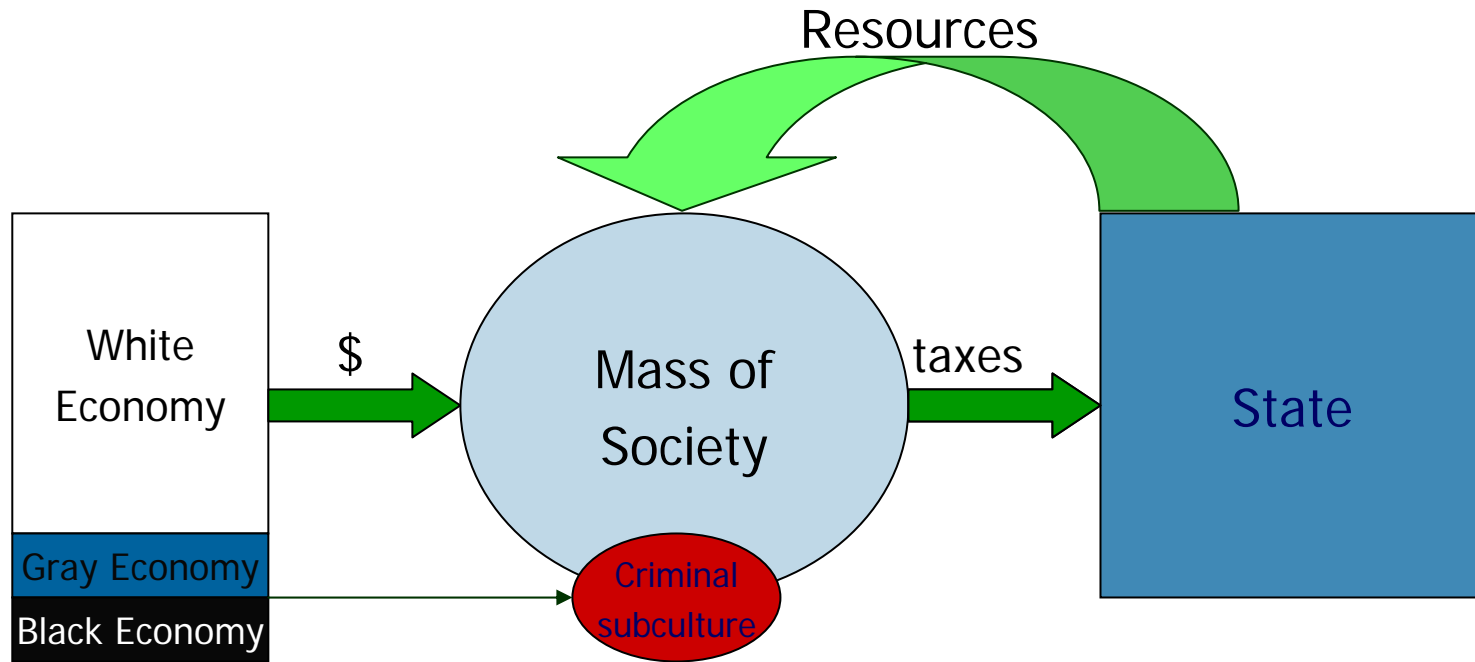
Their application is not usually coordinated...

# I. The Political Economy of Conflict (ch. 8, Blair et al.)



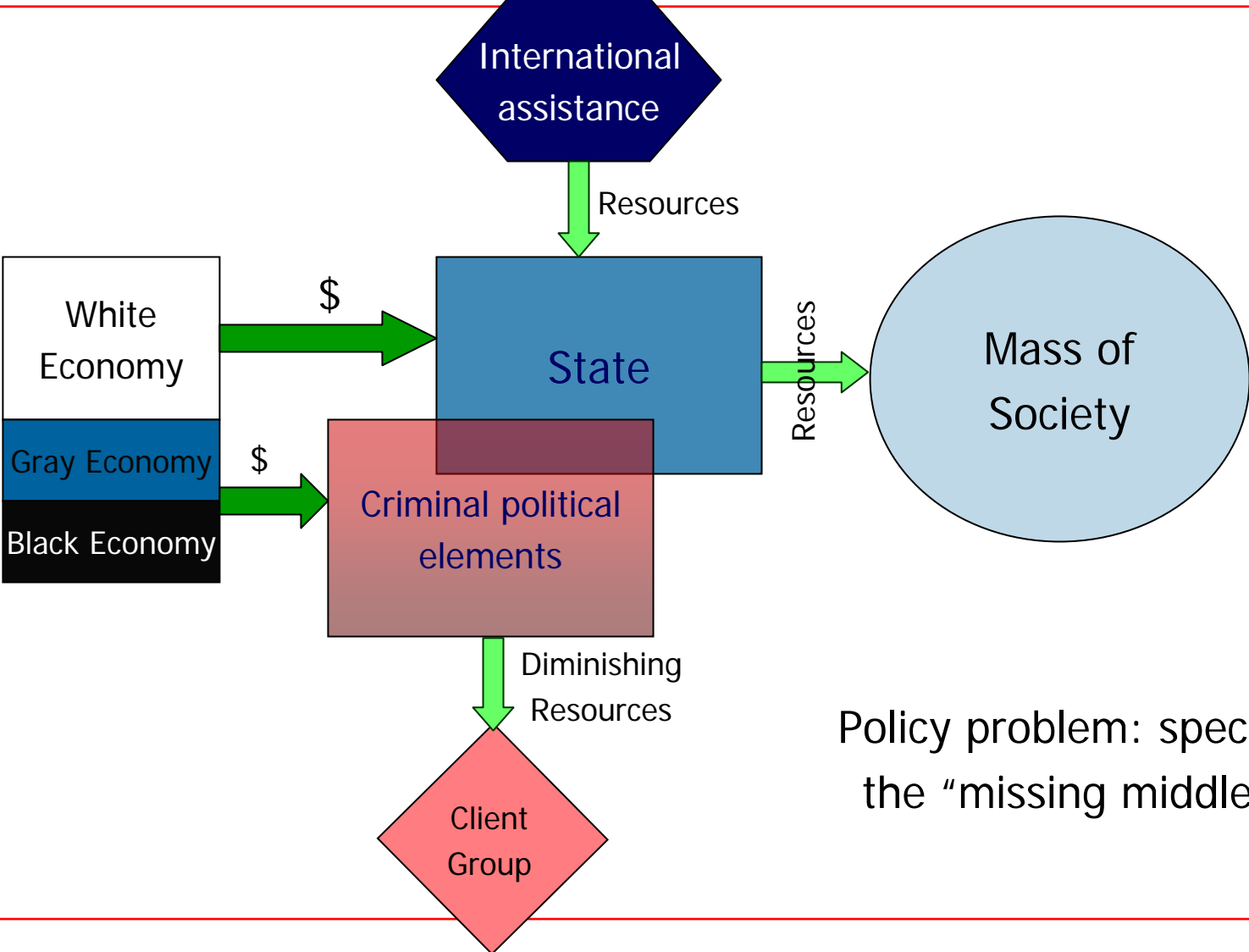
The "start" state

## II. The Political Economy of Self-sustaining Peace



The "goal" state

### III. The Political Economy of Viable Peace

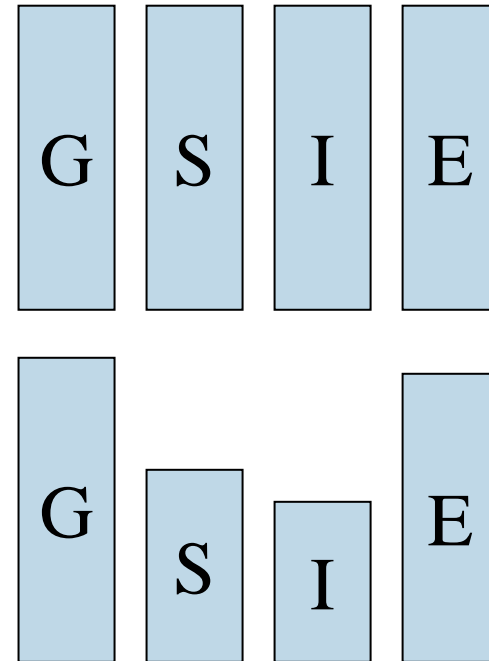


Policy problem: specify the "missing middle"

# Iraq example (failed states/nation building)

Thanks to Col. Darrall Henderson, USMA  
Academy Professor of Mathematical Science,  
for creating this and related slides

- Governance
- Security (COIN)
- Information
- Economic  
(development)



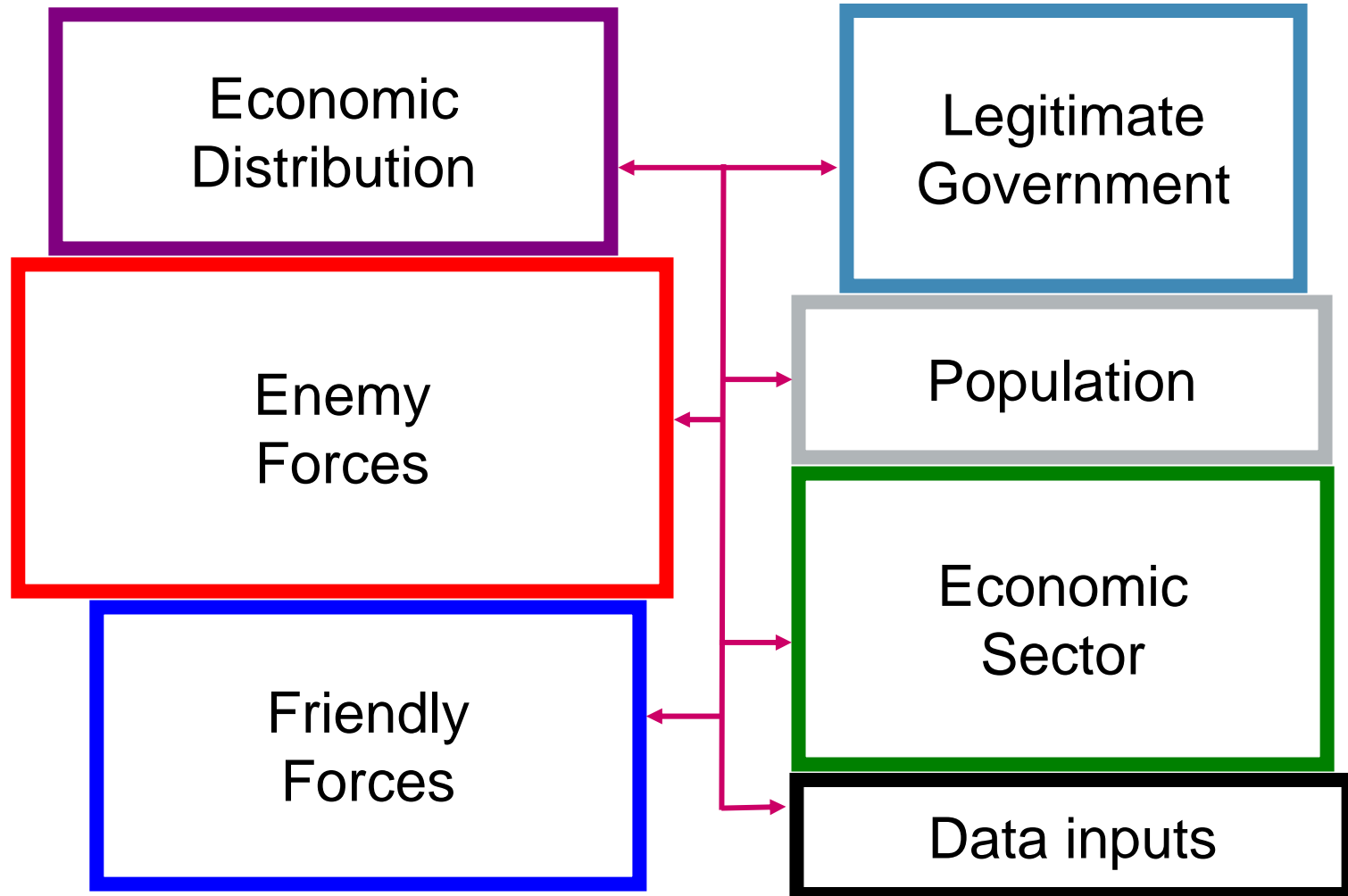
Is governance the main effort?

What comes first, security or development?



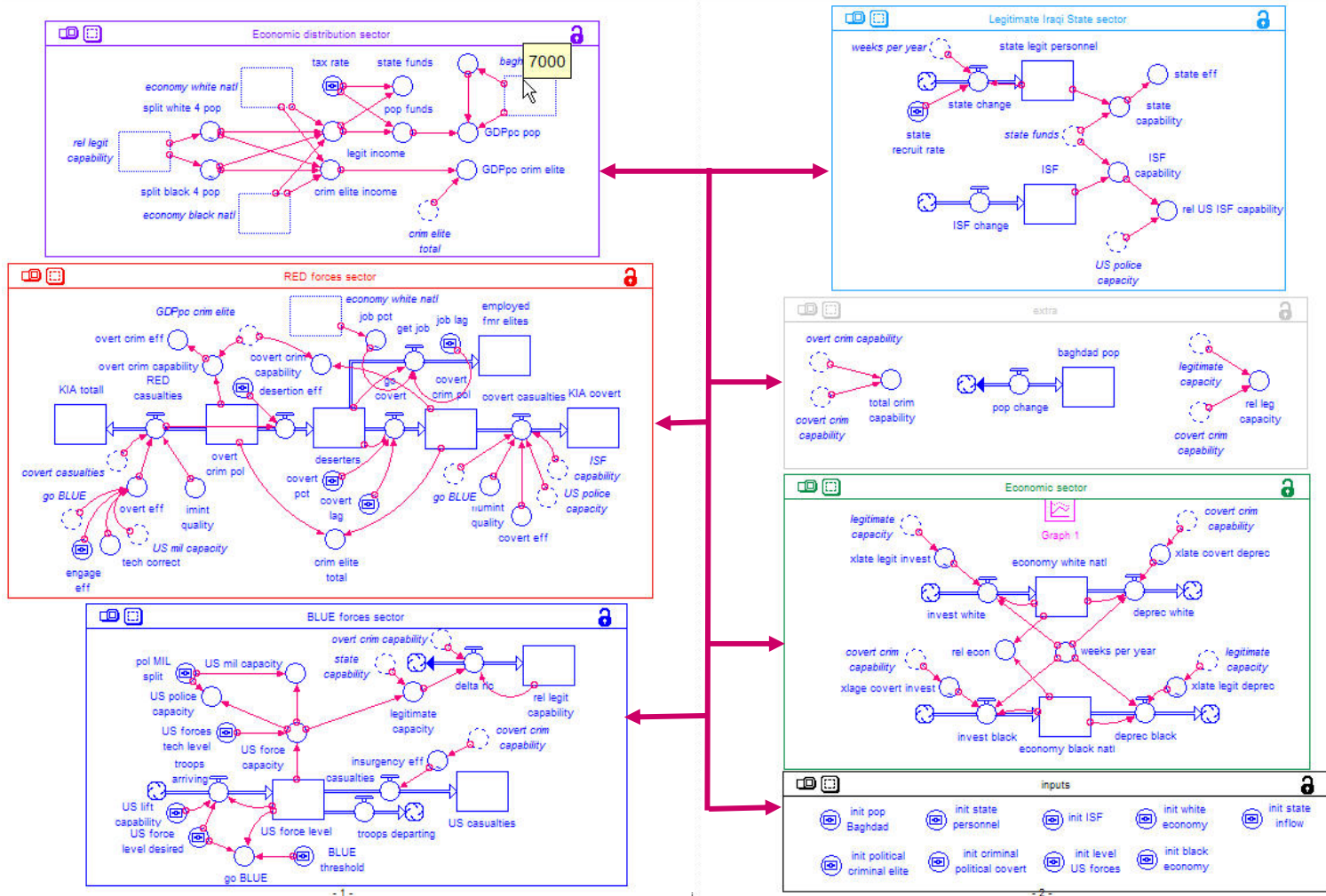
# Pol-Mil Modeling with System Dynamics (SD)

Military and non-military elements of national power are combined w/in a single analysis



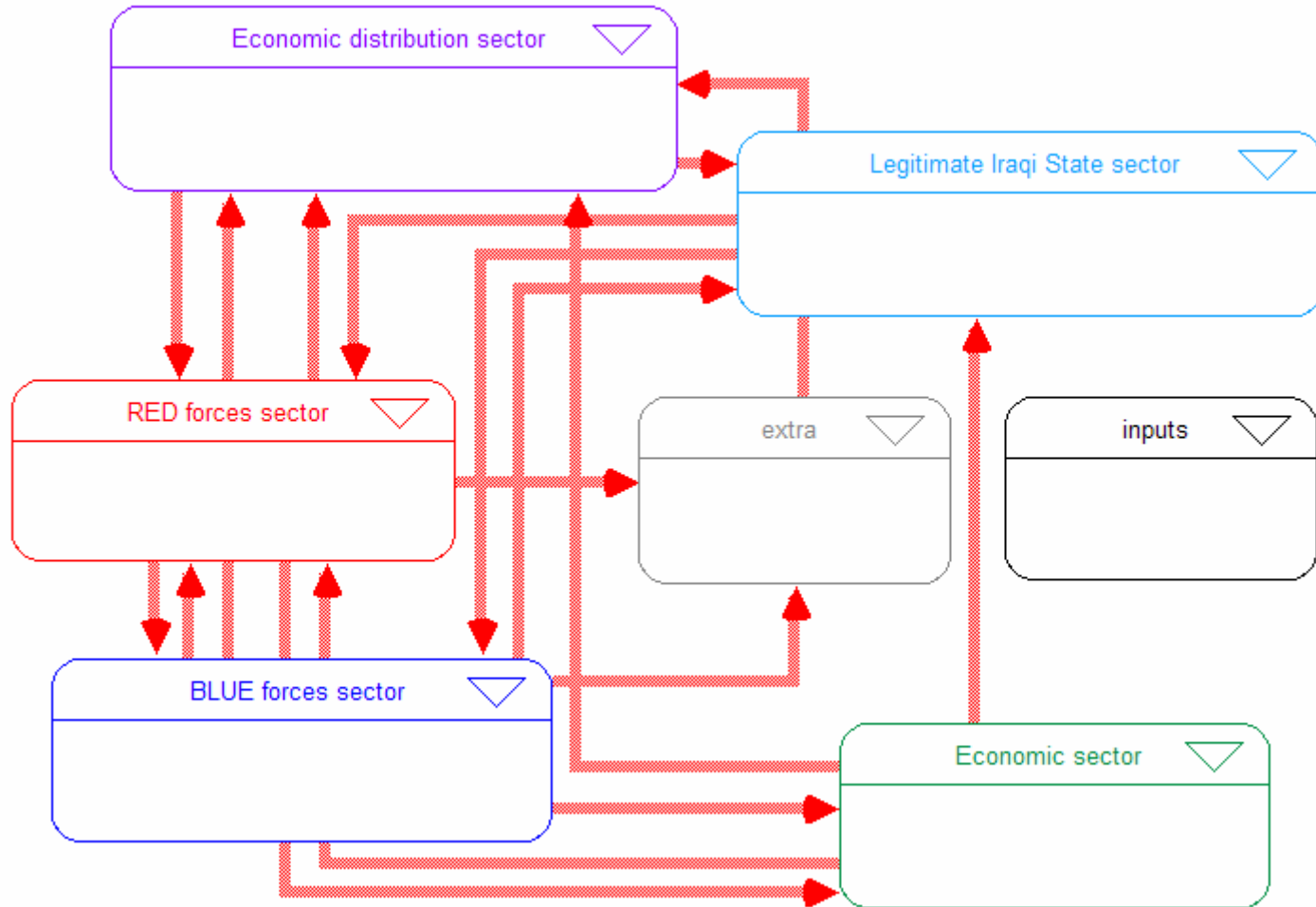
# System Dynamics (SD) modeling

Primary, secondary, and cascading consequences are explicitly represented



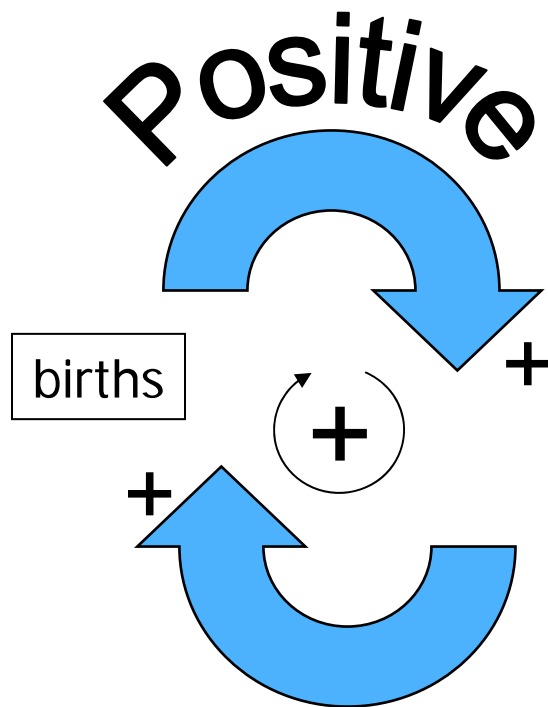
# System Dynamics (SD) modeling

explicit sector interconnections



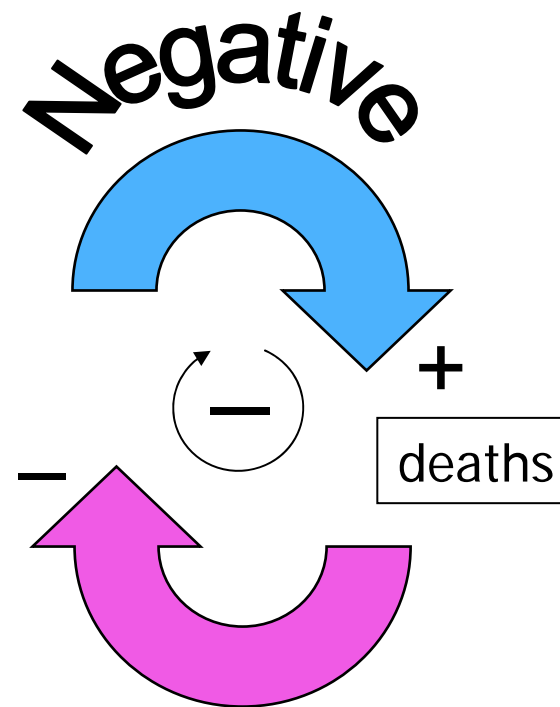
# Cascading consequences lead to *feedbacks*

A central feature of dynamic complexity



Self-**R**einforcing

people

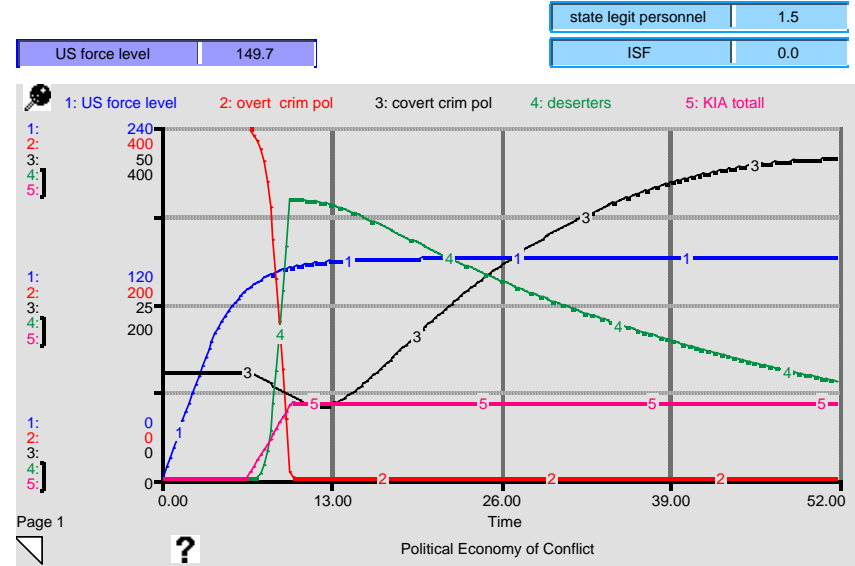


Goal seeking,  
**B**alancing

# Senior-level decision maker's interface (rev. A)

## policy levers and dynamic results

tax rate	0.00 <input type="range"/> 1.00 0.30		
init state personnel	0 <input type="range"/> 100 0	init state inflow	0.0 <input type="range"/> 2.0 0.0
pol MIL split	0.00 <input type="range"/> 1.00 0.96	state recruit rate	0.00 <input type="range"/> 1.00 0.00
job lag	0 <input type="range"/> 12 4	covert pct	0.000 <input type="range"/> 0.100 0.010
BLUE threshold	0.02 <input type="range"/> 1.02 0.85	covert lag	0 <input type="range"/> 12 4
engage eff	0.00 <input type="range"/> 1.00 0.20	desertion eff	0 <input type="range"/> 100 10
US force level desired	0 <input type="range"/> 200 150	init political criminal elite	0 <input type="range"/> 1000 400
US lift capability	0 <input type="range"/> 40 25	init criminal political covert	0 <input type="range"/> 100 15
init ISF	0 <input type="range"/> 500 0	init pop Baghdad	0 <input type="range"/> 10000 7000
US forces tech level	0 <input type="range"/> 150 10	init white economy	0 <input type="range"/> 80000 50000
init level US forces	0 <input type="range"/> 200 0	init black economy	0 <input type="range"/> 80000 10000

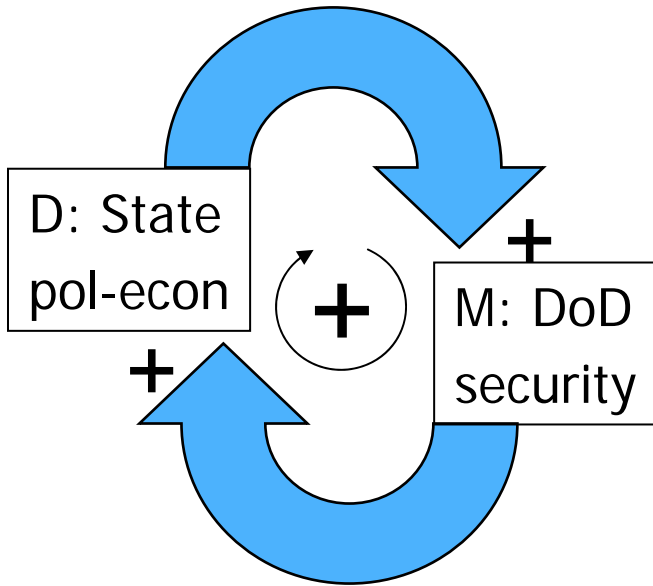


Run Stop Restore All Devices

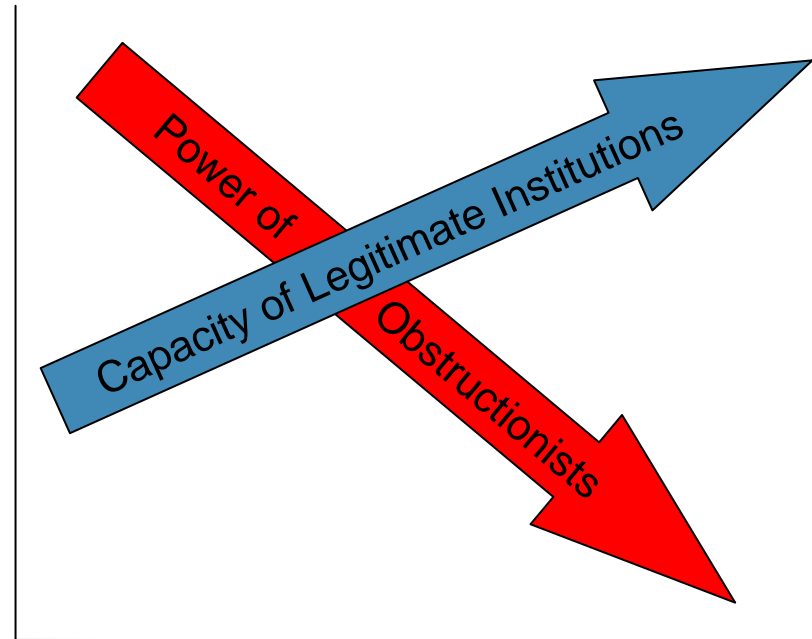
overt crim pol	0.0
covert crim pol	45.3

Data and expertise synthesized into a few contextualized metrics for senior decision makers

# Information synthesis and strategic perspective



“synchronized v. separate lanes”  
(i.e., *feedback*)



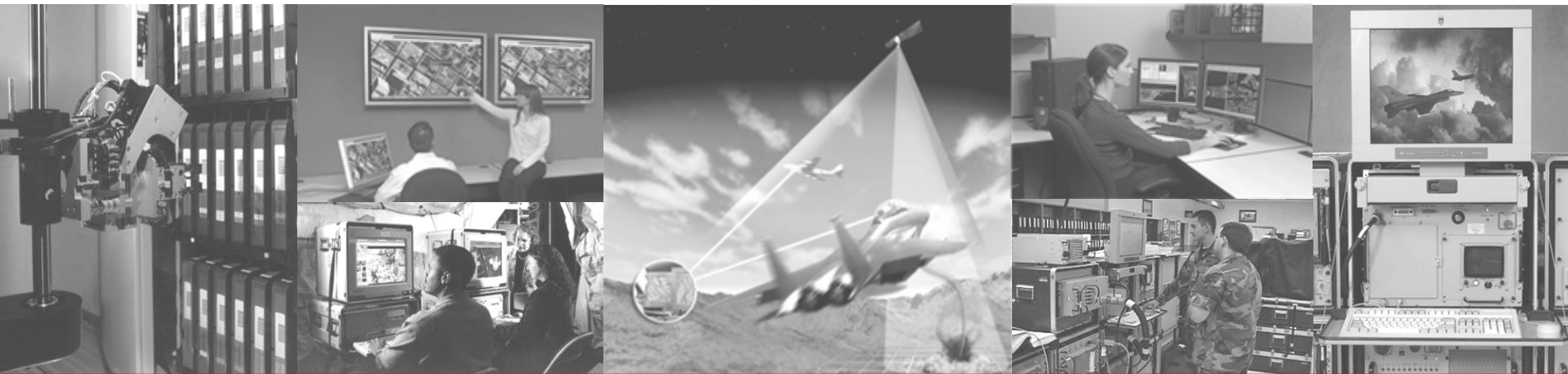
X-chart of flywheel effect  
(i.e., *dynamics*)

- Military and non-military elements of national power can reinforce each other both helpfully when synchronized and unhelpfully when not

- Policy progress can be both planned and tracked using simulation’s scenario analysis capability

# Additional slides

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# Deptula 2001 pulled quotes

- It was not the number of sorties however, that made this first day of air attacks so important, but how they were planned to achieve specific effects.
- The Gulf War began with more targets in one day's attack plan than the total number of targets hit by the entire Eighth Air Force in all of 1942 and 1943.
- Well beyond the activity of destroying an opposing force lies the ultimate purpose of war—to compel a positive political outcome.
- Even when control of the air was wrested from the Luftwaffe in the spring of 1944 and Allied aircraft were free to roam the Axis skies, the level of “precision” bombing still required a thousand aircraft to succeed against one target.
- In some cases, a single aircraft and one PGM during the Gulf War achieved the same result as a 1000-plane raid with over 9000 bombs in World War II—and without the associated collateral damage.
- During the entire war, F-117 stealth aircraft flew less than 2 percent of the total combat sorties, while attacking 43 percent of the targets on the master target list.
- During the war some Iraqi power plant managers shut down their electric plants to avoid targeting thereby creating our desired effect without exposing Coalition members to danger, and freeing up air resources for another task—Sun Tzu's dictum fulfilled.
- The architects of the air campaign did not limit themselves to the “servicing a target list” approach.
- The design of the air campaign grew out of a mindset questioning how to impose force against enemy systems to achieve specific effects that would contribute directly to the military and political objectives of the Coalition.
- An attractive element of parallel war is its potential to reduce the duration of conflict relative to previous wars.
- Adherence to legacy concepts of operation despite the illumination of new ideas is needlessly and dangerously stagnant.
- Surface forces will always be an essential part of the military, but massing surface forces to overwhelm an enemy is no longer an absolute prerequisite to impose control over the enemy.
- Potential adversaries may capitalize on the massing of forces and associated buildup time required by US legacy CONOPS for conducting major theater war (MTW) to deny US access.
- Changing the manner in which we think about the application of force requires changing the way we structure to employ it.
- We must expand our thinking and disengage ourselves from stale notions of warfighting to seize the opportunities at hand.
- Only new organizations and doctrine aiming to exploit effects-based operations can fulfill the full potential of this concept.
- Jointness is the use of the most effective force for a given situation.
- The tenets of effects-based operations can be applied in every medium of warfare.
- The parallel approach is a springboard for better linking military, economic, and political elements to conduct national security strategy in depth.
- Potential antagonists recognize the significance in the “revolution in military affairs” now underway—it would behoove us to do the same.



# M&S VV&A (Verification, Validation, and Accreditation)

Sterman, John D. 2000. *Business Dynamics: Systems thinking and modeling for a complex world*. Boston: McGraw-Hill. Chapter 21.

- Boundary adequacy
- Structure assessment
- Dimensional consistency
- Parameter assessment
- Extreme conditions
- Integration error
- Behavior reproduction
- Behavior anomaly
- Family member
- Surprise behavior
- Sensitivity analysis
- System improvement



# How does SD work?



- SD provides the **wide** and *thin* perspective required by senior decision makers and system designers
- SD simulation models the **complex causal relationships** of technical and social systems

- Feedback
- Stock-flow
- Nonlinear

