

WORKING P A P E R

Structuring Analysis to Support Future Decisions About Nuclear Forces and Postures

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STRUCTURING ANALYSIS TO SUPPORT FUTURE DECISIONS ABOUT NUCLEAR FORCES AND POSTURES

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SUMMARY

This paper is a think piece that looks freshly at how to evaluate future nuclear forces and postures. A fresh look is needed for the New Start era because the role of nuclear weapons in security continues to change—but in ways that are not well understood and have not been much discussed analytically. After reviewing past and present criteria for nuclear assessments, and contrasting enduring stances on such matters by policymakers, I recommend evaluating options for ability to achieve *generalized* versions of five top-level objectives: strategic stability; crisis stability; ability for the United States to act, defeat, and defend; nonproliferation and other policy goals; and risk control. Here stability relates to avoiding coercion, war, and arms competition generally—not just to nuclear-related issues. Crisis stability relates to both first-action stability, whether conventional or nuclear, and to subsequent escalation control. Ability to act, defeat, and defend recognizes that in most crises and conflicts the U.S. will want military options and, if war begins, will want to defeat the opponent and defend against opponent actions—even in a hypothetical but imaginable war that included some limited use of nuclear weapons (as in a rogue leader’s last-gasp flailing out to deter the U.S. from defending an ally or overturning a regime). Force-structure/posture options should, of course, be assessed for their contributions to nonproliferation and other foreign-policy goals. Finally, options should be assessed not only for their allegedly *likely* consequences, but for various risks of worse-than-expected consequences. Some risks, such as underestimating the deterrent value of an option, can be part of assessing strategic stability and crisis stability. Other risks distinguishing among options relate to implementability and sustainability, military/technical matters such as reliability and survivability, and domestic and international perceptions about the balance of power.

It will be important to make the evaluations separately for at least two very different and long-standing strategic perspectives, which differ not only in the relative weight given to the various objectives, but to the objective-by-objective assessments themselves (as in whether, in fact, a given option would improve or worsen proliferation). “Objective analysis” cannot resolve some of these differences, but it can sharpen understanding of agreements and disagreements. An important part of doing so will be to identify vivid stressful test cases relating specifically to nuclear forces and postures *in dilemma-ridden situations*, and to rethink “how much is enough?” for various nuclear or nuclear/conventional missions in crises or conflicts with multiple nuclear actors. Even if these are “virtual missions” that will not be needed if deterrence succeeds, it is important to know what missions could be accomplished with tens, hundreds, or thousands of arriving nuclear weapons, and what this would mean for total force structure and posture that must allow for failures, vulnerabilities, inflexibilities, and reserves given a world with multiple nuclear powers. Part of such future analysis will be assessing the extent to which conventional military capabilities can substitute for nuclear capabilities and the scenarios in which conventional options would even be plausible—recognizing that U.S. conventional military superiority, when it exists, is highly situation dependent.

1. INTRODUCTION

This paper is a think piece developed for a DoD project, “Concepts & Analysis of Nuclear Strategy” (CANS)” accomplished by the Strategic Multi-Layer Assessment (SMA) activity.¹ The challenge for the project is to reevaluate how to analyze nuclear forces and postures in an era following the New START agreement.² That era will include debates about reducing nuclear forces to well below those mandated by the agreement, and about changing force postures. Analysis should play a constructive role, but—as stressed by the sponsors in setting up the CANS study—that will mean going well beyond Cold War exchange calculations. In attempting to define a new approach, the CANS effort is developing an integrated framework paper with inputs from multiple participants and is sponsoring a variety of analytical efforts,³ of which this paper is one. In this paper I describe a possible analytic structure to support strategic-level decision-making. The structure is tied to classic strategic theory, ideas highlighted in the Nuclear Posture Review,⁴ and continuing points of controversy. The paper seeks an inclusive framework that could transcend administrations.

The paper proceeds as follows. Section 2 summarizes desirable features of an analytic structure, Section 3 identifies key variables and suggests a taxonomy within which the variables fit. Section 4 instantiates the analytic structure in a notional analysis using contrived and simplified options. Section 5 summarizes continuing issues and suggests research and analysis efforts to address them, as well as related tool development.

2. GENERAL CONSIDERATIONS IN STRUCTURING A POLICY ANALYSIS

2.1 GENERAL FEATURES

Generic features of a good structure for supporting strategic-level decisions are as follows (summarized in Table 1):

1. *Multiple criteria, i.e., multiple measures of effectiveness*, including multiple measures relating to risk control, with the measures being qualitative or quantitative as appropriate and—as a set—giving fair visibility to all relevant considerations.
2. *A good set of options* that includes the no-changes baseline. The set should cover the spectrum of reasonable positions.
3. *Well-chosen test cases* to evaluate options for the range of stressful circumstances needed to appreciate the options' strengths and shortcomings.
4. *Evaluation tools*: models, structured subjective assessment methods, empirical data, and other means by which to evaluate options.
5. *Exploratory analysis under uncertainty and disagreement*, which may or may not be incorporated in risk analysis.
6. *A scoreboard approach* to comparing options across the multiple criteria.
7. *Drill-down features* to view assessments at different levels of detail, thereby “explaining” higher-level assessments.
8. *Summary comparisons of effectiveness and effectiveness-versus-cost landscapes*, but as a function of strategic perspective that imply different ways of rolling up or aggregating across the multiple attributes after decision-makers have provided interim guidance based on scorecard-level discussion.
9. *The overarching FARness principle*: the principle that analysis should assist decision makers in identifying strategies providing capabilities that will be *flexible* enough to allow for different missions and tasks, *adaptive* across circumstances, and *robust* to shocks.

Table 1
Attributes of a
Policy Analysis To
Support Decision-
Making

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • Multiple criteria • Good set of options • Well-chosen test cases • Diverse evaluation tools • Exploratory analysis under uncertainty and disagreement • Scoreboard approach • Drill-down • Summary effectiveness and cost-effectiveness landscapes by strategic perspective • FARness principle |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

2.2 DISCUSSION

The reasons for these general features are described elsewhere.⁵ The features apply to strategic-level decisionmaking rather than, say, analysis adding incrementally to the knowledge base, to more technical-level analysis on system capabilities, or to maximizing efficiency of operations. Most items may appear unexceptionable, but all are either controversial or challenging. Many analyses, for example, reduce problems to a single measure of effectiveness, as in monetizing all factors or ascribing them positions on some common value scale. Developing good options is notoriously difficult because organizations often put forth only options reflecting current practices or desires. The test cases used are often committee-generated scenarios that have not been designed well for insightful analysis amidst multiple criteria, uncertainty, and disagreement.⁶ Tools for assessing options are always controversial and it is common to use some tools (e.g., computer models) but not others that would add further dimensions of information. Although uncertainty is commonly mentioned, true exploratory analysis across the full range of uncertainties and disagreements remains rare, despite major advances in the ability to do such work.⁷ The scoreboard approach is ubiquitous, whether in consumer magazines or in Pentagon briefings with stop-light charts, but the basis for the evaluations within them is often mysterious. While summary effectiveness, cost-effectiveness ratios, and effectiveness-versus-cost charts are common, it is less usual for decisionmakers to be shown how those depend on assumptions about which there are major disagreements.⁸

Finally, the FARness principle is radical in many respects. In particular, it contradicts the common notion that analysts' jobs are done if merely the policymakers acknowledge and understand the assumptions on which the analysis was based.

- The FARness principle admonishes analysts to discuss risks and show how to hedge in various ways, which will typically produce a much stronger strategy than when uncertainties are given short shrift.

The next section is an attempt to identify what the criteria should be and how they can be organized with respect to each other.

3. IDENTIFYING AND ORGANIZING THE CRITERIA FOR EVALUATION

3.1 APPROACH

The intent here is to be relatively comprehensive in identifying criteria and related variables, although—in any given study—a smaller subset of criteria might suffice. The following subsections use three tacks in identifying criteria: (1) looking at what policymakers talk about; (2) looking at classic variables of strategic nuclear analysis, but amending them to deal better and more candidly with issues; and (3) adjusting for the current era in which military affairs are dominated by conventional forces with precision weapons, but in the ominous shadow of nuclear weapons in the hands of unpredictable rogue states as well as Russia and China,⁹ and with China's having already achieved great-power status in East and Southeast Asia.¹⁰

3.2 UNDERSTANDING POLICYMAKER CONSIDERATIONS

If analysis is to be helpful to decision makers, it must deal with the issues and variables salient to them. It is therefore useful to review briefly the primary issues arising in debates about nuclear strategy and policy. At the price of oversimplification, it is possible to contrast two stylized policy-level stances that bound the range of views.¹¹ These stances are “stylized” in that the views of individual strategists are often more nuanced and combine elements of both.

Stance 1

- Nuclear weapons are useless except for deterring nuclear (and perhaps biological-weapon) use by others.
- Nuclear weapons are also unnecessary, except for deterring others' use of nuclear weapons, because of precision conventional weapons and the major advantage in such capabilities enjoyed by the United States.
- It is in the U.S. interest to pursue the course of nuclear disarmament (to which it is also obligated by international agreement), because progress on such a course can reduce the risk of nuclear war, encourage nations to forego or reverse nuclear weaponization, and encourage other nations to support and enforce the nonproliferation treaty (NPT). Without pursuit of nuclear disarmament, further progress on nonproliferation is unlikely.
- Overall, nuclear stability is tenuous. The world is lucky to have made it out of the Cold War without nuclear weapons being used. As proliferation progresses, the chances of nuclear use go up.
- Deterrence is easy with nuclear weapons. Nuclear deterrence can very probably be achieved with a small number of nuclear weapons (e.g., tens or hundreds). If nuclear deterrence fails (which some believe it will, eventually), the consequences will be less catastrophic in a world with fewer nuclear weapons.
- Nuclear escalation is very difficult, if not impossible, to control.

- International agreements with respect to nuclear weapons, even at low numbers, can be adequately verified, albeit only with substantial political commitments.
- If necessary, nuclear weapons could be redeployed, a fact that would deter nations that might otherwise attempt to cheat on agreements and contemplate breakout.

Stance 2

- Nuclear deterrence has been a *major*, historically unprecedented factor in avoiding major wars since 1945.
- As evidenced by NATO's strategy in the Cold War and by today's Russia, nuclear escalation could rationally be considered for some circumstance. Despite the manifold risks involved, in those circumstances, it could probably be controlled..
- Deterrence is multifaceted and depends on the actors, individuals, circumstances, and other difficult-to-understand considerations. It may require large numbers of nuclear weapons (thousands).
- Conventional weapons do not substitute adequately in deterring aggression because they are much less destructive than nuclear weapons. Moreover, U.S. conventional-force advantages are highly situation dependent and sometimes nonexistent.
- The nuclear-weapon balance affects important perceptions of national strength and foreign affairs—in peace, crisis, and wartime. In particular, the perceived balance of nuclear weapons can be very troublesome domestically.
- Other nations' nuclear decisions will reflect their own interests of security, influence, and domestic politics. Further U.S. and Russian reductions would not affect those other nations' calculations positively but rather could create incentives for nuclear buildups. Nor, except in rhetoric, would such reductions *truly* improve willingness of other nations to enforce provisions of the NPT.
- Sufficiently effective verification at low numbers requires political commitments that are extraordinarily unlikely and probably undesirable. Reducing to low numbers of nuclear weapons would make verification of agreements infeasible and magnify benefits of successful cheating.
- Re-establishing nuclear forces after adversary breakout would be difficult and time consuming because of the loss of capabilities, know-how, and organizational prowess. Risks could be high during the catch-up period.

These dichotomous stances include numerous assertions that cannot possibly be correct in all instances. For example, nuclear weapons may seldom play a role in deterring aggression, but is that always true? Also, while conventional weapons can sometimes substitute for nuclear weapons in war fighting, is it not important to understand when? Table 2 lists some analytic questions in this spirit, suggesting by its form that research and analysis “ought” to be able to narrow the disagreements represented by the two stances.¹²

Table 2
Analytic Questions Motivated by Policy-Level Disagreements

<i>Questions</i>	<i>Some Dimensions of “When”</i>
<i>When</i> are nuclear weapons important for deterring or reversing conventional aggression, or as part of compellence?	Actors in the crisis or conflict (real or virtual) Related geography Relative conventional capabilities
<i>When</i> is deterrence affected by the number and posture of U.S. nuclear weapons?	Absolute and relative nuclear capabilities Stage of crisis and conflict
If other states contemplate deploying nuclear weapons, <i>when</i> do they see them as important for deterrence or compellence?	National histories Recent and past events, leadership behaviors, and apparent trends
<i>When</i> are various measures of U.S. nuclear forces and posture important to assuring allies so as to dissuade them from becoming nuclear-weapon states?	The closeness of cultures and political partnerships U.S. interests and the necessity of the United States honoring its commitments
<i>When</i> can conventional weapons substitute for nuclear weapons in strategic targeting?	The military tasks at issue (e.g., different target classes)

3.2 TAPPING THE CLASSIC CONCEPTS

3.2.1 Sources

Other sources for criteria to be used in an analytic structure are official documents from the Cold War and related scholarly literature, including books and articles by previous officials, which are often more nuanced and informative than purely academic materials. This paper is not the place for a full review of such material,¹³ but what follows attempts to address the major elements of classic nuclear strategy. It also includes rather specialized citations to material that is often overlooked.

3.2.2 Subtleties and the Need for Increased Candor

Reviewing the classic concepts can be puzzling to a careful reader because of a long-standing absence of candor on such issues, particularly in official documents. This can adversely affect analysis by omitting important considerations or, worse, by having analysis depend on deeply buried assumptions. I see some of the more important subtleties as follows:

Strategic stability, during the Cold War, was interpreted to refer to *nuclear* matters between the United States and Soviet Union. That was always an unfortunate usage, since it oddly limited “strategic” matters to nuclear matters and ignored the fact that intermediate range weapons were strategic for European-Soviet relations. In today’s world, the term should reasonably be interpreted in a much broader sense, applying to coercion, war, and arms

competitions generally. Strategic stability should be assessed for individual regions as well as more globally. With this broader understanding, it may be evident that strategic stability is not always desirable. Today's *Arab Spring* movements seek to overturn dictators and, it is hoped, to move toward democracy. That would surely be better than stasis. We should also acknowledge that the United States has on numerous occasions intervened to promote regime change militarily (e.g., Nicaragua, Afghanistan, Iraq) or diplomatically (e.g., Philippines, current-day Libya). Thus, *literal* stability per se is not really a top-level objective.¹⁴ Even strategic stability with respect to nuclear weapons is iffy, as illustrated by NATO's conclusion in the 1970s to introduce limited nuclear options to improve deterrence of an overwhelmingly superior conventional Warsaw Pact threat. In today's world, Russia has found it necessary to depend in part on nuclear weapons for its security because the size and quality of its conventional forces has shrunk substantially and it has potential threats to its west and east.¹⁵ To Russia, the threat of nuclear use is important and credible; presumably, nuclear use is thinkable, even if very unlikely.

Detering War or Big War? Where strategic stability is sought, the intent is to avoid not just large-scale conflict, but also smaller acts of aggression and coercion. It is this increased scope that has made deterrence so challenging from the 1960s onward, especially as the willingness and therefore credibility to use nuclear weapons has decreased.¹⁶

Crisis Stability? In the event of crisis, the United States would arguably prefer to have escalation dominance, so as to have maximum leverage in influencing an adversary.¹⁷ However, it also wishes to avoid first-strike (or first-military-action) instability and to avoid inadvertent escalation. It is true that the feasibility of escalation dominance against the Soviet Union largely vanished as the Soviet Union deployed large numbers of sophisticated nuclear weapons, but in today's world, crisis may involve a mix of major powers, middle-level powers, and limited-capability rogue states. The relevant objective, then, might be escalation dominance *or* crisis stability, depending on details.¹⁸

And if deterrence fails? In most crises and conflicts, the United States will seek to *win*, whether by compelling an adversary to reverse an aggression, by imposing regime change, or in some other way. In the special case of very limited nuclear use, damage limitation and recovery potential might be extremely important and meaningful, and even a kind of victory might be possible.¹⁹ Thus, it is not sufficient to bank exclusively on the success of deterrence in the abstract. Nor is it sensible to rely entirely on non-military instruments of influence, as important as those are.

Larger aspects of foreign policy. Some of the most important factors in evaluating future nuclear-posture options will be the anticipated effects on other foreign-policy matters such as

controlling the proliferation of nuclear weapons and encouraging “a process toward” nuclear disarmament.

Assurance of allies. Assurance of allies is crucial, since alliances are fundamental to America’s grand strategy and the U.S. has sought to dissuade allies from developing their own nuclear-weapon capabilities. The U.S. attitude on this has probably been due to a combination of considerations. First, it is commonly believed that allied military nuclearization would feed more general proliferation and instability, and is therefore undesirable (although exceptions have been effectively accepted, as with Israel in the 1960s). Second, the United States arguably benefits from having strategically important allies dependent on the United States for their security.

Although allied assurance might logically be seen as a mere consequence of maintaining certain military capabilities and policies, rather than an end in itself, the reality is that assurance also depends heavily on perceptions and psychology, which can be affected by what are seen as *negative trends*, despite arguments against such interpretations. Foreign perspectives about the significance of nuclear weapons and related balances are highly complex, and are partially rooted in national histories.²⁰

Managing Risk. It is not sufficient that the best estimate of an option be favorable or at least tolerable; policymakers also need confidence that risks are tolerable (i.e., that the actual consequences of the option will not be much worse than nominally assumed).²¹ For example, even if assessments are sanguine when based on standard scenarios of crisis and war, there may be good reason to worry about more troublesome scenarios. Perhaps even rational adversaries will not reason as we expect, perhaps escalation will be inadvertent, or perhaps some adversary leaders might prefer a “glorious,” “courageous,” or vengeful ending—rather than one good for their country. Substantial risk also exists when projecting outcomes of conventional war. During the Cold War, U.S. strategic nuclear planning was extremely risk averse—much more so in some respects than that of the Soviets or Chinese (neither of whom emphasized bolt-from-the-blue scenarios in which many nuclear forces would be especially vulnerable). Today’s public discussion of the era beyond New Start is remarkably sanguine in comparison because the world is, at least for now, profoundly different.²²

Political stability. Another crucial issue for U.S. policymakers is that the American public perceives that a course of action is sound. When that condition is not met, the domestic political scene can be quite troublesome. Out-of-office political candidates routinely attempt to paint incumbent policies as weak and dangerous, as illustrated by historical political campaigns decrying the alleged “Missile Gap” (1960 election) and “Window of Vulnerability” (1980 election). Because of this dark side of politics, Cold War policymakers sought to assure both the reality and perception of “strategic equivalence,” even when that meant highlighting

operationally irrelevant measures of the strategic-nuclear balance.²³ In today's world, a comparable concern might correspond to maintaining both real and perceived strategic equivalence with Russia and China, *and* manifest superiority over other states. Or perhaps this would not be good enough. Perceptions might be quite adverse if arms control brought about parity with China, after years of China having been satisfied with a lesser status.²⁴ Would parity be perceived as acceptable with India, Pakistan, North Korea, and Iran? And would any of those states accept permanent status at less than parity? The point in this paper is merely to flag an important criterion, not to take a view on what would or should be acceptable, but I see the warning flag as very important based on the strong historical evidence of how strong, disruptive, and "nonrational" internal political dynamics can be. The roots of this problem lie deep and have been revealed in careful empirical analysis.²⁵

Flexibility in crisis and war. In the real world, policy makers in crisis and conflict are constantly looking for flexibility in how they can address challenges. This may mean changing the nature of a coercive threat, finding an acceptable way out for the adversary, executing a limited attack to reestablish deterrence or support compellence, or changing approach when previous strategy has failed. Regardless of what some deterrence theorists might argue for in peacetime, no President has wanted to be left only with options depending on willingness to commit mutual suicide or moral atrocities.²⁶ It is for such reasons that Cold War deterrence by threat of mutual destruction has often been recognized as a condition (i.e., a fact of life) rather than as a strategy.

Executability and sustainability. Yet another under discussed issue is that an option needs to be executable and sustainable. The problems that arise in this domain include motivating top-notch personnel to serve in the nuclear forces and to maintain extremely high operational standards when doing so.²⁷ Various technical and operational issues also arise in seeking to maintain extreme weapon-system reliability and survivability despite severe restrictions on testing and deployment posture.²⁸ Still other considerations include the political viability of an option. During the 1970s, for example, the Department of Defense spent a great deal of effort—over three administrations—studying concepts for survivable ICBMs, including multiple aim-point systems. Although the best of those options was attractive to many analysts and won out within the Carter administration, it was eventually dismissed by President Reagan in significant part because of strenuous objections by the governors whose states would be affected (Utah and Nevada).²⁹ Remarkably, the result was to deploy the Peacekeeper ICBM (previously MX) in silos—thereby exacerbating the crisis- stability problem and leading to increased embrace of launch-under-attack tactics, which had been anathema for many years to most of those contributing to nuclear strategy.³⁰

3.3 ADJUSTING FOR THE CURRENT ERA

3.3.1 Recognizing Classes of Challenge

The special challenges of the current era are considerable,³¹ although some had Cold War precedents. Reviewing the special challenges is helpful in defining stressful test cases for evaluating options on forces and posture, as illustrated in Section 4. Table 3 summarizes some different classes of “special challenge” and speculates about the form that analysis might take and sources of information. Most of the methods are familiar; the method of synthetic cognitive models will be discussed later, in Section 5.

Table 3
Classes of Challenge

<i>Class of Challenge</i>	<i>Examples</i>	<i>Relevant Analytic Methods</i>
Perceived balance of power	US/China, US/Russia; US/China-Russia; US and Allies/China/Russia/India/Pakistan	Bean counts Survey methods
Regional balance of power	Iran/Israel; Iran/Rest of Middle East	Bean counts Survey methods
Strategic and crisis instability: limited provocation or aggression	Chinese seizure of possibly oil-rich islands, followed by military confrontation	War games Agent-based models and other simulations Synthetic cognitive models Subject-matter experts History
Crisis instability: collapse of a rogue state with nuclear weapons	North Korean collapse, perhaps with South Korean and/or Chinese forces entering	War games Agent-based models and other simulations Synthetic cognitive models Subject-matter experts History
Indirect aggression	Vigorous Iranian support of regional irregular-warfare actions, via Hamas and Hezbollah, with military confrontation arising with Israel or other Middle Eastern countries and their ally, the United States.	War games Agent-based models and other simulations Synthetic cognitive models Subject-matter experts History
Based in part on the above, the credibility of U.S. defense commitments	Would the U.S. <i>really</i> risk annihilation of an American city in order to ____	War games Agent-based models and other simulations Synthetic cognitive models Subject-matter experts History

3.3.2 Rethinking Targeting “Requirements”

Another adjustment may be necessary for the current era. Throughout the Cold War, strategists believed that the ability to devastate the adversary’s society was at the core of nuclear strategy—even though policymakers went to great lengths to have more limited options. In the 1960s, the “requirements” to achieve essentially complete destruction (or at least to reach the analyst’s knee of the curve) were estimated at about 400 equivalent megatons, which might have amounted to 2000-4000 smaller-yield weapons.³² Although it was recognized that the prospect of losing even one major city might well be enough to deter, the “requirement” was nonetheless part of the nuclear-strategy story for many years thereafter.

Similarly, separate Cold War targeting options existed for attacking conventional military forces, nuclear-threat forces, and war-supporting industry. One lesser option sought to destroy the adversary’s ability to project and sustain conventional forces. The nominal number of weapons needed for each such option was well understood by analysts, who could even use easy rules of thumb for such matters and rationalize the “requirement” for thousands of nuclear weapons. The “requirements” increased as worst casing was extended to include bolt-from-the-blue attacks with no launch-under attack, independent requirements on each leg of the nuclear Triad, very high damage-expectancy levels, very high certainty about those damage-expectancy levels, and inclusion of some marginal-value targets in target lists.

The Cold War notions of requirements were overdone³³ but there is need for some quantification of today’s needs. Rough, unclassified, estimates are needed about “how much is enough?” for various targeting missions of nuclear forces, or for mixes of nuclear and conventional forces. Arguably, what is needed is discussion somewhat along the lines suggested by Table 4—although the numbers in Table 4 have no basis in actual data aside from modest linkage to assured-destruction capabilities estimated in the 1960s and casual observation of the number of precision weapons used in recent wars such as that in Iraq (as of 2011, Boeing had built more than 200,000 tail kits for the JDAM munitions alone, and news reports indicate that roughly 20,000 precision weapons were used in Iraq).³⁴

If Table 4 happens to be even very crudely accurate, then:

- Dozens or hundreds of *arriving* nuclear weapons would suffice for attacks against a given large nation’s cities, or its economic value, respectively.
- Large-scale counter military attacks (i.e., against *conventional* forces) against large countries, if desired, might require a thousand or more arriving nuclear weapons per large country.
- Counter nuclear-threat attacks, if desired, might require thousands of nuclear weapons, depending on the number of targets, the ability to locate them, and the possible need to use of numerous weapons per site against hardened, deep-

underground targets with unknown configurations or for barraging deployment areas. Even with large numbers of weapons, however, counterforce prospects might be quite poor except in a surprise first strike, and very likely even then for nations with mature strategic postures.³⁵

- Several times more deployed nuclear weapons (as distinct from arriving weapons) might be needed, depending on assured survivability of forces and assumptions about degrees of alert, as well as about reliability and strategic defenses (if any).³⁶
- Reserve requirements might be substantial in a world with multiple nuclear-armed potential adversaries. Much of the arsenal could be depleted in an attack on one adversary, with the result being an adverse balance (at the number level) with other nations.
- Although precision conventional weapons can surely substitute for nuclear weapons in some cases, they are poorly suited for “area targets,” hard and deeply buried targets, and even hardened point targets if target locations have been hidden or mischaracterized because of adversary deception. Further, the ability to deliver large numbers of such weapons would be adversely affected by distance, air defenses, and the limited number of delivery platforms (a far cry from the numbers in World War II or the Korean war).

Table 4 and the points above so not reflect the possibility that cyberwar has arguably changed the situation. Although skepticism is appropriate because the effects and persistence of effects of cyberattacks will probably remain highly uncertain, it can be argued that the threat of massive cyberattack is a not-yet-recognized contributor to deterrence.³⁷ If so, cyberdeterrence should be folded into the discussion and could affect estimates of “requirements” markedly. Even without this complication, the estimates of table 4 are merely approximate and could be wrong. The actual “requirements” would depend not only on the targeting options seen as necessary by policy makers, but also on policy judgments about how much is enough. My intent here is to flag the importance of understanding the rough numbers, not prejudging what policy makers will or should conclude about requirements. After all, the need for and appropriateness of the options contemplated in Table 4 can be regarded as other-worldly, much as the underlying analysis has been referred to by scholars as “crazy math.”³⁸ It is notable that some of the strongest proponents of the process toward nuclear disarmament are stalwarts of national-security policy making such as George Shultz, Henry Kissinger, and Sam Nunn.³⁹

Table 4
Notional Weapon Requirements from a Purely Hypothetical Study

<i>Task</i>	Requirements^a		
	<i>Arriving Nuclear Weapons</i>	<i>Arriving Nuclear and Conventional Weapons in Mixed Attack</i>	
		<i>Nuclear</i>	<i>Conventional</i>
Annihilate 5 cities and their populations (unless evacuated)	5-25 ^b	5-25 ^b	N.A.
Destroy economic value of 5 cities	5-25	N.A.	5,000
Destruction of a society	500 ^c	100	50,000
Destruction of two large-country's societies	1000	200	100,000
Destroy adversary's conventional military infrastructure and forces	1000	100	10,000
Destroy two large-adversary conventional military infrastructures and forces	2000	200	20,000
Destroy adversary's nuclear-threat systems	10-1000s (if feasible at all) ^d	10-100s (if feasible at all)	Countless (if feasible at all)
Maintain strategic reserve for post-exchange deterrence, coercion, and follow-on attacks—of both the immediate adversary and other nations.	1000?	1000?	100?

a. The number of deployed weapons required might be several times larger than those shown in the table, depending on the ratio of alert and nonalert weapons, inherent survivability of deployed weapons, reliabilities, and strategic defenses.

b. The number would depend on the size of cities, extent of damage required, and weapon yields. The assured-destruction “requirement” from the 1960s was 400 delivered equivalent megatons (EMT), or roughly 2000 100-kT weapons.

c. This assumes that most targeted areas can be destroyed by a 100-kT weapon. That was the case for Cold War targeting of Soviet cities, although not for Soviet targeting of U.S. cities.

d. This depends on the adversary and launch facilities being targeted. Feasibility is very much in question for conventional weapons (National Research Council, 2005), and with nuclear weapons, in the absence of exquisite intelligence. The radioactive fallout from such nuclear attacks could be large for attacks on deep underground targets (although much smaller than from surface bursts because of the smaller yields necessary), and would travel to other countries.

3.3 Rethinking the Sub Cases and Measures for Analysis

Another aspect of rethinking analysis will be to reassess for what sub cases nuclear forces should be evaluated. Even for the simple Cold War calculation with only two parties (U.S. and Soviet Union), the result was a sizable combination of sub cases, reflecting who would launch the first attack, the alert posture of both sides, whether launch under attack was executed, and the targeting strategies of all concerned (i.e., countermilitary, counterforce, full-up assured retaliation...). In some periods, the analysis also included effects of strategic defenses—in intercepting some attackers and in creating additional target requirements. Table 5 shows a partial depiction of the sub cases in which retaliatory capability might need to be calculated. The eight empty cells indicate the cases to be considered by merely considering alert posture, the form of the retaliatory attack, and whether or not launch under attack is executed. The number of cases doubles if either side can attack first, and grows geometrically if more than two adversaries are involved, if additional “phases” of war are considered (e.g., a response to the retaliation), and if different sequences occur (e.g., A attacks B; B attacks A; C attacks B;...).

Table 5
Sub Cases for Calculation of Second-Strike Capability

	Alert Posture			
	Day-to-Day Alert		Generated Alert	
Doctrine	CM Response	CV Response	CM Response	CV Response
Launch under attack				
Absorb attack and retaliate				

Notation: CM means countermilitary (against both conventional and nuclear forces); CV means countervalue (e.g., against war-supporting industry, including that in cities).

The measures of effectiveness used in Cold War analysis varied, but included paying attention to the number of nuclear weapons surviving at each stage of simulated conflict, the damage accomplished by attacks, and—in some analyses—such consequence as human fatalities and long-term problems associated with radiation and effects on climate.⁴⁰ Many of these were controversial because, depending on assumptions, it was possible to convey remarkably different impressions about whether U.S. forces were adequate or inadequate, highly vulnerable, or highly secure. There is no reason to review the issues here except to make some points that may be relevant to the future as well:

- As discussed in a study that disparaged the overemphasis on the computational “calculus” of first-strike stability,⁴¹ the primary threat to crisis stability may be “dangerous ideas” triggered or exacerbated by fear, paranoia, desperation, or a

sense that there might be glory and heavenly or historical honor in annihilating large numbers of people. One such dangerous idea in crisis would be that because the adversary is *certain* to attack, the only chance for survival is in preemptively attacking the adversary in the hope of destroying its command and control system as well as most of its nuclear weapons. The preemption might not succeed, but doing nothing would be certain catastrophe.

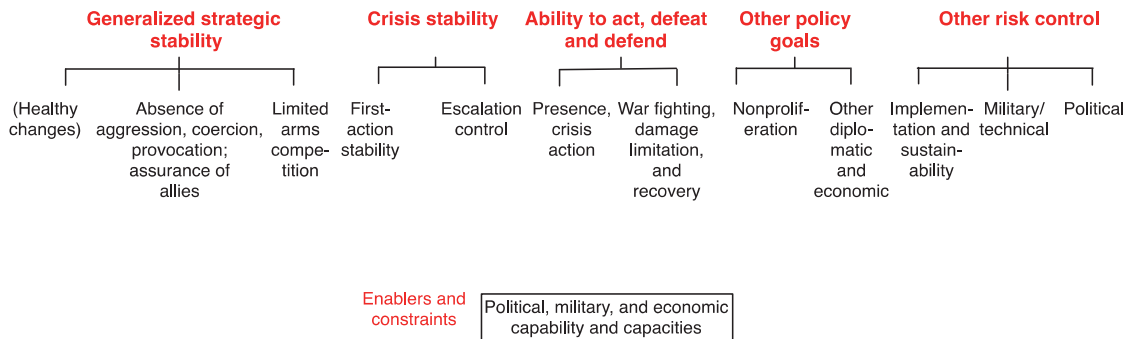
- The measures of crisis stability that have been used in analysis have been mathematically elegant, but of dubious relevance to decision makers. Some measures used in debate (e.g., post-exchange ratios of ICBM weapons) have been demonstrably bad “decision aids,” in the sense of presenting a distorted view of the power balance.⁴²
- Counterforce strategies, and even first strike counterforce strategies, will inevitably be relevant in crises in which the adversary could plausibly be disarmed of nuclear weapons. The splendid-first-strike option vanished in the 1960s, but could reemerge in modern settings. Indeed, over the last fifteen years, the idea of (conventional) attacks to disarm North Korea and, more recently, Iran, has arisen repeatedly.
- Counter military strategies designed to preclude the adversary from having usable projection forces, and perhaps to destroy its security apparatus, will continue to be important.
- As discussed above in Table 4, conventional weapons can sometimes substitute for nuclear weapons, but the extent to which that is true is not yet understood technically or strategically. Further, the ability to deliver massive conventional-weapon attacks will certainly be in question for some conceivable situations. Indeed, U.S. force-projection capabilities face high challenges generally.⁴³

3.4 A PROPOSED ANALYTIC STRUCTURE

3.4.1 A Taxonomy of Criteria

Against this background, Figure 1 shows a suggested top-level structure that seems to cover the above considerations adequately. The higher-level terms are defined in Appendix A. Items in parentheses will subsequently be omitted (i.e., taken for granted). The intent, then, is to evaluate options against all the criteria shown, but in a small spanning set of test cases stressing the force structure and posture in diverse ways across the possibility space. These may be seen as virtual crises and conflicts that are unlikely to occur but that may affect perceptions. In normal parlance, the test cases would be referred to as scenarios. Thus, an option would be deemed very good if it contributed well to achieving or maintaining the objectives above in all of the spanning set of test cases.

Figure 1
A Structured Set of Objectives and Enablers



3.4.2 Relationships to Other Concepts

Deterrence. Some familiar terms do not appear explicitly in Figure 1, terms such as persuasion, dissuasion, deterrence, and influence more generally. If the objectives shown in Figure 1 are achieved, then it may be *in part* because efforts to persuade, dissuade, deter, and influence worked. However, many factors typically affect the actions of nations. A state that foregoes aggression may simply not be motivated to be aggressive, with coercive diplomacy having played no part. That state may never have considered aggression or may have dismissed such ideas for reasons of morality, self-image, or political and economic self-interest. The same is true for states that choose not to develop nuclear weapons. They *may* be persuaded, dissuaded, or deterred by others from such a course, but they may instead have simply judged such weapons to be unnecessary and the pursuit of them inappropriate or foolish.⁴⁴

Flexibility. Another term that does not appear explicitly in Figure 1 is flexibility, but that is an important attribute of the capabilities indicated at the bottom of the figure. It can be measured by the ability of nuclear forces to execute a diverse range of missions in a diverse set of scenarios. Another consideration in flexibility is being able to minimize collateral damage, i.e., the capability for discriminate attacks (even nuclear weapons can be used more or less discriminately). Providing such flexibility is both a moral and pragmatic necessity, as has been recognized since at least the days of President Nixon.⁴⁵

A brief comparison of the structure suggested here with the suggestions of other authors suggests that the structure is indeed rather comprehensive, although not always explicit on the same points as made by other authors.⁴⁶

4. AN ILLUSTRATIVE INSTANTIATION

4.1 SETTING UP THE ANALYSIS

Applying the analytic structure will require substantial work, but what follows sketches higher-level aspects of a notional analysis.

Let us assume that the “substantial work” mentioned above has included:

- Identifying an appropriate spanning set of test cases (scenarios) by which to evaluate options for force structure and posture. As a set, these tests should stress the options in all the ways necessary to assess capability to accomplish the various objectives of interest. Developing a meaningful test set is much more demanding analytically than is sometimes realized because results depend on many variables. Further, how stressful the tests should be must reflect iterations with policymakers. Details on the degree of stress will drive conclusions.
- Decomposing each of the test cases into the many sub cases implied by different assumptions about who attacks whom first, what alert postures apply, and so on.
- Deciding upon measures of effectiveness within the various criteria of the structure.
- Identifying the primary points of analytic uncertainty, so as to define the range of exploratory analysis needed (much of it in background).
- Identifying the primary points of strategic disagreement, and aggregating those into a minimum set of conflicting strategic “perspectives” (assumed to be just two in what follows).

On the latter point, it should be noted that it is not necessary to list every possible combination of assumptions as a different perspective. In practice, considering even a minimal set of stylized perspectives (an analytic analogue to the “stances” discussed earlier in the paper) can be powerful in clarifying issues and opening minds in strategic-level debate. Further, doing so can encourage the search for options that will hedge in various ways when it is not certain which perspective will prove more nearly “right.” The core intent here is to break away from the tyranny of the best estimate (or the estimate by the most powerful faction).⁴⁷

With these heroic assumptions about analytic background work, the next section illustrates how results might be discussed in a decision-support context using the multiple higher-level criteria of Figure 1 and two perspectives corresponding roughly to the relatively more optimistic and skeptical views of further nuclear force reductions and a process working toward total disarmament. I assume that all relevant decisionmakers accept the policy that emerged from the most recent nuclear posture review, but that the optimistic versus skeptical

perspectives will still be very much in play, independent of political administration, as the nation goes on to contemplate future proposals for force structure, posture, and arms control.

4.2 ILLUSTRATING DECISION SUPPORT

To illustrate what displays might look like, imagine a set of options under consideration that include:

- A. the baseline (the future force and posture consistent with decisions already made)
- B. a reduction to 300 nuclear weapons with only minimal verification
- C. the same reduction but with good verification provisions (by the standards of arms control, which seldom allow no-notice, anywhere-type inspections);
- D. Option C, but with a substantial deployment of additional conventional global-strike weapons
- E. Option D plus deployment of hypothetically excellent albeit limited defenses that are quite effective for regional purposes (e.g., defense of allies and U.S. forward-deployed forces), and effective against very small and relatively unsophisticated attacks on the homeland.
- F. The baseline plus the defenses assumed in Option E

In practice, there would be innumerable details to specify, but the intent here is purely illustrative. Figure 2 then shows what the top-level summary assessment might look like. Although the scores shown have no basis in serious analysis, they reflect a hypothetical story. In this story, even the baseline situation does not look very good in some respects and a weakly constructed reductions agreement (Option B) would make things worse. The shortcomings could be reduced with better verification (Option C). Adding more global strike capability improves matters somewhat more (Option D), and defenses improve things even more (Option E). Note that some column pairs show assessments by the same criterion, but from the two different perspectives.

Figure 2
A Notional Summary of Option Assessment

Measures	Strategic Stability (Persp 1)	Strategic Stability (Persp 2)	Crisis Stability	US ability to act, defeat, defend	Nonproliferation	Nonproliferation (Persp 2)	Net Risk Control (Persp 1)	Net Risk Control (Persp 2)
	Detail	Detail	Detail	Detail	Detail	Detail	Detail	Detail
Investment Options	Y	LG	LG	Y	O	Y	G	G
A. Baseline	Y	LG	LG	Y	O	Y	G	G
B. 300 Wpns, Weak Verif.	LG	Y	LG	Y	Y	O	O	R
C. 2 + Verif.	LG	Y	LG	Y	LG	O	Y	Y
D. C + Global Strike	LG	LG	LG	LG	LG	Y	LG	Y
E. D + Defenses	G	G	G	G	G	Y	LG	LG
F. Defenses	G	G	G	G	Y	Y	LG	LG

Note: the color coding is red R (very bad), orange O (bad), yellow Y (marginal), light green LG (good), dark green G (very good). Underlying these are scores from 0 to 1 (not shown).

The approach recommended is that decisionmakers see the multicriteria richness summarized in Figure 2 (although some condensation would be possible). However, once such discussions have been had and assumptions checked and iterated, it is useful to produce simple summaries. In a sense, they merely repeat points that can be made verbally, but such visualizations are often useful in discussion.

Table 6 and Figure 3 show a composite effectiveness score for each of the hypothetical options, but they contrast results for the two perspectives (in a real application, more perspectives might be needed to do justice to issues). The composite effectiveness is given a score from 0 to 1. The scores differ by perspective because those holding the two views put different relative weights on the various criteria *and* because they differ on the likely effectiveness of the options for particular objectives. These are not “technical” disagreements, but strategic-level judgmental disagreements.

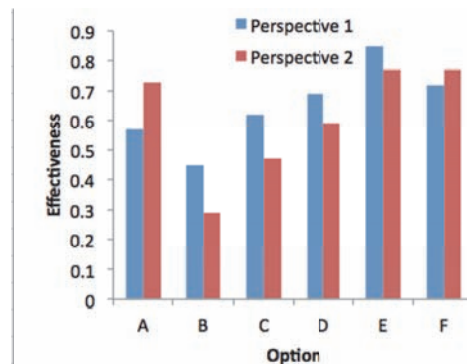
For example (Figure 2), those with Perspective 2 are much more skeptical about the value of reduced weapons in slowing or halting proliferation (orange rather than yellow). Whether using tabular results or the equivalent bar-chart version (Table 5 versus Figure 3), we see that there are clear disagreements about how the options will be viewed in the aggregate. Perspective 1 sees a progression as one moves from Option A (baseline) to Options B, C, D, and E. Option F is seen as not quite as good as Option E. In contrast, Perspective 2 sees significant problems with deep cuts and concludes that the only element of the options that actually accomplishes very

much is the postulated defenses (assumed to be effective for at least limited purposes). Thus, Option F is favored. Despite the disagreement, however, an observer would note that both sides of the debate agree that defenses would be significant (if feasible), although not improving matters relative to the baseline dramatically, and that poorly verified arms control could cause significant problems.

Table 6
Summary Effectiveness

<i>Option</i>	<i>Effectiveness</i>	
	<i>Perspec- tive 1</i>	<i>Perspec- tive 2</i>
A. Baseline	.57	.73
B. 300 Weapons, Weak Verification	.45	.32
C. Option B + Strong Verification	.62	.5
D. Option C + Extensive Global Strike	.69	.59
E. Option D + Good Regional Defenses and Good Homeland Defenses Against Light Attack	.85	.77
F. Baseline + Defenses as in E	.72	.77

Figure 3
Effectiveness by Perspective



Recall that Figures 2-3 and Table 6 all deal with high-level assessments, which are aggregates, or roll ups from numerous subordinate assessments. For example, the assessments of strategic stability vary by perspective. The differences are more stark with regard to the options' effects on nonproliferation objectives. Figure 4 drills down for each of the two perspectives, showing the Perspective 1 and 2 results in the upper and lower panes, respectively. The most marked difference is that the skeptical perspective believes that it is implausible that any of the options will have a substantial effect on enlisting international cooperation in effectively enforcing provisions of the NPT and other arms-control agreements. Also, the skeptics predict that the effect of a poorly verified deep-reductions agreement would be precisely the opposite of what the NPT-optimistic side anticipates, and generally have less confidence that such a regime can be established and effectively maintained. The skeptics are less concerned in the baseline about proliferation prospects, believing that such proliferation can both be more effectively minimized and that proliferation that does occur can ultimately be managed, and they believe that Option B would be seen by allies as establishing a dangerous trend undercutting the credibility of U.S. assurances. This, in turn, would cause them to more seriously examine their

own options for nuclear-weapons capability. At the same time, states such as Iran would, if anything, be emboldened because of seeing the opportunity for their nuclear forces to be relatively more powerful than previously. The NPT-optimist view, to the contrary, is that even Option B, but certainly Option C (the verifiable cuts) would have sizable influence worldwide. With good diplomacy, they would argue, the trends perceived would be positive, would discourage proliferation, and might even encourage some countries to pull back from marginal programs.

Figure 5 is another example of “drill down,” this one dealing with Risk Control. It indicates that, in this notional analysis, those associated with Perspective 2 are more alarmed than the optimists about the potential for divisive political debates unless changes are accompanied by strong buildups in conventional forces (global strike) and strategic defenses.

To reiterate, the assessments shown here are purely notional, intended to illustrate what results of analysis might look like that contain a mix of qualitative considerations that recognize disagreements, and that sharpen discussion of *why* assessments differ.

Figure 4
Drill-Down Assessment of Nonproliferation Prospects, by Option
(Perspectives 1 and 2 are shown at top and at bottom).

Level 1 Measure	Nonproliferation				
Level 2 Measure	Allies	Others	International enforcement	Warning	
Investment Options					Nonproliferation
A. Baseline	0.30	0.30	0.30		0.30
B. 300 Wpns, Weak Verif.	0.50	0.50	0.50		0.50
C. 2 + Verif.	0.70	0.70	0.70		0.70
D. C + Global Strike	0.75	0.75	0.75		0.75
E. D + Defenses	0.80	0.80	0.80		0.80
F. Defenses	0.50	0.50	0.30		0.43
Level 1 Measure	Nonproliferation (Persp 2)				
Level 2 Measure	Allies 2	Others 2	International enforcement 2	Warning	
Investment Options					Nonproliferation
A. Baseline	0.70	0.70	0.10		0.50
B. 300 Wpns, Weak Verif.	0.30	0.30	0.10		0.23
C. 2 + Verif.	0.50	0.40	0.10		0.33
D. C + Global Strike	0.70	0.70	0.10		0.50
E. D + Defenses	0.70	0.70	0.10		0.50
F. Defenses	0.70	0.70	0.10		0.50

Figure 5
Drill-Down for “Control Risks”
 (upper and lower panes correspond to perspectives 1 and 2, respectively; the last column is the roll-up, i.e., the column of values to be found in Figure 2)

Level 1 Measure	Net Risk Control (Persp 1)				
Level 2 Measure	Risk Control				
Level 3 Measure	Implementation	Military/technical	Political	Cheating and Breakout	
Investment Options					
A. Baseline	1.00	1.00	1.00	1.00	1.00
B. 300 Wpns, Weak Verif.	1.00	1.00	0.30	0.20	0.20
C. 2 + Verif.	1.00	1.00	0.70	0.50	0.50
D. C + Global Strike	1.00	1.00	0.80	0.70	0.70
E. D + Defenses	1.00	1.00	0.90	0.80	0.80
F. Defenses	1.00	1.00	0.90	1.00	0.90

Level 1 Measure	Net Risk Control (Persp 2)				
Level 2 Measure	Risk Control (Persp 2)				
Level 3 Measure	Implementation 2	Military/technical 2	Political 2	Cheating and Breakout 2	
Investment Options					
A. Baseline	1.00	1.00	1.00	1.00	1.00
B. 300 Wpns, Weak Verif.	1.00	1.00	0.10	0.10	0.10
C. 2 + Verif.	1.00	1.00	0.50	0.50	0.50
D. C + Global Strike	1.00	1.00	0.70	0.55	0.55
E. D + Defenses	1.00	0.75	0.90	0.90	0.75
F. Defenses	1.00	0.75	1.00	1.00	0.75

5. CONCLUSIONS

The purposes of this think piece have been relatively modest—to suggest a structure for analysis suitable for supporting senior leaders as they discuss and debate nuclear-force options, and to include in that structure ample room for considering qualitative judgments as well as calculated results from models.

One observation that rather stands out is that *most* of the important issues cannot be accurately evaluated with reliably predictive models. To the contrary, the most important challenges are probably identifying appropriate test cases, making qualitative evaluation, sharpening the most important differences of view, eliciting coherent stories corresponding to those views, summarizing results clearly for decisionmakers, and pointing out ways (option adjustments) that would hedge against uncertainty (including uncertainty about who is more right where disagreements exist).

Some suggestions:

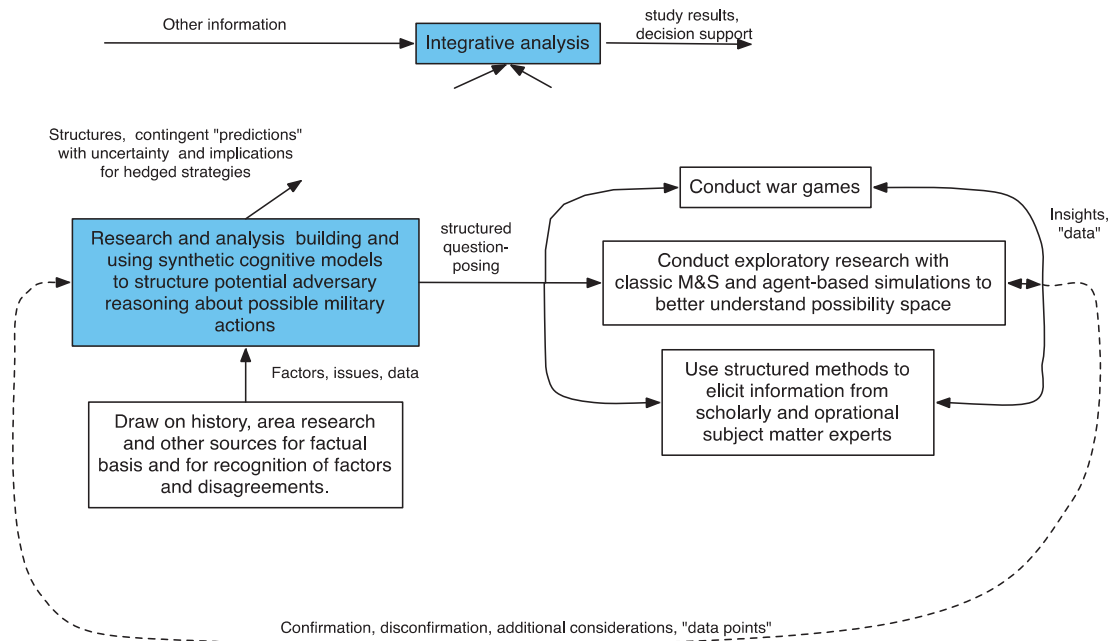
- Identify a spanning set of stressful test cases, each case being parameterized so as to provide varied levels of stress and to deal with major uncertainties and disagreements (reflected in the various sub cases discussed above). In identifying the test cases, look for special troublesome contexts, such as discussed in Tables 2 and 3.
- As suggested in Table 3, use a combination of analytic methods for evaluation.
- Use qualitative modeling, particularly “synthetic cognitive decision models,” to characterize the issues and reasoning as discussed below. Use these models both to help focus the war games and to draw insights from them (e.g., confirmation of disconfirmation of structure, and results for some discrete points, between which analysts could interpolate).
- Use other methods, such as crowd sourcing, to collect additional information—including information about factional differences in narrative (a kind of perspective).

Figure 6, then, suggests a new approach to the combined use of multiple ways of obtaining information and insight. The most important suggestion is that the process of using war games, models and simulations, expert elicitation and the like be informed by synthetic cognitive models, which can be relatively simple qualitative models (largely reducible to viewgraphs) that attempt to characterize alternative *possible* reasoning of adversaries.⁴⁸ These depend on identifying key factors in adversary reasoning, using multiresolution methods to allow higher level factors to be determined by lower-level factors. The result is to improve ability to discuss what situation or case the adversary may perceive himself to be dealing with, and how to affect the adversary’s perception of situation and evaluation thereof. Because the understanding of

adversary reasoning in crisis has been notoriously unreliable over history, it is central to the approach that one consider *alternative* models (i.e., with different relative emphasis on the various factors, with different degrees of risk aversion and sense of desperation). This approach can help frame key issues for exploration with war gaming, simulation, expert consultation, or field research with survey methods, for example. It can also be used to interpolate sensibly between cases that are particularly well understood from history and prior gaming and simulation. As Figure 6 indicates, however, everything in the anticipated research and analysis is iterative with insights potentially coming from a myriad of sources, some of them affirming or disconfirming prior constructs.

The approach suggested is not quite so radical as some readers may imagine. The original ideas of using synthetic cognitive modeling were developed some years ago based on extensive experience with both human and automate strategic-level war gaming sponsored by the Office of Net Assessment. They were simplified for the study of Saddam Hussein before and during the first Gulf War, where they proved quite useful. Some of the ideas were used in early versions of the Pythias agent-based simulations being used in the CANS effort by Alex Levis of George Mason University.⁴⁹ In recent years, some of the very same techniques have been successfully used to construct conceptual models to better understand terrorism and public support of insurgency and terrorism.⁵⁰ In a small current effort for the Human Social and Cultural and Behavioral (HSCB) modeling program I am pursuing ways to turn the conceptual models into qualitative “computational” models (albeit, with continued emphasis on uncertainty). Far more could be done with the approach than has been attempted in the past. In particular, the methods can define distinguishable situations, characterize evaluations for these situations for alternative concepts of the adversary, and thereby “fill in” the possibility space, whereas a given war game (or even a limited knowledge elicitation from experts) typically provides information on much more specific point situations. Simulations can also “fill in,” but they have their own advantages and disadvantages.

Figure 6
A Conceptual Approach to Integrated Analysis



APPENDIX A DEFINITIONS

The terms in Figure 1 are defined here as follows:

1. *Generalized Strategic Stability*: the degree to which international affairs allows for healthy changes, but is characterized by a low probability of war generally and, more specifically, the absence of incentives for nations to engage in arms races, security-related realignments, coercion, preventive war, or preemptive attacks. A special aspect of strategic stability is nations not feeling a security need to develop and deploy nuclear weapons. Thus, “assurance of allies” is subsumed under this criterion. Note that this is a much broader (but also more classic) definition that was used in the Cold War during which the term typically referred to intercontinental (and sometimes intermediate-range) nuclear forces.
2. *Crisis Stability*: the degree to which, in a state of international crisis, parties do not perceive incentives to escalate conflict (or the necessity of doing so)—e.g., by using nuclear weapons, invading another country, or expanding the scope of an existing conflict geographically. Components can be distinguished for first-action stability and subsequent escalation control.
3. *Act, Defend and Defeat*: a measure of the degree to which the option in question would affect U.S. ability to defend its homeland, its forces abroad, and its interests abroad, including those involving allies. This may include routine military presence, crisis action, defeating an adversary in war, and defense. An element under this is damage limitation capability: the capability, in the event of war, to limit damage to the United States, its forces abroad, and its foreign interests including those involving allies.
4. *Contribution to Other Foreign Policy Goals*: a measure of the degree to which an option promotes or otherwise supports broader strategy, such as the U.S. effort under multiple presidents to reduce arsenals of nuclear weapons (including Russian tactical nuclear weapons), reduce reliance on nuclear weapons, limit nuclear proliferation, and even to move toward an eventual goal of nuclear disarmament (Department of Defense, 2010).
5. *Risk Control*: a measure of confidence that an option’s actual effectiveness will not be significantly worse than assessed with the prior criteria and evaluation methods. This means having confidence in implementability, avoiding severe operational or technical problems, and avoiding severe political problems that might undercut effectiveness or sustainability.

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ENDNOTES

¹ I benefited from many discussions with colleagues James Quinlivan and Ely Ratner, and with members of the SMA CANS team, as well as from comments on a draft manuscript by Elbridge Colby and Dane Swango.

² See United States Department of State (2010)

³ CANS-project efforts included a review of theory and concepts, a simulation effort by George Mason University and Carnegie Mellon University, a crowd-sourcing prototype by Monitor 360, a prototype subjective decision analysis by NSI, the current effort, and war games run by the Office of the Director, National Intelligence, and the Army, Navy, and Air Force.

⁴ See Department of Defense (2010).

⁵ The list is rooted in early systems analysis and policy analysis at RAND (Kahn and Mann, 1957; Fisher, 1971; Goeller, 1983; Quade and Carter, 1989) and elsewhere (Hammond, Keeney, and Raiffa, 2002; Morgan and Henrion, 1992; Saaty, 1999), but has a richer treatment of uncertainty and disagreement, as well as drill-down explanations. The approach has evolved over time, helped motivate the good version of capabilities-based planning (Davis, 2002) and has been applied to defense planning (Davis, Shaver, and Beck, 2008; Davis et al., 2010), grand strategy (Davis, Gompert, Johnson, and Long, 2008) and border security (Willis, Predd, Davis, and Brown, 2010).

⁶ See also Davis (2002). How to develop a good “spanning set” of test cases has been illustrated elsewhere (Davis et al., 2008; National Academy of Sciences, 2008).

⁷ Sensitivity analysis changes assumptions one by one. Exploratory analysis examines how results change for all *combinations* of changes—i.e., it explores the entire possibility space. This is especially important when no baseline case is reliable and when important variables are correlated, as when an adversary exploits multiple vulnerabilities simultaneously, or when effectiveness depends on *all* of the critical components of a system working. Exploratory-analysis methods encourage seeking flexible, adaptive, and robust capabilities (Davis, Bankes, and Egner, 2007; Davis, Kulick, and Egner, 2005; Davis, 2002). They encourage what others call *robust decision making* (Lempert, Groves, Popper, and Bankes, 2006) and seeking *agility* in capability (Alberts, forthcoming).

⁸ Aggregate effectiveness depends on how lower-level evaluations are combined. There may be disagreements about, for example, the relative importance of short term and long term, whether threshold levels of component capability are required, and whether an option will do what it advertises or the opposite. A summary depiction should therefore highlight how results vary across points of view (“strategic perspectives”). The mathematics and a related tool are discussed elsewhere (Davis and Dreyer, 2009).

⁹ A current effort led by C. Ryan Henry under RAND’s Project Air Force is addressing such issues (Henry et al., 2011).

¹⁰ See Davis and Wilson (2011).

¹¹ The ideas can be found in a small number of documents, notably the Nuclear Posture Review (Department of Defense, 2010), an excellent compendium of competing essays (Perkovich and Acton, 2009), a cautionary piece drawing on history (Payne, 2011), and two influential OpEds (Shultz, Perry, Kissinger, and Nunn, 2007; Shultz, Perry, Kissinger, and Nunn, 2008). An older document collects historical material (Kunsmann and Lawson, 2001).

¹² The primary limitations in conventional weapons are three: (1) they are not sufficient to attack hard deeply buried targets (National Research Council, 2005) or hard targets with actual locations that are hidden or misrepresented by deception; (2) absent long aerial bombing

campaigns with large conventional weapons, they are not useful for area targets; (3) they do not devastate or terrorize to the same extent as nuclear weapons. See also Colby (2010; 2011).

¹³ For core ideas, see George and Smoke (1974). Early papers by James Schlesinger discuss thinking after the United States had lost its nuclear monopoly and worried about more complex versions of deterrence, as well as nuclear proliferation and arms control (Schlesinger, 1968; Schlesinger, 1974b). Some of the considerations are quite relevant again. Good summaries exist on the concepts emerging from work of three administrations in the period 1969-1980 (Slocombe, 1981; Brown, 1983). Academic books on nuclear strategy are sometimes informative and well written (Freedman, 2003), but less than even handed in discussing crucial issues that concerned serving officials in the 1970s and 1980s. DeNardo (1995) is unique in comparing positions and differences of view by nuclear strategists with empirical information from both students and nuclear experts of the early 1990s. No one reading the book will ever again imagine that the issues of nuclear strategy can be reduced to simple and universal logic or game theory.

¹⁴ See Chernus (2011) for historical difficulty in decoding “stability.”

¹⁵ For an authoritative discussion, see Kokoshin (2011).

¹⁶ Herman Kahn was particularly influential in demonstrating the folly of imagining that nuclear strategy could be restricted to all-or-nothing thinking (Kahn, 1962).

¹⁷ Fundamental disagreements about such matters exist intuitively, whether in the minds of amateurs or experts on nuclear matters (DeNardo, 1995).

¹⁸ Whether to stress escalation dominance or crisis stability was been a matter of fierce debate for decades. For contrasting views, see Kahn (1966) and Freedman (2003). Some scholars have emphasized force-generation stability and prompt-launch stability, which together address first-strike stability (Cimbala and Scouras, 2002). See Huber (Huber and Avenhaus, 1993) for an international collection of analytic papers discussing stability issues more generally in the wake of the Cold War, including issues of conventional stability.

¹⁹ In the only full-up nuclear crisis during the Cold War, assessments of who would “win” a nuclear war (and, therefore, who would blink first) were prominent within both U.S. and Soviet governments, although Kennedy and Khrushchev rose above such assessments in finding a way to avoid war. Sanity prevailed, but the world came much closer to war than was recognized (Dobbs, 2008). By the 1970s, the U.S. found it necessary to contemplate limited versions of nuclear war, such as might occur if the Warsaw Pact invaded NATO and NATO resorted to limited nuclear use to re-establish deterrence. Making the deterrent threats credible was not just a theorist’s game, but something in which NATO’s policy makers invested substantially (Legge, 2003). This said, from the 1960s onward, most policymakers recognized that “victory” in large-scale nuclear war would probably be less than meaningful, although precluding the Soviet Union from imagining that it could win was *very* meaningful. That led to the *countervailing strategy* (Slocombe, 1981). Early in the Reagan administration, some U.S. policymakers sought the capability to “prevail” in war (Freedman, 2003, p.388), although this, as well as the strategic defense initiative (SDI), was intended as a way to strengthen deterrence rather than as expression of enthusiasm for war fighting. The language of “prevail” was extremely controversial and was eventually softened.

²⁰ Despite U.S. capabilities, allies might not be assured because of doubting the resolve of U.S. leaders, because of misperceptions, or because of various failures of diplomacy. See the recent paper by colleague Ely Ratner (Ratner, 2011). See also a full study on foreign attitudes (Dunn, Giles, Larsen, and Skypek, 2006).

²¹ This discussion uses the standard meaning of risk, which depends on the likelihood and consequences of events worse than expected. We don’t *expect* an earthquake tomorrow, but we

may buy insurance to reduce our economic risk. We may *expect* that the military balance will be somewhat more adverse in a region under a given force posture, but it is a separate matter to recognize that consequences could prove to be much worse than expected.

²² For some cautionary discussions see Miller (2009; 2009; 2011).

²³ See Betts (1981).

²⁴ It has long been noted in psychological experiments associated with “Prospect Theory” that people hate giving up something they possess, whether or not their feelings on the matter are rational. Moving from superiority to parity might be felt as a loss, with repercussions for politics.

²⁵ DeNardo (1995) demonstrates that no consensus position exists on a calculus of deterrence and stability. Intuitive differences exist about what can be over simplified as beliefs in symmetry, strength, or a combination. Clear divisions on thee exist and persist among experts as well as “amateurs.” Ideological considerations, prior beliefs about adversaries, organizational matters and other factors also play important roles.

²⁶ For discussion in the Nixon administration, see Burr (2005). Secretary of Defense James Schlesinger discussed such matters compellingly in the Ford administration (Schlesinger, 1974a). In the Carter administration, Secretary of Defense Harold Brown developed the countervailing strategy, which emphasized the ability to cope with diverse circumstances and adversary beliefs (Brown, 1983; Slocombe, 1981). President Reagan introduced the Strategic Defense Initiative (SDI) because he regarded dependence on assured-destruction deterrence to be fundamentally unacceptable (Skinner, Anderson, and Anderson, 2001). See also a famous article by Fred C. Iklé (Iklé, 1973) and a later study on discriminate deterrence (Iklé and Wohlstetter, 1988). For both moral and pragmatic reasons, U.S. nuclear-force commanders have often emphasized the importance of flexibility in U.S. nuclear capabilities and posture.

²⁷ These issues came to the forefront in recent years due to mishaps in the handling of nuclear weapons that led in 2008 to Secretary Robert Gates asking for the resignations of the Secretary of the Air Force and the Air Force Chief of Staff

²⁸ The classic argument favoring the Triad of intercontinental bombers, ICBMs, and SLBMs was based on concerns about common-mode technical failures and hedging against threats to one or another Triad component.

²⁹ Various accounts of this appear in the literature (Glass, 1993).

³⁰ See the discussion of General Lee Butler, the first Commander of U.S. STRATCOM, which expresses anguish about the dangers of the nuclear posture during his period of command—due in part to the launch-under-attack strategy—quoted in Schell (1998) (as cited by Bruce D. Blair at <http://www.cdi.org/blair/launch-on-warning.cfm>). For a nuanced and technical discussion of launch-under-attack issues, see Carter (1987).

³¹ A recent paper (Davis and Wilson, 2011) describes the substantial challenges facing U.S. defense planners that stem from the “democratization of military technology,” geostrategic changes, new theaters of warfare (space and cyberspace), continued nuclear proliferation, and the need to plan for both traditional missions and counterinsurgency. It sees profound difficulties for force projection and does not accept the common claim that the United States can accomplish its objectives with conventional weapons. The paper makes no claims about nuclear forces helping in this regard; rather, it argues that the conventional “balance” will not be nearly so favorable as often asserted.

³² These estimates were published and indeed for public discussion (McNamara, 1969; Enthoven and Smith, 1971).

³³ See Miller (2010).

³⁴ See Boeing (undated).

³⁵ In the 1970s, 7,000 of 8,000 strategic nuclear weapons in the U.S. SIOP were devoted to counterforce according to a recent book by retired VADM Jerry Miller (Miller, 2010).

³⁶ For example, if only half the submarine-based weapons were at sea, those in ports could be vulnerable. Except under alert conditions, launch under attack might not be viable, in which case ICBMs would be vulnerable. If retaliation required defeating defenses, large numbers of weapons might be needed for that alone (overwhelming defenses is more certain than defeating them with countermeasures).

³⁷ A recent study examines the special issues of deterrence and cyberwar, and touches upon substitutability of cyber for nuclear threats (Libicki, 2009). I am indebted to Stephen Cimbala of Pennsylvania State for arousing my interest in the issue.

³⁸ See Cimbala and Scouras (2002).

³⁹ See Shultz et al. (2007; 2008).

⁴⁰ See, e.g., Office of Technology Assessment (1979).

⁴¹ See Davis (1989) and Payne (2008) for discussions that draw on psychology and history for insights.

⁴² See Davis (1989) and Cimbala and Scouras (2002).

⁴³ This is discussed in Davis and Wilson (2011).

⁴⁴ An early example was Sweden's backing away from developing nuclear weapons in the 1970s. The reasons included Sweden's self image, as well as a belief that the U.S. extended deterrent to NATO effectively protected Sweden as well (Cole, 1994).

⁴⁵ See endnote above, "For discussion in the Nixon administration..."

⁴⁶ Elbridge Colby lists seven requirements: to deter aggression against U.S. vital interests; to size and shape forces according to what is needed to deter; to maintain ability to hold an opponent at risk wherever he goes; to assure devastating second strike capability; to maintain and improve limited and discriminate options; to maintain a secure reserve force; and to minimize the destabilizing aspects of U.S. forces (Colby, 2011).

⁴⁷ My colleagues and I discussed such issues in connection with decision science's implications for decision support (Davis et al., 2005), drawing in part on our review of historical errors by national-level decisionmakers in crisis. That review was never published because as it became ready for review and publication, the United States was reeling from the surprising developments of the Iraq war. The work would have inevitably been seen as "political" because some of the classic (and Party-independent) problems had been in evidence during the prewar deliberations.

⁴⁸ A short summary of earlier ideas on synthetic cognitive modeling is available in reprint (Davis, 2004), as well as in National Academy of Sciences (1996). During the 1980s, my colleagues and I built large artificial-intelligence computer models to represent the reasoning of Soviet and U.S. leaders in simulated crisis and conflict. These were part of the RAND Strategy Assessment System (RSAS). The synthetic cognitive modeling was an attempt to abstract the cream from those earlier, and much more expensive efforts. They have their own limitations and should be seen as complementing agent-based simulations.

⁴⁹ See Wagenhals et al. (2006).

⁵⁰ See discussion of "factor-tree" methods in recent publications (Davis and Cragin, 2009; Davis, 2011; Davis et al., forthcoming).