

Synthesizing Information for Senior-level Decision-Makers using Simulation

Corey Lofdahl, Ph.D.

BAE Systems
Burlington, Massachusetts, U.S.A.
email: corey.lofdahl@baesystems.com

Dr. Lofdahl is a principal engineer at BAE Systems in Burlington, Massachusetts and an instructor at Gordon College in Wenham, Massachusetts. He is the author of "Environmental Impacts of Global Trade: A Systems Study" (MIT Press, 2002). He holds degrees in electrical engineering, computer science, and international relations from the University of Colorado at Boulder, Brown University, and MIT.

ABSTRACT

Modern computers have made ever-increasing amounts of processing power available to senior-level decision makers, but they have also overwhelmed them with ever-increasing amounts of hard-to-understand data. Modeling and simulation addresses the data overload problem by "boiling down" data and synthesizing information at the macro-level. This capability is developed in three sections. First, the general policy problem is described. Second, policy is discussed in terms of today's 21st century security context. Third, an example simulation is developed that does three things: it 1) combines military and economic policy factors within a single model, 2) specifies the direct, indirect, and cascading consequences that tend to thwart policies and confound policymakers, and 3) allows policy makers to manipulate policy levers and see their dynamic consequences within seconds using simulation rather than months or years in the real world.

INTRODUCTION

The 21st century security environment has changed markedly from that of the 20th century as the bipolar stability of the cold war characterized by American and Russian tension has been replaced by the more multi-polar and dynamic world system characterized by globalization and complexity. While the formulation of policy by senior-level decision makers in government has never been easy, recent changes in the international environment have made it even more difficult. Computers and other advanced information technologies have been used to address this complexity resulting in a proliferation of collected data, databases to organize the data, and senior-decision makers overwhelmed by data.

Senior decision-makers, instead of needing more data, instead need to have that data "boiled-down" into actionable and contextualized information, which requires notions of information processing more sophisticated than bigger and faster computers. This paper presents one such processing technique, simulation, which is developed in three sections.

First, the basic theory underlying the fundamental *policy problématique* is presented. Second, the particulars of the current, globalized policy environment are discussed. And third, an example is developed that incorporates, synthesizes, and combines both military and economic policy components. This discussion leads to the conclusion that simulation indeed synthesizes or “boils down” information for senior policy makers. More specifically, simulation 1) combines multiple policy factors within a single model, 2) specifies the direct, indirect, and cascading consequences that tend to thwart policies and confound policymakers, and 3) allows policymakers to manipulate policy levers and see their dynamic consequences within seconds rather than years in the real world.

THEORY

Today there is a recognition that the policy community can learn from the complexity sciences, especially within the military. In the 21st century, general officers increasingly find themselves dealing with the complex secondary and cascading consequences of diplomatic, informational, and economic factors rather than the military factors in which they are expert. An emerging body of work called *Effects Based Operations* (EBO) has been created to address such issues (e.g, Davis 2001). The intuitions behind EBO are well grounded: senior-level decision makers require improved tools to help them work effectively and productively in a context of increasing policy complexity. The *Operational Net Assessment* (ONA) has been created to support the analysis of EBO questions, but its database-centric tools have not yet provided senior decision makers with the analytic support or capabilities they require.

EBO indicates a recent, defense oriented effort to address the interconnected and complex nature of modern policy making, but the underlying problem is not new. Former US Secretary of State and National Security Advisor Henry Kissinger went so far as saying that senior leaders “work in darkness” as they make choices with inadequate information of potential consequences or even present circumstances (Kissinger 1979; Tetlock and McGuire 1985). Practitioners and academics familiar with the National Security Council have long appreciated this *policy problématique*:

“We spend billions and billions of dollars to collect information, to get it from the field to an analyst in the bowels of the bureaucracy. Don’t misunderstand me – that is very, very important. But having spent a lot of money to sustain an information collection, dissemination, and analysis process, we spend virtually nothing on direct support to a senior-level policy maker. Virtually nothing. This is a major theme I am going to talk about; we spend very, very little and we have very few analytic tools for the very high-level people. This leads me to my first major observation. I believe this society pays dearly, every single day, in terms of policy, for its failure to teach truly systems-oriented people to synthesize at the macro level. I daresay we could go through the length and breadth of this land and not find twenty people who have that capacity by virtue of training. A lot of people develop capacities by virtue of experience, but I’m talking about those who are both experienced and trained to synthesize information at the macro level. In my judgment the biggest problem in information processing is not sensors, not telecommunications, not CPUs not even analytic procedures. Very little work has gone into the synthesis process. I’m not talking about a partial system, a

little economics and rational decision making and let's throw a little more in the budget. I'm talking about big pieces." (Beal 1985, 6)

Beal makes several key points in the above quote, but his argument can be summarized as so:

1. Senior-policy makers have a *key need*:
2. Current technologies and tools are *insufficient* because...
3. they don't *synthesize* information,
4. which has *policy consequences*.

Thus, the need for a policy relevant systems perspective is as great if not greater today than it was more than twenty years ago. Simply increasing computing power will not solve the problem; in fact, it could exacerbate it by generating even more unstructured data. What is required is a way to think more sensitively, systematically, and synthetically about policy problems. Research has been done that evaluates the efficacy of policies crafted by senior-level decision makers and applied complex social systems. The results are problematic whether the social systems are corporate or governmental:

First, social systems are inherently insensitive to most policy changes that people select in an effort to alter the behavior of the system. In fact, a social system tends to draw our attention to the very points at which an attempt to intervene will fail. Our experience, which has been developed from contact with simple systems, leads us to look close to the symptoms of trouble for a cause. When we look, we discover that the social system presents us with an apparent cause that is plausible according to what we have learned from simple systems. But this apparent cause is usually a coincident occurrence that, like the trouble symptom itself, is being produced by the feedback-loop dynamics of a larger system...

A second characteristic of social systems is that all of them seem to have a few sensitive influence points through which the behavior of the system can be changed. These influence points are not in the location where most people expect. Furthermore, if one identifies in a model of a social system a sensitive point where influence can be exerted, the chances are still that a person guided by intuition and judgment will alter the system in the wrong direction...

As a third characteristic of social systems, there is usually a fundamental conflict between the short-term and long-term consequences of a policy change. A policy which produces improvement in the short run, within five to ten years, is usually one which degrades the system in the long run, beyond ten years. Likewise, those policies and programs which produce long-run improvement may initially depress the behavior of the system. This is especially treacherous. The short run is more visible and more compelling. It speaks loudly for immediate attention. But a series of actions all aimed at short-run improvement can eventually burden a system with long-run depressants so severe that even heroic short-run measures no longer suffice. (Forrester 1971).

Forrester thus helps us to understand the consequences associated with the analysis systemic shortcomings described by Beal (1985): first, social systems are insensitive to most policies; second, locating effective policy levers cannot be done by intuition; and third, there exists an inherent tension between the long and short-term.

In this paper we recommend using the simulation methodology created by Forrester, *system dynamics*, to specify complex social systems, synthesize information, and craft more effective policy (Forrester 1961; Sterman 2000). An example that demonstrates how this can be done is developed in the following two sections. The next section sketches out the 21st century, post-cold war security environment, which provides the context for the system dynamics simulation developed in section three.

CURRENT POLICY PARTICULARS

America's current foreign policy infrastructure was organized around two conflicts of the latter-20th century, World War II and the cold war, each of which featured opposing nation-states with identifiable populations, geographies, and governments. The 21st century, post-Cold War security environment is not quite so clear. Popp (2005) makes a distinction between the 20th century strategic threat that featured nuclear missiles, submarines, and bombers and the 21st century strategic threats featuring Weapons of Mass Destruction (WMD), failed states, and global terrorism.

While WMDs play a role in both security contexts, they are used in very different ways. In the Cold War, only the rich superpowers – most notably the United States and the Soviet Union – had nuclear weapons. That has changed, as now WMDs are sought primarily by poor nations (Campbell et al. 2004; Langewiesche 2007). Nations such as North Korea and Iran feel that having nuclear weapons increases both their security and status and that the benefits outweigh the costs. However, the command infrastructure of countries such as Pakistan is shaky, making the long-term control and security of such weapons a matter of concern. This leads to the paradoxical situation in which the end of the cold war, which featured two countries aiming many weapons at each other in a regime of mutually assured destruction, has resulted in an even more perilous situation.

Second, during the cold war poor, so called “third world” countries were given aid by the United States and Soviet Union. When those funding opportunities went away, many countries faltered, so many that the term “failed states” was coined to describe these non-viable nations. States are complex entities, so they can fail in multiple ways. Foreign Policy (2005) identifies twelve factors that characterize failed states:

- Demographic pressures and overpopulation,
- Group grievances,
- Human flight,
- Economic decline,
- Human rights violations,

- Lack of public services,
- Security apparatus problems,
- Factionalized elites,
- External intervention,
- Uneven development and wealth disparities,
- Delegitimazation of the state, and
- Refugees and displaced peoples.

While there have always been poor, mismanaged states, they have seldom constituted a significant security problem for richer, more developed states. This situation has changed in the 21st century, as even the poorest states can acquire high-technology weapons that pose problems the developed world – with WMD providing the most vivid example. Therefore, rich countries are embarking on a program of *nation building*, of helping failed and failing states so that they can provide for their citizens and not threaten other states. Nation building presents a logical and appealing vision, but the difficulties attendant with such an undertaking are considerable and remain an ongoing policy opportunity (Dobbins 2003).

Third, failed states provide a safe haven for *global terrorism* as evidenced by Al Qaeda in Afghanistan, Iraq, Sudan, and a host of other failed states. In Iraq, terrorism has taken on the form of an insurgency, an asymmetric conflict that the United States was ill-prepared to fight. The US military is equipped and trained to fight a peer competitor like the Soviet Union; it is not prepared to fight a comparatively ill-equipped yet tactically aggressive insurgency as America's experience in Vietnam demonstrated. Nevertheless, the Army has responded by releasing a counterinsurgency field manual, FM-24 (US Army 2006), that addresses the problem. It notes that fighting insurgents is a cerebral exercise, the "graduate school of warfare," because it is *counterintuitive* – what seems right is often wrong and visa versa. For example, protecting friendly forces in the short-term at the expense of the local population only strengthens the insurgency in the long-term. Thus understanding the complex policy consequences, per EBO and Forrester (1971), is paramount. Also, counterinsurgency principles must be applied widely and consistently; there are no single actors or nodes of sufficient value or potency that if neutralized, will automatically yield victory – e.g., Saddam Hussein or Zarqawi in Iraq. Further insights can be gleaned from those returning from Iraq. Hix (2006) articulates several counterinsurgency insights based on his experience:

- Integrate DIME* elements in support of US policy,
- Illuminate possible complex, counterintuitive policy outcomes,
- Support planning (i.e., integrated political and military planning),
- Transform data, knowledge, and expertise into foresight,

* DIME is a US Department of Defense acronym that stands for the Diplomatic, Informational, Military, and Economic elements of national power – that is, how the United States seeks to modify and shape the behavior of other nation-states.

- Identify investments for intelligence and force overmatch,
- Account for time as it influences freedom of action,
- Recognize the importance of perception, and
- Acknowledge that perseverance must be resourced.

Hix's insights echo requirements that have already been articulated for a policy analysis methodology designed to aid senior-decision makers. First, the methodology must integrate the effects of multiple policies. Second, support must be provided so that policymakers can explore and understand complex, counterintuitive outcomes. Third, raw data must be synthesized and transformed into actionable information. These requirements are addressed in the next section through a simple example.

A POLICY SIMULATION EXAMPLE

America has experience in nation-building, but no single government agency has explicit responsibility, so lessons-learned tend not to be captured and the hard-won expertise is lost, leaving the next generation of nation-builders ill-informed and poised for failure. Covey et al. (2005) seeks to correct this by writing up their operational experiences in Kosovo and Bosnia. The example developed herein applies their four-part strategy to Iraq:

- Political strategy,
- Rule of Law strategy,
- Security strategy, and
- Political economic strategy.

This example focuses primarily on integrating military and economic strategies, a traditional foreign policy problem (Destler 1994). In Iraq, this question takes the following form: What comes first, security or development? The Departments of Defense and State each have their own view, but having a clear, coherent understanding of their relationship will result in better policy.

Figure 1 shows a high-level model decomposition featuring combined military and economic concerns. Military concerns are decomposed into friendly and enemy forces, while economic concerns are decomposed into an economic sector that produces goods and services and an economic distribution sector that allocates those goods. Military and economic concerns combine when economic resources are distributed to the criminal, enemy forces of an illegitimate state. Friendly force intervention therefore must not only defeat the enemy militarily but also economically by redistributing economic resources so that they benefit the nascent, legitimate government as well as the general population. The final sector contains data inputs can be manipulated by senior-decision makers including DIME policy levers.

Figure 2 specifies the sectors identified in Figure 1. Using the system dynamics simulation methodology, primary, secondary, and cascading consequences are explicitly

represented within each sector. It is the representation and simulation of these causal connections that makes system dynamics so applicable to EBO questions (Davis 2001).

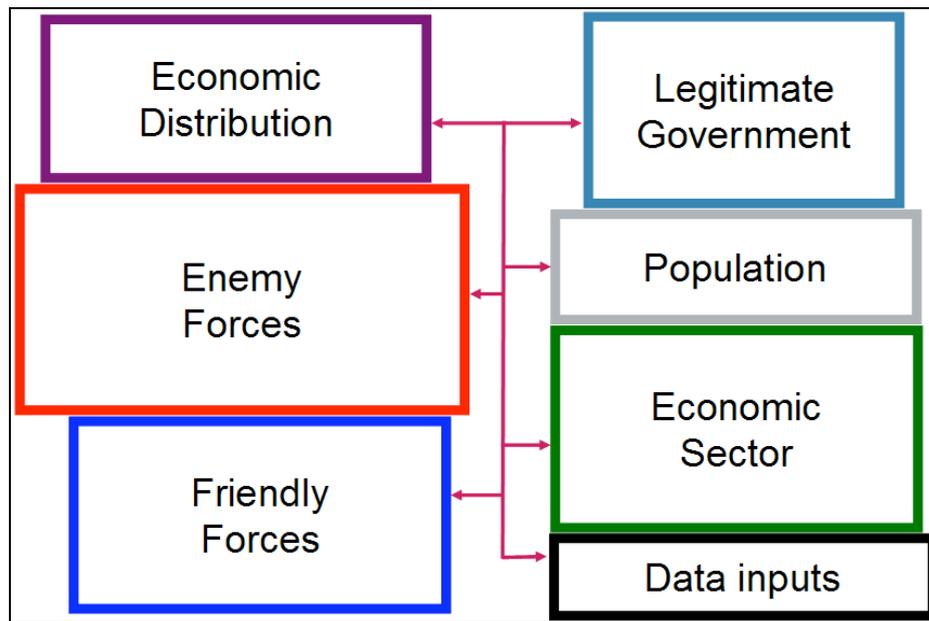


Figure 1: Combined Military and Economic Concerns.

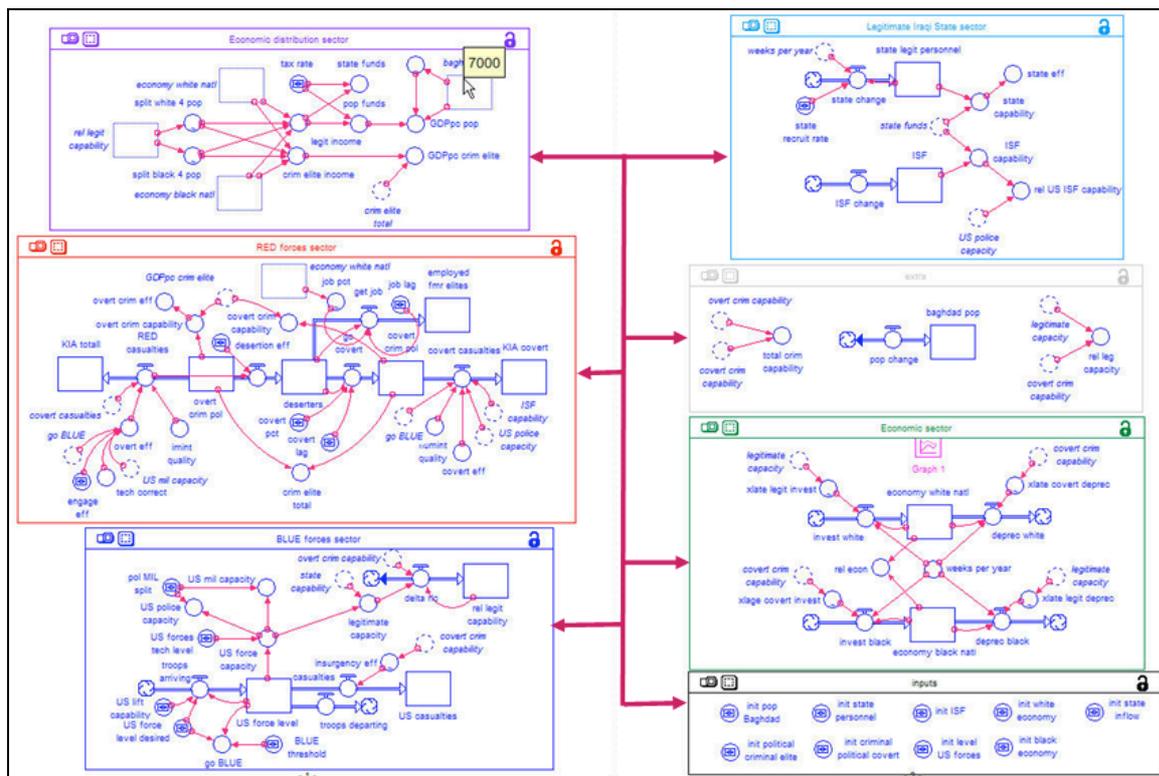


Figure 2: Specified Military and Economic Concerns.

Figure 3 provides an explicit depiction of the connections among sectors. Note especially the connections between the military and economic sectors as these allow synthetic, integrated policies to be simulated and evaluated.

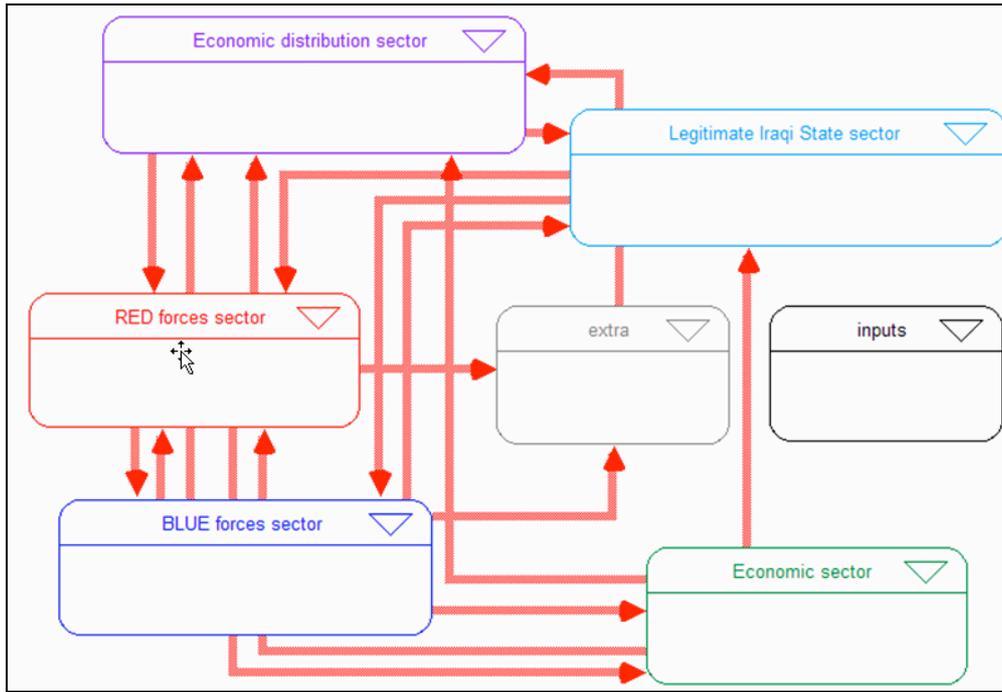


Figure 3: Integrated Military and Economic Concerns.

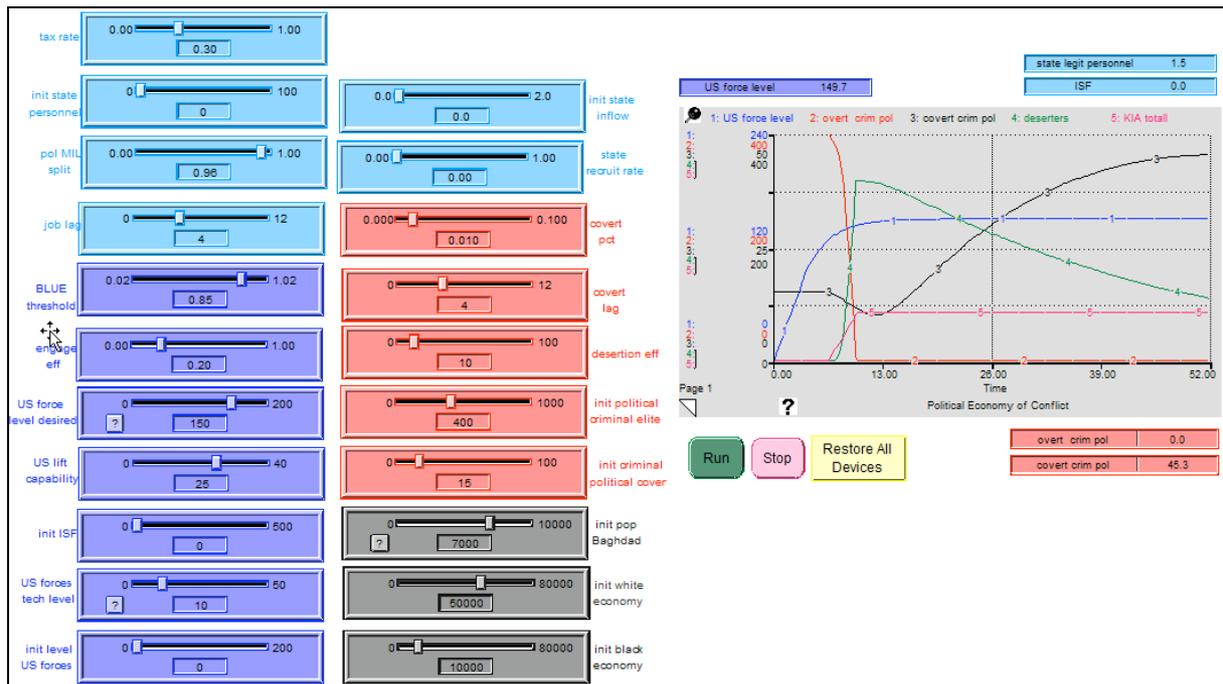


Figure 4: Policy Levers and Dynamic Results.

Figure 4 shows the graphical user interface comprised of policy levers to the left and dynamic results to the right. Note that this interface hides the complexity of Figures 2 and 3, instead revealing to decision-makers only what they need to get their job done – the items over which they have control and their results. Simulations usually run on the order of seconds, so decision-makers receive quick feedback between the time they enter their policy decisions and receive the results of those decisions, which greatly speeds learning. When the simulation results reveal counterintuitive conclusions, they need to be investigated to

determine whether they are indeed truly interesting results or a modeling error. This implies the modeler both delving into the Figure 2 model and working closely with the senior-level decision-maker. As decision-makers become familiar with the analytic capabilities afforded by simulation, it is likely that they will work more closely with simulation analysts.

CONCLUSION

Today's senior-level decision-makers are overwhelmed with hard-to-understand data. Modeling and simulation addresses data overload by "boiling down" data and synthesizing information at the macro-level. This capability has been demonstrated first by describing the policy problem generally; second by discussing it in terms of the modern, 21st century security context; and third by developing an example simulation. This example, 1) combined military and economic policy factors within a single model, 2) specified the direct, indirect, and cascading consequences that tend to confound both policies and policy analyses, and 3) demonstrated the capability of policy makers to manipulate policy levers and see their dynamic consequences within seconds. Adapting policy institutions to incorporate simulation remains an ongoing opportunity.

REFERENCES

- Beal, Richard S., 1985. "Decision Making, Crisis Management, Information, and Technology." Cambridge, MA: Harvard PIRP.
- Campbell, Kurt M., Robert J. Einhorn, and Mitchell B. Reiss (eds), 2004. *The Nuclear Tipping Point: Why states reconsider their nuclear choices*. Washington: Brookings.
- Covey, Jock, Michael J. Dziedzic, and Leonard R. Hawley, 2005. *The Quest for Viable Peace: International Intervention and strategies for conflict transformation*. Washington: US Institute of Peace.
- Davis, Paul, 2001. "Effects Based Operations: A grand challenge for the analytic community." Santa Monica, CA: RAND.
- Destler, I.M., 1994. "A Government Divided: The security complex and the economic complex." In *The New Politics of American Foreign Policy*, David A. Deese, ed., New York: St. Martin's, 132–147.
- Dobbins, James, 2003. "Nation-Building: The inescapable responsibility of the world's only superpower." *RAND Review* 27(2), 16–27, summer.
- Foreign Policy, 2005. "The Failed State Index." *Foreign Policy* (July/August).
- Forrester, Jay W., 1961. *Industrial Dynamics*. Cambridge, MA: Productivity Press.
- Forrester, Jay W., 1973. "Counterintuitive Behavior of Social Systems." *Tech Review* 52-68 (Jan.).
- JFCOM, 2004. "Operational Net Assessment (ONA)." Technical report: US Joint Forces Command, Norfolk, VA (May).
- 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.

Kissinger, Henry A., 1979. *White House Years*. Boston: Little, Brown.

Langewiesche, William, 2007. *The Atomic Bazaar: The rise of the nuclear poor*. New York: Farrar, Strauss, and Giroux.

Popp, Robert, 2005. "Utilizing Social Science Technology to Understand and Counter the 21st Century Strategic Threat." Technical report. DARPA Tech, Arlington, VA (Aug.).

Radi, David A., 1997. "Intelligence Inside the White House: The influences of executive style and technology." Cambridge, MA: Harvard PIRP.

Sterman, John, 2000. *Business Dynamics: Systems thinking and modeling for a complex world*. New York: Prentice Hall.

Tetlock, Philip E. and Charles B. McGuire, Jr., 1985. "Cognitive Perspectives on Foreign Policy." In *Political Behavioral Annual*. Boulder, CO: Westview and in *American Foreign Policy: Theoretical essays* (3rd ed), G. John Ikenberry ed., 484—501. New York: Pearson-Longman. 2005.

US Army, 2006. *Counterinsurgency* (FM3-24). Field Manual, Headquarters, Department of the Army, Washington (Dec.).