Computational Modeling and Simulation and New Approaches to Producer-Consumer Relations in Intelligence

Introduction

Since the twin intelligence failures of 9/11 and the Iraqi WMD Estimate multiple efforts have been made to improve the effectiveness of the intelligence community. Reforms have included the creation of new organizations, the introduction of new collection and operational capabilities, the realignment of roles, responsibilities and authorities, and efforts to improve analytic tradecraft.[1] Whether these reforms ultimately improve the strategic positioning and security of the country remain in doubt however, largely due to a single dubious assumption—that better intelligence, defined as improved collection capabilities and more accurate and timely analytic predictions, leads directly to better policy and strategy. While many reforms should be commended, it would naïve to believe that the presence of powerful institutional and cultural divisions between producers and consumers will not limit their ability to affect policy and policy-making in the ways their most hopeful proponents' desire.

Viewing reforms from the perspective of intelligence consumers rather than producers reveals new challenges and opportunities confronting the community, and suggests the existence of fundamental limitations of what can be achieved as long as reform efforts focus on one side of the policy-process and leave the organizations of the executive branch and congress unaffected. Rather than view intelligence products as the output of collection and analysis, future reforms should reimagine them as inputs into the policy process, thereby giving primacy to questions of relevance and utility to decision-making, rather than epistemologically problematic assessments of timeliness and accuracy, or long-standing debates within the community regarding whether analysis is an art of science.[2]

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[1] Richard K. Betts, "The New Politics of Intelligence: Will Reforms Work This Time?" *Foreign Affairs*, Vol. 83, No. 3 (May/June, 2004), pp. 2-8; National Commission on Terrorist Attacks Upon the United States, *9/11 Commission Report* (New York, NY: W. W. Norton & Company, 2004); U.S. Senate, Senate Select Committee on Intelligence, *Report on the U.S. Intelligence Community's Prewar Intelligence Assessments on Iraq*, (Washington, DC: United States Senate, 7 July 2004); Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, *Report to the President of the United States* (Washington, DC: Government Printing Office, March 31, 2005); Jennifer E. Simms and Burton Gerber, eds., *Transforming U.S. Intelligence* (Washington, DC: Georgetown University Press, 2005); Richard A. Posner, *Uncertain Shield: The U.S. Intelligence in the Throes of Reform* ; Richard K. Betts, *Enemies of Intelligence: Strategic Intelligence and American National Security* (New York, NY: Columbia University Press, 2007); Roger Z. George and Harvey Rishikof, eds., *The National Security Enterprise: Navigating the Labyrinth* (Washington, DC: Georgetown University Press, 2011), pp. 139-155; and Paul R. Pillar, *Intelligence and U.S. Foreign Policy: Iraq, 9/11, and Misguided Reform* (New York, NY: Columbia University Press, 2011).

[2] Walter Lacquer, *A World of Secrets: The Uses and Limits of Intelligence* (New York, NY: Basic Books, 1985); Josh Kerbel, "Lost for Words: The Intelligence Community's Struggle to Find its Voice," *Parameters* (Summer 2008), pp. 102-112; Jennifer E. Sims, "Decision Advantage and the Nature of Intelligence Analysis," in Loch K. Johnson, ed., *The Oxford Handbook of National Security Intelligence* (New York, NY: Oxford University Press,

This paper advocates for a research and development program that seeks to create new technologies and analytic tradecraft for improving producer/consumer relations. The basis of this proposed effort is straight-forward—better relations between policy-makers and intelligence analysts facilitates the production of more relevant intelligence and the acceptability of information, even if it challenges deeply held beliefs or assumptions held by consumers. Thus, research into the look-and-feel of intelligence products and the character of interactions across intelligence producing and consuming institutions is necessary in order to address critical problems that have largely been unaffected by prior reform efforts.

This paper contains four sections, each of which discusses different aspects of challenges and opportunities in intelligence analysis, particularly as they relate to the relationship between producers and consumers. Section 1 discusses the presence and persistence of deep uncertainty that offers a new framing for the role of intelligence analysts in the development of policy and strategy. Section 2 examines the potential of Agent-Based Models (ABMs) to address long-standing gaps in analytic tradecraft. Section 3 offers a speculative assessment regarding the implications of new computing technologies for creating new types of analytic products and interactions between producers and consumers. Finally, Section 4 outlines the prospective design of a research plan for tying these three strands together into a coherent effort to improve producer/consumer relations. Together, these aspects of intelligence analysis reveal why new approaches to analytic tradecraft and reforms are necessary, and how a combination of technology and methodology can assist in addressing the community's most difficult and long-standing problems.

Section 1: Deep Uncertainty and the Epistemology of Intelligence

The basic framework of policy-making is one of deep uncertainty. Deep uncertainty occurs when stakeholders in the decision-making process cannot agree upon the appropriate conceptual models that identify and characterize relationships between key driving forces that will shape the future, the probability distributions used to represent uncertainty about key variables and parameters in formalized representations of conceptual models, and how alternative outcomes should be valued, ranked, or otherwise assessed.[3] Deep uncertainty affects the intelligence process in several important ways, each of which can exacerbate tensions between producers and consumers.

First, deep uncertainty allows for multiple competing perspectives or models of strategic problems to exist, each of which may serve as a legitimate basis of analysis and decision-making. As a result, consumers may possess distinct and divergent expectations about the future of the international system, thus establishing different perspectives on intelligence assessments. Second, the presence of multiple, credible frameworks of strategic problems means that empirical information alone may be ineffective at resolving disputes, either because the data itself is consistent with multiple models, may simply be irrelevant to one or more competing

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2010), pp. 389-403; and Stephen Marrin, "Is Intelligence Analysis an Art or a Science?" *International Journal of Intelligence and Counterintelligence*, Vo. 25, No. 3 (2012), pp. 529-545.

[3] Robert J. Lempert, Steven W. Popper, and Steven C. Bankes, *Shaping the Next One Hundred Years: New Methods for Long-Term Quantitative Policy Analysis* (Santa Monica, CA: RAND, 2003), p. xii.

frameworks, or may not and cannot exist.[4] Finally, in the context of bureaucratic politics, the presence of assessments that support the expectations derived from one framework, while militating against others are inherently viewed as political, even if the assessment's source operates independently of the political process.[5]

When viewed through the lens of the intelligence community's foundational epistemology the institutional challenges posed by deep uncertainty become apparent. Kent divided intelligence problems into three classes—basic, current, and estimative, which formed a pyramid of intelligence types or products and the epistemological foundation upon which assessments rested.[6]

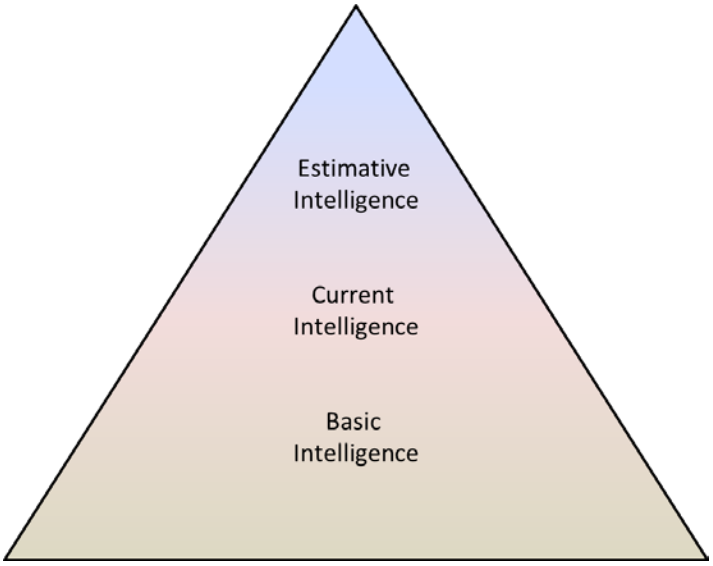

Figure 1: Sherman Kent's Intelligence Pyramid. Kent's intelligence pyramid describes how intelligence assessments may be characterized as estimates regarding potential future developments, or the value of missing information, that are constructed from observations of current activities, i.e. current intelligence, and verifiable, collected facts, i.e. basic intelligence. Image adapted from Sherman Kent, "Estimates and Influence," *Studies in Intelligence*, Vol. 12, No. 3 (1968), pp. 14-17.

Basic intelligence represents the collection of empirical facts: population, geography, infrastructure, climate, natural resources, military order of battle, etc., and is encyclopedic in nature.[7] Current intelligence provides descriptions of ongoing events and concentrates on the observable behavior of intelligence targets. Importantly, current intelligence is descriptive and reportorial, and often denotes a shift in the balance of knowledge between producers and

[4] Richards J. Heuer, Jr., *The Psychology of Intelligence Analysis* (Washington, DC: Central Intelligence Agency, 1999); and Richards J. Heuer, Jr. and Randolph H. Pherson, *Structured Analytic Techniques for Intelligence Analysis* (Washington, DC: Congressional Quarterly, 2011), pp. 160-169.
[5] Paul Wolfowitz, "Comments: Paul Wolfowitz," in Roy Godson, Ernest R. May and Gary Schmitt, eds., *U.S. Intelligence at the Crossroads: Agendas for Reform* (Washington, DC: Brassey's, 1995), pp. 75-80.
[6] Sherman Kent, *Strategic Intelligence for American World Policy* (Princeton, NJ: Princeton University Press, 1949), p. 11-29; and Sherman Kent, "Estimates and Influence," *Studies in Intelligence*, Vol. 12, No. 3 (1968), pp. 14-17.
[7] Sherman Kent, *Strategic Intelligence for American World Policy* (Princeton, NJ: Princeton University Press, 1949), p. 11-29; and Sherman Kent, "Estimates and Influence," *Studies in Intelligence*, Vol. 12, No. 3 (1968), pp. 14-15.

consumers. Whereas intelligence analysts are likely better informed than policy-makers on the basic facts and history of specific problems, interested policy makers are often as informed as their intelligence counterparts with respect to current events and intelligence targets and therefore increasingly likely to perform their own analysis and challenge the judgments of others.[8] In the cases of basic and current intelligence, consumers have generally been appreciative of products, particularly when they are able to provide important encyclopedic, contextual or current information.

The relationship between producers and consumers becomes most problematic on matters of estimative intelligence, however, due to the fact that it is forward looking and analytical—resting upon the placement of facts, observations, and guesses into a theoretical framework for projecting what a target may do in the future, what options it has, and what its reactions to others' policies or actions might be. Estimative intelligence may be regarded as the search for the strategic stature, vulnerabilities, and potential of other actors, and is more dependent on theory rather than facts because of the inherent uncertain futures.[9] The epistemological foundation of estimative intelligence leaves them permanently vulnerable to those who are discomforted by their conclusions. Thus, policy-makers can always operate within the space of viable alternatives allowed under deep uncertainty to dismiss intelligence assessments and offer new estimates in their place based on different theories, alternative facts, different observations, etc.[10] Therefore a paradox emerges where intelligence estimates that offer the most forward-looking assessments of potential futures and are the most capable of aiding in the development and evaluation of policy options, are also the most likely to be rejected by consumers because they necessarily consist of a series of conjectures that go beyond the world of facts and observations.[11]

Given the persistence of deep uncertainty and the epistemology of estimative intelligence, intelligence analysts are unlikely to resolve contentious policy disputes. Indeed, as long as policy-makers operate in a decision-making environment that is both subjected to bureaucratic politics and strategy, and autonomous with respect to the intelligence community, the timeliness and accuracy of intelligence assessments may have little correlation with consumers' use of their products. Indeed, the fundamental challenge facing analysts is their need to provide policy-makers with assessments that are relevant to decision-making while avoiding politicization or being dismissed as ungrounded speculation.

Resolving deep uncertainty is possible, but requires reimagining the role of the intelligence analyst in the policy-process. Rather than direct analysts' expertise towards assessments that focus on the substance of particular intelligence questions, addressing the challenge of deep uncertainty require a shift in analytic emphasis towards epistemology. Thus, analysts and their

[8] Sherman Kent, *Strategic Intelligence for American World Policy* (Princeton, NJ: Princeton University Press, 1949), p. 38; and Sherman Kent, "Estimates and Influence," *Studies in Intelligence*, Vol. 12, No. 3 (1968), p. 15; and James B. Steinberg, "The Policymaker's Perspective: Transparency and Partnership," in Roger Z. George and James B. Bruce, eds. *Analyzing Intelligence: Origins, Obstacles, and Innovations* (Washington, DC: Georgetown University Press, 2008), p. 84.

[9] Sherman Kent, *Strategic Intelligence for American World Policy* (Princeton, NJ: Princeton University Press, 1949), pp. 40, 45-46.

[10] Sherman Kent, "Estimates and Influence," *Studies in Intelligence*, Vol. 12, No. 3 (1968), pp. 17-18.

[11] Roger Z. George, "Central Intelligence Agency: The President's Own," in Roger Z. George and Harvey Rishikof, eds., *The National Security Enterprise: Navigating the Labyrinth* (Washington, DC: Georgetown University Press, 2011), p. 163.

products become more interested in investigating the range of existing or possible frameworks for examining intelligence questions, theories of actors behaviors and interactions, alternative interpretations of available data, and the ways in which these differences relate to one another based on changes in underlying assumptions. The result of analysis is then a movement away from point-estimates about unknown futures towards mapping the ways in which different assumptions, beliefs, and data map to alternative expectations about the future scenarios and options for shaping or hedging against them.

Given long-standing resistance by the community to render their assessments more transparent and accessible to consumers, while limiting the extent to which consumers are responsible for shaping or influencing analytic outputs, new kinds of analytic products that emphasize the epistemology of intelligence problems may be difficult to develop for institutional reasons. First, producers have seen several efforts to reform tradecraft as an institutional threat that implicitly sought to replace their expertise and interpretations of intelligence data with the views of consumers by giving policy-makers access to the data upon which assessments were constructed.[12] Second, it requires that analysts specifically seek out and include the mental models or mindsets of consumers when crafting their analyses, if only to aid consumer's in locating their particular assumptions, interpretations and expectations within the larger universe of the alternatives. This particular approach may ultimately assist in developing more harmonious relations between producers and consumers by giving due consideration to the special knowledge, expertise, and perspectives of their policy-making counterparts, while avoiding direct challenges to their assumptions, interpretations, and expectations by focusing on the ranges of beliefs that are present in the community (inclusive of intelligence producers, the policy-makers they support, outreach, allies, and intelligence targets themselves) rather than the correctness of any individual perspective.[13]

To summarize, the presence of deep uncertainty and its implications for producer/consumer relations requires recasting analysis and analytic products from deep studies that showcase the expertise and judgments of intelligence analysts towards grand tours of the epistemology of intelligence questions that can help consumers understand the implications and role of their own mental models in shaping their expectations about the future and evaluations of policy options, as well as the basis of alternative beliefs that may be held by other stakeholders, intelligence analysts, and intelligence targets themselves.

Section 2: Agent-Based Modeling in Science and Analytic Tradecraft

The intelligence community has largely eschewed the application of formal models in the production of strategic intelligence. For good reasons, producers and consumers have been leery about the ability of mathematical models to capture salient features of long-term, adaptive strategic competition, often echoing the same criticisms leveled against the formalization of analysis that occurred during the development and introduction of operations research and

[12] Forgotten source… Analysts vs. policy on value of analysis

[13] James B. Steinberg, "The Policymaker's Perspective: Transparency and Partnership," in Roger Z. George and James B. Bruce, eds., *Analyzing Intelligence: Origins, Obstacles, and Innovation*s (Washington, DC: Georgetown University Press, 2008), pp. 82-90.

systems analysis in the Pentagon that led to the creation of the Office of Net Assessment.[14] More recently, increased calls for the use of "big data" and evidence in the production of intelligence have shown difficulties finding relevance in the context of strategic intelligence despite demonstrable uses in the development of current and basic intelligence products. Indeed, the employment of empirical models developed on large-N methods cannot identify key scenarios or support choosing between alternative courses of action that have yet to be (or may never be) observed in the empirical record. Thus, formal models and methods have remained difficult to integrate into strategic analysis due to real and imagined difficulties of formalizing fundamentally creative and imaginative intellectual processes that undergird assessments.

ABMs, often referred to as artificial societies, provide a means for adding rigor to the strategic analysis without stifling creative analytic processes due to their representational flexibility. ABMs sit atop an ontological basis that distinguishes them from traditional mathematical models, whether deductive or inductive in origin. These differences are important, because they allow for new opportunities to align rich, heuristically-based descriptions of the behavior (and metabehavior, e.g. learning) of intelligence subjects, whether foreign decision-makers or more abstract systemic relations between states and non-state actors with formal models of complex social systems. Thus, much like popular games like The Sims and Spore, heterogeneous, autonomous actors can interact and adapt in space and time based on any set of behaviors that can be represented algorithmically. As a result, a diverse range of ideas about human and organizational decision-making can be represented computationally and simulated, allowing for intelligence producers and consumers to examine alternative descriptions of intelligence problems through the analysis of artificial systems.

In the context of scientific research, ABMs have had significant success modeling complex systems, particularly social processes of interest to policy-makers, such as military combat, epidemiology, and transportation systems and networks.[15] Broadly speaking, ABMs have been able to assist in the development of new theories and testing of hypotheses whenever one or more of the following five properties are present:

- Agents in the system are **heterogeneous** with respect to their attributes and/or behavior, and cannot be represented as an average or aggregate unit;

[14] Eliot A. Cohen, "Net Assessment: An American Approach," *Jaffe Center for Strategic Studies Memorandum No. 29* (Tel Aviv, IL: Tel Aviv University, 1990); Stephen Peter Rosen, "Net Assessment as an Analytical Concept," in Andrew W. Marshall, J. J. Martin, and Henry S. Rowen, eds., *On Not Confusing Ourselves: Essays on National Security Strategy in Honor of Albert and Roberta Wohlstetter* (Boulder, CO: Westview Press, 1991), pp. 283-30; and Paul Bracken, "Net Assessment: A Practical Guide," *Parameters*, Vol. 36 (Spring 2006), pp. 90-100.

[15] Project Albert, description available at http://www.projectalbert.org/index.html (accessed on December 27, 2012); Andrew Ilachinski, *Artificial War: Multiagent-Based Simulation of Combat* (River Edge, NJ: World Scientific, 2004); EpiSims, description available at http://ndssl.vbi.vt.edu/episims.php (accessed on December 27, 2012); Joshua M. Epstein, Jon Parker, Derek Cummings, and Ross A. Hammond, "Couple Contagion Dynamics of Fear and Disease: Mathematical and Computational Explorations," *PLOS ONE*, Vol. 3, No. 12 (December 2008), pp. 1–11; TRANSIMS, description available athttp://web.anl.gov/TRACC/Computing_Resources/transims.html (accessed on December 27, 2012); and Robert Axtell, *Very Large-Scale Multi-Agent Systems and Emergent Macroeconomics* (Washington, DC: Center on Social and Economic Dynamics, Brookings Institution, 2006), available at http://www2.econ.iastate.edu/tesfatsi/EmergentMacro.Axtell2005.pdf (accessed on December 27, 2012).

- Agents are **autonomous** in the sense that they are each capable of making decisions and acting according to their individual goals, capabilities, information, etc. and are not controlled from a central authority;[16]
- Agents exist in **explicit space** such as geographic terrain, dynamic social networks, or more abstract environments, such as "belief space" that contain notions of distance, closeness, and locality when examining agent experiences and interactions;
- Agents' behavior is **boundedly rational** or subject to cognitive limitations or heuristically driven, thus while their behavior and decision-making is motivated and goal-seeking, it is not necessarily optimal and subject to important cognitive and environmental constraints;
- Model developers and users are agnostic about equilibrium, and interested in **non-equilibrium dynamics** systems such as phase transitions, transients, and other properties that may not be accessible through the study of comparative statics.[17]

Together, these properties make ABMs scientific instruments for exploring complex phenomenon in the physical and social sciences, particularly in cases where strategic interaction and the aggregation of individual choices may affect the overall structure and behavior of systems.[18]

While the properties of ABMs as test beds for scientific experimentation have been well articulated by the scientific community, whether they present important new opportunities for analytic tradecraft within the intelligence community and producer/consumer relations remains an open question. In the context of intelligence analysis and epistemology, ABMs, and simulation more broadly, provide analysts with a basis of grounding estimative intelligence in synthetically generated data. This approach to growing the base of what Kent referred to as the "intelligence pyramid" extends the body of basic and current intelligence to include examinations of artificial societies of interacting agents. In doing so, the epistemological basis of strategic intelligence can be altered, helping hedge against consumer's distrust of mere speculation. Moreover, because ABMs can afford users great flexibility regarding the range of individual and group behaviors they can represent, as well the kinds of physical and social environments within which interactions occur, many alternative competing ideas can be represented and examined via simulation. The result is a rudimentary laboratory for performing experiments on social systems *in-silico*, allowing investigations to occur at scales and circumstances not possible with real-world subjects in behavioral economics, experimental psychology, etc.[19]

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[16] This should be noted that central control is conceived of from a systems perspective. ABMs apply well in cases where agent-principal problems exist in organizations and societies where individual actors are subservient to or work for other actors, but do not always behave according to the explicit or implicit desires of authorities.

[17] Joshua M. Epstein, *Generative Social Science: Studies in Agent-Based Computational Modeling* (Princeton, NJ: Princeton University Press, 2006).

[18] John H. Miller and Scott E. Page, *Complex Adaptive Systems: An Introduction to Computational Models of Social Life* (Princeton, NJ: Princeton University Press, 2007).

[19] It is important to note the "rudimentary" characteristic of the artificial laboratory given that all models are simplifications or abstractions of systems and therefore do not contain the full-richness of the real-world objects and systems they represent. Therefore, they are better considered tools for generating and supporting analytic inferences than crystal balls that replicate the real-world in all of its detail. Joshua M. Epstein and Robert Axtell, *Growing Artificial Societies: Social Science from the Bottom Up* (Cambridge, MA: MIT Press 1996).

Today, the applications of ABMs are being explored within the intelligence community. While results have varied, the scientific, methodological and epistemological features of models continue to make them attractive for addressing long-standing problems that collectors, analysts and managers have wrestled with for decades. Examples include:

- Elicitation;
- Exploration;
- Complexity;
- Resolution;
- Identification;
- Communication.

These contributions can be seen by considering how ABMs can affect, reform, or alter the standard model of how the intelligence community operates and support policy—the intelligence cycle. Traditional depictions of the intelligence cycle place consumers in a position of initiating intelligence collection and analysis, while terminating with their receipt of assessments, shown in Figure 1.

Figure 1: The Intelligence Cycle.[20] The standard depiction of how the intelligence community operates and interacts with consumers starting with Planning and Direction and terminating with the Dissemination of intelligence products. In between these two stages, intelligence information is collected, processed and exploited, and then analyzed and converted into finished intelligence.

The intelligence cycle incorrectly posits that consumers actively drive processes of collection and analysis based on the clear understanding and articulation of their intelligence needs.[21] As noted earlier, this is problematic for several reasons, predominantly regarding incompatible needs and focus on time. Policy-makers rarely look far into the future with any specificity, while potential and current crises dominate their daily agendas.[22] Meanwhile, intelligence analysts and collectors often require years of advanced warning and resource investments in order to develop

[20] Central Intelligence Agency, The Intelligence Cycle, https://www.cia.gov/library/publications/additional-publications/the-work-of-a-nation/work-of-the-cia.html (accessed on September 27, 2013).
[21] Arthur S. Hulnick, "The Intelligence Cycle," in Loch K. Johnson and James J. Wirtz, eds., *Intelligence: The Secret World of Spies* (New York, NY: Oxford University Press, 2011), pp. 65-77.
[22] Interview with Leon Fuerth, National Defense University, September 21, 2001, http://www.aaronbfrank.com/2013/03/interview-with-leon-fuerth/ (accessed on: September 29, 2013).

the collection and assessment capabilities that will be needed to address future intelligence needs. In this space, strategic intelligence needs are rarely known in advance, and even if articulated, would evolve and change as new information and assessments were made.

Given these difficulties, intelligence producers may be better served by developing new means for eliciting the hopes, concerns, agendas and interests of consumers, rather than seek specific guidance for collection and analysis. This effectively changes producer/consumer interactions from one of active tasking, to eliciting spoken and unspoken considerations that will frame how policy-makers evaluate threats, opportunities and prospective courses of action. In effect, engaging with consumers to elicit their long-term objectives subtly, but importantly shifts the ethos of intelligence community from of *stealing target's secrets* to *keeping consumer's secrets* in order to create a space that is safe and supportive for creative, strategic thinking akin to a think-tank devoted to strategic planning, assessment and uncertainty.[23]

By discussing the operations of artificial societies with consumers, intelligence producers can better discern how consumers think about real ones. Specifically, explanations about how they believe foreign leaders make decisions, the resources at their disposal, what kinds of measures or metrics they value when assessing strategic balances, threats and opportunities, etc. can all inform analysts that must ultimately develop assessments that will be used by decision-makers. These elicitations then use models as a means for mediating discussions between communities, rather than as sources of information or knowledge in their own right. Indeed, using simulation as a means for eliciting the mental models or mindsets of consumers is based on the idea of presenting artificial societies to consumers and then having them identify why they seem to behave in inaccurate or unexpected ways.[24]

Information elicited from consumers can shape the relevance of intelligence products, increasing the likelihood that assessments will be used in the formulation and evaluation of policy. However, this approach also carries important risks with respect to politicization because it explicitly places the mindset or mental models of consumers at the forefront of the analytic process, and as a result appears to give deference to assumptions and judgments that reflect thinking already operating in the policy process.[25] However, other aspects of model use can hedge against these risks and even enhance the defense against politicization, thus reinforcing the belief that the contributions of ABMs must be seen in the context of analytic tradecraft as a whole rather than as a set of stand-alone products.

Assessing intelligence questions from perspectives elicited from consumers constitutes an initial foray into improving the relevance and acceptability of analysis. However, this is limited given the broader demands placed on analysts, which require generating and exploring the implications of multiple competing perspectives. Indeed, the range of contemporary Structured Analytic

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[23] Josh Kerbel and Anthony Olcott, "Synthesizing with Clients, Not Analyzing for Customers," *Studies in Intelligence*, Vol. 54, No. 4 (December 2010), p. 16; also see Ellen Laipson, "Think Tanks: Supporting Cast Players in the National Security Enterprise," in Roger Z. George and Harvey Rishikof, eds., *The National Security Enterprise: Navigating the Labyrinth* (Washington, DC: Georgetown University Press, 2011), pp. 289-299.

[24] Waltz, Kenneth N., *Theory of International Politics* (Reading, MA: McGraw-Hill, 1979).

[25] This challenge is not unique to formal models and simulations however, and can result of other intelligence products such as Red Team products and other special assessments developed to assist consumers in performing what-if assessments. For an example see, U.S. Senate, Senate Select Committee on Intelligence, *Report on the U.S. Intelligence Community's Prewar Intelligence Assessments on Iraq* (Washington, DC: United States Senate, 7 July 2004), pp. 359-360.

Techniques (SATs), among the most prominent of which is the method of Alternative Competing Hypotheses (ACH), all emphasize expanding the ways in which analysts search for explanations of the observed or possible behavior and motivations of intelligence targets in order to explain the information they have or generate future scenarios that may be of interest to consumers.[26] However, SATs have often proven difficult to implement for a variety of reasons, among the most important are a failure to generate enough diversity of mental models, frameworks, hypotheses, etc. to cover the space of plausible explanations and scenarios, i.e. the limits of individual and collective imagination.[27] Indeed, as Schelling noted, "One thing a person cannot do, no matter how rigorous his analysis or heroic his imagination, is to draw up a list of things that would never occur to him."[28]

ABMs can be employed to help analysts explore the implications of alternative perspectives on intelligence questions. While this is a relatively straight forward process, indeed it was a recognized use of formal modeling methods within the intelligence community that data back to the 1970s, the computational structure of ABMs lend themselves to an even wider range of exploitation that was not possible in preceding decades.[29] More specifically, employing artificial intelligence and machine learning techniques, in conjunction with artificial societies, to automate the development of new perspectives, generate alternative futures through massive numbers of simulation runs, and home in on the consequences of individual choices provides new means for generating and exploring hypotheses at scales that cannot be done manually.

ABMs can also assist analysts in managing the complexity of intelligence problems that often challenge manual methods.[30] The most prominent scientific contributions of artificial societies have been their ability to generate emergent properties that cannot be derived by analyzing the properties of the system's individual units in isolation or in an additive fashion.[31] Being able to

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[26] Richards J. Heuer, Jr., *Psychology of Intelligence Analysis* (Washington, DC: Central Intelligence Agency, 1999); Central Intelligence Agency, *A Tradecraft Primer: Structured Analytic Techniques for Improving Intelligence Analysis* (Washington, DC: Central Intelligence Agency, 2009); and Richards J. Heuer, Jr., and Randolph Pherson, *Structured Analytic Techniques for Intelligence Analysis* (Washington, DC: Congressional Quarterly, 2011).

[27] Richards J. Heuer, Jr., "Computer-Aided Analysis of Competing Hypotheses," in Roger Z. George and James B. Bruce, eds., *Analyzing Intelligence: Origins, Obstacles, and Innovations* (Washington, DC: Georgetown University Press, 2008), pp. 261-262; and Central Intelligence Agency, *Misreading Intentions: Iraq's Reaction to Inspections Created Picture of Deception* (Washington, DC: Central Intelligence Agency, January 5, 2005), pp. 10-14 (declassified on June 5, 2012), pp. 10-16.

[28] Quoted in Mark Herman, Mark Frost, and Robert Kurz, *Wargaming for Leaders: Strategic Decision Making from the Battlefield to the Boardroom* (New York, NY: McGraw Hill, 2009), p. 3. This point was reinforced in the specific case of the 2003 National Intelligence Estimate of Iraqi Weapons of Mass Destruction, where Richards Heuer noted that analysts never considered the possibility that the behavior of the Iraqi regime was a result of a deception campaign intended to create the impression that the regime possessed capabilities it did not. See Richards J. Heuer, Jr., in George and Bruce.

[29] Richards J. Heuer, Jr., "Adapting Academic Methods and Models to Government Needs," in Richards J. Heuer, Jr., ed., *Quantitative Approaches to Political Intelligence: The CIA Experience* (Boulder, CO: Westview Press, 1978), pp. 1-10.

[30] Michael K. O'Leary, William D. Coplin, Howard B. Shapiro, and Dale Dean, "The Quest for Relevance: Quantitative International Relations Research and Government Foreign Affairs Analysis," *International Studies Quarterly*, Vol. 18, No. 2 (June 1974), p. 228.

[31] Discussions of emergent properties have often been associated with notions of intuitive and counterintuitive results and surprise, but such a line of reasoning becomes problematic given that different individuals may have different a priori expectations about a system's behavior. Alternatively, it has been demonstrated in multiple instances that in complex systems the macroscopic behavior of the system is determined by the interactions between units, feedback that allows for path dependencies to develop and hysteresis to occur, and processes of aggregation

identify emergent properties is an essential analytic requirement given the inner working of existing tradecraft and ACH, which demands that analysts be able to relate the consistency of observations with specific hypotheses. Indeed, ABMs have demonstrated that even the most well specified descriptions of systems at the micro level can generate macroscopic outcomes that may be inconsistent with their developer's expectations. Moreover, these models often contain stochastic or probabilistic elements which allow for multiple simulations of the model to produce ranges of outcomes that may be consistent with many different observations. Thus, ABMs can provide a valuable, perhaps essential hedge, against analytic errors where analysts mistakenly associate evidence as consistent or inconsistent with specific hypotheses.

Because ABMs represent full artificial societies, they allow for the simultaneous modeling of the intelligence problems and the collection against them. Whereas mathematical models ultimately collapse multiple dimensions represented as independent variables into singular dependent variables, artificial societies maintain their dimensionality as the system is simulated over time. As a result, analysts and collectors can examine the "true" behavior of a complex system while also assessing the effectiveness of alternative collection strategies and capabilities within the artificial society. This enables for collectors and analysts to identify the stability of given indicators, potential sources of biases inherent in the collection systems, and the diagnosticity of information regarding whether it can provide unambiguous signals for differentiating between competing hypotheses about a system's behavior or the units within them.[32]

Finally, the employment of ABMs can fulfill the needs of addressing deep uncertainty through the generation and assessment of landscapes of possible outcomes, and association of model assumptions, initial parameters, and other events, e.g. exogenous shocks to the system such as natural disasters, financial crises, etc. Together, this information can allow for analysts locate where in the space of possible models consumers sit, identify what outcomes are the logically generated by their mindsets, and then identify how fragile or robust those expectations are given changes in assumptions about the individual or organizational behavior of intelligence targets, alternative model parameters, and other uncertainties. The result is that ABMs provide a new means for extending existing tradecraft by simultaneously improving opportunities for analysts to engage with consumers and collectors in order to be more effective at working across organizational and functional boundaries. Moreover, by bolstering the diversity and volume of assumptions, data, hypotheses and scenarios that can be generated and assessed, analysts can alter the epistemological basis of intelligence assessments. Taken together, the ability to start and sustain a dialog with consumers that initially focuses on understanding the world based on consumer's mental models and then expanding outwards provides a new approach for making strategic intelligence relevant and acceptable.

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where individual actions and choices are combined. In each case, these dynamics are not discernible by traditional analytic methods that "divide and conquer" systems into independent units to be examined in detail and then recombined afterwards. See Joshua Epstein, Generative Social Science, and A. Frank, et.al., *Security in the Age of Systemic Risk: Strategies, Tactics and Options for Dealing with Femtorisks and Beyond*, (International Institute for Applied Systems Analysis, Interim Report IR-12-010, September 20, 2012), http://webarchive.iiasa.ac.at/Admin/PUB/Documents/IR-12-010.pdf (accessed on September 27, 2013).

[32] Richards J. Heuer, Jr., *The Psychology of Intelligence Analysis* (Washington, DC: Central Intelligence Agency, 1999), pp. 45-46.

Section 3: Computing Technology in Producer and Consumer Relations

The prior sections provided an overview of long-standing challenges in the structure of producer/consumers relations posed by the fundamental characteristics of intelligence and policy problems, and an assessment of the ways in which in new scientific research methods based on the exploitation of computational technology can assist analytic tradecraft. This section offers a speculative assessment regarding how emerging technologies can transform the shape and feel of intelligence products and enable a model-centric approach to tradecraft to achieve its full potential.

While the intelligence community has largely eschewed the use of formal mathematical models in tradecraft, other types of models have played a significant role in the presentation of intelligence to consumers. For example, during the assessment of Osama Bin Laden's compound in Abbottabad, Pakistan, and the planning of the military operation that would ultimately lead to his death, physical or scale models of the compound played a prominent role in developing insights and presenting the bases of inferences about the facility to policy-makers.[33] One of the models developed and employed in presenting intelligence assessments to consumers is shown in Figure 2 below:

Figure 2: A Physical Model of Osama Bin Laden's Abbottabad Compound.[34]

The utility of physical models in the context of performing and presenting intelligence assessments provides important insights into the characteristics of producer/consumers relations regarding the ways in which policy-makers access and consume information. Psychologists have repeatedly identified that in most circumstances, decision-makers reason from narratives and natural language rather than from quantitative information.[35] Thus, quantitative assessments and intelligence products may appeal to consumers with specialized expertise, but once employed in

[33] Peter L. Bergen, *Manhunt: The Ten-Year Search for Bin Laden: From 9/11 to Abbottabad* (New York, NY: Crown, 2012), pp. 164-165, and 182-184.
[34] Image taken from Luis Martinez, *Osama Bin Laden Compound Model on Display at Pentagon*, http://abcnews.go.com/blogs/politics/2012/05/osama-bin-laden-compound-model-on-display-at-pentagon/ (accessed on September 28, 2013).
[35] Daniel Khaneman, *Thinking Fast and Slow* (New York, NY: Farrar, Straus and Giroux, 2011).

a larger strategic decision-making context that includes stakeholders with multiple backgrounds the information proves difficult to use and place into multiple frameworks.

By comparison, humans naturally create and understand narratives when interpreting the world around them, making them an important vehicle for conveying intelligence assessments. This has traditionally been a reason why strategic analysis has remained a fundamentally qualitative endeavor from a methodological perspective.[36] ABMs provide an opportunity to generate new narratives through the simulation of artificial societies, allowing for users to capture and understand the possible experiences of individual actors, groups, and entire populations. Thus, while ABMs have traditionally been used to generate quantitative information, there is no explicit reason why they cannot be employed to provide consumers with highly accessible, documentable narratives of interest at any chosen resolution.[37]

The challenge and opportunities posed by new technologies largely revolved around how to make the range of information that can be generated via simulation accessible and relevant to consumers. This is not a problem that is unique to the exploitation of computational models, but rather a grand challenge for the intelligence community as whole that must compete with a host of open source information providers, including social networks, which allow consumers to quickly access new information that is tailored to their interests. Thus, the intelligence community is largely in a competition with other sources for the attention of consumers, and is increasingly unable to distinguish itself based on access to secret information alone.[38] Instead, the intelligence community must alter the way it conceives of its products and provides them to consumers in a way that creates a user experience that makes their assessments easy to use, interpret, and combine with other sources of information.[39]

The development of cloud computing, secure mobile wireless technology, and personal information technology such as the iPad provide a convergence of technology that create an opportunity to change how intelligence is delivered to consumers. While the iPad has already permeated the interface between producers and consumers, its use as a means of delivering intelligence information to policy-makers remains small and limited compared with its long-term potential.[40]

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[36] Richards J. Heuer, Jr., "Adapting Academic Methods and Models to Government Needs," in Richards J. Heuer, Jr., ed., *Quantitative Approaches to Political Intelligence: The CIA Experience* (Boulder, CO: Westview Press, 1978), pp. 1-10; and James B. Bruce, "Making Analysis More Reliable: Why Epistemology Matters to Intelligence," in Roger Z. George and James B. Bruce, eds., *Analyzing Intelligence: Origins, Obstacles, and Innovations* (Washington, DC: Georgetown University Press, 2008), pp.171-190.

[37] Aaron B. Frank, *Agent-Based Modeling in Intelligence Analysis*, (Doctoral Dissertation, George Mason University: December 2012).

[38] Joshua Kerbel and Anthony Olcott, "Synthesizing with Clients, Not Analyzing for Customers," *Studies in Intelligence*, Vol. 54, No. 4 (December 2010), pp. 11-27.

[39] Interview with John Hanley, Office of the Director of National Intelligence, February 9, 2012, http://www.aaronbfrank.com/2012/04/interview-with-john-hanley-director-of-strategy-for-the-odni-retired/ (accessed on September 28, 2013).

[40] Greg Miller, "Oval Office iPad: President's Daily Intelligence Brief Goes High-Tech," *The Washington Post*, April 12, 2012, http://www.washingtonpost.com/blogs/checkpoint-washington/post/oval-office-ipad-presidents-daily-intelligence-brief-goes-high-tech/2012/04/12/gIQAVaLEDT_blog.html (accessed on September 28, 2013).

Figure 3: President Obama receiving the Presidential Daily Brief on an iPad in the Oval Office.[41]

Exploiting the iPad and other forms of personal information technology means that consumers can enter into the analytic process in new ways. The most obvious of which is the shift from text and graphics to multimedia and interactive presentations. Less obvious, but more challenging implications involve how to bring consumers into the intelligence production process without politicizing the community.[42] For example, consumers may annotate information of interest, ask questions about data or inferences, and ask for new products or follow-up assessments through their devices.

[41] Image taken from http://www.washingtonpost.com/blogs/checkpoint-washington/post/oval-office-ipad-presidents-daily-intelligence-brief-goes-high-tech/2012/04/12/gIQAVaLEDT_blog.html (accessed on September 28, 2013).

[42] Intelligence scholars and practitioners have long debated the merits of new models of producer/consumer relations with some favoring increased closeness with consumers while others remain deeply skeptical of new models and argue that more should be done to return to established practices. For examples see Joshua Kerbel and Anthony Olcott, "Synthesizing with Clients, Not Analyzing for Customers," *Studies in Intelligence*, Vol. 54, No. 4 (December 2010), pp. 11-27; Paul R. Pillar, "The Perils of Politicization," in Loch K. Johnson, ed., *The Oxford Handbook of National Security Intelligence* (New York, NY: Oxford University Press, 2010), pp. 472-484; Jennifer E. Sims, "Decision Advantage and the Nature of Intelligence Analysis," in Loch K. Johnson, ed., *The Oxford Handbook of National Security Intelligence* (New York, NY: Oxford University Press, 2010), pp. 389-403; Thomas Fingar, *Reducing Intelligence: Intelligence Analysis and National Security* (Stanford, CA: Stanford University Press, 2011); and Aaron B. Frank, *Interview with Paul Pillar from Georgetown University*, http://www.aaronbfrank.com/2012/06/interview-with-paul-pillar-from-georgetown-university/ (accessed on September 29, 2013).

While the full implications of these technologies remain to be discovered, two notable possibilities merit investigation. First, the advent of secure, mobile wireless technology allows for relatively light-weight devices to access and operate on massive quantities of data without ever moving sensitive information onto the device itself, allowing for intelligence information to be employed in situations where it was previously too cumbersome to access. Thus, an iPad with 64GB or 128GB of storage can effectively command terabytes or petabytes of data located on remote servers. While analysts have often resisted allowing consumers unfettered access to intelligence information, whether for reasons of preserving secrecy surrounding sources and methods, or due to matters of pride in their expertise and institutional neutrality, it seems unlikely that these barriers can be maintained if priority is given to analytic transparency in an effort to improve the relevance and usability of assessments.[43]

Increasingly, analytic production will follow an evolutionary process where assessments will constitute partial solutions and components of a larger, more complete whole rather than discrete finished products. This is due to the fact that information technology will bring producers and consumers closer to one another—affording consumers new opportunities to question analysts while they are working, while motivating analysts to present preliminary assessments to consumers in an effort to compete with other sources of information. The result will likely resemble Herbert Simon's famous watch-makers, who discovered that building time pieces in a modular fashion allowed for increased productivity and an ability to withstand disturbances to the production process.

> Let me introduce the topic of evolution with a parable. There once were two watchmakers, named Hora and Tempus, who manufactured very fine watches. Both of them were highly regarded, and the phones in their workshops rang frequently—new customers were constantly calling them. However, Hora prospered, while Tempus became poorer and poorer and finally lost his shop. What was the reason?
>
> The watches the men made consisted of about 1,000 parts each. Tempus had so constructed his that if he had one partly assembled and had to put it down—to answer the phone, say—it immediately fell to pieces and had to be reassembled from the elements. The better the customers liked his watches, the more they phoned him and the more difficult it became for him to find enough uninterrupted time to finish a watch.
>
> The watches that Hora made were no less complex than those of Tempus. But he had designed them so that he could put together subassemblies of about ten elements each. Ten of these subassemblies, again, could be put together into a larger subassembly; and a system of ten of the latter subassemblies constituted the whole watch. Hence, when Hora had to put down a partly assembled watch to answer the phone, he lost only a small part of his work, and he assembled his watches in only a fraction of the man-hours it took Tempus.[44]

In this case, the conduct of intelligence analysis will become increasingly modular, partial, and transparent in order to make incremental contributions to policy-debates, and creating new metrics for assessing whether and how analysis can be communicated.

A secondary speculation relates to the availability of computational power within the intelligence community that is historically unprecedented. These computational resources afford new

[43] For a policy-makers perspective on the intelligence community and their efforts to keep their data, source and methods hidden from consumers see Paul Wolfowitz, "Comments: Paul Wolfowitz," in Roy Godson, Ernest R. May and Gary Schmitt, eds., *U.S. Intelligence at the Crossroads: Agendas for Reform* (Washington, DC: Brassey's, 1995), pp. 75-80.

[44] Herbert A. Simon, *The Sciences of the Artificial* (Cambridge, MA: MIT Press, 2003), p. 188.

opportunities to rethink ways of coping with bounded rationality at the level of individual analysts, decision-makers and entire organizations by shifting cognitively costly tasks onto machines without surrendering the power to make strategic, political and ethical choices.[45] SATs discussed earlier have largely sought to address these limitations, but have emphasized lightweight, manual methods in order to assist with difficult cognitive tasks and communication, but not by exploiting computation.[46] The model-centric analytic tradecraft advocated for in Section 2 marks an important divergence from these efforts precisely because it envisions the centrality of the computer as a means for coping with deep uncertainty.

Perhaps the best way to consider the implications of a model-centric analytic tradecraft, specifically tailored to provide consumers with a detailed epistemological assessment of complex intelligence problems is via analogy. As noted in Section 1, deep uncertainty affords the existence of multiple, competing, legitimate perspectives on intelligence problems, which shape the expectations and perceptions of their adherents. If assessments through these perspective are regarded as works of art in a museum, then a model-centric tradecraft that emphasizes making relevance to consumers a priority may advocate shifting from providing consumers with standard tours that lead viewers through the museum on a fixed path and set schedule to the working of private docents that encourage visitors to travel the museum according to their likes, while explaining how each exhibit relates to others. Moreover, by dynamically tracking where consumers tend to spend their time, or what questions they ask, models (whether computational, mathematical, or mental) can be spun up and employed to provide new assessments in near-real time in order to address analytic gaps or other information needs.

In this analogy, the museum exhibits are the same, but consumers can start examining assessments from those models or frameworks that are most appealing to them and then fan out in order to experience increasingly challenging changes in assumptions and beliefs about the problem. While this may not prevent cherry-picking of assessments in order to win personal and bureaucratic conflicts, it will limit the extent to which intelligence assessments can be marshaled without reference to the broader context in which they were generated or references to alternative perspectives available to other stakeholders in the policy-process.

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[45] In many ways, this challenge defines the long and illustrious of Herbert Simon, who served as a founding inspiration for multiple aspects of intelligence analysis, policy-making, organizational design and computation. See, James G. March and Herbert A. Simon, *Organizations* (Cambridge, MA: Blackwill, 1993); Herbert A. Simon, *The Sciences of the Artificial* (Cambridge, MA: MIT Press, 1996); Herbert A. Simon, *Administrative Behavior* (New York, NY: The Free Press, 1997); Richards J. Heuer, Jr., *Psychology of Intelligence Analysis* (Washington, DC: Central Intelligence Agency, 1999); Hunter Crowther-Heyck, *Herbert A. Simon: The Bounds of Reason in Modern America* (Baltimore, MD: Johns Hopkins University Press, 2005).

[46] Efforts to include modeling and simulation in the panoply of SATs have been difficult. Models, simulations, and games were included in early publications on Alternative Analysis and discussions of SATs. However, the prominence of models, simulations, and games has greatly diminished in the more recent literature, and Heuer and Pherson's recent book on SATs considered these approaches as a distinct form of analytic techniques all together. For examples see the Directorate of Intelligence's 25-page *Alternative Analysis Primer* published in the mid-2000s, and its more recent *Structured Analytic Techniques: A Primer*, published in 2009. Also see Roger Z. George, "Fixing the Problem of Analytical Mind-Sets: Alternative Analysis," *International Journal of Intelligence and Counterintelligence*, Vol. 17, No. 3 (2004), p. 404; Central Intelligence Agency, *Structured Analytic Techniques: A Primer* (Washington, DC: Central Intelligence Agency, 2009); and Richards J. Heuer, Jr. and Randolph H. Pherson, *Structured Analytic Techniques for Intelligence Analysis* (Washington, DC: Congressional Quarterly, 2011), pp. 22-24.

Section 4: Developing a Research Plan

The premise behind this paper is a simple hypothesis—ABMs, and simulation more broadly, can provide the basis for a new analytic tradecraft and improve relations between producers and consumers in the intelligence community. Although a simple statement, it is not necessarily easy to test because it presumes the existence of new analytic methods, tradecraft practices, baseline assessments of producer/consumer relations, and a computational infrastructure the supports the development and delivery of intelligence products that is still in development. This final section offers a sketch of how this premise can be tested within the existing intelligence community, yet enables inferences about the viability of future organizations, technologies, and practices.

The fundamental challenge facing this research program is that it must assess producer/consumers relations under new conditions that do not currently exist. Indeed, an examination of the state-of-the-art concerning a variety of technologies and practices reveals a heterogeneous mix of mature, developing, and missing capabilities. For example, the use of the iPad and other advanced model visualization and interaction tools may be restricted as a matter of policy in different parts of the intelligence community, while as a technological artifact, it is perfectly capable of operating as desired. Thus, a research effort focused on producer/consumer relations within the intelligence community must operate on unclassified problems in order to bring the full range of available and potential technologies to bear, and then home in on a set of infrastructure, practices, and team members that can perform a pilot project in a classified setting. Another challenge is that because all research programs possess limited time and funds, it necessary to perform activities in parallel, where certain aspects of producer/consumer relations are examined while a new model-centric analytic tradecraft is developed rather than develop a new tradecraft and then test its ability to alter producer/consumer relations.

A prospective organizational structure for a research and development program is shown in Figure 4 below.

Figure 4: Prospective Organizational Structure of Model-Centric Tradecraft Research Program.

This structure contains a program manager that will be responsible for the planning, direction, and oversight of all research and development activities. The program manager would be supported by a senior advisory panel that would consist of experts in technology development, modeling and simulation, experimental designs and metrics, intelligence analysis and management, infrastructure, and policy-making. These experts would assist the program manager with respect to assessing progress, designing experiments for testing hypotheses, managing risks, and leading a series of research conferences on topics in order to allow project participants to examine lessons learned from the broader community, reach out to specialists in unique fields, such as the design and presentation of interactive narratives from the video game industry, share lessons and ideas from within the program performers, and perform academic, industry and government outreach.

At the performer level, the core research will be performed by modeling teams operating independently. These teams would each address different long-term strategic intelligence problems that may vary with respect to the extent to which they rely on empirical data for trend analysis, pattern recognition, and indicators and warning. Importantly, these teams would not be operating in competition with one another, but would each be encouraged to take different approaches to their specific problem given their innate skills, expertise, development schedule, and prospective consumers.

Investigators from research teams will participate in two working groups devoted to computational and communications infrastructure for the intelligence community and tradecraft development. These working groups will facilitate lessons learned, and capture the most effective and efficient practices, as well as identity long-term challenges that merit further research. Additionally, modeling teams will regularly participate in experiments with

consumers, predominantly composed of current and former policy-makers, where different means of presenting intelligence assessments can be evaluated. These may include the delivery of written reports, briefings, online multi-media, interactive products that place simulations and their outputs into the hands of consumers, and more. Consumers will be asked to provide feedback on the relevance, utility, and ease of understanding intelligence products, as well as opportunities to make spot demands on modeling teams for ad hoc products in order to replicate the real-world circumstances that intelligence analysts operate under. Doing so will ensure that potential tradecraft and technologies are capable of transitioning into real-world working environments and continue to support consumers as they move from having intelligence products pushed onto them from analysts to pulling them via direct involvement in the analytic process.

Table 1 below shows the proposed program schedule, based on an assumed four year research effort.

Table 1: Program Activities and Schedule.

	Year 1				Year 2				Year 3				Year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Model Development and Analysis	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Experiments with Consumers			Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Ad Hoc Consumer Requests						■	■	■	■	■	■	■	■	■	■	■
Infrastrucure Working Group Meeting	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Tradecraft Assessment Meeting	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Conferences Series		Δ		Δ		Δ		Δ		Δ		Δ		Δ		Δ
Ad Hoc Program Taskings for Community Support	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Program Annual Summary Report				Δ				Δ				Δ				Δ

The schedule contains several planned activities, most notably being quarterly experiments where modeling teams present their products to consumers in a variety of ways in order to examine what kinds of products are useful and what are not. These experiments will start after the second quarter of the first year, allowing for modeling teams to develop preliminary models and analytic products to serve primarily as means for eliciting the interests of consumers through initial experiments. Moreover, starting in the second half of year 2, simulated and real consumers, working through the program manager, will be able to make ad hoc requests for analytic products in order to test the feasibility of different tradecraft approaches. Additional quarterly activities include convening of the infrastructure and tradecraft working groups, which allows for performer teams, the program manager, and senior advisors to assess short-term concerns and long-term requirements for transitioning new analytic approaches into real-world use. Research conferences will be performed semi-annually, and will serve as a basis for exploring long-term technical, operational, scientific, and policy-challenges to the program's activities and interests, as well as a means for eliciting new perspectives and participants from outside communities. At the conclusion of each year, an annual report will be produced that will summarize research accomplishments, experimental designs and results, and other notable activities. Finally, program participants will be available to assist intelligence community analysts and policy-makers on real-world problems per requests made to the program manager and program sponsor.

Conclusion

Technological change has dramatically altered the information environment that policy-makers operate in. Although many efforts have been made to capitalize on these capabilities within the intelligence community, reimagining the entire relationship between producers and consumers is necessary if analysts and advances in analytic practices are going to influence policy-making. Given long-standing institutional rivalries and a professional ethic that militates against politicization or exerting undue influence over decision-makers, producers and consumers have continued to struggle with the challenge of relevance and making intelligence assessments more user friendly. While modeling and simulation has proven to be valuable tools in many decision-making contexts, they remain little more than odd curiosities in the production of strategic intelligence largely to due to mismatches between the demands of "good science" and the needs of policy analysis. ABMs provide a new means of performing rigorous, structured analysis without making the powerful, often unjustifiable assumptions required by other formalisms, which allows for new opportunities to employ simulations to examine policy-makers' more complex challenges regarding the future of the international system. However, effectively integrating ABMs into the analytic process requires reimagining analytic tradecraft as a means for coping with deep uncertainty, considering new means of model use and exploitation as the basis for inferences, and a commitment to bringing consumers into the analytic process.