U.S. Air Force Strategic Deterrence Analytic Capabilities: An Assessment of Tools, Methods, and Approaches for the 21st Century Security Environment

Committee on U.S. Air Force Strategic Deterrence Military Capabilities in the 21st Century Security Environment; Air Force Studies Board; Division on Engineering and Physical Sciences; National Research Council

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Committee on U.S. Air Force Strategic Deterrence Military Capabilities in the 21st Century Security Environment

Air Force Studies Board

Division on Engineering and Physical Sciences

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Preface

In 2012, the Assistant Chief of Staff for Strategic Deterrence and Nuclear Integration, Headquarters U.S. Air Force and the Commander of the Air Force Global Strike Command, asked the National Research Council's (NRC's) Air Force Studies Board (AFSB) to conduct a workshop on what Air Force strategic deterrence capabilities would be required for the 21st century security environment. The AFSB agreed and organized a workshop to frame the issues and construct the terms of reference (TOR; see Appendix A) for a follow-on study. A summary of the workshop was approved by the NRC and submitted to the Air Force co-sponsors in early 2013.[1]

TERMS OF REFERENCE

At the Air Force's subsequent request, the NRC approved the terms of reference in March 2013.[2] The chair of the NRC then appointed a committee of experts in June 2013 to conduct this follow-on study.[3] The Committee on U.S. Air Force Strategic Deterrence Military Capabilities in the 21st Century Security Environ-

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[1] NRC, 2013, *U.S. Air Force Strategic Deterrence Capabilities in the 21st Century Security Environment: A Workshop Summary*, Washington, D.C.: The National Academies Press.

[2] The TOR are contained in Appendix A.

[3] Appendix B provides biographies of the committee members. The committee includes experts with experience in academia, government, and industry—combined with many years in Air Force nuclear weapons capabilities, strategies, and postures; decision and game theory; behavior-based profiling; risk management; operations research; and modeling and simulation.

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ment met during 2013 and 2014 to gather and assess facts, discuss findings, and construct recommendations. The TOR include the following:

1. Identify the broad analytic issues and factors that must be considered in seeking nuclear deterrence of adversaries and assurance of allies in the 21st century.

2. Describe and assess tools, methods—including behavioral science-based methods—and approaches for improving the understanding of how nuclear deterrence and assurance work or may fail in the 21st century and the extent to which such failures might be averted or mitigated by the proper choice of nuclear systems, technological capabilities, postures, and concepts of operation of American nuclear forces.[4]

3. Discuss the implications for the Air Force and how it could best respond to these deterrence and assurance needs. Include in this discussion a framework for identifying the risks and benefits associated with different nuclear force postures, structures, levels, and concepts of operation.

4. Recommend criteria and a framework for validating the tools, methods, and approaches and for identifying those most promising for Air Force usage.

5. Recommend an appropriate mix of the classes of analytical tools affordable in today's austere financial climate, and identify what can be planned for by the Air Force as future improvements to this mix if defense budgets increase or decrease.

WHAT THIS STUDY SEEKS TO DO AND HOW IT GOES ABOUT DOING IT

The TOR basically direct the committee to identify the broad issues and factors to be considered in seeking nuclear deterrence of adversaries and assurance of allies in the 21st century and to evaluate and recommend tools, methods, and approaches for (1) understanding nuclear deterrence and assurance in the new security environment and (2) sizing forces appropriate for deterrence and assurance. The sponsor amplified the TOR by asking the committee to answer the following specific questions in the context of deterring adversaries and assuring allies:

• What analytic capabilities are needed to evaluate Air Force concepts and assertions about Air Force capabilities requirements as strategy is developed in the 21st century security environment?

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[4] The committee interpreted items 2 and 3 of the TOR to mean that it should describe and assess analytic tools, methods, and approaches that would help both (1) in improving and understanding deterrence and assurance and (2) understanding how nuclear forces, posture, technological capabilities, and concepts of operations can improve prospects or mitigate failures. The committee and the Air Force understood that the study was not going to make recommendations about force structure and the like.

• How do we develop and validate future deterrence requirements and inject them into the joint requirements development process?

• What analytic capabilities can improve understanding of how nuclear deterrence and assurance work in the 21st century and how they might fail, and how might failure be averted by the proper choice of Air Force systems, technological capabilities, postures, and concepts of operation for American nuclear forces?

• Since what we believe about an adversary will change over time, can we develop systematic, integrated approaches to incorporate feedback, which would narrow the gap between beliefs about the adversary and knowledge about the adversary?

• How can we assist operational planners in matching Air Force capabilities, procedures, and actions to operational deterrence situations?

• How can we detect and evaluate adversary responses to deterrence actions?

The committee conducted its fact-finding and deliberations with those questions in mind.

While this study of deterrence and assurance has applicability to the U.S. Navy and its nuclear forces, the committee's focus was on those forces that the Air Force is responsible for: primarily the strategic systems (intercontinental ballistic missiles [ICBMs] and long-range bombers and stand-off, air-launched missiles) but also dual-capable aircraft for theater operations.[5]

The committee grappled with a number of issues in deciding how to approach the study. First, it understood that to produce a result that is useful to the sponsors, the study's recommendations should be cognizant of Air Force roles and authorities in the Department of Defense (DoD). As a military department, the U.S. Air Force has the legal authority to organize, train, and equip forces, which it then provides to joint combatant commands. The Air Force neither commands forces in peacetime or combat operations nor prepares operational plans for their use. The command and operational planning functions are done by functional or regional joint combatant commanders and their subordinate joint task forces, which, of course, does include Air Force personnel.[6]

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[5] See Amy F. Woolf, 2013, *U.S. Strategic Forces: Background, Developments, and Issues,* Washington, D.C: Congressional Research Service, October 22 and Amy F. Woolf, 2012, *Nonstrategic Nuclear Forces,* Washington, D.C.: Congressional Research Service, December 19.

[6] The Air Force was established as a separate military department by the National Security Act of 1947, with its legal authorities (as were those of the Army and Navy) codified in Title X of the U.S. Code. This is what is meant when one finds the Air Force referred to as a "Title X organization." The Defense Reorganization Act of 1986, also known as the Goldwater-Nichols Act, changed the mission of the military departments. Goldwaters-Nichols limited their authorities to organizing, training, and equipping forces, while assigning the responsibility for commanding and operational planning to the functional and regional COCOMs. The responsibilities and alignments of the COCOMs are specified

This creates a known tension. Combatant commands (COCOMs) develop operational plans with short horizons relative to procurement and training timelines. The Air Force time horizon is much longer than those of combatant commands. In balancing readiness and modernization, the Air Force must organize, train, and equip for today's requirements (the current fight) *and* for the requirements not only of the next Future Years Defense Program (FYDP) but even for the "FYDP after next" (future contingencies). The question of what time horizon is appropriate for this study thus emerged as an important issue, which will be discussed further in this chapter.

The committee acquainted itself in broad terms with the process for establishing requirements in DoD. Prior to the reforms put in place by the Goldwater-Nichols legislation, the combatant commands had no formal role in the requirements process, nor did they have large supporting staffs that were expert in DoD's elaborate Planning, Programming, Budgeting, and Execution (PPBE) System. Goldwater-Nichols assigned leading roles in setting requirements for the Joint Chiefs of Staff (JCS) Chairman and brought the joint combatant commanders into the process.

Today, requirements are set by a joint system supporting the Secretary of Defense, where the Air Force has a voice but does not make final decisions. The Air Force has a seat on the Joint Requirements Oversight Council (JROC), which is chaired by the Vice Chairman of the JCS.[7] JROC is responsible for identifying, assessing, validating, and prioritizing joint military requirements, to include requirements for delivery systems but not for the nuclear stockpile. Stockpile requirements are addressed in the Nuclear Weapons Council (NWC), where the Air Force does not have a seat.[8]

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in the Unified Command Plan, which is prepared by the JCS Chairman, reviewed and updated every two years, and approved by the President. There currently are nine COCOMs: Special Operations Command, Strategic Command, Transportation Command, African Command, Central Command, European Command, Northern Command, Pacific Command, and Southern Command. See Andrew Feickert, 2013, *The Unified Command Plan and Combatant Commands: Background and Issues for Congress*, Washington, D.C.: Congressional Research Service, January 3.

[7] In addition to changing the relationship of the armed services to joint combatant commands, Goldwater-Nichols created the position of Vice Chairman of the JCS, strengthened the role of the JCS Chairman and the Joint Staff, and gave the combatant commanders an important role in the process for establishing requirements. Under the Goldwater-Nichols reforms, the JROC was created. JROC is chaired by the Vice Chairman of the JCS. The Air Force is represented on the JROC by the Air Force Vice Chief of Staff.

[8] NWC is a joint DoD-National Nuclear Security Administration (NNSA) organization established to facilitate cooperation and coordination between the two Departments. Among other things, it addresses requirements for the nuclear stockpile. The NWC is chaired by the Under Secretary of Defense for Acquisition, Technology and Logistics (USD/AT&L). Members are the Vice Chairman of the JCS, the NNSA Administrator, the Under Secretary of Defense for Policy, and the Commander of STRATCOM. The NWC is supported by the Nuclear Weapons Council Standing and Safety Committee, where the Air Force does have a seat at the table.

In this complicated requirements system, the Air Force may seek to advance the understanding of the requirements for deterrence and assurance, but it does so primarily within the processes, assumptions, and lexicon of the joint force, and in a system where it does not have the final decision authority.

Of special importance to the committee's work was to gain an understanding of the role and perspectives of U.S. Strategic Command (STRATCOM). The committee reviewed STRATCOM documents (especially the *Deterrence Operations Joint Operating Concept*), received briefings from and interacted with STRATCOM staff, and devoted one of its fact-finding visits to STRATCOM headquarters at Offutt Air Force Base (AFB) in Omaha, Nebraska. The committee also acquainted itself with the views of STRATCOM's senior leadership.[9] Those have been taken into account in this report.

There are other major factors that were especially important to the committee's deliberations. One was the attempt in DoD to shift its force planning framework away from platform-centric thinking (the ICBM and the long-range bomber are delivery platforms) to a capability-based approach (where a capability is defined, in joint parlance, as "the ability to achieve a desired effect under specified standards and conditions through a combination of means and ways across the DOTMLPF (Doctrine, Organization, Training, Leadership, Materiel, Personnel, Facilities)."[10] DoD has developed an elaborate Joint Capabilities Integration and Development System (JCIDS) to support JROC. This establishes the framework and processes the Air Force must work within in DoD.

The committee found that, while thinking in terms of capabilities and effects, it is highly conducive to deterrence analysis (as will be discussed in subsequent chapters), constructing and defending a deterrence-related program within DoD, and successfully advocating the program to the White House and, ultimately, to the Congress, cannot be done simply by discussing capabilities and effects but must focus on platforms, e.g., the next generation bomber, ICBM, and SSBN. While it is currently U.S. policy to retain a traditional triad of strategic nuclear forces (which, for the Air Force, means retaining the ICBM and the long-range bomber) and to retain the Air Force dual-capable aircraft, it is unclear whether that will remain the case as arms control proceeds, budgets shrink, and hard choices must be made between force readiness and force modernization. There already have been advocates for eliminating the ICBM force and/or the nuclear-armed bombers and nuclear-

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[9] Those views are readily available in statements prepared for testimony to Congress. Of special relevance were General Kehler's posture statement to the Armed Services Committees in March 2013 and his statement to the House Armed Services Committee Strategic Forces Subcommittee hearing on nuclear weapons modernization programs in October 2013, General Kehler relinquished command of STRATCOM to Admiral Haney on November 15, 2013.

[10] See http://static.e-publishing.af.mil/production/1/af_a3_5/publication/afpd10-6/afpd10-6.pdf. Accessed November 21, 2014.

capable fighters and cancelling the Navy's SSBN-X as cost-saving measures. While the committee does not take a stand on such issues, it does acknowledge the debate as part of the unfolding security environment, which underlines the importance of providing the sponsors with the best possible tools, methods, and approaches for conducting sound deterrence analysis.

There are other considerations that were important factors in conducting this study, five of which deserve highlighting: (1) the meaning of *strategic* (as opposed to *nuclear*) deterrence; (2) the increasing importance of deterrence in regional settings; (3) nonstate actors; (4) the distinction between delivery systems and the nuclear weapons themselves, and (5) the possibility of changed circumstances, both positive and negative.

Like the workshop that preceded it, the committee spent considerable time discussing the fact that *nuclear* deterrence is not synonymous with *strategic* deterrence. There is a tension in these two concepts of deterrence, which is acknowledged and concisely expressed but not resolved in a white paper signed by senior Air Force civilian and military leadership on the Air Force Nuclear Enterprise and issued while this study was ongoing. Two passages from the white paper illustrate the tension:

> Nuclear weapons are not an anachronism of the Cold War but some concepts are outdated; the Nation requires fresh thinking to meet the deterrence challenges of today's strategic environment. Deterrence in the twenty-first century demands credible, flexible nuclear capabilities, linked to comprehensive strategies and matched to the modern strategic environment.

> Nuclear deterrence operations do not occur in a vacuum. All Air Force capabilities, including space, cyber, and conventional capabilities play a role in effective deterrence and provide options for decision makers. *Airmen must understand the interactions of these capabilities and how to integrate them to achieve the desired deterrent effects* (emphasis added).[11]

The white paper is silent on who is responsible for ensuring that airmen understand the interactions of these effects. That assurance appears to be a responsibility shared among a number of Air Force organizations, but with no common framework. That is true not only for the Air Force, but for DoD in general.

There does appear to be agreement within DoD and within the Air Force that *strategic* deterrence is *cross-domain* deterrence. This is emphasized in the STRATCOM documents the committee reviewed and in STRATCOM presentations. It is beyond the scope of this present study to provide a new analytic framework for cross-domain deterrence. It is reasonable to expect that the tools, methods, and approaches that this study addresses may help advance the analytic agenda for

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[11] Air Force Headquarters, 2013, *Flight Plan for the Air Force Nuclear Enterprise,* Washington, D.C., June 26.

understanding cross-domain deterrence, even though they focus first and foremost on understanding how the nuclear dimension of deterrence is evolving.

Second, one of the major shifts in priority in U.S. deterrence thinking occurring over the years since the Cold War ended is reflected in the increased attention paid to nuclear weapons states in regional settings, and to ways not only to deter such states but also to assure their neighbors, (many of whom are U.S. allies, that they do not need nuclear weapons to protect their interests against regional aggressors. This study places an emphasis on how the concept of *tailored* deterrence is evolving,[12] the different mindsets of regional aggressors, controlling escalation in regional crises, the growing importance of missile defenses, and new dynamics for a concept that in the Cold War was called *extended* deterrence (which then was especially prominent for the North Atlantic Treaty Organization [NATO]) and now is referred to in policy documents as *assurance.* Planning for assurance is a major feature of the evolving security environment.[13]

Third, even before al-Qaeda launched its attack on September 11, 2001 (known to history as 9/11), U.S. policy makers were aware of the possibility that nonstate terrorists might acquire nuclear weapons or other weapons of mass destruction (WMD) and use them against the United States, its allies, or other nations. This nuclear concern was intensified exponentially after 9/11. Countering nuclear terrorism and nuclear proliferation were elevated in priority in U.S. policy, eclipsing (many would argue) the traditional nuclear deterrence missions. The committee is aware of this fact and devoted attention to understanding deterrent requirements related to counterterrorism and nonproliferation planning.

The committee did not try to probe deeply into the nuclear weapons side of the equation. That would have required special clearances and a work schedule beyond the charter of the study. However, the committee was briefed on current plans. Today's U.S. nuclear stockpile consists of two nuclear weapons types for submarine-launched ballistic missiles (SLBMs), two others for ICBMs, and three (with multiple modifications) for airborne platforms.[14] The NWC, the senior body synchronizing requirements for nuclear weapons, has approved a "3+2 Strategy," which is the "long-term strategy to move toward a stockpile consisting of only three interoperable ballistic missile warheads deployed on both the SLBM and ICBM

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[12] See M. Elaine Bunn, 2007, *Can Deterrence Be Tailored?,* Washington, D.C., Institute for National Security Studies, National Defense University, January.

[13] The committee devoted much of its fact-finding to the regional dimension, reviewing literature, and receiving briefings from experts. It did not, however, have an opportunity to visit the regional combatant commands (as it did STRATCOM) to gain their perspectives on deterrence in regional settings.

[14] The current U.S. nuclear stockpile includes the W76 and W88 warheads for SLBMs, theW78 and W87 warheads for ICBMs, the B61 and B83 bombs, and the W80 warhead for air-launched cruise missiles.

legs of the triad and two air delivered warheads, (1) a gravity bomb deployable on both bombers and tactical aircraft" and (2) a warhead for a long-range stand-off (LRSO) capability ultimately to replace the air-launched cruise missiles (ALCMs).[15] Whether this strategy can be sustained with adequate funding over the long term remains to be seen.

Fourth, while this committee addressed tools, methods, and approaches appropriate to sizing the *delivery* systems, it did not extend its discussions to whether the same tools, methods, and approaches provide an analytically sound basis for determining the appropriate stockpile size and mix. Fifth and last, the committee understands that over the planned lifetime of U.S. Air Force and Navy nuclear delivery platforms and weapons, both continuity and change will be significant. Planning for continuity must also provide flexibility and options to respond to change, both geostrategic and technological, which could be very sudden and dramatic in the years ahead.

It was our great pleasure to work with the extremely dedicated and professional members of the committee during this study. We would like to single out committee members Michael Wheeler, Paul Davis, Stephen Walker, W. Peter Cherry, and Jerrold Post for their outstanding contributions as chapter leads. It is our hope that this report provides a useful service to DoD and the nation.

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Allison Astorino-Courtois, *Co-Chair*
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   Deterrence Military Capabilities in the
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[15] See B61 Life Extension Program and Future Stockpile Strategy, House Armed Services Committee Subcommittee on Armed Services, testimony of Donald L. Cook, Deputy Administrator for Defense Programs, NNSA, October 30, and 2013. Those hearings addressed the increasingly costly B61 life extension program and its place in the future stockpile strategy.

Acknowledgment of Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Kevin P. Chilton, U.S. Air Force (retired),
Raymond Jeanloz, University of California, Berkeley,
Michael E. Kassner, University of Southern California,
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C. Paul Robinson, Sandia National Laboratories (emeritus),
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Alan Washburn, Naval Postgraduate School, and
Larry D. Welch, Institute for Defense Analyses (emeritus).

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Stephen M. Robinson, University of Wisconsin,

Madison. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

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APPENDIXES

Acronyms

AFB	Air Force Base
AFGSC	Air Force Global Strike Command
AFSB	Air Force Studies Board
ALCM	air-launched cruise missile
BMD	ballistic missile defense
CAS	complex adaptive systems
COCOM	combatant command
CTBT	Comprehensive Nuclear Test Ban Treaty
DAAP	deterrence and assurance analysis program
DARPA	Defense Advanced Research Projects Agency
DoD	Department of Defense
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities
DSB	Defense Science Board
FYDP	Future Years Defense Program
IAEA	International Atomic Energy Agency
ICBM	intercontinental ballistic missile
IT	information technology

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JCIDS	Joint Capabilities Integration Development System
JCS	Joint Chiefs of Staff
JROC	Joint Requirements Oversight Council
LEP	Life Extension Program
LRSO	Long-Range Standoff (Missile)
MIRV	multiple independently retargetable reentry vehicle
MM	Minuteman missile
NATO	North American Treaty Organization
NNSA	National Nuclear Security Administration
NPR	Nuclear Posture Review
NPT	Nuclear Nonproliferation Treaty
NRC	National Research Council
NSA	National Security Agency
NSC	National Security Council
NWC	Nuclear Weapons Council
OSD	Office of the Secretary of Defense
PPBE	planning, programming, budgeting, and execution
RSAS	RAND Strategy Assessment System
SAC	Strategic Air Command
SALT	Strategic Arms Limitation Treaty
SLBM	submarine-launched ballistic missile
SNA	social network analysis
START	Strategic Arms Reduction Treaty
STRATCOM	Strategic Command
TOR	terms of reference
UN	United Nations
USD/AT&L	Under Secretary of Defense (Acquisition, Technology, and Logistics)
WMD	weapons of mass destruction

Summary

The United States developed and used nuclear weapons in the Second World War and, since the surrender of Japan, has maintained a nuclear capability to deter and influence the behavior of adversaries and assure allies. Over time, geopolitical developments have transformed what started as a bipolar world order after that war, which involved the United States and the Soviet Union and their respective allies, into the current multinodal global reality, in which nonstate and state actors play an important role. Since the early 1960s, the U.S. strategic nuclear posture has been composed of a triad of nuclear-certified long-range bombers, intercontinental ballistic missiles, and submarine-launched ballistic missiles. Also, since the early 1970s, U.S. nuclear forces have been subject to strategic arms control agreements. The large numbers and diversified nature of the U.S. nonstrategic (tactical) nuclear forces, which cannot be ignored as part of the overall nuclear deterrent, have decreased substantially since the Cold War. While there is domestic consensus today on the need to maintain an effective deterrent, there is no consensus on precisely what that requires, especially in a changing geopolitical environment and with continued reductions in nuclear arms. This places a premium on having the best possible analytic tools, methods, and approaches for understanding how nuclear deterrence and assurance work, how they might fail, and how failure can be averted by U.S. nuclear forces.

In a 2013 speech following negotiations for the New Strategic Arms Reduction Treaty (entry into force: February 5, 2011), President Obama took a further step and announced that the United States had "determined that we can ensure the security of America and our allies, and maintain a strong and credible strategic deter-

rent, while reducing our deployed strategic nuclear weapons by up to one-third…" and that he intended to "seek negotiated cuts with Russia to move beyond Cold War nuclear postures."[1] President Obama's announcement carried with it a series of complex conceptual and analytic challenges. For example, if nuclear weapons are to take a lesser role in U.S. security strategy, what role should that be? In which circumstances is it reasonable and credible to pose a nuclear threat? At lower levels of deployed nuclear weapons, which systems and postures are essential for maintaining a strong deterrent to attack by both known and unforeseen adversaries? What should be cut, and how is this to be done without causing harm to strategic stability in multiple areas of the globe? Which nuclear capabilities, if any, are needed to assure allies of U.S. commitment to their security? Each question is made all the more challenging when considered in light of U.S. fiscal austerity, global power shifts, and other changes currently under way in the international environment.

STUDY APPROACH AND CAVEATS

While this study of the Committee on U.S. Air Force Strategic Deterrence Military Capabilities in the 21st Century Security Environment was mutually requested by the Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering and the Assistant Chief of Staff of the Air Force for Strategic Deterrence and Nuclear Integration, the results are intended to inform the Air Force research enterprise as a whole, as well as the larger audience of stakeholders involved in issues of deterrence and assurance generally and nuclear deterrence and assurance in particular. During this study of analytic tools, methods, and approaches for strategic deterrence and assurance of adversaries and allies, it became apparent that no single tool, method, or approach could address the array of deterrence and assurance challenges the Air Force and the nation will face in coming years. It also became evident that there is a critical deficit in the Air Force capacity to sustain high-quality analysis in support of its newly broadened nuclear deterrence and assurance responsibilities. Namely, the Air Force lacks a means for organizing and ensuring the training necessary to build a cadre of methodologically savvy analysts conversant in nuclear deterrence and assurance issues. Simply put, regardless of the analytic tools it possesses, the Air Force has too few people with the personal experience and rigorous analytic training required to generate the analyses necessary to determine the nuclear force structures and postures most likely to be effective deterrents. Before discussing the specific items in the terms of reference and where

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[1] Executive Office of the President, Transcript of remarks by President Obama at the Brandenburg Gate, Berlin, Germany, June 14, 2013, http://www.whitehouse.gov/photos-and-video/video/2013/06/19/president-obama-speaks-people-berlin#transcript.

and how this study addresses them, the study's orientation to the issues and, thus, what is included and what is left out of this report are explained.

First, much of Cold War era deterrence theory and analysis assume a causal or nearly causal relationship between possessing massive physical power and being able to deter unfavorable actions. One of the results of this assumption has been that, until relatively recently, higher priority was given to developing tools, methods, and approaches for estimating physical effects of weapons than to the human perceptual aspects of deterrence and assurance.[2] Well-founded understanding of adversary and ally perceptions, motivations, and decision processes is a critical precondition for producing the types of analyses needed to support planning for nuclear capabilities relevant to assuring multiple actors across a variety of international circumstances. As a consequence, this study focuses on tools, methods, and approaches for understanding human behavior and does not address assessments of physical effects and capabilities.

Second, there are literally scores of analytic tools, methods, and approaches.[3] It would be neither reasonable nor useful to conduct a comprehensive review of all of them. Instead, the study leveraged the substantial expertise of the committee membership, previous reviews, and numerous briefings and discussions in workshops and committee meetings to identify a set of appropriate tools, methods, and approaches and assess their general applicability to deterrence and assurance issues, as well as the type of analytic role (e.g., data generation, decision support) for which each tool, method, and approach is best suited. Relatedly, this report does not suggest either a single or a set of silver bullets for addressing the range of issues confronting the Air Force, and nowhere does the report imply or state that computers or checklists might replace the human intellect.

Third, the report is not limited to nuclear deterrence or assurance. Of note, there do not appear to be standard definitions of basic deterrence-related concepts within the U.S. national security community. Theoretically, if not doctrinally, assurance of allies, together with deterrence of adversaries from nuclear use, or deterrence of other activities by way of nuclear threats are at the far ends of a spectrum of influence activities that concern the U.S. defense establishment. Moreover, some argue that attempting to consider nuclear deterrence in isolation from

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[2] Official recognition of the importance to deterrence and assurance of understanding human decision processing and perceptions is illustrated in *Joint Publication 1-02*, which states that deterrence is "the prevention from action by fear of the consequences … a state of mind brought about by the existence of a credible threat of unacceptable counteraction;" and the 2006 *Deterrence Operations Joint Operating Concept*, where "deterrence" equates to "decisive influence over [adversaries'] decision making" by increasing the costs associated with taking an action and decreasing the rewards and costs of restraint.

[3] National Research Council, 2013, *U.S. Air Force Strategic Deterrence Capabilities in the 21st Century Security Environment: A Workshop Summary*, The National Academies Press, Washington, D.C.

TABLE S-1 Items in the Terms of Reference (TOR) and Corresponding Recommendations

TOR Item	Response[a]
Item 1, Key Issues. Identify the broad analytic issues and factors that must be considered in seeking nuclear deterrence of adversaries and assurance of allies in the 21st century.	Key concepts, definitions, and issues presented in Chapter 2.
Item 2, Tools, Methods, and Approaches. Describe and assess tools, methods—including behavioral science-based methods—and approaches for improving the understanding of how nuclear deterrence and assurance work or may fail in the 21st century and the extent to which such failures might be averted or mitigated by the proper choice of nuclear systems, technological capabilities, postures, and concepts of operation of American nuclear forces.	Review of readily accessible analytic tools, methods, and approaches appears in Chapter 3, with an extended example in Appendix E. **Recommendation 2.** The Air Force should focus analytic enhancements in support of deterrence and assurance assessment on the human and human organizational factors at the heart of deterrence and assurance. The committee interpreted Items 2 and 3 of the TOR to mean that it should describe and assess analytic tools, methods, and approaches that would help both (1) in improving and understanding deterrence and assurance and (2) understanding how nuclear forces, posture, technological capabilities, and concepts of operations can improve prospects or mitigate failures. The committee and the Air Force understood that the study was not going to make recommendations about force structure and the like.

other deterrence considerations—to the degree that was possible during the Cold War—is increasingly difficult and likely to be shortsighted in the current security environment.

METHODOLOGY FOR RESPONDING TO THE TERMS OF REFERENCE

The recommendations discussed in this section are organized as they relate to the five items in the terms of reference (TOR). Briefly, these are (1) to identify key issues in 21st century deterrence and assurance analysis; (2) describe and assess analytic tools, methods, and approaches; (3) discuss how the Air Force could respond to deterrence and assurance needs, including suggesting an analytic framework; (4) suggest how the Air Force might evaluate and validate new tools, methods, and approaches; and (5) recommend specific classes of tools, methods, and approaches. All of the TOR are listed in the left-hand column of Table S-1.[4] How and where each item of the TOR is addressed in the report are described in

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[4] Appendix A also provides the TOR.

U.S. Air Force Strategic Deterrence Analytic Capabilities: An Assessment of Tools, Methods, and Approaches for the 21st Century Security E

S U M M A R Y

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TABLE S-1 Continued

TOR Item	Response[a]
Item 3, Framework. Discuss the implications for the Air Force and how it could best respond to these deterrence and assurance needs. Include in this discussion a framework for identifying the risks and benefits associated with different nuclear force postures, structures, levels, and concepts of operation.	A high-level deterrence and assurance task framework is presented in Chapter 4.

Recommendation 1. In support of senior Air Force leadership guidance, including the *Flight Plan for the Air Force Nuclear Enterprise*,[b] the Air Force should develop and maintain a comprehensive strategic deterrence analysis plan to identify the tasks that produce information required to organize, equip, and train Air Force nuclear deterrence and assurance forces and support combatant commanders.

Recommendation 2. The Air Force should focus analytic enhancements in support of deterrence and assurance assessment on the human and human organizational factors at the heart of deterrence and assurance.

Recommendation 3. The Air Force, working with its Service partners and the Department of Defense more generally, should pursue research on deterrence and assurance with a coherent approach that involves content analysis, leadership profiling, abstract modeling, and gaming and simulations as a suite of methods. It should organize its investments in analytic and other activities accordingly.

Recommendation 4. The Air Force analytic community should pursue methods of understanding and incorporating the concept of deep uncertainty.

The committee interpreted Items 2 and 3 of the TOR to mean that it should describe and assess analytic tools, methods, and approaches that would help both (1) in improving and understanding deterrence and assurance; and (2) in helping to understand how nuclear forces, posture, technological capabilities, and concepts of operations can improve prospects or mitigate failures. The committee and the Air Force understood that the study was not going to make recommendations about force structure and the like.

| Item 4, Evaluation. Recommend criteria and a framework for validating the tools, methods, and approaches and for identifying those most promising for Air Force usage. | Readily accessible analytic approaches and methods are reviewed in Chapter 3, with an extended example in Appendix E. |

Continued

TABLE S-1 Continued

TOR Item	Response[a]
Item 5, Tools. Recommend an appropriate mix of the classes of analytical tools affordable in today's austere financial climate and identify what can be planned for by the Air Force as future improvements to this mix if and should defense budgets increase or decrease.	The choice of the *appropriate* analytic method or approach is fully dependent on the type of analytic question posed; the data and time available for analysis; and the quality of results desired. Beyond what was presented in *Concepts and Analysis of Nuclear Strategy Framework Report*, there is no way to correctly recommend specific approaches or tools without these details.[c]
	Recommendation 5. Air Force analysis supporting nuclear deterrence and assurance issues should draw from a suite of appropriate methods, including hybrid methods that combine and integrate different methods.
	Recommendation 6. The Air Force should maintain its cadre of career analytic professionals (both civilian and military) with expertise in nuclear deterrence and assurance strategy to improve Air Force support to Combatant Commanders' planning and operations, since methods can inform, but never replace, the judgment of expert analysts. This could be facilitated by specific treatment of analysts in Vector 5 of the *Flight Plan for the Air Force Nuclear Enterprise.*[b]

[a] Chapter 4 provides suggestions for Air Force organizations that would have roles in implementing the report's recommendations.

[b] Air Force, 2013, *Flight Plan for the Air Force Nuclear Enterprise,* Washington, D.C. The TOR are contained in Appendix A.

[c] B. Bragg, ed., 2011, *Concepts and Analysis of Nuclear Strategy Framework Report,* prepared by NSI, Inc., for the Strategic Multilayer Assessment Office, Department of Defense, http://nsiteam.com/publications/.

the right-hand column of Table S-1 and discussed in more detail in the next section. Supplemented by the discussions and examples provided in Chapters 2 and 3 and supporting appendixes, the individual recommendations should be read as aspects of an overarching theme of the report, which is the need for the Air Force to refocus and sustain its intellectual capital in the areas of deterrence and assurance in general and political understanding of nuclear issues in particular. Table S-2 provides a complete list of report observations, findings, and recommendations mapped against the TOR.

TABLE S-2 Complete List of Observations, Findings, and Recommendations

Terms of Reference Item	Observation, Finding, Recommendation
Item 1, Key Issues. Identify the broad analytic issues and factors that must be considered in seeking nuclear deterrence of adversaries and assurance of allies in the 21st Century.	Observation 2-1 (Norms of Behavior), p. 35 Finding 2-1 (Deep Uncertainty), p. 38 Observation 2-2 (Missile Defense), p. 40 Observation 2-3 (Extended Deterrence), p. 41 Observation 2-4 (Dissuasion by Denial), p. 41 Finding 2-2 (Analytic Framework), p. 46
Item 2, Tools, Methods, and Approaches. Describe and assess tools, methods—including behavioral science-based methods—and approaches for improving the understanding of how nuclear deterrence and assurance work or may fail in the 21st century and the extent to which such failures might be averted or mitigated by the proper choice of nuclear systems, technological capabilities, postures, and concepts of operation of American nuclear forces.	Observation 3-1 (Building Air Force Subject Matter Expertise), p. 52 Finding 3-1 (Long-Term Career Development), p. 52 Observation 3-2 (Effective War-Gaming), p. 62 Finding 3-2 (Psychological Framework), p. 65 Finding 3-3 (Tailoring Key Messages), p. 66 Observation 3-3 (Alternative Adversary Models), p. 74 Observation 3-4 (Modeling and Limited Rationality), p. 76 Finding 3-4 (Tailored Deterrence), p. 78 Observation 3-5 (Fostering Cross-Domain Collaboration), p. 83 Recommendation 2 (Actor and Multiactor Modeling), p. 93
Item 3, Framework. Discuss the implications for the Air Force and how it could best respond to these deterrence and assurance needs. Include in this discussion a framework for identifying the risks and benefits associated with different nuclear force postures, structures, levels, and concepts of operation.	Finding 2-2 (Analytic Framework), p. 46 Recommendation 1 (Analysis Plan), p. 92 Finding 3-2 (Psychological Framework), p. 65 Finding 3-3 (Tailoring Key Messages), p. 66 Recommendation 2 (Actor and Multiactor Modeling), p. 93 Finding 3-4 (Tailored Deterrence), p. 78 Recommendation 3 (Research), p. 94 Finding 2-1 (Deep Uncertainty), p. 38 Recommendation 4 (Deep Uncertainty), p. 96
Item 4, Evaluation. Recommend criteria and a framework for validating the tools, methods, and approaches and for identifying those most promising for Air Force usage.	Observation 3-1 (Building Air Force Subject Matter Expertise), p. 52 Finding 3-1 (Long-Term Career Development), p. 52 Observation 3-2 (Effective War-Gaming), p. 62 Finding 3-2 (Psychological Framework), p. 65 Finding 3-3 (Tailoring Key Messages), p. 66 Observation 3-3 (Alternative Adversary Models), p. 74 Observation 3-4 (Modeling and Limited Rationality), p. 76 Finding 3-4 (Tailored Deterrence), p. 78 Observation 3-5 (Fostering Cross-Domain Collaboration), p. 83 Recommendation 2 (Actor and Multiactor Modeling), p. 93

Continued

TABLE S-2 Continued

Terms of Reference Item	Observation, Finding, Recommendation
Item 5, Tools. Recommend an appropriate mix of the classes of analytical tools affordable in today's austere financial climate and identify what can be planned for by the Air Force as future improvements to this mix if and should defense budgets increase or decrease.	Finding 3-4 (Tailored Deterrence), p. 78 Recommendation 5 (Methods), p. 96 Finding 3-1 (Long-Term Career Development), p. 52 Recommendation 6 (Analysts), p. 97

Key Issues in 21st Century Deterrence and Assurance Analysis

Item 1 of the terms of reference was addressed by extensive committee debate and by input from subject matter expert speakers in a variety of disciplines, ranging from the new and eclectic, such as *neurodeterrence,* which combines advances in neurobiology and study of deterrence and threat behaviors, to more familiar political and technical experts with decades of experience in arms control and management of the nuclear enterprise. The "broad analytic issues and factors" gleaned from these sessions appear throughout Chapter 2, which suggests and discusses three broad categories into which recommended themes fall (see Table S-3). Chapter 2 also lays out "stressful questions" associated with peer, near-peer, regional, and nonstate challenges, as well as important deterrence and assurance issues like nuclear command and control, force modernization, air and missile defense, and geostrategic and technological changes not directly addressed in this study.

Description and Assessment of Analytic Tools, Methods, and Approaches

The first component of Item 2 of the terms of reference—assessing tools, methods and approaches—was addressed in light of the issues identified in Chapter 2 as critical to 21st century deterrence and assurance analysis. A summary of reviewed methods and tools appears in Chapter 3 with further illustration in Appendixes D and E. Given the time limitation of this study, the second element of this item was not addressed. Understanding the psychological mechanisms that govern what deters and what assures are preconditions for assessment of the attributes of various nuclear systems, technological capabilities, postures, and concepts of operation of U.S. nuclear forces. Consequently, improving the Air Force's capacity to account for and use the types of actor- and decision-unit-specific information needed to tailor deterrence and assurance messages and activities is a necessary requirement.

U.S. Air Force Strategic Deterrence Analytic Capabilities: An Assessment of Tools, Methods, and Approaches for the 21st Century Security E

SUMMARY

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TABLE S-3 Focus Issues

Category	Theme
Understanding deterrence and influence in modern contexts	Increased importance of general deterrence and cumulative deterrence.
	The need to move beyond strict rational-actor assumptions.
	More complex regional and escalatory dynamics.
	The role of dissuasion by denial.
Planning and analysis	Dealing with expanded uncertainty.
	The relationship between defense and assurance.
	Anticipating the unexpected, geopolitically and technologically.
Attending to basics	Maintaining safe, secure, and effective forces.

Doing so will allow the Air Force to better calculate the specific regional capabilities it will need to provide to allow maximum flexibility to identify and influence activities likely to be most effective in present conditions and those it may face in the future. In addition, improved understanding of the human factors involved in deterrence and assurance situations may facilitate earlier recognition of potential deterrence or assurance failures.

The Air Force needs to plan now to contribute the capabilities required to deter and assure decades into the future. Further, the Air Force would be the obvious advocate for a U.S.-government-wide program to develop systematic, multidisciplinary *generalized* leadership and decision-making constructs and models to improve the robustness of that planning by anticipating the range of potential behaviors, consequences, and situations that may be faced. This will also provide a baseline set of regional deterrence and assurance environments that could help analysts assert how current and future leadership changes might affect the deterrence and assurance environment. Finally, the Air Force would ideally explore the notion of "deep uncertainty" in planning support analyses in order to expand analysts' awareness of future uncertainties and the types of circumstances most prone to significant unintended consequences. [5]

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[5] Deep uncertainty refers to "materially important uncertainties that cannot be adequately treated as simple random processes and that cannot realistically be resolved at the time they come into play" (Paul K. Davis and James P. Kahan, 2007, *Theory and Methods for Supporting High Level Military Decisionmaking,* RAND Corp., Santa Monica, Calif., http://www.rand.org/pubs/technical_reports/TR422.html, p. 6).

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10   U.S. Air Force Strategic Deterrence Analytic Capabilities

Suggested Analytic Framework for Air Force Deterrence and Assurance Needs

A high-level deterrence and assurance task framework is presented in Chapter 4. Awareness of the web of complexities involved in managing the multitude of overlapping deterrence and assurance issues led the formulation of Recommendation 1. Namely, that the Air Force design and pursue a coordinated deterrence and assurance analysis program—something that does not currently exist—to guide its efforts. Recommendations 2, 3, and 4 refer to some of the attributes that a deterrence and assurance analysis program should have. In addition, the program might include tracks to refine and apply the psychologically based concepts at the heart of deterrence and assurance; to encourage practitioner-academic dialog to facilitate practitioner access to academic strategic studies on the one hand and educate academics on operational priorities and constraints in the military setting on the other; to institutionalize and integrate ongoing efforts across the Air Force, including the Air Force Global Strike Command, the Strategic Command (STRATCOM), and elsewhere; and, finally, to train a cadre of deterrence and assurance analysts conversant in multiple analytic methods and approaches.[6]

Such a program would benefit the Air Force directly by providing a guide for developing the types of robust analyses currently lacking, but necessary to underpin and defend Air Force capabilities. The recommended deterrence and assurance analysis program would also provide the means for coordinating and monitoring analytic projects across the Air Force, limiting both (1) costs associated with duplicate independent efforts and (2) overreliance on traditional deterrence metrics—for example, damage expectancies and comparative weapons counting, which are less relevant in the current security environment.

Air Force decision makers, analysts, and, most critically, consumers of deterrence and assurance analyses may also consider adopting the habit of considering the limitations and appropriate uses of any analytic tool, method, and approach, along with the results such use might generate. Like hammers, saws, and other carpenter's tools, analytic methods have appropriate and inappropriate uses according to the nature of the task to which they are put. As with using hand tools to build a table, well-executed analysis of issues of human perception and behavior require integrated use of multiple methods and tools to produce robust and defensible results. Using tools properly and in tandem can significantly improve analytic breadth, accuracy, and insight. As such, the approach to deterrence and assurance analysis adopted by the Air Force would ideally include as a specific goal

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[6] Officials at STRATCOM discussed their general awareness of efforts to reinvigorate deterrence thought and develop deterrence experts, including educational courses offered at the Air Force Nuclear Weapons Center, establishment of a Deterrence and Assurance Working Group, and a proposed nuclear fellows program.

the careful integration of analytic techniques. Combining methods in a planned and coordinated way can also help refine analyses over time.[7]

Methods for Air Force Evaluation and Validation of Tools, Methods, and Approaches

Rather than propose a static set of deterrence and assurance tools, the report identifies factors that might be used to guide a multiyear, multimethod research agenda. [8] Moreover, the task of providing a framework for "validating" tools became both less relevant and exponentially more complex with the report's focus on tools, methods, and approaches tied to better understanding of the impact of perceptual factors as opposed to capability factors on deterrence and assurance.[9] Where human behavior is the subject of concern, there are two types of validity that must be tested: internal and external. Internal validity refers to the internal logic of the model and the degree of confidence that it actually taps into and explains the underlying construct that the researcher intends—for example, the psychological mechanisms that account for decisions to forego benefits in light of costs and thus be deterred from taking an action. Implicit in this is that the model is a comprehensive representation of that construct. External validity refers to the degree to which a model or tool is applicable beyond the particular circumstance for which it was built—for example, whether a model explaining Russian decision making would also apply to China. The means of validity testing, or validation, however, vary according to the specific tool, method, or approach used. Thus, while

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[7] Integrating analytic methods need not be a costly or onerous undertaking in order to produce valuable results. In many cases, the output of one approach fits perfectly into or can help frame the required input of another. For example, social network analysis can identify key decision makers who should be subject to leadership profiling and other decision analyses. Hypotheses regarding the strategic interactions of regional adversaries derived from game theoretic analysis and case studies can be further tested in series of human (war) games, and so on. Table 3-1 in Chapter 3 illustrates the general mixes of the methods reviewed for this study. For a thorough discussion of integrating multiple analytic techniques for deterrence analysis, see Office of the Secretary of Defense Multi-layer Analysis Deterrence Subgroup A Report: Deterrence-Supporting Approaches and Comparative Analysis and Integration Recommendations, June 30, 2009.

[8] It should be noted, however, that a nuclear force posture comparison modeling project undertaken by STRATCOM (J5) for the 2010 Nuclear Posture Review may serve as the core of a development project in this area.

[9] It is important to note that, although the words used are often the same, tools, methods, and approaches for issues of human behavior are subject to different notions of what constitutes a model and tool "validation" than is typical in engineering and other scientific disciplines. These concepts can also be different from what analysts often mean by "validation." For example, How well has the model performed in the past? or How much confidence should I have in what it tells me? are often what analysts (as opposed to model builders) mean when they refer to "validating" an analytic model, framework, or tool.

no general framework for validation is suggested in this report, where appropriate, these issues are treated in the reviews of methods presented in Chapter 3 and Appendixes D and E.

Recommending Specific Classes of Tools, Methods, and Approaches

As noted above, the number and variety of analytic tools, methods, and approaches is enormous. Each of those reviewed for this report is relatively mature and accessible to the Air Force, if not directly to analysts, then via experts and companies that can easily be found to apply them. The complexity of planning and analysis for nuclear deterrence and assurance that will confront current and subsequent generations is likely to continue to increase exponentially. Paradoxically, rapid advances in communications technologies means that conveying deterrence and assurance messages will become increasingly difficult to control as counter-communications are easier to issue and perceived U.S. intentions become subject to literally global interpretation. The relative lack of exposure of many of today's analysts to nuclear-related issues may make it premature for the Air Force to consider significant investment in classes of tools, methods, and approaches and certainly, in particular, in tools needed to conduct deterrence analyses now and into the future. Instead, the Air Force would do well to focus on its people first. This will ensure that Air Force personnel are able to provide the most credible and analytically based perspectives in both Air Force and joint decision fora, and that the Air Force is able to provide leaders with informed and reliable reviews and critiques of alternative force structures, sizing, and deployment options.

1

Introduction

THE EVOLVING 21ST CENTURY SECURITY ENVIRONMENT

Path to the Present

On June 14, 2013, President Obama spoke in Berlin. He used the occasion to announce the completion of a two-year review of American nuclear weapons policy and his related decisions on the next steps in nuclear arms control. Some 75 years before the President's Berlin speech, two German scientists, working in a laboratory in the suburbs of a Berlin not far from where he spoke, achieved nuclear fission. That passage of time (75 years) suggests one time frame appropriate for thinking about the security environment. Although not easily adapted to security planning, a 75-year horizon does begin to approach the life spans of major strategic weapons systems such as the B-52 bomber and the Minuteman (MM) III missile.[1] In the future as in the past, however, rapid political, economic, and technological change may alter priorities in national and thus in Air Force deterrence considerations.

During a period of extreme national emergency in the middle of the 20th century, the United States partnered with its British allies in a secret, expensive, risky, and urgent project, which created the world's first nuclear weapon. By the time the bomb was available in 1945, Germany had surrendered but Japan was

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[1] The B-52H and MM III have been in the force since the 1960s. They of course have been refurbished and modified over time to extend their lives and/or improve their performance, a process that continues today. It is thought that they can be sustained until about 2030 (and perhaps beyond, if necessary).

still at war. The United States used the bomb with the intent to shock Japan into surrendering sooner rather than later so as to avoid the need for an invasion of the Japanese main islands.[2]

During a brief postwar interregnum, the United States proposed the Baruch Plan to place nuclear weapons under international control. The plan failed as the Cold War set in. For the next quarter century, the world was caught in a largely bipolar power struggle, with nuclear weapons at the heart of the competition. The evolution of American deterrent strategy (and its supporting concepts) reflected that reality.[3]

In waging the Cold War, the United States developed a large nuclear enterprise to design, test, and produce nuclear weapons. At its peak in the mid-1960s, the U.S. nuclear stockpile rose to over 31,000 weapons, including deployed and nondeployed weapons.[4] Strategic weapons were deployed briefly on a quadrad of delivery systems, which included intercontinental-range cruise missiles,[5] and then on a triad of long-range bombers,[6] intercontinental ballistic missiles (ICBMs),[7]

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[2] Although there is scholarly debate about how to weigh the different factors that led to Japan's surrender, the decision came rapidly after the deployment of nuclear weapons. The first atomic bomb was dropped on Hiroshima on August 6, 1945. A second bomb was used on Nagasaki three days later. Hostilities ceased on August 14, 1945, followed by Japan's unconditional surrender.

[3] There were a succession of presidential guidance documents issued during the nine American administrations that governed the evolution of Cold War American deterrence planning: National Security Council (NSC) papers NSC-68 (1950), NSC 162/2 (1953), and NSC 5906/1 (1959), National Security Decision Memorandum 242 (1974), Presidential Directive 59 (1980), and National Security Decision Directive 13 (1981). Academics tend to look at the surface of change, using phrases like massive retaliation, flexible response, and mutual assured destruction. Those are phrases grounded in the realities of the time (and especially the desire of new administrations to distinguish their policies from those of their predecessors), but they tend to oversimplify the evolution of American nuclear deterrence policy by suggesting sharp divides, where in fact there was a more gradual evolution and considerable continuity. For instance, the Eisenhower administration already was moving toward flexible response by the time NSC 5906/1 was issued in 1959, and the Kennedy administration kept NSC 5906/1 as policy until it was rescinded in 1963, toward the end of Kennedy's presidency. In practice, the classified documents often codified changes that already were under way in American policy and strategy. Those changes are reflected in official speeches, news releases, internal memoranda, and the like.

[4] Department of Defense (DoD), 2010, *Fact Sheet: Increasing Transparency in the U.S. Nuclear Weapons Stockpile,* Washington, D.C., May 3.

[5] The early intercontinental cruise missile, the SNARK, went on alert in March 1960. It was retired soon after its initial deployment but not before the *USS George Washington* Polaris missile submarine left on its inaugural deterrent patrol in November 1960.

[6] Strategic Air Command (SAC) bombers initially were not on continuous 24-hour (24/7) alert. From November 1956 to June 1957, SAC began experimenting with the practice of keeping bombers and tankers on continuous 24-hour alert. The experiments showed that ground alert was feasible, and a large percentage of the SAC bomber force went on routine day-to-day alert in late 1957. They continued this practice throughout the Cold War, and for 8 years, during the crisis atmosphere of the 1960s, a part of the bomber force also was on 24/7 airborne nuclear alert.

[7] The first U.S. ICBM, an Atlas missile, went on alert in October 1959.

and submarine-launched ballistic missiles launched from nuclear-powered submarines.[8] The United States also deployed a wide variety of so-called "tactical" nuclear weapons at sea (for land, sea, and undersea warfare), with Army missile and tube artillery units and special operations groups, on ground-based Air Force aircraft, and on missiles designed for air and ballistic missile defense.[9] The United States also extended a nuclear umbrella to allies.[10] It pursued nuclear arms control regimes, which sought to stabilize the bipolar competition with the Soviet Union,[11] to constrain (and, where possible, prevent and roll back) nuclear proliferation while allowing the pursuit of peaceful applications of nuclear energy,[12] and to protect the environment.[13] And notwithstanding the speculation of some early nuclear

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[8] The first U.S. fleet ballistic missile submarine, the *USS George Washington,* deployed on its first operational patrol in November 1960. Earlier, the Navy had a submarine equipped with a nuclear-armed cruise missile, the Regulus, which had a relatively short range (less than 1,000 km) and could only be launched while the submarine was surfaced.

[9] The United States developed and deployed a large variety of tactical nuclear weapons for a variety of platforms: aircraft, artillery, missiles of various ranges, torpedoes, mines, and so forth. See Amy F. Woolf, 2012, *Nonstrategic Nuclear Weapons,* Congressional Research Service, Washington, D.C., December 19.

[10] In 1949 the United States was a founding member of the North Atlantic Treaty Organization (NATO). U.S. nuclear forces were a vital part of NATO planning from its inception. The first NATO strategy-planning document, Standing Group 1, was circulated to the allied chiefs of staff for comment in early October 1949. It assumed that U.S. nuclear weapons would be used at the outset of any NATO war with the Soviet Union.

[11] During the Cold War, the United States negotiated a network of bilateral nuclear arms agreements with the Soviet Union. In 1972, the United States completed the Strategic Arms Limitation Treaty (SALT) I talks, resulting in an interim agreement on offensive strategic arms and the Anti-Ballistic Missile Treaty; the interim agreement was followed by SALT II (signed in 1979 and observed until 1986, although never ratified); Intermediate Nuclear Forces (signed in 1987 and still in force); and the Strategic Arms Reduction Treaty, START I (signed in 1991 before the Soviet Union collapsed and brought into force following the Lisbon Protocols of 1992). Following the Cold War, the United States negotiated START II, which was signed in January 1993 and repudiated by the Russian Federation when the United States unilaterally withdrew from the Anti-Ballistic Missile Treaty in 2002, roughly coincident with negotiating the Treaty of Moscow (which used START I verification provisions). The Obama administration entered office shortly before START I expired. The New START treaty was signed in 2010 and entered into force the following year.

[12] President Eisenhower's Atoms for Peace speech to the United Nations in December 1953 led to the creation a few years later of the International Atomic Energy Agency (IAEA). In 1965, President Johnson made the decision that the United States would make it a top priority to pursue a Nuclear Non-Proliferation Treaty (NPT). By 1968, the NPT was signed, although its entry into force was delayed until 1970 because of the political environment following Russia's invasion of Czechoslovakia. The NPT was extended indefinitely in 1995 and remains in force today, although some believe its future is problematic if a new wave of proliferation begins.

[13] In 1954, an American thermonuclear test contaminated a Japanese fishing trawler, helping spark a worldwide movement seeking the end of nuclear testing. The United States entered into nuclear testing talks with Russia and Britain in 1958. The talks cut across security and environmental issues

strategists that the awesome power of nuclear weapons merely by their existence made major war obsolete, the United States fought major regional conventional wars (Korea, Vietnam) where nuclear weapons cast a shadow over but were not employed in the conflicts.

The Berlin Wall fell in 1989, and by the end of 1991, the Soviet Union had dissolved. Although there were residual actions required to record the transition (including the question of who would inherit the Soviet Union's nuclear weapons), for all practical purposes the Cold War was over.

The above discussion presents an incomplete picture of a complex environment over the almost 50 years within which U.S. nuclear weapons policy and strategy evolved during the Cold War. Another potential time span for the committee's deliberations is 25 years (roughly the time that has passed since the end of the Cold War), which, for purposes of deterrence and assurances, spanned a radically different geopolitical world.

As the Cold War was ending, another nuclear era was unfolding. In August 1990, Iraq invaded Kuwait. The United States assembled a coalition to reverse Iraq's aggression, and following the First Gulf War, helped organize an international inspection regime to dismantle Iraq's weapons of mass destruction (WMD). The new inspection regime revealed how far Iraq had advanced toward developing a nuclear weapons program, covertly and behind the veil of seemingly legitimate nuclear activities subject to then-routine IAEA inspections. Coinciding as it did with the end of the Cold War, this revelation helped shift U.S. attention toward regional aggression and the dangers posed by nuclear weapons proliferating into the hands of leaders like Saddam Hussein.[14]

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and also came to be seen as a mean of restraining further proliferation. Formal agreements followed: the Limited Test Ban Treaty (1963); the Threshold Test Ban Treaty (1974), and the Peaceful Nuclear Explosions Treaty (1976), which were observed but did not come into force until the negotiation of verification protocols in 1990. At the transition from the Cold War, Congress first imposed a moratorium on further American nuclear testing (Hatfield-Exon-Mitchell Amendment, 1992), and the Clinton administration then championed Comprehensive Nuclear Test Ban Treaty (CTBT) talks, which began in 1994 and resulted in opening a treaty for signature in 1996. The United States was the first to sign, but in October 1999, the Senate rejected the treaty. The CTBT regime remains on the books and, arguably, has created new norms, but it has yet to formally enter into force.

[14] For the Air Force, the First Gulf War and the subsequent enforcement of the no-fly zone in Iraq led to a cycle of continuous wartime footing and expeditionary operations that characterized the 1990s and beyond. As for Iraqi WMD, they of course figured prominently in the controversial U.S. decision in 2003 to intervene militarily in Iraq.

That shift was reflected in American nuclear policy and priorities for deterrence and assurance.[15] It coincided with a decade of relative American prosperity, with the explosive development of new technologies for military application (e.g., information, precision strike) and with a new age of globalization. Washington championed the development of "net-centric" military operations, which many, but not all, believed had radically transformed warfare. This was an era of U.S. strategic euphoria. It was, some have argued, our unipolar moment in history. It also was a decade when China continued its slow, steady growth.

The United States' strategic euphoria was shattered on September 11, 2001, when a small group of al-Qaeda terrorists married crude technologies (box cutters) with modern high-technology devices (four fuel-laden jet passenger aircraft) to destroy the World Trade Center, strike and severely damage the Pentagon, and come close to attacking another iconic and high-value target in Washington, D.C. (some speculate it was the White House, others the Capitol). In a matter of hours, security policy shifted radically. Countering nonstate terrorism became the highest near-term priority, with ramifications that continue today.

The United States reorganized its institutions, reoriented its military operations, and went to war, first in Afghanistan, then in Iraq, and globally against al-Qaeda and its affiliates. The threat of nonstate terrorists acquiring and using a nuclear weapon dominated Washington's strategic concerns and coincided with a focus on homeland security and on regional (vice global) problems. Fears that Iraq was reconstituting its nuclear program, and nuclear proliferation in North Korea,[16]

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[15] President William Jefferson Clinton took office in 1993 as the first post-Cold War American president. Proliferation of WMD to rogue states became a priority for his administration. In December 1993, in a speech at the National Academy of Sciences, Secretary of Defense Les Aspin announced a counterproliferation initiative that joined nonproliferation as a U.S. strategy. Counterproliferation concerns quickly were reflected in a new emphasis on ballistic missile defenses to counter the missile programs of the regional rogues.

[16] North Korea (formally known as the Democratic Peoples' Republic of Korea, or DPRK) lost confidence in its Cold War patron when, in September 1990, the Soviet Union announced it would establish diplomatic relations with South Korea (the Republic of Korea, or ROK). The end of the Cold War turned North Korea's world upside down. In 1991, a North–South denuclearization agreement was concluded between the two Koreas along with a North–South reconciliation agreement. Both Koreas were admitted to the United Nations (UN) in 1992, and North Korea established diplomatic relations with South Korea. In the context of continuing insecurity and negotiating tactics, North Korea continued to pursue its nuclear weapons and missile programs, and a complicated web of regional negotiations began. In 1993, North Korea announced it was withdrawing from the NPT. This led to a re-energized American initiative that resulted in the Agreed Framework, which was signed in 1994, but which would collapse in 2002. In October 2006, North Korea conducted its first nuclear test. It remains U.S. policy to roll back the North Korean nuclear program, but there is considerable uncertainty whether that can ever succeed. This has placed a premium on U.S. security assurances to North Korea's neighbors, Japan and South Korea, and on ways to make those assurances credible.

in South Asia,[17] and in Iran,[18] became major concerns. Meanwhile, China continued its steady growth, and Russian policy took a sharp turn after 2000 under the leadership of Vladimir Putin toward a more confrontational approach to the West.

This was the world inherited by President Obama when he took office in January 2009, in the midst of a major global economic crisis. Within weeks of taking office, in a speech in Prague in April 2009, the President unveiled an ambitious agenda to reduce nuclear weapons. The new agenda was greeted with great enthusiasm in many parts of the world and contributed to President Obama receiving the Nobel Peace Prize later in the year.

The Prague speech was followed by other actions, including a new national security strategy (2010), a range of new accompanying strategy documents in the Pentagon,[19] a New START treaty (signed and ratified in 2010), a new Nuclear Posture Review (2010), and a new strategy for modernizing the nuclear stockpile

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[17] In 1974, 10 years after the first Chinese nuclear test, India conducted what it called at the time a peaceful nuclear explosion (essentially, an underground test). China and India had fought a brief but intensive border war in 1962 and had major unresolved border problems. India's neighbor, Pakistan, began its own covert nuclear weapons program, which gained notoriety not only because of regional implications but also because of the covert nuclear trafficking network established by the Pakistani scientist A. Q. Khan. In 1998, India and Pakistan both conducted nuclear weapons tests, which they announced to the world. The nuclear arms race between these two rivals is a continuing source of concern, as are such possibilities as political change in Pakistan that could bring a radical Islamic government to power and Pakistan's security arrangements with Saudi Arabia (some speculate that if Iran goes nuclear, Saudi Arabia will get nuclear weapons from Pakistan).

[18] The United States has a complicated political relationship with Iran, dating to the Second World War. In 1953 the United States supported a coup that kept the Shah in power, and in 1957, it began helping the Shah develop a nuclear program for peaceful purposes under the Atoms for Peace framework and IAEA inspections. Iran signed the NPT in 1968 and ratified it 2 years later. In 1979, the Shah was overthrown and an Islamic government was established in Iran. Relations with the United States deteriorated sharply when Iran seized U.S. diplomats twice in the same year, the second time holding them hostage for over a year. Iran fought a bloody war with Iraq from 1980 to 1988, which included massive missile attacks on Iranian cities and Iraqi use of chemical weapons against Iran, which the international community tolerated. In 2002, an Iranian dissident group revealed the existence of secret nuclear facilities under construction in Iran. Iran has maintained that its program is exclusively peaceful. That is disputed by much of the international community. The United States has orchestrated a complicated diplomacy of sanctions and talks, to try to resolve the Iranian challenge while keeping the option of military action against Iran open. Israel, which took unilateral action against the Iraqi nuclear program with its strike on the Osirik reactor in 1981, watches the situation warily, as does Saudi Arabia, where there have been statements that if Iran goes nuclear, Saudi Arabia will as well. This committee devoted a considerable time to trying to understand better the Iranian challenge and its implications for this study.

[19] The National Security Strategy guides preparation of the Defense Secretary's National Defense Strategy and its associated Quadrennial Defense Review and of the Chairman of the Joint Chiefs of Staff's National Military Strategy. For discussion of these reports, and their basis in legislation, see C. Dale, 2013, *National Security Strategy: Mandates, Execution to Date, and Issues for Congress,* Congressional Research Service, Washington, D.C.

(2012). This provides the contextual prologue to President Obama's speech in Berlin in June 2013.

The President's Berlin speech and a nine-page report on the nuclear employment strategy of the United States, which was released in Washington to coincide with the Berlin speech, reaffirmed the key objectives of the 2010 Nuclear Posture Review (NPR) and their implicit prioritization. One of the decisions especially relevant to this study was to maintain a nuclear triad and to support continued NATO deployments.

Issues Moving Forward

This study acknowledges the policymakers' expectation that U.S. nuclear forces will continue to be important in both security matters and international relations. In the words of the NPR,

> As long as nuclear weapons exist, the United States must sustain a safe, secure, and effective nuclear arsenal—to maintain strategic stability with other major nuclear powers, deter potential adversaries, and reassure our allies and partners of our security commitments to them.[20]

The administration also has made clear that the United States will continue seeking to "reduce the role of nuclear weapons in deterring nonnuclear attacks," consistent with its security assurances to others and with continued efforts at negotiating further numerical reductions in nuclear arsenals. [21]

Looking forward, this study takes note of what has changed that affects deterrence and assurances, and the analytic approaches needed to support sound deterrence and assurance choices. The principles of deterrence and assurance have not changed, but other factors have.

First, the international context has changed and continues to change. The committee looked at many factors, but found several compelling in their importance for understanding deterrence requirements. There are more states that either are nuclear armed or that could become nuclear armed if they chose. Nonstate terrorists seeking nuclear weapons are a reality. Conventional weapons are vastly more precise than before. Modern warfare is changed by the overlapping effects of conventional, chemical, biological, nuclear, cyber, and space capabilities. And the balance of power between the United States, Russia, and China is shifting constantly. Added to all this is the potential for multiparty conflicts, including conflicts among regional nuclear actors other than the United States.

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[20] Department of Defense, 2010, *Nuclear Posture Review,* Washington, D.C.
[21] Ibid.

Second, while the need for a U.S. nuclear force capable of deterring Russia and China from executing an existential attack on the U.S. homeland remains, the possibility of regional crises escalating to the use of (or threatened use of) theater nuclear weapons has increased. The latter possibility demands increased examination by U.S. military planners and political leaders.

Finally, the fiscal environment in which the United States moves to sustain an effective nuclear deterrent is currently daunting, even though U.S. nuclear forces have been reduced to a small fraction of the defense budget.[22] During the Cold War, the nuclear deterrence capabilities acquired by the United States constituted a defensible and sound investment to overcompensate, given the vast and inevitable uncertainties about adversary nuclear intentions and capabilities. In recent decades, U.S. nuclear forces have been a lower priority for national leaders, and analysis and investment in nuclear deterrence have declined. Major programmatic decisions have been postponed and options reduced. The United States does not have the luxury of robustly and redundantly hedging against an uncertain nuclear future. Resources are constrained. This suggests that the analytic framework the United States needs to sustain 21st century deterrence needs to be richer and more refined than ever before.

Capabilities are important, force levels matter, and the increasing costs of nuclear systems cannot be ignored, but difficult decisions can be made better through sound analysis.

ORGANIZATION OF THE REPORT

The remainder of the report is structured as follows. Chapter 2 defines concepts, raises issues, poses problems, and indicates the themes that those involved in assessing U.S. deterrence and assurance issues need to consider. The discussion makes clear just how complex the challenges are but ultimately converges

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[22] The fiscal environment for beginning and carrying through an expensive modernization program for U.S. nuclear forces remains highly uncertain. Budget battles between Congress and the administration often force DoD to cut funds from modernization accounts in order to fund operations and maintenance, in effect trading future capabilities for near-term readiness. This is happening at a time when almost all nuclear delivery systems and the weapons they carry must be modernized or replaced over the next two decades. For background, the committee consulted the following: Congressional Budget Office, 2013, *Projected Costs of U.S. Nuclear Forces: 2014 to 2023,* Washington, D.C.; J.B. Wolfsthal, J. Lewis, and M. Quint, 2014, *The Trillion Dollar Nuclear Triad: US Strategic Nuclear Modernization Over the Next Thirty Years,* James Martin Center for Nonproliferation Studies, Monterey, Calif.; and T. Harison, 2013, *Chaos and Uncertainty: The FY2014 Defense Budget and Beyond,* Center for Strategic and Budgetary Analysis, Washington, D.C.

on suggested directions. Chapter 3 discusses specific analytic tools, methods, and approaches for deterrence and assurance and points to the need to view these as a collection—that is, as a tool suite—to support analysis plans. Finally, Chapter 4 provides the complete sets recommendations, along with supporting findings and associated rationales.

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Analytic Issues and Factors Affecting Deterrence and Assurance

INTRODUCTION

This chapter, which responds to Item 1 in the terms of reference (TOR), highlights key analytic issues, questions, and challenges that arise in attempting to deter adversaries and assure allies. It also provides definitions and sets the stage for discussions of analytic approaches in Chapter 3.

The word deterrence is often used as shorthand for a set of complex matters.[1] Figure 2-1 draws on classic strategic thinking to infer a set of de facto objectives for U.S. strategic planning including nuclear and other forces.[2] These objectives include (1) a generalized strategic stability that includes healthy change without aggression or arms races; (2) crisis stability; (3) the ability of the United States to act militarily as necessary in peacetime and in crisis, and, in the event of war, to fight effectively and limit damage to the United States, its allies, and other interests; (4) nonproliferation and other policy goals; and (5) other kinds of risk control such as those relating to the implementation of strategy, military-technical risks, and political

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[1] See National Research Council (1997), chaired by GEN Andrew Goodpaster (U.S. Army [USA], retired) for related discussion.

[2] The objectives are drawn or inferred from such classic deterrence literature as Kahn (1960), Schelling (1960, 1966), and Morgan (1983, 2003) and from statements of senior officials (Schlesinger, 1974a,b; Brown, 1981; Slocombe, 1981; Brown, 1983; Department of Defense (2010c, 2014). The figure builds on Davis (2011). Other objectives are implicit, such as shaping the postcrisis and post-conflict environments.

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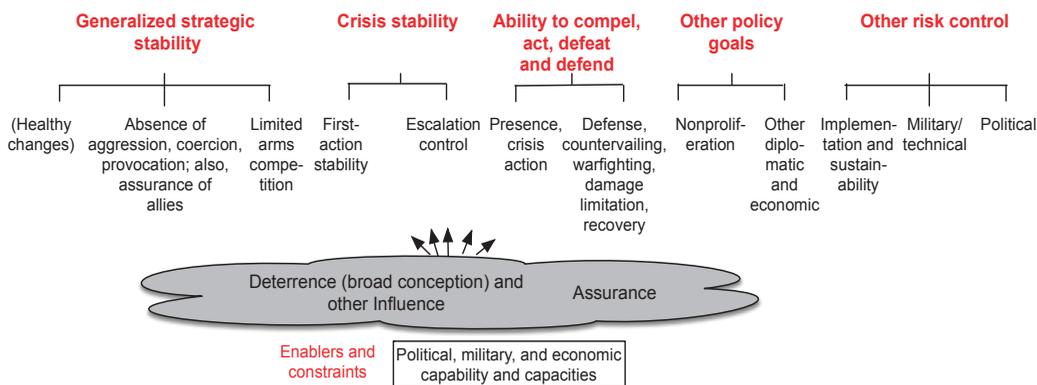
FIGURE 2-1 Objectives in strategic planning that includes nuclear forces. SOURCE: Adapted from Davis (2011), with permission by the RAND Corporation.

risks. Casual reference to the U.S. objective of deterrence, then, often involves much more than deterrence per se. A sharpened discussion requires tighter definitions.

DEFINITIONS AND DISTINCTIONS

Figure 2-2 illustrates a number of distinctions and subtleties that are reflected in the definitions listed in Table 2-1. The figure shows the adversary comparing two options (top), of which we prefer the one on the left (that might be "no action") and seek strongly to avoid the one on the right. It is common to refer to trying to "deter" the adversary from the decision on the right, but the adversary's behavior will actually depend on quite a number of considerations.

The adversary perceives pros and cons to each action, and we may affect those perceptions by various influences (red dotted items), including deterrence.[3] Our influences attempt to increase the attractiveness of the preferred option and to decrease (see the negative signs in the figure) the attractiveness of the option to be avoided. The adversary's decision, however, is subject also to factors that one cannot easily influence, such as his internal politics, nationalism, pride, and rationality.

Influences other than normal deterrence by threat of punishment include inducements or reassurances to an adversary who fears attack; coercive threats or actions to *compel* action; dissuasion by being able to deny an adversary's success

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[3] Seeing deterrence as one element of influence is discussed in Davis and Jenkins (2002) and George (2003). See also George and Smoke (1974).
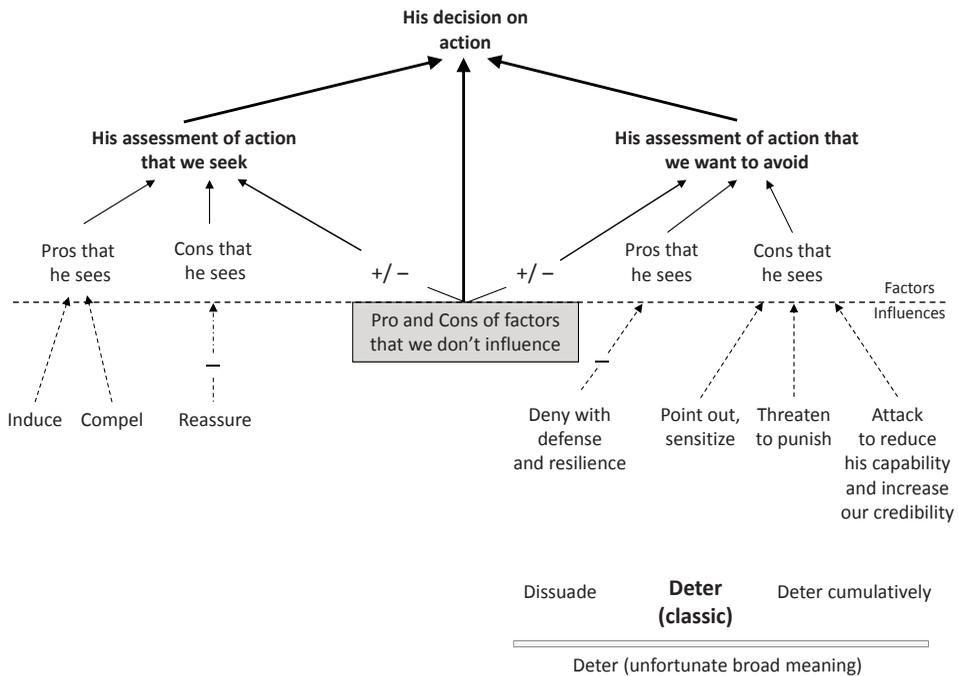
FIGURE 2-2 Relationships among concepts. SOURCE: Davis (2014a), reprinted with permission by the RAND Corporation.

with defense or resilience or by helping an adversary recognize courses of action more in the adversary's interest; and punishments for past actions to improve future deterrence—that is, to improve "cumulative deterrence."[4] Discussions sometimes use "deterrence" to refer, with regrettable looseness, to a combination of dissuasion, classic deterrence, and cumulative deterrence. The report recognizes this (bottom right of figure) with the umbrella term "broad deterrence" but attempts to be more specific in the related discussion.

With this background, Table 2-1 shows the key definitions used in this study. Two final observations are significant: (1) deterrent actions may or may not have much effect in "causing" the adversary's subsequent behavior because of the multiple influences at work simultaneously and (2) actions taken to deter may have unintended side effects, sometimes the opposite of those intended, as when a side's efforts to deter are seen as aggressive and reckless.

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[4] Had the United States attacked Syria in 2013, it would have been to "punish now" so as to deter further use of chemical weapons.

TABLE 2-1 Definitions

Term	Meaning
Influence	Effects on the decisions of another party by, for example, positive inducements, persuasion, dissuasion, deterrence, compellence, and punishment.[a]
General deterrence	Deterrence over time in periods of peace. If successful, it will head off crises in which immediate deterrence would be at issue.
Deterrence (classic)	Convincing an adversary not to take an action by threatening punishment only if the action is taken but not otherwise [see also "broad deterrence," below].
Dissuasion by denial (often called deterrence by denial)	Convincing an adversary not to take an action by having the perceived capability to prevent success adequate justify the costs.[b]
Cumulative deterrence	The quality of deterrence at a given time due to the history of prior successful and failed deterrent actions, crises, and conflicts.[c]
Broad deterrence	A combination of the previous three.
Direct deterrence	Deterring an attack on the United States or its immediate interests. Direct deterrence is more likely to succeed than extended deterrence (see below), because the deterrent threat is inherently more credible.
Extended deterrence	Convincing an adversary not to take an action against the interests of an ally by the methods of broad deterrence.
Dissuasion	Persuading an actor (such as an adversary) from taking a particular action.
Compellence	Causing an actor (such as an adversary) to take an action despite its preferences to the contrary, by using or threatening to use military, economic, or political power.
Coercion	Causing an actor unwillingly to do something by use of force or threat. Deterrence and compellence are different kinds of coercion.
Assurance	Convincing an ally of U.S. commitment to and capability for extended deterrence for the purpose of dissuading the ally from developing its own nuclear arsenal.
Reassurance	Reducing fears of potential adversaries regarding U.S. intentions or the intentions of U.S. allies.

[a] See George and Smoke (1974), Davis and Jenkins (2002), and George (2003).

[b] We adjust the concept of deterrence by denial (Snyder, 1961) by expressing it as dissuasion based on adversary perceptions of potential gains and losses (Davis, 2014b). See also Waltz (1990) and Sawyer (forthcoming).

[c] Cumulative deterrence is important in Israeli strategy (Doron, 2004; Rid, 2012; Adamsky, forthcoming). It overlaps with the credibility component of deterrence but reflects the history of events that also affect psychological appreciation of and distaste for what the punishment would mean. That is, it affects perceived consequences and saliency.

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STRUCTURING THE ISSUES

Are Nuclear Weapons Relevant?

Deterrence and assurance contribute to several higher-level objectives, as indicated by the gray cloud in Figure 2-1. The objectives referring to defense, countervailing, war fighting, and damage limitation may seem more appropriate to Cold War days than to now. However, they remain enduring objectives that are applicable in many military situations. They also apply when deterrence fails. Even if objectives are agreed, how best to build and employ nuclear forces has always been controversial. Presidents have long insisted on employment flexibility, complaining about the narrowness of options provided to them in operations plans. They have been concerned both about the immorality of indiscriminate use and about how overly blunt options undercut the credibility that the United States would use nuclear forces if it had to. Having no option other than Armageddon is, arguably, to have no option.[5]

As a result of such concerns, limited nuclear options were emphasized as part of flexible-response strategy, and by the end of the 1970s and after extensive analysis across three administrations, the United States settled on an even broader "countervailing strategy." The term countervailing was a nuance: Although assumptions about warfighting and war winning seem to lose meaning in scenarios involving massive nuclear exchanges, the United States wanted to assure that *any* Soviet leaders would conclude that no nuclear warfighting strategy could lead to meaningful victory and that the price would be too high.

Why is this relevant today when the Cold War is so long gone? The core reason is that the imperative to avoid nuclear war at all costs is not now, nor has it been, an inviolate and universally accepted principle of nature. During the Cold War, both the Soviet Union and the United States regarded nuclear weapons as valuable for coercive diplomacy.[6] They also developed first-nuclear-use options for scenarios that were deemed conceivable.[7] The North Atlantic Treaty Organization (NATO) developed and practiced operational doctrine for initiating nuclear use as needed to re-establish deterrence in the event of a Warsaw Pact invasion that could not be defeated with conventional forces. Despite an ostensible no-first-use policy, the Soviets had war plans for massive first use, which they characterized as preemptive.

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[5] See Burr (2005) for archival data, including Henry Kissinger's comment that "To have the only option that of killing 80 million people is the height of immorality." The comment reflected President Nixon's strong discontent with the options provided him. He found the all-or-nothing options appalling and, according to an interpretation of a comment by Henry Kissinger, expressed unwillingness to order the war plan's execution (Mastny et al., 2013, p. 121).

[6] See Delpech (2012, pp. 61-80) for a comprehensive review.

[7] See a recent review (Long, 2008).

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Finally, during the Cuban missile crisis, Fidel Castro had urged the Soviet Union to use nuclear weapons if Cuba was invaded, even though he presumably knew it would lead to the destruction of Cuba.[8] We now we know that the world was lucky to have escaped that crisis.[9,10]

Today, Russia regards nuclear weapons as a core element of its ability to deter China and NATO from nuclear or conventional attack[11] and has well-developed options for using them on the battlefield and geo-strategically with escalation control as a centerpiece. Pakistan regards nuclear weapons as a key to deterring a conventionally dominant India. Its programs appear to include tactical nuclear weapons, and its planning presumably includes preparing for at least limited nuclear warfighting.[12] Although Indian nuclear policy is ambiguous, Indian officials have spoken of being at liberty to use conventional force given their nuclear capability. Additional observations could be made regarding Israeli, North Korean, British, and French perspectives. The overall point is that nuclear weapons have played an important role in nations' foreign policies for a number of different reasons: Nuclear weapons have on occasion been considered usable, even when the condi-

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[8] Castro apparently saw the potential invasion of Cuba in apocalyptic terms, an attack of "Imperialism on Socialism." In a telegram to Khrushchev, he appeared to urge a nuclear strike on the United States in the event of such an invasion. See Garthoff (1992) and the original telegram at http://digitalarchive.wilsoncenter.org/document/114501.

[9] See Nathan (1992), Fursenko and Naftali (1997), Dobbs (2008), and Kokoshin (2012).

[10] Robert McNamara once said

> Had Khrushchev not announced publicly on the 28th of October—a Sunday—that he was removing the missiles, I believe that on Monday the majority of President Kennedy's military and civilian advisers would have strongly urged air attacks, with the likelihood of a sea and land invasion . . . . Some of us thought then the risks were very, very great. We underestimated them. We didn't learn until nearly 30 years later, that the Soviets had roughly 162 nuclear warheads on this isle of Cuba, at a time when our CIA said they believed there were none. . . . Had we . . . attacked Cuba and invaded Cuba at the time, we almost surely would have been involved in nuclear war.

(National Archives Project, undated).

[11] According to Russian scholars (Arbvatov and Dvorkin, 2013, p. 16), the official Russian statement is that

> the Russian Federation reserves the right to use nuclear weapons in response to the utilization of nuclear and other types of weapons of mass destruction against it and (or) its allies and also in the event of aggression against the Russian Federation involving the use of conventional weapons when the very existence of the state is under threat.

The final phrase reflects Russian concern about the current inadequacies of its conventional forces given the threat Russia sees from both China and NATO. All five members of the U.N. Security Council have no-first-use pledges to nonnuclear weapons states parties to the Nuclear Non-Proliferation Treaty (NPT), some with qualifications. China has a less qualified declaration in public, but some limits on its no first use pledge related to attacks on Chinese territory may exist.

[12] See Khan (2005). Feroz Khan, a Pakistani, was writing while serving as a visiting fellow at the Stimson Center and has since written on the history of the Pakistani bomb (Khan, 2012).

tions of mutual assured destruction exist, and nuclear weapons have been "brandished" as part of strategic communication.[13] There has never been a clean break between deterrence and warfighting, or between counterforce and countervalue attacks. Scenario details have matured and likely will continue to matter greatly. To reiterate, and despite successes in establishing international nonproliferation regimes and pressures in some areas of the world to eliminate nuclear weapons altogether, it is likely that some countries in some circumstances will in the future have powerful incentives for using or credibly threatening to use them.

What Do Nuclear Forces Help to Deter?

One of the most important contributions of nuclear strategic thinking in the 20th century was recognizing how the deterrent challenge varies with circumstances. Myriad scenarios should be considered, with certain distinctions being particularly important: (1) extended versus immediate deterrence; (2) direct versus extended deterrence; (3) deterring nuclear attacks versus deterring conventional attacks; (4) deterring small rather than large attacks; (5) deterrence before, during, or after war; and (6) deterring different countries or leaders (i.e., personalities, cultures, and mindsets matter).

What about today? Is the only significant role of U.S. nuclear forces to deter an adversary's use of weapons of mass destruction (WMD), as some believe? Or, do nuclear weapons have a continuing, albeit less direct role to play in deterring conventional aggression against U.S. allies by creating a "shadow"? The 2010 Nuclear Posture Review (NPR) takes a view somewhere in the middle, observing that the role of nuclear weapons in deterring conventional, chemical, or biological aggression continues but has declined.[14] Most recently, some have argued—quite controversially—that deterrence should also extend to preventing high-end versions of cyberwar—that is, cyberattacks so broad and destructive as to have massively destructive effects analogous in some respects to nuclear war. [15,16]

In fact, all extensions of scope beyond deterring use of nuclear weapons continue to be controversial. One view is that the other classes of attack are in a lesser league and can be deterred or countered without resort to nuclear weapons. Another view is that the most destructive but not-implausible versions of biological attack especially would be catastrophic. The Soviet Union had a massive biological

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[13] See Bracken (2012) and Delpech (2012).

[14] See Department of Defense (2010b, p. 15).

[15] The report interprets "existential deterrence" as "deterrence due to fear of attack so catastrophic as to make details of both pre- and postconflict power balances irrelevant." To some, referring to existential deterrence is "getting real." To others, it seems like a cessation of critical thinking.

[16] See Defense Science Board (2013b) and rejoinders (Clarke and Steve, 2013; Colby, 2013).

warfare program,[17] Iraq pursued biological capabilities under Saddam Hussein (Zilinskas, 2000), and North Korea may have biological weapons (Bennett, 2013). Such weapons are extremely lethal.[18] It is well to note here that heuristics such as "nuclear weapons only deter nuclear use" are examples of how people have sought to categorize weapons neatly. If history is a guide, however, nations, regimes, and commanders will not respect categorical boundaries, especially if stakes are high enough.

What Should Be the Basis of Nuclear Employment Planning?

Modern discussion of nuclear matters, including possible reductions to very small numbers or even to zero, typically does not address what operational nuclear planning should focus on—even if merely deterrent options that, presumably, would never be triggered. The question is this:

> If deterrence requires credibility and if credibility requires operational capability, then employment planning is necessary. But what should the targets be and what capabilities are needed?

Perhaps some, such as proponents of depending solely on "existential deterrence," would argue that it is only "arsenals" that must be kept "safe, secure, and effective," without need for ready forces or ready-to-implement targeting plans. Even if this is so, it would be necessary that forces could be brought to high readiness quickly and that actual operational targeting could be decided at the time (with some preplanning). For that to be viable, however, the substantial background work, training, and development of alternative targeting plans would still have to deal with the same issues faced by U.S. Strategic Command (STRATCOM) today. Thus, the question cannot be avoided: What should be targeted by nuclear weapons and what does this imply for planning and operations?

The targeting question might be addressed from diverse perspectives. Some observations are as follows:

1. Despite the precedents in the Second World War that included carpet bombing, fire bombing, and atomic bombing of Hiroshima and Nagasaki, attacking population centers raises enormous moral and legal concerns, even if the attacks are nominally on collocated industry.

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[17] See Leitenberg et al. (2012) and Albeck and Handelman (1999).

[18] See Lederberg (1999). Terrorist attacks are of special concern, although the application of nuclear deterrence is unclear in such scenarios and higher priority should probably be given to preparing defenses and adaptations (Danzig, 2009).

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2. Further, such an attack would virtually guarantee a response in kind, if possible. Thus, would such an attack merely be part of mutual suicide? If so, how could the capability for such an attack provide credible deterrence?

3. Continuing from (2), would such capability be credible for deterrence? Strategists have been extremely doubtful since the 1950s.

4. By analogy with armies attacking armies rather than razing cities (something usually regarded as a momentous advance in civilization's norms), shouldn't nuclear targeting focus on threat, notably nuclear and comparably threatening systems rather than innocent civilians?

5. Alternatively, if the counter-nuclear-threat targeting is too difficult, shouldn't nuclear targeting focus on other military targets with the intent of crippling the ability of the target state to project force or maintain authoritarian control?

6. If presented with the need to actually employ nuclear weapons, wouldn't any U.S. President seek very limited options—for example, destroying a class of adversary forces or weapons, blunting an invasion, or demonstrating ruthless resolve?

It is not the purpose of this report to resolve these weighty issues but rather to lay them out candidly because they bear heavily on nuclear analysis and the methods that should be brought to bear in such analysis.

What Are the Key Principles for Thinking About Assurance?

Although mostly focused on deterrence, this study considers assurance issues at every stage. The committee heard directly from officials and officers who are intimately involved in related work.[19] Many of the methods used to evaluate military issues and the quality of deterrence can be applied to questions of assurance and even shared or conducted with partners (for example, studies, analyses, and political–military gaming) as part of assurance activities.

The committee did not identify a separate class of "assurance methods," and it is difficult even to characterize a framework or theory for this quintessentially diplomatic activity. Nonetheless, the following can be considered as contributing principles.[20]

1. *Even at its simplest, assurance is complex.* Even if deterrence is in fact strong, assurance can be demanding. Diplomats often claim that achieving assurance is

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[19] This included a session with Bradley Roberts, until recently the Deputy Assistant Secretary of Defense for Nuclear and Missile Defense Policy, an earlier briefing by David Stein, Office of the Secretary of Defense (Policy), and an information-gathering session at U.S. STRATCOM in Omaha.

[20] This discussion draws in part on unpublished work by Ely Ratner for an earlier STRATCOM-sponsored study, on Wheeler (2010), and—for the last item—on Crawford (2003), which discusses "pivotal deterrence."

more difficult than deterrence itself because it involves building—and sustaining—trust and confidence among people, organizations, and countries.

2. *There is no single definition of "credibility."* Allies are not likely to assess credibility in the same way as the United States. U.S. reasoning often revolves around shared interests, U.S. capability, formal agreements, policy, and intent. Affected allies are rationally sensitive as well to how a nation's commitments may become slippery when fulfilling them becomes too risky or costly. The degree of assurance that can be achieved, then, is inextricably related to the credibility of extended deterrence.

3. *Assurance can have negative side effects.* It is possible for efforts taken in the name of assurance to encourage allies to take courses of action contrary to U.S. interests (and perhaps to the ultimate interests of the ally). This is why U.S. assurances have long been deliberately ambiguous on matters relating to China and Taiwan.

4. *Assurance involves all forms of national power.* U.S. success in assurance efforts often depend as much or more on its capability for coercive diplomacy as on its capability to deter. The strength of a security relationship depends, after all, not just on deterring particular actions but also on its effectiveness in influencing events more generally, sometimes coercively.

5. *What assures changes?* Assurance success in the current era depends on the United States being seen as successfully adapting to shifting power alignments in ways acceptable to the security partners. This issue is prominent not only in the Asia-Pacific region but also in the Middle East and along the borders of the former Soviet Union.[21]

The Department of Defense (DoD) is sensitive to these issues and has strived to engage officials and military officers from key countries—with site visits and in-depth discussions, not just exchanges of policy statements. One recurring issue is that influential allied representatives often see great value in forward-deployed systems, including nuclear-capable systems. Such deployments may not seem necessary or appealing to Americans given the demonstrated ability to fly long-distance missions and to redeploy forces if necessary, but they are seen as significantly improving the credibility of the U.S. commitment.

WHAT IS NEW IN THINKING ABOUT DETERRENCE AND ASSURANCE?

The preceding material was largely general. The following sections describe what is new about the current era and what has been learned from the past.

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[21] See, for example, Research Group on the Japan–U.S. Alliance (2009).

Changes

Thomas Schelling (2012) wrote recently about the success of mutual deterrence between the Warsaw Pact and NATO but then observed

> What a simple thing that was, that bilateral mutual relationship! Just two parties, fully identified, sophisticated and "rational," fully reciprocal, with nothing at stake worth a war, no real territorial threats, at least after 1962, no great technological secrets, good diplomatic communication, especially after the "hotline" of 1963.

Schelling went on to discuss differences today. For the particular book, he was stressing issues raised by the terrorist threat, but many of the differences were more general, such as multiple adversaries, multiple motives, poor communications, no collaboration, no confidence in taboos, and no confidence in "rationality." To be sure, almost nothing is truly new for deterrence theory in that antecedents can usually be found. Nonetheless, as Table 2-2 suggests, some important differences of degree exist and some issues are indeed new. [22] One consequence of change is that it is now more necessary to study the possibilities of very limited nuclear exchanges and limited nuclear war. During the Cold War, the overwhelming emphasis was on general nuclear war (despite the attention to NATO's flexible response).

Have the Right Lessons Been Learned from the Past?

The lessons some draw from the Cold War are often dubious. It is sometimes argued, explicitly or implicitly, that (1) nuclear weapons are useful only for deterring use of nuclear weapons; (2) that deterrence in the Cold War ultimately came down to nothing more complicated than existential deterrence, which could be achieved with very few nuclear weapons; (3) that defenses are ineffective because the offense-defense competition favors the offense; and that (4) a Third World War was averted because of rational behavior under the reality (rather than the strategy) of mutual assured destruction. The first argument is false; the second is widely (but not unanimously) believed by experienced strategists to be false; the third reflects a judgment that was arguably valid at certain points in history but may not be true now or in the future; and the fourth argument gives only part of the story since the objective motivations for war between the Soviet Union and West were low in historical terms.

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[22] Keith Payne makes similar points (Payne, 2008, p. 205 ff.), drawing contrasts with the Cold War, during which the United States and the Soviet Union had strong reasons for avoiding conflict. See also Davis and Jenkins (2002) and Lowther (2013), a recent book on deterrence from the Air War College. For discussion of technological issues, see Lehman (2013) in a recent book on strategic stability (Colby and Gerson, 2013).

TABLE 2-2 What Is New or Different?

Class of Issue	Changed Circumstance
Actors	More nuclear-weapon or nuclear-capable states, and bigger arsenals. Violent extremist organizations that may not be deterrable in the same manner as nation-states.
Strategic context	Potential for *n*-party arms races. Increased globalization that means damage from attacks would disrupt international commerce severely and anger nations worldwide.
Weapons and technology	Long-range precision conventional weapons for strategic attack. Dependence of modern nations on space systems and worldwide networking disruptable by physical attack or cyberwar.
	Implications of modern science for biological warfare. Accelerated advances and spread of strategic technologies. The expectation of future technologies that may alter basics such as how we think about command and control, air and missile defense, antisubmarine warfare, and survivability against nonnuclear forces.

What, then, are the better lessons? Some were stimulated by top-level war-gaming in the Reagan administration (Bracken, 2012). Although war games usually did not cross the nuclear threshold because of political sensitivities and the fact that such use would be a game-stopper interfering with other game objectives, the Proud Prophet exercise resulted in general nuclear war growing out of the "seemingly inexorable consequences of nations and organizations implementing their own strategies and doctrine" (Bracken, 2012, pp. 84-89). Bracken believes the exercise had a major, lasting, and sobering influence on the thinking of top officials.

Similar lessons have been drawn over the years stem from the RAND Corporation's "Day After Exercises" and from political–military war games at the Naval War College and elsewhere. Protagonists (often senior civilians and military officers) routinely "brandish" nuclear weapons ambiguously without intending to use. Misperceptions and miscalculations are common, with both acts of resolve and demonstrations of restraint having unintended results; the most important risks are sometimes ignored until too late, and participants take escalatory actions that might naively have been thought "unthinkable." Other sources of lessons include historical case studies (see Chapter 3) and often-candid reflections by past practitioners of nuclear strategy.[23] A "meta lesson" for today is that those working on deterrence and assurance should draw on diverse sources of knowledge.

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[23] See Quinlan (2009), Delpech (2012), and observations made in various venues by former Secretaries of Defense James Schlesinger and Harold Brown. The committee received a briefing on such reflections by Larry Welch, a former Chief of Staff of the Air Force and president of the Institute for Defense Analyses. See also two recent studies (Utgoff and Wheeler, 2013; Coe and Utgoff, 2008).

TABLE 2-3 Selected Focus Issues

Category	Theme
Understanding deterrence and influence in modern contexts	Increased importance of general deterrence and cumulative deterrence. Need to improve and move beyond rational-actor assumptions. More complex regional/escalatory dynamics. The role of dissuasion by denial.
Planning and analysis	Dealing with expanded uncertainty. The relationship between defense and assurance. Anticipating the unexpected, geopolitically and technologically.
Attending to basics	Maintaining safe, secure, and effective forces.

WHAT ISSUES SHOULD ANALYSIS ADDRESS?

A core task for this study is identifying which issues involving nuclear forces should be of concern, which questions should be addressed analytically, and which methods of analysis might help. The following describes selected issues that appear to merit special attention and have significant implications for the discussion of analytic methods in Chapter 3. The themes fall into groups as indicated in Table 2-3: (1) understanding deterrence and influence in the modern context, (2) planning and analysis for future forces and operations, and (3) attending to basics. They are discussed in turn.

Increased Importance of General Deterrence

General deterrence—that is, peacetime efforts to deter conflict—is especially important because, if successful, it will head off what otherwise could become crises: events that are notoriously difficult to control. It is better for the states in question to avoid actions that take matters into potential danger zones than to plan on cleverly navigating the shoals of near-crisis situations.[24] The potential for "small" events to have large impact is worrisome.[25] Part of what is needed are called "rules of the road" that govern normal and crisis-time military operations and that can avoid or mitigate the escalatory consequences of more militarily conservative doctrine.

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[24] See Morgan (1983, 2003).

[25] Davis and Wilson (2011) note the possibility of troublesome actions in East Asia such as preemptive island grabs or "incidents" on the high seas. See Colby and Ratner (2014) for arguments about the need for the United States to be more assertive.

Observation 2-1. Norms of Behavior. Because of the escalatory potential of even smallish conflicts, "rules of the road" are vague in important areas such as cyberspace, outer space, South Asia, the Middle East, and East Asia. Better ones are needed.

As an example, when U.S. naval ships were operating recently near the early operations of a new Chinese carrier and its escorts, China maneuvered a warship in such a way as to nearly cause collision with a U.S. missile ship. As for cyberspace, it seems evident that the technology for aggressive actions has proceeded faster than the understanding of likely and potential consequences. The most well-known example involves the Stuxnet worm (Sanger, 2012), which had temporary effects of the sort intended, but which also had subsequent unintended effects broadly. Most recently (Spring 2014), related problems arose as Russia absorbed Crimea and threatened the rest of Ukraine.

While confidence-building measures and rules of the road can have undesirable or unintended consequences, recognized norms of behavior that encourage restraint can be useful. Improving general deterrence and related rules of the road will necessarily involve government-wide discussions, government-to-government negotiations, and military-to-military interactions. However, it should be noted that developing well-understood international norms (rules of the road) favorable to the United States depends on the national leaders of the countries in question seeing some value in more restrained, cautious interactions. That condition may or may not apply to China and Russia in what they think of as their natural spheres of influence.

Improving and Moving Beyond Rational-Actor Assumptions

The dominant paradigm for theoretical discussion of deterrence and even for codification of concepts in doctrine is that of rational-actor decision making. In this paradigm, one deters by convincing the adversary that the risks of the action to be deterred outweigh the benefits, compared to inaction. The degree to which the paradigm relies on the rational-actor model can be seen in the terminology, which refers to affecting the adversary's "calculus."[26] This paradigm can be powerful when the emphasis is placed on the *adversary's* reasoning and conclusions, which in turn are affected by the adversary's objectives, values, and perceptions. It can even anticipate and explain seemingly irrational behaviors such as suicide bombing by terrorists by understanding martyrdom in behalf of a people, cause, or god. That requires extending the rational-actor calculus to go beyond materialistic values

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[26] This concept can be found in multiple scholarly and official sources (USSTRATCOM, 2006). The committee was briefed on interpretations by Jonathan Drexel and Lt Gen Robert Elder (USAF, Ret.).

and allow for, for example, nationalism, identity, religious convictions, honor, and self respect.[27,28] Substantial success has also been reported in the ability to use rational-actor theory to predict political maneuverings and eventual compromise in organizations and foreign affairs involving multiple actors.[29]

Although rational-actor approaches can, then, be improved, there are also limitations because people do not always behave rationally and because, even if they do, their reasoning may not be understood. There is a long history of trying to get into the adversary's head when contemplating deterrence, although the history of efforts to do so has been decidedly mixed. Fortunately, deterrence can sometimes work against adversaries whose reasoning is not understood.

Even with good attempts to understand the adversary, the rational-actor paradigm—especially the version that assumes a desire to maximize expected subjective utility—has serious shortcomings.[30] The problems include these: (1) The adversary may not have objectives, values, and a way to evaluate options; (2) Even if he does, they may not be inferable with available information; (3) In many circumstances, *stable* "utility functions" do not exist: leaders may not know their "true" objectives and values and, in any case, those may change as matters evolve.

The first point has been made by Patrick Morgan, who notes that policy makers often defer deciding on their objectives and value trade-offs, expecting to learn from events and interactions and not wanting to tip their hands early (Morgan, 2003). It is of interest to note how little eventual U.S. war objectives in Iraq and Afghanistan relate to those stated at the outset. More generally, policy research has long demonstrated that many of the most important policy challenges involve "wicked problems" that have no clear solutions. Instead, people work the problems until, as the result of interactions, events, and sometimes weariness, they discover acceptable solutions that reflect history, personalities, and process.[31] That is, solutions emerge.

The second item is well illustrated by the case of Saddam Hussein. Only in retrospect is it clear that he had put on hold his nuclear program but kept that

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[27] See Berrebi (2009) for empirical analysis of terrorist behavior.

[28] Henry Kissinger observed, looking back on Egypt's invasion of Israel in 1973, that "our definition of rationality did not take seriously the notion of Egypt and Syria starting an unwinnable war to restore self-respect" (Kissinger, 2011).

[29] The most important work of this type was initiated by Bruce Bueno de Mesquita in the 1980s (Bueno de Mesquita, 1981). Related work continues (see, e.g., National Research Council, 2011, and Abdollahian et al., 2006, with the Senturion model). Similar work at RAND has been led by Eric Larson. Such work, however, is typically not about deterrence per se.

[30] The literature on the subject is lengthy: for example, Jervis (1976), Jervis et al. (1985), Green and Shapiro (1994), Lebow and Stein (1989 and other articles in the same issue of *World Politics*), Morgan (2003), Kahneman (2011), and Davis (2014b).

[31] See Rosenhead and Mingers (2002). Wicked problems are more heavily studied in Europe than in the United States, but the approaches resonate with many scholars of policy analysis.

fact secret from nearly everyone in order to influence the United States, Iran, and potential domestic rivals.[32] The instability of utility functions is a a fundamental but often-undiscussed problem (Davis, 2014b). Everyone does things that, in retrospect, were not in their best interests even though they seemed right at the time. Leaders are no different, and there is ample laboratory evidence of related matters, including the celebrated paradoxes of behavior described below. [33]

The failure of U.S. planning that led to the Bay of Pigs fiasco has long been described as a peacetime example of group-think.[34] The widely accepted notion that heavy-handed threats of military attack will deter states such as Iran from developing nuclear weapons, or even having virtual weapon-system capability, may be a modern example (however sensible the goal of persuading Iran to do otherwise). The conditions under which threats do or do not work are not always well understood and can change.

It is perhaps surprising that the literature on deterrence theory continues to be dominated by rational-actor theory, but this is changing with the more widespread appreciation of lessons from psychology accumulated over the last half century or so. Which types of approaches can help in going beyond rational-actor assumptions? The answers include leadership profiling, qualitative cognitive modeling, human gaming with role-playing, the use of alternative adversary models to hedge against uncertainty, and—in principle—even agent-based simulation. Most important, however, is doing the "hard thinking." After all, people like Herman Kahn and Thomas Schelling discussed many ways in which behaviors would depart from what is ordinarily thought of as rationality.

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[32] A mass of information is now available on Saddam Hussein's thinking in both 1990-1991 and 2003 from extensive interviewing, his own lengthy discussions with an FBI questioner while in custody (Woods and Stout, 2010; Woods et al., 2011; Woods, 2008), and even audio and video tapes that Saddam recorded of private conversations (Woods, 2012, p. 4).

[33] These have been summarized by Nobelist Daniel Kahneman (Kahneman, 2011) and in a popular book on behavioral economics (Thaler and Sunstein, 2009). Decades of research now exists on actual decision making and behavior, on the role of heuristics and biases, and the sometimes-helpful/sometimes-hurtful role of intuitive decision making (Gigerenzer and Selten, 2002; Klein, 2001, 1998). Those who support decision making should seek to achieve the advantages of both the heuristics-and-biases and naturalistic approaches, while mitigating their shortcomings (Davis et al., 2005; Kahneman, 2011). It is also important to reject the false dichotomy of rationality and psychology (Mercer, 2005). Interestingly, some practitioners of rational-actor modeling have found ways to incorporate some of the nonrational considerations while preserving analytic virtues of the earlier methods. See, for example, Bueno de Mesquita and McDermott (2004).

[34] See Janis (1972).

Planning Under Uncertainty

Analytic conclusions about deterrence are often dominated by the assumptions of a planning scenario even though such scenarios are notoriously unreliable and the odds of error are great. The challenge of planning under uncertainty has bedeviled decision making for millennia. This is especially the case for situations of deep uncertainty in which we do not know the relevant probability distributions (if they exist), understand the underlying phenomena, or know how to formulate the decision rigorously. Considerable technical progress has been possible due to the confluence of theoretical work, computational advances, empirical psychology, and other efforts. Addressing deep uncertainties need not mean paralysis; instead, it means pragmatically recognizing and bounding them, assessing the relative significance of the many such uncertainties, and identifying hedges and adaptations.[35]

Less work has been published on deep uncertainty in connection with deterrence and assurance, but a review of modern decision science for the Air Force Office of Scientific Research drew on historical lessons about flaws in top-level U.S. national security planning in crisis and implications from decision science.[36] A major conclusion was that it has been common for flawed decision making to be driven by best estimates about the adversary and that it should be a matter of doctrine for high-level decision-aiding to seek strategies that hedge against potential misunderstanding about the adversary. The report suggested using alternative cognitive models,[37] as one mechanism for doing so, pointing out that the empirical evidence is that causing people to entertain even two alternative constructs of how the adversary may be reasoning opens minds, which in turn makes hedging and preparing for adaptation easier. In contrast, devil's advocate methods often fail because the other position is too heavily discounted and discussions become personalized. The recommended approach is to make consideration of alternative assumption sets more routine and analytic, even doctrinal, depersonalizing the discussion.

Finding 2-1. Deep Uncertainty. Planning to support deterrence and assurance with both current operations and longer-term programs to organize, equip, and train is characterized by deep uncertainty, described more fully in Chapter 3. Nonetheless, methods exist for dealing with such uncertainties effectively, primarily by hedging and capabilities for adaptation.[38]

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[35] See section on exploratory analysis in Chapter 3.

[36] These aspects of the study were not published at the time because of sensitivities, but a published product (Davis et al., 2005) includes suggestions for decision support motivated in part by history as well as psychological research (pp. 83-93).

[37] See National Research Council (1997) and Davis (2010) and references therein.

[38] See Hallegatte et al. (2012).

Test Cases for Planning

The need for tailoring deterrence is hardly new.[39] What is more important is deciding on the "difficult cases" on which deterrence studies should focus—especially when it is not known what crises will occur in the future, or even the circumstances of tomorrow's crises. Ideally, test cases for planning emerge from in-depth examination of possibilities followed by identification of those cases that, if planned for, will likely provide the capabilities needed to deal with actual crises when they arise. Table 2-4 provides key questions suggesting test cases for analysis. The questions are grouped by the committee in the categories of Peer, Near-Peer, Regional (both Responsible and Rogue), and Nonstate Actors (see Table 2-4).[40]

Reexamining Ballistic Missile Defense with Extended Deterrence in Mind

One theme that emerges from discussion of modern-day deterrence and assurance is the increasing significance of ballistic missile defenses (BMD). This is indicated by the intense and dedicated efforts of Japan and the increasing interest of other states in these systems.[41]

Those recalling the Cold War often are skeptical about BMD, seeing offense as more cost-effective than defense and ineffective only against moderately sophisticated countermeasures. However, effective defenses against lower-level threats currently exist, and many of these could be substantially upgraded. Further, the technological balance between offense and defense changes over time. Open minds are important. Still, serious doubts exist regarding the technical viability of effective BMD against large, advanced attacks or even against small attacks by "advanced rogues." These issues are at the center of the credibility of U.S. extended conventional deterrence to critical allies such as Japan and South Korea.[42] DoD includes BMD prominently in its comprehensive approach to regional security discussions with Middle Eastern and Asian-Pacific nations (the initiatives also deal with cy-

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[39] The strategist Fred C. Iklé sometimes observed wryly that one of the big lessons was that it was necessary to remember that there is no Red and Blue, but instead specific actors such as the United States and Soviet Union (Iklé, 2005).

[40] Similar questions are expressed by Keith Payne (2008), who draws on disquieting historical events when expressing skepticism about dependence on deterrence. See, for example, 334 ff.

[41] See a Japanese-U.S. study (Research Group on the Japan–U.S. Alliance, 2009).

[42] One recent study (National Research Council, 2012) strongly criticizes current DoD programs. Other studies have been more optimistic about the theoretical viability of boost-phase defenses against North Korea and more pessimistic about prospects for effective mid-course discrimination (American Physical Society, 2003; Sessler et al., 2000). Still others are quite critical of current programs for many reasons, including inadequate testing (Coyle, 2013).

TABLE 2-4 Key Questions Suggesting Test Cases for Analysis of Deterrence

Type of Adversary	Stressful Question
Peer	Could Russia find itself providing nuclear deterrence enhancement to regional players such as China or the DPRK, which could transform regional escalatory calculations into global deterrence dynamics?
Near-Peer	Might China, in a crisis involving Taiwan, see the issues as raising core values (what might even be seen as "sacred values") about the very nature of China and her place in the world, rather than as disputes about a small island nation with different attitudes but good economic relations with the Mainland?[a]
	Would Chinese military figures interpret events in terms of the United States attempting to squelch China's natural and proper aspirations as a great power, in which case the stakes would loom larger than might seem "reasonable?"
Regional	Might a future authoritarian leader of a rogue state, analogous to a Saddam Hussein, prefer going down with destruction of his enemies to accepting an island retirement or public hanging?[b] Would he see events apocalyptically rather than pragmatically?
	Might a future leadership of a state such as North Korea see its only possible route to success being to deter the United States, and the only route to success in that being willing to use nuclear weapons on a limited basis against our regional allies, our forces deployed forward such as aircraft carriers, or even the U.S. homeland such as submarine or bomber bases?
	Might the United States be self-deterred from decisive intervention in protection of an ally because of the credible threat of nuclear attack? What would the nuclear deterrence implications be for the United States of the breakout of nuclear use between India and Pakistan, especially if China were to support Pakistan, etc.?
Nonstate	How might extremist nonstate actors such as an al-Qaeda use or brandish weapons of mass destruction? What role can deterrence and assurance play in such cases?

[a] Sacred values have been addressed with deep social science research (Atran and Axelrod, 2008; Atran, 2010). Such values often lead to behaviors that appear to others as irrational; they are "ignored only with peril when discussing deterrence. Significantly, such matters interact with politics, as when Slobodan Milošević recreated ancient ethnic tensions in firing nationalistic emotions. Another example is how China's Communist Party has "created" sacred values with respect to Taiwan's relationship to China.
[b] Such possibilities were discussed at the end of the Cold War (Watman et al., 1995; Wilkening and Watman, 1995).

bersecurity, space resilience, and other matters).[43] It is important to resolve the technical questions to inform both investment and policy.

Observation 2-2. Missile Defense. Because regional and intercontinental missile defenses have become so important to extended deterrence and assurance, a new

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[43] The comprehensiveness of the approach can be seen in some recent Department of Defense reports (2014; 2010a, pp. 31-35; 2010b).

round of intensive research and debate is needed—with the best science and *independent* assessment available—to assess what is truly feasible.

Observation 2-3. Extended Deterrence. As during the Cold War, there are inherent credibility problems when the United States seeks to extend deterrence to allies by using nuclear threats against nations that also possess nuclear weapons and could strike the United States. *Reassurance efforts, however zealously attempted, may not be persuasive to allies for understandable reasons.*

This observation may surprise some readers, but longstanding U.S. allies are having public discussions that include advocates of exploring nuclear weapons options.

Observation 2-4. Dissuasion by Denial. Dissuasion by denial is especially important for the era lying ahead. Relying entirely on the threat of punishment, especially nuclear threat, is fraught with risks—more so than in the past.

What methods might be useful in addressing such matters? In-depth scientific and engineering-level analysis is needed, along with gaming and game-structured modeling, among others. Chapter 3 discusses a number of these.

Anticipating the Unexpected: Technological and Other Drivers of Change

The pace of technological change increases the likelihood of technological surprise with strategic consequences.[44] The synergistic advances in information technology (IT), computation, materials, advanced manufacturing, exotic sensors, enhanced energetic materials and fuels, and the like may have direct effects in the areas of air and missile defenses, advanced conventional munitions, ballistic and cruise missiles, antisubmarine warfare, cyberwarfare, counter-space capabilities, and others which could undermine traditional nuclear deterrent forces. These are familiar and enduring challenges for U.S. planners and need no elaboration.

A rather different great challenge is that technologies such as ubiquitous sensors, the Internet, and smartphones are opening the world with the prospect of great situational awareness and communication. At the same time, cyberattack, electromagnetic pulse, and critical infrastructure vulnerabilities raise the prospect of suddenly losing awareness and connectivity. Rapid changes from one state to another are possible, creating a new kind of potential instability.

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[44] For more background, see Lehman (2013), from which some of the committee's discussion draws, Bracken (2012), and Defense Science Board (2009, 2010).

In contemplating strategy to avoid or mitigate strategic surprise, past lessons should be recalled. These include (1) nations and nonstate actors do not always follow the paths taken by the United States; (2) silver bullet technologies are rare, but accretion of lesser capabilities can have similar effects; (3) the variety of technologies available, many close to military application, increases the chance of surprise; (4) many military technologies have different values for different players or scenarios; and (5) in a complex world, precise predictions of events and timing is difficult, and, even when predictions are correct, responses are seldom timely and often ineffective (Lehman, 2013).

What can be done? A principle is that strategy should at once seek vigorously to effectively anticipate possible major developments *and* lay the groundwork for mitigating consequences and exploiting opportunities. History shows that surprise often has badly adverse effects not because events were unforeseeable, but because nothing was done even when warnings were observed or because the ability to adapt to surprises proved poor, or both. Which methods might help? Modern simulations, exploratory analysis, and studies can help by generating a richer understanding of possibilities and consequences, and perhaps by helping to find ways to prepare or hedge. So also, certain types of human gaming can be very helpful, as illustrated by the years of experience with such games by DoD's Office of Net Assessment, "Foresight exercises" used in planning social policy and various scenario-based methods used in both national security work and private enterprise. These and others are discussed in Chapter 3.

Maintaining the Reality and Perception of Safe, Secure, and Effective Nuclear Forces

Perceptions and Assurance

Deterrence and assurance depend on both the reality and perception, by ourselves and others, of the safety, security, and effectiveness of nuclear forces. Perceptions vary on what nuclear weapons and their delivery systems and infrastructures can do, what they are for, and how others perceive them (a core element of assurance). For example, some allies feel more assured by local deployments while others feel less secure. Some allies have wanted systems that they see tangibly as "their nuclear umbrella," such as the TLAM-N sea-launched cruise missile, while others have been satisfied seeing central system components such as sea-launched ballistic missiles. Even the nature of individual nuclear warheads can be controversial. The value of reducing the yields of warheads is emphasized by some as a sign of restraint or an act to increase their credibility as a deterrent.

Potential adversaries may also have different perceptions of the significance of force characteristics. The Soviet Union placed a greater emphasis on geographical location of forces than did the United States, with NATO's forward-deployed forces seen as strategic because they could hit the Soviet homeland. While the United States emphasized the robustness, flexibility, survivability, and agility of a strategic triad, the Soviet Union relied heavily on the coercive power of its highly multiple independently targetable reentry vehicles (MIRV)ed, liquid-fueled heavy missiles. The United States has eliminated battlefield nuclear weapons and keeps only a small force of air-delivered tactical weapons. In contrast, Russia has shown renewed interest in modern, low-yield tactical and battlefield weapons. Other measures on which perceptions vary include fast versus slow flyers, alert rates, unit versus force survivability, day-to-day versus generated force postures, individual versus force performance, dependence on warning, and safety and security measures. This study did not examine such issues in detail but thought that they should be highlighted in future Air Force and DoD efforts to address safety, security, and effectiveness.

Efforts to assure that forces are safe, secure, and effectiveness should recognize and deal explicitly with alternative perspectives on how to measure them, thereby anticipating and dealing with perceptions crucial to both deterrence and assurance.

Weapons and the Stockpile

The National Nuclear Security Administration (NNSA) within the Department of Energy has the responsibility for maintaining a safe, secure, and effective nuclear weapons stockpile without underground nuclear testing. It provides an annual report to the Congress (Department of Energy, 2013). The current weapons stockpile and the design technology within it are old. According to the NNSA website,

> Most nuclear weapons in the U.S. stockpile were produced anywhere from 30 to 40 years ago, and no new nuclear weapons have been produced since the end of the Cold War. At the time of their original production, the nuclear weapons were not designed or intended to last indefinitely.[45]

The absolute and relative ability of different nations to sustain existing nuclear weapons, or perhaps to design and deploy reliable "new" nuclear weapons without testing, is subject to debate. Although what is meant by "new" or "modernized" nuclear weapons involves a range of definitions and considerable debate, many scientists believe that it is possible to develop and deploy some "new" or "modernized" nuclear weapons without full-scale testing. Indeed, China, Pakistan, and Russia have taken that course.

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[45] For additional information, see NNSA, "Maintain the Stockpile," http://nnsa.energy.gov/ourmission/managingthestockpile, accessed January 29, 2014.

Prohibiting actual weapon-detonation tests has, under the Strategic Stockpile Management Plan, forced U.S. reliance on subcomponent and noncritical nuclear tests, analysis, and scientific modeling and simulation. The program includes life extension efforts, updating subsystem technology and components to improve reliability and safety, and replacing end-of-life components. An alternative approach, the Reliable Replacement Warhead program, a program to develop a family of "new" warheads embodying advanced technologies and designs intended to be highly reliable and more sustainable (Congressional Research Service, 2005) was terminated in 2009. Consequently, the Life-Extension Program (LEP) remains the main mechanism for achieving sustainability. This program is expensive, which is why the Stockpile Stewardship and Management Program 2014 (Department of Energy, 2013) calls for a reduction in the types of nuclear warhead designs in the inventory that need to be sustained. This plan calls for reducing the B61 series to just the new B61-12, which will consolidate the B61-3, -4,-7, and -10, completing the W76-1 LEP earlier, and a W88 Alteration program. The long-term plan is the so-called "3+2 vision," which calls for shrinking the stockpile to just three ballistic missile warheads and two air-delivered warheads. Although this would limit flexibility for future systems and increase some risks associated with common-mode failures (while perhaps reducing others), it would greatly reduce the cost of maintenance, safety, and support of the inventory, while retaining a strategic-upload hedge in the ballistic missile force at lower numbers and cost. Whether this strategy can be sustained with adequate funding over the long term remains to be seen.

Are these judgments valid today? Are things better or worse? The committee did no independent research on these matters, but committee members were concerned about patterns of decision and behavior on weapons (described in briefings to the committee) that are at odds with what would ordinarily be expected for critical systems that are supposed to be safe, secure, and effective. Proponents of the current approach point to past testimony and reports from officials, general officers, and scientists, which would seem to provide confidence in such matters. However, in the committee's reading they underplay troubling judgments. Five years ago, a congressional commission chaired by William Perry and James Schlesinger (United States Institute of Peace, 2009, pp. 40-41) reported as follows:

> The possibility of using this approach [current policy] to extend the life of the current arsenal of weapons indefinitely is limited. It might have been possible to do so had the United States designed differently the weapons it produced in the 1960s, 1970s, and 1980s. But it chose to optimize the design of the weapons for various purposes, for example, to maximize the yield of the weapon relative to its size and weight. It did not design them for remanufacture. This approach also requires that the United States utilize or replicate some materials or technologies that are no longer available. Designs constraints also prevent the utilization of advanced safety and security technologies. . . . The process of remanufacturing now underway introduces some uncertainty about the expected operational reliability

of the weapons. So far at least, the directors of the weapons laboratories have been able to certify that they retain confidence in the remanufactured (and other stockpiled) weapons. But there are increasing concerns about how long such confidence will remain as the process of reinspecting and remanufacturing these weapons continues. Indeed, laboratory directors have testified that uncertainties are increasing.

Again, the committee did not have the time or budget for independent research on these matters, which relate strongly to the subject of its report and are important to the Air Force. It seems likely that at some point—despite the sensitivity related to these topics and the likely disruptive effects—the nation will review all of these matters and either reaffirm or alter stockpile-related policies and programs. If a clean-sheet-of-paper approach is taken, the committee believes that, while new analytic methods will be useful and internal peer review should be strengthened, it would also be valuable to give a major role to scientific and technical experts from outside of the current nuclear enterprise. Such experts would have fresh eyes and would have more independent perspectives with respect to the feasibility, wisdom, and affordability of continuing to repair and replace components developed decades ago.

Nuclear Command and Control

Another crucial subject that the committee was unable to look into during its short study was nuclear command and control. Logically, this deserves to be covered in a study of nuclear deterrence and assurance. Further, it is an important and troubled subject area. DoD initiatives in the last several years, championed by Ashton Carter while he was Deputy Secretary of Defense, sought vigorously to remedy problems of technological obsolescence and various other problems at the nuclear-enterprise level. Little public information is available as yet about what progress has been made and what remains to be done. This report can only highlight the problem area as one worthy of top-level attention, especially by the Air Force, the Navy, and DoD. The relevant analytic methods already exist, so the subject is not addressed in Chapter 3 or the remainder of the report. Nor are issues related to management of the nuclear enterprise, as discussed in a report chaired by James Schlesinger in the wake of weapon-mishandling incidents that led to the dismissal by Secretary Gates of the Secretary and Chief of Staff of the Air Force.[46]

Given the breadth of challenges involving the nuclear enterprise and particularly the Air Force role within it, there is need not only for improved policies and management, which has been discussed elsewhere (as in the references cited above and DoD directives), but also on the analytic front.

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[46] See Schlesinger et al. (2008a,b) and a follow-up by the Defense Science Board on response by the Air Force (Defense Science Board, 2013a).

Finding 2-2. Analytic Framework. Because the U.S. approach to strategic deterrence and assurance needs to be continually adapted, a management plan is required that defines comprehensively the set of *continuing* analytic foci, which includes nuclear command and control; air and missile defense; cyber, space, geostrategic, and technological changes; and the challenges of tailoring deterrence and assurance to adversaries and allies. This analytic management plan is in addition to tasks related to weapons, forces, personnel, and the nuclear enterprise in general.

CONCLUDING REMARKS

This chapter has sought to lay out the issues and challenges. Chapter 3 discusses methods and tools that seem valuable for future study of, planning for, and operations of nuclear forces. It prefaces that discussion with strong words emphasizing that the expertise and sophistication of analysts is more important than improvement in methods.

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3

Selected Discussion of Tools, Methods, and Approaches for Deterrence and Assurance

INTRODUCTION

The committee reviewed analytic tools, methods, and approaches (collectively referred to henceforth as "methods") to address deterrence and assurance problems. It drew on members' prior expertise and previous reviews and held as information-gathering meetings. This chapter summarizes by identifying—with caveats—methods that have significant potential. Some general observations include the following:

1. *None* of the methods are "commodities" to be purchased to find "answers." Rather, they are merely aids to research, analysis, and decision making.
2. The value of analysis depends primarily on the talent, education, and experience of the analysts and their work environments.
3. Analysis quality is greatly improved if the people involved have been exposed to an interdisciplinary range of methods in the course of their careers through classroom learning, experiential learning (e.g., gaming), analysis, and practical experience.
4. Analytic organizations need *method suites*—a plentiful *kit bag*. For a particular purpose, the analyst may use intellectual capital, draw from the kit bag, or reach out to experts in applying the methods well.
5. *Significant* improvements in deterrence and assurance analysis are possible with synthesis using hybrid methods. The analysis community has tribes that do

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not routinely interact, but much can be gained by forcing interactions (e.g., among gamers, modelers, empiricists, and analysts).

6. In looking back to 20th-century developments in deterrence and assurance theory, the biggest payoffs were insights, frameworks, and strategies rather than the nuts and bolts of methods. The primary benefit of game theory, for example, was facility not in solving academic game-theory math problems but in conveying concepts such as how to recognize prisoner-dilemma-type tensions, opportunities for a non-zero-sum game approach, and the pressures creating Chicken-game behavior.

Observation 3-1. Building Air Force Subject Matter Expertise. Improving analysis of deterrence and assurance problems will depend on the systematic education and nurturing of experts that exposes them over time to a rich suite of methods.

Finding 3-1. Long-Term Career Development. Education and nurturing of experts in deterrence and assurance will not happen without a management plan to do so in the Air Force (and other services, particularly the Navy), partly in coordination with joint assignments but also bearing in mind longer-term career development and assuring adequate expertise (a Service responsibility).

After considering a much broader range of methods, the committee pruned to the still-sizable list in Table 3-1. The leftmost column groups the methods in three major classes: those that help to collect, organize, or analyze data; those that involve knowledge structuring, model building, and theory building; and those for analysis to aid decision making. The committee did not include methods regarded as simply part of the baseline (e.g., operations research, statistics, quantitative political science, simulation, standard game theory, and standard decision analysis) or as having less potential for deterrence and assurance. Subsequent columns in Table 3-1 connect to the issues identified in Chapter 2 as particularly important for the study. The committee identified some methods relevant to all of those issues. The number of bullets shown in the table cells convey a rough sense of relative strength with no pretense of rigor.

The following sections cover the individual methods in the left column in the order shown (readers may wish to proceed in a different order). Level of discussion varies based on the methods' relative familiarity, their significance to the study, and the committee's use of appendixes for detail. The issue of validation is discussed along the way.

TABLE 3-1 Selected Methods to Address Issues in Analysis of Deterrence and Assurance

Methods	General Deterrence	Test Cases for Planning	Beyond Rational Actor	Planning Under Uncertainty	Anticipating the Unexpected	Safe, Secure, and Effective
Empirical and quasiempirical						
Data collection	••	••	••	••	••	
Crowdsourcing						
Data mining						
Social science analytics	••••	••	••••	••	••	
Case studies and narratives						
Content analysis and profiling						
Social network analysis						
Gaming and computational experimentation	••••	••	••••	••	••	
Human gaming						
Computational experimentation						
Knowledge organization, modeling, and theory						
Frameworks and qualitative modeling	••••	••••	••••	••••	••	••
Broadened framework of decision making						
Complex adaptive systems						
Causal system depictions						
Qualitative system modeling						
System diagrams						
Factor trees, cognitive maps and models						
Qualitative game theory						
Computational modeling		••		••	••	
System dynamics, Bayesian nets, influence nets						
Game-structured agent-based modeling						
Modeling of limited rationality						
Analysis						
Analysis methods	••••	••••	••••	••••	••••	••••
Leadership profiling						
Analyzing receptivity issues						
Exploratory analysis and robust decision making						
Strategic portfolio analysis						
Synergy across methods	••••	••••	••••	••••	••••	

NOTE: Number of bullets indicates subjectively assessed relative applicability.

EMPIRICAL: DATA COLLECTION AND SOCIAL SCIENCE ANALYSIS

The committee begins with empirical methods for crowdsourcing and mining of big data.

Crowdsourcing

Crowdsourcing taps into the knowledge of a group of people with diverse perspectives, sources of information, or ideas about an issue of interest. It reflects the Aristotelian view that wisdom is to be found in the mean: that querying numerous individuals with knowledge of different aspects of a problem will produce the most comprehensive and truthful picture. Crowdsourcing is most commonly associated with extraction of knowledge from geographically distributed groups, especially via the Internet. It has a different purpose and character than usual public polling.

One approach to crowdsourcing uses a wiki-type collaboration information system that allows knowledgeable people to modify information until the crowd reaches relative consensus. Another approach has "information markets" in which invited or self-selected participants bet on the likelihoods of future events or responses to those events. This approach can yield on-the-ground information from, for example, locals, aid workers, journalists, and others. Web-based methods, especially where immediacy and absolute precision are unnecessary, can be significantly less costly than other collection methods

Caveats. The cautions in interpreting crowd-sourced results are similar to those for interpreting public opinion polling. What types of individuals contributed? Did they have good information? What were their likely biases and how representative were they for the information asked? Second, variation is important. Were there significant outliers or a bimodal distribution, in which case the aggregation could be misleading? A problem related to the first caution is that it can be difficult to identify, check, and incentivize the most appropriate individuals to contribute. In particular, government-run crowdsourcing may be viewed with suspicion. For this or other reasons, private companies can sometimes do better in this regard.[1]

Big Data Mining

Experiments, observations, and numerical simulations in science and business are currently generating terabytes of data, verging on petabytes and beyond.[2] In contrast to traditional isolated analysis, the paradigm for "big data" is often for

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[1] Companies offering crowd sourcing analyses include Monitor 360 and Wikistrat. RAND researchers have also developed a system Called ExpertLens (Dalal et al., 2011).

[2] Terabyte, petabyte, and exabyte correspond to 10^{12}, 10^{15}, and 10^{18} bytes, respectively.

highly distributed groups to share data routinely.[3] Analyzing such information has led to breakthroughs in such fields as genomics, astronomy and high energy physics. The scientific community and the defense enterprise have long generated and used large data sets, but the commercial sector is now a major player. Google, Yahoo!, and Microsoft have data in exabytes. Some social media (e.g., Facebook, YouTube, Twitter) have hundreds of millions of users.

Data mining is transforming the way one thinks about "crisis response, marketing, entertainment, cybersecurity, and national intelligence" (National Research Council, 2013). It is also transforming how one thinks about information storage and retrieval. "Collections of documents, images, videos, and networks are thought of not merely as bit strings to be stored, indexed, and retrieved but also as potential sources of discovery and knowledge"—although exploiting the potential requires "sophisticated analysis techniques that go far beyond classical indexing and key-word counting"—such as finding relational and semantic interpretations of the underlying phenomena (National Research Council, 2013).

Caveats. The potential of the big data approach is undeniable. At the time of its study, however, the committee did not yet see successful unclassified applications clearly relevant to deterrence and assurance, although it noted opportunities as mentioned in the later section on Content Analysis. Further, the committee noted that inquiry seems to be strongly data-driven without adequate grounding in theory and with "validation" often discussed only in statistical terms. The committee did not look into intelligence efforts, such as those of the National Security Agency (NSA), where the situation may be different.

SOCIAL SCIENCE ANALYTICS

Case Studies and Narratives

Some of the most important social science methods relevant to deterrence and assurance involve comparative case studies or the somewhat related approach of cultural narratives. Although not new, both are underused in DoD's work on deterrence and assurance.

Comparative Case Studies

"Structured, focused comparison of cases" (George and Bennet, 2005) can illuminate how deterrence, assurance, dissuasion, and compellence actions and messages have been handled in real-world crises. Scholars working with such diverse sources as memoirs, declassified archives, oral histories, public statements

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[3] This discussion is based on a National Research Council report (2013).

and documents, and with secondary literature as well, describe with a high degree of fidelity and texture the context for and activities in cases, including cases in which the background of nuclear weapons played a role. It is of particular value to *compare* studies chosen to be different along important situational dimensions. Doing so converts descriptive explanations of case outcomes into analytic causal but contingent explanations: a form of inductive theory building rather than raw empiricism. It identifies the "real" factors that appear to have been at work (e.g., sometimes personal and emotional, sometimes political) rather than restricting discussion to easily measured abstractions (e.g., population or force ratios).

Caveat. The final history is never written. Case studies must be revisited as new information arises that alters the inferred story, to include perceiving how deterrence was attempted and how signals were perceived.[4] Comparisons and debates are important because results can depend on both methodology and assumptions.

Cultural-Narrative Case Studies

A narrative is a spoken or written account of connected events. Cultural narratives are about a society's ideas, customs, and social behaviors. Understanding them may improve deterrence and assurance by allowing better messages to be crafted for a particular population or leader. Narratives are defined by their sequence and consequences with events selected, organized, connected, and evaluated as meaningful for a particular audience (Riessman, 1993). They shed light on such aspects of culture as values, morals, and perspectives (Chay, 2013). Narratives are seen as produced by people in a specific social, historical, and/or cultural context, and as devices through which individuals represent themselves and the world around them (Griffin, 2013). An example of where narrative analysis may be useful for deterrence and assurance is when it reveals "sacred values," defense of which may cause behaviors that would appear irrational to those from another culture.

Narrative analysis includes *thematic, structural, interactional, and performative* aspects. Thematic analysis focuses on the "what"—that is, on the meaning rather than the language used. It looks across stories in different styles to find common elements of meaning. Structural analysis focuses on how a story is told—examining syntax, rhythm, and pattern of words and sounds. It is currently arduous for long narratives. Interactional analysis emphasizes the process of teller and listener—that is, the exchange between storyteller and listener; it usually requires transcripts of conversation. Performative analysis examines the method of transmission, including who is involved, who persuades, and who does the storytelling.

Caveats. Understanding narratives is unquestionably important (as has long been recognized by intelligence services), but even a valid narrative for a society

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[4] See Gerson (2010) for an example mentioned also in Chapter 2.

may not be characteristic of how leadership will reason or act. To some extent, leaders choose among themes or even modify them (think of Anwar Sadat in 1977 or Vladimir Putin in 2014). It is also possible to detect a valid theme but exaggerate its importance in determining actions. It follows that narrative analysis is probably more valuable for identifying factors and *possible* reasoning patterns than in reliably predicting actions.

Related Methods

The committee considered a number of other methods that, broadly speaking, are in the same category as case studies and narrative but are not discussed here. In particular, the committee was briefed by William Casebeer of the Defense Advanced Research Projects Agency (DARPA) on a program concerned with narratives, neurobiology, and implications for subjects such as radicalization and messaging strategies. See particularly Post (2003), including articles by Margaret Hermann and others.

Content Analysis and Profiling

Content analysis is the systematic retrieval of contents from a picture or a text. The content may be fact or fiction and may be manifest or latent (obvious or inferred). It may be keyed to different units such as words, phrases, sentences, or paragraphs. The assumption in content analysis is that the material studied contains information about the source's state of mind or information. Content analysis draws on data from, among other things, dreams and diaries, feelings and thoughts, and behavior and events in human societies (McClelland, 1961; Carney, 1972; Holsti, 1969). As discussed later in this chapter under "Analysis Methods" and in much more detail in Appendix E, modern quantitative content analysis can be a powerful tool in developing and updating leadership profiles directly useful for deterrence and assurance.

Information retrieval more generally may be qualitative or quantitative and may be recorded in narrative, statistical, or visual formats. Related tools are ordinarily based on theoretical constructs that help interpret the results. Several constructs categorize behaviors in world politics. The basic categories of behavior are (1) types of words and deeds and (2) types of cooperation and conflict behavior. Evidence on the behaviors is retrieved from sources such as newspapers and other media. Trends are then observed regarding the variety, sequence, volume, and intensity of actor behaviors in interactions with others. Speeches and interviews are analyzed to retrieve thoughts, beliefs, emotions, and motivations (Post, 2003). Well-validated tools are available, some of them automated (Smith, 1992; Post, 2003; Young, 2001).

TABLE 3-2 An Example of a Taxonomy and Scale for Interactions

Conflict		Cooperation	
Deeds	Words	Words	Deeds
Force (−10)	Threaten (−5)	Approve (+1)	Yield (+6)
Seize (−9)	Warn (−4)	Consult (+2)	Grant (+7)
Expel (−8)	Demand/accuse (−3)	Request (+3)	Reward (+8)
Reduce relations (−7)	Protest (−2)	Propose (+4)	Agree (+9)
Demonstrate (−6)	Reject/deny (−1)	Promise (+5)	

NOTE: Numbers in parentheses illustrate values of escalation and de-escalation of conflict or cooperation behavior.
SOURCE: Data from McClelland (1972, pp. 96-97; 1968, p. 168).

Prominent examples in world politics use scales developed some years ago (McClelland, 1966; Schrodt, 1994; and Goldstein, 1992). All of these base their categories on word/deed and conflict/ cooperation distinctions. The automated descendants of these early coding schemes employ dictionaries of synonyms for various transitive verbs. They retrieve not only verbs, but also nouns representing the relevant subjects and objects of the verbs in the text. It is now possible to conduct a huge quantitative content analysis of electronic text quickly.

Table 3-2 illustrates a scale stemming from such work. Such a scale might describe evidence relating to escalation, de-escalation, or cooperation over a crisis period . The scale uses event categories from the World Event Interactions Survey (McClelland, 1972; see also McClelland and Hoggard, 1969). They distinguish cooperation and conflict by rankings along a continuum of words and deeds, with deeds ranked as more intense instances of cooperation or conflict than words. The scales used (−10 to 10, with protocols for assigning values) have been subjected to both conceptual and empirical scrutiny for reliability and validity (e.g., McClelland and Hoggard, 1969; Hermann 1971; Kegley, 1973; Beer et al., 1992). The assessments report good reliability except for some problematic distinctions among categories at the upper end of the cooperation continuum (Beer et al., 1992).

Scholarly controversies exist over whether these categories should be seen as measuring intervals, measuring ordinal rankings, or simply indicating nominal but independent categories. Thus, the methods may be seen as quantitative or qualitative (McClelland, 1983; Howell, 1983; Vincent, 1983; Beer et al., 1992), which affects the mathematical sophistication that can be used. However, even the more qualitative versions allow monitoring activities for changes in indicated trends toward escalation, de-escalation, or cooperation, and perhaps what actions may

be expected of an adversary or ally (Walker et al., 2011; Walker, 2013). Again, see Appendix E for more details relevant to deterrence and assurance.

Caveats. Practitioners have varied skill—for example, in extracting valid insights in the midst of boilerplate and sometimes hypocritical prose. Also, certain kinds of evidence can be manipulated (a country may, for example, release materials intended to threaten and scare without the intention of action, or may release materials intended to soothe despite actual malintent).

Social Network Analysis

Sometimes deterrence requires understanding groups and networks rather than just individuals. An element of doing so is social network analysis (SNA). In the popular psyche the notion of tracing complex networks of social connections shows up in the common acceptance of the idea that any two people on Earth are separated by no more than six degrees of separation, as popularized in the Broadway play by John Guare and the popular Kevin Bacon game.[5]

SNA refers to an application of network theory to the study of complex, formal and informal social systems.[6] SNA views the links between actors as the "channels for transfer or 'flow' of resources (either material or nonmaterial)" (Wasserman and Faust, 1994, p. 4).[7] The unit of analysis is not the actor itself but the *network* that consists of the actors and the linkages between them. SNA can be applied to vastly different networks, such as national-leadership groups, graduates of military academies and exchange programs, academic researchers, or to church and neighborhood groups. Typically analysts begin an SNA analysis by constructing an adjacency matrix or a sociogram to visualize a social structure in which people or organizations are represented as "nodes" and the relationships or linkages as "edges" (see Figure 3-1). Linkages can be direct (e.g., brothers, sisters, coworkers), or indirect, as in a common demographic such as age or sex or some other shared attributes (graduation from the same college).

Once the network has been defined, metrics can be calculated to aid in analysis and interpretation. Centrality measures characterize the relative importance of a node in a network—for example, "degree centrality" which calculates the number of direct ties to a node; "betweenness centrality," which measures the relative importance of a particular node by how many other nodes it connects to; and

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[5] To play the Kevin Bacon game, players search for the shortest connections between a chosen individual and the actor. For example, an individual's Bacon number would be 6 if his or her second cousin was Anne Bancroft, Anne Bancroft was in *Waking Ned* with Ian Bannen; Ian Bannen was in *Braveheart* with Mel Gibson; Mel Gibson was *in Bird on a Wire* with Goldie Hawn; Goldie Hawn was in *Housesitter* with Steve Martin; and Steve Martin was in *Novocain* with Kevin Bacon.

[6] Sociogram source: de Nooy et al. (2005, p. 5).

[7] Wasserman and Faust (1994).
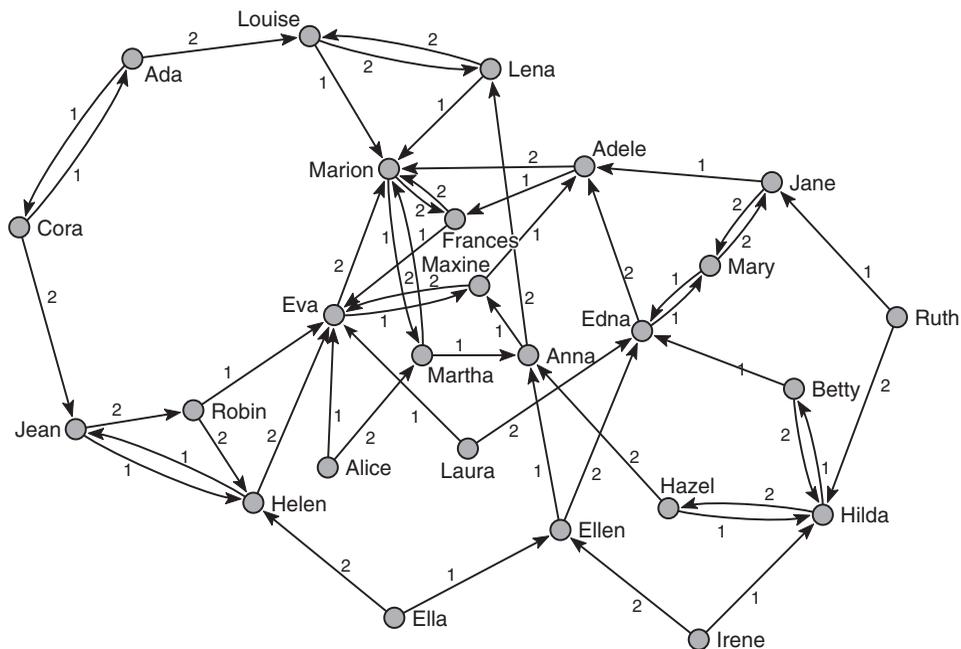
FIGURE 3-1 Nodes and edges in a social network. SOURCE: de Nooy et al. (2005), copyright 2005, reprinted with permission of Cambridge University Press.

"Eigenvector centrality," which measures a node's influence by the number of its connections while giving greater weight to high-value connections.

SNA has been widely applied in sociology and other social sciences. It has proved useful in applied settings such as law enforcement, threat finance, counterinsurgency, and counterterrorism. In the area of deterrence- and assurance-related assessment, SNA can be used to test models and hypotheses about relational structures or networks. It would be an appropriate tool for addressing questions of the following types: Which nodes (individuals, organizations, etc.) in a network are the most critical to its operation? What is the structure, density, and size of a human network? What is the nature of the power relations? How has a group gained and retained its power? How can a leader be influenced by threatening to or actually affecting those to whom he is linked and on whom he is dependent for power?

Caveats. The compilation and coding of network information can be long and tedious. Moreover, while relatively simple in concept, analytic interpretation of centrality and other measures requires knowledge and technical expertise. Also, SNA's scope is limited. It would not be an appropriate method to assess, for example, the substance of an actor's intention and world view, leadership style, decision-making style under threat or stress, or other nonnetwork-related attributes and behaviors.

QUASIEMPIRICAL SOURCES:
GAMING AND COMPUTATIONAL MODELING

This section discusses important sources of what we have called quasi-empirical information in the categories of human war-gaming and computational modeling.

Human War-Gaming

Human war-gaming has been used for centuries in a variety of ways, as discussed in a book by Peter Perla (1990). The perspective and observations made here are more narrow, reflecting certain types of military war gaming conducted by the Services and major commands, sometimes through war colleges (Downes-Martin, 2013).

Seminar War-Gaming

The goal of a war game is to provide insights by identifying hypotheses for testing by other means. There are three main challenges when using seminar war-gaming within military organizations to explore strategic nuclear deterrence.

First, unlike tactical conventional kinetic warfare, there is no long history of understandable results with credible statistically valid data for activities related to strategic nuclear deterrence. War-game adjudicators therefore have no rules determining the possible outcomes between protagonist players' decisions. The second challenge stems from the first in that the need to develop rules at the time means that the adjudicators are de facto decision makers or players—even dominant players—something very different from their ostensible role as impartial referees. This suggests that war games dealing with strategic nuclear deterrence should collect data and information from adjudication teams as from traditional player cells. This is not usually possible because it would mean additional and time-consuming overhead, making it difficult to have an effective game within the usual one-week time period allocated by major commands for a war game.

A third challenge is that decisions made during game play are probably poor proxies for decisions that even the same players would make in real life.[8] Fortunately, strong evidence from psychological research, as well as observation of games, indicates that their beliefs about a situation and their reflexive decision-making styles and preferences are more stable, even when they are confronted with credible evidence.[9]

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[8] Jervis (2006, pp. 3-52); Wilson (2002); Pronin (2007); Nisbett and Wilson (1977, pp. 231-259).

[9] Ross and Anderson (1982, pp. 129-152); Ross et al. (1975, pp. 880-892); Anderson et al. (1980, pp. 1037-1049).

Observation 3-2. Effective War-Gaming. It is more fruitful to design war games to understand player *beliefs* and perspectives, than to treat decisions within games as reliable information. The focus should be on the *reasons* for decisions, the messages sent and received, and the interpretations and misinterpretation of messages.

If these reasons are understood, then it should be possible to embed the underlying belief systems in models, simulations, and analysis for subsequent research (see also the section on synthesis). Seminar gaming is also conducted in other settings, such as civilian think tanks. The purposes are then different, as are their challenges. In some cases, members of the adjudication team may reflect deep knowledge (sometimes from prior real-world experience) regarding how decision makers would reason and about possible political and economic consequences of decisions not so evident to more typical adjudicators. So also for members of the country teams. Even so, the games are likely to provide better insights about factors, considerations, and beliefs than about what decisions would actually be.

Lessons To Be Learned from War-Gaming

War games as practiced at the Air University and the Air Force Global Strike Command (AFGSC) in recent years have had some severe limitations. Annual end-of-the-year Air War College and Air Command and Staff political–military games have often not had the objective of representing weapons of mass destruction (WMD) play. Controllers have often outlawed early use of WMD because it would stop the game, thereby ruining the opportunity for participants to go through the learning of routines that are the purpose of the games. This may have communicated the wrong lessons on WMD play because of artificial restraints.

War games involving nuclear exchanges conducted by AFGSC may err in the opposite direction. These exercises usually begin with early use of nuclear arms and do not include decision makers who have political or diplomatic roles. Each exercise thus is a walk up the escalation ladder without remedy to diplomatic or political means of arresting the conflict. These games have also omitted use of chemical and biological weapons in conjunction with nuclear employment, even though possible U.S. adversaries have a combination of such WMD assets.

AFGSC games are designed to start with early nuclear use. Such games avoid the problems of the Air University games because nuclear weapons employment is not arbitrarily prohibited. Indeed, the games are designed to acquaint participants with the nuances of nuclear warfare. However, the lack of a means of achieving a diplomatic end to such conflict in games may lead participants to the dubious belief that they can play nuclear chess. This remains highly speculative since there exists no historical record by which to judge. *There is also no way to know if real decision makers in actual future crises and conflicts would act in reality as they act in games.*

Caveats. War gaming must be integrated with other methods of inquiry and analysis since such war games by their nature do not prove or validate anything; any specific war game is a single trajectory through the space of possible scenarios defined by the interactions of all players in a game. Even the broader insights gained from post-game "hot washes" discussing both a particular game and what might have been must be regarded as tentative. That said, they can be quite valuable. Further, players learn a great deal about the relevant strategic "chessboard."

Computational Experimentation

Significance

Computational experimentation systematically harnesses a causal model of a phenomenon to conduct "experiments" over much of the model's operating domain, generating substantial "data." In some problem domains (e.g., in some engineering applications), the model may be validated, in which case the data can treated as empirical. More relevant to this study is computational social science in which the model in question is afflicted with uncertainties of two primary types: (1) parametric (i.e., input uncertainty) and (2) structural (i.e., uncertainty about the model's content, such as completeness of its variables and the algorithms by which they interact).

Computational modeling will be discussed primarily in later sections relating to knowledge and theory development, but its data-generating role has become important with the advent of new technology, computer power, and conceptual approaches to analysis. This section discusses the vexing and cross-cutting problem of validation. Some of the points apply more broadly to validation of qualitative models as discussed in the next section.

Validation

Given the uncertainties typically associated with social-science computational models, a fundamental question is how they can be "validated" and what that should mean. A modest but thoughtful literature exists on this subject.[10] It is inappropriate to see the models as "predictive," as are models in the physical sciences

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[10] See McNamara et al. (2011) and Bigelow and Davis (2003), which discuss validation for an analogous class of computational exploration. For results of an National Research Council (NRC) workshop, see National Research Council (2011b) and the unedited proceedings at http://sites.nationalacademies.org/DBASSE/BOHSI/DBASSE_071321. An earlier NRC report discusses the different classes of uncertainty (National Research Council, 1997).

and engineering. Even so, exploration with such models can yield valuable insights. A natural and common rejoinder is, What good is a model if it can't predict? How can the insights allegedly gained be valid? The answers begin with the observation that qualitative models have long been useful in all walks of life. For example, they may characterize the system, its parts, and the ways in which the parts interact with each other and the external environment. Even if the consequences of the interactions depend on unknown at-the-time details, the models may provide a structure for understanding the system and adapting to developments.

The word "may" applies because the model must be sufficiently solid "structurally," and there must be some understanding of the range of plausible values for the variables within it.[11] That is, the model must incorporate the most important variables at work—the right "factors." Also, the model must convey a roughly right sense for how the factors affect system behavior. Fortunately, and despite their notorious shortcomings, experts in a given subject area usually have a strong sense of what variables matter and some sense about how they interact qualitatively.[12] It is possible to "validate" their judgments by, for example, consulting different experts; conducting case studies to see whether the variables that they identify appear to have been important and whether other variables had been omitted; and evaluating the qualitative theories logically.

Caveats. Computational experimentation can be a good source of tentative insight about subtle possibilities, including possibilities against which deterrent strategies should hedge. If the models have sufficient structural validity and uncertainties can be bounded, exploratory analysis can yield nontrivial insights. Those, however, must then be assessed separately, as are, for example, potential insights from war gaming or experience.

FRAMEWORKS AND QUALITATIVE MODELING

In this section, we start with two subsections providing frameworks for thinking about deterrence and assurance. The subsequent subsections then describe particular qualitative methods for modeling or building theory.[13] Some of these discuss qualitative aspects of what are more typically seen as quantitative methods.

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[11] A model can be useful even if based on assumptions known to be false. For example, a useful rational-actor model may claim that behavior will be *as though* reasoning followed rational-actor prescriptions (an argument first made by Milton Friedman).

[12] See Tetlock (2005 and earlier works).

[13] Whether a model is qualitative or quantitative is murky in both theory and practice. Included here as qualitative are models that may use numbers that are merely mapped from subjective measures such as "low" and that emphasize problem structure and logic rather than computations.

A Broadened Framework

Deterrence and assurance depend fundamentally on psychological matters. Those are often strongly affected by "objective" situational considerations, such as geography and relative power. However, to be deterred or assured involves a state of mind. As discussed in more detail in Appendix D, which draws on a rich multidisciplinary literature, it is useful to have a broad framework for discussing such issues.[14] The framework in Figure 3-2—for the simplified case of actor A and actor B—highlights a number of important concepts. First, the decisions the actors make (box in center) occur in an "external level" of context that includes the geopolitical situation, the relevant balances of power and threat, and so on. Second, decisions are ultimately made by some decision unit that may be a predominant individual, group, organization, or country and that may arrive at decisions based on any of a variety of processes characterized by rational-actor, limited-rational-actor, highly emotional, or other labels.

As if this were not enough complexity, the decision units of A and B are influenced by (note left column) systemic-, social-, and individual-level considerations. Here "social" includes type of regime and political system, standard operating procedures, factional interests, and related social psychology. "Individual-level" refers not just to the idealized thinking of the economic rational actor, but to psychological considerations such as beliefs, emotions, motivations, and personality traits.

Finding 3-2. Psychological Framework. Deterrence and assurance are largely psychological concepts. Thus, a proper evaluation of proposals for them will rely not only on the balance of military forces but also, whenever possible, on an understanding of the mindset and decision making of the adversary or ally.

As a corollary, the modern concept of "tailored deterrence" should be devised accordingly. As discussed at more length in Appendix D, a key element of this is how "messages" are passed and interpreted between or among parties ("messages" may range from diplomatic exchanges to signals accomplished with military or other actions). A substantial base of research describes just how complex and subtle such communication matters often are.

Finding 3-3. Tailoring Key Messages. To elicit the intended response, it is important for the sender to have methods and tools that can detect opportunities and send messages tailored to a recipient that is open (willing and able) to make a

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[14] As discussed in Appendix D, the construct uses the levels of analysis of Waltz (1959), alternative images of decision making introduced by Allison (1969) and supplemented by Post (2003), and ideas from, for example, Campbell et al. (1960) and Kegley and Witkopf (1982) among others.
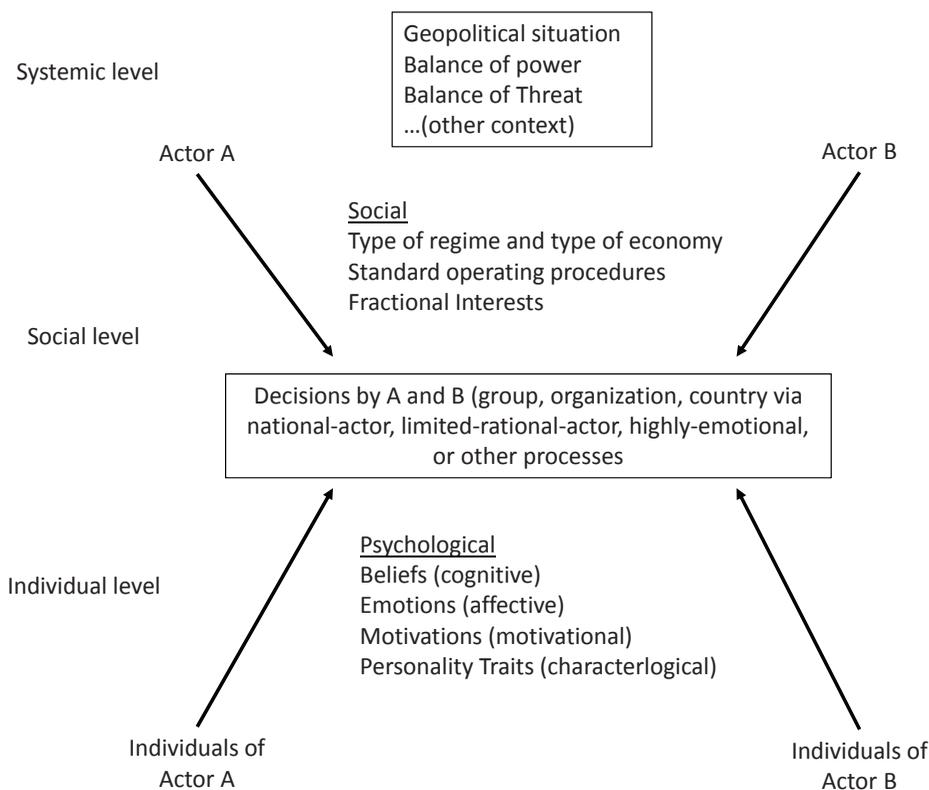
FIGURE 3-2 A broad framework for thinking about human decision making.

response based on available information rather than on motivational, affective, or cognitive biases in a deterrence or assurance situation.

This finding means that the deterrer needs to diagnose the situation, identifying the adversary's decision unit and elements within it, understanding when one or more elements is likely to be open or closed, what might be causing "blockages," how channels could be opened or open channels found, how messages of different types will be interpreted and how the likelihood of correct interpretations can be increased. Appendix D includes a relatively simple heuristic method (requiring analytic artistry, of course) for thinking through such issues.

Complex Adaptive System Theory

Figure 3-2 provides a kind of conceptual framework. An analytically richer scientific framework is provided by the theory of complex adaptive systems (CAS). CAS are usually described as hierarchical or nearly hierarchical collections of interacting entities that are adaptive in responding to each other and the external environment. Macroscopic system characteristics may "emerge" as a result of the interactions. Although CAS theory is quite general, it has been strongly motivated by such biological systems as the human body with its cells, tissues, organs, and functional systems. Most interesting social systems are examples of CAS, including a system of state and nonstate actors interacting in crisis.

A famous characteristic of complex adaptive systems is that—in some circumstances—small changes can have large and essentially unpredictable effects, sometimes with the system moving into one of two or more alternative states, to include peace or war. Describing a system in crisis this way is different from using a deterministic model that sees inexorable and predictable outcomes.[15]

CAS theory is a natural paradigm for work on deterrence and related matters and even for research on military matters more generally. Earlier NRC studies have urged DoD's modeling and analysis to embrace the CAS paradigm (National Research Council, 2006). Doing so should also be part of the basic education of analysts seeking to describe or understand phenomena such as deterrence.[16] Complexity thinking affects many of the other sections of this report, including that on computational modeling.

Caveats. As with many "new" and important subjects, CAS research is sometimes afflicted with breathless popular accounts, amateurish attempts to apply its concepts, and exaggerated claims about the usefulness of related models and the validity of their predictions.

Qualitative System Modeling

The subject of deterrence is both complex and "soft" because it is about the thinking and behavior of people influenced by myriad interacting factors. Qualitative system modeling can be quite fruitful in understanding situations and evaluat-

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[15] Books by pioneers are still especially illuminating (Holland and Mimnaugh, 1996; Gell-Mann, 1994). Some texts on CAS and agent-based modeling are Bar-Yam (2003) and North and Macal (2007).

[16] See Robert Jervis on applying complexity theory to war-and-peace issues (Jervis, 1997a,b).

ing strategies.[17] It can have many of the virtues of system modeling generally: (1) representing the "whole," (2) characterizing influences, (3) representing interactions and feedback effects, and (5) conveying a coherent albeit complex story. In contrast with many quantitative models, however, these do not purport to predict or forecast—something arguably beyond the pale in the presence of deep uncertainties, as discussed later in the analysis section. The following subsections discuss three classes of qualitative model.

System Diagrams of System Dynamics, Bayesian Nets, and Influence Nets

MIT-style system dynamics is more fully described in a later section under computational modeling, but a key element is its use of causal-loop and stock-flow diagrams that convey a "system map" or "system view."[18] Somewhat analogous "influence diagrams" stemming from Carnegie Mellon research by Granger Morgan and Max Henrion serve similar purposes.[19] System Dynamics is especially good at representing dynamical developments in systems with feedback loops. The Morgan-Henrion style has advantages for uncertainty analysis, multiresolution modeling, and decision aiding.

Other approaches using diagrams for visual modeling are Influence Nets and Timed Influence Nets, which stem from earlier work in Bayesian inference networks and related influence diagrams (with a different meaning of the term).[20] Belief networks and related influence diagrams are directed graphical representations for models of probabilistic reasoning and decision making under uncertainty. They capture important relationships among uncertainties, decisions, and values. Applications of Bayesian-net and influence-net methods abound, many of them in risk-related subjects and some related to national security (Caswell et al., 2011). Bayesian-net analysis requires a great many input assumptions such as conditional probabilities. Influence nets use an approximation that greatly reduces this

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[17] The committee considered quantitative political science and was briefed on recent interesting work related to nuclear matters. However, such research has limited value for its purposes because the historical data are and hopefully will remain sparse, and such work is usually about correlations, not the causality that decision makers often care about. Approaches that combine in-depth case studies and quantitative analysis would probably have more potential (Sambanis, 2004), as concluded also in a study of social science for understanding intervention operations (Davis, 2011).

[18] Sterman (2000) is a text. Specialized software tools include STELLA (from ISEE Systems) and VENSIM (from Ventana Systems, Inc.). A broad discussion of system thinking is in Senge (2006).

[19] See Morgan and Henrion (1992), a textbook on uncertainty analysis. The associated software is Analytica, developed and sold by Lumina Corp. Its use of the term "influence diagram" is different from some decision-analysis subdomains, where diagram nodes have probabilistic meanings.

[20] A tutorial is available from the vendor for Netica, one of the tools available for such work at http://www.norsys.com/tutorials/netica/nt_toc_A.htm. A simple description from an authoritative volume is in Schachter (2007).

burden. An extension to "timed influence nets" has been used for some years in work at George Mason University, including simulation of crisis developments and deterrence.[21]

Factor Trees, Cognitive Maps, and Cognitive Models

Recent DoD-sponsored research introduced deliberately simpler diagrams, *factor trees*, which show the factors influencing something of interest at a slice in time, such as whether an individual will become a terrorist or whether a population will support an organization that uses terrorism. [22] Factor trees have proven effective for interdisciplinary discussion involving social scientists, officials, and military officers. They have been used in both unclassified and highly classified work. Factor trees can be turned into modular computational models that exploit more social science knowledge. However, because of uncertainties, they should be used for exploratory analysis, as described in the later section by that name, rather than forecasting.[23]An example, Figure 3-3, shows a factor tree for public support for insurgency and terrorism. The structure of this qualitative model was developed in one project and then subjected to validation testing in a study using new case histories involving al-Qaeda, the Taliban in Afghanistan, the Kurdistan Workers' Party (known by its Kurdish acronym, PKK) in Turkey, and the "Maoists" in Nepal. The validation testing was encouraging; it led to modest refinements and sharpening but nothing new structurally.[24] The factor-tree approach should be directly useful in modeling deterrence and assurance issues.

Other qualitative diagram-based methods also deal with the thinking of individuals and groups. One method is cognitive mapping, as in the work of Robert Axelrod[25] and subsequent efforts.[26] A different kind of cognitive map appears in several strands of British work, including some that use such qualitative extensions of game theory as hypergames and drama games, which apply to problems involving confrontations and misperceptions. Participant may effectively be "playing

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[21] See Levis et al. (2010) and earlier work referenced therein. Some of the Wagenahls-Levis work supplemented human play in war games at the Naval War College. SAIC (now Leidos Corp.) has developed proprietary tools called SIAM and Causeway for applications to government and industry, including crisis simulation work. An overview is available at http://www.inet.saic.com/inet-public/inet-intro.htm.

[22] Davis and Cragin (2009).

[23] Davis and O'Mahony (2013).

[24] Davis et al. (2012).

[25] Axelrod (1976).

[26] The term "cognitive map" has many meanings with related streams of literature. It did not seem appropriate to discuss most of them here.
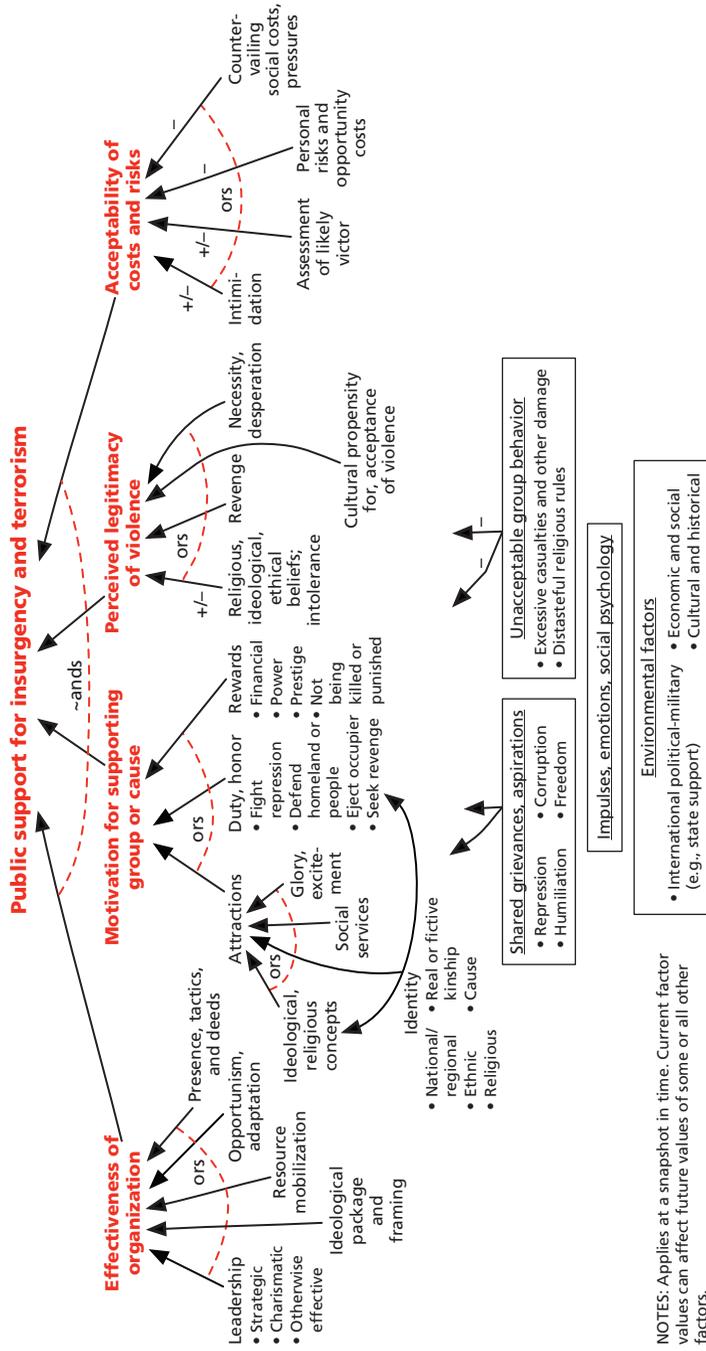
70

FIGURE 3-3 Factor tree for public support of insurgency and terrorism. SOURCE: Davis et al. (2012), adapted with permission by the RAND Corporation.

different games" and thus not even be sharing the same "gameboard," emotions, and other complications—all relevant to deterrence research.[27]

More specific to deterrence, simple *qualitative cognitive models* expressible in diagrams and hierarchical decision or outcome tables have been used to understand the potential reasoning of adversaries such as Saddam Hussein in 1990-1991,[28] Kim Jong Il in the mid-1990s, and terrorist leaders in recent times. These can aid coherent discussion of *different* ways in which adversaries may reason and aid development of related hedged strategies. Such hedging is important because best-estimate assessments of adversary thinking have often been quite wrong (a problem highlighted in Chapter 2).[29] Such cognitive models can be informed by a combination of strategic thinking, personality profiles, as discussed later in this chapter and Appendix E, and additional inputs from regional/cultural experts.

Caveats. As with other methods, the value of qualitative modeling depends on the particular modelers and analysts, their access to relevant information, and exposure to peer review. Considerable knowledge and sophistication are necessary, even though some of the methods appear simple.

Qualitative Game Theory

Game theory has long been important background for strategic thinking and practice with the basic concepts providing insights and language, such as Prisoner's Dilemma or Chicken. These are useful even in real-world problems that are far more multidimensional and otherwise complex than can be dealt with convincingly by mathematical game theory. The committee does not review game theory here, instead regarding it as part of the baseline of methods. As discussed in Appendix D, however, it is useful to highlight certain advances in qualitative game theory that are valuable and simple enough to be understood and used, if only for background. Appendix D illustrates these by discussion of advances in the 2×2 "ordinal" game in which players have only two strategies and four possible qualitatively expressed outcomes to consider. This is by contrast with having more options, quantitative evaluations, and the need to make sometimes tricky mathematical calculations.

The primary innovations with significant value for drawing insights include using (1) sequential games in which the sides alternate in their moves until play stops and (2) allowing for asymmetric and perhaps incorrect information. In contrast with traditional game theory, results are seen (realistically) to be very dependent

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[27] See British work (Bennett, 1985), including some applied to understanding and succeeding in operations other than war (Howard, 1999).

[28] These grew out earlier work that built massive "analytic war games" with optional agents for decision making by U.S. or Soviet leadership. One conclusion was that the cream could be skimmed in representing adversary reasoning with drastically simpler qualitative models.

[29] See National Research Council (1997), which drew on previous work (Davis and Arquilla, 1991).

on where the game begins, what sequencing occurs, and who has the "move power" to end the game. It follows that game outcomes include some worrisome situations that are not the familiar Nash equilibria of static game theory: they reflect dilemmas analogous in significance to, say, the Prisoner's Dilemma or the game of Chicken. Game theoretic methods are valuable not only because of their insights but because, despite their simplicity and unpretentiousness, they add important aspects of realism that can readily be communicated and learned.

COMPUTATIONAL MODELING

Earlier discussion covered some of the same tools but emphasized their qualitative-modeling aspects. Here the discussion is about computational capabilities.

System Dynamics, Bayesian Nets, and Influence Nets

MIT-style System Dynamics, mentioned above, was introduced about a half-century ago (Forrester, 1963, 1969, 1971) and is well described by a modern textbook with examples and problem sets (Sterman, 2000). It was remarkable in part for taking on "soft" social problems of great significance and bringing to bear mathematical and computer methods familiar from other disciplines. One stumbling point was *Limits to Growth* (Meadows, 1974), a book that was contentious for both good and bad reasons. The book and the related controversy, however, stimulated constructive counterstudies and considerable progress in understanding how to use model-based analysis and how to improve the modeling itself (Greenberger et al., 1976). A 30-year retrospective is a well-regarded cautionary piece about the potential for societal "overshoot" due to the interactions between human development and other matters such as sustainability.[30] System Dynamics has been used extensively over the years and the approach remains vibrant. Other studies have used somewhat similar methods but different modeling tools.

A good deal of computational modeling has been used for defense work, much of it DARPA-funded science and technology.[31] Some has dealt with the road from crisis to conflict and escalation, as in work briefed to the committee by Alex Levis and Kathleen Carley from George Mason and Carnegie-Mellon universities. They used multimodels that combine timed influence nets, agent-based modeling, and system dynamics. Somewhat analogous multimodeling research is ongoing at other universities.

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[30] The Australian government's Commonwealth Scientific and Industrial Research Organization published a balanced review that compares actual developments over the 30 years with scenarios examined in the original work (the work held up rather well).

[31] See Popp and Hen (2006).

Caveats. If studies involve major uncertainties, then models should be used for exploratory analysis, as discussed in the later section on the subject, rather than using just best-estimate cases and some excursions. Another caution is that the models in question often have buried structural shortcomings, as in assuming independence of events and ignoring some nonlinear effects. Finally, it is not customary as yet for such models to undergo the substantive peer review that would be necessary in strategic applications. So far, studies have often been better in their computer science than in the depth of their social science. Hopefully, that will change and there are great opportunities to be exploited.

Game-Structured, Agent-Based Modeling

Example from the 1980s

Lessons can be learned from a game-structured simulation that was developed in the Cold War as the RAND Strategy Assessment System (RSAS).[32] This was a global analytic war game covering conventional war through general nuclear war. It allowed for independent decisions by NATO, the Warsaw Pact, and individual nations such as Britain and France with their independent nuclear deterrent. Human teams or models (agents) could be used interchangeably.

Rather than trying dubiously to "optimize," the agents used heuristic artificial-intelligence devices. Higher-level models drew on escalation-ladder structures and the current and projected status of combat and conflict levels to make decisions. Operational war plans were modeled with what in artificial intelligence circles were called branched scripts (what a commander would call branches and sequels).

The RSAS had *alternative* versions of the top-level agents to embody different "mindsets." This innovation was significant because then, as today, experts argued about how the sides' leaderships would reason and act. Further, no one knew. In stereotype, one Red model was a determined "warfighter" reflecting Soviet military doctrine; another reflected the more pragmatic image many Sovietologists had of political leadership. Both models intended, however, to make rational decisions. Thus, the agents departed from their stereotypes: The warfighter might compromise and the "pragmatic" model might escalate.

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[32] See Davis and Winnefeld (1983) and Davis (1989). "Game-structured" means that the model was organized around decision-making entities (agents) as in a human war game. One simulation run was analogous to a single human war game. Only some game-structured models are "game-theoretic." For example, some combat models have the simulated commanders allocate their air forces and even ground forces so as to *optimize* simulation results, taking into account that the adversary model might be trying to do so also. See Hillestad and Moore (1996). Such methods are valuable for analysis dominated by physical phenomena such as conventional combat.

As one relevant example from 30 years ago, RAND conducted experiments with limited nuclear options. Blue had a model of Red, which had a simpler model of Blue, which had an even simpler model of Red. In some cases, Blue would use a limited nuclear option to "re-establish deterrence," as in NATO doctrine. Red, however, would perceive the act as Blue having initiated nuclear war and would immediately engage in all-out general nuclear war. In other runs, depending on details and model, Red would de-escalate or continue even though not having "won." This study cast doubts on NATO's concepts and plans for nuclear use shortly before collapse of its conventional defenses (Davis, 1989), suggesting that such late use might be especially ill-advised. The insights were similar to those from sensitive high-level U.S. war games conducted in the 1980s (Bracken, 2012). Another observation drawn by RAND was that many (most?) of the insights to be gained can be obtained with simpler models and even simpler methods, such as described elsewhere in this report (e.g., qualitative cognitive modeling).

Observation 3-3. Alternative Adversary Models. Because of irresolvable uncertainties, disagreements among experts, and the need to open decision maker minds to non-best-estimate possibilities, it is important to use *alternative* adversary models rather than relying on best estimates, however carefully developed.

This finding reinforces the need for leadership profiles as discussed later and in Appendix E, but with some tension because it emphasizes having alternative assessments.

Modern-Day Options?

Analogous game-structured computational models could be built today with more advanced technology.[33] The value of such work would still depend on the models representing deep knowledge of political and military issues and of human and organizational decision making. They would be even more complex because of needing to represent economic instruments of power, the interaction of multiple nuclear powers (some with chemical and biological weapons as well), and the consequences of precision weapons and the cyber and space domains. The classic escalation ladder could no longer be used as an organizing principle because the types of war have become intermingled. Such an enterprise would be a daunting and sizable undertaking, as was the 1980s effort, which stemmed from

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[33] Relevant technologies include agent-based modeling, multimodeling that combines models of different types (Fishwick, 2007), more powerful graphics, and mechanisms for exploratory analysis.

a recommendation of the Defense Science Board and was funded by the Secretary of Defense's Office of Net Assessment.[34]

Caveats. If one were contemplating a modern-day construct, it should be noted that, while the RSAS was technically successful, afforded insights, and became the basis for a number of studies, it proved too difficult for inside-government work, despite heroic efforts to make it comprehensible and modular (Hanley, 1991). The reasons included the sophistication needed, personnel turnover, and something more subtle: Effective use required independent thinking against the grain of conventional wisdom and with not too much respect for "best estimates." Such thinking is often not the strong suit of military or other government organizations.

Modeling of Limited Rationality

A cross-cutting issue in computational modeling (and, also in the qualitative modeling described earlier) is the type of reasoning assumed. Regrettably, too many modern computational models give their agents simplistic rational-actor algorithms. Fortunately (see also Chapter 2), the rational-actor model has been embellished and other steps taken to go beyond it by focusing on, for example, perceptions rather than reality, recognizing that utility functions (to the extent that utility functions exist and are stable) vary across individuals and groups and are often poorly understood by others, that individuals have only limited rationality, that agents in multiagent situations will assess their power positions relative to others and adjust their positions accordingly to improve their overall prospects, and that risk aversion is an important consideration.

One element of such work has been to represent rather predictable behavioral considerations demonstrated in experimental psychology[35] and discussed by some political scientists.[36] The most well-known consideration is described as "prospect theory," which asserts that a decision maker evaluates options differently depending on whether he is in the "domain of losses" or the "domain of gains." This explains why deterrence is easier than compellence: The perceived value from possible gains is seen as less than the perceived value of maintaining gains already achieved. Some such work is cross-cutting and discusses how rational-choice theory can perhaps accommodate prospect-theory effects (essentially by recognizing that utilities are

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[34] One modern game-structured simulation is the British Peace Support Operations Model (PSOM), used to support operations in Afghanistan. It was not designed to deal with nuclear issues or deterrence. See Body and Marson (2011) and accompanying articles.

[35] The work was pioneered by Daniel Kahneman and Amos Tversky. See Kahneman's Nobel address (Kahneman, 2002) and a recent accessible synthesis (Kahneman, 2011).

[36] See, for example, Jervis et al. (1985).

not stable and correcting for predictable situation-dependent effects, including risk-taking).[37]

In contrast to thinking in the 20th century, it is now increasingly recognized that the rational-actor model is not always appropriate, even as a normative standard. That is, it is not only not descriptive; it is sometimes not appropriate. This stems from recognition of the value of "naturalistic," heuristics-driven human adaptivity using cognitive short cuts.[38] Some of the literature discusses the need to synthesize the perspectives of rational-analytic and naturalistic reasoning, emphasizing that both classes have their place (Davis et al., 2005). Someone in the heat of battle should rely on heuristics, while someone in peacetime should take the time for more deliberate and rational-analytic reasoning. However, the heuristics should reflect knowledge informed by rational analysis and rational analysis should allow for creative thinking, which is often intuitive. This balanced perspective has recently been described by Kahnemann (2011), dissipating earlier controversy between the heuristics-and-biases and naturalistic schools.[39]

Observation 3-4. Modeling and Limited Rationality. Both qualitative and computational modeling in support of deterrence and assurance should incorporate aspects of "limited rationality" and even more strongly emotion-driven behaviors.

ANALYSIS METHODS FOR DECISION AIDING

The committee did not review methods seen as part of the baseline.[40] A number of advancements, however, are relevant to modern-day analysis of nuclear-force issues.[41] What follows highlights four methods with direct implications for deterrence and assurance studies. They deal with (1) leadership profiling), (2) analyzing

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[37] One often-cited paper was specifically undertaken to cross the intellectual divide between rational-choice and behavioral-theory perspectives (Bueno de Mesquita and McDermott, 2004). The article appears in one of two special issues of *Political Psychology* devoted to related matters (Volumes 2 and 3 in 2004).

[38] See Klein (1999, 2006a,b), Gigerenzer and Selten (2002), and Suedfeld et al. (2003).

[39] See Bueno de Mesquita (1997); National Research Council (2011a) and references therein, and DoD work with the Senturion model (Abdollahian et al., 2006).

[40] Examples include operations research, systems analysis, statistics, and classic game theory as described in, for example, Powell (2005), Washburn (2003), and Poundstone (1992). The first two are texts; the last describes game-theory history and its implications for arms races.

[41] One example showed attacking mobile launchers has more leverage than intercepting missiles in flight (Shaver and Mesic, 1995). A second example showed that optimizing resources to protect infrastructure has a different character when the infrastructure is large and attackers are limited (Brown et al., 2005). Third, optimizing to assure resilience involves sequential non-zero-sum games with three phases: (1) initial defense preparations, (2) an attacker observing the preparations, and (3) the postattack adapting with what remains.

receptivity of adversaries, (3) exploratory analysis and robust decision making, and (4) strategic portfolio analysis. The method of sequential ordinal games discussed earlier (under qualitative game theory) is also relevant.

Leadership Profiling

Motivation Approaches

As discussed in Chapter 2 and earlier in this chapter, deterrence and assurance depend strongly on the psychology of those to be influenced. It follows that we should be quite interested in developing profiles of both adversaries and allies. What profiling methods are available? As discussed in considerable length in Appendix E, drawing on substantial literature, two distinct approaches exist (each with many variations). The first may be seen as top-down and is based on developing a subject's psychobiographical background and then using the insights to assess current circumstances. The second approach may be seen as bottom-up and draws on more proximate evidence to infer characteristics such as openness and risk-taking propensity. This second approach emphasizes *quantitative content analysis*, as also discussed briefly early in this chapter. Methods have been developed and substantially refined that allow significant inferences to be drawn from, among other things, speeches, interviews, news conferences, diplomatic exchanges, and (in principle) classified documents. Changes in the inferred behavior over time can be particularly valuable. Appendix E describes both approaches in moderate detail and illustrates them by working through the example of Saddam Hussein, on whom a great deal of peer-reviewed research has been published illustrating the approaches.

Selected Observations

When decisions are made, psychological and social processes act as causal mechanisms of cognition, emotion, and motivation, which Ledoux (2002) calls the "trilogy" of the mind. Contemporary neuroscience focuses on how the brain's physiology generates these mechanisms (Schafer and Walker, 2006: 49, n. 2; see also Ledoux and Hirst, 1986). In this model, the brain sends and receives messages along neural networks containing information in the form of cognitions, emotions expressed as feelings, and motivations directing action (Ledoux, 2002).

Learning and adaptation reflect such stimuli and information stored in the brain: they are emergent properties of human decision-making. Beliefs and belief systems, in turn, reflect these properties as higher-level and relatively conscious knowledge networks that are activated and modified by such environmental stimuli as threats or promises, These knowledge networks are linked with more primitive,

lower level, unconscious elements of the trilogy outside the full awareness of the decision maker (Schafer and Walker, 2006, pp. 29 and 30). Observing the operation of these networks is difficult even if one has access to the decision maker and, certainly, if one does not (Schafer, 2000; Schafer and Walker, 2006).

While it is difficult to access and then assess the decision-making processes of a single leader, it is not impossible. The "at a distance" approach in political psychology infers subjective thoughts, emotions, and motivations of leaders and groups from the language that they use to express them. The assumption is that these sentient features of an individual or group can be modeled and tested (measured repeatedly) for accuracy with the aid of this information. These efforts yield a deeper understanding of the system of interest and its causal mechanisms. They may enable some predictions about future behavior under different assumptions about its evolving relationship to other objects. Fortunately, much can be done, as described in Appendix E.

Finding 3-4. Tailored Deterrence. The methods of content analysis and leadership profiling in conjunction with other methods have the potential to help meet requirements of actor-specific knowledge for a strategy of tailored deterrence. An alliance among content analysis, leadership profiling, abstract modeling, and gaming and simulations as a suite of methods is possible in order to solve the complex problems associated with studying the decision-making dynamics of single groups and multiple autonomous actors as decision units.

Understanding and Affecting Receptivity to Messages

As discussed earlier in "Content Analysis and Profiling," an important aspect of tailored deterrence must be understanding whether and how adversaries and allies receive "messages." The need to so has long been understood, but modern social-science methods provide a number of valuable ways to help. These are discussed in more depth in Appendix D, which includes a heuristic model (Figure D-2) that can be used artistically to diagnose the receptivity of the target, differentiating among different elements within the target, and to then identify priorities for "unblocking" channels when blocks exist (as is common). Although systematized and based on extensive theoretical and empirical scholarly research, the tactics and stratagems of the method relate well to real-world concepts familiar (if less systematically) to diplomats.

Exploratory Analysis and Robust Decision Making

With roots back to the early 1980s, a new approach to uncertainty analysis has evolved and been applied in many studies on defense planning, private-sector

strategic planning, and social problems such as climate change and water manage-ment.[42] The approach deals pragmatically with deep uncertainty[43] by better under-standing which such uncertainties matter most and where it is feasible, affordable, and fruitful to build hedges into plans, to prepare for inevitable adaptations, or both. The approach calls for exploratory analysis and seeks strategies that will be effective in any of a broad range of futures, although not optimal for any one of them. The methods are highly relevant to deterrence, assurance, and related matters where uncertainties loom large.

The concept of exploratory analysis is seemingly straightforward. If one has a good model representing the problem, but with the variables highly uncertain, then to test strategy options, one should want to know how they would perform throughout the entire scenario space or case space implied by the uncertainties. This goes far beyond sensitivity analysis around a standard case. A good strategy is one that would likely do well for much of the possibility space. Such a strategy would exhibit "FARness"—that is, it would be flexible, adaptive, and robust in the sense that it could accommodate changes of mission or objectives, changes of circumstance, and adverse shocks.

Modern methods allow such exploration, especially if the model is designed with two or more levels of resolution, in which case broad and comprehensible exploration can be made first, followed by more selective exploration of individual issues in more detail. "Scenario discovery" methods have the computer search for regions of case space that are, for instance, favorable or unfavorable.

Caveats. The value of exploratory analysis depends on knowing the primary factors, bounding uncertainties, and making judgments about what portions of the possibility space to plan for (which might be constrained by budget, technology, or plausibility). Tendencies to treat quantitative versions of such analysis as rigor-ous should be resisted and details of such uncertainty-sensitive analysis should be kept "down in the ranks," with higher-level discussions being simpler, more nearly qualitative, and unpretentious. The greatest value is in suggesting practical ways to cope with uncertainty with reasonable hedging and preparation for adaptation. If uncertainty analysis is obtrusive or complicated, it can become paralyzing or appropriately off-putting.

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[42] See Davis (2014), a review (Davis, 2012), Lempert et al. (2003), and a website on robust decision making, http://www.rand.org/topics/robust-decision-making.html.

[43] Deep uncertainties (a term apparently introduced by Kenneth Arrow) are those that cannot be treated fruitfully with probabilistic methods because, for example, we don't understand the phenom-ena, we don't know all the factors, or we understand the phenomenon and have the factors but not their distribution functions (Lempert et al., 2003). Deep uncertainty incorporates what has sometimes been called future-scenario uncertainty.

Strategic Portfolio Analysis

"Strategic portfolio analysis," as the term is used here, is an approach to analysis with the following features:[44] (1) a focus on aiding policy makers; (2) multiple incommensurate criteria, some of them soft and in tension; (3) visual displays facilitating qualitative and quantitative discussion and debate; (4) the ability to examine issues at different levels of detail, and (5) confronting deep uncertainty and, often, disagreement among policy makers, when establishing strategy and allocating resources.

It has a metaphorical relationship to financial portfolio analysis and is logically just another example of multiple-criteria decision analysis. Its character, however, is different from that of most such methods. It is much less about solving a mathematical problem (e.g., "optimizing") than discovering—amidst strategic uncertainties and disagreements—acceptably balanced strategies that attend adequately to the multiple considerations, in part by hedging. In a defense context, criteria may include acceptable predicted results for test-case scenarios stressing different aspects of capability; dealing with various types of risk and up-side potential; and costs.

Decision makers see option comparisons expressed with policy scorecards showing how well the various options perform by different criteria. This is the level at which strategic decision is encouraged because, for strategic problems, it is seldom that there are well-defined a priori "weights" for the different criteria or that prudent decisions will correspond to taking linear-weighted sums. To the contrary, policy makers contemplate the assessments, ponder, discuss and debate with peers to "discover" their objectives and values. They think about balance and hedging because they must pay attention to *all* objectives. Further, they must deal with uncertainties and strong disagreements.[45] Policy-maker review can include interactive probing to understand in more detail underlying assumptions leading to demands for refined options and criteria and guidance about balance. Such iteration can be rapid rather than requiring repeated extensions of lengthy studies.

It then becomes possible to construct a composite measure of option effectiveness. The de facto "utility function" involved may turn out be nonlinear and is a *product* of decision making rather than an input. Since it reflects prior iterative discussion, it can be very helpful in constructing better-crafted composite options attending to the multiple criteria. As an example for nuclear forces, a composite option might include adjustments in force structure, force posture (e.g., forward deployment or routine deployments), weapons mix, and changes of employment

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[44] For highlights, see Davis (2014), which includes references to more detailed work and a related tool.

[45] This type of thinking about "balance" was particularly evident in the speeches and actions of Robert Gates when Secretary of Defense.

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strategy. These adjustments might be tested for deterrence in scenarios with different assumptions about circumstances and adversary mindset, and for deterrence with different assumptions about what allies find reassuring. New methods exist for considering a vast range of possible composite options and then filtering to retain those that could plausibly meet decision-maker criteria.

Consistent with the general emphasis on coping well with uncertainty and disagreement, cost-effectiveness analysis treats effectiveness and costs as uncertain. Further, it evaluates options using different "strategic perspectives" to highlight how disagreements do or do not affect the relative attractiveness of options. For strategic forces, such alternative perspectives may amount to different relative emphasis on, say, modernization, current operations, robustness of deterrence, reductions of weapons, regional stability, and nonproliferation objectives. Overall, the method is useful for integrative strategic analysis and debate. Its strengths are framing issues and providing insights about balance across multiple objectives, thereby influencing resource allocation.

Caveats. Some aspects of strategic portfolio analysis are familiar and seemingly straightforward. In practice, developing the appropriate structures to support vigorous strategic-level debate and decision is difficult—in part because it requires confronting sensitive uncertainties and disagreements, and raising options and considerations that are contrary to prevailing thought. Useful versions may be impossible without strong support from top policy makers insisting that that the sensitive matters be addressed. In the corporate world, this is sometimes accomplished with outside strategic consultant companies enlisted by top corporate officials.

OPPORTUNITIES FOR SYNERGY ACROSS TOOLS, METHODS, AND APPROACHES

Opportunities exist for synergy among, for example, human gaming, qualitative and computational modeling, historical studies, and game theory—traditionally separate activities. A synthesis would improve the quality of knowledge. As an analogy consider that one lesson from the hard sciences and engineering when dealing with complex systems is that the model becomes the centerpiece of knowledge with experimentation used to test, falsify or affirm, and/or calibrate the model—but with no illusions about it being possible to base reasoning and decision making on experimental data per se because the necessary data cannot be obtained or maintained. The model must then become the workhorse for aiding decision. As a result, experimentation is designed to test the model wisely. Rather than squandering tests on circumstances for which the model can reasonably be expected to be accurate, the experiments are focused primarily where they might yield new information about serious inaccuracies, random instabilities, or magnitudes of effects.

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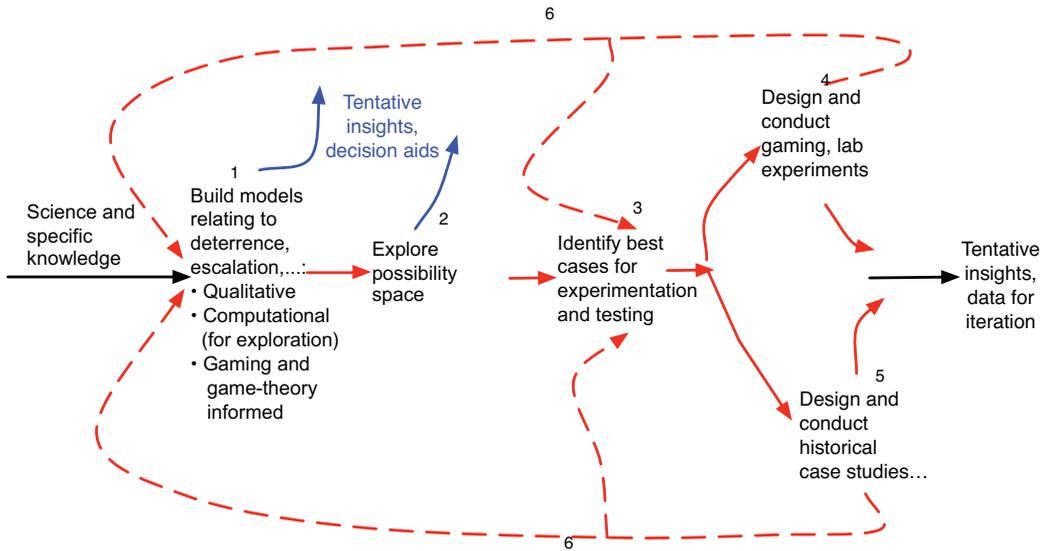
FIGURE 3-4 Synthesis of modeling and gaming approaches.

Figure 3-4 illustrates a concept that could be brought to bear in advancing the analytic study of deterrence-related issues. Some of its elements have precedent, but—overall—Figure 3-4 suggests a radically different approach to inquiry. It assumes that

1. An initial qualitative model is constructed drawing on the best social science, using both qualitative and quantitative methods and reflecting lessons from gaming and game theory.

2. A computational version is used for broad exploration.

3. Test cases are identified for more detailed experimentation, testing, and supportive research.

4. Such research is conducted using, among other things, human gaming, red teaming, and laboratory experiments (say, on behavioral matters), and also traditional social science methods such as comparative case studies.

5. Research results are folded back into the science and models with the process iterating (the time ordering is somewhat misleading, since knowledge building respects no particular sequencing).

Along the way, insights and data can be used (blue arrows pointing outward) as necessary, albeit with humility.

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The schema of Figure 3-4 is not unreasonably ambitious; it is merely a construct for more systematic investigations of a sort that we know from experience are possible but that do not occur routinely or consistently.

Caveats. The caveats applicable here include the accumulation of caveats of previous sections. It should also be recognized that the kind of agenda envisioned in Figure 3-3 is challenging and difficult. It should be seen as a continuing community-wide idealization rather than, say, the sketch of a single study.

Observation 3-5. Fostering Cross-Domain Collaboration. Perhaps the most important next step in methods relevant to deterrence and assurance would be organized support for *cross-cutting* work drawing on the tentative insights and analysis from such disparate domains as human war-gaming, qualitative sequential games, simple cognitive modeling, leadership profiling, computational modeling, history, and other sources. Much can be gained by encouraging and "forcing" the related tribes to deal with each other.

This finding should *not* be interpreted as recommending some grand integration in a comprehensive model. An effort to accomplish that would almost certainly fail. The image should instead be one of cross-cutting work to develop better insights and analysis.

CONCLUDING REMARKS

This chapter has provided brief overviews and pointers to the literature of the many methods that can be brought to bear in studying deterrence and assurance in the years ahead. The topics discussed represent the committee's assessment of which methods considered have the most value for deterrence and assurance work.

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4

The Recommended Way Forward

In some respects, nuclear deterrence and assurance are now more complex than during the Cold War. Deterring a new set of nuclear-armed or potentially nuclear-armed adversaries while also assuring threatened allies requires continuous and informed balancing of both objectives. As current nuclear nonpeers emerge as near-peers or peers, they may not act as we expect. The nonpeer states that currently possess nuclear weapons and who are developing them are often ruled by regimes difficult to penetrate and about which decision-making dynamics are difficult to divine. Planning for the future must accommodate the uncertainty associated with the transformation of regimes from those that are staunch adversaries to those that may be tomorrow's allies. The situation is further complicated by the need to address the possibility of surprise in areas of technology or unforeseen changes in equipment effectiveness. Finally, because research addressing deterrence and assurance has declined since the end of the Cold War, the conceptual basis for developing and improving U.S. strategy and for equipping forces may not be as robust as it once was.

In Chapter 3, the committee reviewed and assessed tools, methods, and approaches (collectively referred to henceforth as "methods") that might be used to improve our understanding of how nuclear deterrence and assurance may work or fail in the 21st century and the extent to which such failures might be averted by proper choice of nuclear systems, technological capabilities, postures, and concepts of operation for U.S. nuclear forces. The committee had background in and was briefed on current analytics efforts. It concluded that while methods are important, the key to high-quality analysis in support of nuclear deterrence and assurance is

qualified people who have extensive experience in the nuclear deterrence and assurance domain as well as in the relationships of nuclear options to general deterrence and assurance. The committee identified two types of methods that should be emphasized because of their relevance to the added complexity and uncertainty inherent in a deterrence and assurance environment that contains a more and more diverse set of nuclear adversaries. These are methods for (1) gaining insight into different styles, modes, and motives of an actor's decision making (discussed in Chapters 3, Appendix D, and Appendix E) and (2) dealing with "deep uncertainty" (discussed in Chapters 2 and 3). The committee also points out the need for analysts to be conversant in and use a suite of analytic methods, as well as the promise of hybrid methods in which different tools and methods, or the results of different approaches, are integrated—for example, using human gaming to inform quantitative modeling, as discussed in Chapter 3.

In considering how the Air Force should best approach deterrence and assurance analyses, the committee developed a top-level framework, primarily as a basis for categorizing these tasks and associated requirements for methods. Conceptually, the framework is straightforward. The reality is that the Air Force analytic community is not resourced to perform the analyses identified in this framework, many if not most of which require a whole-of-government perspective.

At a conceptual level, deterrence and assurance proceed through a sequence of steps, beginning with characterization of the situation or scenario involving potential actions adverse to the interests of the United States. That characterization leads to the identification of alternative U.S. objectives and then a characterization of the players in terms of their objectives, constraints, and values. Because of uncertainties associated with this characterization, alternative characterizations would ideally be constructed. The next step consists of determining feasible response options in the context of available capability and legal and political constraints, followed by the construction and assessment of a set of integrated, well-hedged, whole-of-government options, the choice of initial actions and the execution of a strategy, observing and adapting as the situation unfolds. It is within this context that the Air Force fulfills it deterrence and assurance mission. The subject of this study was analytic methods used to support Air Force decisions as it organizes, equips, and trains to meet its responsibilities in deterring adversaries and assuring allies.

The committee developed and applied criteria for evaluating methods. No candidate stands out alone. For example, methods related to actor-specific modeling and deep uncertainty have matured over the last two decades and are particularly relevant. Qualified analysts will, based on broad knowledge and expertise with the spectrum of available methods, select and apply those which are most appropriate. For many analysis tasks, a suite of methods will be the sensible and preferred tactic. As noted above in examining the current analysis efforts in nuclear deterrence and assurance the committee observed that analysts were doing a remarkable job given

the resources available. The community makes excellent use of classic analytical methods. It has begun to address the challenge of actor-specific knowledge, but it is not currently prepared to fully exploit developments in this domain. This community has taken preliminary steps to address *deep uncertainty*. A significant impediment to improved analysis in the deterrence and assurance domain is the limited number of analysts assigned to the deterrence and assurance mission and the organizational barriers that separate military and nonmilitary analytical agencies addressing deterrence and assurance in a whole-of-government context.[1]

FRAMEWORK FOR ANALYSIS

In broad terms a responsive analysis will include the tasks illustrated in Figure 4-1. Initially, potential adversaries and allies must be identified, together with the deterrence and assurance goals associated with each—those viewed in the larger context of influence, to include combinations of carrots and sticks. Since strategies should be tailored to specific adversary/ally combinations, separate analyses are required for each combination. As displayed in Figure 4-1, the first and most important task in a specific crisis is to understand both adversaries and allies, which can be aided with leadership profiles. These profiles, addressed in Chapter 3 and Appendix E, are designed to identify an adversary's or ally's valued assets, help identify the range of behaviors that might be seen in crisis, assess the barriers to reception of deterrence messages, and estimate responses to perceived messages. They should describe likely changes in these factors as situations change. Given this information, and recognizing that peer/near-peer, regional and nonstate actors pose significantly different challenges, sets of capabilities can be generated and evaluated in terms of effectiveness of actions ("messages") in producing a desired change in adversary behavior. This information can then be used to construct alternative organizations, equipment, and training, assuming different but explicit contributions from other services and government agencies.[2]

Alternatives should be analyzed and evaluated for flexibility, adaptability, and robustness, primarily in the context of uncertainty. Leadership profiles will be subject to varying degrees of uncertainty and error. Accordingly, provision must be made for undesirable, unexpected, and surprising behavior by adversaries and allies. Similarly, alternatives must be examined and evaluated from the perspective of technological surprise and unexpected changes in equipment effectiveness.

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[1] Hunter Hustus, Technical Advisor, Office of the Assistant Chief of Staff of the Air Force for Strategic Deterrence and Nuclear Integration, personal communication to the committee on December 19, 2013.

[2] With respect to the Air Force, a broad spectrum of contributions could be brought into play, including, intelligence, surveillance, and reconnaissance and cyber operations. Also, there are second-order contributions such as the use of Air Force assets to deploy missile defense systems.
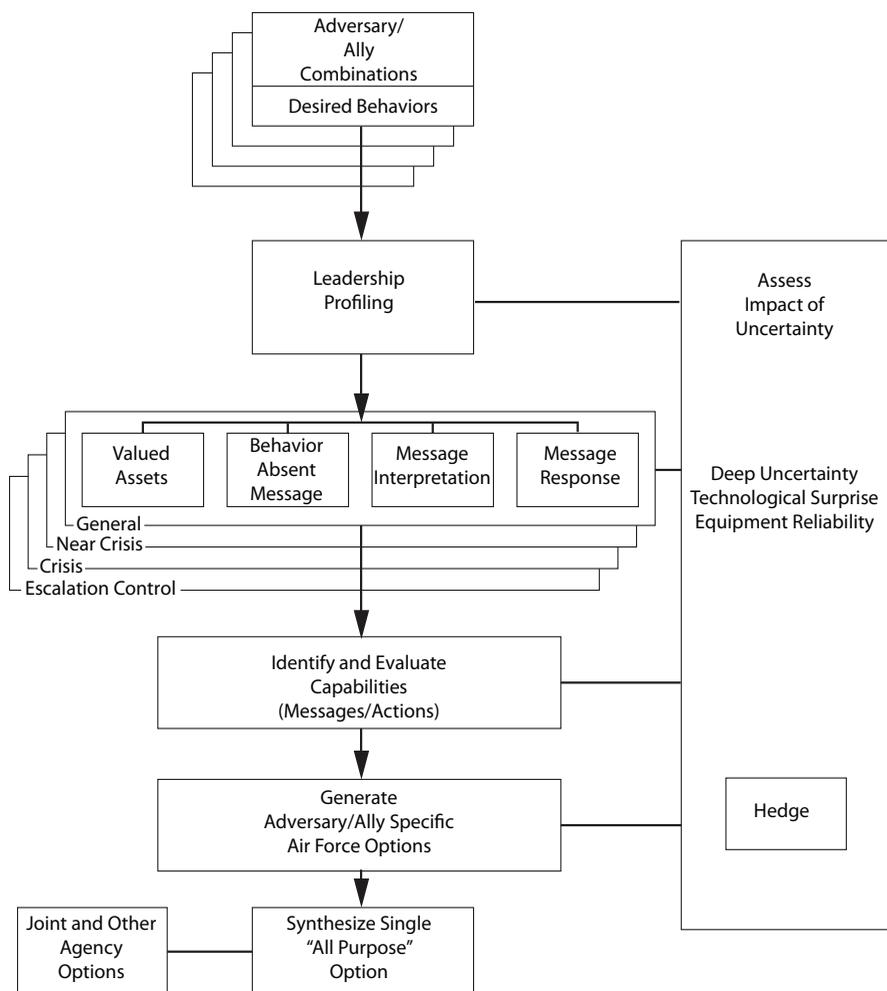
FIGURE 4-1 Notional tasks involved in deterrence analysis.

Sensitivity to the roles of other services, other government agencies, and possible actions by allies should also be analyzed. Keeping in mind the presence of deep uncertainty, assessments must consider the risk of being unable to deliver a particular capability at the time it is needed or the risk that the capability does not produce the desired effect. Such assessments can characterize the alternative under consideration taking into account actor-specific and situation-specific knowledge.

Based on the information developed for the set of adversary/ally combinations, recommended alternatives can be synthesized, integrating the information from the separate analyses to produce one or more options for consideration by the leadership of the Air Force. It is clear that the Air Force is a major but not the only member of the deterrence team. Each of the Services and many other departments and agencies have roles and responsibilities and should be considered in developing understanding and conducting analysis. However, to meet its Title 10 responsibility to organize, train, and equip the Air Force contribution, the Air Force should undertake a series of tasks related to analysis in support of deterrence and assurance.

FINDINGS AND RECOMMENDATIONS

Analysis Plan

Finding 2-2. Analytic Framework. Because the U.S. approach to strategic deterrence and assurance needs to be continually adapted, a management plan is required that defines comprehensively the set of *continuing* analytic foci, which includes nuclear command and control; air and missile defense; cyber, space, geostrategic, and technological changes; and the challenges of tailoring deterrence and assurance to adversaries and allies. This analytic management plan is in addition to tasks related to weapons, forces, personnel, and the nuclear enterprise in general.

Recommendation 1. In support of senior Air Force leadership guidance, including the *Flight Plan for the Air Force Nuclear Enterprise*, the Air Force should develop and maintain a comprehensive strategic deterrence analysis plan to identify the tasks that produce information required to organize, equip, and train Air Force nuclear deterrence and assurance forces and support combatant commanders (Air Force, 2013).

Rationale. Organizing, equipping, and training Air Force elements to be used in conventional and nuclear deterrence and assurance is a critical and complex challenge. The Air Force should develop sound and defensible strategies for developing and fielding its force. Given the current state of scholarship generally and expertise in the Air Force in particular, a multiyear plan for study and analysis of the widening range of deterrence and assurance issues is a key requirement. Furthermore, once in place, an Air Force deterrence and assurance analysis program (DAAP) would provide a means of ensuring that sufficient attention is paid to generating flexible, adaptive, robust strategies, which the committee believes are essential in the nuclear deterrence and assurance domain in the 21st century.

The envisioned DAAP would rely on input from the Department of Defense and other U.S. government agencies. Based on its deliberations, the committee believes that tools, methods, and approaches are available but that an institutionalized means of cross-agency collaboration and coordination does not exist. The analysis plan would provide the basis for establishing such an organization and defining its responsibilities.

Implementation. With respect to implementation, the Assistant Chief of Staff for Strategic Deterrence and Nuclear Integration should be assigned responsibility, with contributions from the Deputy Chief of Staff for Intelligence, Surveillance, and Reconnaissance; the Deputy Chief of Staff for Operations, Plans and Requirements; the Deputy Chief of Staff for Logistics, Installations and Mission Support; the Deputy Chief of Staff for Strategic Plans and Programs; and the Director for Studies and Analyses, Assessments and Lessons Learned, as well as the Air Force Global Strike Command and the Air Force Materiel Command, for developing and recommending to the Chief of Staff of the Air Force an outline of the DAAP.

Actor and Multiactor Modeling

Finding 3-2. Psychological Framework. Deterrence and assurance are largely a psychological concept. Thus, a proper evaluation of proposals for them will rely not only on the balance of military forces but also, whenever possible, on an understanding of the mindset and decision making of the adversary or ally.

Finding 3-3. Tailoring Key Messages. To elicit the intended response, it is important for the sender to have methods and tools that can detect opportunities and send messages tailored to a recipient that is open (willing and able) to make a response based on available information rather than on motivational, affective, or cognitive biases in a deterrence or assurance situation.

Recommendation 2. The Air Force should focus analytic enhancements in support of deterrence and assurance assessment on the human and human organizational factors at the heart of deterrence and assurance.

Rationale. In identifying and assessing analytic "issues and factors that must be considered in seeking nuclear deterrence of adversaries and assurance of allies in the 21st century," the committee noted that deterrence is largely a psychological concept and that sophisticated evaluation of the requisites for deterrence and assurance does not rest solely in the balance of military forces but must include insight into the mindset and decision making of the adversary or ally. An understanding of the impact of any action taken, including unintended consequences, must be central to the design of strategies for deterrence and assurance. Thus, as

the number of possible adversaries has grown, so has the need for actor/situation knowledge. The adoption of tailored deterrence results in a set of unique cases that must be considered.

Many analytic methods exist for exploring the nature and content of an individual's or a collective's decision making. These include various content analysis approaches, leadership profiling, qualitative and quantitative cognitive decision modeling, and representing an actor's decision making in agent-based and simulation models. However, it is important to note that because the Air Force is not the only consumer of these analyses it should work to coordinate its needs with the U.S. government agencies that produce information about international leaders in the course of executing their assigned missions. To be skilled users and to generate comprehensive and feasible requirements the Air Force must develop and maintain expertise in this domain. The Air Force will not be solely responsible for production but should make use of Air Force capacity and joint assignments to augment efforts carried out by the primary agencies—that is, the Central Intelligence Agency and Defense Intelligence Agency within the intelligence community and U.S. Strategic Command and other military commands—and ensure that those efforts meet Air Force requirements. Actor and multiactor modeling support both planning and operations. Performed on a continuous basis, this modeling will provide the Air Force with analytic input appropriate to specific deterrence and assurance needs and better estimation of the likelihood of the success of an action based on the decision and risk propensities of adversaries and allies.

Implementation. With respect to implementation, the Air Force Research Laboratory, with input from the Air Force Global Strike Command and the Director for Studies and Analyses, Assessments and Lessons Learned, should be tasked to provide to the Chief of Staff of the Air Force a description of the current state of the Air Force's analytic capabilities in actor and multiactor modeling and a recommended way ahead.

Research

Finding 3-4. Tailored Deterrence. The methods of content analysis and leadership profiling in conjunction with other methods have the potential to help meet requirements of actor-specific knowledge for a strategy of tailored deterrence. An alliance among content analysis, leadership profiling, abstract modeling, and gaming and simulations as a suite of methods is possible in order to solve the complex problems associated with studying the decision-making dynamics of single groups and multiple autonomous actors as decision units.

Recommendation 3. The Air Force, working with its Service partners and the Department of Defense more generally, should pursue research on deterrence

and assurance with a coherent approach that involves content analysis, leadership profiling, abstract modeling, and gaming and simulations as a suite of methods. It should organize its investments in analytic and other activities accordingly.

Rationale. While a variety of methods to generate actor- and situation-specific knowledge are available to support Air Force planning for deterrence and assurance, the problem of looking ahead over a planning horizon of 20 years or more places additional demands on the need to understand potential adversaries and allies, being cognizant of the fact that today's adversary may be tomorrow's ally and that regional political–military situations may change, sometimes quickly. One approach to uncertainties such as these is to base analyses on a set of generic decision makers similar to but larger than the four categories described in Chapter 3 in order to explore the degree to which adversaries or allies are willing and able to receive different types of deterrence or assurance messages.

A multimethod approach to this research is necessary and should include many or all of the following methods in addition to others: game theory, human gaming, simulation, qualitative cognitive modeling, agent-based modeling, leadership profiling, and content analysis. An understanding of the variation across decision-making units and contexts will lead to more robust plans by allowing analysts and Air Force leadership to consider a range of motivations, behaviors, consequences, and situations. It would also provide the Air Force with a better appreciation of the implications of leadership changes in state and nonstate adversaries and allies.

Implementation. With respect to implementation, the recommended research deals with an interagency issue. The Office of the Secretary of Defense (OSD) should take the interagency lead, in collaboration with the Joint Chiefs of Staff and U.S. Strategic Command. The Assistant Chief of Staff for Strategic Deterrence and Nuclear Integration should be the focal point for the Air Force and should prepare an Air Force advocacy briefing for approval by the Chief of Staff of the Air Force. The briefing should identify relevant agencies inside and outside the Department of Defense. Once approved, it should then be taken to the Joint Chiefs of Staff, OSD, and the U.S. Strategic Command as a basis for OSD action in an interagency initiative.

Deep Uncertainty

Finding 2-1. Deep Uncertainty. Planning to support deterrence and assurance with both current operations and longer-term programs to organize, equip, and train is characterized by deep uncertainty, described more fully in Chapter 3. Nonetheless, methods exist for dealing with such uncertainties effectively, primarily by hedging and capabilities for adaptation (Hallegate et al., 2012).

Recommendation 4. The Air Force analytic community should pursue methods of understanding and incorporating the concept of deep uncertainty.

Rationale. Among the factors that contribute to deep uncertainty in deterrence and assurance planning are the lack of actor-specific/situation-specific knowledge, limited capacity to predict how messages will be interpreted, random events that may occur during crises or periods of tension, technological surprise, and the impact of fleet-wide capability degradation. Substantial progress has been made on how to plan under deep uncertainty, in which a set of techniques is employed including, for example, alternative cognitive models, test cases, and portfolio management.[3] Use of such techniques is consistent with the analytic approach referred to as hedging, with an emphasis on developing strategies and plans that are flexible, adaptive, and robust.

Implementation. With respect to implementation, the Air Force Research Laboratory, coordinating with the Director for Studies and Analyses, Assessments and Lessons Learned and the Assistant Chief of Staff for Strategic Deterrence and Nuclear Integration, should identify current and anticipated analysis issues in which the concept of deep uncertainty is important and then recommend a program to develop and reinforce relevant knowledge and expertise in the analysis workforce.

Methods

Finding 3-4. Tailored Deterrence. The methods of content analysis and leadership profiling, in conjunction with other methods, have the potential to help meet requirements of actor-specific knowledge for a strategy of tailored deterrence. An alliance among content analysis, leadership profiling, abstract modeling, and gaming and simulations as a suite of methods is possible in order to solve the complex problems associated with studying the decision-making dynamics of single groups and multiple autonomous actors as decision units.

Recommendation 5. Air Force analysis supporting nuclear deterrence and assurance issues should draw from a suite of appropriate methods, including hybrid methods that combine and integrate different methods.

Rationale. In examining the need to solve and understand the decision-related dynamics of effective deterrence and assurance, the committee recognized the potential value of conducting analyses on the basis of a combined approach. Indi-

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[3] Davis (2012) is a broad review of RAND's work on dealing with uncertainty. For further discussion of methods to support "robust decision making," see Lempert et al. (2006).

vidual methods that might be included are content analysis, leadership profiling, abstract modeling, and gaming simulation. In many respects this is consistent with current and past practices for conducting deterrence analyses in which a wide range of methods have been used.

The notion of tailoring deterrence poses a set of analytic challenges in which certain attributes and factors will differ, perhaps significantly, across the range of adversaries, allies and regions. The committee believes that methods must be selected, adapted when necessary, and applied by analysts with two types of expertise: (1) sufficient facility with a variety of analytic methods to be able to distinguish appropriate use of each and (2) knowledge of the deterrence and assurance actors and processes relevant to the analysis task.

Hybrid methods involving the integration of expertise drawn from multiple disciplines, and the application of the analytic approaches of those disciplines in an integrated and novel way, were evident in the committee's investigation and assessment of theory, applications, and research addressing decision-making units. In this domain and across the extent of nuclear deterrence and assurance analysis, hybrid methods offer greater breadth and accuracy because of the multiple disciplines involved. They may contribute to developing a wider range of insights.

Implementation. With respect to implementation, Assistant Chief of Staff for Strategic Deterrence and Nuclear Integration should coordinate with the Director for Studies and Analyses, Assessments and Lessons Learned to describe the unique attributes of deterrence and assurance analysis and the value of integrated hybrid approaches. Based on that description, the Director for Studies and Analyses, Assessments and Lessons Learned and the Air Force Education and Training Command should recommend a program to ensure that analysts have the knowledge and expertise required to bring appropriate hybrid approaches to bear on the analyses of deterrence and assurance issues.

Analysts

Finding 3-1. Long-Term Career Development. Education and nurturing of experts in deterrence and assurance will not happen without a management plan to do so in the Air Force (and other services, particularly the Navy), partly in coordination with joint assignments but also bearing in mind longer-term career development and assuring adequate expertise (a Service responsibility).

Recommendations 6. The Air Force should maintain its cadre of career analytic professionals (both civilian and military) with expertise in nuclear deterrence and assurance strategy to improve Air Force support to Combatant Commanders' planning and operations, since methods can inform, but never replace, the judgment of

expert analysts. This could be facilitated by specific treatment of analysts in Vector 5 of the *Flight Plan for the Air Force Nuclear Enterprise* (Air Force, 2013).

Rationale. In the course of its efforts the committee was briefed on current analyses related to deterrence and assurance and on various methods. These briefings led to a critical finding—namely, that the primary element in improving and sustaining high-quality analysis of deterrence and assurance is the continued education and nurturing of people, which should include frameworks, theory, and critical reasoning. The nation currently has a small pool of such analysts, who are very capable, but the pool is not large enough.

While the qualifications required of an analyst in the deterrence and assurance domain include a thorough understanding of the methods widely used throughout the military analysis enterprise, deterrence and assurance have attributes that require specialized expertise. Unfortunately the number of deterrence and assurance "experts" appears to be declining as personnel with experience dating back to the Cold War retire. It is possible for people to gain and retain knowledge necessary to conduct sophisticated deterrence and assurance analysis and planning without becoming career specialists. Such knowledge can be acquired through academic courses and experiential learning tailored to the 21st century security environment, yet deterrence and assurance analysis is currently underresourced. If the Air Force is to develop analytically based strategies and perspectives that are credible in the joint arena, and if Air Force leaders are to be prepared with reliable, informed reviews of alternative options considered in that arena, then the relevant analytic community must be adequately resourced.

Implementation. With respect to implementation, the Air Force Education and Training Command should be tasked, in coordination with Deputy Chief of Staff for Intelligence, Surveillance, and Reconnaissance; the Director for Studies and Analyses, Assessments and Lessons Learned; and the Assistant Chief of Staff for Strategic Deterrence and Nuclear Integration to provide a way-ahead briefing for the Chief of Staff of the Air Force.

THE VALUE PROPOSITION FOR IMPLEMENTING
THE RECOMMENDATIONS

In the process of preparing for this report the committee was given the opportunity to interact with analysts currently engaged in planning for deterrence and assurance and in supporting deterrence and assurance missions. Given the resources available, these people are doing a remarkable job. The current community makes excellent use of classical analytic methods. It has begun to address the challenge of actor-specific and situation-specific knowledge but is not resourced to exploit advances in these disciplines. It has taken only preliminary steps to address

deep uncertainty and has limited capacity for the research necessary to develop new deterrence and assurance concepts, theories, and strategies.

The report's recommendations respond to observed shortfalls and identified opportunities. The development of an comprehensive analysis plan will provide a framework in which to develop strategies for organizing, equipping, and training Air Force personnel. It will allow the Air Force to avoid overreliance on tools that are most appropriate for physics or engineering questions and contribute to the adoption of well-hedged, robust, and adaptive strategies. Increasing the Air Force analytic capacity to understand and utilize human and human organization factors will inform the region by region contributions the Air Force must make to tailored deterrence, facilitate earlier recognition of potential failure, expand understanding of the risk-taking behavior of adversaries and allies as well as allowing more specific tailoring of the Air Force response to potential deterrence or assurance needs. Advocacy of research to develop a generalized understanding of leadership, decision making, and behavior dynamics related to deterrence and assurance will improve the robustness of longer-term planning, provide a region by region baseline deterrence environment and assist in responding to leadership changes in adversaries or allies. Incorporating deep uncertainty into Air Force analyses supporting strategic planning will reduce the risk of being unprepared for unforeseen situations, increase awareness of the value of hedging in the face of uncertainty, and provide an approach to identifying and dealing with unintended consequences. All of these recommendations rely on the cadre of Air Force career analytic professionals. These professionals ensure that the Air Force has credible and analytically based perspectives in the joint arena, and that Air Force leadership is provided with informed and reliable information to support selection of an Air Force strategy, plans, and materiel.

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Appendixes

A

Terms of Reference

Mindful of the different classes of adversaries in the 21st Century and recent U.S. policy statements regarding the Triad and the strategy for employing U.S. nuclear forces, an ad hoc committee will:

1. Identify the broad analytic issues and factors that must be considered in seeking nuclear deterrence of adversaries and assurance of allies in the 21st Century.

2. Describe and assess tools, methods—including behavioral science-based methods—and approaches for improving the understanding of how nuclear deterrence and assurance work or may fail in the 21st Century and the extent to which such failures might be averted or mitigated by the proper choice of nuclear systems, technological capabilities, postures, and concepts of operation of American nuclear forces.[1]

3. Discuss the implications for the Air Force and how it could best respond to these deterrence and assurance needs. Include in this discussion a framework for identifying the risks and benefits associated with different nuclear force postures, structures, levels, and concepts of operation.

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[1] The committee interpreted this to mean that it should describe and assess methods and tools that would help both (1) in improving and understanding deterrence and (2) in helping to understand how nuclear forces, posture, technological capabilities, and concepts of operations can improve prospects or mitigate failures. The committee and the Air Force sponsor understood that the study was not going to make recommendations about force structure and the like.

4. Recommend criteria and a framework for validating the tools, methods, and approaches; and for identifying those most promising for Air Force usage.

5. Recommend an appropriate mix of the classes of analytical tools affordable in today's austere financial climate, and identify what can be planned for by the Air Force as future improvements to this mix if and should defense budgets increase or decrease.

B

Biographical Sketches of Committee Members

GERALD F. PERRYMAN, JR., *Co-Chair*, is an independent consultant. Upon concluding military service with the U.S. Air Force in 2002 as a major general, Gen Perryman joined Raytheon Company as vice president and lead executive for the company's intelligence, surveillance, and reconnaissance (ISR) Strategic Business Area. There he developed strategies for ISR growth using capabilities from across that diverse, global company, helping it provide integrated mission systems. Prior to his Raytheon work, Gen Perryman was assistant deputy chief of staff, Warfighting Integration, Headquarters U.S. Air Force, providing guidance and direction for transforming Air Force warfighting capability by integrating command and control, communications and computer networks, and ISR systems. Earlier Gen Perryman had led the Air Force's Aerospace Command and Control and ISR Center at Langley Air Force Base. He had commanded the 14th Air Force, which encompasses all Air Force space operations forces worldwide. He had also commanded both an Air Force space wing and a strategic missile wing. He currently serves on the National Research Council's (NRC's) Air Force Studies Board and is a past member of the Committee on Examination of the Air Force ISR Capability Planning and Analysis Process. A graduate of Texas A&M University, Gen Perryman received his MBA from the University of North Dakota.

ALLISON ASTORINO-COURTOIS, *Co-Chair*, is executive vice president at National Security Innovations (NSI), Inc. She has served as technical lead on a number of Office of the Secretary of Defense (OSD) multi-layer analysis (SMA) projects in support of U.S. forces and combatant commands. Prior to joining NSI,

Dr. Astorino-Courtois worked for Science Applications International Corporation (2004-2007), where she served as a U.S. Strategic Command liaison to U.S. and international communities and was a tenured associate professor of international relations at Texas A&M University in College Station (1994-2003), where her research focused on the cognitive aspects of foreign policy decision making. She has received a number of academic grants and awards and has published articles in multiple peer-reviewed journals including *International Studies Quarterly, Journal of Conflict Resolution, Political Psychology, Journal of Politics,* and *Conflict Management and Peace Science.* She has also taught at Creighton University and was a visiting instructor at the U.S. Military Academy at West Point. Dr. Astorino-Courtois earned her Ph.D. in international relations from New York University.

JOHN F. AHEARNE is executive director emeritus of Sigma Xi, the Scientific Research Society; emeritus director of the Sigma Xi Ethics Program; and an adjunct professor of engineering at Duke University. Prior to working at Sigma Xi, Dr. Ahearne served as vice president and senior fellow at Resources for the Future and as commissioner and chair of the U.S. Nuclear Regulatory Commission. He worked in the White House Energy Office and as Deputy Assistant Secretary of Energy at the U.S. Department of Energy. He also worked on weapons systems analysis, force structure, and personnel policy as deputy and principal deputy assistant secretary of defense. Serving in the U.S. Air Force, he worked on nuclear weapons effects and taught at the Air Force Academy. Dr. Ahearne's research interests include risk analysis, risk communication, energy analysis, reactor safety, radioactive waste, nuclear weapons, materials disposition, science policy, and environmental management. He was elected to the National Academy of Engineering (NAE) in 1996 for his leadership in energy policy and the safety and regulation of nuclear power. Dr. Ahearne has served on and chaired numerous NRC committees related to U.S. strategic deterrence, including the Committee on Russian Academy of Sciences/U.S. National Academies Joint Committee on U.S.-Russian Cooperation on Nuclear Non-Proliferation; the Committee on Counterterrorism Challenges for Russia and the United States; and the Committee on Opportunities for U.S.-Russian Collaboration in Combating Radiological Terrorism. Dr. Ahearne earned his Ph.D. in physics from Princeton University.

GERALD G. BROWN is a Distinguished Professor of Operations Research and executive director of the Center for Infrastructure Defense at the Naval Postgraduate School, where he has taught and conducted research in optimization and optimization-based decision support since 1973, earning awards for both outstanding teaching and research. His military research has been applied by every uniformed service, in areas ranging from strategic nuclear targeting to capital planning. He has been awarded the Barchi, Rist, and Thomas prizes for military operations research

and been credited with guiding investments of more than a trillion dollars. He has designed and implemented decision support software used by the majority of the Fortune 50 Companies, in areas ranging from vehicle routing to supply chain optimization. His research appears in scores of open-literature publications and classified reports, some of which are seminal references. Dr. Brown is a member of the NAE, a recipient of the U.S. Navy Distinguished Civilian Service Medal, an INFORMS fellow, and a founding director of Insight, Incorporated, the leading provider of strategic supply chain optimization tools to the private sector. He currently serves on NRC boards on Mathematics, Statistics and their Applications, and on Explosives and Survivability.

ALBERT CARNESALE is chancellor emeritus and professor at the University of California, Los Angeles (UCLA). He was chancellor of the university from 1997 through 2006 and now serves as professor of public policy and of mechanical and aerospace engineering. Prior to joining UCLA, he was at Harvard University for 23 years as the Lucius N. Littauer Professor of Public Policy and Administration, dean of the John F. Kennedy School of Government, and provost of the University. Prior to that, he served in both government and industry. His research and teaching focus on public policy issues having substantial scientific and technological dimensions, and he is the author or co-author of six books and more than 100 articles on a wide range of subjects, including national security strategy, arms control, nuclear proliferation, the effects of technological change on foreign and defense policy, domestic and international energy issues, and higher education. He is a member of the NAE and of the Council on Foreign Relations; is a fellow of the American Academy of Arts and Sciences and of the American Association for the Advancement of Science; and serves on the board of directors of Harvard University's Belfer Center for Science and International Affairs and on the advisory board of the RAND Corporation's Center for Global Risk and Security. He was a member of the Obama administration's Blue Ribbon Commission on America's Nuclear Future. He chaired the NRC Committees on NASA's Strategic Direction, on America's Climate Choices, on Sustaining and Improving the Nation's Nuclear Forensics, and on U.S. Conventional Prompt Global Strike Capabilities. Dr. Carnesale holds a Ph.D. in nuclear engineering from North Carolina State University.

W. PETER CHERRY is an independent consultant who retired in 2010 as the chief analyst on the U.S. Army's Future Combat Systems Program at Science Applications International Corporation (SAIC). He was responsible for analytic support to requirements analysis, performance assessment, and design trades. Previously, Dr. Cherry was leader of the Integrated Simulation and Test Integrated Program Team, focusing on test and evaluation planning, the development of associated models and simulations, and the development of the Future Combat System of

Systems Integration Laboratory. He was a participant in the Future Combat Systems program from its inception, leading analysis and evaluation of concepts as a member of the Full Spectrum Team during the contract activities that preceded concept and technology development. Since the completion of his studies at the University of Michigan, he has focused on the development and application of operations research in the national security domain, primarily in the field of land combat. He contributed to the development and fielding of many of the major systems employed by the Army, ranging from the Patriot Missile System to the Apache helicopter, as well as command control and intelligence systems such as ASAS and AFATDS. In addition, he contributed to the creation of the Army's Manpower Personnel and Training Program (MANPRINT) and to the Army's Embedded Training Initiative. His recent research interests include peacekeeping operations and the development of transformational organizations and materiel. Dr. Cherry was a member of the Army Science Board and served as chair of the Board's Logistics Subpanel. In addition he has participated over the past 10 years in independent reviews of the Army's science and technology programs and on NRC studies addressing a variety of defense issues. Dr. Cherry received a Ph.D. in industrial engineering from the University of Michigan. He is currently a member of the Board on Army Science and Technology, a fellow of INFORMS, and a member of the NAE.

PAUL K. DAVIS is a senior principal researcher at the RAND Corporation and a professor of policy analysis in the Pardee RAND Graduate School. His research interests include strategic planning and methods for improving it, decision-making theory, counterterrorism, and advanced methods of analysis and modeling (notably exploratory analysis and multiresolution modeling). He has authored or coauthored widely read books on defense planning, capabilities-based planning, portfolio analysis, and deterrence and influence theory, as well as an integrative review on social science for counterterrorism. Before joining RAND, Dr. Davis was a senior executive at the Department of Defense (DoD). He has served on numerous national panels for DoD, the National Academies, and the intelligence community. He also is a regular reviewer on several professional journals. Dr. Davis served as a member of the NRC Committee on Conventional Prompt Global Strike Capability and the Committee on Modeling and Simulation for Defense Transformation. He received his Ph.D. in chemical physics from the Massachusetts Institute of Technology.

STEPHEN DOWNES-MARTIN is currently a research professor at the U.S. Naval War College and has over 30 years of experience in developing and applying war gaming, game theory, decision analysis, and systems thinking to tactical, operational, and strategic military problems for a wide variety of government, military,

aerospace, and commercial organizations in the United States and abroad. His research focus is on how decision support and assessment methods can be manipulated to deceive decision makers, how decision makers misuse such methods to deceive themselves, how to detect such attempts and protect from them. In 2010, he was awarded the Superior Civilian Service medal for in-theater support of I Marine Expeditionary Force (Forward) and Regional Command (Southwest) in Afghanistan. During Spring 2012, he supported in-theater the Afghan Assessment Group at ISAF HQ, Kabul. He was a reserve military intelligence officer in the British Army, and is now a U.S. citizen. Dr. Downes-Martin holds a Ph.D. in mathematical physics from London University.

KATHLEEN L. KIERNAN is the founder and chief executive officer of Kiernan Group Holdings, Inc. Dr. Kiernan is a 29-year veteran of Federal Law Enforcement. She previously served as the assistant director in the Office of Strategic Intelligence and Information for the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF), where she was responsible for the design and implementation of an intelligence-led organizational strategy to mine and disseminate data related to explosives, firearms, and illegal tobacco diversion, the traditional and nontraditional tools of terrorism. Dr. Kiernan is the chair emeritus for the InfraGard Program, a public–private alliance with over 62,000 members representing all 18 critical infrastructures and key resources. She co-chairs the Homeland Security Intelligence Council (HSIC) for the Intelligence and National Security Alliance and is the former chair of the Division of Criminal Investigation's Law Enforcement Working Group, an initiative designed to bridge the communities of intelligence and law enforcement. Dr. Kiernan is a senior member on the International Association of Chiefs of Police Terrorism subcommittee and serves on the Board of Regents of the Potomac Institute for Policy Studies. Dr. Kiernan served as the ATF representative to the Counterterrorism Center at the CIA during 1993 and 1995; is the Council vice president for ASIS International, with oversight of the Critical Infrastructure Working Group; and chairs the Domestic Intelligence Council for the Intelligence and National Security Alliance. Dr. Kiernan led a nationwide intelligence community project involving the active interdiction of weapons of mass destruction throughout the law enforcement and public safety communities and led a team in the Quadrennial Intelligence Community Review. Dr. Kiernan serves as a subject matter expert for the Rapid Reaction Technology Office in the OSD and other elements of the defense community. Dr. Kiernan was the recipient of the Women of Influence—Public Sector award in 2010. Dr. Kiernan completed her doctorate in education at Northern Illinois University and her master of science in strategic intelligence at the Joint Military Intelligence College in Washington, D.C. She also holds a master of arts in international transactions from George Mason University Homeland Security Policy Institute and is a faculty member at Johns

Hopkins University and the Naval Postgraduate School's Center for Homeland Defense and Security.

RONALD F. LEHMAN II is the Counselor at Lawrence Livermore National Laboratory (LLNL). Dr. Lehman is also chairman of the governing board of the International Science and Technology Center and vice chair of DoD's Threat Reduction Advisory Committee. He recently co-chaired the study on the future of cooperative threat reduction For 16 years, he headed the Center for Global Security Research at LLNL. Dr. Lehman was director of the U.S. Arms Control and Disarmament Agency from 1989 to 1993, when START I, START II, the Chemical Weapons Convention, and other historic agreements were concluded. Previously, he served in DoD as Assistant Secretary for International Security Policy, in the State Department as Ambassador and U.S. Chief Negotiator on Strategic Offensive Arms (START I), and in the White House as Deputy Assistant to the President for National Security Affairs. He has also served on the National Security Council staff as a senior director, in the Pentagon as deputy assistant secretary, on the senior professional staff of the U.S. Senate Armed Services Committee, and in Vietnam commissioned in the U.S. Army. In past years, he served on the Presidential Advisory Board on Proliferation Policy, on the State Department's International Security Advisory Board, as chair of the NATO High Level Group, on the governing board of the U.S. Institute of Peace, and as a U.S. representative to a number of United Nations disarmament and review conferences.

JOHN A. MONTGOMERY is the director of research at the Naval Research Laboratory (NRL), where he oversees research and development programs with expenditures of approximately $1.2 billion per year. He joined the NRL in 1968 as a research physicist in the Advanced Techniques Branch of the Electronic Warfare Division, where he conducted research on a wide range of electronic warfare (EW) topics. In 1980, he was selected to head the Off-Board Countermeasures Branch. In May 1985, he was appointed to the Senior Executive Service (SES) and was selected as superintendent of the Tactical EW Division. He has been responsible for numerous systems that have been developed/approved for operational use by the Navy and other services. He has had great impact through the application of advanced technologies to solve unusual or severe operational deficiencies noted during world crises, most recently in Afghanistan, Iraq, and for Homeland Defense and in the Pacific theater. Dr. Montgomery received the DoD Distinguished Civilian Service Award in 2001. He was recognized by the Department of the Navy Distinguished Civilian Service Award in 1999 and by the Department of the Navy Meritorious Civilian Service Award in 1986. As a member of the SES, he received the Presidential Rank Award of Distinguished Executive in 1991 and again in 2002, and the Presidential Rank Award of Meritorious Executive in 1988, 1999, and again in 2007. He also received

the 1997 Dr. Arthur E. Bisson Prize for Naval Technology Achievement, awarded by the Chief of Naval Research in 1998. Further, he has received the Association of Old Crows (Electronic Defense Association) Joint Services Award in 1993. He was an NRL Edison Scholar, and is a member of the NAE and of Sigma Xi. He served as the U.S. national leader of the Technical Cooperation Program's multinational Group on EW from 1987 to 2002, and served as its executive chairman. In 2006, Dr. Montgomery received the Laboratory Director of the Year award from the Federal Laboratory Consortium for Technology Transfer, and in 2011 he received the Roger W. Jones Award for Executive Leadership from American University's School of Public Affairs. Dr. Montgomery received his Ph.D. in physics from the Catholic University of America.

JERROLD M. POST is professor of psychiatry, political psychology, and international affairs and director of the Political Psychology Program at George Washington University. Dr. Post has devoted his entire career to the field of political psychology. Dr. Post came to George Washington after a 21-year career with the Central Intelligence Agency, where he was the founding director of the Center for the Analysis of Personality and Political Behavior. He played the lead role in developing the "Camp David profiles" of Menachem Begin and Anwar Sadat for President Jimmy Carter and initiated the U.S. government program in understanding the psychology of terrorism. In recognition of his leadership at the center, Dr. Post was awarded the Intelligence Medal of Merit in 1979. He received the Nevitt Sanford Award of the International Society of Political Psychology in 2002 for Distinguished Professional Contributions to Political Psychology. In December 1990, he testified before the House Armed Services Committee and the House Foreign Affairs Committee on the political personality profile of Saddam Hussein he had developed. Since 9/11, he has testified on the psychology of terrorism before the Senate, the House, and the United Nations. Dr. Post has written or edited 10 books, including *The Psychological Assessment of Political Leaders, Leaders and Their Followers in a Dangerous World,* and *The Mind of the Terrorist,* and he contributed the lead chapter "Actor-Specific Behavioral Models of Adversaries: A Key Requirement for Tailored Deterrence" in *Tailored Deterrence: Influencing States and Groups of Concern.* He is a frequent commentator in national and international media on such topics as the psychology of leadership, the psychology of terrorism, weapons of mass destruction, Osama bin Laden, Hugo Chavez, Mahmoud Ahmadinejad, Kim Jong Il, Muammar Qaddafi, and, most recently, Bashar al-Assad. Dr. Post received his baccalaureate degree magna cum laude from Yale College. After receiving his medical degree from Yale, where he was elected to Alpha Omega Alpha, the honor medical society, he received postgraduate training in psychiatry at Harvard Medical School and the National Institute of Mental Health.

BARRY R. SCHNEIDER is a professor of international relations at the Air War College and the retired director of the U.S. Air Force Counterproliferation Center at Maxwell Air Force Base. Dr. Schneider specializes in weapons of mass destruction counterproliferation and nonproliferation issues as well as the profiles of adversary leaders and their strategic cultures. He is the author of *Future War and Counterproliferation: U.S. Military Responses to NBC Proliferation Threats* (1999); the editor, of *Middle East Security Issues, In the Shadow of Weapons of Mass Destruction Proliferation* (1999), and contributor to and coeditor of *Avoiding the Abyss: Progress, Shortfalls and the Way Ahead in Combating WMD* (2005, 2006); *Know Thy Enemy: Profiles of Adversary Leaders and Their Strategic Cultures* (2003), *The Gathering Biological Warfare Storm* (2002), *Pulling Back from the Nuclear Brink: Reducing and Countering Nuclear Threats* (1998), *Battlefield of the Future: 21st Century Warfare Issues* (1998), *Missiles for the Nineties: ICBMs and Strategic Policy* (1984), and *Current Issues in U.S. Defense Policy* (1976). He has served as a foreign affairs officer (GS-14) and public affairs officer (GS-15) at the U.S. Arms Control and Disarmament Agency, as a congressional staffer on arms control and defense issues, and was a senior defense analyst at the Harris Group and the National Institute for Public Policy. He has taught at the Air War College since 1993. As a faculty member, he has taught core courses of instruction and elective courses in areas such as international rivals, homeland security issues, international flashpoints, counterproliferation issues, 21st century warfare issues, and CBW issues for the Air Force. He has taught at five other colleges and universities and has a Ph.D. in political science from Columbia University.

STEPHEN G. WALKER is emeritus professor of political science in the School of Politics and Global Studies at Arizona State University. He has published *Role Theory and Foreign Policy Analysis* (1987), *Beliefs and Leadership in World Politics* (2006), *Rethinking Foreign Policy Analysis* (2011), and *U.S. Presidents and Foreign Policy Mistakes* (2011), plus articles in several journals, including *World Politics, Journal of Conflict Resolution, Journal of Peace Research, International Studies Quarterly, International Interactions, Foreign Policy Analysis,* and *Political Psychology.* The National Science Foundation funded his research on the belief systems and conflict management strategies of political leaders (1982-1983). He served as a coeditor of *International Studies Quarterly* (1985) and as a vice-president of the International Society of Political Psychology (1997-1999) and the International Studies Association (2003-2004). He received the Distinguished Scholar Award from the Foreign Policy Section of the International Studies Association in 2003.

MICHAEL O. WHEELER is a member of the senior research staff at the Institute for Defense Analyses (IDA) and since 1991, a past member of the Strategic Advisory Group at USSTRATCOM. A 1966 graduate of the U.S. Air Force Academy,

Dr. Wheeler retired in 1991 at the rank of Colonel. While in the Air Force, he served in tactical and strategic air commands, in Thailand during the Vietnam War, on the Air Staff, at the National Security Council and the State Department, on the faculty of the U.S. Air Force Academy, and on the Joint Staff. At retirement, he was the arms control advisor to the chairman of the Joint Chiefs of Staff. In 1978 and 1979, Dr. Wheeler was a White House fellow. Following retirement from the Air Force, Dr. Wheeler joined strategic studies centers, first at System Planning Corporation, then at SAIC, and then at IDA. Dr. Wheeler also has served on Defense Science Board task forces and on the advisory committees for Lawrence Livermore National Laboratory and the National Nuclear Security Administration. He was the executive secretary of the congressionally chartered Commission on Nuclear Expertise (aka the Chiles Commission), and from 2006 to 2008, was director of the Advanced Systems and Concepts Office at the Defense Threat Reduction Agency. He has published broadly in national security affairs. Dr. Wheeler holds a Ph.D. in philosophy from the University of Arizona.

C

Meetings and Speakers

MEETING 1
JUNE 26-27, 2013
KECK CENTER OF THE NATIONAL ACADEMIES
WASHINGTON, D.C.

Vision for the Study
    Michael Shoults, Senior Executive Service, Office of the Assistant Chief
    of Staff of the Air Force for Strategic Deterrence and Nuclear Integration,
    Headquarters U.S. Air Force

Air Force Global Strike Command Perspectives
    Duane Hiebsch, Chief, Strategic Plans (A8X)

Regional Conflict and Nuclear Deterrence
    David Stein, Office of the Secretary of Defense (Policy)

Defense Intelligence Agency (DIA) Perspectives
    Pamela McCue, Deputy Director for Analytic Resources, DIA

Discrimination and Escalation Management in U.S. Nuclear Policy
    Elbridge Colby, Principal Analyst and Division Lead for Global Strategic
    Affairs, Strategic Initiatives Group, Center for Naval Analyses

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Joint Staff Perspectives
  Timothy G. Fay, Deputy Director, Command, Control and Nuclear
  Operations, Joint Staff

Recent Deterrence Studies at IDA
  Mike Wheeler, Senior Research Staff Member, Institute for Defense Analyses

RAND Corporation (Results of Recent Studies)
  Paul Davis, Principal Researcher, Pardee Graduate School

MEETING 2
SEPTEMBER 17-19, 2013
U.S. STRATEGIC COMMAND
OFFUTT AIR FORCE BASE, NEBRASKA

Deterrence Planning
  STRATCOM J52, J53, J55

Wargaming
  STRATCOM J55

Force Structure Analysis
  STRATCOM J55 and J87

Stockpile Sizing
  STRATCOM J87

Campaign Plan Assessment
  STRATCOM J9

Ongoing Areas of Improvement
  JFCC GS, STRATCOM J55

MEETING 3
OCTOBER 8-9, 2013
KECK CENTER OF THE NATIONAL ACADEMIES
WASHINGTON, D.C.

North Korea's WMD Profile
  Katy Hassig, Senior Research Staff Member, Institute for Defense Analyses

Iran
    Gregory Giles, SAIC

Deterrence of Russia: Past and Present
    Linton F. Brooks, Department of Energy (retired)

China
    J. Stapleton Roy, Distinguished Scholar and Founding Director Emeritus,
    Kissinger Institute on China and the United States Wilson Center

Deterrence and the Social Sciences
    Hriar Cabayan, Joint Staff/J-38

Narrative Dimensions of Deterrence: Recent Developments in Neurobiology
    William Casebeer, Program Manager, DARPA

MEETING 4
NOVEMBER 19-21, 2013
ARNOLD AND MABEL BECKMAN CENTER
UNIVERSITY OF CALIFORNIA AT IRVINE

Crisis Stability and Long-Range Strike
    Forrest Morgan, Senior Political Scientist, RAND Corporation

*Reducing the Great Divide: Leveraging the Data Deluge to Modernize Operational
Deterrence Analytics*
    Andrea Little Limbago, Chief Social Scientist, Berico Technologies

Ballistic Missile Defense and Associated Analytic Issues
    John Ahearne, Executive Director Emeritus, Sigma Xi, The Scientific
    Research Society

*An Enabler for Smart Power Analytics: The Hybridization of Algorithmic and
Heuristical Methodologies and Tools—The Vit Tall Analytical Approach*
    Steve Chan, Director/Senior Fellow, IBM Network Science Research Center/
    Harvard Kennedy School Center for Public Leadership

WMD and Deterrence: A Game-Theoretic Overview
    Robert Powell, Robson Professor of Political Science, University of
    California, Berkeley

Quantitative Approaches to the Study of Nuclear Deterrence
    Matthew Fuhrmann, Assistant Professor of Political Science, Texas A&M
    University

Deterrence in Context
    Patrick Morgan, Emeritus Tierney Chair, Peace and Conflict, Political
    Science School of Social Sciences, University of California, Irvine

Sanctions, Statecraft, and Nuclear Proliferation
    Etel Solingen, Thomas T. and Elizabeth C. Tierney Chair in Peace Studies,
    Political Science School of Social Sciences, University of California, Irvine

Perspectives
    Brad Roberts, William J. Perry Fellow in International Security, Stanford
    University

WRITING MEETINGS

• Meeting 5, December 17-19, 2013, AT&T Conference Center, University of
Texas, Austin
• Meeting 6, January 13-15, 2014, The Keck Center of the National
Academies, Washington, D.C.

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Tailored Deterrence and Strategic Capabilities: Situation-Specific Knowledge of Peers, Near-Peers, Regional, and Non-State Actors

INTRODUCTION

The changing international security environment since the end of the Cold War between the United States and the Soviet Union has created incentives to revisit with new approaches, methods, and tools the Cold War doctrine of strategic deterrence as the cornerstone of U.S. national security strategy. The principal change that has prompted a reassessment is the transformation of the international system from a bipolar world in which the Soviet Union posed the only major threat of an armed attack on the United States with nuclear weapons to a world of multiple potential adversaries with different cultures and decision-making processes and armed with nuclear weapons or other weapons of mass destruction (WMD).

Does this more complex strategic environment demand a more complex strategy of nuclear deterrence for the Air Force, the Department of Defense (DoD) and the other elements of the U.S. national security community (Morgan, 2003)? A comprehensive answer to this question appeared in a review of U.S. deterrence strategy by DoD in 2006, summarized as follows by Bunn (2007, p. 1):

> In its 2006 *Quadrennial Defense Review (QDR) Report*, the Bush administration set forth a vision for tailored deterrence, continuing a shift from a one-size-fits-all notion of deterrence toward more adaptable approaches suitable for advanced military competitors, regional

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weapons of mass destruction (WMD) states, as well as non-state terrorist networks, while assuring allies and dissuading potential competitors.[1]

Bunn (p. 1) pointed out that this official U.S. document was the one in which the term tailored deterrence first appeared but without explaining what it means in detail or how this strategy might be carried out. However, 7 years later it is the term of art to describe the joint strategy of deterrence pursued by the United States and South Korea in dealing with the threat posed by North Korea (Parish, 2013) and has become the focus of increased attention in the academy and by analysts in the policy community (Post, 2012; Schneider and Ellis, 2012; Lowther, 2013a).

Bunn (2007) identified three aspects of any deterrence strategy and specifically highlighted a fourth aspect in a tailored deterrence strategy. Any deterrence strategy has a focus on (1) the *adversary's action* to be deterred, (2) the *agent's military capabilities* necessary to deter the action, and (3) the *communications capabilities* necessary to provide the adversary with information about the action to be deterred and the agent's military capabilities. A tailored deterrence strategy highlights specifically the *situation-specific knowledge* and *actor-specific knowledge* required to communicate this information to the adversary and thereby deter the action.

In Bunn's words (p. 1), "Deterrence aims to prevent a hostile action (for example, aggression or WMD use) by ensuring that, in the mind of a potential adversary, the risks of action outweigh the benefits, while taking into account the consequences of inaction." This statement is not the whole story, since adversaries do not always do a rational cost-benefit calculation and act accordingly. Further, success in deterrence often depends on a broader set of influences, such as the organizational and societal characteristics of the deteree, as described below.

To take account of these complexities, a tailored deterrence strategy in the current strategic environment requires actor-specific knowledge about a variety of actual and potential adversaries whose culture and cost/benefit calculus may differ, depending on the type of decision unit (predominant leader, single group, or a coalition of multiple autonomous actors) that defines the governmental decision units of different adversaries and the cultures of the societies in which these governments are located (Allison, 1969; Hermann and Hermann, 1989; Post, 2012).

Tailoring deterrence and assurance strategies calls as well for situation-specific knowledge. The external position of the adversary or ally in the regional or global strategic environment needs to be taken into account to implement a tailored strategy of deterrence or assurance. Are the adversaries and allies peers and near-peers, regional actors, or non-state actors? Do they have weapons of mass destruction and the means to use them (Bunn, 2007; Schneider and Ellis, 2012)? Is the occasion

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[1] Bunn's summary is taken from Department of Defense (2006, p 2). She notes additional discussion of tailored deterrence in this document is on pages 4, 27, and 50-51.

for making decisions a general deterrence or assurance situation; an immediate deterrence or assurance situation; or an extended deterrence or assurance situation (Morgan, 1983, 2003)? Also, is it a crisis or noncrisis situation in which the task is to establish credibility and dissuade adversaries or allies from escalating a conflict (Hermann, 1969; Brecher and Wilkenfeld, 2000)? Is it a potential proliferation situation in which the arms control task is to strengthen trust and dissuade allies or adversaries from taking independent action to acquire or increase their nuclear capabilities (Morgan, 2003; Bunn, 2007)?

In summary, tailoring a strategy must account for myriad details, ranging from the objective and emotional stakes of affected parties, internal domestic politics in all of the parties involved, to the operational military capabilities of all parties. What follows draws on political science research in the area of comparative foreign policy analysis to highlight and integrate these considerations that operate at different levels of analysis. The goal is to provide a clear and concise analytical framework for identifying how adversaries and allies see and think about the strategic environment, in order to reduce uncertainty and anticipate their responses to U.S. deterrence and assurance decisions. The analytical framework focuses specifically on the "human factors" involved in deterrence and assurance decisions, which need to be factored into the deployment and use of weapons and delivery systems in the complex strategic environment of the 21st century.

TAILORED DETERRENCE AND ASSURANCE: THE ANALYSIS OF HUMAN FACTORS

Kenneth Waltz (1959) has identified three main levels of analysis, which identify the locations of different causal mechanisms for the analysis of decisions to deter or assure and their consequences. Psychological mechanisms such as belief systems, motivational biases, and personality traits are located at the individual level of human nature. Social mechanisms, such as the type of government or economy, are domestic-level mechanisms at the level of society, while systemic mechanisms, such as the distributions of economic and military power among states, are located at the external level of the international system. In this appendix, the focus is primarily on social mechanisms and external situations that define situation-specific knowledge, while Appendix E will focus on the psychological mechanisms and internal dispositions of decision units that specify actor-specific knowledge.

In the top half of Figure D-1 the social psychology of mechanisms located at the external systemic, societal, organizational, and bureaucratic levels of analysis is characterized by roles (in bold) for Actor A and Actor B in which decision units are composed of individuals playing roles within a decision unit and in the larger strategic environment. In the bottom half of Figure D-1 the individual psychol-

SOCIAL CAUSAL MECHANISMS

ACTOR A   ACTOR B

Systemic   Balance of power/balance of threat   Systemic
Societal   Type of regime/type of economy   Societal
Organizational   Standard operating routines   Organizational
Bureaucratic   Factional interests   Bureaucratic
Role   Group/organization   **Role**

Decisions by A & B

Individual   Leader/Clique   **Individual**
Cognitive   Beliefs   Cognitive
Affective   Emotions   Affective
Motivational   Motivations   Motivational
Characterological   Personality Traits   Characterological

PSYCHOLOGICAL CAUSAL MECHANISMS

FIGURE D-1 Decision units and the funnels of social and psychological causality. SOURCE: Adapted from Campbell, et al. (1960); Waltz (1959); Allison (1969); Kegley and Witkopf (1982); Post (2003).

ogy of mechanisms located within each individual (in bold) are the processes that generate thoughts, feelings, and motives regarding the enactment of their roles in the strategic environment, which are the focus Appendix E. As one moves up the levels of analysis from the individual through the bureaucratic and organizational levels of the state and the society to the regional or global system, the locations of the causal mechanisms become more remote from the decision unit as the site of the decisions by Actor A to deter or assure and the decisions by Actor B to respond. However, they may still act to constrain the range of choices and perhaps even influence the actual choice of action.

Collectively, these mechanisms act as a funnel of causal forces and conditions that interact with mechanisms of the decision units to produce decisions by two actors (A and B), as shown in Figure D-1 (Campbell et al., 1960; Kegley and Witkopf, 1982). The relative influence of each level of social and psychological mechanisms is likely to vary by the type of decision-making situation. The remote social mechanisms may influence strategic decisions of general deterrence and assurance, which involve weapons procurement, development, and deployment and require more resources, time, and planning to implement (Trexel, 2013). The proximate psychological mechanisms may be more influential in crisis decision-

making situations when stress from the situational features of surprise, high stakes, and short response time can influence immediate and extended deterrence and assurance decisions (Brecher and Wilkenfeld, 2000).

Graham Allison (1969) has identified three models of the social mechanisms in the upper half of Figure D-1, differentiated by distinct decision-making processes: rational choice processes at the external and societal levels (Model I), standard operating procedures at the organizational level (Model II), and bargaining processes at the bureaucratic level (Model III). Depending on which of these mechanisms dominates the decision-making process, the decision to deter or assure by Actor A and the decision to respond by Actor B may be the products of the processes of deliberation and choice associated with Model I; the organizational routines associated with Model II; or the consensus-building processes associated with Model III (Allison and Zelikow, 1999).

Post (2012) has suggested an additional decision-making model (Model IV) of the psychological mechanisms in the lower half of Figure D-1, which specifies a predominant leader's character, combinations of personality traits, and cognitive, affective, and motivational processes as important causal mechanisms. If an individual occupies a role in a decision unit where the individual's actions are indispensable in producing the decision, and if the decision maker's choice of action is idiosyncratic— that is, other individuals placed in the same strategic location would choose a different action then the individual's psychological decision-making mechanisms may be more powerful than the social mechanisms located in more remote sites in the funnel of causality (Greenstein, 1987).

To illustrate Model IV, consider the analysis by Sherman Kent, the founding father of the Central Intelligence Agency's (CIA's) Office of National Intelligence Estimates, who was tasked with understanding the reasons for the intelligence failure during the Cuban missile crisis to understand until too late that the Soviet Union was installing offensive missiles in Cuba. The U.S. government had found it difficult to believe that rational adversaries could take such a risky step. Kent concluded that insufficient attention had been paid to the personalities and political behavior of two key adversaries, Nikita Khrushchev and Fidel Castro. While they were not "irrational," they were both adventurous leaders with high risk-taking propensities, which were personality traits that were not given sufficient weight in understanding their likely behavior and the decision to install Soviet missiles in Cuba (Post, 2012).

The simplest kind of decision unit that meets the conditions of action and actor indispensability is the predominant leader decision unit, in which the power to decide rests in the hands of a single leader, such as Saddam Hussein in Iraq or Muammar al-Gaddafi in Libya and the Great Leader, Dear Leader, or Great Successor (Kim Il Sung, Kim Jong Il, or Kim Jong Un) in North Korea. External events and actions by others may also empower individuals: In crisis situations, for example,

decision making may gravitate into the hands of a leader or a small, ad hoc group, which may become indispensable in making decisions insulated from the organizational and bureaucratic constraints associated with noncrisis decisions (Hermann, 1969, 1972; Brecher and Wilkenfeld, 2000; Allison and Zelikow, 1999; Schafer and Crichlow, 2010).[2] It is useful, therefore, to distinguish among both the different kinds of decision units and the situations in which they operate as decision units.

Studies of leaders, single groups, and multiple autonomous actors have revealed a common thread connecting their decision-making processes, which scholars have identified with different labels that tap the same variable namely, whether these different decision units are "open" or "closed" with respect to the external strategic environment (Rokeach, 1960; Rosenau, 1966; Kowert, 2002; Hermann and Hermann, 1989). Analyses of leader personalities identify open and closed minded individuals as extroverts or introverts (Rokeach, 1960; Etheredge, 1978; Kowert and Hermann, 1997; Kruglanski, 2004). Other analyses distinguish open and closed leader/advisor systems (Kowert, 2002; Hermann and Preston, 1994; Schafer and Crichlow, 2010; Hermann, 2003).

Analyses of different societies contrast open and closed regimes and economies as outward-looking or inward-looking (Rosenau, 1966; Solingen, 1998, 2007; Schaub, 2013). Analyses of international conflict and cooperation identify periods of relative inattention or attention in the relations between strategic dyads in the regional and global international systems (Deutsch, 1954; Deutsch and Singer, 1964; Waltz, 1959, 1964; Cobb and Elder, 1970; Solingen, 2007; Rasler et al., 2013). All of these studies focus at external systemic, societal, or state levels of analysis on whether the causal mechanisms in the decision unit (predominant leader, single group, multiple autonomous actors, or the state) operate to make it relatively "self-contained" or "externally influenceable" (Hermann and Hermann, 1989; see also Rosenau, 1966, and Solingen, 2007).

In a given crisis or conflict any one or a combination of the four models discussed earlier, Allison's Models I, II, III or Post's Model IV, may shed light on the manner in which decisions to escalate or de-escalate are made and expected. In addition, in acute international crises characterized by the elements of surprise, high stakes, and short time for decisions, it is likely that Post's Model IV will be all the more important to explain how decisions are skewed by personality traits, group dynamics, and fuzzy thinking caused by fatigue and acute stress. Crises such as the Cuban missile crisis are characterized by a threat to major values, ambiguous

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[2] Not all predominant decision units are in autocratic regimes. Some democratic regimes assign this power to a leader on some issues, but the U.S. president has the decision-making authority to use U.S. nuclear weapons but shares power with others (in this case, Congress) on other nuclear decisions, such as acquisition of nuclear weapons.

or incomplete information, short time for decisions, and surprise (see Hermann, 1969, 1972; Brecher and Wilkenfeld, 2000).

Unfortunately, at such times when the smartest decisions need to be made, it is also the most difficult from a psychological standpoint. Crisis stress and fatigue may lead to emotionally distorted decisions. Such decisions under high anxiety are more likely to reflect groupthink, ethnocentric (or we-they) thinking, oversimplification, stereotyping, and premature conclusions before all the facts are considered. High stress can also cause a tendency in some leaders to freeze and become ineffective. Others indulge in mirror imaging and selective perception. Crisis decisions are also often made in small, ad hoc, face-to-face groups that can be influenced by group dynamics and a tendency to exhibit a risky shift phenomenon and conformity to group perspectives (groupthink) as well as decision momentum (Jervis, 1976; 't Hart et al., 1997; Schafer and Crichlow, 2010).

INTEGRATING HUMAN FACTORS IN DETERRENCE AND ASSURANCE DECISIONS

It is helpful in diagnosing and prescribing deterrence and assurance strategies and tactics to focus the attention of decision makers on those specific conditions that enhance the effectiveness of deterrence and assurance strategies rather than the conditions that make it more difficult to deter adversaries and assure allies. In order for a deterrence or an assurance message to be effective, it is necessary that the target of the message be *receptive* to it. Two general conditions of receptivity are that the recipient must be both willing and able to receive the message. If these conditions are weak or nonexistent, then the sender of the message will have to develop strategies to overcome these deficits or somehow work around them in order to deter or assure the recipient.

An effective strategy of tailored deterrence or assurance is designed to meet these two conditions. The first step in tailoring a deterrence or assurance message is to diagnose the situation-specific and actor-specific features of the strategic environment and decision unit, respectively, which indicate whether the relevant systems of interest are "open" (receptive) or "closed" (unreceptive) to the message being sent. The second step is to ask and assess whether or not these conditions effectively block the message. Depending on the answer to this question, the third step is either to send the message "as is" or devise a "work-around" strategy to overcome or otherwise neutralize the blocking conditions in order to communicate the tailored message. If it proves impossible or too costly to do so, then decision units should probably consider another means than deterrence or assurance and/or change their own goals in dealing with the adversary or ally.

It is also important to understand that the same conditions apply in effectively diagnosing and prescribing both deterrence and assurance decisions. The same

decision may have both deterrence effects on adversaries and assurance effects on allies. The interdependence of these decisions has long been recognized by deterrence theorists in extended deterrence situations (Schelling, 1960, 1966; Jervis and Snyder, 1991; Khong, 1992). The most famous historical example of this analytical linkage is articulated by the Domino Theory, coined initially in the Eisenhower administration regarding the threat to the security of SEATO members posed by a communist seizure of power in Vietnam. This move would pose a geographical threat of communist invasion into neighboring states, such as Laos and Cambodia, which would fall like a row of dominos (Wolf, 1967). It also raises the issue of the credibility of U.S. commitments to deter and defend threats to other U.S. allies outside Southeast Asia during the Cold War (Schelling, 1966). These examples underline the interdependence of credible deterrence and assurance commitments: Deterring an adversary assures an ally, and vice versa, assuring an ally deters an adversary (Schelling, 1966).

An initial estimate of the degree of difficulty either in deterring an adversary or assuring an ally is a function of the answers to the questions posed in Figure D-2 about the targets of deterrence or assurance. The menu in Figure D-2 is a helpful tool as a decision-making heuristic or checklist in integrating the causal mechanisms to obtain a cross-level understanding of the likely degree of receptivity by the adversary or ally to deterrence or assurance decisions.

External Systemic and Domestic Societal Strategic Environments

System: attention (+) or distraction (−)?   **Society**: outward (+) or inward (−) looking?
  Balance of power (+ or −)   Regime (+ or −)
  Balance of threat (+ or −)   Economy (+ or −)

Characteristics of Decision Unit

State: outward (+) or inward (−) looking?   **Individual**: outward (+) or inward (−) looking?
  Multiple autonomous Actors (+ or −)   Predominant Leader's Advisory System (+ or −)
  Single group (+ or −)   Predominant Leader's Personality (+ or −)

Initial Overall Conditions of the Adversary or Ally

Degree of Receptivity: receptive (# of +'s) v. nonreceptive (# of −'s)?
      Able: (System and Society) (+'s and −'s)
      Willing (State or Individual): (+'s and −'s)

FIGURE D-2 Decision-making heuristics for deterrence and assurance decisions. NOTE: Open (+); closed (−). SOURCE: Waltz (1959); Hermann and Hermann (1989); Solingen (1998, 2007).

The mechanisms in the menu can each take two values: plus (+) or minus (−), which represent the binary states of "open" or "closed" for each mechanism. The binary values for each mechanism on the menu act as logic gates for assessing the likely response of the adversary or ally to the U.S. stimulus. The menu identifies potential necessary and sufficient conditions for the stimulus to elicit the desired response under the macrolevel conditions of human nature, domestic society, and the international system that either reenforce or mitigate the effects of the stimulus (Waltz, 1959). The state's organizational and bureaucratic mechanisms supplement the view of those macrolevel processes with a view inside the state of microlevel processes at the organizational, group and individual levels of analysis (Hermann and Hermann, 1989; Hermann, 2003; Post, 2003, 2012).

If the two initial logic gates of external system and society in the strategic environment are open (+), then the background conditions of the target are receptive to a deterrence or assurance message from the sender. These initial conditions at the external and domestic levels of analysis permit the target to receive a message from the sender. If one of the logic gates is open while the other is closed, then a deterrence or assurance message should be tailored toward the open gate. Depending on which gate is open, the message should be a military or an economic threat or promise. If both gates are closed, then it is relatively unlikely that the exercise of hard power based on military or economic resources will be effective, and the exercise of soft power through other means may be needed—for example, appeals to core norms of the target through diplomatic or cultural channels of communication (Nye, 1990, 2011).

The next level of analysis in Figure D-2 is the internal characteristics of the decision unit (multiple autonomous actors, single group, predominant leader and advisory system). It is possible for all three types of decision units to be present in a given society and accessible to messages from the sender (Rosati, 1981). It is also possible for decision makers at one of these levels of analysis to be receptive to a deterrence or assurance message even if the external conditions in the strategic environment are not receptive. The center of decision-making gravity may reside in one of them or be arranged in a hierarchical or a segmented configuration. It is possible as well for different decision units to be associated with different issues or situations.[3] Ideally, a deterrence or assurance message is targeted at a decision unit that is in the open condition and has the power to respond to the message.

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[3] For example, in the U.S. case the separation of powers among executive, legislative, and judicial branches along with a bureaucratized executive branch may make the decision-making process more complex in some situations and more centralized in other situations (Hermann, 1969; Walker and Watson, 1992). In the U.S. case the power to make foreign policy decisions resides in both the White House and the Congress for some issues and situations while in others the White House has the power to make decisions.

The "ultimate decision units" (Hermann and Hermann, 1989) in any state are individuals who may decide alone or with others to respond authoritatively to a deterrence or assurance message.[4] It may be the case that a heterodox pattern of open and closed conditions exists inside the state at the levels of different decision units. Some individuals may be receptive to the message while others are not, which makes the exercise of deterrence and assurance power a relatively uncertain enterprise. In the end, it depends on (1) whether the external environmental situation permits a decision maker to be receptive, (2) the condition of the decision unit in which an individual or group resides is in a receptive condition, and (3) whether an individual is also psychologically in a receptive condition.

In particular, the relevant indices from content analysis techniques employed to study predominant leaders may also be useful for studying single groups and multiple autonomous actors as decision units. They may indicate whether these aggregate decision units as well as predominant leaders are in an open or closed condition. Generally, open decision units are more slow and deliberate while closed decision units are relatively fast and frugal in making decisions. Some configurations of decision units and situations can produce interaction effects leading to different types of risky decisions defined as extreme (risk-acceptant) rather than moderate (risk-averse) decisions (Hermann and Hermann, 1989). These possibilities are tabulated in Table D-1 for the four types of decision units.

The relevant indicators of open or closed conditions for predominant leaders are high or low integrative complexity; moderate or extreme needs for power, affiliation, and achievement; symmetrical or asymmetrical beliefs about the control of historical development by self and other; and non-zero-sum or zero-sum subjective games for self and other.[5] The analysis in Appendix E of these psychological

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[4] Hermann and Hermann (1989, p. 363, n.1) define an ultimate decision unit this way: "If there is a decision, it is made by an individual, group of individuals, or multiple actors who have both (a) the ability to commit or withhold the resources of the government in foreign affairs and (b) the power or authority to prevent other entities within the government from overtly reversing their position without significant costs (costs which these other entities are normally unwilling to pay). We refer to the decision unit that has these two characteristics for a given issue at a particular time as the 'ultimate decision unit.'"

[5] Some of these indicators also interact with other personality traits to generate open or closed conditions: low need for power in combination with a low belief in historical control produces respect for external constraints, awhile a high need for power in combination with either a low or high belief in historical control produces challenges to external constraints. Different combinations of conceptual complexity and self-confidence interact to cause variations in openness to information (Hermann, 2003, pp. 188-195). Different combinations of power, affiliation, and achievement motivations are indicators of a decision unit's risk-averse or risk-acceptant orientations, as are different combinations of the instrumental operational code beliefs I-3, I-4a, and I-4b (Winter 2003; see also Walker et al., 2003). These indicators are discussed and illustrated in Appendix E.

TABLE D-1 Risk Propensity of Different Decision Units in Different States

Decision Unit	Internal States	Open/Closed System	Risk Propensity
Predominant leader	Contextual sensitivity	Insensitive (c) Sensitive (o)	Extreme Moderate
Single group	Degree of consensus	Agreement (c) Disagreement (o)	Extreme Moderate
Multiple autonomous actors	Relations among actors	Zero-sum (c) Non-zero-sum (o)	Extreme Moderate

NOTE: Open (o); closed (c).
SOURCE: Adapted from Table 1 in Hermann and Hermann (1989).

mechanisms concludes that these indicators are also likely to be valid for assessing the open or closed conditions of single groups and multiple autonomous actors.

In each instance and at each level within a decision unit, the key questions regarding receptivity are whether the conditions of *opportunity* (is the decision unit able?) and *willingness* (is the decision maker willing?) are present (Most and Starr, 1989). It is possible for the environment at each level to permit a response; however, the decision maker(s) may be unaware and/or unwilling (Sprout and Sprout, 1956; Kupchan, 1994; Walker, 2013). These uncertainties pose dilemmas in the form of crises of observation for the sender of the deterrence or assurance message. To whom should the message go and how should it be tailored?

A strategy of deterrence or assurance in this context refers to sending a message that recognizes the constraints and incentives in the recipient's strategic environment at the systemic and societal levels of analysis while navigating the organizational and bureaucratic constraints and opportunities inside the recipient's decision units. The response by a decision unit in the open condition is normally not an extreme decision that radically escalates or deescalates from the status quo. It is instead a pattern of decision making that is risk-averse rather than risk-acceptant and, therefore, is likely to be an incremental rather than a radical departure from the status quo (Braybrooke and Lindblom, 1963; Hermann and Hermann, 1989; see also Walker and Malici, 2011; Tuchman, 1984; Neustadt and May, 1986).

In the open condition a response is based primarily on information about the strategic environment and the sender's message rather than on structural biases and social mechanisms inside multiple autonomous actors or single groups as the decision units or unconscious psychological mechanisms in the decision-making processes of predominant leaders as the decision unit. Departures from the status quo are governed by the amount of information available to the decision maker; the less information available, the bigger is the uncertainty about the consequences of actions and the smaller is the opportunity and willingness to initiate bigger

changes from the status quo. Conversely, the more information available, the bigger is the possible change because of the increase in certainty in a high-information environment about the consequences of various courses of action.

Since decision units normally operate in a complex environment with a relatively low information-processing capacity, they should be risk-averse and make moderate decisions. However, if decision units are closed and do not recognize the conditions of environmental complexity and low information due to the operation of psychological or social mechanisms, then they are prone to being risk-acceptant and making extreme rather than moderate decisions (Braybrooke and Lindblom, 1963; Hermann and Hermann, 1989; Walker and Malici, 2011).

TOOLS FOR MAKING TAILORED DECISIONS TO DETER AND ASSURE

There are four central research questions about deterrence and assurance strategies: (1) What deters and assures? (2) What military capabilities and optimal force postures are needed to provide deterrence and assurance effects? (3) What are the communications capabilities required to send effective deterrence and assurance messages? (4) What situation-specific and actor-specific knowledge is desirable to tailor effective deterrence and assurance messages? These four questions correspond to the three aspects of any deterrence or assurance strategy and the importance, identified by Bunn (2007), of tailoring the strategy.

In addressing these four questions it is important to recognize that the answers are interrelated. The answer to what deters or assures is that military capabilities can help deter and assure; however, they are neither a necessary nor a sufficient condition for deterrence success. As discussed in Chapter 2, a variety of influences may be necessary (diplomatic and economic among them), and, in some cases, deterrent efforts will fail even when the would-be deterer believes they should succeed. Another factor in success is the communications capabilities available to convince both adversaries and allies that military capabilities (and other aspects of influence) are available and ready for use against an adversary and on behalf of an ally.

The possibility of strategic deception in the form of convincing allies and adversaries that one has more military capabilities than is actually the case underlines the psychological character of deterrence or assurance success. A strategic surprise, such as the U.S. discovery after the invasion of Iraq in 2003 that Saddam Hussein did not have nuclear weapons, is always possible. Conversely, deterrence failure may occur even though the distribution of military capabilities may be asymmetrical in favor of the deterring power, because the putative deteree does not believe this information. In turn, the effective communication of military capabilities and the resolve to use them depends on the application of local knowledge of the situation and actors in question. However, admitting these strategic possibilities does not negate the central importance of military capabilities (actual or perceived) in tak-

ing credible deterrence or assurance actions, even if deterrence failure occurs due to domestic imperatives to attack anyway or doubts about the deterring power's credibility.

What Military Capabilities Deter and Assure?

Specifically, what are the optimal nuclear and conventional force postures for carrying out deterrence and assurance, including toward non-state actors as well as peers or near-peers and regional state actors? Schneider and Ellis identify seven classic elements of the U.S. deterrence strategy directed toward the Soviet Union during the Cold War:

• Having retaliatory forces capable of inflicting a level of damage considered unacceptable to the Soviet leadership,
  • Possessing a second strike capability that could survive a surprise attack,
  • Having a will to use this nuclear force in a confrontation if necessary,
  • Communicating that the United States had both the will and the capability described so the U.S. threat was credible.
  • Having an intelligence, surveillance, and reconnaissance system able to identify the origins of any attack, thereby answering the "who did it?" question,
  • Having the capability to identify and strike a target set of the highest value to the Soviet Union and its leaders,
  • Having a rational adversary leadership who preferred to live and stay in power rather than die in order to inflict destruction on the United States (Schneider and Ellis, 2012, pp. 462-463).

With the end of the Cold War and the emergence of multiple new nuclear powers led by decision makers with different cultures, personalities, historical experiences, and military capabilities, this Cold War deterrence strategy may not be optimal for all possible rivals, especially those far different from the Soviet Union, including some non-state actors (Lowther, 2013b; Trexel, 2013).

In particular, non-state actors like al-Qaeda may be significantly more difficult to deter than state actors since the former may have no known return address. Some of their followers may also be willing to martyr themselves in order to strike a blow against the far enemy—that is, the United States. A policy of deterrence by denial may be the most effective means of deterring a non-state actor's use of WMD. By keeping chemical, biological, radiological, and nuclear weapons out of the hands of such radical groups, they will be unable to strike a WMD blow.

Thus, it is desirable to deter such groups from acquiring WMD capabilities by adopting security measures to lock down so-called loose nuclear material, to make it more difficult to smuggle materials out of nuclear facilities worldwide, to increase

surveillance of threatening groups, to take offensive actions against terrorist rings, and to provide a layered defense in depth against the transfer of WMD materials, WMDs, and persons of concern into the continental United States and allied territories. By making it more difficult to acquire WMD materials, to acquire the ability to transport and manufacture weapons from it, and to transport such arms and penetrate to significant targets, the U.S. can deny terrorists and other non-state foes the ability to destroy targets with such weapons.[6]

The Use of Game Theory

What if these kinds of efforts fail and nuclear proliferation occurs so that peers or near-peers, regional powers, and non-state actors acquire nuclear weapons? Game theory has long been a traditional tool for answering this question about capabilities along with operations research and systems analysis (Schelling, 1960; Ellsberg, 1961). Together with gaming possible scenarios in man/machine simulations, the representation of the logic of maximizing benefits and minimizing costs in strategic interactions with game theory is still a desirable research strategy for investigating the logic of deterrence and assurance against peers and near-peers, regional actors, and non-state actors in the 21st century security environment.

The 2×2 ordinal game (two players with two choices) is a mature tool in the repertoire of rational choice theories of decision making, including decisions for war or peace. It focuses on the deliberations and decisions of two rational players who realize that the outcomes of their decisions depend significantly on each other's choices and capabilities. Classical game theory models of this kind assume that both players make their choices based on the condition of two-sided information, i.e., that each knows the capabilities and preference rankings of both self and other for the four different outcomes generated by the intersection of their respective choices. With this information each player can calculate the optimum

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[6] There are about 20 steps a non-state group would have to take to get and use a nuclear weapon in the United States. Such a group would have to acquire WMD material and then transport it outside of the state where it was stolen. Then the group would have to manufacture such an explosive and transport it to the United States passing through several layers of defenses designed to detect and intercept it. Finally they would have to successfully transport the finished nuclear weapon to the target area and employ it against a continental U.S. target. If the probability of each such step is assumed to be independent of the others in the process and if each step is reduced to just a 50 percent probability of success by taking defensive measures at each point in the 20-step process, then the chance of a successful terrorist nuclear attack would be reduced to less of than one in a million. If each step is assumed to be necessary, then failure at any one of the 20 steps could prevent the attack by itself. Of course, if the terrorist group were to steal a finished nuclear weapon and acquired an ability to detonate it, then the risk to the United States and allies would be much higher (see Mueller, 2010).

outcome and choose simultaneously on the basis of the two-sided information available to them.

Recent modeling efforts have analyzed theoretical solutions to the 2×2 game under conditions of *incomplete* information, when the players do not share accurate information about each other's preference rankings. Each is instead playing a different *subjective* game, and the outcome of their strategic interaction is the intersection of their choices based on their respective subjective games (Maoz, 1990; Walker et al., 2011). The rules of play also stipulate alternating rather than simultaneous moves based on information from revealed preferences inferred from prior behavior or pre-play communication between the players.

These two changes increase the likely external validity of the model and its usefulness for understanding adversaries and allies in deterrence and assurance situations in real-world interactions. The results of these more realistic games can identify the distribution of risk-acceptant and risk-averse paths forward for the United States and its adversaries and allies regarding the problems of deterring the escalation of conflicts and dissuading the spread of nuclear weapons and other weapons of mass destruction. A world of nuclear-armed powers in several regions increases the risk of escalation to a nuclear war from a conventional war and makes it desirable to focus increased attention on general deterrence and the dissuasion of nuclear proliferation, so that the occurrence of crisis and near-crisis situations involving extended and immediate deterrence actions are minimized.

Game theory provides a set of abstract models to represent the types of adversaries and allies that are possible in these security environments. The possible situations with the three types of actors (peers/near-peers, regional, and non-state actors) shown in Figure D-3 are represented as having different distributions of military capabilities in two types of strategic environments. The two players (U.S. and Other) rank their preferences from (4) highest to (1) lowest for the four outcomes (cells) where their choices of Cooperate (CO) or Conflict (CF) intersect as possible solutions to the game: mutual cooperation (CO,CO), mutual conflict (CF,CF), domination by one player and submission by the other player (CO,CF) or (CF,CO). For example, in the United States, peer/near- peer game, the (CO,CF) outcome of (1,4) is the lowest-ranked outcome of submission (1) for the United States and the highest-ranked outcome of domination (4) for Other. Conversely, the (CF,CO) outcome of (4,1) in the same game is the highest-ranked outcome of domination (4) for the U.S. and the lowest-ranked outcome of submission (1) for Other.

In a world of conventional weapons with peer/near-peer, regional, and non-state actors, the United States has the military capabilities to dissuade allies who are not assured by the U.S. strategy toward adversaries and, if necessary, dominate (CF,CO) or block (CF,CF) an adversary or ally if the other player refuses mutual cooperation (CO,CO) as the equilibrium solution. However, in the world of nuclear

		Adversaries						
		Peer/Near-Peer		Regional		Non-State		
		Other		Other		Other		
		CO	CF	CO	CF	CO	CF	
Conventional Weapons	CO	**4,3**	1,4	CO	**4,3**	1,4	CO	4,2	1,4
	U.S.			U.S.			U.S.		
	CF	2,1	3,2	CF	3,2	2,1	CF	3,1	**2,3**

Strategic Environment

		Other		Other		Other		
		CO	CF	CO	CF	CO	CF	
Nuclear Weapons	CO	**4,3**	**2,4**	CO	**4,3**	**2,4**	CO	**4,2**	**2,4**
	U.S.			U.S.			U.S.		
	CF	3,2	1,1	CF	3,2	1,1	CF	**3,3**	1,1

FIGURE D-3 U.S. games with types of adversaries in different strategic environments. The solutions from the Theory of Moves (TOM) are in bold (Brams, 1994). Cooperation (CO) and Conflict (CF) are the choices for each player, which can intersect and result in the following possible outcomes: mutual cooperation (CO,CO); row submits and column dominates (CO,CF); mutual conflict (CF,CF); row dominates and column submits (CF, CO).The logic of these conflict games also applies to allies who disagree with the U.S. strategy of ranking (CO,CO) as the highest outcome. Two players who agree on the highest-ranked outcome play a no-conflict game, with that outcome as the game's solution. SOURCE: Brams (1994, Appendix).

capabilities in Figure D-3 the U.S. ability to dominate (CF,CO) is in question, and deadlock (CF,CF) is a very risky outcome as both players in each game rank deadlock as the lowest-ranked outcome. In this strategic environment the risk of deadlock is nuclear war as the final outcome of a conflict, which would pose an existential threat to what each player wishes to protect.[7]

The solutions for all of these games with alternating moves and prior communication between players as the rules of play represent the logical outcomes in these two worlds if the United States chooses deterrence and assurance as its strategy

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[7] This existential deterrent effect may have different referents in addition to or instead of the existence of the decision unit, such as family members, religious institutions, or a revolutionary movement that members of the decision unit hold dear. A deterrent threat will by definition not work against a completely nihilistic adversary who does not care whether anyone or anything survives a war.

for managing and resolving conflicts.[8] It is important to understand as well that deterrence/assurance is not the only strategy available to the United States in these two worlds. The focus here is on the logical consequences of a deterrence/assurance strategy, because this strategy is the current strategy of the United States and the mission of the U.S. Air Force.

The results in Figure D-3 illustrate the continued value of game theory as a tool to specify conflict situations with potential adversaries in which assumptions are made about the preferences of each player for the possible outcomes to the game. They show that if hard power (military capabilities) really matters, then the games (strategic interaction situations) against different types of adversaries have different outcomes for a deter/assure strategy of threats and promises by the United States. The U.S. outcomes depend as well on whether it is a world of conventional or nuclear weapons, even if the power position of the United States in the world changes or if the United States changes its strategy toward potential adversaries, because the introduction of nuclear weapons alters the ranking of each player's preference rankings for the possible outcomes of their games.

Finally, the results in Figure D-3 demonstrate how if the two players are truly strategic, that is, open to the information about their respective power positions in the world and aware of the nature of the outcomes of a nuclear war between them then when a CF,CF deadlock risking nuclear war is ranked lowest (1), the asymmetrical conventional superiority of the United State does not guarantee the outcomes of either settlement (CO,CO) or U.S. domination (CF, CO) as a solution to the strategic interaction problem. In a game of multiple equilibrium solutions, therefore, it is not always desirable in some cases for the United States to confront a nuclear adversary.

For example, a projection of the submission outcome (2,4) in Figure D-3 for the United States as the equilibrium solution in a nuclear strategic environment is a sufficient condition for the United States to consider disengaging militarily from this type of conflict situation under certain conditions of play against any type of

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[8] In sequential game theory a strategy "is a complete plan that specifies the exact course of action a player will follow, whatever contingency arises" (Brams, 1994, p. 227). Strategies are distinguished and specified further here by the rank order of the four outcomes: mutual cooperation (CO,CO); mutual conflict (CF,CF); U.S. domination (CF,CO), U.S. submission (CO,CF). There are four families of strategies whose members share one of these four outcomes as the top-ranked outcome; members within each family of strategies are differentiated by variations in the rankings of the remaining three outcomes. For example, a deter/assure strategy ranks CO,CO as the highest ranked outcome. In Figure D-3, the U.S. deter/assure strategies in a strategic environment of conventional weapons rank CO,CO highest (4), CF,CF (3), CF,CO (2), CO,CF lowest (1) toward peers/near peers; the rankings are CO,CO (4), CF,CO (3), CF,CF (2), CO,CF (1) against regional and non-state actors. More generally, variations in rankings are specified by assumptions about differences in the distributions of power and interests between players (Walker, 2013).

adversary—peer/near-peer, regional, or non-state actor. [9] Instead, it should pursue its interests indirectly with soft power (diplomatic and economic tools of statecraft) to assure allies and isolate the adversary rather than employ hard power (military tools of statecraft) directly in an attempt to deter an adversary or dissuade an ally.[10]

It is important as well to acknowledge that these abstract, game-theoretic models may not have external validity. In the real world of historical cases between the United States and the three types of actors in Figure D-3, the assumptions in the model may not always be present. Each player may instead rank the four possible outcomes differently than the ones specified in this figure, or they may make decisions that are not based on information about all possible outcomes and the distribution of military capabilities between them. Specifically, if an adversary armed with nuclear weapons is not open (receptive) to deterrent threats, especially if backed into a corner with no way out, then it might elect to use those weapons first in a conflict for four reasons. First, the United States is very likely to win a conventional war, and defeat would mean the adversary state's leadership would lose power and perhaps their lives. Second, U.S. and allied airstrikes likely would force the adversary's leaders into a use-or-lose dilemma regarding their nuclear and other WMD capabilities. Third, the adversary might be tempted to use nuclear explosives to create electromagnetic pulse effects that would help level the playing field against a technically superior U.S. force. They might believe that since EMP was relatively bloodless, it might not provoke a nuclear response from the United States. Fourth, if an adversary was about to go down to defeat, it could elect to launch a revenge nuclear strike on U.S. forces, allies, and—in the future—against the U.S. homeland.

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[9] In the games in the nuclear strategic environment shown in Figure D-3 with multiple equilibria as stable outcomes, the actual final outcome depends on the order of play (who has the next move) from each possible initial state (cell) at the beginning of the game, whether preplay communication of threats and promises is allowed between the players, and whether the game is likely to be repeated between the two players (Brams, 1994). These conditions may not always favor the United States in an actual historical situation.

[10] The logical implications of these two strategies for exercising power directly or indirectly against an adversary are modeled with game theory in Walker and Malici (2011, Appendix, pp. 303-304).

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E

Tailored Deterrence and Strategic Intentions: Actor-Specific Knowledge for Deterrence and Assurance Strategies

INTRODUCTION

Can behavioral science research into the local knowledge of the personalities and cultures of state and non-state actors provide actor-specific knowledge for tailoring a U.S. communications strategy designed to deter adversaries, assure allies, and dissuade both adversaries and allies from developing, expanding, and using weapons of mass destruction (WMD) capabilities? This chapter discusses how actor-specific knowledge and the tools that can inform it—for example, leader personality profiling and both automated and expert-intensive content analysis, are useful for doing so, particularly in helping tailor communications with both adversaries and allies. They can help (1) assess whether the "decision unit" (predominant leader, single group, or multiple autonomous actors) is "open" or "closed" to receiving a deterrence or assurance message and (2) whether the decision unit is relatively risk-averse or risk-acceptant in its strategic orientation toward action.

WHICH COMMUNICATIONS CAPABILITIES DETER AND WHICH ASSURE?

The basic stimulus-response behavioral model of communications and information theory is relatively clear as a descriptive model (Shannon and Weaver, 1964;

Holsti et al., 1968). A message in the form of an action (e.g., a threat or promise) is sent by Actor A as the stimulus (S). Actor B receives this message and follows with a response (R) in the form of cooperation or conflict behavior. Social scientists have scales and indices that can measure (S) and (R) to see if there is congruence between them, i.e., whether S and R "match up" (correlate) in the way intended by Actor A. If so, then the outcome is deterrence or assurance success, and if not, then the outcome is deterrence or assurance failure.

However, it is not so clear what the intervening causal processes are that account for the correlation between S and R, or how these explanatory models can be specified and measured. The conventional model in the classical deterrence literature assumes a causal mechanism of "economic rationality," in which costs (c) and benefits (b) are calculated by Actor B. For the simple case of B having only the choices of escalating or deescalating, then if (c) > (b) regarding escalation (e) and if (b) > (c) regarding de-escalation (d), then Actor B will choose deescalation (d) (see Ellsberg, 1961; Robbins, et al., 2013). Unfortunately, it is difficult both conceptually and empirically to define and measure (c) and (b) with reasonable reliability and validity. In addition, there are problems, discussed in Chapter 2 of this report, such as the actors may not in fact have stable utilities and may not base their actions on "expected-value" calculations as assumed by the original notions of economic rationality.

Another basic assumption in rational choice models of deterrence and reassurance is that the both Actor A and Actor B understand the costs and benefits in the same way. These assumptions are at best first approximations and, at worst, they are radically wrong under real-world circumstances in which threats and promises may be exchanged between Actor A and Actor B but are communicated or interpreted ineffectively. Motivational and emotional biases, such as fear, anger, or mistrust, and cognitive biases, such as ideological beliefs or cultural norms, may distort the identification, weighting, and calculation of costs or benefits.

The result is a choice that follows rational procedures in the sense of actors trying to relate ends and means, but it may be unwise because of distorted perceptions at the point of decision (Post, 2003a; Downes-Martin, 2013; see also Holsti et al., 1968; Zinnes, 1968; Holsti, 1972; Jervis, 1976; Fiske and Taylor, 1991; Davis and Arquilla, 1991; Steinberg, 1996). The influence of these actor-specific factors is heightened under certain stressful decision-making conditions when a crisis situation, defined as a surprise involving high stakes with a short time in which to respond, is the occasion for decision (Hermann, 1969, 1972; Brecher and Wilkenfeld, 2000).[1]

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[1] Deterrence theorists also recognize shortcomings of the rational choice mechanism connecting threats and responses (Morgan, 2003). It is often argued that the value of the rational choice model lies in its value as a normative standard against which to assess what is actually occurring in strategic

These problems are compounded when the mechanisms connecting S and R are social as well as psychological. If multiple actors are involved rather than a single predominant leader, then results may depend on complex interactions among the various individual cost-benefit equations, as well as the effects of imperfect communications and power relationships. The results may therefore be unpredictable. To put it differently, trying to open the black box and understand the intermediate causal mechanisms leading to a decision inside a predominant leader, within a single group, or among a coalition of autonomous actors may not be feasible by outside observers, especially if they lack the tools for decoding their interactions and organizational context (t'Hart et al., 1997; Schafer and Crichlow, 2010; Allison and Zelikow, 1999).

A strategy of tailored deterrence and assurance attempts to reduce the gaps between the rational model implying desired results and the psychological and social mechanisms that generate the actual results. The particular emphasis in this chapter is on the psychological mechanisms of object appraisal, mediation of self–other relations, and ego defense identified in Appendix D (see Figure D-1).[2] The basic communications problem to be solved is reducing the problem of uncertainty in the decision-making environment for Actor A in dealing with Actor B as an adversary or an ally. There may be uncertainty about the capabilities, goals, or intentions of Actor B. In the absence of direct and updated evidence (new information) about these items, decision makers in Actor A may substitute beliefs (old information) inferred vicariously from lessons learned in previous personal encounters or analogous situations (Jervis, 1976; Neustadt and May, 1986; Larson, 1985; Vertzberger, 1990).

The recall of this information may be accompanied by undesirable emotional tags in the form of the arousal of motivations or feelings that were actually stimulated earlier by the actions of the other actor and shaped the recall of inappropriate analogies (De Rivera, 1968; Jervis, 1976; Zajonc, 1980; Steinberg, 1996; Post, 2003a; Marcus, 2003; Neumann et al., 2007; Downes-Martin, 2013). Therefore, it can be important for Actor A to know B's psychology as well as B's sense of power balances and utilities, in order to tailor the communication of a threat or promise

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interactions and then taking steps to share more information and thereby increase the chances of a rational response and outcome in subsequent interactions (Fearon, 1994a,b; Zagare and Kilgore, 2000; Glaser, 2010). The debate over whether and how the actual mechanism needs to be specified correctly in order to understand how deterrence works is the subject of a symposium in *World Politics* (Downes, 1989), an edited volume by Geva and Mintz (1997), and a book by Morgan (2003). As discussed in Chapter 2, another view is that the economic-rationality model is not necessarily a good normative model and is certainly not descriptive: Different decision styles are appropriate, not just common, in different types of circumstances.

[2] The social mechanisms also identified in Figure D-1 were discussed in Appendix D.

accordingly. What are the available profiling methods and tools for accessing this psychological knowledge?

An individual's basic personality characteristics are relatively stable traits that are inherited genetically and shaped into different configurations or syndromes by childhood and adolescent psychobiographical experiences; they are relatively constant and not likely to change without psychiatric treatment or perhaps genuinely life-altering experiences (Post, 2003a). However, these structural characteristics of the personality system are not all equally relevant for explaining political behavior, as different situations are likely to selectively engage aspects of the basic personality system as causal mechanisms (Funk et al., 2013). For example, an individual with a narcissistic personality syndrome that is characterized by a motivation to seek glory and adulation from others to compensate for underlying self-doubts may be more likely to seek careers in the public arena of politics as well as other venues of social life where a leading role is available.

In immediate political situations these enduring structural personality characteristics may act as unconscious influences that condition the range of options a leader considers, and they perhaps influence the actual choice of actions in ways that outside observers would deem "radically irrational"—that is, as triggered and driven by unconscious emotional and motivational impulses unmediated by conscious thoughts and beliefs and information available from the environment (Simon, 1985). While constant features of a leader's personality structure may define the character of the leader and influence all of his political decisions, three questions also arise: How exactly do these structural features of the personality system influence a decision? Is it a matter of kind or degree? When (in what situations) do they matter and at which stages in the decision-making process are they relatively unimportant?

There are two ways to answer such questions in linking personality with decisions: (1) pursue a top-down strategy that defines the leader's basic personality structure from psychobiographical evidence remotely located from the occasion for decision and then examine how proximate processes of cognition, emotion, and motivation associated with an immediate decision-making situation link personality structure with political behavior or (2) pursue a bottom-up strategy that first examines those proximate processes that are direct causal mechanisms of behavior in the immediate decision-making situation and then contextualize these results by linking them with the underlying structure of the leader's personality.

These two approaches characterize the leadership profiling literature in political psychology and are illustrated in this chapter with their application to the personality of Iraqi leader Saddam Hussein in the decision-making situations that he faced in the 1990-91 Persian Gulf conflict with the United States and its allies. The example of the Persian Gulf conflict includes efforts by the U.S. government to deter an attack on Kuwait by Iraq and subsequently to coerce Iraq's withdrawal

from Kuwait. The following analysis presents brief illustrations of several profiling methods for analyzing actor-specific knowledge relevant for making tailored deterrence and assurance decisions. The examples all draw on the case of Saddam Hussein as a predominant leader who was neither deterred from invading Kuwait in 1990 nor persuaded to withdraw voluntarily in 1991.

The first example is a summary of the top-down, holistic study of the Iraqi leader Saddam Hussein by Post (2003b), which was presented in testimony before the House Armed Services and Foreign Affairs Committee in December 1990. The method employed in this study is the use of available historical and psycho-biographical sources to construct a political personality profile of a leader's basic personality type, such as one of the three examples in Table E-1.

TABLE E-1 Examples of Types of Basic Personality Structure and Leadership Styles

| Mechanism | Example of Political Personality Types | | |
	Narcissistic	Obsessive-Compulsive	Paranoid
Ego defenses	Grandiose self, sense of superiority, and denial.	Abhorrence of emotionality that implies lack of control.	Suspiciousness and mistrust
Externalization	Projects arrogance and grandiose self-image. hypervigilance.	Projects fixation with rules, order, efficiency, isolates, rigid, sublimates, intellectualizes.	Projects hostility and stubborn
Mediation of self–other relations	Hunger for reassurance and vulnerability to criticism, lacks empathy. Exploitative, sense of entitlement.	Preoccupied with relative status, is oppositional or domineering. Formal, over moralistic, micro- manages, does not delegate.	Fear of closeness, projection, search for enemies and distrusts all.
Object appraisal	Dogmatic certainty and manipulation of information.	Attention to detail and insistence on rational information processing. Less aware of big picture.	Exaggerates danger and capabilities of adversaries. Black and white thinking.
Decision-making orientation	Risk-averse and dominated by centrality of self. Identifies self-interest with country.	Risk-averse and perfectionistic with decisions avoided, deferred, protracted, and based on expertise.	Risk-averse and worst-case thinking based on competitive advisors.
Leadership style	Search for glory and recognition	Driven, deliberate, myopic, dominated by shoulds, not wants, and search for certainty	Strongly prefers use of force over persuasion.
Prototype	Saddam Hussein	Menachem Begin	Josef Stalin

NOTE: The personality characteristics in this table are representative, but they do not exhaust the defining features of each personality type.
SOURCE: Based on information from Post (2003a).

Iraq under Saddam is an exemplar of a society with a predominant leader. In such situations, it is imperative to have a nuanced personality profile of the leader. As was regularly stated, "Saddam is Iraq, Iraq is Saddam" (Post, 2003b, p. 343). Post diagnosed Saddam Hussein's basic personality type as "malignant narcissism" (a narcissist with a paranoid outlook, absence of conscience, and a willingness to use whatever aggression is required to accomplish his goals). While psychologically in touch with reality and not "crazy" in a clinical sense, Saddam was often out of touch with political reality. He was surrounded by a group of sycophants who, for good reasons, were reluctant to criticize his decision making and told him what he wanted to hear rather than what he needed to hear. To disagree with Saddam was to lose one's job or lose one's life (Post, 2003b).

An examination of Saddam's career reveals a number of occasions when he reversed course, considering himself a "revolutionary pragmatist" (Post, 2003b). Why then was Saddam, who was characterized as risk-averse, not deterred from invading Kuwait? Further, why was he not responsive to coercive diplomacy by the United States in the form of a massive military buildup and threatened air campaign as the January deadline approached for him to withdraw Iraqi forces from Kuwait? [3] Why did he not reverse himself as he had in the past and withdraw from Kuwait? [3]

With intelligence indicators and warnings that Saddam was planning an invasion of Kuwait and Iraqi troops massing on the border, U.S. Ambassador April Glaspie was instructed to inform Saddam that the United States considered the territorial dispute between Iraq and Kuwait to be an Arab-Arab dispute and that the U.S. government did not take a position on it. She was to be clear in expressing the hope and expectation that Iraq and Kuwait would settle their differences peacefully. There was no overt threat of a U.S. military response should Kuwait be invaded. Glaspie's message did not represent a clear cease-and-desist message (Schneider, 2012). Although Saddam did not see the *demarche* as a green light to invade Kuwait, he also did not calculate accurately the risk of a massive U.S. response to Iraq's invasion of Kuwait (Freedman and Karsh, 1993, pp. 47-61). [4]

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[3] Saddam's past course reversals include (1) yielding on the Shatt al Arab issue with Iran to quell Kurdish rebellion; (2) attempting to end the Iraq-Iran war; (3) yielding to Iran on the Shatt al Arab waterway issue to end their war; (4) releasing all foreign hostages during Persian Gulf crisis. See Post (2003b, pp. 340-342).

[4] It was not only that the Glaspie message contained no threat. The United States had not deployed aircraft carriers to the region, and it seemed unlikely that even if it wanted to act militarily, it could not do much because the Saudis would not accept U.S. forces. Further, it seemed that the United States did not have much stomach for casualties, as evidenced by Vietnam and the pull-out of forces from Lebanon. Saddam also greatly underestimated the effects of modern air power and had no idea how totally over-matched his ground forces were. Even though he seems to have rationally contemplated risks, he underestimated them greatly while at the same time having grandiose ambitions. For other discussions of Saddam's potential and actual thinking, see Davis and Arquilla (1991), Stein (1991), and Brands and Palkki (2012). The analysis of Saddam Hussein's perceptions and misperceptions by

I. Historical Antecedents Iraq suffers from foreign rule, succession of revolutionary regimes, and Iran-Iraq War. **II. Childhood Experiences as Development Context** Mother abandons Saddam, who suffers abuse from stepfather. Uncle tutors young Saddam in Baathist worldview and dreams of glory, compensating for low self-esteem from earlier abuse and abandonment.	**III. Personality Processes and Dispositions** **Ego Defense** Unconstrained conscience. Unconstrained aggression. Paranoid orientation. **Externalization and Projection** Identifies self with Iraq. **Mediation of Self and Others.** Adopts the "great struggler" role against Zionism, Iran, and West. **Object Appraisal** Overestimates Iraqi and under-estimates U.S. power and resolve.	**IV. Immediate Situation as Occasion for Action** Saddam's advisors reluctant to disagree with his plans. Arab and Israeli neighbors' beliefs that Saddam was posturing or bluffing. No explicit U.S. deterrent threat. **V. Political Behavior** Iraq invades Kuwait and exults in world attention. U.S. threatens to expel Iraq from Kuwait. Iraq first resists and then retreats as U.S.-led coalition attacks.
Past ———————————————————————————————————→		**Present**

FIGURE E-1 Map of Saddam Hussein's political personality and behavior. NOTE: The map's narrative locations are numbered left to right in temporal order from I to V. SOURCE: Based on information from Post (2003b); map adapted from Smith (1968) in Greenstein and Lerner (1971, p. 38).

Following Iraq's invasion and occupation of Kuwait, however, U.S. intentions were not ambiguous. If Iraq did not withdraw from Kuwait, the United States threatened the massive destruction of Saddam's military might. This threat was communicated not only with mere words, but with evidence on the ground in Saudi Arabia and the Persian Gulf of a massive U.S. buildup preparing for military action. To understand why Saddam stood fast in the face of this imminent threat, one must consider the psychodynamic effects of the conflict thus far on Saddam, and the psychobiography-based political personality profile predicting Saddam's likely behavior summarized in Figure E-1 and discussed below.

As the map in Figure E-1 shows, this perspective highlights Saddam's background as one of a deeply traumatized individual, a wounded self, dating back to the womb. Saddam's father had died of cancer during the fourth month of his mother's pregnancy with Saddam. In the eighth month, her first born son died under a surgeon's knife. Understandably deeply depressed, Saddam's mother first tried to abort herself of the pregnancy with Saddam and then made a suicide attempt. When Saddam was born, she turned away from him and finally gave his care to her brother Khairallah, who raised Saddam for the first two and a half years of his life, when his mother remarried and the new step-father was physically and

Woods and Stout (2010) reflects extensive documentary material gathered after the 2003 war with Iraq.

psychologically abusive to young Saddam. At age 8, when his parents refused Saddam's request to go to school, he fled back to his uncle Khairallah (Post, 2003b).

His Uncle Khairallaha filled young Saddam with dreams of glory, telling him some day he would be listed among the great heroes of Iraq and the Arab world, Saladin and Nebuchadnezzar. The dramatic invasion of Kuwait, which drew the attention of the world to the Iraqi leader, consummated his aspiration to be an important world leader, nurtured since childhood and accompanying his rise to regional prominence in the Middle East. It was dreams of glory fulfilled. As a narcissistic personality he could not then easily reverse himself without opening old psychological wounds unless there was a way that he could declare victory and withdraw (Post, 2003b).

So the notion that Saddam Hussein would respond to threatened military action and, humiliated, retreat from Kuwait to his previous obscurity was not intuitively obvious. He had reversed himself in the past; however, these reversals had only occurred when he could do so without loss of face while retaining his power.[5] By mid-December, 1990 Saddam Hussein was adamant and had resolved to stand fast. When Secretary of State Baker had his last-minute diplomatic visit with Iraqi Foreign Minister Tariq Aziz, he found that Saddam Hussein was no longer open to complying with a U.S. compellent threat to withdraw or face expulsion by military force (Post, 2003b; Schneider, 2012).

The second type of analysis is a bottom-up approach that focuses on the proximate causal mechanisms of ego defense, externalization, mediation of self–other relations, and object appraisal under Personality Processes and Dispositions in Figure E-1 that connect a leader's personality traits, motivations, and cognitions

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[5] This condition was not met when U.S. President George H.W. Bush pounded on a table, declaring, "There will be no face saving," and a leak from a U.S. general (subsequently forced to retire early) indicated that the U.S. contingency plans were to kill Saddam. In this context, it was not irrational for Saddam to believe that he did not have a way out of the conflict with the United States. Moreover, his decision to absorb the anticipated massive airstrike was buffered by his belief that the United States still suffered from a Vietnam syndrome, and if he could withstand the airstrike and get involved in a ground campaign, the specter of U.S. troops being returned in body bags would lead to massive U.S. protests against the Pentagon and White House, leading to a political stalemate. Saddam, by having the courage to stand up to the U.S. superpower, would win a hero's mantle. Indeed, on the fifth day of combat, Saddam held a press conference and declared victory. It was explained to the incredulous press that it was widely believed that Iraq could not withstand more than 3 days of the air attack with smart bombs and guided missiles, and had already survived for 5 days. Each further day would only magnify the scope of the victory (see Post, 2003b). Saddam Hussein had stated previously in an interview on German television the belief that the United States would end the conflict once they had lost 5,000 or more killed in action, which unfortunately for the Iraqi leader did not happen (see Schneider, 2012, p. 217). RAND work at the time also foresaw Saddam's being willing to fight but, if necessary, to find a way to exit later if need be. The analysis was influenced by the belief that Saddam would assume that the U.S. would violate any agreement; other considerations were also part of the analysis (Davis and Arquilla, 1991, pp. 53-61; see also Brands and Palkk, 2012).

with decisions and leadership style within the boundaries set by the leader's character. The method employed to study these mechanisms is quantitative content analysis, which detects variations in the operation of these causal mechanisms, in contrast to qualitative content analysis, which identifies character structure as a constant in a leader's personality. The tools associated with quantitative content analysis are scales and indices that summarize the central tendency and range of variation over time in the cognitive, motivational, and other psychological traits in a leader's personality.

In contrast to a leader's character, these features of the leader's personality are relatively more plastic features that change shape over time in response to changing environmental conditions. While different leaders may have different structural configurations of personality traits that transcend situations and define character, a leader's individual personality traits also become aroused in different degrees and combinations, depending on environmental stimuli. So Leader A's significant difference from Leader B in self-confidence may remain robust across situations, but the intensity and influence of self-confidence in combination with other personality traits on behavior may vary for each leader in the same situation.

Similarly, different situations arouse different motivations within a leader's personality—for example, a conflict situation with adversaries may engage a leader's need for power, while a cooperation situation with allies may arouse a leader's need for affiliation (Winter, 2003a). The same is true for a leader's cognitions, because different configurations of beliefs and levels of cognitive complexity may be triggered as mechanisms to assist a leader's information processing and decision-making in different situations (Suedfeld et al., 2003; Walker, 2013).

Saddam Hussein's personality traits associated with the externalization of his leadership style via his motivational and cognitive processes associated with the mediation of self–other relations and object appraisal displayed these variations across different periods and situational contexts preceding, during, and following the 1991 Gulf war. In Figure E-2, his mean scores on seven personality traits differentiated him from the average Middle East leader and the average world leader: "Saddam Hussein is different from the two samples of leaders on over half of the traits—nationalism, need for power, distrust of others, and self-confidence. He is like other leaders with regard to his belief that he can control events, conceptual complexity, and his focus on accomplishing something versus focusing on the people involved… " (Hermann, 2003b, p. 376).

The four traits that distinguished the Iraqi leader from others also varied significantly across contexts. His conceptual complexity was significantly lower (.27) in the 1991 Gulf War period in contrast to the pre-Iranian War (.50) and Iran-Iraq War (.55) periods. The nationalism trait was significantly higher (.72) in the Gulf War than in his relations with either Arabs or non-Arabs (.58). His need for power (.39) was strikingly lower in domestic politics and during the Gulf War than the
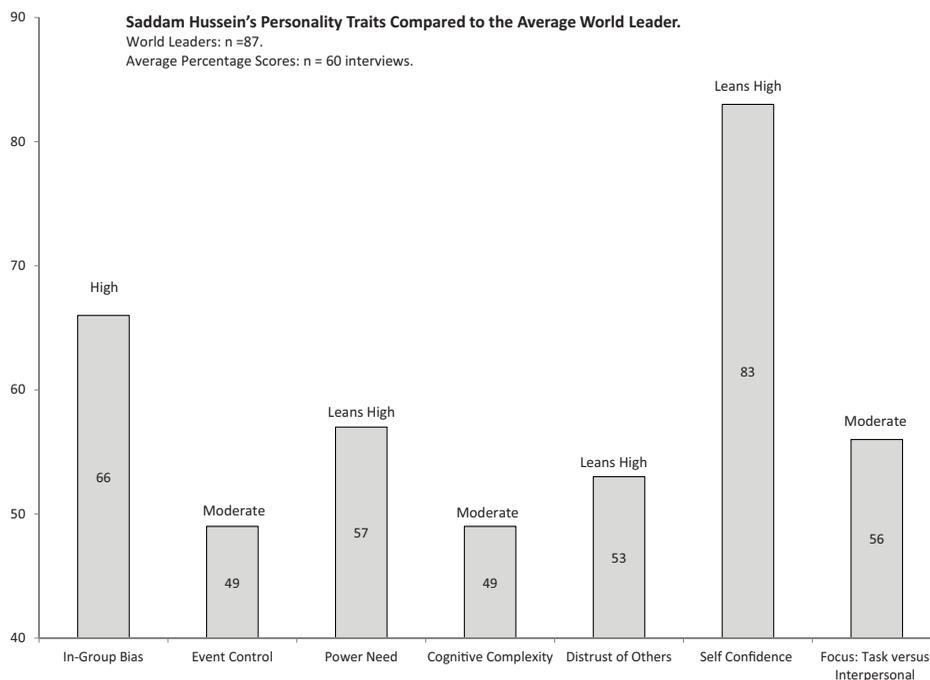
FIGURE E-2 Fluctuations in Saddam Hussein's personality profile. SOURCE: Based on Post (2003a); data from Table 17.1 in Hermann (2003b).

range of his need for power scores (.53 to .69) in dealing with the Kurds and relations with both Arabs and non-Arabs. His distrust of others was elevated during the Gulf War (.68) and the Iran-Iraq War (.66) periods and in dealing with the Kurds (.65), in contrast to domestic politics (.39) and relations with both Arabs (.44) and non-Arabs (.49), which had lower scores (Hermann, 2003b, p. 383).

Saddam Hussein's motivational profile regarding the needs for power, affiliation, and achievement over a 17-year period between 1974 and 1991 showed that he had a "quite high power motivation, above average affiliation motivation, and very low achievement motivation" in comparison with the average world leader in a sample of 22 world leaders from a variety of geographical regions occupying different political roles (Winter, 2003b, p. 371). The results in Figure E-3 from a content analysis of 11 interviews are relatively stable when broken down by different sources (more versus less spontaneous interviews). The results are consistent with Post's structural personality profile that emphasizes Saddam's "extreme narcis-

Saddam Hussein's Motivational Profile Compared to the Average World Leader.
World Leaders: n =22. Interviews: n=11.
Standardized Scores: mean = 50.
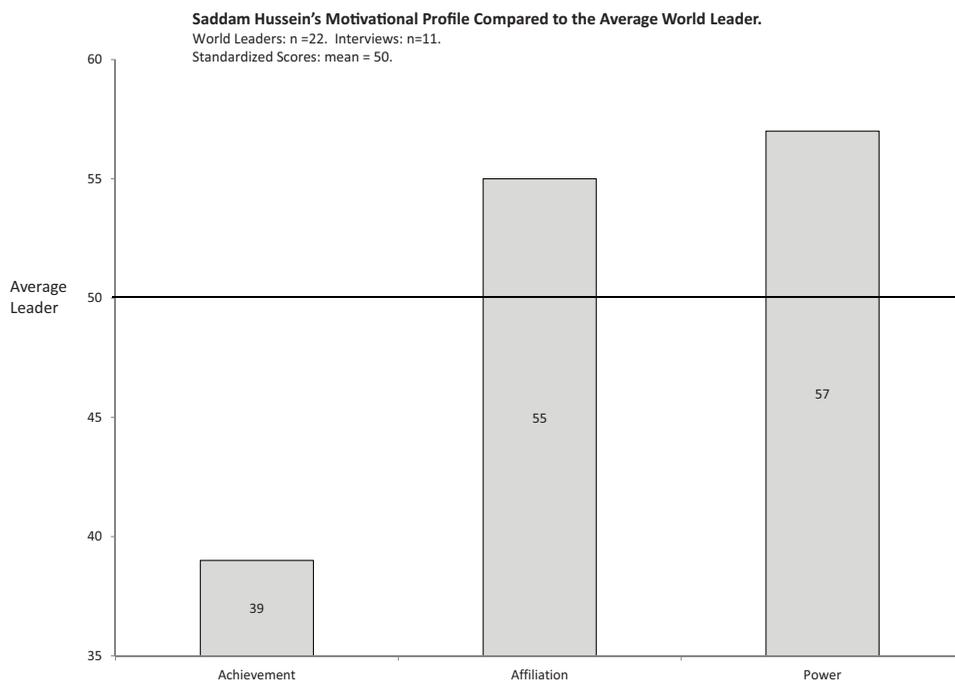
FIGURE E-3 Saddam Hussein's motivational profile. SOURCE: Based on Post (2003a); data from Table 16.2 in Winter (2003b).

sism, exalted and extravagant rhetoric, aggression as an instrument of policy, and a paranoid fear of enemies" (Winter, 2003b, p. 372).

The two-point difference between the Iraqi leader's power and affiliation scores is also consistent with Hermann's observations of fluctuations in Saddam's personality traits aroused in his relations with different "others" in different situations. His high need- for-affiliation score indicates a capacity to cooperate with an in-group of like-minded people from his own family and village and be defensive and "prickly" in the wider world of Iraqi politics and foreign strangers. The same dynamic characterizes Saddam's relations with "brother" Arabs and his defiant and hostile relations with adversaries in stressful crisis situations (Winter, 2003b, p. 373).

The same patterns of and volatility and stability that characterize the externalization of personality traits and the mediation of self–other relations regarding motivations are evident in the object appraisal patterns displayed in the cognitive complexity patterns of Saddam Hussein in Figure E-4. The processes of object ap-
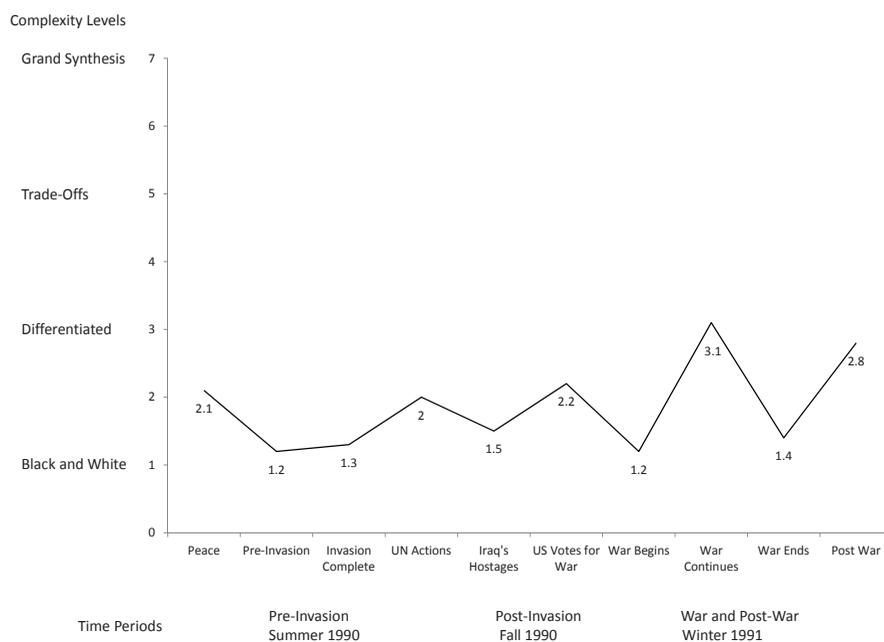
FIGURE E-4 Saddam Hussein's Gulf War patterns of cognitive complexity. SOURCE: Data from Table 18.2 in Suedfeld (2003).

praisal are the most conscious causal mechanisms in the leader's personality system and reflect how overt decisions are reached to pursue or maintain goals and select the means to achieve or protect them.

Saddam's cognitive complexity scored lower during the Gulf crisis (not shown in Figure E-4) leaders of other less-involved nations. "This finding supports the disruptive stress hypothesis, which states that severe and/or prolonged stress leads to reduced complexity because of a depletion of psychological and other resources" (Suedfeld, 2003, p. 393). However, prior to the Gulf crisis, Saddam's complexity was relatively high. It then dropped immediately prior to the decision to invade Kuwait, before rising after the invasion was successful and his stress level had decreased (Suedfeld, 2003, p. 393).

The cognitive complexity indices for Saddam Hussein in Figure E-4 continued to be relatively volatile during the ensuing confrontation with the United States and UN coalition forces. The overall pattern is consistent with Post's "great struggler" finding as Saddam's political role in Middle East and global politics. "New actions against him, rather than motivating him to search for compromise, buttress a uni-dimensional strategy; more cognitive investment in a differentiated and integrated

viewpoint occurs when it becomes obvious that the simple strategy is unavailing" (Suedfeld, 2003, p. 395).

This pattern of stubborn resilience, as shown in Figure E-4 during the run-up to war following his invasion of Kuwait, was punctuated by sharp drops in complexity levels with the onset of the air and ground war attacks on Iraq and the defeat of the Iraqi army by coalition forces before rising to a prewar level with the beginning of postwar restructuring inside Iraq. Overall, the cognitive complexity results in Figure E-4 express his cognitive style and reflect variations in Saddam Hussein's level of cognitive effort during the Persian Gulf conflict, as he attempted to reconcile stimuli from the environment with the cognitive dispositions in his belief system (Suedfeld, 2003).

An example of the contents of the Iraqi leader's beliefs is in Table E-2 and identifies a snapshot of his "operational code"—that is, his state of mind at a particular point in time regarding the exercise of power by Self and Others. It also contains an index of Saddam's risk orientation regarding interaction with others in the political universe plus his beliefs about risk management tactics and the utility of different forms of political power as means in the pursuit of goals. The analysis in Table E-2 compares Saddam's beliefs to a sample of world leaders from a variety of historical eras and regions. These scores are expressed in terms of standard deviations from the sample's average for each belief.[6]

The results show that Saddam believed that the most effective strategies (I-1 = −1.24) and tactics (I-2 = −1.08) for exercising power were definitely conflictual; however, he was very risk averse (I-3 = −1.71) and controlled the risks of escalation by being extremely flexible in shifting between cooperation and conflict tactics (I-4a = +2.40) and very flexible in shifting between word and deed tactics (I-4b = +1.60) in the exercise of power. He believed that the utility of exercising rewards and punishments was somewhat high (I-5a = +0.40) while the utility of exercising promises (I-5b = −4.67) and threats (I-5e = −3.00) was extremely low. His belief in the utility of opposition and resistance tactics was very high (I-5d = +1.71) while his belief in the utility of appeal and support tactics (I-5a = 0.00) was the same as that of the average world leader (Walker et al., 2003b pp. 388-389).

The VICS indices for I-1, P-1, and P-4 are the basis for constructing a formal model of strategic interaction, which expresses the leader's definition of the strate-

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[6] A deviation is the distance between a leader's score and the average score for the norming group sample. A standard deviation is the distance around the sample mean within which two-thirds of the scores for the entire sample fall. When a leader's score has a standard deviation above (+) or below (−) the sample mean greater than one standard deviation, it indicates that s/he has a score higher (+) or lower (−) than two-thirds of the sample. The words "Somewhat", "Definitely", "Very", and "Extremely" to describe the standard deviation scores are applied in Table E-2 to half-standard deviation intervals above or below the mean score of the norming group sample for each VICS belief index (see Walker et al., 2003a).

TABLE E-2 The General Operational Code and Subjective Game of Saddam Hussein

General Operational Code	VICS Indices[a]	
	Std. Dev	Descriptor
Philosophical Beliefs		
P-1 Nature of the political universe	−1.47	Very hostile
P-2 Prospects for realization of political values	−1.33	Very pessimistic
P-3 Predictability of the political future	−4.67	Extremely low
P-4 Control over historical development		
a. Other's control	−3.80	Extremely low
b. Self's control	+3.80	Extremely low
P-5 Role of chance	+4.00	Extremely high
Instrumental Beliefs		
I-1 Approach to goals	−1.24	
I-2 Pursuit of goals	−1.08	
I-3 Risk orientation	−1.71	
I-4 Timing of action		
a. Flexibility of coop/conf tactics	+2.40	Extremely high
b. Flexibility of word/deed tactics	+1.60	Very high
I-5 Utility of means		
a. Reward	+0.40	Somewhat high
b. Promise	−4.67	Extremely low
c. Appeal/support	+0.00	Average
d. Oppose/resist	+1.71	Very high
e. Threaten	−3.00	Extremely low
f. Punish	+0.60	Somewhat high

Saddam's Subjective Game			**US Deter/Assure Game**			**Intersection of Two Games**		
	Other			US			US	
	CO	CF		CO	CF		CO	CF
CO	3,2	**2,4**	CO	**3,4**	**2,3**	CO	2|0	1|0
Self			Iraq			Iraq		
CF	4,1	1,3	CF	4,1	1,2	CF	2|0	2|2
Self Bluff; Other: Bully			Iraq Bluff, US: Deter			Exp|Act Row Outcomes[b]		

[a] VICS indices are expressed as standard deviations above and below the mean for the 20 world leaders.

[b] Expected versus actual outcome for row player where 0 is upper-left, 1 is upper-right, 2 is lower-right, and 3 is lower-left quadrant of game matrix. Game solutions are in bold.

NOTE: Speeches: $n = 6$, world leaders: n = 20 from a variety of historical eras and geographical regions.

SOURCE: Adapted from Table 18.1 in Walker et al. (2003b), copyright 2003, courtesy of University of Michigan Press.

gic and tactical situation between Self and Other as a subjective game (Walker et al., 2011). Saddam Hussein's negative I-1 (−1.24) and negative P-4a (−3.80) valences for Self (Ego) plus his negative P-1 (−1.47) valence and positive P-4 (+3.80) valence for Other (Alter) specify his subjective strategic interaction game as characterized by a Bluff strategy for Self and a Bully strategy for Other.

These strategic orientations for Self and Other in his belief system make it likely that Saddam Hussein will define Other as an adversary rather than an ally, will pursue bluff tactics and increase them to punish, and will use bully tactics to dominate a weaker opponent unless met with firm resistance by an equal or stronger opponent (Schafer and Walker, 2006; Walker et al., 2011). Deterrent and compellent threats are unlikely to be effective unless made by a stronger adversary that has shown firm resolve to carry out the threat in the event of noncompliance. Then he will back down and retreat, as also predicted by Post's analysis, which documents historical examples of this pattern prior to the 1991 Iraq War (Walker et al., 2003b, pp. 389-390; see also Post, 2003b, pp. 341-342).

The outcome in Table E-2 for playing the bluff strategy assigned to Self and the bully strategy assigned to Other in the Iraqi leader's subjective game is (CO,CF) domination for Other (US) and submission for Self (IRQ), which Saddam found unacceptable. If US plays a deter/assure strategy instead of a bully strategy against Iraq's bluffing strategy, the outcome in Table E-2 is either (CO,CO) mutual cooperation or (CO,CF) submission by Iraq and domination by US. If the subjective game for Iraq is Bluff v. Bully and the subjective game for US is Deter versus Bluff and if each plays their own subjective game, then the outcome is always (CO,CO) mutual cooperation with one exception: if the game begins in the lower-right cell (CF,CF) deadlock and Iraq has the next move, then the final outcome is also (CF,CF) deadlock (Walker et al., 2011 Appendix, p. 289).

The examples of Saddam Hussein's personality traits, motivations, cognitive complexity, operational code beliefs, and subjective game illustrate how content analysis and leadership profiling can provide insights into the psychology of a peer/near-peer, regional, or non-state actor, which reflect a decision unit's definition of the situation, strategic orientation, and risk-taking propensity in a general, immediate, or extended deterrence situation. Employed with other methods of assessment, such as qualitative cognitive modeling, gaming, and simulations, the convergent validity of the results from any one of these methods can be tested by comparison with the results from the other methods.

There is an extensive store of information in the form of records from past gaming exercises and decision-making processes within those games, which may be re-analyzed with automated content analysis systems to retrieve the personality traits, motives, beliefs, and cognitive styles reflected in these texts attributed to participants in these games (Mintz et al., 1997; Young, 2001; Downes-Martin, 2013). They can reveal more precisely the personality biases at the individual level of the players, which may either reenforce or qualify the external validity of generalizations based on aggregation from individual to larger decision-making units.

Finally, there are also efforts to extend the models, methods, and tools for studying individual leaders to the examination of their social identities and roles in various group, organizational, and societal settings. Some analyses model the

problem of studying larger units of analysis as the study of different forms of leader-advisor systems. They attempt explicitly to model the impact of a leader's personality on the decision-making dynamics of these systems (Leites, 1951; George, 1980; Winter, 2003b; Kowert, 2002; Hermann and Preston, 1994; Preston, 2001; Hermann, 2003a). The results of these studies in particular may provide the intellectual capital to eventually bridge the present gap between understanding the decisions of individual leaders and various kinds of group decisions in different cultural contexts.

For example, cultural norms and social identities may constrain leaders in recognizing and following the norms of arms control regimes such as the nuclear nonproliferation treaty (NPT). Therefore, it may be difficult for a general deterrence strategy to prevent proliferation of WMD even in the absence of the security threat posited by *Realpolitik* models as an incentive to acquire them. Cultural forces at work within societies and deeper, nationalist-based norms about what is legitimate and appropriate for countries that aspire to great power or regional power status may over-ride attempts to dissuade states from becoming members of the nuclear club. [7] France's creation of a nuclear *force de frappe* under De Gaulle is an example of these forces at work during the Cold War. Iranian aspirations for enhanced regional status in the post-Cold War era is another potential cause of proliferation, in which the outcome of the struggle in this case between going nuclear and limiting further proliferation is uncertain.

These possibilities also support the measurement and analysis of robust reasons and beliefs from historical case studies. It is possible with content analysis and leadership profiling tools to retrieve and model cultural drives and beliefs from real-world decision units as well as from the participants in laboratory gaming simulations and from the idealized decision units assumed by modeling efforts with game theory.

This step is necessary to assess the external validity of results from the hybrid application of abstract modeling and inductive gaming exercises. The external validity question associated with gaming, simulations, experiments, and math modeling efforts is whether the processes and outcomes created in the labora-

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[7] The literature on norms and behavior is vast. A good discussion of a norms model, a security model, and a domestic/bureaucratic politics model applied to proliferation decisions is Sagan (1996-1997). An extension of this discussion with case studies of Iraq, China, Yugoslavia, and Argentina is contained in Hymans (2012). Discussions of the insights from models based on, respectively, social identities, status positions and belief systems are Hymans (2006), Larson and Shevchenko (2010), and O'Reilly (2012). A provocative treatment of the issues surrounding the creation and maintenance of international norms and nonproliferation regimes (nuclear, chemical, and biological) is in Joyner (2009). An excellent analysis of the motivations of small states to acquire WMD is in Preston (2007). An important comparative theoretical analysis of the operation of cultural norms in the international relations of different civilizations is contained in Lebow (2008).

tory simulations or math modeling exercises correspond to the behavior of actual decision-making units in the political world.[8]

CONCLUSION

Deterrence is at heart a psychological concept, resting on understanding the psychology of the deteree—for example, if the deteree is a non-state terrorist group seeking martyrdom, the threat of death will be taken as an incentive rather than a deterrent. Therefore, evaluation of proposals for deterrence and assurance must rest on a nuanced understanding of the mindset and decision-making of the adversary or ally whenever possible. In contrast to during the Cold War era, when the Soviet Union was the main source of a strategic threat to the United States, in the 21st century it is necessary to have an accurate understanding of the leadership styles and decision-making processes of a broad spectrum of dangerous adversaries and a proliferation of threats from very different sources. One can neither effectively and efficiently deter with a threat nor assure with a promise an adversary or ally that one does not understand.

The tools of content analysis and leadership profiling in conjunction with other methods and tools have the potential to meet the requirements of actor-specific knowledge for a strategy of tailored deterrence. An alliance of content analysis, leadership profiling, abstract modeling, gaming, and simulations as a suite of methods and tools is possible in order to solve the complex problems associated with studying the decision-making dynamics of single groups and multiple autonomous actors as decision units.

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[8] In a recent review, Downes-Martin (2013) concluded that war games, models and simulations in think tanks and planning cells used to plan strategic deterrence face two problems. The decisions predicted by participants for themselves and the leaders to be deterred are most likely inaccurate; decisions made or implied during precrisis war games are poor proxies for the decisions that will actually occur, even if the evolving situation is accurately predicted. However, cultural drives and, especially, beliefs are remarkably robust, even in the face of proven and credible contradictory evidence. Downes-Martin concludes that war games to address nuclear deterrence problems are more likely to provide credible results under the following conditions: (1) when the focus is on reasons for decisions made and predicted, not the decisions themselves; (2) the focus is on messages sent, and reasons for their (mis)interpretation; (3) the focus is on the beliefs of the players (planners) as well as the beliefs of the players; (4) the focus is on embedding these reasons into the models and simulations.

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