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Commentary

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The New Era of Nuclear Weapons, Deterrence, and Conflict

We have published a series of articles in recent years about the role of nuclear weapons in international politics.[1] Taken together, these articles advance two main arguments: First, technological innovation has dramatically improved the ability of states to launch "counterforce" attacks—that is, military strikes aimed at disarming an adversary by destroying its nuclear weapons. Second, in the coming decades, deterring the use of nuclear weapons during conventional wars will be much harder than most analysts believe. Both of these arguments have important implications for the US nuclear weapons modernization effort currently underway, and both have generated discussion and criticism in the nuclear analytical community. Thus, we offer here a brief summary of our main points and rebuttal to several of the criticisms.

The Counterforce Revolution and US Nuclear Primacy

The first set of arguments is about an important, yet virtually unnoticed, consequence of changes in military technology and the balance of power. In a nutshell, the same revolution in accuracy that has transformed *conventional* warfare has had equally momentous consequences for *nuclear* weapons and deterrence.[2] Very accurate delivery systems, new reconnaissance technologies, and the downsizing of arsenals from Cold War levels have made both conventional and nuclear counterforce strikes against nuclear arsenals much more feasible than ever before. Perhaps most surprising, pairing highly accurate delivery systems with nuclear weapons permits target strategies that would create virtually no radioactive fallout, hence, vastly reduced fatalities.

For nuclear analysts weaned on two seeming truths of the Cold War era—that nuclear arsenals reliably deter attacks via the threat of retaliation, and that nuclear weapons use is tantamount to mass slaughter—the implications of the counterforce revolution should be jarring.

The conventional view linking nuclear weapons to stalemate and slaughter was correct during the latter decades of the Cold War. By the mid 1960s, a truly effective nuclear counterforce strike by either side—that is, a disarming blow by one superpower against the nuclear arsenal

of the other—had become impossible.[3] Each of the superpowers wielded an enormous arsenal, which was deployed on a diverse set of delivery systems. The sheer number of targets that would have to be destroyed, combined with the limitations of contemporary guidance systems, virtually guaranteed that any disarming attack would fail, leaving the enemy with a large number of surviving weapons with which to retaliate. Furthermore, any significant counterforce strike would have produced enormous quantities of lethal radioactive fallout and hence caused millions of civilian casualties.[4] Most Cold War strategists—many of whom are still active in the nuclear analytical community today—came to instinctively associate nuclear weapons with stalemate and nuclear use with Armageddon.

But nuclear weapons—like virtually all other weapons—have changed dramatically over the past four decades. Modern guidance systems permit nuclear planners to achieve "probabilities of damage" against hardened nuclear targets that were unheard of during the Cold War. And heightened accuracy also permits nontraditional targeting strategies that would further increase the effectiveness of counterforce strikes and greatly reduce casualties.[5] The revolution in accuracy and sensors, and the relatively small contemporary arsenals, mean that nuclear balances around the world—for example, between the United States and China, the United States and North Korea, and perhaps in the future between Iran and Israel—bear little resemblance to the Cold War superpower standoff.

To illustrate the revolution in accuracy, in 2006 we modeled the hardest case for our claim: a hypothetical US first strike on the next largest nuclear arsenal in the world, that of Russia. The same models that were used during the Cold War to demonstrate the inescapability of stalemate—the condition of "mutual assured destruction," or MAD—now suggested that even the large Russian arsenal could be destroyed in a disarming strike.[6] Furthermore, the dramatic leap in accuracy—which is the foundation for effective counterforce—is based on widely available technologies within reach of other nuclear-armed states, including Russia, China, Pakistan, and others. Our overriding message is not about the US-Russian nuclear balance per se. Rather, our point is that key beliefs about nuclear weapons have been overturned; scholars and analysts need to reexamine their underlying assumptions about nuclear stalemate and deterrence.

Since 2006, we have discussed these issues with many nuclear analysts, US government officials, and military officers involved with the nuclear mission. Almost everything we learned reinforced our views about the

counterforce revolution and suggests our earlier work *understated* the leap in US counterforce capabilities—with one exception. We previously argued that US "nuclear primacy"—the ability to use nuclear weapons to destroy the strategic forces of any other country—appeared to be an intentional goal of US policymakers. We noted that even as the United States greatly reduced its nuclear arsenal, it retained, and in some cases improved, those nuclear forces that were ideally suited to the counterforce mission. Based on what we have subsequently learned, we would recast and sharpen this part of our argument to contend that the United States is intentionally pursuing "*strategic* primacy"—meaning that Washington seeks the ability to defeat enemy nuclear forces (as well as other WMD)—but that US nuclear weapons are but one dimension of that effort. In fact, the effort to neutralize adversary strategic forces—that is, achieve strategic primacy—spans nearly every realm of warfare: for example, ballistic missile defense, antisubmarine warfare, intelligence-surveillance-and-reconnaissance systems, offensive cyber warfare, conventional precision strike, and long-range precision strike, in addition to nuclear strike capabilities.

In sum, two fundamental "truths" about nuclear weapons—they reliably produce stalemate and their use would necessarily create mass casualties—have been quietly overturned by changes in technology and dramatic force reductions. Unfortunately, many contemporary analyses of nuclear politics seem to rest on the assumption that nuclear deterrence still functions as it did in the 1970s. The stipulation of mass slaughter under MAD conditions may be true for some nuclear relationships in the world but not for others. And new conditions generate new questions: for example, how is deterrence likely to work when nuclear use does not automatically imply suicide and mass slaughter? In particular, what are the implications for US nuclear policy?

The Problem of Coercive Escalation and US Nuclear Modernization

A second set of arguments stems from the problem of nuclear escalation and the future of the US nuclear arsenal. Our main claim is that deterring nuclear conflict will be much more difficult in the coming decades than many analysts realize. As nuclear weapons proliferate, it becomes increasingly likely that the United States will find itself in conventional

conflicts with nuclear-armed adversaries. Those adversaries understand the consequences of losing a war to the United States—prison or death typically awaits enemy leaders.[7] Coercive nuclear escalation as a means of creating stalemate and remaining in power is one of the only trump cards available to countries fighting the United States.

Some analysts might scoff at the notion that a rational leader would use nuclear weapons against a superpower like the United States. But that retort conflates the logic of peacetime deterrence with the logic of war, and it ignores history. During peacetime, almost any course of action is better than starting a nuclear war against a superpower. But during war—when that superpower's planes are bombing command and leadership sites, and when its tanks are seizing territory—the greatest danger may be to refrain from escalation and let the war run its course. Leaders of weaker states—those unlikely to prevail on the conventional battlefield—face life-and-death pressures to compel a stalemate. And nuclear weapons provide a better means of coercive escalation than virtually any other.

The notion of countries escalating conflict to avoid conventional defeat may sound far-fetched, but it is well grounded in history. When nuclear-armed states face overwhelming conventional threats—or worry about the possibility of catastrophic conventional defeat—they often adopt coercive escalatory doctrines to deter war or stalemate a conflict that erupts. Pakistan openly intends to use nuclear weapons to counter an overwhelming conventional Indian invasion. Russia claims it needs theater nuclear weapons to counter NATO's conventional advantages. Israel expects to win its conventional wars but retains the capability for nuclear escalation to prevent conquest in case its conventional forces suffer a catastrophic defeat.

The discussion of coercive nuclear escalation should sound familiar to Western analysts, as it was NATO's strategy for three decades. From the mid 1960s until the end of the Cold War, NATO planned to deter war, and stalemate it if necessary, through coercive nuclear escalation. NATO understood that—by the mid 1960s—it could no longer win a nuclear war against the Soviet Union, but it still based its national security strategy on coercive escalation because it believed Warsaw Pact conventional forces were overwhelming.

In short, the escalatory dynamics that existed during the Cold War exist today—and they are just as powerful. States still face the same critical

national security problem they faced during the Cold War and throughout history: namely, how to prevent stronger countries from conquering them. The high-stakes poker game of international politics has not ended; the players and the cards dealt have merely changed. Those who were weak during the Cold War are now strong, and another set of militarily "weak" countries—such as North Korea, Iran, Pakistan, and even China and Russia—now clutch or seek nuclear weapons to defend themselves from overwhelming military might, just as NATO once did.

What can the United States do to mitigate the problem of escalation? Ideally, it should avoid wars against nuclear-armed enemies. But that option may not be possible given current US foreign policy and alliances. War may erupt on the Korean Peninsula, ensnaring the United States in a battle against a desperate nuclear-armed foe. In the future, Washington may fight a nuclear-armed Iran over sea lanes in the Persian Gulf. And the United States could someday be dragged into war by a clash between Chinese and Japanese naval forces near disputed islands.

Alternatively, the United States could seek to develop conventional war plans designed to wage limited war without triggering enemy escalation. Development of alternative plans is sensible, but history shows that wars are difficult to contain, and modern conventional warfare is inherently escalatory.

A third option to mitigate these dangers is to retain, and improve, US nuclear and nonnuclear counterforce capabilities. Fielding powerful counterforce weapons may help deter adversary escalation during war—by convincing enemy leaders to choose a "golden parachute" rather than escalation—and would give US leaders better response options if deterrence failed. In particular, the United States should retain and develop nuclear weapons that bring together three key characteristics of counterforce: high accuracy, flexible yield, and prompt delivery.

To be clear, sharpening US counterforce capabilities is not a "solution" to the problem of adversary nuclear weapons. Although, ceteris paribus, it would be better to have excellent counterforce capabilities than to lack them, given enough time and motivation, many countries could greatly increase the survivability of their forces. But given the plausible prospect that the United States will find itself waging war against nuclear-armed states, and given the powerful incentives of US adversaries to brandish or use nuclear weapons, it would be reckless to proceed without a full suite of modern nuclear and nonnuclear counterforce capabilities.

Response to Our Critics

A recent conference panel devoted to our work raised several criticisms, some familiar and others new.[8] Below we summarize the main objections and offer our response.

"The United States is not seeking to neutralize adversary deterrent forces."

Some critics argue that the United States is not seeking strategic primacy. They reject any intent behind the emergence of US nuclear primacy and downplay the effort to neutralize adversary deterrent forces in US military strategy. Instead of the United States bolstering its counterforce capabilities, critics emphasize how it is minimizing the role of nuclear weapons in national security strategy—as only this is consistent with international arms control and nonproliferation efforts aimed at convincing other states to forego strategic weapons, reduce existing arsenals, or cancel modernization programs. The implication is that we have mistakenly imputed sinister motives to US defense programs and planning.

Disavowal of the US pursuit of strategic primacy comes most frequently from those who work inside or outside the government on arms control and nonproliferation policy. Yet, those who work on US regional war plans and counterproliferation policy typically see nothing controversial in our claim that the United States seeks the ability to neutralize adversary strategic weapons. In fact, this effort appears to be official US policy. As a simple Internet search shows, the US government does not hide the wide range of research and planning efforts underway that fall under the rubric of "defeat WMD" or "combatting WMD." And the underlying logic behind those efforts is simple: deterrence may fail, especially during conventional wars, and therefore the United States needs the ability to defend US forces, allies, and the US homeland from enemy WMD using, depending on the circumstances, conventional strikes, missile defenses, special operations, offensive cyber attacks, and in extreme cases nuclear strikes. In short, "defeating WMD" and "seeking strategic primacy" are essentially synonymous: protecting oneself from others' strategic weapons (which sounds reasonable) and neutralizing others' strategic deterrent forces (which sounds more malicious) are simply two phrases describing the same behavior.

Current US grand strategy—which takes an expansive definition of national interests and is committed to a global network of alliances—

means that the United States may be drawn into wars with WMD-armed adversaries. We agree with many US government officials that the ability to neutralize those adversary capabilities in such a conflict may be critical. Others are free to disagree. But all analysts should recognize that current US efforts to neutralize adversaries' deterrent forces are inherently threatening to those states, and few should be surprised when those adversaries treat US pleas for greater arms reductions with considerable skepticism.[9]

"Nuclear weapons are unnecessary; conventional weapons can do the job."

A second criticism is that retaining (or improving) specific US nuclear weapons for the counterforce mission is unnecessary. The idea is that modern delivery systems are now so accurate that even conventional weapons can reliably destroy hardened targets. The key, according to this argument, is simply knowing the location of the target: if you know where it is, you can kill it with conventional weapons; if you do not, even nuclear weapons will not help. The implication is that even though counterforce capabilities are crucial, nuclear weapons are not needed for this mission.

This criticism is wrong, because there is a substantial difference between the expected effectiveness of conventional strikes and the expected effectiveness of nuclear strikes against a range of plausible counterforce targets. Even the most powerful conventional weapons—for example, the GBU-57 "Massive Ordnance Penetrator"—have an explosive power comparable to "only" 3–5 tons of TNT. By comparison, the least-powerful (according to open sources) nuclear weapon in the US arsenal explodes with the equivalent power of roughly 300 tons of TNT.[10] The higher yield of nuclear weapons translates to greater destructive radius and higher likelihood of target destruction.[11] Against ordinary targets, the accuracy and destructive power of conventional weapons is sufficient. Against nuclear targets—if success is defined by the ability to destroy *every* weapon targeted—the much greater destructive radius of nuclear weapons provides a critical margin of error.

Furthermore, in real-world circumstances delivery systems may not achieve their usual levels of accuracy. Jammers that degrade the effectiveness of guidance systems and active defenses that impede aircraft crews or deflect incoming missiles can undermine accuracy. Even mundane things

like bad weather can degrade wartime accuracy. Against hardened targets, conventional weapons must score a direct hit, whereas close is good enough when it comes to nuclear weapons. Lastly, many key counterforce targets are mobile. In those cases, nuclear weapons allow for greater "target location uncertainty" (when the target has moved since being observed) compared to their conventional counterparts.[12]

It is true that modern guidance systems have given conventional weapons far greater counterforce capabilities than ever before, but there is still a sizable gap between what nuclear and conventional weapons can accomplish.

"These arguments undermine US arms control and nonproliferation policy."

Finally, some critics suggest that whatever the truth of our claims, an open discussion of these issues is counterproductive because it undermines US arms control and nonproliferation objectives. They worry that our analysis emboldens defense hawks in other countries (particularly in Russia and China), undermines informal "Track II" diplomacy, and may catalyze foreign nuclear arms modernization. More broadly, by drawing too much attention to the leap in US nuclear capabilities and the utility of nuclear weapons for relatively weaker states, we undermine US efforts to delegitimize and prevent the spread of the nuclear weapons.

This critique is misguided for three reasons. First, other countries understand that the United States wields enormous counterforce capabilities and seeks to enhance them. For example, defense analysts in Russia and China closely watch and frequently comment on changes in US military capability. Moreover, potential US adversaries understand that nuclear weapons are uniquely suitable tools to deter a superior adversary or prevent catastrophic conventional defeat. This is why Pakistan relies on nuclear weapons to deter India; why Russia says it needs theater nuclear weapons; why Israel will not abandon the "Samson Option"; and why North Korea clings at such great expense to its nuclear weapons.

Second, stifling discussion of these issues is detrimental to US national security. For example, some defense analysts seem to have adopted the assumption that no country would deliberately use nuclear weapons against the United States, even though deliberate escalation was US policy when NATO felt it was too weak to defend itself against a Soviet invasion of Europe. If analysts continue to hold a false sense of the irrelevance of nuclear weapons even as US adversaries cling to them to

try to keep the United States at bay—and if analysts convince enough policymakers to do the same—there is a real danger the United States could stumble into a nuclear war. The lack of open discussion about the role of nuclear weapons is compounded by the constraints of security classification, which further limits the ability of policymakers to explain important issues. In short, ignoring these issues—not discussing them—is the real danger.

Finally, unless they recognize the strategic incentives faced by countries like North Korea, Pakistan, Iran, and China, US leaders are susceptible to misattributing malign and aggressive intentions from those countries' efforts to acquire nuclear weapons or modernize delivery systems and arsenals. Unless US leaders understand that other countries rely on nuclear systems to keep more powerful potential adversaries in check—and unless they acknowledge to themselves that the United States is working steadily to neutralize adversary deterrent forces—they are more likely to misperceive enemy efforts to develop a robust deterrent force as a clear sign of hostility and as evidence that the other country is out of step with international standards of behavior. Simply put, the United States may prefer that its adversaries disarm or remain unarmed and thus leave themselves vulnerable to US power, but the fact that they often do not should not be misperceived as a sign of aggression.

Conclusion

The arguments we advance here raise new puzzles for scholars and pressing issues for policymakers. Scholars need to reexamine much of the established wisdom about nuclear deterrence. From Schelling's early works to the present, many scholars have explored nuclear deterrence dynamics by modeling coercion under conditions of mutual vulnerability. Those models suggest that deterrence success depends principally upon resolve rather than capabilities (because the capability of each side to inflict unacceptable damage is an assumption of the model). Schelling's formulation made sense when he developed it—to explore the challenges of Cold War deterrence under conditions of MAD—but the same analytic framework is still used today even though many nuclear dyads are not characterized by nuclear stalemate. The counterforce revolution means that nuclear exchanges may not lead to mutual devastation—one party may suffer far less or even be spared entirely. Analytical models

and conclusions derived from them (for example, about the importance of resolve over capabilities for deterrence success) need to be reexamined and updated.

The challenges facing US policymakers, given the changes in the nuclear landscape, are profound. They must find a way to build sufficient counterforce capabilities to protect the United States and its allies from quite plausible adversary escalatory strategies—all the while avoiding building so much capability that it triggers a Cold War–style arms race with Russia and China. They must direct the US military to develop concepts for waging *conventional* war against nuclear-armed adversaries that would permit the United States to achieve its military objectives yet reduce the incentives for adversary escalation.

Perhaps most fundamentally, US leaders must encourage a more transparent and public debate about the roles and missions of US nuclear forces—and the capabilities that must be retained in the arsenal to execute those missions. Unfortunately, many contemporary nuclear analysts, policy advocates, and policymakers seek to minimize discussion about nuclear weapons and simply assert that nuclear weapons are not particularly useful in the twenty-first century. That is a dangerous approach. The very reason the United States relied on nuclear weapons in the past is the reason potential US adversaries will rely on them now and in the future: nuclear weapons are a powerful deterrent against conventionally superior adversaries. In short, we need to be honest about why states rely on nuclear weapons, as we once did, and the dangers this poses for the United States and its allies.

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Notes

1. See Keir A. Lieber and Daryl G. Press, "The Rise of U.S. Nuclear Primacy," *Foreign Affairs* 85, no. 2 (March/April 2006): 42–54; Lieber and Press, "The End of MAD? The Nuclear Dimension of U.S. Primacy," *International Security* 30, no. 4 (Spring 2006) 7–44; Peter C. W. Flory, Keith Payne, Pavel Podvig, Alexei Arbatov, Lieber, and Press, "Nuclear Exchange: Does Washington Really Have (Or Want) Nuclear Primacy," *Foreign Affairs* 85, no. 5 (September/October 2006): 149–57; Jeffrey S. Lantis, Tom Sauer, James J. Wirtz, Lieber, and Press, "The Short Shadow of U.S. Primacy?" *International Security* 31, no. 3 (Winter 2006/07): 174–93; Lieber and Press, "U.S. Nuclear Primacy and the Future of the Chinese Nuclear Deterrent," *China Security Quarterly*, no. 5 (Winter 2006/07): 66–89; Lieber and Press, "Superiority Complex: Why America's Growing Nuclear Supremacy May Make War with China More Likely," *Atlantic Monthly* 300, no. 1 (July/August 2007) 86–92; Lieber and Press, "The Nukes We Need: Preserving the American Deterrent," *Foreign Affairs* 88, no. 6 (November/December 2009): 39–51; Jan Lodal, James M. Acton, Hans M. Kristensen, Matthew McKinzie, Ivan Oelrich, Lieber, and Press, "Second Strike: Is the U.S. Nuclear Arsenal Outmoded?" *Foreign Affairs* 89, no. 2 (March/April 2010): 145–52; and Lieber and Press, "Obama's Nuclear Upgrade: The Case for Modernizing America's Nukes," *Foreign Affairs* (July 2011, Postscript).

2. We use "revolution in accuracy" as shorthand for a broad set of changes (still underway) that stem from the integration of computers into warfare. Among other things this has led to vastly improved guidance, surveillance, and command and control systems. Each of these improvements has greatly increased the ability to locate targets and precisely deliver munitions.

3. It is essential to differentiate the 1950s—during which the United States possessed a potent disarming capability against the Soviet Union—from the subsequent era of Cold War stalemate. During the 1950s, the US nuclear force far outmatched the meager Soviet arsenal. Until 1956, the Soviet Union had no weapons with the range to reach the United States, and even in the latter parts of the decade Moscow's rudimentary long-range nuclear arsenal was highly vulnerable to a nuclear disarming strike. The United States recognized its huge advantage and planned to fight and win World War III—if it occurred—by launching a massive nuclear disarming strike on the Soviet Union. Ironically, the era that spawned the term "mutual assured destruction (MAD)" was not characterized by the condition of MAD; nuclear stalemate only emerged later. See Lieber and Press, "Nuclear Weapons and International Politics," unpublished book manuscript.

4. See, for example, the fallout models in William Daugherty, Barbara G. Levi, and Frank von Hippel, "The Consequences of 'Limited' Nuclear Attacks on the United States," *International Security* 10, no. 4 (Spring 1986) 3–45; and Levi, von Hippel, and Daugherty, "Civilian Casualties from 'Limited' Nuclear Attacks on the USSR," *International Security* 12, no. 3 (Winter 1987/88): 168–89.

5. The accuracy revolution has greatly increased the probability that a given warhead will destroy a hardened target, but the full range of consequences is much broader. For example, high accuracy allows targeteers to assign many weapons to a given target, greatly increasing the odds of a successful strike. In the past, "many-on-one" targeting was difficult because weapons that missed their targets—but which detonated nearby—might create dust clouds that would shield the target from additional incoming warheads. This problem of "fratricide" has been essentially eliminated by the leap in accuracy. See discussion in Lieber and Press, "End of MAD?" 20–22. Additionally, the revolution in accuracy permits planners to target an enemy's hardened nuclear sites using low-yield weapons, set to detonate as airbursts, thereby vastly reducing fallout and collateral damage. See Lieber and Press, "The Nukes We Need," including the "Technical Appendix." We have subsequently redone the calculations underpinning

our models of hypothetical counterforce strikes using the US Department of Defense VNTK (Vulnerability Number for Thermonuclear Kill) damage assessment system, and the core results are confirmed. (Contact authors for information on those results.)

6. Our analysis turned out to be a highly provocative exercise for some, including many Russian policymakers and analysts. See, for example, "Russian Media See Article on U.S. Nuclear Primacy as Provocation," *OSC Analysis*, 3 April 2006; "Replying to Foreign Affairs Article, Expert Mulls Nuclear Arms Programs," *Krasnaya Zvezda*, 12 April 2006, translated in OSC, Doc ID: CEP20060411330004; Pavel K. Baev, "Moscow Puts PR Spin on its Shrinking Nuclear Arsenal," *Eurasia Daily Monitor*, 17 April 2006; "Moscow Rejects U.S. Authors' Claims of U.S. First-Strike Capability, as Putin Protects Nuclear Weapons Infrastructure," *WMD Insights*, issue 5 (May 2006): 17–21; and "Chinese Media Discusses U.S. Nuclear Superiority," ibid., 15–17.

7. The experience of leaders who recently lost wars to the United States is enlightening. In 1989 the United States conquered Panama and arrested its leader, Manuel Noriega; he has so far spent 23 years in prison. Saddam Hussein lost power, his sons were killed, and he was humiliated and hung in front of cheering enemies. Muammar Qaddafi spent his last days hiding from US-supported rebels, who eventually found him and beat him to death on the side of a road. Even leaders whose countries were never conquered—i.e., they only suffered "limited" military defeats—often paid a high price. The Bosnian Serb leaders Radovan Karadzic and Ratko Mladic are in prison in The Hague, where Serbia's former leader, Slobodon Milosevic, died in detention.

8. "Roundtable on U.S. Nuclear Posture: Assessing the Lieber-Press Series in *Foreign Affairs*," Annual Conference of the International Security Studies Section (ISSS) of the International Studies Association and the International Security and Arms Control Section (ISAC) of the American Political Science Association, in conjunction with the Triangle Institute of Security Studies, 5 October 2012, Chapel Hill, North Carolina.

9. During the 2011 military intervention in Libya, the North Korean government proclaimed that NATO's action "teaches the international community a serious lesson" about the consequences of "nuclear dismantlement"—namely, it meant for Libya that the United States "swallowed it up by force." "Foreign Ministry Spokesman Denounces U.S. Military Attack on Libya," *Korea News Service*, 22 March 2011. The US State Department response—that NATO's action in Libya "has absolutely no connection with [Libya] renouncing their nuclear program or nuclear weapons"—obfuscates the issue because the North Korean claim was that the lack of Libyan nuclear weapons *permitted* (not triggered) NATO's attack. *New York Times*, 24 March 2011. That the North Korean regime's statement was more frank than the US one indicates the deep contradictions in US policy between the lofty proposals for nuclear disarmament and the desire to be able to use military force effectively against adversaries around the globe.

10. According to open sources, the lowest-yield setting of the B61 bomb is 0.3 kilotons, which means the equivalent of 300 tons of TNT. The GBU-57 explodes with roughly 1 percent of the B61's explosive power.

11. As a rule of thumb, destructive radius typically varies as a function of "yield" to the one-third power, so the B61 would have roughly 4.5 times the destructive radius of the most powerful conventional weapon.

12. Low-yield nuclear weapons could be detonated at altitudes that would create a sufficiently large lethal area on the ground against mobile missile systems to account for the target location uncertainty that is often created by lags between "sensor," "shooter," and "munition arrival" without subjecting large areas of enemy territory to destruction and without creating fallout.

Between Integration and Coexistence

US-Chinese Strategies of International Order

Liselotte Odgaard

In March 2011, the United States supported UN Security Council Resolution (UNSCR) 1973 which approved a no-fly zone over Libya, authorizing all necessary measures to protect civilians from attacks by its own government under Chapter VII of the UN Charter. The resolution was passed by a vote of 10 in favor with five abstentions. China abstained from voting on UNSCR 1973. Its abstention was determined by Beijing's preferences for noninterference in the internal affairs of other states and for peaceful means of conflict settlement as well as by its concern not to block measures approved by regional organizations. This incident illustrates that the current international order is characterized by conflicting US and Chinese concepts for international order. The US version is founded in universal liberal values of civil and political rights and market economic structures. These principles have been translated into US post–World War II efforts at constructing an alliance system and economic and political institutions with a view toward integration between member states on the basis of common liberal values. By contrast, the Chinese version of international order is founded on coexistence, promoting policy coordination to maintain international peace and stability and enhance the ability of states to pursue their own national interests. These principles have been translated into efforts at preserving a UN-based international order founded in the Cold War interpretation of the UN charter. This interpretation stresses that absolute sovereignty and noninterference in the internal affairs of other states are fundamental principles that allow states to choose their own model of state-society relations.

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Analyses of US aspirations for world order are often based on considerations of relative military, economic, and political power and the extent to which the United States is able to maintain its current position of preeminence in the international system. For example, John Mearsheimer argued in 2001 that if China's economy continues to grow at a robust pace and it eventually becomes a potential hegemon, its huge population advantage will allow it to build the most powerful army in the region and acquire an impressive nuclear arsenal. This would force the United States to remain a major military power in Northeast Asia to contain China and prevent it from becoming a peer competitor.[1] Stephen Walt argues that the current world order is not determined merely by the condition of unipolarity, but also by the particular geographic location of the United States, the liberal ideals with which it is associated, and the specific historical features and institutional connections inherited from the Cold War. For example, the fact that the United States is the sole great power in the Western Hemisphere while all other major powers are located on the Eurasian landmass means that a coalition against the United States is very unlikely to emerge. Similarly, in addition to the outward thrust of liberal ideology with its built-in universalism, the US effort to exert active global leadership is also an artifact of the particular historical circumstances in which unipolarity emerged. These particular features of the specific unipolar order either strengthen or weaken the impact of unipolarity on state behavior, but they do not alter the causality following from the structural condition.[2] Barry Posen and Andrew Ross contend that the basic premises of international politics determine the various strategic arguments on the propensity for developments unfavorable to the United States to move in ever more unfavorable directions or for developments favorable to the United States to move in ever more favorable directions. These premises are: first, whether states tend to balance against or bandwagon with a neighbor growing in power and ambition; second, whether nuclear weapons make conquest easier or harder; and third, how much influence can the United States exercise due to its share of gross world power resources. Posen and Ross acknowledge the impact of factors such as political will and institutional preferences on states' strategies, but relative power considerations are fundamental to the strategic choices available.[3]

Analyses of Chinese aspirations for world order are based most often on the growing economic power of China since Deng Xiaoping pushed

for aggressive economic reforms beginning in 1978 and the extent to which this challenges US unipolarity. Avery Goldstein analyzes how China's diplomacy of reassurance, partnerships, and a quid pro quo policy toward other states is founded in its attempt to cope with the constraints of US power and the continuing dominance of the United States in the international system.[4] Taylor Fravel substantiates that it is not psychological-cultural factors, such as individual leaders' characteristics or nationalism, which determine China's inclination to use force in territorial disputes but rather the threats facing the regime. China's propensity to use force in a territorial dispute is determined by growing weakness or decline in relative power in the particular dispute, whereas domestic threats to regime security may induce Chinese leaders not to use force in territorial disputes.[5] Aaron Friedberg argues that as a state's capabilities grow, its leaders define their interests more expansively and seek a greater degree of influence in the international system. This logic suggests that China seeks regional hegemony. This aspiration is enhanced by its history of being the center of civilization in East Asia, encouraging it to attempt to reestablish a Sino-centric system, which adds to US-Chinese mistrust and competition. Additional rivalry derives from the fact that the United States is a liberal democracy while China maintains authoritarian rule.[6]

Most analyses of the US and Chinese approaches to world order recognize that both changes in the distribution of power affecting China's growing challenge to US preeminence in the international system and Washington's response to this challenge remain subject to the domestic political characteristics of the two polities. This paper focuses on the link between the domestic political systems of the United States and China and their strategies for positioning themselves in the current world order. It argues that basic ideological principles built into the US and Chinese polities emerge in their respective aspirations for world order, encouraging Washington and Beijing to pursue fundamentally different international objectives by different means. The most pervasive consequence of US aspirations for international integration is its post–World War II efforts to construct an alliance system based not merely on momentarily overlapping interests but also on common values of liberal democracy and human rights. The most obvious consequence of China's aspirations for international coexistence is its efforts since the beginning of the reform and opening period in the late 1970s to convince international

society that its rise to great power status would remain peaceful through engagement in multilateral security institutions all over the world.[7]

In the vacuum left by the Soviet implosion in the post–Cold War era, the liberal integration and coexistence perspectives have been translated into programs of international order. The US proposal for international order is based on the right to use a broad interpretation of international norms to counter grave violations of human and political rights.[8] The argument rests on the notion that serious threats toward the peace and security of individuals spill over to the international realm and threaten international peace and security. US efforts to revise the world order are based on the use of existing provisions of international law to establish new legal precedents to promote fundamental liberal notions of democracy and human rights at the global level. The attractions of this version of international order give the United States sufficient political influence that it can continue to advocate and implement the program at the international level. The viability of the US alliance system in all regions of the world and widespread support for US initiatives on global security issues in the UN Security Council testify to its attractions. In particular, the strength of the US alliance system allows Washington sufficient power to implement its worldview, even at times of crisis when its policies meet with considerable and prolonged criticism, such as when the United States decided to go to war against Iraq in 2003.

China's response has been to present an alternative interpretation of existing UN charter provisions based on its principles of mutual respect for sovereignty and territorial integrity, mutual nonaggression, noninterference in the internal affairs of others, equality and mutual benefit, and peaceful coexistence.[9] The Chinese concept of international order is useful for a would-be great power that does not yet command the military and economic capabilities of a full-blown great power but has already obtained political influence at a great power level. Coexistence requires extensive policy coordination for conflict management and promotes a system of co-management of global security issues between great powers that subscribe to different programs of international order. The Chinese version of international order is also based on existing provisions of international law. At the center are the principles of absolute sovereignty and nonintervention adjusted to demands from the developing world for enhanced regionalization and specialization of global security management. In the absence of an alliance system, Beijing relies predominantly on

UN-based multilateral institutions to spread its worldview internationally. China's growing role in institutions engaged in security governance and the widespread support for Chinese policies on global security issues in the UN Security Council indicate the attraction of its program of international order.

This article discusses the US integration approach and the Chinese coexistence approach to international order. It then examines US and Chinese strategies for implementing their programs and concludes by discussing the implications of these findings for managing US-China relations.

US and Chinese Programs of International Order: Integration vs. Coexistence

The United States took the lead in formulating Western political aspirations for enhancing international integration.[10] Spreading the liberal ideas of human rights, democracy, and a market economy is the long-term means for preserving US dominance. The concept of human rights is based on respect for the autonomy of individuals.[11] A society based on individual autonomy requires the protection of such rights by means of law to ensure the right to life and property as well as the obligation to respect agreements. No entity, not even the state, ranks above the law, and as such, the state apparatus itself is also obliged to respect the law. The liberal idea of democracy requires that people are sovereign and that the will of the people is respected by the right to elect representatives to manage the political authority. In essence, the liberal democratic model implies that adult members of society determine what constitutes the good life and how it is realized. The liberal idea of the market entails that economic growth is the road to prosperity. This economic philosophy implies that the state plays a minor role in the economy, allowing the decisions of market agents to engender the most effective use of resources.

US foreign policy since the Cold War involves globalizing these liberal concepts to ensure the strengthening of international peace, security, and prosperity. Economic globalization is not a fundamentally contested issue since it has been embraced worldwide by and large. The financial and economic crisis of the late 2000s has not given rise to alternatives, but instead suggestions for revisions in market economic structures to make them more robust against abuse. According to some analysts,

governments cannot resist the tides of international trade and finance, but instead compete for the benefits of globalization by accommodating themselves as much as possible to the preferences of market agents to enhance their wealth. In trade, this means opening the economy to foreign competition through commercial exchange and direct investment. In finance, it means creating an environment of sound monetary and fiscal policies to sustain the confidence of creditors and portfolio managers.[12] Economic globalization is a more pervasive feature in terms of trade than finance, but the trend points consistently toward enhanced financial interpenetration. Consequently, at present the principal US concern is to maintain the United States as the economic and military world leader by advancing proposals for economic freedom through open markets.

Liberal democratic and legal globalization has, however, yet to take root. The United States still foresees a mission to build and preserve a community of free and independent nations with governments that answer to their citizens and reflect their own cultures. Thus, the US national security strategy document of January 2012 states that the United States seeks "a just and sustainable international order where the rights and responsibilities of nations and peoples are upheld, especially the fundamental rights of every human being."[13] And because democracies respect their own people and their neighbors, the advance of freedom will lead to peace. The United States believes in the concept of democratic peace, meaning that international peace is best engendered by democracies governed by rule of law. Such states are less likely to go to war against one another because they consider each other legitimate entities behaving in accordance with common rules of state conduct.[14] The US goal of spreading democracy may be traded for stability in the short term, but it remains the long-term goal of US governments. Even the Obama administration, which tends to prioritize stability rather than democratization, fights terrorism and rogue regimes by military means initially to create the preconditions for the spread of liberal democracy in the long run, arguing that peace and international stability are most reliably built on a foundation of freedom defined as democracy.

One core element in Washington's program for international order is the US alliance system. It originates from the Cold War threat of Sino–Soviet expansion and does not merely encompass the customary understanding of alliances as pacts of mutual military assistance. Rather, the

United States developed an extensive system of alignments in which the actual military alliances formed the iron core. Initially, the Soviet Union was surrounded by a virtual power vacuum along its entire periphery, from Scandinavia and the British Isles, along the rimlands of Eurasia, to Japan and Korea. The United States therefore established and maintained a substantial military presence in and close to the chief Eurasian danger areas, projecting US power across the water barriers.[15] After the Cold War, the US alliance, or perhaps more precisely, alignment system has remained in place. One of the core strategic objectives of US national defense is to strengthen security relationships with traditional allies and to develop new international partnerships, working to increase the capabilities of its partners to contend with common challenges. The US overseas military presence operates in and from four forward regions: Europe, Northeast Asia, the East Asian littoral, and the Middle East–Southwest Asia. The United States has embarked on a comprehensive realignment of its global defense posture to enable US forces to undertake military operations worldwide, reflecting the global nature of its interests. However, the enhanced prioritization of the Asia-Pacific in the US military force posture testifies to the fact that this region is of primary significance to US interests. As such, it is pivotal for the United States to assure partners, dissuade military competition, deter aggression and coercion, and be able to take prompt military action in this region. The continued US ability to perform in these capacities aids Washington in promoting its program of international order.

China's promoting coexistence as a basis of world order has developed into a steadily more effective foreign policy doctrine for advocating international political pluralism as an alternative to the liberal integrationist US pursuit. Coexistence allows for a plurality of domestic regimes to coordinate their national interests without jeopardizing international peace and stability. This has proven most effective in allowing China to focus on its domestic development toward being a power based on independent ideological principles adapted to Chinese circumstances and interests. Chairman Mao Zedong, who led the People's Republic of China (PRC) from its establishment in 1949 until his death in 1976, based his concept of coexistence on Lenin's belief that the capitalist and communist systems could exist side by side if the Soviet state could exploit the differences between them. Unlike Lenin, however, Mao was engaged in intermittent civil war over a period of more than 20 years before

seizing power. Consequently, Mao's doctrines and precepts combine prudence with revolutionary enthusiasm as a result of having to adapt to the conditions that confronted him on the ground.

By August 1946, Mao set down four theses on the international state of play, which, with some modification, continued to guide China's national security strategy throughout his rule. First, an all-out war between the United States and the Soviet Union in the immediate future between the socialist and imperialist camps would take place in "the vast zone" separating the two. Second, this zone included many capitalist, colonial, and semicolonial countries in Europe, Asia, and Africa. This principle was the origin of the concept of the "intermediate zone." Third, the atomic bomb was a paper tiger because the outcome of war was decided by the people, not by one or two new types of weapons. Fourth, all reactionaries, including US reactionaries, were paper tigers. Though these reactionaries may have been terrifying in appearance, in reality they were not so powerful from a long-term point of view. This first independent assessment by Mao of the global situation confronting the international communist movement reflected his strategy during the Chinese revolution.[16] Mao took the view that China must learn how to wage diplomatic covert struggles against the imperialists, eyeing the possibility of adding developed countries like France and Japan as a top tier to the intermediate zone of countries in Asia, Africa, and Latin America, and throwing them all into the balance against the encircling great powers, the United States and the Soviet Union, that were colluding and competing for hegemony over them. In so doing, China hoped to establish a third force in the international system that could challenge the dominance of the Eastern and Western blocs.

It was on this basis that Premier Zhou Enlai launched peaceful coexistence in his address to the developing world at the 1953 summit of the Non-Aligned Movement.[17] Although the 1966 Cultural Revolution—aimed at removing all liberal, bourgeois elements from the Chinese Communist Party and Chinese society—put a temporary halt to the peaceful coexistence effort, it resumed in 1969. On 1 January 1970, China restored peaceful coexistence as the primary theme of its foreign policy by officially declaring its willingness to establish or improve diplomatic relations with all countries, regardless of their social systems, on the basis of the Five Principles of Peaceful Coexistence. China received a large number of foreign delegations, expressed renewed interest in joining the United

Nations, signed aid agreements, and established diplomatic relations.[18] China's resurrection of peaceful coexistence improved its foreign relations so dramatically during 1970 that it could claim with justification that it had friends all over the world. In November 1970, the UN voted in favor of the PRC's membership, and in 1971 it replaced Taiwan as the fifth permanent, veto-wielding member of the UN Security Council.[19] In 1982, the Five Principles of Peaceful Coexistence were written into the Chinese constitution. This act confirmed that the principles express the Chinese concept of right and wrong state conduct.[20]

China's foreign policy profile during the Cold War points to the existence of an alternative worldview to that of the United States and the Soviet Union. China presented itself as a developing state aiming for peaceful coexistence, a new economic world order, and the defiance of alliances. In contrast to the great powers, China did not occupy a position that enabled it to export its development model to other countries to any significant extent. China demanded respect from other powers and sought to play a significant role in international affairs, even when it had little money to spend. For example, Beijing undertook the prestige project of building the Tanzania-Zambia railway. But in contrast to India, which intervened to exercise sovereignty over the Portuguese colony of Goa, China left the Portuguese colony of Macao alone. China displayed a strong streak of pragmatism at the time, which was largely determined by the failure of the 1960s development project known as the Great Leap Forward.[21] For the most part, the alternative political framework remained a rhetorical device designed to highlight China's foreign policy independence, because Beijing was insufficiently influential to have an impact on the fundamental principles of international order. China's principal gain was the considerable strategic, economic, and political benefits it was able to extract through its foreign policy. However, it did not fundamentally contribute to, or alter, international order.[22]

China's current strategy of peaceful coexistence is designed to maximize its national interests from the uneasy position of a weak power that may wield political influence at the great power level, but as of yet, without commanding the economic and military power of the United States. Its international political influence stems from the fact that it provides secondary and small powers with an appealing complementary model of world order which attracts support from developing countries seeking protection against a liberal integrationist West. In effect, China has created

a parallel structure to the US alliance-based version of international order offering security guarantees. This parallel structure is based in regional and global organizations under the UN system, offering influence over the principles that govern international behavior. For economically and militarily weak developing countries, this is an appealing alternative that limits US preeminence and gives China international political influence.

China is attempting to revise the current international order by focusing on negotiation, compromise, and policy coordination in conflict management efforts; by increasing the role of regional and functional institutions in security management in the UN system; and by preserving the status of absolute sovereignty and noninterference in the internal affairs of other states. China's understanding of peaceful coexistence does not entail extensive cooperation on the basis of common values. Instead, Beijing advocates that national interests should be pursued on the basis of a combination of individual foreign policy choices and extensive international dialogue to prevent the use of force between states with conflicting national interests. This form of policy coordination is a means of allowing states to concentrate on fulfilling their individual goals rather than an end in itself.

Coexistence is potentially at odds with national identity issues linked to demands for the restoration of China's so-called motherland.[23] For example, in the South China Sea, Beijing maintains an enigmatic claim to the entire area and regularly exercises its alleged right to exploit resources and refuse passage to foreign vessels.[24] On another note, uncontrolled Chinese migration into the Russian Far East creates the perception that China is effectively colonizing Russian territory, slowly but surely undermining existing border arrangements by means of immigration.[25] In its relations with India, the low-intensity skirmishes and China's demands for sovereignty over Ta Wang, birthplace of the sixth Dalai Lama, along the eastern part of the Chinese-Indian border raise doubts about China's willingness to continue to prioritize peace and stability with India.[26]

China reconciles the apparent dilemma between coexistence and national identity issues by seeing coexistence as a means to an end—the restoration of Chinese supremacy—rather than an end in itself. The principles of coexistence are designed for a world consisting of states, and as such, they offer China protection from foreign threats while it builds up economic and military capabilities necessary to revise the setup

of the international realm to suit its national unity goals. Consequently, the principles are not intended as guiding tenets of international relations on a permanent basis. Instead, they are to serve in the interim until such time as China has been restored to its former historical greatness as a full-blown great power on par with the United States.

The essential differences between the US and Chinese approaches to international order are summarized in the following table:

Comparison of US and Chinese programs of international order

Factors	United States	China
International objective	Integration	Coexistence
Institutional basis	Alliance system	UN system
Membership basis	Liberal states (common values)	Developing countries (common interests)
International relations dynamics	Cooperation	Coordination

US and Chinese Strategies for Implementing International Order

Programs of international order would ordinarily address issues of how state survival is secured under conditions of international anarchy. How can states continue to go about pursuing their interests without destroying the condition of international anarchy which forms the basis of their political authority? Preservation of the state system requires a framework for international order that regulates the use of force, the control of persons and territory, and agreements with other political entities.[27] The first requirement, principles on the use of force, is designed to ensure that peace is the normal condition in an international system in which states enjoy a monopoly on the issue of who holds political authority and as such forms part of the diplomatic community. The second requirement, diplomacy, concerns the power, will, and intellectual and moral impetus to shape the entire international system in accordance with one's own values.[28] Henry Kissinger points out that the elusive aspect of intellectual and moral impetus that is nowadays often called ideational power is at least as important as the more substantial elements when we address issues of diplomacy and great power status. Third, influence on international order requires legitimacy in the eyes of other international actors. International legitimacy depends on the collectivity of states' assessment of the righteousness of the designs on international order suggested by a

great power. Influence is a function not of a country's stature only, but of its connections.[29] Goodwill with other states and status as a worthy partner is the basis for a state's successful interaction with other states. Reputation is an asset that states cannot afford to take lightly.[30] The fact that states routinely look to the collectivity of states for approval indicates that they invariably attach importance to acceptance of their foreign policy decisions from the diplomatic community.[31] In other words, allies and partners are a necessity for a state to exercise influence on the rules of the game. Even the most powerful state needs to convince its partners that its policies are responsible and feasible to avoid the eclipse of common interests due to internal differences.[32] The principles pertaining to a particular order will often be nested in actual state behavior rather than in written agreements, since decades or even centuries may pass before a principle has become accepted by all states as a legal rule. The remainder of this section addresses US and Chinese strategies on the use of force, diplomacy, and legitimacy as reflected in their international state practice.

The US Program of International Order

US policies on the use of force, one of the fundamental elements of international order, are based on deterrence through the use of alliances. US deterrence involves a wide range of policy initiatives and options, such as its policy of strategic ambiguity with regard to Taiwan, the permanent US military presence on the Korean peninsula, and its nuclear deterrent. Washington's post–Cold War approach to deterrence, especially under the 2009 Obama administration, involves the strengthening of existing alliances and the building of strategic partnerships, allowing the United States to reorganize its force posture to increase its flexibility and its rapid power projection capabilities. To implement these plans, the United States will focus on smaller conventional ground forces but increase capabilities in intelligence, surveillance, and reconnaissance (ISR), counterterrorism, countering weapons of mass destruction (WMD), and operating in environments of attempted access denial.[33] In addition, trilateral and bilateral security dialogues with core allies such as Japan, South Korea, and Australia have become more significant. The concepts of pivoting and rebalancing launched by the Obama administration testify to the US concern to demonstrate its enhanced focus on key Asian allies including Japan, South Korea, Australia, the Philippines,

and Thailand—as well as key partners such as India, Singapore, and Indonesia—and its desire to demonstrate the superior security benefits from cooperation with the United States. Washington also encourages cooperation with Beijing to establish common approaches to security challenges, recognizing that the US-China relationship is among the most important and also the most challenging in the world.[34] At the same time, the United States stresses that it is a global power which will continue to invest in critical partnerships and alliances, such as NATO, and stay vigilant in regions like the Middle East.[35]

However, the US alliance system is not only a mechanism for deterrence; it also forms the basis for Washington's diplomacy beyond concerns about traditional security threats and the US force structure. The president's visit to Australia celebrating the 60th year of the US-Australian alliance signifies the security infrastructure that allows for the free flow of trade and commerce throughout the region. The US security posture in the Asia-Pacific will continue to be a top priority, because the alliance system is key to continued US prosperity.[36] Therefore, updating the alliance system is accompanied by US steps to strengthen economic cooperation with core allies. Examples include the US-Korea free trade agreement which entered into force in March 2012 and US support for Japanese efforts to become a member of the Trans-Pacific Partnership, which is a multilateral free trade agreement that aims to further liberalize the Asia-Pacific economies. These recent efforts continue the trend of post–World War II efforts at integrating security and economic concerns by a unified diplomatic effort to promote cooperation between states on the basis of common liberal economic and political values.

Multilateral security institutions with a membership basis outside of the US alliance system are secondary to US efforts at integrating liberal states. The involvement of global and regional organizations such as the UN and ASEAN (Association of Southeast Asian Nations) is ad hoc and conditional, depending on their contributions to US security priorities. If their contribution does not exceed the cost, the United States prefers to rely on its alliance system.[37] Washington is concerned about the emergence of pan-Asian regional structures that may tackle security problems with China as the central actor rather than the United States. It is anxious that new "Asia-only" institutions might duplicate the work of existing trans-Pacific structures, because US interests would be greatly challenged by evolution of the region into an exclusionary bloc.[38] Examples

that fall within this category are the Shanghai Cooperation Organization (SCO), which includes Russia, China, Uzbekistan, Kazakhstan, Tajikistan, and Kyrgyzstan, and the ASEAN+3, which includes Southeast Asia, China, Japan, and South Korea. Such concerns explain US efforts to strengthen and expand its alliance system in the Asia-Pacific.

US policies on legitimacy are founded in the logic that the spread of liberal democracy across the world will serve to sustain the popularity of the United States as the principal power representing this model of state-society relations. The 2012 US national security strategy is formulated on the belief that "regime changes, as well as tensions within and among states under pressure to reform, introduce uncertainty for the future. But they also may result in governments that, over the long term, are more responsive to the legitimate aspirations of their people, and are more stable and reliable partners of the United States."[39] Again, the alliance system forms the basis for creating the preconditions for the spread of liberal democracy. Efforts such as the war on terrorism, which is based principally on military initiatives of the United States and core allies, and the Trans-Pacific Partnership, which is mainly founded in trade agreements between liberal democratic states, are seen as preconditions of liberal political development. These efforts are seen to contribute to stability and prosperity on the basis of liberal market economic principles and liberal rule of law regimes that pave the way for liberal political systems. The near universal embrace of market economic structures, save for a few regimes such as North Korea, is considered an encouraging step toward subsequent transformations to more liberal political structures that include individual rights which liberals argue further enhance stability and prosperity. Developments such as Myanmar's preliminary legal and political reforms in 2012 indicate that political liberalism is gaining ground.[40]

US efforts to maintain its alliance system as the foundation for military, economic, and political integration on the basis of common liberal values appear to be relatively successful, judging from the fact that the majority of the world's states continue to rely on US security guarantees. The United States has formal pacts of mutual military assistance with states such as Japan, the UK, Canada, Denmark, Senegal, and numerous others around the world. It also has defense responsibilities for the Pacific islands of Guam, American Samoa, and the Commonwealth of the Northern Marianas, which are US territories, and the Marshall Islands,

Palau, and Micronesia that have signed compacts of free association. Some states which do not have a formal alliance with the United States are close, de facto strategic partners. For example, Singapore hosts a contingency of the US Pacific Command. Taiwan is not a state de jure, but considerable US military assistance and Taipei's participation in the theatre missile defense program indicate that it occupies a central position in the US alliance system. Outside of this core, the United States has strategic partnerships with states such as Afghanistan and India. Russia is a strategic partner of the NATO alliance, and states such as Indonesia, Malaysia, and Mexico have military cooperation agreements with the United States. Washington uses its global alliance system to assure states that they form part of the US security umbrella, giving them some measure of protection against aggression.

The Chinese Program of International Order

Chinese policies on the use of force are based on a Cold War interpretation of the UN system, advocating a fundamental role for the principles of absolute sovereignty and noninterference in the internal affairs of other states. China argues that force should not be used for conflict resolution and that interference in the internal affairs of another state is only justified to prevent a threat to international peace and security or if the target government approves of interference. According to Beijing, its military modernization program is intended only for access denial, stressing China's right to be left alone to pursue its national interests.[41] China's record of not using force outside its borders lends some merit to this claim, if for no other reason than, as the weaker power without an alliance system, China simply cannot afford to project military power beyond its borders in ways that may produce military conflict.

China's approach to using force within the UN system contrasts with US and European efforts to do so in the event of alleged serious breaches of civil and political rights covenants or the nonproliferation treaty, such as genocide or the acquisition by nonnuclear powers of material used to produce WMD. China has used its permanent membership on the UN Security Council to block using force for these reasons and to reduce punitive measures taken in the event of proof of noncompliance with the UN system. For example, it supports Iran's right to peaceful uses of nuclear energy on the grounds that nonnuclear powers are entitled to establish civil nuclear programs under the Non-Proliferation Treaty.

In November 2011, the International Atomic Energy Agency (IAEA) published a report suggesting that Iran is engaged in nuclear weapons–related development without saying anything about its prospects for developing a nuclear weapon or who might be responsible for these activities.[42] On these grounds, China refuses to tighten sanctions against Iran in contrast to the United States which, recognizing that China will block a punitive UNSC resolution, tightened sanctions unilaterally on 20 November 2011. The IAEA board of governors resolution, approved by both the United States and China on 17 November 2011, expressed continued support for a diplomatic solution and called on Iran to engage in talks aimed at restoring international confidence in the exclusively peaceful nature of its nuclear program.[43]

Another example is China's response to UNSC Resolution 1973 which, acting under the peacemaking provisions of Chapter VII, approved a no-fly zone over Libya. The resolution authorized all necessary measures to protect civilians by a vote of 10 in favor with five abstentions. China's abstention was determined by its preference for peaceful means of conflict settlement and its concern not to block measures approved by the African Union, the Organization of the Islamic Conference, and the League of Arab States.[44] China has been critical of NATO's very wide interpretation of the resolution. This interpretation has made China reluctant to accept similar UNSC resolutions, as demonstrated by its veto of a proposed resolution endorsing an Arab League peace plan which called for Syrian president Assad to resign.[45] Beijing was not willing to approve what it saw as a violation of Syrian sovereignty. A proposal merely supported by the Arab League but not by other regional organizations was not considered representative but seen instead as an expression of Western demands for order that do not carry any weight in Beijing.

Outside the UN system, China also adopts a policy of nonuse of force to manage conflicts, demonstrating its concern to maintain international peace and stability by peaceful means and to uphold the Cold War interpretation of UN principles of absolute sovereignty and nonintervention. For example, China has settled most of the 17 territorial disputes it was party to at the end of the Cold War. In those remaining, it has engaged in dialogue and negotiation with a view to avoid the use of force. Beijing's approach involves trying to forge a compromise to maintain peace and stability, allowing the parties to focus on the pursuit of their national interests. Instead of insisting on rights of effective control, China has

entered into dialogue with all disputing parties after the Cold War, focusing on the political and practical aspects of border disputes rather than the legal principles. At a minimum, this approach has contributed to a rapprochement between the contending states. Despite continued low-intensity conflict, bilateral talks from 2003 to 2007 have arguably kept a lid on the Chinese-Indian border dispute.[46] The approach has sometimes contributed to agreement on shelving sovereignty issues to allow the parties to pursue their national interests, as in the South China Sea disputes involving China, Taiwan, and several Southeast Asian states which agreed on this formula for using the sea in 2002.[47] The approach even resulted in a permanent settlement in the Chinese-Russian border dispute.[48] Even in territorial and maritime disputes that have proved difficult to resolve, China has been reasonably successful in avoiding zero-sum contests over relative gains and achieved peace and stability along its borders.

The UN system forms the basis for China's bilateral and multilateral diplomacy. After the Cold War, China put a high premium on normalizing diplomatic relations with other states to maintain international peace and stability with a view toward allowing Beijing to pursue its national interests. In the 1990s, China began experimenting with multilateral security dialogue and institutionalization of security cooperation in Southeast and Central Asia. International cooperation beyond the stage of dialogue requires a willingness to compromise, such as shelving the sovereignty question in the South China Sea in return for the opportunity to develop economic and security ties with the ASEAN. The main payoff for this new policy was that China established links with US allies and strategic partners, making inroads into the US alliance system by offering alternative benefits. In a sense, China overtook US post–World War II multilateralism, presumably out of necessity because its economic and military capabilities remain far too modest to pursue a policy of imposition. In a very few years, China's diplomacy has helped obtain numerous strategic partners across the world's regions.

In diplomatic relations, China tends to emphasize areas of mutual benefit rather than areas of conflict, which can be shelved to proceed with dialogue where the element of common interest dominates. For example, in its relations with Russia, China focuses on their mutual interest in preserving the Cold War interpretation of the UN system and mutual trade relations rather than issues of contention, such as Chinese

immigration into Russia's Far East and Russia's 2008 military intervention in Georgia.[49] Similarly, despite the South China Sea disputes of overlapping maritime claims between China and several Southeast Asian states, China's relations with the ASEAN focus on trade and investment relations. Those relations are founded in China's accession to the ASEAN's Treaty of Amity and Cooperation in Southeast Asia.[50] This accession implies China's willingness to adapt to programs for preserving international peace and stability set up by other states, provided these are based on the provisions for international relations under the UN system. Similarly, China addresses fora such as the African Union (AU), the Organization of the Islamic Conference, and the IAEA as entities recognized by the UN system. As such, it sees them as entities that should play a determining role in establishing the existence of threats and what is to be done about these threats within their regional and functional area of specialization. For example, in the run up to the UNSC vote which established a joint UN-AU hybrid force, China's special envoy to Darfur, Liu Guijin, commented that "it is not China's Darfur. It is first Sudan's Darfur and then Africa's Darfur."[51]

The Shanghai Cooperation Organization in Central Asia arguably demonstrates the kind of coexistent world order envisaged by China. The SCO was created at Beijing's initiative to exercise some control over the growing great power competition for strategic and economic influence in Central Asia.[52] The SCO brings together China, Russia, Kazakhstan, Uzbekistan, Kyrgyzstan, and Tajikistan in an attempt to establish policy coordination on economic and military issues. This coordination is largely limited to the annual summit, joint cultural events, and annual joint military exercises on a moderate scale. The SCO's principal usefulness is as a flexible platform for policy coordination between its members as well as its observers: India, Iran, Pakistan, Mongolia and Afghanistan. Policy coordination is not an instrument for enhanced multilateral cooperation. Instead, it keeps a lid on potential international conflicts and facilitates bilateral agreements.

At the practical level of implementation, Chinese-style peaceful coexistence involves policy coordination on conflict resolution and prioritizing nonmilitary means of persuasion and negotiation rather than coercion and punishment. It is based on solidarity with other governments through top-down cooperation, and it involves strengthening the old UN system and its emphasis on absolute sovereignty. In addition,

China appears to promote the regionalization and specialization of authority to assess and act upon alleged threats to regional peace and security. This set of coexistence principles enjoys widespread legitimacy in the developing world and justifies China's status as a maker rather than a taker of international order. An indication of the support for China's program of world order is that approximately half of the states in the UN Security Council favor the Chinese principles of mutual respect for sovereignty and territorial integrity, nonaggression, equality and mutual benefit, and noninterference in the internal affairs of other states in the cases of Iran's nuclear program, Sudan's Darfur conflict, and Myanmar's conflict between the regime and the opposition.[53]

Reservations about China's program of world order emerge due to the secondary nationalist theme in its security strategy.[54] This theme is less pronounced in China's multilateral diplomacy, which involves large elements of international coordination, and more pronounced in its territorial and maritime border disputes where coordination with multiple actors is less important. The nationalist theme comes to the fore in situations where China is under pressure to compromise on issues of national identity and its definition of the so-called Chinese motherland giving rise to the use of coercive means. This secondary nationalist theme calls into question Beijing's genuine commitment to its coexistence program of international order, indicating that national identity issues linked to demands for the restoration of the Chinese motherland are its ultimate objective. These identity issues hamper Beijing's efforts to win a stable group of loyal partners comparable to Washington's alliance system.

Comparing US and Chinese Implementation Strategies

The US and Chinese programs of international order are based on different dynamics. As a full-blown global great power, the United States bases its program on liberal values of integration requiring extensive cooperation. By contrast, China's uneasy position in between a great power and a secondary power gives rise to a program of international order based on mutual interests in policy coordination on issues of great power conflict. The two programs are not functioning in different geographical hemispheres. Instead, they intersect on numerous issues across economic, military, and political sectors of the international system in an uncoordinated fashion. This dynamic gives rise to a type of in-between international system that is not necessarily more prone to the outbreak

of war than the Cold War system between the Soviet Union and the United States. However, it is an unpredictable and expensive system to operate in because permanent conflict resolution mechanisms cannot be devised in such an environment. Instead, security threats are addressed by means of ad hoc frameworks of conflict management. The membership and rules of these frameworks are defined on a trial-and-error basis.

This in-between system leaves great room for secondary powers such as Russia, India, Brazil, and South Africa to exercise influence, because both Washington and Beijing will vie for their attention. Russia considers its national interests to be best served by aligning with China on the majority of global security issues, but Moscow keeps its options open, maintaining a high-level strategic dialogue with NATO. Similarly, Washington has recognized de facto that India is a responsible nuclear weapons state despite the fact that New Delhi is not a signatory to the Non-Proliferation Treaty. Despite closer relations with the United States to counter growing Chinese power, India also keeps its options open, maintaining a strategic dialogue with China through measures such as Indian observer status in the SCO and endorsement of China's observer status in the South Asian Association for Regional Cooperation. Secondary powers do not have sufficient influence to pursue a program of international order that protects the common interests of states, but they have sufficient influence to maximize their own national interests by siding with both the United States and China on different issue areas without choosing sides.[55]

Implications for Managing the US-China Relationship

The US integrationist and the Chinese coexistence programs of international order give rise to an international system characterized by a proliferation of loose strategic partnerships and ad hoc collaboration, the absence of permanent conflict resolution mechanisms, and competing programs for maintaining international peace and stability. These characteristics produce a highly unpredictable international environment requiring swift policy adjustments and considerable freedom of action. What are the implications for Washington's ability to manage the US-China relationship?

The principal US concern is to maintain world economic leadership by advancing proposals for financial liberalization through open mar-

kets. China has not handed over control of its economy to corporations or other nonstate actors. Even if it does not have the hyperglobalist inclination of the United States to break down state barriers by means of growing interdependence in trade and finance, China has fundamentally embraced the international market economic structures. Due to the innovation and research-and-development investments of the US economy, Washington remains the principal beneficiary of this development. Most obviously, China's market economy development is a vast improvement compared with the East-West partitioned economic order of the Cold War.

Moreover, the United States has an unprecedented chance to promote its domestic political system. The post–Cold War Iraq and Afghanistan interventions have brought out the difficulties of undertaking overseas nation-building projects in states with weak sociopolitical structures. By contrast, the power of example is a source of strength in an international system without great power agreement on common rules of the game and with competition for strategic partners. And in this game, the liberal political model of the United States has attractions because it clearly defines its long-term objectives. US great power status is by and large a known quantity, not only because the United States is the incumbent superpower, but also because it is defined by liberal values that have been translated into a model for economic and political state-society relations—the alliance system—that also defines its overseas engagements. The United States may not always live up to the liberal standard by which its performance is measured, but the international community knows which standard to use when assessing Washington's policies. By contrast, China is in a transition period from communism to a state-society model that is as yet unknown to the Chinese leaders or their international audience.

The Chinese coexistence model is an interest-based one designed to protect China against overseas interference and maintain international peace and stability without obligations for extensive cooperation. One reason for these modest international ambitions is that China does not have a domestic state-society model which complements its model of international order. The Confucian notion of harmonious society remains a rhetorical device without much practical applicability. The idea has not been translated into essential political structures, such as feedback mechanisms from society to government, or into processes such

as the use of elections to facilitate political succession. The absence of a stable political model to complement the market economy transition of recent decades means that China relies on continued economic growth and improved standards of living for regime legitimacy. The lack of a state-society model also implies that Beijing relies on random feedback mechanisms of protest and complaint and on coercion for dealing with societal dissatisfaction. Another implication is that one does not know by which value standard to measure China's performance. Hence, Beijing's objectives as a prospective great power remain unknown beyond those of maintaining national unity and restoring the Chinese motherland. This is not an attractive great power in the eyes of the international community. A majority of states will therefore continue to rely on US security guarantees and support continued US preeminence in the international system.

As of late, Washington has reasserted itself as an Asia-Pacific power intent on paying attention to the security concerns of allies by updating security commitments to states such as Japan and South Korea, by stepping up military and economic support for states such as the Philippines and India that enables them to counter growing Chinese assertiveness, by reengaging with multilateral institutions such as the ASEAN and the UN Security Council, and by promoting free trade agreements such as the South Korean–US Free Trade Agreement. Not surprisingly, China expresses a strong critique of this development. However, US clarification of its priorities and policies and its limits of acceptance with respect to China's behavior in places such as the UN Security Council and the South China Sea reassures the international community of Washington's continued commitment to the responsibilities toward other countries that comes with global great power status. This reassurance will continue to keep Chinese challenges to US preeminence at a manageable level. SSQ

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The New Media and the Rise of Exhortatory Terrorism

George Michael

The world is becoming a less hospitable place for large, clandestine terrorist organizations. The collapse of the Soviet Union led to the "unipolar" era dominated by a sole superpower, the United States. After the Cold War, terrorism initially went into steep decline, in large part because several leading terrorist groups lost material support from communist states in the East and their client states such as Cuba.[1] In an era of globalization dominated by the United States, other countries presumably would have more to gain by accommodation with the West than by confrontation. More and more governments are coordinating their counterterrorism efforts with the United States as they seek to dismantle terrorist organizations and deny them funding and resources. Obviously, this trend accelerated after the attacks of 9/11.[2] Moreover, new surveillance technology enables better monitoring of dissident groups and potential terrorists. Consequently, larger groups cannot operate effectively because they are more vulnerable to infiltration and disruption.

In adapting to these strategic realities, insurgent and terrorist groups are increasingly using the so-called new media to exhort sympathizers and fellow-travelers to commit acts of resistance on their own initiative. This article examines the relationship between the new media and contemporary terrorism, first by explaining the development of new media. Next, it explores various extremist and terrorist subcultures—the extreme right, the far left, and radical Islam—that use the new media to pursue their strategic objectives. The final section discusses implications of the intersection between the new media and terrorism and suggests policies to meet this challenge.

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The Internet and the New Media

The Internet is at the center of an ongoing revolution in communications and networking which enables new forms of organization and greater dissemination of information. Prior to the Internet, physical proximity usually determined one's associates. Now people are linked across great distances and national borders. Over two billion people worldwide now have Internet access, and when they organize, they tend to do so by affinity.[3] Communities of affinity forged through the Internet build a sense of collective identity, resulting in "virtual communities," not unlike the "imagined communities" Benedict Anderson wrote about in his study on nationalism.[4]

The new media developed concomitant with Web 2.0, which arose after the dot-com bubble burst in the year 2000. Out of the rubble, a crop of new web-based companies and services emerged that offered interactivity and "user-generated content." This development enabled greater creative participation from users and facilitated the formation of online communities. Web 2.0 encompasses an array of interactive communications facilitated by a rapidly expanding set of platforms—including blogs, web forums, Facebook, Twitter, and YouTube—that are linked together in innovative ways. These platforms enable so-called many-to-many communications and the sharing of user-generated content.[5] The openness of the new media democratized the creation, publication, distribution, and consumption of information. The new media consist primarily of the Internet but also include innovations such as smartphones and text messaging. The rise of the new media ushered in a new era of communications which allowed much greater and broader participation from users, not only in the spheres of commerce and social networking, but terrorism and insurgency as well.[6]

The Internet offers several advantages for dissident movements, such as greater interconnectivity and the power to communicate and network with far more people and more quickly than ever before. Furthermore, encryption technologies enable covert communication and anonymity. Access is inexpensive, which increases availability. The ubiquity of the Internet allows small groups to maintain a global presence that can rival larger entities. Because it is difficult to regulate, the Internet enables political dissidents to circumvent restrictions on speech and avoid censorship.[7] The growth of bandwidth, combined with the development of new software, permits users to disseminate complex information.[8] This

communications revolution has empowered individuals to move money, products, information, and ideas across borders—activities previously restricted primarily to governments and big corporations.[9] Of course, these same capabilities allow terrorists to disseminate propaganda, communicate, raise money, and plan and coordinate operations.

Prior to the Internet, terrorist recruitment depended on face-to-face interaction, which greatly limited the scope of participation. The Internet has given rise to loose, decentralized networks of terrorists that can all work toward a common goal.[10] Several terrorist and extremist subcultures employ the new media to pursue their revolutionary goals: specifically, the extreme right, the far left, and radical Islamists.

The Extreme Right

Since the early 1980s, the American extreme right has evolved from a movement characterized by patriotism to one which increasingly exhibits a revolutionary outlook. This can be explained in large part by the various social trends that over the past several decades have significantly changed the texture of the country. For those in the extreme right, the United States is not the same country they once knew. According to Census Bureau projections, by the year 2050, whites will no longer comprise a majority of the US population.[11] Such a development is viewed in near apocalyptic terms in the racialist segment of the American extreme right. Many in the movement consider the "damage" done too great to be repaired by conventional methods. Only radical solutions, it seems, can save the nation and race, which the movement believes are imperiled by a Jewish conspiracy that has been reified in the acronym ZOG, or "Zionist Occupation Government." During the 1990s, the extreme right appeared to gain ground as a social movement. Trends in technology, such as the Internet, enabled the movement to reach out to a potentially larger audience than in the past.

The American extreme right's foray into cyberspace came in the mid 1980s, when three electronic bulletin boards were launched—Aryan Nations Liberty Net, White Aryan Resistance, and Liberty Bell.[12] For the most part, these bulletin boards were unsophisticated and did not reach many people. That changed, however, on 27 March 1995, when Don Black, a close associate of Ku Klux Klan leader David Duke, launched Stormfront.[13] Over the years, Stormfront has come to host many extreme right websites and serves as an important entry point for

those curious web surfers who seek them out. As of early 2009, board membership exceeded 159,000, and more than 5.5 million posts had been submitted on the site in response to at least 450,000 threads.[14]

The increasing popularity of the Internet dovetailed with the notion of leaderless resistance, which began to gain currency in the extreme right subculture in the 1980s. In 1983, Louis Beam, a long-standing extreme right activist, first released the seminal essay, "Leaderless Resistance," in which he argued that the traditional hierarchical organizational structure was untenable under current conditions. This essay was disseminated through computer networks which Beam pioneered in exploiting during the 1980s. According to Beam, the US government was too powerful and would not permit any potentially serious opposition organizations to challenge its authority. Beam reasoned that in a technologically advanced society such as contemporary America, the government could easily penetrate the structure of a dissident group and reveal its chain of command. As a strategic alternative, he invoked the "phantom cell" organization model. Applying this model, Beam argued that it becomes the responsibility of the individual to acquire the necessary skills and information to carry out what is to be done. Members take action when and where they see fit.[15]

Toward that end, Dr. William L. Pierce (1933–2002), founder and leader of the National Alliance, effectively used the Internet to propagandize. Arguably the most influential theoretician of revolution that the American extreme right ever produced, he was best known as author of *The Turner Diaries*—a fictional story of an apocalyptic race war that convulses America. The novel gained him considerable notoriety and was even thought to have inspired several episodes of right-wing violence, including the campaigns of the Order and the Aryan Republican Army, the Oklahoma City bombing, and the London bombing spree of David Copeland.[16] Perhaps the most widely read book in the subterranean world of the extreme right, the novel had sold between 350,000 and 500,000 copies as of 2000—an astounding figure for an underground book.[17]

On his Internet audio program, *American Dissident Voices*, Pierce exhorted people to share his evolutionary outlook. The cogency of his propaganda lies in his analysis of the extreme right's predicament, which is precarious. Inasmuch as the movement is weak and monitored very closely by the federal government and private watchdog groups, he had

no illusions of successfully confronting "the system" at that particular point in his struggle. He warned that any premature resistance or terrorism would only provoke the government into repressive measures that the extreme right was unable to counter. Nevertheless, Pierce repeatedly maintained that conventional political activity was futile and that armed struggle would someday be inevitable. But until that time came, he emphasized building a revolutionary infrastructure in which he could disseminate his message to more people and expand his following. Pierce and his National Alliance therefore concentrated on building a multimedia propaganda network.

To Pierce, virtually all contemporary institutions in America were corrupt, with no hope of redemption. Still, he believed there were sympathetic people in these institutions who would be receptive to his message. Reaching, educating, and inspiring these insiders was the centerpiece of his revolutionary model. In an age in which the masses were hopelessly misled by the influence of the media, Pierce considered it infeasible to try to organize them into a howling revolutionary mob. Rather than directly storming the Bastille, he sought to recruit insiders who were already part of the machinery of government and institutions with access to the levers of power. When the proper revolutionary conditions arrived, they could then throw open the gates to their ideological compatriots on the outside. As conditions in the world changed, Pierce predicted that leaders and other persons of influence would change their calculations and act accordingly.[18]

After his death in 2002, Pierce's organization experienced a number of setbacks but continues to this day under the leadership of Erich Gliebe. In the final years of his life, Pierce occasionally offered veiled praise for Islamic terrorists such as Osama bin Laden and Palestinian suicide bombers who were "paying a terrible price" to liberate their land. Through his various writings and broadcasts, he formulated a doctrine of revolution. In so doing, he created a potentially effective foundation for leaderless resistance, which requires a semblance of ideological cohesion and coherence so members of a movement can act on their own initiative yet still work toward the same goals, however broadly defined. The widespread availability of the World Wide Web has made the propaganda of Pierce and the National Alliance accessible to potential sympathizers around the world. Although the contemporary extreme right in the United States is generally weak and loosely organized, Pierce

formulated the most workable revolutionary strategy the movement ever produced.

At one time, one of the most vociferous online advocates of leaderless resistance was Alex Curtis, a young man who operated the *Nationalist Observer* website out of San Diego, California. Like Beam, Curtis reasoned that at the present time, dissident groups can be too easily infiltrated to mount any kind of organized resistance campaign. Moreover, those organizations that suggest such actions, even in an abstract way, could possibly be slapped with a civil suit for "vicarious liability," in which they are blamed for influencing the violent actions of others.[19] To avoid these potential pitfalls, Curtis instructed his readers and listeners that they must act entirely alone.

Curtis envisaged a two-tiered resistance organizational structure with an aboveground propaganda arm and a second tier of lone wolves. He advised against formal memberships and meetings, as they offered opportunities for authorities and monitoring groups to identify and gather information on activists and sympathizers. In 1998, he created an Internet site which included an audio "update" program that reviewed and critiqued recent episodes of right-wing violence. Also, he sent out regular e-mail messages to an estimated 800 subscribers.[20] In these media, he pointed out mistakes and offered suggestions on how they could be avoided. He counseled lone wolves not to cooperate with authorities and only respond with "the five words"—"I have nothing to say."

For a while, Curtis was the extreme right's most vitriolic advocate of terrorism. Each month he would designate someone as "Aryan of the Month." He bestowed this recognition on lone wolves such as Benjamin Smith, Scott Baumhammers, and David Copeland.[21] For Curtis, the end justified the means; he once contemplated the suitability of illegal drug sales as a way to further the racial revolution.[22] Moreover, he had no compunctions about the most lethal methods of terrorism. One issue of his bimonthly periodical, the *Nationalist Observer*, contained an article which described various biological toxins that could be used as weapons of mass destruction, including the bubonic plague and typhoid.[23]

Essentially, Curtis saw leaderless resistance as a means to provoke a crisis atmosphere that would polarize the population along racial lines. Actually, he welcomed measures such as hate crime laws, because he believed that they are selectively used against whites and would engender hostility among them. According to Curtis, leaders in the movement

should never condemn hate crimes perpetrated by whites.[24] Although random hate crimes would appear to have little tactical value, he saw them as a means to foment a revolutionary atmosphere.[25]

To be expected, Curtis' strident rhetoric caught the attention of authorities and monitoring organizations. In November of 2000, he was arrested, along with two other individuals, for various civil rights violations.[26] In June 2001, he received a three-year prison sentence and agreed not to consort with activists in the white nationalist movement after his release.[27]

More recently, Harold Covington has used the Internet to promote his revolutionary strategy. Over the years, Covington has earned a controversial reputation in the extreme right subculture. Highly literate and articulate, he has done a significant amount of writing and theorizing on strategy.[28] Yet, he has also been involved in some very bitter internecine feuds that have led some activists to impugn his credentials.[29]

Beginning in 2003, Covington published a quartet of novels based on a white separatist insurgency in the Pacific Northwest region of the United States.[30] Set in the not-too-distant future, the novels extol the exploits of the Northwest Volunteer Army (NVA), which wages a war of national independence. Eschewing grandiose schemes to foment a nationwide white revolution, Covington argues for mounting a separatist guerilla campaign in a limited region. On his online *Radio Free Northwest* program, Covington exhorts racially conscious whites to relocate to the Pacific Northwest to form a critical mass for the formation of his future NVA. To date, he has attracted few volunteers, but he has produced a concrete plan for a guerrilla campaign in the Pacific Northwest. In 2011 Covington began a series of "Brandenburg" lectures in which he discussed the prospect of revolution against the federal government, but he did so in a general rather than specific style to remain within the boundaries of First Amendment protection of free speech.[31]

Various online forums and resources appeal to the militia movement as well. For example, in a short online novelette, *Absolved*, Michael Manderboegh tells the story of Phil Gordon, a terminally ill Vietnam veteran and ardent Second Amendment advocate. A desperate man with nothing left to lose, he fights off an army of federal agents who seek to confiscate his guns.[32] The novel inspired members of a Georgia militia group that allegedly planned attacks on US federal law officers and others.[33]

More recently, on 22 July 2011, the Norwegian lone wolf Anders Behrig Breivik, who bombed government buildings in Oslo and went on a subsequent shooting spree which left 76 people dead, employed the new media to get his message out. Shortly before he began his attacks, he uploaded his 1,500-page electronic book, *2083: A European Declaration of Independence*, on the Internet. He explained in detail how he spent nine years methodically planning his attacks, procuring firearms and tons of fertilizer while evading suspicion from authorities. He also uploaded a video on YouTube titled "The Knight Templar 2083," which contained numerous references to the Islamic threat to Europe, interspersed with iconic images of Crusaders. Whereas the Unabomber, Ted Kaczynski, implored major newspapers to publish his manifesto (from which, incidentally, Breivik plagiarized) to ensure maximum exposure of his ideas, Breivik took advantage of the Internet and posted his manifesto online, thus bypassing major media outlets. The notoriety stemming from his attack, he predicted, would serve as a "marketing" ad for his manifesto, thus assuring substantial interest in its contents. Claiming to be a member of the Knights Templar—a medieval order that protected pilgrims in the Holy Land after the First Crusade in the eleventh century—he saw himself as part of an unorganized and leaderless vanguard that would awaken Europe to the perils of Islamicization brought about by the immigration policies engineered by Europe's liberal parties. In that sense, the seemingly senseless shootings at the youth camp were meant to punish the ruling party for their "treasonous acts against Europe and Europeans."[34]

The Far Left

The political left has proven adept at exploing the Internet as well. In 1999, two researchers at the RAND Corporation, John Arquilla and David Ronfeldt, first predicted that the old hierarchical organization structures of terrorist groups were giving way to flatter or horizontal organizations that would be more network-based. New information technology, they presaged, would enable these networked insurgencies to take hold. This allowed for "swarming"—an operational innovation whereby dispersed nodes of a network of forces converge on a target from multiple directions to accomplish a task. The overall aim is for network members to converge rapidly on a target and then disperse immediately until it is time again to recombine for a new pulse.[35] What

distinguishes net war from previous forms of conflict is the networked organizational basis of the practitioners. Many of the groups are leaderless, yet their members are able to combine in swarming attacks.[36] The emergence of so-called amateur terrorism is related to the spread of information technologies that allow dispersed groups and individuals to conspire and coordinate attacks across considerable distances.[37]

The political left has used the new media to implement swarming protests. For example, in the fall of 1999, diverse elements of the antiglobalization movement converged in Seattle to disrupt an important meeting of the World Trade Organization. Through the Internet, various groups and activists were able to coordinate their efforts and swarm, or come together. Much of the cohesion of the activists stemmed from improvised communications, including cell phones, radios, police scanners, and portable computers. Employing these media, they were able to link into continuously updated webpages and other news sources which gave reports from the street.[38] A variety of movements, groups, and activists came together to oppose the "neoliberal" orientation of the global economic order sometimes referred to as the "Washington Consensus."[39] Antiglobalization activists created their own "Independent Media Centers" in those cities where the major protests occurred.[40] By exploiting new forms of communication, such an Indymedia, activists seek to break the information monopoly of the corporate media and become actively involved producing information.[41]

Often associated with the political left, elements of the radical ecology and animal liberation movements have demonstrated adeptness in implementing leaderless resistance. The Earth Liberation Front (ELF) was founded in Brighton, England, in 1992 after activists from another environmentalist group—Earth First!—decided to distance themselves from illegal activities. Not long thereafter, the idea of decoupling the aboveground segment of the movement from illegal activities took hold in America. Essentially a leaderless movement, the ELF has no official membership, leadership, or central organization. Rather, ELF activists and cells act autonomously and remain anonymous to the public. Rather than use a formal membership, the ELF produces guidelines that exhort activists to cause economic damage to firms despoiling the environment, educate the public on the harm being done to the environment, and take all necessary precautions to avoid harming life. Since the ELF is essentially a state-of-mind organization, anyone who follows these

guidelines is considered a member.[42] There is overlap between the ELF and the Animal Liberation Front (ALF), another leaderless movement whose members seek to stop animal suffering through "direct action," which includes illegal activities involving the rescue of animals and inflicting damage on businesses and facilities that use and abuse animals. In various harassment campaigns, ALF activists have used the Internet to target firms that use laboratory animals.

The Internet has enabled mass collaboration on a global scale. The online encyclopedia Wikipedia, for example, demonstrates how thousands of dispersed volunteers can create fast, fluid, and innovative products that can outperform some of the largest and best financed enterprises.[43] Mass collaboration has its genesis in the open source movement in software. In 1986, Linus Torvalds envisaged an operating system that could be available to anyone. Users would be permitted to modify it with the proviso that they would not license it or restrict its use. That year, the Linux operating system was created by a collaborative effort of numerous independent programmers.[44] Behind these most successful "crowdsourcing" efforts is a collaborative effort between the crowd and highly motivated individuals that guide them.[45] The growing accessibility of information and technology puts tools into the hands of people all over the world who are now capable of collaborating on a truly global scale.

A pernicious example of crowdsourcing is the so-called Anonymous group linked to numerous episodes of Internet "hacktivism." Essentially a leaderless movement, its origins can be traced to 2003 with the launching of the imageboard (a type of Internet forum devoted to the posting of images) "4chan," which became linked to various hacktivist subcultures. Members maintain online anonymity while conducting civil disobedience, with the primary goal of promoting Internet freedom. With increasing notoriety, the concept of Anonymous as a collective of unnamed individuals became an Internet meme.[46] Collectively, Anonymous activists consist largely of users from multiple imageboards and Internet forums. Anonymous hacktivists were behind a number of denial of service attacks.[47] On YouTube, figures purporting to be members of Anonymous wear Guy Fawkes masks popularized by the comic book and film, *V for Vendetta*, and rail against their targets. Members have attacked a variety of online networks including those operated by Arab dictatorships, the Vatican, the Church of Scientology, banking and entertainment firms, the FBI, and the CIA. Indicative of the movement's

growing notoriety, in 2012, *Time* magazine listed Anonymous as one of "The World's 100 Most Influential People."[48]

Authorities have begun taking the antics of Anonymous more seriously. In July 2011, 20 or more suspected Anonymous hackers were arrested in the United States, the United Kingdom, and the Netherlands following "Operation Avenge Assange." The group attacked PayPal, MasterCard, and Visa after those firms froze the accounts of WikiLeaks created by embattled Australian journalist, Julian Paul Assange.[49] In the US Congress, Senator Joseph Lieberman (I-CT) demanded that firms, including Amazon, MasterCard, Visa, and PayPal, terminate WikiLeaks' accounts and refuse to provide the online platform with any services.[50]

Radical Islam

The global Islamic resistance movement has established a robust presence on the Interent despite a multinational effort to eradicate it since 9/11. The Internet is an important aspect of al-Qaeda's campaign, as Dr. Ayman al-Zawahiri once declared: "We are in a battle, and more than half of this battle is taking place in the battlefield of the media. We are in a media battle for the hearts and minds of our *umma."*[51] To that end, al-Qaeda has a media committee which was first led by a jihadist with the nom de guerre "Abu Reuter." Presently, the leadership operates more as a communications company, producing occasional videotapes rather than actual terrorism.[52] In essence, al-Qaeda has become the strategic communicator for a larger global Salafist movement. Over the years, it has stepped up its media operations.[53]

Apparently, the Iraq war was the catalyst for the surge in the number of jihadist online media outlets since 2003. In the media age, previously local insurgencies whose ramifications remained isolated now have the potential to capture worldwide attention. Abu Musab al-Zarqawi, the recognized leader of the foreign insurgents and al-Qaeda in Iraq, mobilized computer-savvy allies to resist the US occupation.[54] During the Iraq war, he embraced the video camera as a weapon and encouraged militant groups to videotape their operations so they could later be broadcast as propaganda.[55] Using camcorders and the Internet, he was able to mount international media events at the tactical level which produced tremendous strategic impact. He pioneered a new method of communication and even employed an online press secretary. An online jihadist, "Irhabi007," was responsible for posting many of al-Zarqawi's

pronouncements on the web and played a central role in his public relations network. It later transpired that Irhabi007 was Younis Tsouli, a 22-year-old West London resident of Moroccan descent.[56] His example illustrates how an audience can take an active role in conflicts around the world.

Al-Qaeda's media outreach suffered a setback in 2005, when Al Jazeera stopped airing the organization's videos in their entirety. Meanwhile, the US government and its allies pressured Internet service providers (ISP) to shut down Islamist websites. In May 2008, Senator Joseph Lieberman, chairman of the Senate Homeland Security Committee, wrote to Google officials and urged them to take down video produced by al-Qaeda and other terrorist groups.[57] Despite these measures, al-Qaeda's web presence has been resilient.

Researcher Brynjar Lia observed a shift from noninteractive, more-or-less official jihadist websites toward a much more multilayered and redundant media production and distribution system.[58] A thorough scan of the Internet revealed more than 4,300 websites that serve terrorists and their supporters.[59] Moreover, there are now Islamist sites that reach out to a Western audience.[60] West Point's Combating Terrorism Center estimated that by late 2007, there were as many as 100 English-language websites offering militant Islamic views. There are also sites for non-Arabic speaking and non-English speaking countries, suggesting a more multilingual propaganda approach. This could enable jihadists to reach a new audience in the West and elsewhere.[61]

According to US and European intelligence sources, al-Qaeda's media committee—as-Sahab (the clouds)—has established a secure base in the ungoverned tribal areas of western Pakistan.[62] According to Lia this so-called e-jihad depends significantly on free web hosting, anonymous access to web storage, and file sharing.[63] Websites on which large video files can be uploaded for free and without any ID control are invaluable to online jihadists, allowing them to disseminate high-quality material. Lia identified several categories of jihadist websites, suggesting a division and specialization of labor.[64] It is now possible for terrorist movements to control the entire communications process so they can determine the content and context of their messages and the means by which they are conveyed to specific audiences.[65] By doing so, al-Qaeda reaches several target audiences, including both its supporters and enemies. Thus the Internet is an important contributing factor that makes jihadist terrorism

more global in scope by reducing the need for physical contact and enables forming a decentralized structure of autonomous groups that share the same ideology. Furthermore, the anonymity provided by the Internet enables extremists to interact more freely with fewer constraints than in a physical setting where monitoring is pervasive.[66]

Numerous resources for would-be terrorists are available online. For example, al-Qaeda's *Encyclopedia of Jihad* offers religious guidance as well as instructions on terrorism and insurgency. This Internet library allows scattered jihadists not affiliated with al-Qaeda to train at their leisure in their own homes and plan operations with less chance of being detected or interdicted.[67] Terrorists can find training materials online, such as *The Mujahedeen Poisons Handbook* and *How Can I Train Myself for Jihad?*[68] Operationally, the Internet allows al-Qaeda to post data and intelligence requirements and ask Muslims to help meet these requests. Most respondents are not al-Qaeda members. Moreover, they can remain anonymous and thus avoid police attention.[69] These various features of the Internet make leaderless jihad possible.

A Syrian member of al-Qaeda, Abu Musab al-Suri, advanced an operational strategy of decentralization to fit contemporary conditions. His 1,600-page online tome, *A Global Islamic Resistance*, seeks to provoke a global Islamic uprising led by autonomous cells and individual jihadists. In it, he argued that it was folly for the movement to fight from fixed locations, because their units could be trapped where Western forces could eventually invade and destroy them. Furthermore, he saw the traditional hierarchical model of a terrorist group as outdated, because if authorities could capture one member, that could put the whole organization at risk. Taking these factors into account, al-Suri proposed a "jihad of individual terrorism" in which self-contained cells implement their own terrorist template to start their own jihad. What is critical is a shared ideology that serves to create a feeling of common cause and unity of purpose. There would be no formal organizational links between the cells. This model fosters adaptability and creativity in the realm of terrorism. He advises Islamists to focus on jihad in their own countries of residence.[70]

The power of the Internet is integral to al-Suri's strategy of individual terrorism because it serves as a mobilization tool. To make leaderless resistance orderly, al-Suri recognized that it was necessary to direct such actions through strategic guidance from al-Qaeda's leaders to ensure a

unity of purpose. Al-Qaeda's leaders have taken his advice, as demonstrated by locally recruited cells carrying out attacks under the guidance of the parent organization, as in the Madrid and London attacks.[71]

As Marc Sageman explained, the Internet is central to the evolution of contemporary terrorism. Specifically, the vast system of active communications that includes e-mail, list servers, and chat rooms is essential in forging networks. The Internet has undermined the traditional hierarchy of terrorist organizations, thus paving the way for "leaderless jihad." Sageman argues that al-Qaeda's new modus operandi is to advertise demands for terrorist operations on the Internet in the hope that local networks will provide the terrorist activities on their own without direct guidance from the central organization. In many cases, al-Qaeda merely telegraphs its desire for attacks.[72] Each small terrorist organization may pursue disruptive activities for its own local reasons, but by doing so, it promotes al-Qaeda's grand strategy. Often, the local group receives recognition from al-Qaeda only after the fact.[73]

A few examples illustrate this tactical approach. On 1 August 2007, an al-Qaeda website promised that a big surprise would soon occur. Although the message did not specify the precise nature of the surprise, the accompanying visual displayed a montage of Pres. George W. Bush with then-visiting Afghan president Hamid Karzai and Pakistani president Pervez Musharraf against a backdrop of the White House in flames, thus suggesting that they should be targeted. This was followed on 5 August by a video in which Adam Gadahn, an American al-Qaeda spokesman, warned that US embassies would be attacked.[74] Such threats have of course become commonplace in al-Qaeda discourse but, as terrorism analyst Brian Jenkins observes, highlight the organization's communications strategy. Gadahn's videotape threatened no specific action; rather, it identified targets that ought to be attacked and left it up to jihadists to act on their own initiative.[75] Not long thereafter, he appeared in another video in which he seemingly commanded sleeper agents to attack nuclear power plants inside the United States.[76]

More threats would follow. In March 2010, al-Qaeda's media army, as-Sahab, released a videotape in which Gadahn commended MAJ Nidal Malik Hasan, the Fort Hood shooter, calling him an "ideal role model" whose lone wolf terrorism should be a model of emulation for other jihadists in America and the West.[77] And in June of 2011, Gadahn appeared in another video, titled "Do Not Rely on Others, Take the Task

upon Yourself," in which he urged Muslims in the United States to take advantage of lax firearm laws to purchase guns and carry out attacks on their own initiative.[78] Such threats, often conveyed through the new media, are an integral part of al-Qaeda's grand strategy.

As terrorism analyst Peter Bergen observed, the increasing role of Gadahn is indicative of the Americanization of al-Qaeda's leadership.[79] For example, Anwar al-Awlaki, a Yemini cleric who grew up in New Mexico, played an important operational role for al-Qaeda in the Arabian Peninsula (AQAP) and reached out to several American jihadists. He exerted a strong influence on Major Hasan with whom he exchanged e-mails several times before the attack at Fort Hood. Al-Awlaki met with Umar Farouk Abdulmutallab, who was arrested for his alleged attempt to blow up a Detroit-bound flight on Christmas Day in 2009. His sermons also inspired Faisal Shahzad, who attempted to set off a car bomb in New York's Times Square in May 2010, and Zachary Chesser, a Fairfax, Virginia, man of Somali origin who was arrested on charges of trying to join the Somali Islamic terrorist group al-Shabab. Once characterized as the "bin Laden of the Internet," Al-Awlaki's pronouncements are broadcast on sites such as YouTube.[80]

US intelligence agencies identified al-Awlaki as the "chief of external operations" for al-Qaeda's Yemini branch. By skillfully combining religious doctrine with colloquial Western references, al-Awlaki appealed to disaffected Muslims in the West whom he exhorted to join al-Qaeda's jihad. Presented in an emotional rather than intellectual style, his sermons were easily comprehensible without a deep knowledge of Islamic history or complex theological arguments. Ironically, it was his lack of depth as a Salafist cleric that added to his authenticity and accessibility. He offered his listeners the unvarnished "truth" that cut to the issues that mattered in their daily lives.[81] His online speech, "Constants on the Path to Jihad," has been described as a "virtual bible for lone wolf extremists."[82] On 30 September 2011, a US military drone attack in Yemen killed al-Awlaki. Just two weeks later, another strike in Yemen killed his 16-year-old son.[83]

In 2010, an al-Qaeda-affiliated group based in Yemen launched an English-language online magazine titled *Inspire*, which contained a foreword by Osama bin Laden in which he encouraged "individual jihad" against Americans and Westerners. One article suggested random shooting rampages in crowded restaurants in Washington, DC, at lunch hour,

while another instructed readers on how to weld blades to the front of a pickup truck so it could be used as a mowing machine—not to mow grass but to "mow down the enemies of Allah." A similar tactic was actually employed in 2006 by Mohammed Taheri-azar, an Iranian-born US citizen who injured nine persons with a sports utility vehicle on the campus of the University of North Carolina at Chapel Hill.[84]

Several jihadist terrorist conspiracies suggest a strong Internet link. The bombing plot against the London transit system on 7 July 2005 is instructive. According to some sources, al-Qaeda had a role in supporting the locally recruited cell that carried out the attack, which killed 52 and injured more than 700 others. In a 2004 tract, al-Suri instructed how a leader should form cells and recruit from individuals who are able to influence a wide circle of friends. Although some of those involved in the Madrid and London attacks reached out to more-experienced jihadists for help and guidance, the important point is, the cells were autonomously formed, following al-Suri's model.[85] Hussein Osman, a defendant in the London bomb trial, told investigators that although he had no direct contacts to al-Qaeda, he regularly visited the organization's websites, viewed their videos, and read their propaganda.[86] He explained to investigators that he and his group regularly watched videos of the Iraq war and used the Internet to "read up" on jihad. Although he denied any direct link to al-Qaeda, he admitted to using the organization's online platforms.[87]

The six Muslim men involved in the 2007 Fort Dix plot were united via the Internet, where they downloaded videos of Osama bin Laden preaching inspirational jihadist messages. The men allegedly planned to sneak onto the Army base to carry out a terrorist attack but were arrested after a store clerk alerted authorities. The accused had hired the clerk to dub a video of their training and practice attacks onto a digital disk intended for Internet use.[88] Similarly, a terrorist plot involving 17 young Muslims was foiled by the Canadian Security Intelligence Service in 2006 after surveillance of an online chat room revealed inflammatory anti-Western rhetoric which was thought to have precipitated a homegrown bomb plot.[89]

Some observers argue that radical Islamist sites might actually have a cathartic effect by serving as an outlet and alternative for would-be jihadists to vent their anger.[90] However, case studies illustrate how online, virtual jihadists can make the transition to real-world terrorists. For

some, the gap between online involvement and real-world action can be a source of angst. For instance, in an attempt to restore balance between virtual and real-world jihad, Jordanian physician Humam al-Balawi blew himself up in a suicide bombing attack on 30 December 2009 against a CIA base near Khost, Afghanistan.[91] Following a similar path, a Portland teenager using the online moniker "Ibn al-Mubarak" researched and wrote articles for the online pro-al-Qaeda magazine, *Jihad Recollections*. After publishing three articles there, he sought to publish in *Inspire*. In late 2010, he transitioned from cyber to real-world terrorism when he attempted to detonate a bomb at a Christmas tree-lighting ceremony in Portland.[92]

Al-Qaeda's appropriation of the new media, however, is not without drawbacks. To a certain extent, this has taken much control out of the leadership's hands. Their appeal to the lowest common denominator will inevitably lead to unaffiliated individuals and groups operating in the name of al-Qaeda carrying out acts counterproductive to the movement's overall strategic objectives.[93] As a result of the democratization and decentralization of the media, would-be leaders find it increasingly difficult to exercise control over the debate in their ideological circles.[94] This was illustrated by Mohamed Merah, a 23-year-old French citizen of Algerian descent, who in March 2012 videotaped some of his attacks that resulted in the deaths of seven people—three French paratroopers, three Jewish schoolchildren, and a rabbi—over the course of 10 days. He hoped that Al Jazeera would broadcast his videos for propaganda effect.[95] If Al Jazeera had followed through with his desires, it is hard to fathom how it could have been anything other than a public relations embarrassment for all but the most fanatical of jihadists.

Implications

In the unipolar era, the United States was thought to have a near monopoly on "soft power," which Joseph Nye described as the ability to determine the framework of the debate in international affairs.[96] However, the popularity of the Internet has led to a diffusion of soft power around the world. Extremist and terrorist groups are now exploiting the new media and youth culture as powerful recruitment tools to communicate their views and incite violence.[97] Increasingly, there is cross-fertilization between the "old media"—such as major television networks

and traditional news outlets—and the new media, including YouTube, MySpace, and Facebook.[98] A dialectic between the old and new media is now underway in which consumers increasingly participate, contribute, and modify the content.

The growth and expansion of the media was an important factor in the rise of terrorism in the 1970s.[99] It is no coincidence that contemporary terrorism gained prominence concomitant with the media age which allowed the widespread dissemination of news and events around the world. Today, media products created by the major networks can be recycled and refashioned to fit the designs of dissident groups. For example, local affiliates supplement al-Qaeda Central and combine archival material with local content. Groups as varied as Hezbollah, Hamas, Liberation Tigers of Tamil Eelam (LTTE), the Shining Path of Peru, and White Aryan Resistance (WAR) have propaganda videos on YouTube. The increased availability of sophisticated but inexpensive video-capturing hardware and interactive online network platforms has revolutionized terrorists' online communications.[100]

Modern technology facilitates the leaderless resistance trend in terrorism in several ways. First, the Internet can serve as a conduit for information flow which enhances recruiting. Second, secure communications—strengthened through such devices as encryption, free e-mail accounts, Internet relay chat, steganography, anonymous remailers, and web-based bulletin boards—make it difficult to link a message with an individual, thus enhancing operational security.[101] Third, through Internet gathering points, such as electronic chat rooms, dispersed individuals can share information and develop a shared worldview which subsumes their local agendas in support of a common goal.[102] Some groups avoid membership lists and place much recruitment effort on the Internet. Through that medium, one can become a true believer of the ideology without any formal organizational nexus.[103]

Websites can even serve to instigate terrorism without any specific nexus to the perpetrators. As an example, the Nüremberg Files—a website operated by Neal Horsley, an antiabortion activist in Oregon—listed the names and addresses of doctors who performed abortions and contained unsubtle suggestions that there should be some kind of retribution against them. In February 1999, the site was removed by its ISP after a red line was drawn through the name of Dr. Barnett Slepian on the day he was killed by an antiabortion assassin.[104] As illustrated by

this case, Internet activism blurs the distinctions on acts that constitute terrorism. On the Internet, supporters can openly cheer for al-Qaeda by replicating the organization's message in the form of videos, audio files, composite images, and monographs without resorting to actual terrorism.[105] Furthermore, the new media have the potential to rapidly polarize segments of society and create a charged atmosphere conducive to violence. For example, statements made by Dan Cathy, chief operations officer of Chick-fil-A, in expressing his opposition to same-sex marriage sparked numerous debates on Facebook and other online outlets. On 15 August 2012, Floyd Lee Corkins II, armed with a 9 mm handgun and carrying a satchel with a bag from a Chick-fil-A restaurant, entered the headquarters of the Family Research Council, a conservative political organization that opposes abortion and same-sex marriages. He made disparaging remarks about the group and then opened fire, but a security guard, who was wounded in the attack, wrestled him to ground before he could inflict more damage.[106]

In their study, *War 2.0: Irregular Warfare in the Information Age*, Thomas Rid and Marc Hecker examine the intersection of technology and insurgency. Two contemporaneous trends—the growing popularity of the World Wide Web and the rise of insurgencies—are shaping the course of modern warfare. As they observed, military applications previously spurred novel media technologies such as radio, television, and the Internet; however, that phenomenon has been reversed, as it is now the new media that shape contemporary warfare. New technology has increased the options for irregular forces more than for governments and armies, but in counterintuitive ways. Ironically, Rid and Hecker find a reversal of historic trends. First, regular armies engaged in counterinsurgency operations are refining the use of modern information technology for *external* purposes—to reach the local population in the theater of operations. By contrast, insurgents are increasingly using the Internet for *internal* purposes—to communicate with fellow irregulars. Still, insurgents and their supporters have become increasingly sophisticated in getting out their side of the story. New podcasting capabilities enable amateurs to record and disseminate graphic battlefield images. In sum, recent innovations in information technology have leveled the playing field for irregular forces.[107]

The ease with which people can upload material to the Internet has the potential to introduce innovative methods of terrorist exhortation.

For example, terrorism from the American extreme right has often been marked by ineptitude. Extreme right groups are infiltrated by both government agents and undercover operatives working for private monitoring organizations. In that setting, planning terrorist attacks is problematic due to a strong risk of exposure and manipulation by agents provacateurs. By contrast, radical Islamists, despite many failures, have carried out several lethal attacks in the West, as evidenced by the 9/11, Madrid, and London attacks. Insofar as the American extreme right and radical Islam share a very similar concept of who they consider to be the enemy—Jews and the US government—what would stop an enterprising extreme rightist from donning a Keffiyeh mask, reciting some Koranic verses, and exhorting Islamists to attack specific targets that would further the revolutionary goals of the extreme right?

The case of David Myatt is instructive. Arguably England's principal proponent of contemporary neo-Nazi ideology and theoretician of revolution, in 1998 he converted to Islam, assumed the nom de guerre "Abdul Aziz," and openly announced his support for Osama bin Laden and his declared war against the United States and Israel. Myatt's articles on the World Wide Web exhort his Aryan followers to make common cause with the Islamists. The primary battle against the ZOG, he says, has shifted from the West to the Islamic world, in areas such as Afghanistan, Palestine, and Iraq.[108] Conceivably, a person from one terrorist orientation could seek to inspire those in another since different terrorist movements often target the same enemies.

The growing pervasiveness of the new media brings new opportunities for oppositional groups to reach out to larger audiences than in the past. The democratization of the media has empowered many who previously would not have much voice in the marketplace of ideas. Chris Anderson, editor-in-chief of *Wired* magazine, developed the concept of the "long tail" to explain how new Internet platforms such as Amazon enable firms to employ a niche marketing strategy in which they sell large volumes of unique items to a larger number of customers instead of selling only a lesser variety of popular items in large quantities. The major reason is because the Internet lets customers choose from a vast number of products. The long-tail operation makes it easier for a highly specialized company to be viable and enter a market without having a locally concentrated customer base. A similar logic applies to extremist groups and terrorism in that a large popular following is not required.

Likewise, in the information age, a relatively low number of highly motivated, partly self-recruited, and geographically dispersed followers can share an extremist cause without broad appeal, thus making niche terrorism possible.[109] Meanwhile, sophisticated tools with uses that are not always benevolent continue to be developed and made widely available, and in complex, contemporary societies, there are a myriad of soft targets which, if disrupted, can cause major perturbations throughout the system.[110] Consequently, a few angry people now have the potential to cause unprecedented destruction. The frequency of sporadic episodes of lone wolf terrorism in the headlines suggests leaderless resistance has become the most common tactical approach to political violence in the West.[111] The Internet and the new media have been instrumental in this trend by enabling representatives of extremist and dissident subcultures to reach out to potential sympathizers dispersed around the world so that terrorist movements can now survive without formal organizations.

How should policymakers confront this problem? The new media are generally unregulated and difficult to police. A legal argument has been made that online forums, such as Twitter, could be held culpable for provident "material support of terrorism." Discussion groups that are forums for radical discourse often display notices indicating the material displayed on the sites does not necessarily reflect the views of the administrators, thus suggesting a waiver of liability. Since users can have multiple, fraudulent, and shifting identities, they are hard to trace. And site administrators are often slow to act against threats posted online.[112] To counter these online threats, some have recommended the use of various material support statutes to hold ISPs responsible for the content of websites. Others, such as Aaron Weisburd who operates the online monitoring site, Internet Haganah (Hebrew for *defense*), have sought to "shame" those ISPs that host terrorist-related sites so they will sever their connections.[113] One innovative intitiative underway to counter online extremism is a software program that would allow the US military to secretly manipulate social media sites by using fake online identities. In March 2012, a California company was awarded a contract by the US Central Command (CENTCOM) to develop an "online persona management service" that would enable one US serviceman to control up to 10 identities based around the world. The operators would seek to influence Internet discussions and spread pro-American propaganda.[114]

More direct approaches to counterterrorism can be applied to lone wolves inspired by radical online forums. To be sure, government authorities should deal resolutely with lone wolves who commit serious crimes. However, blanket repression against extremist and dissident subcultures that hold unpopular beliefs should be avoided. Although state repression can be effective, especially if the targeted group or community has not established deep roots, it can also backfire. Arguably, the 1992 Ruby Ridge and 1993 Waco fiascos were counterproductive. In particular, the siege of the Branch Davidian compound in Waco, Texas, which resulted in the death of 76 persons, enraged Timothy McVeigh and set him on his course of action which culminated in the 1995 bombing of the Alfred P. Murrah Federal Building in Oklahoma City—the most horrific act of domestic terrorism prior to 9/11. Resentment from how the US government handled these events did much to fuel the militia movement in the mid 1990s.

Another strategy to counter the threat of online extremism is community engagement. In August 2011, the White House released a document titled "Empowering Local Partners to Prevent Violent Extremism in the United States." The report warned that political extremism had the potential to divide the nation. Rather than blaming certain communities, the report called for forging community partnerships. Information about the threat of radicalization and violence could be provided to a wide range of community groups and organizations. According to the report, the government should be ready to respond to community concerns about government policies and actions. The report also called for more monitoring of the Internet and social network sites to understand their role in advancing violent extremist narratives.[115] Perhaps the most effective approach to countering the threat of exhortation would be to use elements of the new media, including YouTube and similar platforms, to post videos and improve public relations.

Traditionally, the military has maintained centralized control over information. The emergence of the new media, however, calls for a more decentralized approach. The propaganda that the US government seeks to counteract reaches a wide variety of audiences. To meet this challenge, those web forums and new media platforms that are instrumental in disseminating terrorist propaganda must be identified. Only by embracing the new media and disseminating compelling counternarratives, can the hearts and minds of audiences be won. SSQ

Notes

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11. Susan Miller, "Census Predicts Decline of Whites," *Washington Times*, 18 March 2004.

12. Jack Kay, "Communicating through Electronic Bulletin Boards in the White Supremacy Movement: Creating Culture via Computer," paper presented at the International Communication Association Conference, Mass Communication Division, New Orleans, June 1988.

13. Previously, Black had been affiliated with the National Socialist White People's Party, the successor to George Lincoln Rockwell's American Nazi Party. Later, he joined the Knights of the Ku Klux Klan, which was led by David Duke at the time. The two developed an enduring friendship. Black even married Duke's ex-wife and helped raise his two daughters. In 1981, Black was arrested for his role in a bizarre 1981 plot to invade the Caribbean island of Dominica and overthrow its government. Supposedly, the plan was to spark a coup led by Don Black and nine other white mercenaries who would lead disgruntled black soldiers against the island nation's 70-man police force. He spent 1982 to 1985 in a federal prison in Texas, where he studied computers and became quite proficient in their use. He settled in Palm Beach, FL, in 1987. David Schwab Abel, "The Racist Next Door," *Broward-Palm Beach New Times*, 19 February 1998.

14. Lorraine Bowman-Grieve, "Exploring 'Stormfront': A Virtual Community of the Radical Right," *Studies in Conflict & Terrorism* 32, no. 11 (2009): 996–97.

15. See Louis Beam, "Leaderless Resistance," *Seditionist* 12 (February 1992): 12–13; Beam, "Understanding the Struggle or Why We Have to Kill the Bastards," in *Essays of a Klansman*, ed. Beam (Hayden Lake, ID: A.K.I.A. Publications, 1983), 45–51; and Beam, "Understanding the Struggle Part II," in *Essays of a Klansman*, 52–72.

16. Statements by McVeigh seem to indicate that *The Turner Diaries* may have been determinative in his choice of target and his decision to carry out the attack. See Lou Michel and Dan Herbeck, *American Terrorist: Timothy McVeigh and the Oklahoma City Bombing* (New York: Diane Publishing Co., 2001), 304. For more on the Order, see Kevin Flynn and Gary Gerhardt, *The Silent Brotherhood: Inside America's Racist Underground* (New York: Free Press, 1989). For more on the Aryan Republican Army, see Mark S. Hamm, *In Bad Company: America's Terrorist Underground* (Boston: Northeastern University Press, 2001). For more on David Copeland, see Graeme McLagan and Nick Lowles, *Mr. Evil* (London: John Blake Publishing, 2000).

17. John Sutherland, "Gospels of Hate that Slip through the Net," *Guardian* (UK), 3 April 2000, http://www.guardian.co.uk/mcveigh/story/0,7369,488284,00.html; and David Segal, "The Pied Piper of Racism," *Washington Post*, 12 January 2000.

18. For more on Pierce's revolutionary strategy, see George Michael, "The Revolutionary Model of Dr. William L. Pierce," *Terrorism and Political Violence* 15, no. 3 (Autumn 2003): 62–80.

19. The Southern Poverty Law Center (SPLC), a monitoring organization based in Montgomery, AL, has won several civil suits against extreme right groups and individuals. In doing so, the SPLC has effectively shut them down. For more on the SPLC's response to the extreme right, see George Michael, *Confronting Right-Wing Extremism and Terrorism in the USA* (New York: Routledge, 2003).

20. This is according to an Anti-Defamation League (ADL) report, "Alex Curtis: 'Lone Wolf' of Hate Prowls the Internet," 2000, http://www.adl.org/curtis/default.htm.

21. On the July Fourth weekend of 1999, Benjamin Smith, a former member of the World Church of the Creator who had recently resigned from the organization, embarked on a shooting spree in Illinois and Indiana that left two dead and several injured. Edward Walsh, "'Appalled' Reno Pledges Review of Midwest Shootings," *Washington Post*, 9 July 1999, A-12. In April of 2000, Richard Baumhammers, an immigration attorney and founder of a miniscule right-wing organization, the Free Market Party, killed five people—his Jewish neighbor, three Asian-Americans, and one Black—in a shooting rampage near Pittsburgh. Lynne Duke, "Pittsburgh Reels from another Apparent Hate Crime," *Washington Post*, 30 April 2000, A-4. David Copeland single-handedly conducted a campaign of terror in 1999 during which he bombed Bangladeshi, Black, and gay districts in London. His bombings killed three persons and injured 128 others. For more on Copeland, see McLagan and Lowles, *Mr. Evil*.

22. ADL, "Extremism in America: Alex Curtis," http://www.adl.org/learn/ext_us/curtis.asp?LEARN_Cat=Extremism&LEARN_SubCat=Extremism_in_America&xpicked=2&item=curtis.

23. See Alex Curtis, "Biology for Aryans," *Nationalist Observer* no. 21 (June 2000): 1.

24. ADL, "Extremism in America."

25. Quoted in the ADL report, "Alex Curtis: 'Lone Wolf.'"

26. The alleged offenses include placing racist stickers at some of the victims' offices, placing a snake skin in the mail slot of Congressman Filner's office, spray painting anti-Semitic words and symbols on a synagogue, and perhaps the most serious act, placing an inactive hand grenade at Mayor Madrid's residence. For more on this investigation see the FBI's report "Operation Lone Wolf," 2000, http://www.fbi.gov/majcses/lonewolf1/htm.

27. ADL, "Alex Curtis."

28. See Harold Covington, *The March up Country* (Reedy, WV: Liberty Bell Publications, 1987).

29. He attained notoriety for his connection to the so-called Greensboro Massacre that occurred on 3 November 1979 when members of a neo-Nazi party, the National Socialist Party of America (NSPA), and a local Ku Klux Klan organization clashed with demonstrators

led by members of the Communist Workers Party in a "Death to the Klan" rally. The confrontation had been a culmination in a series of disputes between the two sides. A shootout ensued in which five members of the Communist Workers Party were fatally wounded. At that time, Covington was the leader of the NSPA and a principal organizer of the demonstration but was conspicuously absent from the actual event. Rumors surfaced that he was an informant and agent provocateur for the FBI, BATF, and CIA. Covington categorically denied these allegations. For more on the Greensboro Massacre, see Elizabeth Wheaton, *Codename Greenkil: The 1979 Greensboro Killings* (Athens: University of Georgia Press, 1987). For a brief biographical sketch of Covington, see "Little Big Man," *Intelligence Report* (Winter 2008), http://www.splcenter.org/intel/intelreport/article.jsp?aid=980.

30. Those novels are Harold A. Covington, *The Hill of the Ravens* (Bloomington, IN: 1stBooks, 2003), *A Distant Thunder* (Bloomington, IN: Authorhouse, 2004), *A Mighty Fortress* (New York: iUniverse, 2005), and *The Brigade* (Philadelphia: Xlibris Corporation, 2008).

31. In his lectures, Covington referered to the US Supreme Court case *Brandenburg v. Ohio* (1969), which protected speech that advocated violence, but with limitations. Clarence Brandenburg was the leader of an Ohio-based Ku Klux Klan organization in the 1950s. During a rally, which was filmed by reporters, Brandenburg expressed his desire to expatriate Jews and African-Americans to Israel and Africa respectively. Several of his fellow klansmen were filmed carrying firearms. Based on this film, Ohio authorities charged him with violating an Ohio syndicalism law enacted in 1919 which forbade the spread of unpatriotic views and the advocacy of criminal syndicalism. In *Whitney v. California* and *Dennis v. United States*, the court upheld the right of the state to proscribe advocacy of violent means of effecting political change. However in *Brandenburg* the court sought to distinguish between the abstract advocacy of the use of force or law violation and the actual planning of an illegal act that was likely to result in its actual completion. In doing so, the court overruled *Whitney v. California* by deciding that the mere abstract advocacy of an illegal act that was not likely to incite or produce an illegal action was protected by the First and Fourteenth Amendments of the Constitution. In the court's view, Brandburg's actions did not constitute a "clear and present danger." For more on *Brandenburg v. Ohio* see Lee Epstein and Thomas G. Walker, *Constitutional Law for a Changing America* (Washington: Congressional Quarterly Press, 1992), 143–45.

32. Michael Vanderbrogh, "Absolved," *The Price of Liberty*, 28 July 2008, http://www.thepriceofliberty.org/08/07/28/absolved.htm.

33. Greg Bluestein, "Feds: Online Novel Played Role in Ga. Militia Plot," *Post and Courier* (Charleston, SC), 2 November 2011, http://www.postandcourier.com/news/2011/nov/02/feds-online-novel-played-role-ga-militia-plot/.

34. George Michael, "Anders Behring Breivik: A New Breed of Lone Wolf Terrorist?" *Journal of Counterterrorism & Homeland Security International* 18, no. 1 (2012): 14–18.

35. John Arquilla and David Ronfeldt, "Afterword (September 2001): The Sharpening Fight for the Future," in *Networks and Netwars: The Future of Terror, Crime, and Militancy*, eds. Arquilla and Ronfeldt (Santa Monica, CA: RAND, 2001), 367.

36. John Arquilla and David Ronfeldt, "Summary," in *Networks and Netwars*, ix.

37. John Arquilla, David Ronfeldt, and Michele Zanini, "Networks, Netwar, and Information-Age Terrorism," in *Countering the New Terrorism*, eds. Ian Lessler et al. (Santa Monica, CA: RAND, 1999), 45.

38. Paul de Armond, "Netwar in the Emerald City: WTO Protest Strategy and Tactics," in *Networks and Netwars,* 210.

39. Michael Hardt and Antonio Negri, *Multitude: War and Democracy in the Age of Empire* (New York: Penguin Press, 2004), 285–88.

40. Jim Redden, *Snitch Culture* (Venice, CA: Feral House, 2000), 151.

41. Hardt and Negri, *Multitude*, 305.

42. Donald R. Liddick, *Eco-Terrorism: Radical Environmental and Animal Liberation Movements* (Westport, CT: Praeger, 2006), 64–67.

43. The software engineer Ward Cunningham created the first wiki in 1995. One of his fundamental assumptions was that people who collaborate with one another also tend to trust one another. His wiki—a user-editable website—became the model for subsequent wikis. Don Tapscott and Anthony D. Williams, *Wikinomics: How Mass Collaboration Changes Everything* (New York: Portfolio, 2008), 111. As of 2008, Wikipedia had approximately 2.2 million entries—23 times the number of entries in the *Encyclopedia Britannica*. Jeff Howe, *Crowdsourcing: Why the Power of the Crowd is Driving the Future of Business* (New York: Crown Business, 2008), 61.

44. Howe, *Crowdsourcing*, 52–55.

45. According to Wikipedia founder Jimmy Wales, approximately 50 percent of edits are made by less than 1 percent of users. This suggests that behind the legion of users, there is a small but committed core who does most of the work. Tapscott and Williams, *Wikinomics*, 73.

46. Tom Whipple, "Scientology: The Anonymous Protestors," *Times* (London), 20 June 2008.

47. Alexia Tsotsis, "My Date with Anonymous: A Rare Interview with the Elusive Internet Troublemakers," *LA Weekly*, 4 February 2009, http://www.laweekly.com/2009-02-05/columns/my-date-with-anonymous-a-rare-interview-with-the-illusive-internet-troublemakers/.

48. Barton Gellman, "Anonymous," *Time*, 18 April 2012, http://www.time.com/time/specials/packages/article/0,28804,2111975_2111976_2112122,00.html.

49. "'Anonymous' Hackers Arrested in US Sweep," *Herald Sun*, 20 July 2011, http://www.heraldsun.com.au/news/breaking-news/anonymous-hackers-arrested-in-us-sweep/story-e6frf7jx-1226097971794; and Andy Greenberg, "Fourteen Anonymous Hackers Arrested For 'Operation Avenge Assange,' LulzSec Leader Claims He's Not Affected," *Forbes*, 19 July 2011, http://www.forbes.com/sites/andygreenberg/2011/07/19/anonymous-arrests-continue-lulzsec-leader-claims-hes-not-affected/.

50. Glen Greenwald, "The U.S. Government targets Twitter Terrorism," *Salon.com*, 20 December 2010.

51. Hanna Rogan, "Abu Reuter and the E-Jihad: Virtual Battlefronts from Iraq to the Horn of Africa," *Georgetown Journal of International Affairs* (Summer/Fall 2007): 89.

52. Fareed Zakaria, *The Post-American World* (New York: W. W. Norton, 2008), 13.

53. As Rohan Gunaratna found, "in the twelve-month period ending December 2007, al Qaeda produced a cassette, sermon, or video every three days." Gunaratna, "Al-Qaedastan: The Sanctuary of the Afghan-Pakistan Border," *Intel File*, 12, http://events.fcw.com/events/2008/GLR/downloads/GLR08_T1_GUNARATNA_THE%20TERRORIST%20SANCTUARY%20OF%20THE%20AFGHAN-PAKISTAN%20BORDER.pdf. In the six years following 9/11, Osama bin Laden appeared in more than 20 videos and audiotapes. His chief lieutenant, Ayman al-Zawahiri communicated more frequently, appearing in more that 40 productions during that period. Brian Michael Jenkins. *Will Terrorists Go Nuclear?* (Amherst, NY: Prometheus Books, 2008), 247.

54. Rogan, "Abu Reuter and the E-Jihad."

55. Michael Moss and Souad Mekhennet, "An Internet Jihad Aims at U.S. Viewers," *New York Times*, 15 October 2007, http://www.nytimes.com/2007/10/15/us/15net.html.

56. Nadya Labi, "Jihad 2.0," *Atlantic*, July/August 2006, 102–8.

57. Although YouTube pulled some videos, some of the others that Lieberman had requested were not removed because they were not violent or did not qualify as "hate speech." Craig Whitlock, "Al-Qaeda's Growing Online Offensive," *Washington Post*, 24 June 2008, A-1.

58. Brynjar Lia, "Jihadi Web Media Production: Characteristics, Trends, and Future Implications," *Norwegian Armed Forces*, February 2007, http://www.mil.no/multimedia/archive/00092/Jihadi_Web_Media_Pro_92100a.pdf.

59. Weimann, *Terror on the Internet*, 15.

60. Moss and Mekhennet, "Internet Jihad Aims at U.S. Viewers."

61. Lia, "Jihadi Web Media Production."

62. Whitlock, "Al-Qaeda's Growing Online Offensive."

63. Hanna Rogan, *Al-Qaeda Online: Understanding Jihadist Internet Infrastructure* (Kjeller, NO: Norwegian Defence Research Establishment, 2006).

64. These include, first, the key nodes or mother sites which are the official home pages of jihadist groups. Second, there are distributors—a host of various websites that copy and upload material on multiple sites and direct the viewers to the most important sites. Finally, the producers reformat and refashion the raw material from the key nodes into a sleeker and more attractive product. Lia found that the sites have evolved from noninteractive, more-official websites that are established by the jihadist groups toward a more multilayered and redundant media production and distribution system. Rogan, *Al-Qaeda Online*.

65. Bruce Hoffmann, "Introduction," in Weimann, *Terror on the Internet*, ix.

66. Rogan, *Al-Qaeda Online*.

67. Michael Scheurer, *Imperial Hubris: Why the West is Losing the War on Terror* (Dulles, VA: Potomac Books, 2004), 81–82.

68. Gregory S. McNeal, "Cyber Embargo: Countering the Internet Jihad," *Case Western Reserve Journal of International Law* 39, no. 3 (undated): 797–98.

69. Scheurer, *Imperial Hubris*, 83.

70. Paul Cruickshank and Mohannad Hage Ali, "Abu Musab Al Suri: Architect of the New Al Qaeda," *Studies in Conflict and Terrorism* 30 (2007): 1–14.

71. Brynjar Lia, *Architect of Global Jihad: The Life of Al Qaeda Strategist Abu Mus'ad Al-Suri* (New York: Columbia University Press, 2008).

72. Cruickshank and Ali, "Abu Musab Al Suri," 9.

73. Marc Sageman, *Leaderless Jihad: Terror Networks in the Twenty-First Century* (Philadelphia: University of Pennsylvania Press, 2008).

74. Adam Gadahn, a.k.a. Azzam the American, has emerged as one of al-Qaeda's leading spokesmen. Amazingly, the young California native and convert to Islam was able to ingratiate himself into the highest echelons of al-Qaeda. A seemingly alienated youth, he underwent a radicalization process and made his way to Pakistan, where he was recruited and served as a translator for the terrorist organization. He emerged as somewhat of an Internet celebrity on websites such as YouTube. For more on Gadahn, see George Michael, "Adam Gadahn and Al Qaeda's Internet Strategy," *Middle East Policy* 16, no. 3 (Fall 2009): 135–52.

75. Jenkins, *Will Terrorists Go Nuclear?* 127–29.

76. "Al-Qaida American Was Poster Boy for USC Muslim Student Association," *WorldNetDaily*, 14 July 2006, http://www.worldnetdaily.com/news/article.asp?ARTICLE_ID=51050.

77. "Al-Qaeda on Alleged Fort Hood Killer: 'Ideal Role Model,' " *USA Today*, 7 March 2010.

78. "American Al Qaeda Adam Gadahn's Chilling Video Shows how the Gun Lobby Hampers the War on Terror," *Daily News*, 4 June 2011, http://articles.nydailynews.com/2011-06-04/news/29636176_1_gun-show-terror-gap-gun-sellers.

79. Peter Bergen, "Why Bin Laden Still Matters," *Newsweek*, 4 September 2010, http://www.thedailybeast.com/newsweek/2010/09/04/why-osama-bin-laden-still-matters.html.

80. Aamer Madhani, "Clear al-Awlaki dubbed 'bin Laden of the Internet,' " *USA Today*, 24 August 2010, http://usatoday30.usatoday.com/news/nation/2010-08-25-1A_Awlaki25_CV_N.htm.

81. Jarret M. Brachman and Alix N. Levine, "You Too Can Be Awlaki!" *Fletcher Forum of World Affairs* 35, no. 1 (Winter 2011): 26–29.

82. This is according to the terrorism analyst Evan Kohlman. Jasper Hamill, "Web Watch: How the Internet Cultivated the New Bin Laden," *Herald* (Scotland), 26 September 2010.

83. Mark Mazzetti, Eric Schmitt, and Robert F. Worth, "Two-Year Manhunt Led to Killing of Awlaki in Yemen," *New York Times*, 30 September 2011; and "Al-Awlaki's Son among Al Qaeda Militants Killed in Yemen Air Strike," *Associated Press*, 15 October 2011.

84. Richard Spencer, "Al-Qaeda Magazine Teaches How to Kill Americans," *Telegraph*, 12 October 2010; and Shaun Waterman, "In Online Journal, Al Qaeda Pushes 'Lone-Wolf' Attacks; Jihad Abroad Discouraged," *Washington Times*, 13 October 2010.

85. Cruickshank and Ali, "Abu Musab al Suri," 9, 10.

86. Robyn Torok, "'Make a Bomb in Your Mums [*sic*] Kitchen': Cyber Recruiting and Socialisation of 'White Moors' and Home Grown Jihadists," in *Proceedings of the 1st Australian Counter Terrorism Conference* (Perth, Australia: Edith Cowan University, 2010), 58.

87. Akil N. Awan, "Virtual Jihadist Media: Function, Legitimacy, and Radicalizing Efficacy," *European Journal of Cultural Studies* 10, no. 3 (August 2007): 400.

88. McNeal, "Cyber Embargo," 796.

89. Awan, "Virtual Jihadist Media," 400.

90. Ibid., 404.

91. Brachman and Levine, "You Too Can Be Awlaki!" 43.

92. Ibid., 26.

93. Ibid., 45.

94. Rid and Hecker, *War 2.0*, 204.

95. "Suspect in French Killing Spree Dead," *USA Today*, 22 March 2012, http://www.usatoday.com/news/world/story/2012-03-22/French-killing-spree/53697578/1.

96. Such intangibles, including media, culture, and ideology, are in contrast to tangible resources such as military and economic might. Joseph Nye, "The Changing Nature of World Power," *Political Science Quarterly* 105, no. 2 (Summer 1990): 177–92.

97. Kara-Jane Lombard, "Gen E (Generation Extremist): The Significance of Youth Culture and New Media in Youth Extremism," in *Recent Advances in Security Technology*, eds. Priyan Mendis et al. (Melbourne: Research Network for a Secure Australia, 2007).

98. Henry Jenkins, *Convergence Culture: Where Old and New Media Collide* (New York: New York University Press, 2006).

99. John A. Nagl, *Learning to Eat Soup with a Knife: Counterinsurgency Lessons from Malaya and Vietnam* (Chicago: University of Chicago Press, 2005), 24.

100. Gabriel Weimann, "Terror on Facebook, Twitter, and Youtube [*sic*]," *Brown Journal of World Affairs* 16, no. 2 (Spring/Summer 2010): 52–53.

101. Definitions of these terms are in order. *Encryption* transforms electronically transmitted information so that it is unreadable for anyone except the person with a password that would allow the message to be decrypted. *Free e-mail accounts* are offered by certain sites that provide registration, e-mail construction, and sending and receiving facilities. *Internet relay chat* is a form of real-time text messaging, mainly designed for group communication in discussion forums but also allows for one-to-one communication by way of private messages. *Steganography* is the practice of embedding hidden messages within other messages or

images. An *anonymous re-mailer* is a server computer that receives messages with embedded instructions and then forwards them without revealing the original source. *Web-based bulletin boards* are areas on websites where users can leave and/or erase messages so that other people can read them.

102. Linda Garrison and Martin Grand, eds., *National Infrastructure Protection Center Highlights*, issue 10-01, 10 November 2001.

103. Carol M. Swain, *The New White Nationalism in America: Its Challenge to Integration* (New York: Cambridge University Press, 2002), 309.

104. Mark Juergensmeyer, *Terror in the Mind of God: The Global Rise of Religious Violence* (Berkeley: University of California Press, 2000), 142; and "Anti-Abortion Web Site Goes on Trial," *USA Today*, 7 January 1999.

105. Brachman and Levine, "You Too Can Be Awlaki!" 34.

106. Mary Pat Flaherty, "Guard at D.C. Conservative Group Shot," *Washington Post*, 15 August 2012, http://newsle.com/article/0/27417478/.

107. Rid and Hecker, *War 2.0*, 208.

108. For more on Myatt, see George Michael, *The Enemy of My Enemy: The Alarming Convergence of Militant Islam and the Extreme Right* (Lawrence: University Press of Kansas, 2006).

109. Rid and Hecker, *War 2.0*, 219–20.

110. Thomas P. M. Barnett, *The Pentagon's New Map: War and Peace in the Twenty-First Century* (New York: G. P. Putnam's Sons, 2004).

111. For example, using FBI data on terrorism, Smith and Damphousse found that prior to 1976 the average number of members indicted in each right wing terrorist group was 9.4. After 1976, that figure had dropped to 5.8. A similar pattern was evident for international terrorist groups operating in the United States, with a figure of six members prior to 1976 and three thereafter. Brent L. Smith and Kelly R. Damphousse, *American Terrorism Study: Patterns of Behavior, Investigation, and Prosecution of American Terrorists* (Rockville, MD: National Institute of Justice, 2002), 6. Similarly, during the period from 1955 to 1977, 7 percent of all terrorist fatalities in the United States were attributed to individuals, according to the research of Christopher Hewitt. However, for the period from 1978 to 1999, that proportion rose to 26 percent. Christopher Hewitt, *Understanding Terrorism in America: From the Klan to Al Qaeda* (London: Routledge, 2003), 78. Likewise, the US Department of State observed a trend whereby more dispersed, localized, and smaller-scale groups are increasingly active in terrorism, often with great lethal effect. Department of State, *Country Reports on Terrorism 2005* (Washington: Government Printing Office, 2005), chap. 2.

112. Torok, "'Make a Bomb in Your Mums [*sic*] Kitchen,'" 59.

113. McNeal, "Cyber Embargo," 788–826.

114. Nick Fielding and Ian Cobain, "Revealed: US Spy Operation that Manipulates Social Media," *Guardian*, 17 March 2011, http://www.guardian.co.uk/technology/2011/mar/17/us-spy-operation-social-networks.

115. *Empowering Local Partners to Prevent Violent Extremism in the United States* (Washington: The White House, August 2011, http://www.whitehouse.gov/sites/default/files/empowering_local_partners.pdf.

Deterrence Logic and NATO's Nuclear Posture

Damon V. Coletta

At an April 2010 meeting of NATO foreign ministers in Tallinn, Estonia, Secretary of State Hillary Clinton announced a key policy principle—that US tactical nuclear weapons would remain in Europe—thus avoiding consternation within the alliance. Anticipating the New Strategic Concept that would win consensus later that year, Secretary Clinton linked NATO's nuclear capability to the continued presence of nuclear weapons in the rest of the world. The weapons in question were approximately 200 adjustable-yield gravity bombs that remain near NATO air bases after the dramatic drawdown of the 1990s. A heated dispute might have jeopardized the solidarity of the alliance during discussions to formulate a new strategic concept.[1] That said, the controversy over NATO's nuclear posture has not been entirely resolved. Despite the tenor of subsequent declarations at the Lisbon and Chicago summits, where leaders reaffirmed that NATO would remain a nuclear alliance, the current deployment of US nuclear bombs in Europe cannot be chalked up as a routine chore for collective defense without second thought.

Both a German-led initiative to remove the weapons and official US acquiescence in the status quo highlight that American B61 warheads remain in Europe under the banner of deterrence. What has not been determined is how the alliance can prepare for a most extreme crisis—one evoking nuclear threats and straining the Article 5 guarantee of mutual defense—if, under close analysis, deterrence logic undermines justification for such weapons as the backbone of NATO's nuclear posture.

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The Obama administration's *Nuclear Posture Review*, released the same month as the foreign ministers meeting, notably incorporated the final decision-making process on alliance nuclear posture neatly within NATO institutions. This was in marked contrast to bilateral action that heralded the previous administration's move to deploy missile defense elements in Poland and the Czech Republic, or to the Obama team's essentially unilateral decision to retract these plans. Nevertheless, once Secretary Clinton spoke in Tallinn, it was hard to imagine NATO's New Strategic Concept saying anything different than what it eventually declared just seven months later in Lisbon: NATO would retain an "appropriate mix" of assets to deter any attack on the territorial integrity of member states.[2]

The reference to deterrence and the explicit link to collective defense under Article 5 of the North Atlantic Treaty sent a reassuring signal to new NATO members in Central and Eastern Europe, including the Baltic States. These allies, more than others, feared intimidation tactics and escalating demands from evidently fluid Russian diplomacy in the wake of its military invasion of Georgia. To the extent that protection at lower levels of aggression depended on the credibility of NATO going all-out to defend its members in extremis, these states had wondered, again, what the removal of US nonstrategic nuclear weapons might mean.

Yet, in the venerable tradition of Article 5, language in the New Strategic Concept left some discretion. Although the preface reprised Secretary Clinton's formulation—as long as nuclear weapons remained in the rest of the world, NATO would remain a nuclear alliance—the very same section committed members to creating a world without nuclear weapons. The juxtaposition of contradictory impulses—nuclear reliance and nuclear abolition—reflected the politics of the moment. It also opened the door to new shades of meaning, if only to pull the concept into a safe harbor of logical consistency.

What, for example, were the minimum requirements for NATO to remain a "nuclear alliance"? Would it be enough to retain the Nuclear Planning Group and the capacity to reconstitute capabilities once it mothballed its US warheads? Did explicit reference to the "supreme guarantee" of independent strategic nuclear forces controlled by the United States, Great Britain, and France imply that the gravity bombs in Germany, for example, were less than crucial for deterring threats to NATO's territorial integrity? In short, use of the term *nuclear alliance* primarily for deterring

nuclear attacks by the rest of the world opened "Pandora's box," calling forth old debates that racked the alliance throughout the Cold War.[3]

As heartfelt supporters of the status quo, the coalition of Central and Eastern European members, who equate US nonstrategic bombs in Europe with indispensable proof of the commitment to collective defense, had the most to fear from previous contests. The flexible response and multilateral force debates of the 1960s, on top of NATO's two-track decision and the short-range nuclear forces (SNF) clashes of the 1980s, probed deeply into the nature and plausibility of a US commitment to defend Europe from the Soviets at all costs. Contemporary advocates of keeping the US weapons, reiterating an established line from previous debates, naturally justified NATO's nuclear posture in terms of deterrence. However, an alliance of democracies with special regard for transparency and accountability sooner or later must confront actual deterrence logic and the question of whether current nuclear deployments make strategic sense.

Deterrence logic—at least the kind formulated by legendary theorists such as Bernard Brodie, Glenn Snyder, and Thomas Schelling—may actually *exclude* current nuclear warheads from NATO's appropriate mix under the new strategic concept and within the framework of the Deterrence and Defence Posture Review (DDPR) announced at the Chicago Summit.[4]

To see how authentic deterrence eliminates the need for US nonstrategic nuclear weapons in Europe, it is useful to remember how NATO ended up with these weapons and the roles proposed for this arsenal by constituencies within the alliance. When policymakers, in consultation with think tanks and academics, formulated deterrence strategy for the deployment of nuclear weapons, they did not theorize in a political vacuum. Avoiding nuclear war was a top priority, or on par with national success against rivals, for many of them.[5] When the present NATO mix is mapped against requirements for this kind of nuclear deterrence—one that recognizes a general nuclear exchange as unwinnable—the best fit theoretically and politically, given the alignment of stakeholders on this issue, occurs when gravity bombs under dual responsibility are taken out of the NATO posture for collective defense.

NATO's Nuclear Capability and another Great Debate

In his history of the short-range nuclear forces controversy that roiled NATO meetings in the late 1980s, Tom Halverson noted with relief that

the SNF most likely represented the last great nuclear debate for NATO; by the mid 1990s the alliance had endorsed near-complete removal of US nuclear weapons from Europe in response to implosion of the Soviet threat.[6] Halverson aligned with several scholars who saw little need for nuclear weapons to reinforce Article 5 commitments following the withdrawal of Soviet forces from Central Europe and unilateral arms cuts undertaken by both sides after the Cold War.[7] Indeed, the greater concern was whether the alliance could maintain its cohesion without a common military threat.[8]

Twenty years later, however, experienced hands found darker auguries among those few remaining NATO weapons.[9] After so much time, standards and objectives had changed for a new generation of political actors adapting to dramatic shifts in the international distribution of power. Attention once again turned toward nonstrategic nuclear weapons, and despite the hopes of historians at the end of the Cold War, policymakers in charge of NATO found them increasingly difficult to ignore.[10]

Obligations of declared nuclear weapon states under Article VI of the 1970 Non-Proliferation Treaty (NPT) have become more salient as emerging powers and violent nonstate actors flirt with weapons of mass destruction. Established powers aim to strengthen the international nonproliferation regime by eliminating nuclear warheads without clear military utility or political purpose.[11] Meanwhile, as post–Cold War NATO enlarged into the former Soviet sphere of influence, Article 5 of the North Atlantic Treaty became more important. Small or mid-size members in Central and Eastern Europe aimed to strengthen collective defense commitments from their colleagues in Western Europe and North America by persuading them, through the North Atlantic Council, to maintain their current nuclear obligations irrespective of military utility or shifting political significance.

The largely forgotten gravity bombs of the 1990s now lie at the center of a brewing policy debate. The stakes are high, since these weapons conjure primal threats against the national security of at least some alliance members. Also, the institutional processes to forge consensus promise to be complicated, since these tactical nuclear weapons are tangible, undeniable reminders that the number one concerns on the security agendas of NATO allies are not, unfortunately, always identical.

NATO's Faulty Deterrence Logic

If the United States and NATO enter discussions with Russia to reduce tactical nuclear weapons, the opening gambit will likely present the B61s as a key component of NATO's extended deterrent. Withdrawing them will therefore require a corresponding relaxation on the Russian side—a proportionate reduction or, better yet, a disproportionate cut to transform Russia's current tenfold superiority in tactical warheads into something approaching parity.

Equating relative numbers of deployed US weapons to the strength of NATO's deterrent may, however, prove invalid. NATO calculations and the implications of its New Strategic Concept rest on a questionable premise—that US B61s offer a unique capability and serve as indispensable proof of alliance solidarity, thus reinforcing the collective defense commitments under Article 5. In fact, B61s provide totemic protection, akin to the Maginot Line, rather than the politically important troop deployments to Berlin during the 1960s. Whatever effect they may have now works at the margins to further placate NATO members already under the protection of US strategic arms. Where is the sign that these B61s constrain any Russian designs for Europe? Once tactical arms control negotiations begin, and the longer talks stumble along, the weaker NATO's negotiating position will be because the more exposed these warheads will become as false talismans.

During Cold War strategy debates, when NATO divisions faced far superior numbers on the other side of the Fulda Gap, 10-kiloton gravity bombs had a plausible military function. If the Soviets attempted to exploit their conventional advantage, a seamless fabric of response options ran from conventional denial capabilities through short-range nuclear forces to NATO nuclear weapons states' strategic arsenals. *Seamless* meant there was no identifiable break in the escalation chain. To forestall a catastrophic defeat by Soviet mechanized armies, the allies could credibly cross the nuclear threshold without ending the world, employing tactical nuclear warheads to break up Soviet formations or in some other way signal NATO's resolve. If the Soviets responded by launching nuclear bombs and destroying cities in Central Europe, Article 5 announced that all bets were off. The allies would consider punishing Russia to get the Kremlin to stop. Once that occurred, the situation could spin out of control, and the world would be on the verge of a general nuclear exchange. During the evolution of Cold War debates, Germany eventually

supported short-range forces like the B61 bombs but in tandem with US intermediate-range nuclear missiles on its territory to reduce the likelihood of a limited war terminating shortly after the destruction of the German homeland. German elites wanted Soviet leaders to face a steep, slippery slope from their first aggressive move toward Armageddon to deter that first thrust.

In a 1989 comprehensive treatise, *NATO Strategies and Nuclear Weapons*, Stephen Cimbala explained why the Germans at times objected strenuously to US formulas for deterring Soviet aggression in Europe. He argued that deterrence during the Cold War followed not one but two separate logics.[12] Cimbala's first deterrence logic properly emphasized what might happen if a crisis slipped out of control: mutual destruction or death and mayhem, all out of proportion to any conceivable political objective. Following the first generation of deterrence theorists of the 1960s, this logic focused on the competition in risk-taking.[13] Declarations and deployments in support of deterrence were crafted to influence an adversary's perceptions that the unthinkable and irrational could still happen. Since few crises justified running a substantial risk of losing everything, the deployment of nuclear weapons defended Western interests and thwarted Soviet aggression without their ever being used, either on the battlefield or against utterly vulnerable population centers.

The original deterrence reasoning did have major drawbacks, particularly for an alliance championing liberal democratic values. Under deterrence, national security depended on the vagaries of losing control at the critical moment and doing something irrational to seal the fate of ordinary people. This madman strategy undercut transparency and accountability of decision makers before their fellow citizens—despite the fact that transparency and accountability were pillars of democratic governance.

Moral questions surrounding deterrence encouraged US statesmen to raise the threshold for using nuclear weapons in Europe. Defense Secretary Robert McNamara attempted this with his flexible response advocacy of the 1960s. Remaining in control as long as possible, however, opened the possibility that the United States might refuse to launch weapons when the massive destruction they caused would serve no political purpose. A reasonable suspicion that the United States might spare the world, even in the throes of a communist triumph, left NATO's European allies naked before overwhelming Soviet and Warsaw Pact conventional arms.

This newer "deterrence" analyzed by Cimbala nevertheless survived NATO's internal policy debates; it answered the understandable desire for US officials to remain in charge of their nation's destiny, to retain freedom to decide on life-or-death questions, and to escape the unyielding tyranny of the first deterrence logic.

The second approach, under the name of deterrence, clawed back control step-by-step, breaking superpower crisis scenarios into discreet stages. At each stage—a Soviet probe into West Germany, a communist-inspired insurgency in Southeast Asia, the clash of mechanized divisions, or the exchange of tactical nuclear warheads on military targets—the United States, as the alliance's great protector, should be prepared to dominate at every level through the entire arc of escalation. Any Soviet leader surveying this smothering posture would conclude that no form of aggression against the West could pay dividends.[14] Whereas the original competition in risk-taking dared adversaries to test US resolve, escalation dominance was an attempt to shut down Soviet options systematically until their only rational course was to avoid the initial provocation.

Nuclear control seemed safer and morally appealing for democratic leaders who wanted to discharge their national security responsibilities until the very end, but it was no longer tied to the original deterrence logic, and it, too, had flaws. Perhaps the greatest of these were the challenge of defining superiority at the final strategic level of escalation and the tension that strategic superiority created against stabilizing concepts such as mutual assured destruction and secure second strike.[15] Cimbala observed that his two versions of deterrence, actually two distinct logics under the same label, fought each other through the end of the Cold War. In retrospect, only the first described true deterrence; the second posed under the same label but actually rested on a different, and ultimately less realistic, logic of control.

With the Russian threat reduced, though not eliminated after 20 years, and the transatlantic alliance now acutely aware of its political as well as military functions, NATO rediscovered its clashing "deterrence" alternatives.[16] Its Deterrence and Defence Posture Review in the wake of its new Strategic Concept conceded—as both President Reagan and Chairman Gorbachev did in 1985 after an especially contentious period in the superpower relationship—that "nuclear war cannot be won and must never be fought."[17] The 2010 concept already implied as much when it reiterated how the supreme guarantee of deterrence under Article 5

inheres in the strategic forces of NATO nuclear weapon states.[18] Those are precisely the weapons with upward of a half-million megatons of TNT, the detonation of which could not serve any purpose trumpeted in NATO enlargement, NATO partnership, or NATO diplomacy.[19] Although New START, the strategic arms reduction treaty ratified with Russia shortly after NATO published its new concept, represented a reset of US-Russian relations, treaty limits remain high enough to reinforce international understandings of secure second strike and mutual assured destruction.[20]

In short, there is little reason to imagine that Cimbala's original deterrence logic, the one involving risk-taking under uncertainty, is nothing less than *the* operating deterrence logic which rests, as ever, on the possibility that nuclear powers could make a mistake through a psychological or organizational breakdown and release their absolute weapons.[21] Nonetheless, highly sophisticated analyses of national security strategy often rely on a simpler, broader, and ultimately misleading definition of deterrence: nothing more than convincing potential adversaries not to attack.[22] Nuclear deterrence in this casual usage sounds more prudent than arming for war, despite some of the possibilities lurking inside the umbrella definition, including *limited nuclear strikes* to establish escalation dominance over an adversary. The deterrence brand, whether connoting the logic or not, almost always hits the right chord in policy discussions after its widely regarded contribution to Cold War containment and eventual defeat of the Soviet Union. In twenty-first-century variants, defense planners turn first to less reprehensible means of altering an adversary's expected utility of attack, although how often these purported deterrence measures work or how logic flows through a final decision, or endgame, are not clearly defined. Moreover, a wide variety of national and allied security stakeholders can participate: the vaguer the deterrence concept, the bigger the potential coalition in favor of the strategy.

Despite all the rhetoric, however, the clear alternative to deterrence by punishment so provocative or disproportionate that a rational defender would hesitate to unleash it is some form of control. *Control* means the enemy cannot hurt the homeland regardless of its intentions, or however the enemy prepares to strike, it must contemplate a rational nightmare—a near certain and proportional price—that torpedoes its enterprise. It describes the opposite of what happens at the true deterrence endgame, when the supreme guarantee of strategic nuclear warheads

comes into play because of a kind of weakness in leadership—the substantial yet incalculable likelihood that responsible officials or administrations under stress may succumb to irrational forces.

With respect to NATO's current tangle over the appropriateness of its nuclear posture, three contending alternatives all seek protection, and legitimation, under the banner of deterrence. Either k*eeping the weapons* or *cashing in the B61s* for reductions on the Russian side might still end up being effective policies of control, particularly as more information becomes available on Russian calculations. But in an honest debate, only the German-sponsored proposal—*eliminate the weapons*—merits designation as a deterrence strategy. It is the only alternative that works based on authentic deterrence logic. The others may purport to strengthen deterrence, but in fact, they invest in sophisticated manipulation of adversary utility functions, which, like flexible response and escalation dominance of old, come with their own set of risks.

Keep the Weapons

Poland, the Czech Republic, the Baltic States, and Turkey were vocal in support of NATO freezing its nuclear posture and holding the US bombs in Europe. Interestingly, only one of these members, Turkey, actually hosts a B61 base. Central and Eastern European allies nevertheless feel protected by the estimated 200 bombs in Germany, Belgium, the Netherlands, Italy, and Turkey which may be delivered by US or NATO fighter-bomber aircraft.[23]

The US warheads, according to the Central and Eastern European perspective, signal to a resurgent Russia or any adversarial power the seriousness with which NATO members, especially those with strong conventional militaries and strategic nuclear arsenals, treat their Article 5 commitment to defend the territorial integrity of fellow allies. Any power that attempted to intimidate Poland or Estonia, for example, would have to consider that coercive tactics could escalate out of control. While it might not be credible to imagine that the United States would launch a nuclear warhead from one of its ballistic missile submarines to turn back military encroachment on a frontline NATO state, it is more plausible, at least to some, that the alliance as a whole would mobilize the fighter-bombers of dual-capable aircraft (DCA) states. Such a decision by NATO would arguably bring the United States closer to crossing the threshold of nuclear use than it has ever been since 1945.

NATO's nuclear mobilization, according to the B61 defenders, might succeed in reminding all parties of the disproportionate risks involved in pressing a military advantage against any NATO ally without actually dropping a bomb. Simply eliminating the B61 might send the opposite message to potential aggressors—that they could crowd the newest NATO states without rousing the full capabilities of the alliance as a whole. Unless nonstrategic nuclear weapons are reserved on behalf of NATO, an adversary might find the vaunted indivisibility of allied security to be a mere slogan—once the salami slices taken from Central and Eastern European members were each made sufficiently thin.

A critical evaluation of this argument for keeping the weapons must note that the military capability of NATO's short-range nuclear forces has fallen dramatically since the Cold War. The Brookings Institution reported that the state of readiness for employing the remaining warheads is now measured in months.[24] Several high-profile exercises would likely be required to make those weapons effective tactically against advancing columns of mechanized forces.[25] Without refueling assets, which are in short supply, these bombs could ultimately explode on NATO territory. Unclassified US Air Force factsheets list the unrefueled combat radius of the F-16 fighter-bomber as roughly 500 miles. That figure, of course, cannot support genuine military planning, but it does send a message to the public. That capability would carry the bombs from a base in Western Germany to somewhere in Poland, or bombs from a base in Italy might end up in central Romania. To reach Moscow, the notional combat range from the closest European bases would nearly be tripled.[26]

The political utility of NATO's posture also remains ambiguous due to a significant feature of the B61. The adjustable-yield warhead ranges from 0.3 kiloton—50 times smaller than the explosion over Hiroshima—to a city-busting 170 kilotons.[27] At the moment when nuclear-capable fighter-bombers took off from their European bases, an adversary attempting to read NATO's crisis escalation would have little certainty of what to expect, with worst-case scenarios reinforcing the conclusion that a full-blown strategic exchange had already begun.

Cash in the B61s

Ultimately, the most influential opponents of keeping the weapons may operate behind the diplomatic scenes through transgovernmental connections. The official US view has already linked reduction of nonstrategic

weapons assigned to NATO with proportional or even accelerated cuts from the Russian arsenal. In doing so, the United States struck a double compromise. First, it opened the possibility of withdrawing the B61s from Germany and other DCA states while it signaled for frontline members in Central and Eastern Europe that removal will take a while. An agreement to dramatically reduce US (and Russian) nuclear arms could occur but not without concurrent political changes that (it is hoped) would relieve security pressure on the frontline members. The second and concurrent compromise disappointed opponents of keeping the B61s in Europe, for the time being, while signaling they would not have to pry very far behind official language to find kindred spirits across the Atlantic—the US compromise policy of seeking negotiation on the B61s was also patching a rift within the US government.

The timeline of the US formula, as it emerged in spring 2010, spoke to the sand at its foundation. Secretary Clinton did give speeches before and during the April 2010 Tallinn meeting to rein in NATO abolitionists, but the US president followed a different tack. Not that he contradicted the notion of NATO as a nuclear alliance, but he devoted his spring to strengthening the regime anchored in the NPT which committed nuclear powers to good faith efforts at general and complete disarmament. In the same month as the foreign ministers' meeting in Tallinn, President Obama signed the New START treaty. This symbolically reset relations with Russia after the debacle caused by its invasion of Georgia during his election campaign 20 months earlier and marked a significant reduction in strategic nuclear weapons. The president also convened a summit of 47 countries to discuss greater cooperation in the control of weapons material, and he released the aforementioned *Nuclear Posture Review*. This new document emphasized incentives for nonnuclear weapon states to follow the NPT regime, the importance of the United States along with other powers reducing reliance on nuclear weapons, and the wisdom of deciding future NATO posture within alliance processes.[28] All this came at the one-year anniversary of Obama's Prague speech to a packed Hradčany Square in a country that strongly supported US warheads in Europe as part of NATO's deterrent. The president opened his essay on the nuclear future saying, "The existence of thousands of nuclear weapons is the most dangerous legacy of the Cold War." To applause, he laid out "clearly and with conviction

America's commitment to seek the peace and security of a world without nuclear weapons."[29]

The Prague speech would inspire the Foreign Ministry in Germany during late 2009 and 2010. Looking back, the speech adopted tones from two riveting newspaper editorials by America's own gang of four wise men, who called for abolition of nuclear weapons in the foreseeable future. The open letters in 2007 and 2008 from unimpeachable US Cold Warriors set the stage and format for the German plea signed by Helmut Schmidt and his compatriots just three months before Obama's speech.[30]

Officially, the Obama administration and leading members of the German foreign policy establishment disagreed over whether eliminating tactical weapons in Europe should occur late or early in the disarmament process. At the same time, the two allies agreed on means and ends of greater significance: national policies, for example, should be modified to reduce reliance on nuclear weapons and strengthen the NPT regime; arms reductions constituted meaningful steps toward abolition; and abolition was the most effective way to prevent nuclear weapons use by state or nonstate actors.

Intriguingly, wariness from nuclear weapons may now extend beyond political levels of the US administration.[31] Nongovernmental organizations promoting arms control have found allied officers who, off the record, question the utility of the B61s in Europe, given the costs required to maintain the safety and security of the warheads.[32]

Officially, of course, the armed services will do whatever is necessary to accomplish the deterrence mission as set by civilian authorities. Still, the extraordinary lapse involving unauthorized transport of nuclear-armed air-launched cruise missiles across the United States, the conclusions of a Pentagon investigation into the matter, and the pain imposed on units of the US Air Force—the organization responsible for bombers, missiles, and land-based nuclear ordnance, including the nonstrategic warheads in Europe—all point to a desire, albeit closely held, to ease the institutional burden of these weapons.[33] The US military-industrial complex, often accused of inflating acquisition and modernization budgets, will not necessarily dig in to keep the B61s in Europe.

The US formulation—no abolition for NATO as long as nuclear weapons remain in the rest of the world—sounded firm in Lisbon, but the position was born of US resignation rather than the conviction displayed earlier in Prague. If only, one might imagine members of the

Obama administration reflecting, there was a path to reduce holdover B61s without discomfiting the newer frontline members of NATO. The only way to nurture the grand bargain underpinning the international nonproliferation regime and simultaneously reinforce extended deterrence under NATO's Article 5 appeared to be through arms control progress on tactical nuclear weapons—following the success of New START at the strategic level.[34] Under this scenario, elimination was not taken off the table, which gave hope to the German-led coalition on nonproliferation. Yet, any reductions were tied to Russian disarmament, which reassured the frontline states.

Unfortunately, the US-brokered compromise, rather than entombing NATO's next great nuclear debate, actually planted new seeds. Pursuit of an agreement on tactical nuclear weapons cannot be put off forever, and negotiations with the Russians are bound to expose certain contradictions in NATO's approach.

Eliminate the Weapons

Low military utility against conventional or in-kind attacks, a real likelihood of garbling the political signal when mobilizing variable-yield B61s, and a desire to advance the global nonproliferation agenda and reduce reliance on nuclear weapons, encouraged several Western allies, led by Germany, to call for elimination of the US tactical nuclear weapons reserved for NATO. Germany did sign conservative formulations in the New Strategic Concept and at the 2012 Chicago Summit, but its reasoning leading up to the alliance decisions of 2010 merits reexamination. Despite NATO's rhetoric on continuing the nuclear alliance and endorsing the status quo as an appropriate posture—for now—the camp arguing against NATO-designated B61s still enjoys advantages in the long run.

With Germany's economy remaining strong, the key proponent for eliminating the weapons occupies the diplomatic center stage, orchestrating intergovernmental efforts to rescue the euro zone from the global financial crisis.[35] Germany will also have an influential voice in how Europe answers US calls to share the international security burden, as the last superpower reins in its own defense budget for the first time since the 9/11 terrorist attacks. Moreover, for many years, even before unification, several historians recorded how West Germany leveraged institutional structures within the alliance to shed the stigma of World

War II and punch above its weight on several issues, especially nuclear policy.[36] Finally, on the present question of eliminating residual US nuclear weapons in Europe, Germany has many friends and few steadfast opponents.

Germany's position derived officially from an agreement by Chancellor Angela Merkel's Christian Democrats and Foreign Minister Guido Westerwelle's Free Democratic Party to pursue the removal of US nuclear weapons from German soil as a goal of their coalition government in fall 2009.[37] The parties were appealing to public opinion, but they also codified and reinforced a long-simmering ambition among German foreign policy elites. Frank-Walter Steinmeier, the Social Democratic Party foreign minister from the previous coalition, had endorsed the new US president's call in Prague to work toward a nuclear-weapon-free world. In doing so, he referred to an extraordinary open letter from four senior statesmen of Germany, including former chancellor Helmut Schmidt, that advocated concrete steps toward that goal such as implementation of disarmament obligations under the NPT and removal of nuclear weapons from German territory.[38] The German editorial received more serious attention than previous post–Cold War calls from the Foreign Ministry to reduce reliance on the nuclear option. The names on this piece hearkened back to the Cold War when West German diplomacy exerted formidable influence on NATO's nuclear policy.

When NATO shifted to a "flexible response" strategy in 1967, the Federal Republic of Germany (FRG) resolutely exercised its new voice on the alliance's Nuclear Planning Group and later the advisory High Level Group to steer political guidelines away from controlled, or gradual, escalation during a nuclear crisis. The eminently comprehensible German fear was that the Americans, to spare New York and Washington from a strategic missile exchange, would employ conventional and short-range nuclear forces to wage a drawn-out defensive campaign on German soil: "The shorter the missiles [and the longer the strategic lag], the deader the Germans."[39]

Throughout the Cold War, West German diplomats largely succeeded in resisting the coupling of tactical forces to the supreme deterrent of US strategic weapons. The 1969 Provisional Political Guidelines for nuclear use remained pointedly ambiguous—against US preferences for caution—on just how quickly tactical and follow-on warheads would come into play. The 1986 revision of the guidelines also accounted for

FRG objectives, linking thousands of NATO and US short-range warheads to higher—not lower—probability of intermediate-range and strategic-level responses to Soviet aggression.[40] Helmut Schmidt, the famed signatory on the German letter of 2009, was also a catalyst in the development of NATO's so-called two-track decision 30 years earlier when the alliance elected to pursue new arms control agreements with the Soviet Union at the same time it incorporated intermediate-range nuclear forces—ballistic and ground-launched cruise missiles—as part of a *comprehensive*, and continuous, mix to deter superior Soviet conventional forces.[41]

The double-zero agreement achieved by the Intermediate-Range Nuclear Forces (INF) Treaty of 1987, the first arms control initiative to eliminate an entire class of US and Soviet delivery systems, admittedly undercut long-standing German interests. Yet, West Germany almost immediately leveraged its rising credibility in NATO to push a triple-zero outcome, going after those SNFs that dangled German territory as a buffer to absorb fallout from even a temporary breakdown of the superpower relationship. West Germany turned up the heat on George H. W. Bush's administration to include SNFs in arms reduction talks at any sign of progress in conventional force redeployments.[42] Disintegration of the Warsaw Pact and unilateral force withdrawals by both superpowers during the 1990s rendered the question moot but in a way compatible with German views. Today, only an estimated 20 B61s remain on German soil.[43] If the history of NATO nuclear debates offers any track record, it favors the persistence, quality, and effectiveness of German advocacy in alliance forums.

As always, there are limits to how far any ally can stretch the bonds of transatlantic solidarity, but on the issue of nonstrategic nuclear weapons, Germany has several friends. Parliamentarians in the Netherlands, Belgium, and Norway have offered declaratory support for elimination. Two of these countries are basing nations, along with Germany. Norway, a traditional advocate for Article 5 and the integration of the Baltic States into NATO, may be considered a frontline state in negotiations with Russia. The remaining basing allies are Italy and Turkey. Both have expressed preferences for building cooperation with Russia after the violence in Georgia, and hints from the arms control literature question the readiness of Turkish aircraft to deliver their B61s following a transfer from US custody.[44]

Governments in the United Kingdom and France are reluctant to discuss changes to NATO's deterrence posture. Yet, both these independent nuclear powers are hard-pressed to elaborate on the deterrent value of the B61 vaults in NATO Europe. The main concern seems to be that the North Atlantic Council not rattle the confidence of new members by unilaterally dismantling its nuclear deterrent with respect to Russia.[45]

This suggests that other Western European powers might join Germany and the Benelux parliaments, especially if withdrawing the weapons today drew a reciprocal response from Russia. Though the New Strategic Concept declared NATO's intention to continue as a nuclear alliance, the precise meaning of that phrase, in accordance with the accompanying summit declaration at Lisbon and the DDPR at Chicago, was held open for further review.[46]

Whither NATO's Nuclear Weapons

NATO's B61 gravity bombs are, despite careful upkeep by small groups of Americans within the dual-capable aircraft states, vestigial arms from a bygone era when the alliance urgently prepared a *comprehensive mix* of capabilities to complicate Soviet plans. The current strategic concept omits that requirement, calling only for an "an appropriate mix" as collateral on nuclear members' Article 5 commitments. NATO officials will not concede the point in current discourse, but the B61s now are hardly appropriate: their range does not appear to be right; neither do their numbers nor their readiness for ending battle or sending a political signal during crises. Deterrence based on the risk of strategic exchange should trump less practical hopes based on escalation control. Yet, no advocate for keeping the B61s has presented publicly a convincing scenario in which launching an attack with these weapons from Western Europe or Turkey would pin the last clear chance for avoiding nuclear war on a nuclear-armed adversary.[47]

After the Georgia operation, the Russians appear to suffer conventional inferiority to NATO but retain dramatic quantitative superiority in tactical nuclear weapons, affording a clear response option against US B61s and making reciprocal, not to mention proportional, agreements to reduce the number of tactical weapons problematic. Also, designated nonnuclear states hosting the B61s in Europe wield a kind of veto; they can unilaterally reduce NATO's effective nuclear ordnance by replacing

current fighter-bombers with the Eurofighter, which unlike the US-sponsored F-35, is not certified to carry nuclear payloads.[48]

Admittedly, US nuclear weapons assigned to NATO provide an option for the alliance to cross the nuclear threshold. What remains unsaid is that this option will not shape Russian utility calculations within some neatly discrete stage of conflict escalation. Crossing the nuclear threshold with these B61s would not defeat Russia militarily, so advocates must believe it could change Russian perceptions as to the risk of escalation leading to a large-scale nuclear response.

Accordingly, B61s as a deterrent force should be a tripwire of the kind Glenn Snyder, one of the first-generation deterrence theorists, used to describe outgunned American troops in West Berlin: that brigade's involvement in combat and resulting casualties would have made it difficult for any US commander in chief to slow crisis momentum. An adversary contemplating the first aggressive move would have to think twice about the tripwire force, since rolling it would raise the probability of US escalation and eventual resort to strategic nuclear weapons use rather than calm acceptance of defeat in Europe.[49]

For a few reasons, though, today's B61s are not as appropriate as the Berlin Brigade for manipulating risk under deterrence logic. Unlike the brigade, the B61s are likely to be *distant* from initial action if it took place, say, in the territory of Baltic allies. NATO members would have to make a consensus decision to involve the B61s, and this choice would not be automatic. No one can say precisely what provocation would be enough to justify an alliance representing values of Western civilization crossing the nuclear threshold first. Moreover, if the allies decided to launch a nuclear bombing run, the signal would be very different from the sacrifice of a brigade. The capacity to dial up B61 yield to 170 kilotons and to extend aircraft range through refueling or radical mission profiles would make the approach of NATO fighter-bombers far more threatening—the B61s might communicate *uncontrolled* escalation, inflating the risk of an irrational exchange too abruptly.

Finally, if deterrence and competitive risk-taking are truly the main concern, there ought to be alternative means for conveying NATO's resolve in a crisis. The value of allied missile defense equipment in Poland or the Baltic States could substitute for the old symbolic units in beleaguered West Berlin without perturbing the independent and jealously guarded strategic forces of the United Kingdom or France. Meanwhile,

the punitive capacity of precision-strike conventional munitions and the demonstrated will to use them, even in less than vital out-of-area operations, might provide more utility for raising the stakes in a bid to strengthen immediate deterrence: getting an adversary to desist after it crossed a redline. Still another possibility would build an alliance protocol, a multilateral decision process to bring US nuclear warheads, perhaps even the B61s, into NATO-Europe from *au-delá de l'horizon* (from over the horizon). US warheads stored in Europe are not the only or necessarily the best way of structuring shared risks and responsibilities for extended deterrence.

The striking weakness of the official NATO position, as well as the US compromise for eventually altering the nuclear status quo, is that the B61s are justified as bolstering deterrence when they actually defy the risk-based logic of nuclear deterrence. Even in the twenty-first century, deterrence yet rests on the supreme guarantee of absolute weapons—the heavy arsenals of NATO's nuclear member states—the engagement of which would be irrational in the sense that megatons of TNT and widespread radiological poisoning serve no legitimate political purpose. The costs of US tactical warheads in Europe must be tolerated, it is said, to strengthen deterrence. Yet, a wartime transfer of nuclear bombs to European fighters in reluctant DCA states offers no positive prospect of managing or winning a competition in risk-taking against a virulent Russia or an emergent power that attacked NATO's territorial integrity and triggered Article 5 commitments.

Assuming NATO reserves collective defense as its core task, it will pay a political price for weapons programs that dismiss ground truth. Russia or any potential adversary can observe the low military utility of 200 B61s dotting Belgium, the Netherlands, Germany, Italy, and Turkey, where most of these allies signal their desire to abandon a nuclear combat role. Parties outside or within the alliance can challenge the feasibility of controlling escalation at every point along the arc to some ill-defined threshold when crisis moves finally take their own momentum and an exchange of strategic nuclear weapons becomes a real possibility. In short, they can plainly see the differences between residual gravity bombs stored in reserve vaults and a genuine tripwire such as the forward-deployed Berlin Brigade in its prime.

The truth about the B61s has serious consequences for the present US compromise—the idea that reduction of US tactical nuclear weapons

in Europe should only take place in the context of negotiated reductions in the far superior Russian tactical arsenal. US diplomats cannot count on the specter of large-scale Russian cuts scaring their interlocutors away from the negotiating table. The Russians have much to gain from protracted haggling that could only bear fruit if the West offered up more serious stakes—perhaps involving US space and missile systems or impinging upon the national interests of Georgia and Ukraine—to spark Russian motivation for discarding its quantitative advantage in nonstrategic warheads.

Given long experience in arms control on all sides, NATO should expect to gain little, indeed, for bargaining chips that carry questionable military or political value. Worse from the alliance's perspective, nonstrategic arms negotiations will play out during an ongoing review of NATO's nuclear posture in which the logical inconsistencies of its current policy present an inviting target. Moreover, Germany's economic growth, defense reform, and increased willingness—Libya notwithstanding—to participate in international security missions, all point to a secular rise in its influence. Should this intra-alliance shift continue, now more than 20 years after German unification, NATO will have to make appropriate adjustments in any case, but US-driven arms negotiations will complicate the process of accommodation.

As in the late 1970s and 1980s, German officials again have a strong case in a tense nuclear debate. Bargaining within the alliance promises to be hard because of increasing US vulnerability, its faltering claim to leading "from behind" or from Asia rather than the front of the transatlantic pack, and because remaining defenders of US B61 deployments into Western Europe will dig in for psychological reasons, quixotically invoking their narrowly defined national interest and their Article 5 ancestral bond to a now sprawling 28-member pact.[50] Even if Russia intends *friendly* competition among pan-European strategic partners before eventual agreement on a peaceful vision for the world, the recovering Russians should welcome complex and tortuous arms control that would exacerbate NATO's internal divisions.[51]

The 2010 strategic concept reconfirmed collective defense as a core task of the alliance, but the same document also embraced the notion of NATO as a special political group, one sharing common values and a pledge to cooperation that went beyond combining forces against obvious military threats. The very definition of threat and meaning of security

have been fluid over the past decades, and the alliance has closed ranks, shifting toward liberal democratic principles to remain cohesive during turbulent times.

Liberal democracies characteristically place transparency and accountability at the center of good governance; now the logic of deterrence and the balance of intra-alliance influence point toward fewer weapons assigned to NATO, in particular, to removal of residual US nonstrategic nuclear warheads from bases overseas. A serious problem for an institution that prizes free expression and girds itself by holding power accountable to truth is that, counter to its own official claims, deterrence of attacks on NATO does not require these weapons.[52] US bombs presently stored inside European shelters carry tactical warheads that by treaty commitment would not transfer to European allies until after general deterrence failed and war began. Under such volatile conditions, NATO's current nuclear arrangements would as soon provoke as deter massive destruction in the zone protected by allies' solemn commitments to collective defense. Diplomatically, the treaty organization has less to fear and more solidarity to showcase the sooner its members—together with full participation—modernize NATO's deterrence posture, unburdening it of 200 B61 variable-yield gravity bombs now residing so awkwardly in Europe. SSQ

Notes

1. Nicole Gaouette, "Clinton Says NATO Should Keep Tactical Nuclear Arms," *Bloomberg BusinessWeek*, 22 April 2010.

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23. Robert Norris and Hans Kristensen, "U.S. Nuclear Forces, 2010," *Bulletin of the Atomic Scientists* 66, no. 3 (May/June 2010): 57–70, esp. 67–68; and Robert Norris and Hans Kristensen, "U.S. Tactical Nuclear Weapons in Europe, 2011," *Bulletin of the Atomic Scientists* 67, no. 1 (January/February 2010): 64–73.

24. Pifer et al., *U.S. Nuclear and Extended Deterrence*, 19.

25. Indeed, NATO strategy does not have a war-fighting concept for nuclear operations. Since the late 1960s, NATO political guidelines have described a political use for the weapons—to confront the enemy with the prospect of escalation, presumably toward an exchange that would bring about mass destruction. David Yost, "The History of NATO Theater Nuclear Force Policy: Key Findings from the Sandia Conference, *Journal of Strategic Studies* 15, no. 2 (June 1992): 228–61, esp. 229–33.

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27. Norris and Kristensen, "U.S. Nuclear Forces," 58. Most of the strategic warheads deployed on US submarine-launched ballistic missiles have a yield of 100 kilotons, just 60 percent of the maximum setting on the European B61s.

28. *Nuclear Posture Review Report* (Washington: DoD, April 2010), http://www.defense.gov/npr/docs/2010%20Nuclear%20Posture%20Review%20Report.pdf.

29. "Remarks of President Barack Obama, Hradčany Square, Prague, Czech Republic, April 5, 2009," http://prague.usembassy.gov/obama.html.

30. Op-eds by George Shultz, William Perry, Henry Kissinger, and Sam Nunn were published in the *Wall Street Journal* on 4 January 2007 and 15 January 2008.

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34. Steven Pifer, "After New START: What Next?" *Arms Control Today*, December 2010, http://www.armscontrol.org/act/2010_12/%20Pifer.

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36. Bluth, *Britain, Germany, and Western Nuclear Strategy*; Halverson, *Last Great Nuclear Debate*; and Haftendorn, *NATO and the Nuclear Revolution*.

37. Sonia Phalnikar, ed., "New German Government to Seek Removal of US Nuclear Weapons," *Deutsche Welle*, 25 October 2009, http://www.dw-world.de/dw/article/0,,4824174,00.html.

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39. This oft-repeated line was attributed to West German moderate, Volker Rühe, in the context of intermediate-range nuclear forces (INF) debates of the late 1980s. Thomas Risse-Kappen, "Odd German Consensus against New Missiles," *Bulletin of Atomic Scientists* 44, no. 4 (May 1988): 14–17, esp. 14; and Robert Zoellick, "Two plus Four," *National Interest*, Fall 2000, para. 5, http://nationalinterest.org/article/two-plus-four-1205.

40. Haftendorn, *NATO and the Nuclear Revolution*, 172–73; Michael Wheeler, "NATO Nuclear Strategy, 1949–1990," in *A History of NATO: The First Fifty Years*, vol. 3, ed. Gustav Schmidt (Hampshire, UK: Palgrave, 2001), 121–39, esp. 132; and Bluth, *Britain, Germany, and Western Nuclear Strategy*, 261–63.

41. This history is well known but curiously shelved by distinguished B61 advocates who darkly accuse Germany—and by extension Chancellor Schmidt—of hypocrisy *and* naiveté on deterrence strategy for the alliance. Lord Robertson, Franklin Miller, and Kori Schake, "It's Time to Put the Nuclear Issue Behind Us: The Chicago Summit Has More Urgent Priorities than Nuclear Theology," issue brief (Washington: ACUS, May 2012), http://www.acus.org/files/publication_pdfs/403/93516_AC_ChicagoSummit_IB_p2-final.pdf; and Miller, Robertson, and Schake, "Germany Opens Pandora's Box."

42. Halverson, *Last Great Nuclear Debate*, 102, 124–33.

43. Norris and Kristensen, "U.S. Tactical Nuclear Weapons in Europe," 68–69.

44. Ibid., 69–70.

45. This point does not address Turkey's concern with respect to a nuclear-armed Iran. Even so, there are questions about the B61's military utility for punishing Iran, most of which lies beyond the published 500-mile combat radius of delivery aircraft. Moreover, no NATO member is likely to endorse a posture in which Turkey became the only dual-key state in the alliance.

46. NATO, "Lisbon Summit Declaration," 20 November 2010, para. 30–31, http://www.nato.int/cps/en/natolive/official_texts_68828.htm. See Hans Kristensen, "NATO Strategic Concept: One Step Forward and a Half Step Back," *Federation of American Scientists Strategic Security Blog*, 19 November 2010, http://www.fas.org/blog/ssp/2010/11/nato2010.php; Oliver Meier, "NATO Revises Nuclear Policy," *Arms Control Today*, December 2010, http://www.armscontrol.org/act/2010_12/NATO_Nuclear; and Daryl Kimball, Oliver Meier, and Paul Ingram, "NATO on Nuclear Weapons: Opportunities Missed and Next Steps Forward," *Arms Control Now*, 21 May 2012, http://armscontrolnow.org/tag/nato-2012-chicago-summit/.

47. Turkey is distinguished here from Western Europe not to debate the merits of European integration, but to recognize the militarily significant longitudinal shift between host country air bases in

Germany and Italy versus the base in Turkey. In "Nuclear Issues for NATO after the Strategic Concept," *EUCOM Task Force* (Washington: ACUS, June 2011), 7, Walt Slocombe pointed out operational and targeting difficulties in employing the European-based B61s not just on the battlefield, but as a political demonstration during a crisis to discourage further escalation. High-profile advocates for robust and flexible nuclear arsenals failed to include a scenario in which tactical gravity bombs stored in Europe would save the United States or its allies. Keir Lieber and Daryl Press, "Obama's Nuclear Upgrade: The Case for Modernizing America's Nukes," *Foreign Affairs*, 6 July 2011, www.foreignaffairs.com /articles/67973/keir-a-lieber-and-daryl-g-press/obamas-nuclear-upgrade; and Keith Payne, "Maintaining Flexible and Resilient Capabilities for Nuclear Deterrence," *Strategic Studies Quarterly* 5, no. 2 (Summer 2011): 13–29.

48. Pifer et al., *U.S. Nuclear and Extended Deterrence*, 23.

49. Glenn Snyder, "Deterrence and Power," *Journal of Conflict Resolution* 4, no. 2 (June 1960): 163–78.

50. David Yost, "The US Debate on NATO Nuclear Deterrence," *International Affairs 87*, no. 6 (November 2011): 1401–38. Yost provided perhaps the most comprehensive public review to date of contending positions on the fate of US nuclear bombs in Europe. Psychological reasons were referenced on a number of occasions as compensation for the lack of military utility or US military requirement for the DCA-designated B-61s (p. 1420 in reference to the 2008 Schlesinger Report on DoD nuclear weapons management; p. 1429 on the Estonian defense minister's case for "demonstrating and maintaining capability to employ them"; p. 1432 on a former Czech Foreign Ministry official's rhetorical question about whether allies could "imagine nuclear deterrence without the physical presence of American weapons in Europe"; and p. 1435 on former OSD official Elaine Bunn's perceptual metaphor likening B61 withdrawal to removing a wedding ring.) The crucial psychology in all these examples is not that of the unknown adversary in some undetermined future but of the known emotions among those allies who seek reassurance, now. Such reassurance at home can happen, or not, quite independently of deterrence logic as applied to enemies. Edward Seay, "NATO's Incredible Nuclear Strategy: Why U.S. Weapons in Europe Deter No One," *Arms Control Today*, November 2011, http://www.armscontrol.org/act/2011_11/NATO_Incredible_Nuclear_Strategy _Why_US_Weapons_in_Europe_Deter_No_One.

51. Even better from the Russian perspective, since the US administration has already promised publicly to pursue an agreement addressing the disparity in nonstrategic nuclear weapons, demand a high price from the Americans—in B61s, space and missile systems, or other creatively linked assets—just to enter the negotiations, and then drag out the talks. Stela Petrova, *New START: A Net Assessment*, policy brief no. 3 (London, UK: European Leadership Network, August 2012), 18–20.

52. For brief identification of this looming problem and the role public discussion should play on the nuclear deployment issue so internally sensitive to the alliance, see George Perkovich, Malcolm Chalmers, Steven Pifer, Paul Schulte, and Jaclyn Tandler, *Looking Beyond the Chicago Summit: Nuclear Weapons in Europe and the Future of NATO*, Carnegie Papers (Washington: Carnegie Endowment for International Peace, April 2012), 36.

What Great Powers Make It

International Order and the Logic of Cooperation in Cyberspace

James Wood Forsyth Jr.

In many scientific problems, the difficulty is to state the question rightly; once that is done, it may almost answer itself.

—Jacob Bronowski

Public goods are commonly referred to as the collective benefits provided by governments to the larger society.[1] In international politics, a general assumption about public goods is that the more states partake of a good, the greater the benefit for all. Historically speaking, achieving international cooperation on such issues has been relatively easy—the costs of cooperating are fairly low and interests harmonious. The evolution of the global postal and telecommunications systems is illustrative. Initially, postal services and telecommunications networks posed challenges to cooperation because no international standards or procedures existed to coordinate state policies or actions. Over time, the Universal Postal Union and the International Telegraph Union were created, improving communications for citizens worldwide. The World Wide Web is another good example; more consumption has yielded greater demand for faster, more reliable, worldwide communication networks.

One might expect cooperation to easily emerge within cyberspace, yet the pessimism surrounding that idea is profound; one scours the literature to find analyses that do not stress the enormity of the difficulties, vulnerabilities, and dangers governments face as they enter the cyber age. Indeed, some cyber pessimists have referred to the idea of devising a comprehensive treaty on cyberspace as a "pipe dream."[2] Homeland Security Secretary Janet Napolitano noted that efforts for "a comprehensive international framework" to govern cyber behaviors are still at "a

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nascent stage."[3] No doubt, cyberspace poses problems for international cooperation—some could even prove to be severe—but do the problems it poses differ substantially from those governments have faced in the past? That is an important question worth examining.

The central claim advanced here is: as cyberspace continues to evolve, the great powers will *inevitably* use their collective powers to transform it into a legitimate, durable, and relatively peaceful realm of activity bound by established standards and procedures in which they and others can operate and thrive. Since this is an unconventional claim, it is important to elaborate the argument by examining the pessimists' claims and the logic of cooperation. Next, international order and the role of the great powers are discussed, before offering a framework for the coming cyber regime and the policy implications that stem from it. In short, mine is an optimistic argument that pivots on one central, albeit overlooked idea: Cyberspace is, and will be, what the great powers make it.[4]

The Pessimists' Claims

Cyber pessimism stems from Hobbesian logic—a logic that suggests we are living in a world where state interests compete, conflict abounds, and the war of "all against all" is always a possibility. Reflecting on this, cyber experts Richard Clarke and Robert Knake write, "Cyber war is real; it happens at the speed of light; it is global; it skips the battlefield; and, it has already begun."[5] In equally stark terms, David Lonsdale asserts, "Potentially the biggest change to the existing character of warfare, and therefore also the most substantial challenge to the nature of war, is provided by Strategic Information Warfare."[6] Along these lines, Antoine Bousquet concludes that, "network-centric warfare may yet come to be retrospectively viewed as merely the birth pangs of a truly future chaoplexic regime in the scientific way of warfare."[7] Not all of these influential authors are equally dire, but when thinking and writing about cyberspace, pessimism is the order of the day.[8] This is especially true in areas where the question is not so much about war as it is about the prospects of cooperating to prevent it.

Reflecting upon the likelihood of achieving meaningful international cooperation on cyberspace, Adam Segal and Matthew Waxman caution that "the idea of ultimately negotiating a worldwide, comprehensive cybersecurity treaty is a pipe dream." In their view, differences in ideologies

and priorities will keep the great powers from reaching meaningful agreements: "With the United States and European democracies at one end and China and Russia at another, states disagree sharply over such issues as whether international laws of war and self-defense should apply to cyber attacks, the right to block information from citizens, and the roles that private or quasi-private actors should play in Internet governance."[9]

These are problems of considerable proportion, yet there seems to be a bit of schizophrenia here. On the one hand, cyber—in the form of information and networks—is already changing the nature of war and, perhaps, international politics. On the other hand, cooperation to mediate the effects of those possibilities remains "a pipe dream." What accounts for this duality? Nearly every version of cyber pessimism seems to express the "feeling of being swept into the future by irresistible forces." Karl Popper wrote about something similar in his critique of historicism. As he put it, modern historicists believe "that their own brand of historicism is the latest and boldest achievement of the human mind, an achievement so staggeringly novel that only a few people are sufficiently advanced to grasp it."[10] One gets the idea that cyber pessimism turns on the notion that "we" (cyber pessimists) are onto something "staggeringly novel;" something we alone understand. The trick to unraveling this puzzle is to conceptualize the "extraordinary" problem of cyberspace in the ordinary language of international politics. Thus, to state this rightly, the pessimists' claims must be reconciled: Cyberspace does indeed pose challenges to international order, but those challenges do not make cooperation unlikely; on the contrary, they make cooperation inevitable.[11] Understanding the logic of cooperation is the first step in understanding why.

Logic of Cooperation

In the language of international cooperation, cyberspace is a common property resource—which is to say, no one can be excluded from it. When exclusion is not an option, states have little incentive to pay for a good. Instead, they prefer to be free riders, enjoying the benefits of a good without paying for it. In such a world, overexploitation is the problem. Think of fishing on the high seas. Each fishing state seeks to obtain as much fish as it can, and yet they cannot exclude others from doing the same. Each year the fishing states rationally seek to increase

their share of the catch. As each state increases its catch, however, the fisheries are depleted, and "overexploitation" is the result. Since all fishing fleets share the costs of over fishing, each fleet contributes to the demise of all others, even if that is not their intention. This is commonly referred to as the tragedy of the commons, where individual interest inadvertently conflicts with that of the group.[12] Now let us suppose that nothing in the world changes. Sooner or later all the fish in the world worth catching would be caught, and all the fishing fleets would suffer the same fate—extinction. Since all states know this in advance and presumably want to live to fish another day, they sensibly cooperate to limit the catch.[13]

A central assumption about cyberspace is that achieving such commonsensical agreement is difficult if not impossible. In an important article entitled "Depleted Trust in the Cyber Commons," Roger Hurwitz argues that cyberspace is a common property resource where trust is overexploited. He writes, "maintaining a secure cyberspace amounts to sustaining a commons, which benefits all users, but its overexploitation by individual users results in the well-known 'tragedy of the commons' . . . the users are nations, organizations, and individuals, *whose behaviors in cyberspace are not subject to a central authority.* Their actions, which harm the well-being of other users, diminish trust and amount to overexploitation of a common resource" (emphasis added).[14] There is much to be said for Hurwitz's original argument. Reducing or eliminating the overexploitation of trust in cyberspace is critical to achieving any sort of international agreement on standards and procedures. But for those interested in cooperation in general, his conclusions are not encouraging. He writes: "conditions are not ripe for reaching and enforcing international agreements on the uses of cyberspace."[15] Apparently, even when states share a common interest in preventing overexploitation, cooperation is not guaranteed.[16]

How is it that states can cooperate in one issue area (fishing on the high seas) but not another (cyberspace)? One way to think about that question is to look at the problem from the perspective of underprovision. If all goods were provided all the time, there would be no logic for cooperation. But that is not the case. In every corner of meaningful political activity, someone or something has to play the role of provider. In the fishing example, states agree to cooperate to limit the catch; by doing so they "provide" for their collective well-being by minimizing

overexploitation. But who or what "provides" in cyberspace? For Hurwitz, the answer is apparently no one—since "behaviors in cyberspace are not subject to a central authority," the domain must provide for itself. This is made more obvious when one examines how the domain is defined by practitioners. One quotation can serve for many others. Cyberspace is "a global domain within the information environment consisting of the interdependent network of information technology infrastructures, including the Internet, telecommunications networks, computer systems, and embedded processors and controllers."[17] Note the author's emphasis upon interdependence. One must ask, interdependent to what? In this definition of cyberspace, technology infrastructures, telecommunications networks, and computer systems float freely. But is this conceptualization of the domain an accurate one? In conceptualizing cyberspace as a realm of activity that provides for itself or "floats freely," analysts have confused a condition with a cause. This is the same mistake made by others when attempting to conceptualize the "new" relationship among politics and economics.

Since the arrival of globalization, it has become customary to assume that economic orders give rise to political ones, but nothing could be further from the truth.[18] While globalization is real, economic orders do not provide for themselves or float freely; they are embedded within political structures.[19] That is to say, political structures beget economic orders, not the other way around. Following World War II, the United States along with Britain fashioned a global economic order embedded within a liberal political structure that was fundamentally different than the one devised by the Soviet Union.[20] The Anglo-American agreements "established rules for a relatively open and multi-lateral system of trade and payments, but did so in a way that would reconcile openness and trade expansion with the commitments of national governments to full employment and economic stabilization."[21] This brief illustration captures the heart and soul of international politics: order is structurally derived.[22] And if it is derived in one realm of activity, it is derived in others; thus, the contemporary political structure has begotten today's cyber disorder.

Unipolarity has placed an undue burden upon the United States to ensure an equitable distribution of public goods exists throughout the world. Thus it might be true that "conditions are not ripe for reaching and enforcing international agreements on the uses of cyberspace." But

it would be truer if we added the word *yet*. International structures do not last forever; they change and so, too, does the order of things.[23] Few things affect international structure more than the great powers. Who are the emerging great powers capable of changing the order of things? Brazil, Russia, India, and China (the BRICs) are poised to become the four most dominant economies by the year 2050. These four states encompass more than 25 percent of the world's land coverage, 40 percent of the population, and hold a combined GDP of approximately $18.5 trillion. Collectively, they comprise the world's largest entity. Hardly an alliance, they have taken steps to increase their political cooperation, mainly as a way of influencing the US position on trade accords. As the BRICs rise in power, the structure of international politics will change from unipolarity to multipolarity. Interestingly, as this shift takes place, the costs of governing the global commons will decrease, and cooperation will increase.[24] Why?

As each new power grows, its dependencies upon the global commons—sea, air, space, and cyber—will intensify. As dependencies intensify, oligopolistic behaviors will result, where the actions of one great power will have a noticeable effect on the rest. Since the great powers share in and are dependent upon the resources of the commons, the security of each great power will be tightly coupled to the security of the commons. Thus the great powers—for no other reason than survival—will inevitably cooperate and share the costs of providing security even if they might prefer not to. Importantly, it is not necessary to assume that international systems are "all Hobbesian all the time." International systems are varied and nuanced; they tend to resemble arrangements that can be classified by their dominant features: enmity, rivalry, and amity or Hobbesian, Lockean, and Kantian.[25] In simple terms, the kinds of interests states have in a Kantian system differ from those in a Hobbesian one—just like the kinds of interests the United States has with Britain (amity) differ from the ones it has with Iran (enmity). For this discussion, the most significant aspect of this line of theorizing is this: if cooperation can take hold in Hobbesian systems, it is even more likely to take hold in others. In other words, Hobbesian arrangements pose a "hard test" for cooperation, and since it is reasonable to assume that states can pass the Hobbesian test, it is reasonable to assume they can pass the Kantian and Lockean one. The central character of international systems is the result of state interaction, particularly interaction with the great powers.[26] The

great powers provide structure to international life by socializing others to the rules of the game.

Rules of the game refers to those "imperative principles" which require or authorize states to behave in prescribed ways. Few would deny that states share many beliefs about the "rules of the game, who its players are, what their interests are, what rational behavior is, and so on."[27] In other words, few would deny that order is maintained in an international system "not merely by a sense of common interests . . . but by rules that spell out the kind of behavior that is orderly."[28] Socialization is the process by which one learns what those behaviors are. Since it is so important here, it is important to be clear of its meaning.

Socialization refers to a relationship between at least two parties where "*A* influences *B. B*, affected by *A*'s influence, then influences *A*." As Kenneth Waltz put it, "Each is not just influencing the other; both are being influenced by the situation their interactions create." Moreover, the behavior of the pair cannot be "apprehended by taking a unilateral view of either member."[29] Each acts and reacts in accordance with the other. The "global teenager" provides an example of the socialization process that occurs throughout the world. No one tells all the teenagers in the world to dress alike, but most of them do most of the time.

Likewise, no one tells all the states in the world to behave themselves but most of them do most of the time. States are socialized to this idea by interacting with one another. In this regard, socialization is "a process of learning to conform one's behavior to societal expectations" and a "process of identity and interest formation."[30] Socialization draws members of a group into conformity with its norms. Socialization also encourages similarities in behavior.

With respect to socialization, interest formation, and encouraging similarities in behavior, critics will rightly contend, "But what about China? Their image of cyberspace appears to be incompatible with our own." That might be the case, but that line of reasoning tends to overlook a larger question: Can China learn to behave like a great power?[31] As argued below, great powers serve a moral and functional purpose. That is to say, they possess "special rights and duties," none more important than the preservation of international society itself. This, of course, demands that great powers act to sustain the elementary or primary goals of the society of states, of which cyberspace is one small, albeit important part. If, as I contend, great power is a role and China is a great

power, it stands to reason that despite differences, China can *and* will learn how adapt to the demands of "societal expectations" and behave in ways similar to those ordinary great powers of the past.[32] There is no natural reason to think that the United States and China are imprisoned in a Hobbesian relationship any more than they might be freed in a Lockean one. International systems are not predetermined. They are the result of interaction, socialization, and power.

Power is a vexing word. And while it might be hard to define, it is not hard to recognize.[33] Most scholars of international politics accept Waltz's conception. In the standard Waltzian account, power provides a means to achieve autonomy, permits a wider range of actions, increases margins of safety, and for the sake of great power gives its possessors a greater stake in the management of the system.[34]

Nothing affects the management of the international system more than security, and the literature on cyber security is voluminous.[35] Much of it pivots on differentiating cyberspace from cyber power, defining cyber security, and devising cyber security strategy and policy options.[36] In 2009, scholars warned that

> The cyber domain is undergoing extraordinary changes. . . . This evolution is apparent in the increasing numbers of participants in cyberspace and the quality of their participation, both technically and socially. . . . However trends in cyberspace also raise major challenges [arising] from malevolent actors (such as terrorists and criminals) and the many security vulnerabilities that plague cyberspace . . . to exploit these opportunities and to overcome these challenges, we must begin to assemble a balanced body of knowledge of the cyber domain.[37]

The central question emerging from this literature is: Has the security of cyberspace reached a tipping point where ensuring it is of paramount importance to the international system? Put differently, since international life appears to be so dependent upon a viable cyber network, is the maintenance of a secure cyber realm in the general interests of the great powers? Taking the pessimists' claims seriously, I answer "yes," which is why it is at least prudent to think that the great powers—the United States, the European nations, China, and Russia—will cooperate to ensure the security of cyberspace. By doing so, they will assert their role as great powers—just like the United States and Britain did following World War II—and create order where little exists. That order will not reflect all of the norms and values of the great powers, which are real and diverse; nor will it initially decipher if "international laws of war

and self-defense should apply to cyber attacks."[38] As in other areas of international cooperation, those will evolve with time. It merely needs to serve as an institutional mechanism robust enough to create, coordinate, and enforce standards and procedures within a particular domain or realm of activity as is routine in sea, air, and space.

International Order and the Role of the Great Powers

Up to this point, I have described the logic of international cooperation to illustrate why cooperation is inevitable in cyberspace. Here I want to explain why great powers have an interest in creating legitimate, durable political orders by focusing on the symbiotic relationship between great power and international order. But before doing so, it is worth examining two alternatives: domination and abandonment.

To dominate is to use one's commanding material capabilities to literally remake the world. This is essentially what the Soviet Union did in Eastern Europe after World War II. Land power allowed Stalin to dominate as far as "his army could reach." As he remarked to Tito, "This war is not as in the past; whoever occupies a territory also imposes on it his own social system."[39] Mahan had similar thoughts regarding sea power. Those states that could control the sea could accumulate such wealth that they could dominate other states both militarily and politically. Contemporary thoughts regarding domination extend to outer space where Everett Dolman has written that "the United States should seize control [of space] . . . [and] become shepherd . . . for all who would venture there."[40]

Abandonment presupposes that great powers can "let go" of their relations with other states and live in splendid isolation. But great powers are never afforded that luxury. This is obvious when considered from the perspective of the weak. As Prime Minister Pierre Trudeau of Canada once put it, being America's neighbor was "like sleeping with an elephant. No matter how friendly or even tempered the beast . . . one is affected by every twitch and grunt."[41]

Thus, while domination and abandonment might sound good in theory, they are not choices democracies are prone to make. Democratic regimes prefer bargaining, compromise, and consensus to resolve conflict, which explains why domination and abandonment have never been preferred by the United States. But democratic theory cannot

explain why great powers with different domestic arrangements—like the United States and the former Soviet Union—chose to cooperate. For this reason, I put democracy aside and propose a functional rather than a normative argument.

It is important to stress that great powers serve a moral and functional purpose. As Martin Wight put it, great powers are powers with "general interests, whose interests are as wide as the states-system itself, which today means worldwide."[42] Arnold Toynbee formulated it this way, "A great power may be defined as a political force exerting an effect coextensive with the society in which it operates."[43] Sir Alfred Zimmern put the same idea differently, "every Foreign Minister of a great power is concerned with all the world all the time."[44] Hedley Bull clarified this further by claiming that great powers: were members of a club who were comparable in status; in the front rank of military power; and were recognized by their own leaders and peoples to have "special rights and duties."[45] From this last criterion, great power is a role.

To think of great power as a role is to think in terms of international order, which refers to a "pattern of activity that sustains the elementary or primary goals of the society of states."[46] The elementary goals of international life include the preservation of the society of states, maintaining the independence of states, peace, and those goals essential for the sustainment of international life such as the limitation of violence, the keeping of promises, and possession of property. As Bull saw it, great powers contributed to international order in two ways: they managed relations among one another, and they exploited their preponderance of power in such a way as to "impart a degree of central direction to the affairs of international society as a whole."[47] More specifically, the great powers manage relations with one another in the interests of international order by (a) preserving the general balance of power, (b) seeking to avoid or control crises in their relations with one another, and (c) seeking to limit or contain wars among one another." They exploit their preponderance of power in relation with the rest of international society by (d) "unilaterally exploiting their local preponderance, (e) agreeing to respect one another's spheres' of influence, and (f) joint action, as is implied by the idea of a great power concert or condominium."[48] Seeking to contain war and joint action are of particular importance here.

In their attempts to limit war, the great powers strive to avert it by accident or miscalculation, to reduce misunderstanding, to settle or

contain disputes through negotiation, to control competition in armaments, to prevent wars among lesser powers, or if they occur, to limit them geographically and end them quickly. One need only think of the Cold War to get the idea here—as the United States and the Soviet Union increased their power to become "super," they also strove to reduce the chances for accidental nuclear war or miscalculation by relying on negotiation through arms control.[49] When war did break out—as in the case of Korea and Vietnam—the superpowers went out of their way to ensure the wars remained limited and did not widen. Joint action is another matter.

Throughout most of the Cold War, the superpowers did little to advance the idea of a condominium or a concert of power, relying instead on alliance politics. Alliance politics were both a cause and a cure for the hegemonic wars that ripped Europe apart throughout the nineteenth and twentieth centuries. The relatively peaceful end of the Cold War, however, does serve as a historical break, different from the run of historical cases. The decision by the Soviet leaders to allow for peaceful change within Eastern Europe and the Soviet Union is indicative of the abilities of the great powers—particularly the United States—to show institutionalized restraint when dealing with other great powers. Since the United States established a postwar order that became "more deeply rooted in the wider structures of politics and society" throughout Europe, Gorbachev's reforms were less risky.[50] This same sort of restraint explains why the European Union—in the guise of a powerful Germany—continues to function in spite of economic shocks and institutional challenges. The fear of German power has been tamed by the union, and this institutionalized arrangement is thought to be preferable to what had been the pattern of great power behavior for centuries: runs at hegemony and cold wars.

By necessity then, great powers have an interest in creating order that is "legitimate and durable." A legitimate political order is one where its "members willingly participate and agree with the overall orientation of the system."[51] Once in place, these orders tend to facilitate "the further growth of intergovernmental institutions and commitments."[52] Such arrangements create deeper institutional linkages and make it difficult for alternative orders to replace existing ones. In short, legitimate political orders are "transformative" ones, making their dissolution difficult if not impossible. Moreover, there is a functional imperative for great

powers to seek institutional solutions—they allow for the conservation of power itself. To remain great, great powers have to conserve power, making the creation of agreement on the basic rules and principles of political order a necessity for survival. In essence, to remain strong great powers must make their "commanding power position more predictable and restrained."[53] This is precisely what the United States did following World War II.

In 1948, George Kennan noted: "We have about 50 percent of the world's wealth but only 6.3 percent of its population. . . . Our real task in the coming period is to devise a pattern of relationships which permit us to maintain this position of disparity without positive detriment to our national security." At war's end, the United States "found itself in a rare position. It had power and choices."[54] It chose to use its remarkable position to create an institutionalized world order that continues to facilitate or regulate nearly every aspect of international politics some 20 years after the fall of the Berlin Wall—there is no natural reason to think the great powers will not do the same in cyberspace.

Summing up, history and common sense tell us that great powers use their influence to create international order—that is the instrumental role of great power. Since cyberspace is part of this world, there is every reason to think that the great powers will transform it by creating a legitimate cyber regime wherein members would "willingly participate and agree" with its overall orientation. Such an arrangement will not solve all the problems of cyberspace, but it will foster deeper institutional linkages among states, bring order to what is a disorderly realm of activity, and make it difficult for rival orders to replace existing ones.

Framework of a Regime Foretold

In fairness, the pessimists' logic is not completely wrong—international life is not preordained and the possibility of conflict does exist. So to suggest that cooperation in cyberspace is inevitable might sound teleological, but that is not my intent. Here I want to stress why statesmen rely on institutions to mediate the challenges of living in a Hobbesian world and provide a framework for the coming cyber regime.

Even from a Hobbesian perspective, there is order to international life, but that order is not the hierarchical one characteristic of domestic politics. International order is anarchic but not chaotic.[55] Anarchy merely refers

to the absence of rule or a lack of formal subordination and authority. That said, the consequence of anarchy can be severe—and not only for those states in Hobbesian arrangements. Because no higher authority exists to protect states from the harmful intentions of others, statesmen must pay attention to security, regardless of the type of arrangement they might find themselves in. Though demands for security are less intense for states within a Kantian arrangement than for those in a Hobbesian one, nothing trumps demands for security. Even states in a Kantian world must be concerned with the great powers that live outside it. Therefore, no matter how good their intentions, statesmen must bear in mind that in the absence of world government, states must provide for their own protection. To do so means marshaling their power or the power of friends and allies who will support and defend them. In so doing, they are not alone; regimes and institutions also exist to help statesmen meditate the challenges of living in a dangerous world.

In multipolar structures, where there are two, three, or even five great powers to contend with, regimes play an important role. They assist the great powers in coordinating, provisioning, and distributing public goods. Regimes are defined as "principles, norms, rules, and decision-making procedures around which actor expectations converge in a given issue-area."[56] Regimes can be found in nearly every corner of international political activity to include security and trade.[57] In sketching out a framework for the coming cyber regime, the arms control regime and the World Trade Organization (WTO) are illustrative.

In the late 1950s, the idea of nuclear deterrence was a concept that "could neither be taken for granted nor ruled out."[58] Over time, as scientists and strategists became aware of the vulnerability of US nuclear weapons and concerned about the fear of surprise attack, a consensus emerged around the idea that security could be enhanced through arms control. These same scientists and strategists shared an understanding of the "causes of war, the effects of technological change on the arms race, and the need for nuclear adversaries to cooperate."[59] As the group matured, they reached into the highest offices of government and turned their ideas into policies that impacted both the United States and the Soviet Union. The initial regime—comprised of concerned scientists and strategists—was "a necessary precondition" for the forging of the "superpower-led" arms control regime that followed.[60] That regime—essentially a great power condominium—exercised considerable influence

on international security policy. Key treaties that grew out of their ideas were the ABM Treaty, SALT I and II, START I–III, SORT, and New START. In short, the arms control regime made conflict resolution in the form of arms control a preferable option to nuclear war, even between two antagonistic, heavily armed rivals.

Today, the WTO, the regime that facilitates international cooperation in the area of global trade, holds similar sway.[61] Its predecessor, the General Agreement on Tariffs and Trade (GATT), served the needs of mass production well, but as technical developments led the world toward a more service-oriented economy, the Reagan administration initiated the Uruguay Round in a major effort to reduce global trade barriers. The Uruguay Round's most significant achievement was the WTO, which should be thought of as an important step toward completing the international institutional framework that began in 1944 with the Bretton Woods agreements. Accordingly, the legal authority and rule-binding capacity of the WTO is designed to play a significant role in the management of international commerce.[62]

The principles, norms, rules, and decision-making procedures governing arms control and international trade are embedded within the international system, which is another way of saying that if the arms control regime or the WTO did not exist, the great powers would have to invent them. In keeping with this line of reasoning, it is worth highlighting the evolutionary character of both regimes—they did not "spring" into existence. They evolved slowly as ideas and practices orbited within the minds and habits of concerned scientists and practitioners. Judging from the volume of literature on the subject, one might deduce that a similar community of scholars and policymakers exists that shares a common concern about cyberspace—even if its members cannot agree on what to do about it. Might this be a precondition for the emergence of a cyber regime? I believe it is. Therefore, with the arms control regime and the WTO in mind, it is not difficult to reason (with considerable certainty) how a cyber regime would "impart a degree of central direction to the affairs of international society as a whole." A cyber regime could assist in this by strengthening legal liability, reducing transaction costs, and mitigating uncertainty.

Reflecting upon the growth of legal liability in cyberspace, Gary Brown and Keira Poellett conclude, "In the absence of formal international agreements, cyber custom is beginning to develop through the

practice of states." Yet while there has been "some movement toward declarations, agreements, treaties and international norms in the area, the hopeful statements most often heard do not coincide with current state practice."[63] It is worth noting that similar concerns existed in the nineteenth century before the advent of the International Telecommunication Union (ITU). Today, the ITU is an intergovernmental organization within the United Nations that has broad authorities in the area of global communications governance.

Originally devised when telephone service was a government-run function, the ITU's Telecommunication Standardization Sector (ITU-T) issues technical and operating standards for telecommunications networks and addresses tariff questions that can affect the Internet. The worldwide telecommunication system is dependent upon the ITU-T, which might be a reason why some have speculated about the role it might play in future Internet governance. Thus for "what it does and might do" the ITU plays an important role in Internet decision making.[64]

Yet, I want to suggest that the principal significance of the ITU may not reside in formal declarations or legal status. As important as both might be, appeals to sovereignty trump claims to legal liability and property rights. From this perspective, the significance of the ITU and other international regimes can be thought of in terms of international practices—practices that might be legally unenforceable by law but work to organize relationships among states in mutually beneficial ways. International practices, like conventions, create and shore up common knowledge within a community. Deterrence, for example, might be considered a practice. There is nothing legal about it, but it has proven to be a strong contributor to stability among nuclear powers. If there is common knowledge regarding nuclear practice it is this: statesmen, socialized to the danger of nuclear war, tend to behave cautiously in the face of grave danger.[65] As in the case of deterrence, one might conclude that actors behave according to practice not because these practices are uniquely best, but because others conform to them as well.[66]

Anthropologists have been writing about the importance of practices for some time. International relations scholars are just now turning their attention to them. As Jack Donnelly posits, "binding through sharing" is a reasonable practice states pursue in some anarchic arrangements.[67] His remarkable study of forager societies illustrates the connection between "sharing" and the formulation of interests and needs. Similarly, the

evolution of cyber custom is a promising sign of international practices yet to come. Practices that work to make international life more tolerable, whether found in deterrent relationships or forager societies, take time to evolve, but there is no natural reason to think they will not take hold in cyberspace, especially in light of pending structural changes to the international system.[68]

International regimes also affect transaction costs, and not just in the mundane way of being cheaper. "International . . . regimes usually incorporate international organizations that provide forums for meetings and secretaries that can act as catalysts for agreement."[69] In as much as the principles and rules of a regime can be applied to a wide variety of issues, "establishing the rules and principles at the outset makes it unnecessary to renegotiate them each time a specific question arises."[70] Currently, there is a network of organizations that provides forums and secretaries who work to establish rules and principles governing the Internet. As a practical matter, these organizations are functionally differentiated, making Internet governance a division of labor.

In matters of jurisdiction, the Internet Corporation for Assigned Names and Numbers (ICANN) supervises the Domain Name System, allocates Internet protocol, and oversees root servers that provide access to information on the Internet. The Internet Society develops standards for operating the Internet and its overall architecture. The World Wide Web Consortium (W3C) develops standards for the World Wide Web. The ITU develops standards for telecommunications, including interface with the Internet. The Organization for Economic Cooperation and Development (OECD) develops ad hoc policies on issues of importance, while national governments perform similar functions, especially related to cyber crime, use, and regulatory issues. The Institute for Electrical and Electronics Engineers (IEEE) establishes standards for manufacturing products.[71]

Tensions exist within Internet governance.[72] Nonetheless, the system has worked reasonably well, and some scholars even give it good marks, noting its "openness, democracy, transparency, dynamism, adaptability, accountability, efficiency, and effectiveness."[73] In fairness, one might ask, "Compared to what?" As with any institutional arrangement, questions abound, but the evidence is clear—Internet governance is a reality. It is neither tidy nor robust but its practices serve to foster deeper institutional

linkages among organizations and bring some order to what is a disorderly realm of activity.

Lastly, in keeping with the institutionalized nature of Internet governance, regimes provide information to their members, thereby reducing uncertainty and the risks associated with making agreements. The information provided not only informs states of the current negotiating positions but provides "accurate knowledge of . . . future positions," according to Robert Gilpin. Since reputations are on the line in any sort of agreement, regimes enforce compliance and shore up international prestige. Prestige is the "functional equivalent of the role of authority. . . . it is linked to but distinct from the concept of power." More precisely, prestige is the "reputation for power . . . in the language of contemporary strategic theory, prestige involves the credibility of a state's power." Prestige can be thought of as the "everyday currency of international relations." Thus, prestige, like power, is fungible; it can be squandered or saved. Taken together, prestige and power also have a moral and functional basis. The lesser states tend to follow the leadership of the more powerful, in part "because they accept the legitimacy and utility of the existing order" and, in part, because they prefer the "certainty of the status quo with the uncertainty of change."[74]

As argued here, a legitimate, global cyber regime would make international life more predictable. It would work to restrict legal liability as well as reduce transaction costs and uncertainty. *Moreover, membership in such a regime would buttress a state's reputation, prestige, and power.* Like regimes that came before it, a cyber regime would facilitate the growth of intergovernmental practices, institutions, and commitments; create deeper institutional linkages among states; and make it difficult for alternative orders to replace existing ones. A strong regime might even be able to reduce the likelihood of armed conflict among states by making conflict resolution preferable to war, much like the arms control regime between the United States and the former Soviet Union. For prudential reasons, creating a cyber regime appears to be anything but a pipe dream; it is a natural response to the world around us.

Conclusions

The extraordinary puzzle of cyberspace can be made less daunting by conceptualizing it in the ordinary language of international politics. Along those lines, the ideas and arguments presented here should be

thought of as a first cut. It is worth recalling that nothing is preordained in international life and there are recurring patterns of activity that make it intelligible. First among them is this: order is structurally derived. That is to say, political structures beget order be it economic, cyber, or otherwise. To assume differently is to assume international politics are not shaped or shoved by anything, but that is not the case. International politics are shaped by the great powers. And those great powers are the "providers." They provide order to international life by socializing others to the rules of the game.

But structures change and so, too, does the order of things. As the international system transitions from unipolarity to multipolarity, the great powers will rise in stature, and their dependencies upon the global commons—sea, air, space, and cyber—will intensify. As dependencies intensify, oligopolistic behaviors will result. Since the survival of each great power will be tightly coupled to the security of the global commons, they will inevitably agree to share the burden of security and create a legitimate and durable institutional arrangement that suits their interests as well as the interests of others. SSQ

Notes

1. Mancur Olson, *The Logic of Collective Action* (Cambridge, MA: Harvard University Press, 1971), 14.

2. Adam Segal and Matthew Waxman, Council on Foreign Relations, 27 October 2011, quoted in Roger Hurwitz, "Depleted Trust in the Cyber Commons," *Strategic Studies Quarterly* 6, no. 3 (Fall 2012): 20.

3. "Remarks by Secretary Napolitano before the Joint Meeting of the OSCE Permanent Council and OSCE Forum for Security Cooperation," Department of Homeland Security news release, 1 July 2011, quoted in Hurwitz, "Depleted Trust."

4. This is a paraphrase of Alexander Wendt in "Anarchy is What States Make It: The Social Construction of Power Politics," *International Organization* 46 (1992): 391–425.

5. Richard A. Clarke and Robert K. Knake, *Cyber War: The Next Threat to National Security and What to Do About It* (New York: HarperCollins, 2010), 30–31.

6. David J. Lonsdale, *The Nature of War in the Information Age* (London: Frank Cass, 2004), 135.

7. Antoine Bousquet, *The Scientific Way of Warfare: Order and Chaos on the Battlefields of Modernity* (New York: Columbia University Press, 2009), 234.

8. Pessimism is not the same as fatalism. In philosophy, *pessimism* refers to the belief that reality is flawed, a thought expressed by Milton and Malthus. Realists, in general, are pessimists. My use of the term here stems from the tenor and tone of some (most) of the cyber literature, which suggests that the present state of affairs will or cannot be changed anytime

soon—that there is some central defect in the order of things that prevents change. It is the lack of change that I am most interested in understanding and explaining.

9. Segal and Waxman, quoted in Hurwitz, "Depleted Trust," 20–21.

10. Karl Popper, *The Poverty of Historicism* (New York: Routledge, 2010 ed.), 148.

11. At the outset it is important to stress that mine is a systemic argument. I do not address second-image concerns in achieving cooperation, which are real and substantial. Elites who are threatened by the free flow of information will pose problems for states and international cooperation. But that is a levels-of-analysis question and another article for another time. If this makes me guilty of flying over cyberspace at 30,000 feet—as some might contend—so be it. Since this article is just a beginning, structural theory is a reasonable place to start.

12. Garrett Hardin, "Tragedy of the Commons," *Science* 162 (1968): 1243–48.

13. I do not assume that states will not defect from such arrangements, but I do assume that defectors can be identified and punished, as is common practice today.

14. Hurwitz, "Depleted Trust," 21.

15. Ibid., 41.

16. In fairness, Hurwitz is more optimistic on the matter of cooperation than most. His innovative work inspired this piece, but all of the faults herein are my own.

17. Daniel T. Kuehl, "From Cyber-space to Cyber-power: Defining the Problem," in *Cyberpower and National Security*, eds. Franklin D. Kramer, Stuart H. Starr, and Larry K. Wentz (Washington: Potomac Books, 2009), 28.

18. This theme reverberates throughout the writings of Robert Gilpin. See his *Global Political Economy: Understanding the International Economic Order* (Princeton, NJ: Princeton University Press, 2001), and *The Political Economy of International Relations* (Princeton: Princeton University Press, 1987).

19. This theme is common in neorealist writings. See Kenneth N. Waltz, *Theory of International Politics* (New York: McGraw-Hill, 1979); and John Gerard Ruggie, "Continuity and Transformation in the World Polity: Toward a Neo-Realist Synthesis," in *Neo-Realism and Its Critics*, ed. Robert Keohane (New York: Columbia University Press, 1986).

20. G. John Ikenberry, "A World Economy Restored: Expert Consensus and the Anglo-American Postwar Settlement," in *Knowledge, Power, and International Policy Coordination*, ed. Peter M. Haas (Columbia: University of South Carolina Press, 1992).

21. Ibid., 290.

22. To make this more dramatic, try this thought experiment: What type of global economic order would the Nazi's have developed had they won the war?

23. While balance of power theory tells us that change will occur, there is no known, reliable instrument that can predict with certainty when it will occur.

24. There should be no expectation that the costs of governing the global commons will be evenly divided. Even in small groups, there is the tendency for exploitation of the great by the small. See Olson, *Logic of Collective Action*, 27–30.

25. This formulation is Wendt's. See Alexander Wendt, *Social Theory of International Politics* (Cambridge, UK: Cambridge University Press, 1999); and Hedley Bull, *The Anarchical Society* (New York: Colombia University Press, 2002).

26. The other significant side of this line of theorizing is agent-structure interaction.

27. Wendt, *Social Theory of International Politics*, 190.

28. Bull, *Anarchical Society*, 52.

29. Waltz, *Theory of International Politics*, 74–75.

30. Wendt, *Social Theory of International Politics*, 170.

31. To assume that China is incapable of acting like a great power is to assume that China is extraordinarily different than all the rest. See Adam Watson, *The Evolution of International Society* (New York: Routledge, 2002), for a discussion.

32. A corollary to this line of reasoning is states and nuclear weapons. Despite the hysteria from some corners, most states with nuclear weapons behave remarkably similar—regardless of their internal composition, goals, or desires. As a minimum, they tend to be risk averse in acute conflict situations, especially when facing another nuclear power.

33. Joseph S. Nye Jr., *The Future of Power* (New York: Public Affairs, 2011), 5.

34. Waltz, *Theory of International Politics*, 194.

35. For a sample, see Bousquet, *Scientific Way of Warfare*; Clarke and Knake, *Cyber War*; Chris Demchak, *Wars of Disruption and Resilience: Cybered Conflict, Power, and National Security* (Athens: University of Georgia Press, 2011); James Gleick, *The Information: A History, a Theory, a Flood* (New York: Pantheon Books, 2011); Kramer, Starr, and Wentz, eds., *Cyberpower and National Security*; Martin C. Libicki, *Conquest in Cyberspace: National Security and Information Warfare* (Cambridge: Cambridge University Press, 2007); Lonsdale, *Nature of War in the Information Age*; and Evgeny Morozov, *The Net Delusion: The Dark Side of Internet Freedom* (New York: Public Affairs, 2011).

36. See Kramer et al., *Cyberpower and National Security*, for a good summary.

37. Ibid., xiii. Mark Zuckerberg's recent announcement regarding the number of active Facebook users—one billion each month—is testimony to these potentialities.

38. Hurwitz, "Depleted Trust," 21.

39. G. John Ikenberry, *After Victory: Institutions, Strategic Restraint, and the Rebuilding of Order after Major Wars* (Princeton: Princeton University Press, 2001), 50.

40. Dolman is a distinctive voice in space affairs, but even he insists dominating space is not something the United States is likely to do. For his discussion on why the United States should weaponize space, see Everett C. Dolman, *Astropolitik* (New York: Frank Cass, 2002).

41. Waltz, *Theory of International Politics*, 192

42. Martin Wight, *Power Politics* (New York: Continuum, 1978), 50.

43. A. J. Toynbee, *The World after the Peace Conference* (Oxford, UK: Oxford University Press, 1926), 4.

44. Alfred Zimmern, *Spiritual Values and World Affairs* (Oxford, UK: Clarendon Press, 1939), 32.

45. Bull, *Anarchical Society*, 196.

46. Ibid., 8.

47. Ibid., 200.

48. Ibid.

49. Ibid., 206.

50. Ikenberry, *After Victory*, 253.

51. Ibid., 52.

52. Ibid., 5.

53. Ibid., 53.

54. Ibid., 169.

55. Anarchy is generally understood to be an ordering principle, but that idea is under attack. Jack Donnelly insists neorealists' use of the term is too neat—that anarchy does all the work. His solution: abandon the idea of anarchy altogether, which sounds radical. His six elements of structure—stratification, functional differentiation, unit differentiation, norms and institutions, geotechnics, and polarity—form the backbone of his "new" structural theorizing. See

Donnelly, "The Elements of the Structures of International Systems," *International Organization* 66, Fall 2012.

56. Stephen D. Krasner, "Structural Causes and Regime Consequences: Regimes as Intervening Variables," in *International Regimes*, ed. Krasner (Ithaca, NY: Cornell University Press, 1983), 1. Also see other articles in the same work by Ernst Haas, Donald J. Puchala and Raymond F. Hopkins, Oran R. Young, Arthur A. Stein, Robert Keohane, Robert Jervis, John Gerard Ruggie, and Krasner.

57. Robert O. Keohane, *After Hegemony: Cooperation and Discord in the World Political Economy* (Princeton: Princeton University Press, 2005), 88–95.

58. Emanuel Adler, "The Emergence of Cooperation: National Epistemic Communities and the International Evolution of the Idea of Arms Control," in *Knowledge, Power, and International Policy Coordination*, 101.

59. Ibid., 102.

60. Ibid., 145.

61. Gilpin, *Global Political Economy*, 222.

62. Ibid.

63. See Gary Brown and Keira Pollett, "The Customary International Law of Cyberspace," *Strategic Studies Quarterly* 6, no. 3 (Fall 2012): 141.

64. Harold Kwalwasser, "Internet Governance," in *Cyberpower and National Security*, 510.

65. James Wood Forsyth Jr., "The Common Sense of Small Nuclear Arsenals," *Strategic Studies Quarterly* 6, no. 2 (Summer 2012): 93–111.

66. Keohane, *After Hegemony*, 88–89.

67. Donnelly, "Elements of the Structures of International Systems," 609–43.

68. On international practices, see Emanuel Adler and Vincent Pouliot, *International Practices* (Cambridge: Cambridge University Press, 2011); and Vincent Pouliot, *International Security in Practice: The Politics of NATO-Russia Diplomacy* (Cambridge: Cambridge University Press, 2010).

69. Keohane, *After Hegemony*, 90.

70. Ibid.

71. Kwalwasser, "Internet Governance," 494.

72. Some of the most focused attention is on the dominating role played by the United States. Brazil, for example, has pressed for "equal footing" regarding Internet policy issues, while Saudi Arabia has argued for a greater ITU role in "worldwide coordination of technical and policy issues related to the management of Internet domain names and addresses." See Kwalwasser, "Internet Governance," 513.

73. Ibid., 520.

74. Robert Gilpin, *War and Change in World Politics* (Cambridge: Cambridge University Press, 1981), 30.

Energy Insecurity

The False Promise of Liquid Biofuels

T. A. "Ike" Kiefer, Captain, USN

Some prominent arguments appear almost daily in the media that biofuels will increase our domestic supply of transportation fuel, end our dependence on foreign oil, reduce military vulnerabilities on the battlefield, and generally improve national security. Biofuels are further touted to reduce fuel price volatility, polluting emissions, and greenhouse gases (GHG) and even stimulate the economy. These arguments all fall apart under scrutiny. The promise and curse of biofuels is that they are limited by the energy that living organisms harvest from the sun and suffer a fatal "catch-22": uncultivated biofuel yields are far too small, diffuse, and infrequent to displace any meaningful fraction of US primary energy needs, and boosting yields through cultivation consumes more energy than it adds to the biomass. Furthermore, the harvested biomass requires large amounts of additional energy to convert it into the compact, energy-rich, liquid hydrocarbon form required for compatibility with the nation's fuel infrastructure, transportation sector, and especially the military. The energy content of the final-product biofuel compared to the energy required to produce it proves to be a very poor investment, especially compared to other alternatives. In many cases, there is net loss of energy. When energy balance (energy output minus energy input) across the full fuel creation and combustion lifecycle is considered, cultivated liquid biofuels are revealed to be a modern-day attempt at perpetual motion that is doomed by the laws of thermodynamics and a fatal dependence on fossil fuel energy. The United States

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cannot achieve energy security through biofuels, and even the attempt is ironically achieving effects contrary to "clean" and "green" environmental goals and actively threatening global security.

This article focuses on cultivated biomass converted into liquid transportation fuel, and all references to *biofuels* throughout refer to these circumstances unless specified otherwise. The overall approach is an analysis of alternatives comparing three distinct biofuels methodologies with conventional petroleum fuel to assess their relative costs and benefits. It begins by considering what energy security means in terms of fuel quality and supply, then builds an analytical framework of key parameters and evaluates how each of the biofuel methodologies fall short. Next it provides evidence that pursuit of biofuels creates irreversible harm to the environment, increases greenhouse gas emissions, undermines food security, and promotes abuse of human rights. The article concludes with specific recommendations for policy and action.

Energy Security

The ability of biofuels to truly substitute for petroleum fuels is the core question addressed here. The US Congress has authoritatively defined *energy security* in Title 10 of the US Code as "having assured access to reliable supplies of energy and the ability to protect and deliver sufficient energy to meet mission essential requirements."[1] In 2011, the United States imported 45 percent of its petroleum, and this generates concern because of US dependence on other nations for supply and unpredictable global market price volatility.[2] If a way existed to reliably supply US transportation energy exclusively from domestic sources with reasonable and stable prices, it would clearly enhance energy security.

An Appeal to Science over Politics

This research is based on an extensive literature survey of recent and reputable sources emphasizing US government agency data published in official reports and university studies published in peer-reviewed scientific journals. Since 2008, a new generation of more rigorous studies has dramatically undermined the naïve assumption that biofuels are inherently clean and green, carbon-neutral, and the world's solution to petroleum dependence. But these watershed scientific documents have so far had little impact on US government or military energy policy. The US Navy

directly rejected a RAND study conducted at the direction of Congress and delivered to the secretary of defense in January of 2011 that unambiguously found biofuels of "no benefit to the military."[3] A second RAND study and a report by the US National Academy of Sciences, both severely questioning the wisdom and efficacy of current US biofuels policies, also resulted in no adjustments to US biofuels programs.[4] In August 2012, the German National Academy of Sciences, in a country very aggressive in its pursuit of alternative energy, released the report of a three-year study that concluded biofuels offer little or no benefit in reducing GHG emissions and that "the larger scale use of biomass as an energy source is not a real option for countries like Germany." The German scientists even went so far as to flatly recommend all of Europe abandon biofuel production mandates.[5] In October 2012, the National Research Council released a report which critically questioned the feasibility of sustainable production of algae-based biofuels and highlighted five areas of major concern that parallel and support arguments made in this article against all cultivated biofuels.[6] These are but a few of the studies that point out fatal flaws in pursuing biofuels as a substitute for petroleum. There are several key parameters that, when understood, help to evaluate the utility of fuels and the costs and consequences of their production and use.

The Science of Fuels

The energy carriers in fossil fuels and biofuels are hydrogen and carbon atoms. Hydrogen is abundant, is very reactive in accepting and releasing energy in its chemical bonds with other atoms, and is the lightest element, giving it a very high *gravimetric energy density* (joules per kilogram). Pure hydrogen powers everything from microorganisms to turbine engines.[7] Carbon is another common and lightweight element with very high combustion energy. It also readily forms long molecular chains and can serve as a backbone to organize many other atoms into dense and neatly organized packages. Combined with hydrogen in equal parts, it forms highly versatile and energetic liquid fuels. Carbon transforms hydrogen from a diffuse and explosive gas that will only become liquid at -423° F into an easily handled, room-temperature liquid with 63 percent more hydrogen atoms per gallon than pure liquid hydrogen, 3.5 times the *volumetric energy density* (joules per gallon), and the ideal characteristics

of a combustion fuel.[8] If we did not have carbon, we would have to invent it as the ideal tool for handling hydrogen.

In 1909, Fritz Haber discovered the chemistry of converting natural gas into ammonia (i.e., converting fossil fuel into plant fuel). Ammonia (NH_3) is a potent organic fuel for most bacteria and plants which have the ability to metabolize its nitrogen and hydrogen energy.[9] Placing ammonia in the soil to fuel plant growth is known as "nitrogen fixing."[10] It can be done naturally and slowly by symbiotic soil and root bacteria using photosynthesis energy borrowed from their host plant, or it can be done artificially and quickly by humans manufacturing it and plowing it into the soil.[11] The manufacture of ammonia is second only to plastics in consumption of US industrial energy, and 80 percent of ammonia goes into making fertilizer.[12] Today, Iowa farmers pump pure liquid ammonia into the soil at the rate of 150–200 lbs/acre[13] to harvest consecutive annual crops of 160–180 bushels per acre of corn—a sixfold increase over historical yields.[14] It is largely because of the global conversion of fossil fuel energy into food that the world has avoided Robert Malthus' 1798 prophecy of global famine from population growth overtaking food production.[15]

Without the addition of artificial fertilizer energy, plants are limited to getting their energy from the sun. The devastating limiting factor for all biofuels is that photosynthesis captures solar energy with surprisingly poor speed and efficiency—only about 0.1 percent of sunlight is translated into biomass by the typical terrestrial plant,[16] and this translates into an anemic *power density* of only 0.3 watts per square meter (W/m^2).[17] This is 20 times worse than the 6.0 W/m^2 that current solar panels arrayed in large farms can collect from the same sunlight and acreage.[18] Humans must input fossil fuel energy in the form of ammonia fertilizers to overcome this solar limit on biomass production for crops. While this is a justifiable option to increase food production, it makes no sense to add energy to something that is supposed to be an energy source such as biofuel crops. It is also nonsensical to add fossil fuel energy when the objective is to *displace* fossil fuel energy.

A perfect combustion fuel possesses the desirable characteristics of easy storage and transport, inertness and low toxicity for safe handling, measured and adjustable volatility for easy mixing with air, stability across a broad range of environmental temperatures and pressures, and high energy density. Because of sweeping advantages across all these parameters, liquid hydrocarbons have risen to dominate the global economy. No materials

other than very exotic and toxic substances like lithium borohydride ($LiBH_4$) or expensive rare metals like beryllium surpass the energy density of diesel and jet fuel. Biodiesel and ethanol both fall short. Hydrogen fuel cells, electrical storage batteries, and capacitors miss by a much greater margin. Other alternatives, such as wind, solar, geo-thermal, or waste-to-energy devices, can power some laptops and light some fixed facilities but simply cannot harvest enough energy to propel the tanks, jets, helos, and trucks that are by far the major battlefield fuel consumers. These can offer only an incidental decrease in overall fuel requirements for mechanized forces and then only in low-hostility circumstances where they can be set up and safeguarded.

In addition to inorganic and organic chemistry, an energy strategist must understand two unbreakable laws of the universe. The first law of thermodynamics (conservation) states that energy is neither created nor destroyed, but only changes form. The second law (entropy) distinguishes between useful energy that can perform work and useless energy that cannot. It holds that some fraction of useful energy irreversibly becomes useless every time energy is converted from one form to another. In other words, any conversion process consumes some of the useful energy and leaves less in the output products. Together, these two laws declare that the amount of useful energy that can be recovered from a system is always less than the energy that was put into the system. Every transaction, process, or conversion pays an energy tax, which is why it is impossible to construct a perpetual motion machine. The ratio of energy-out to energy-in is a critical parameter in evaluating energy sources.

Energy Return on Investment

For energy strategists to get the right answers, they must first ask the right questions. When choosing a primary energy source and a fuel to derive from it, it is essential to be sure the fuel will meet the demands of the civilization that will consume it—not only in terms of quantity, but even more fundamentally, in terms of quality. One key measure of fuel quality is how much useful energy the fuel yields divided by how much energy is required to extract the primary energy source from the environment and convert it into that fuel. This metric is known as *energy return on investment* (EROI).[19]

$$\text{EROI} = \frac{\text{Energy available in newly produced fuel}}{\text{Energy consumed in producing the new fuel}}$$

Raw primary energy sources require some energy to be consumed to process them into finished fuels. An EROI of 1:1 would mean the useful energy in a newly produced quantity of fuel is exactly equal to the energy consumed in its production. It might seem that any EROI greater than unity is of net benefit to civilization, but this is not the case. A modern civilization requires a much greater return on its investment, because survival and standard of living depend upon the size of this margin.

Civilization Is a Living Organism

Dynamic energy budget (DEB) theory is a sophisticated approach to looking at living things in terms of energy.[20] A thermodynamic analysis reveals that any organism can only afford to expend a small fraction of its current energy stores finding and processing new primary energy sources into fuel (*assimilation*) because there are many other essential energy-consuming (*dissipation*) tasks it must perform to survive; these include sustainment, repair, protection, maturing and increasing in complexity, and reproduction. Only if there is surplus energy after all of these demands are fully satisfied will the organism increase its mass (*growth*). To power all these activities, the organism needs food that is not just fractionally positive in net energy, but rather has an EROI many multiples greater than unity. A civilization is itself a high-order physical and biological organism that has tremendous overhead costs and can spare only a fraction of its energy to assimilate new energy.

Minimum EROI for Modern Civilization

A study of historical US economic performance over the last century has found that economic recessions are linked to primary energy EROIs dipping below a critical threshold of 6:1.[21] This value represents the minimum energy quality an industrial civilization must have to sustain a modern, energy-intensive quality of life. Another macroanalysis found that an EROI of 3:1 is the bare minimum quality a raw energy feedstock must have to overcome all the production costs and conversion losses and still deliver positive net energy to modern civilization.[22] A 3:1 EROI thus also represents a critical tipping point. To put these values in biological terms, a modern industrial civilization is very energy-hungry, and if undernourished on a diet of foods with lean EROIs below 6:1, it becomes catabolic, eating into the fat of its savings and the muscle tissue of its infrastructure to replace the missing calories. As long as EROI

remains below 6:1, industrial civilization is locked into a death spiral where an ever increasing fraction of its economic output (GDP) is spent on energy at the cost of eroding standard of living.[23] At EROIs below 3:1, the food is so poor that digesting it into fuel takes more energy than it returns, and full starvation sets in. The only way out of this hunger trap is either to find higher-EROI energy or to decay into a preindustrial civilization with lower energy needs.

The bottom line is that a healthy modern economy must be fed by hearty primary energy sources with a collective EROI above 6:1. Purposely displacing high-EROI energy sources with anything that returns less than 6:1 is ill advised. Plotting out fuel EROI estimates versus their current energy contribution to the US economy provides a useful perspective on their relative utility (fig. 1). [24]

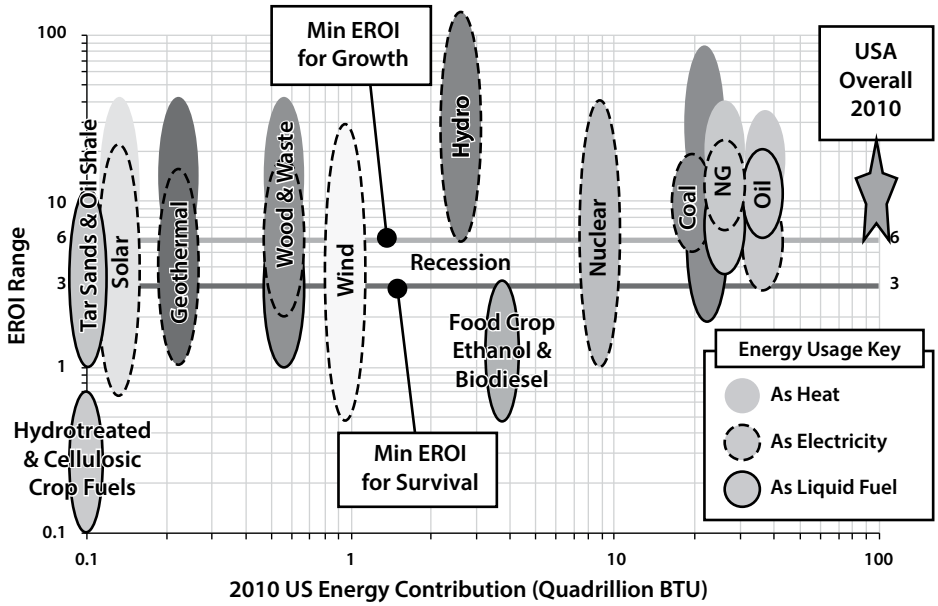

Figure 1. Energy return on investment (EROI) of US energy sources

Evaluating Biofuels

Food Crop Ethanol

Over the past 70 years, the United States has nearly perfected corn as a high-yield food and industrial starch feedstock. Unfortunately, the laws of physics exact large energy tolls from processes that require many

conversions, such as producing liquid fuels from solid biomass. After decades of study and experimentation and continuously refined commercial production, the scientific literature consensus for corn ethanol EROI is a lowly value of 1.25:1.[25] Even worse, there is no net gain in liquid fuel energy—the ethanol produced contains energy barely equal to the input fossil fuel energy. The small energy profit is contained in byproducts, principally high-protein biorefinery leftovers called distillers' dry grains and solubles (DDGS) that can be used as cattle feed. More than $6 billion a year in direct federal assistance to corn growers and ethanol refiners since 2005 has served only to reduce a nonexistent foreign dependence on animal feed protein supplements.

It should be pointed out that the corn ethanol EROIs published in the literature and discussed above are not for a pure corn ethanol lifecycle, but for a hybrid lifecycle involving both fossil fuel and corn ethanol where fossil fuel provides much of the input energy. A proper corn ethanol EROI would be calculated using corn ethanol as the exclusive energy source to make more corn ethanol, but no example is available today. This is telling. It will be shown below by lifecycle analysis that making corn ethanol is a negative energy-balance process that consumes more than five-sixths of the energy invested. Civilization would get six times more output energy from the fossil fuel diverted to make corn ethanol if it were instead used directly as fuel.[26]

Modern intensively farmed corn, with its huge appetite for fossil fuel–based ammonia and agrichemicals, is making a large, net negative contribution to the nation's energy budget and working to increase rather than decrease petroleum demand. Using biomass to replace fossil fuels is futile if a large portion of the energy invested to make them is *from* fossil fuel. Applying ammonia fertilizer to any crop intended for biofuel is an indefensible waste of energy.

Cellulosic Ethanol

The facts are even less kind to liquid fuels made from cellulosic materials such as wood, switchgrass, and harvest wastes, which contain no easy sugars and starches. Cellulose can be broken down into fermentable sugars but must first be separated from the lignin. Paper manufacturers use concentrated acid and explosive steam treating known as the "Kraft process." However this one step alone consumes as much energy as exists in the final ethanol. Those who want to make energy out of lignocellulose

must use much slower and more expensive enzyme or microbial processes; and then still remains fermentation, distillation, and dehydration. A rigorous thermodynamic analysis found that cellulosic ethanol is three or more times more difficult to produce than food crop ethanol, with an EROI far below 1:1.[27] However, a much-touted USDA study that assumed away many of the known difficulties and costs to predict a fanciful EROI for switchgrass of 5.4:1 (four times better than corn ethanol) has been used to justify spending billions of dollars in federal and private funds on some high-profile entrepreneurial misadventures.[28] Nevertheless, the proof is in the performance.

Despite all the subsidies, tax breaks, and fuel-mixing mandates since 2005, there is not a single commercially viable cellulosic ethanol facility in the United States today.[29] Rather, the landscape has been rocked by high-profile frauds and failures, such as Cello and Range Fuels.[30] Instead of the 500 million gallons of cellulosic ethanol a year by 2012 promised by huge federal expenditures on startups and biorefineries,[31] the Environmental Protection Agency (EPA) officially counts only one 20,000-gallon commercial transaction to date to an undisclosed buyer.[32] Nevertheless, the EPA continues to fine US oil refineries for not mixing nonexistent cellulosic ethanol into their gasoline.[33] Some of the companies that have been working on cellulosic ethanol the longest—such as Gevo, Amyris, and Cellana—have shifted to corn ethanol, industrial chemicals, and fish food.[34] British Petroleum and others have suspended construction of huge biorefineries in the United States.[35] Other companies such as Coskata and Primus Green Energy are quietly leading a mass migration away from any pretense of renewable fuels to instead boldly embrace synthetic liquid fuels made from natural gas.[36] The former CEO of Codexis, who presided over the spending of $400 million in pursuit of cellulosic ethanol, has publically confessed that making hydrocarbons from carbohydrates is a dead end. He is now at Calysta working on natural gas–to–liquid fuel.[37]

Biodiesel

Plant species which yield some biomass as lipids include soy, camelina, rapeseed, oil palm, jatropha, peanut, sunflower, cottonseed, safflower, and microalgae. All of these crops, including a nonpoisonous Mexican variant of jatropha, have provided human and animal food over the centuries. The natural lipids in these plants can be broken down

by adding methanol to become fatty-acid methyl esters (FAME), commonly known as *biodiesel*. Contrary to popular belief, biodiesel is a very different chemical cocktail than conventional diesel fuel and has a lower energy density and inferior physical properties. To overcome biodiesel and other liquid biofuel shortcomings and make them more compatible with existing fuel infrastructure and high-performance engines, they must be transformed into true "drop-in" hydrocarbons by a series of processes, known as "hydrotreating," that increase the ratio of hydrogen to carbon, remove all oxygen, and change the structure and blend of the constituent molecules.[38] Hydrotreatment greatly increases the cost and reduces the renewable nature of the fuel, because the hydrogen added comes from fossil-fuel natural gas and the process releases 11 tons of CO_2 for every ton of hydrogen added. A national security energy strategist must understand such technical details as these and also be aware that all military aircraft and combat vehicles and civilian airline fleets must have hydrotreated biofuel. Even before being punished by hydrotreatment, biodiesel EROIs calculated from rigorous, full commercial-scale lifecycle studies range from 1.9:1 for soy[39] down to well below 1:1 for microalgae.[40]

Algae is the only biodiesel crop with high-enough potential yields to replace petroleum without consuming all US territory and deserves further consideration. Optimistic studies have projected algae biodiesel to achieve much higher EROIs, but a critical analysis of their assumptions reveals they depend on a host of unrealistic circumstances. These include massive supplies of free water and nutrients, a free pass on enormous environmental impact, and market economics that miraculously transform enormous accumulations of soggy biomass byproduct with a per-ton value less than the cost of transportation into a cash commodity crop. A literature survey of reported algae EROIs performed by the National Research Council found values from 0.13:1 to 7:1, but in the higher cases, energy credits from co-products dwarfed the energy delivered as liquid fuel—biodiesel was really the co-product and solid biomass the product.[41] Algae are much more efficient in producing "soylent green" than in producing green fuel. Proponents often claim that algae need only sunlight and CO_2 to grow. In practice, however, the need for high yields compels use of fossil fuel–based commodity fertilizer typically delivered as urea.[42] Solazyme Inc., the US Navy's choice for algae biofuel, actually grows its product in dark bioreactors using carbon and hydrogen energy in the form of sugar. This makes it unique in producing a biofuel 100 percent dependent upon a

food crop and getting 0 percent of its energy from the sun via direct photosynthesis—a worst-case scenario.[43]

The simple but decisive math is that, even at commercial scale with generous assumptions about cellular reproduction rate and lipid fraction and oil extraction, and ignoring the costs of facilities and water, Argonne National Laboratory has calculated that it takes 12 times as much total energy and 2.6 times as much fossil fuel energy to put a gallon of algae biodiesel in a gas station pump instead of a gallon of petroleum diesel—and this is before hydrotreatment.[44] Direct comparison of alternatives is a sound evaluation technique and introduces the important economic concept of *opportunity cost*.

Fuel Lifecycles and Opportunity Cost

Not only should new fuels have an EROI greater than 6:1, they should also have an EROI greater than available alternative fuels suitable to the same purpose. If they have a lower EROI and their use is compelled, production will sap energy from higher EROI fuels and create an energy deficit to the economic sector they serve.[45] This can be demonstrated by comparing petroleum fuels to corn ethanol. Current petroleum diesel and gasoline production EROIs are variously estimated between 10:1 and 20:1. A conservative approach least favorable to petroleum is to postulate an 8:1 EROI, which represents the lowest value calculated since 1920.[46] An 8:1 EROI means that one barrel of liquid fuel energy input can support the exploration, drilling, extraction, and refining of enough crude oil to make eight new barrels of liquid fuel energy[47]—which for petroleum happens to come with a bonus of one barrel of chemical feedstock for plastics, lubricants, organic compounds, industrial chemicals, and asphalt (see fig. 2).[48] The much lower 1.25:1 EROI of corn ethanol means that to produce the same net gain of eight barrels of energy requires *not one, but 32 barrels* of input energy. And for ethanol, the output energy profit is delivered not as liquid fuel, but as 5.5 tons of cattle feed co-product. The 52 barrels of lower energy density, lower compatibility, and more corrosive ethanol produced as the primary product contain just enough energy to make up for the 32 barrels of fossil fuel energy used to make them and deliver no net energy gain. This picture looks completely different than the one in biofuels advocacy literature because it shows true lifecycle and opportunity costs, not just a misleading combustion-only comparison of a barrel of oil versus a barrel of ethanol.

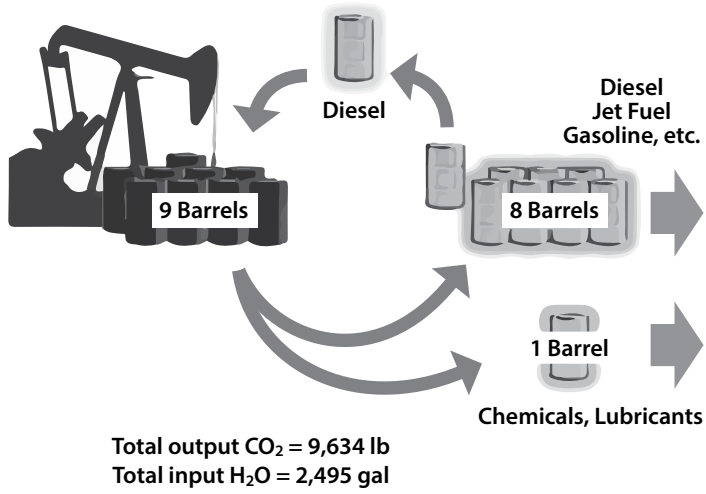

Figure 2. Petroleum motor fuel lifecycle at 8.0:1 EROI

Biofuels can only truly substitute for petroleum fuels when the EROIs of both converge, and this cannot happen if the former is an energy parasite of the latter. The parasitic dependence of biofuels upon fossil fuels precludes any chance of their reducing dependence on foreign oil, assuring domestic supply, or stabilizing prices. Liquid biofuel prices are already as volatile as oil prices and track up and down with the international oil market.[49] Deriving fuel from farming further increases price volatility by adding an additional linkage to global agricultural commodities markets. Energy security is reduced by choosing a fuel subject to floods, freezes, and droughts, and which must be recreated annually from scratch with no proven reserves.

To summarize the corn ethanol fuel lifecycle depicted in figure 3, it is the transformation of 4.7 tons (180 gigajoules) of high-quality fossil fuel and 11,000 tons of fresh water into 7.2 tons of lower-quality ethanol fuel-additive (180 gigajoules) and 18.5 tons of CO_2-equivalent, all for the net creation of 5.5 tons of protein supplement.[50] From the perspective of opportunity cost, one barrel of fossil fuel energy can either deliver 340 pounds of DDGS or 2,200 pounds (336 gallons, 1 metric ton) of petroleum fuel. The much more efficient and economical path to generate high-protein animal feed supplement chosen by US farmers in the absence of ethanol subsidies is growing soy, which fixes its own nitrogen and has 49 percent protein content vice 27 percent for DDGS.[51] Compared to the petroleum fuel lifecycle (fig. 2), the corn ethanol fuel lifecycle (fig. 3) consumes 3.5 times more fossil fuel, more than triples GHG

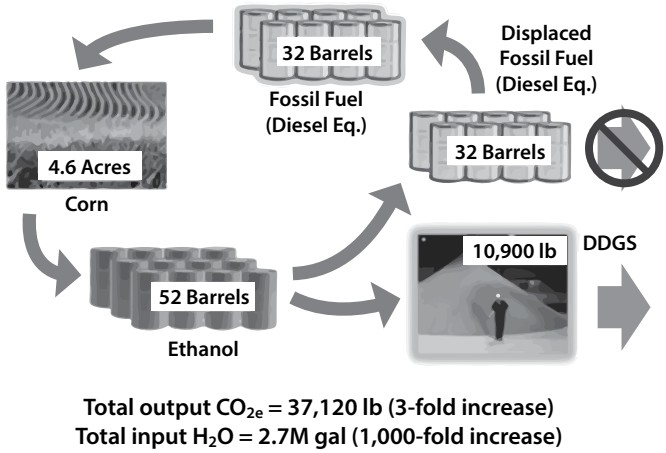

Figure 3. Corn ethanol motor fuel lifecycle at 1.25:1 EROI

emissions, increases water use by three orders of magnitude, adds environmental costs from agrichemical runoff while still suffering those associated with crude oil, and competes with food cultivation for cropland acreage and associated agricultural production capital and resources.

Closer examination reveals how intractable is biofuels' dependence on fossil fuel energy. Fossil fuels provide 82 percent of all US energy, including the vast majority of electric power and 94 percent of liquid transportation fuel.[52] They provide the farm machinery fuel and processing plant heat and electricity used to make biofuels from biomass. Petroleum and natural gas are also the feedstock for the massive organic chemical industry that makes the herbicides and pesticides applied to biofuel crops and the designer enzymes used in the latest high-technology approaches. The energy to prepare the giant yeast and microbe cultures that ferment the sugars into alcohol and the immense heat needed to distill the 4 percent alcohol beer into 99.5 percent pure anhydrous ethanol are overwhelmingly supplied by fossil fuel. Of course the energy used to build the biorefineries in the first place and to transport the final product to market is largely from fossil fuel as well. Some might argue that all of the above is only true because biofuels have not yet gained enough of a market share to provide these energies. However, the truth is that biofuels have been around for a century (the first US commercial cellulosic ethanol plant was opened in 1910)[53] but have failed to gain market share because they are a poor energy investment. They are crippled by the thermodynamic energy losses of all the transformations involved from making a low-energy-density, solid carbohydrate into a

high-energy-density, liquid hydrocarbon. If they were used to provide the energy for their own manufacture, or even allowed to compete without subsidies, there would be little if anything profitable left at the end to market.[54]

Every fuel with an EROI less than the prevailing average drags down the average and multiplies rather than eases the burden placed on higher EROI fuels. The only way to displace imported petroleum use and thereby improve national security is to domestically produce fuels with higher EROI than refined petroleum. Any such fuel will be instantly adopted because the evidence of its higher EROI will be a lower price.[55] Without petroleum or a replacement source for massive quantities of hydrogen to make ammonia, all biomass yields, particularly food, will plummet toward what they were before Haber's monumental discovery in 1909, with devastating consequences for the world.[56] Accelerating the use of petroleum by using it to make biofuels accelerates future scarcity, undermines international food security, is counterproductive to "green" energy goals, and is not sound energy strategy.

The Real Cost of Biofuels

The Military's Cost

One of the core goals of the DoD's new *Operational Energy Strategy* is to reduce military energy costs so the department can "shift resources to other warfighting priorities, and save money for the American taxpayers."[57] The civilian leaders of the US Navy quote the statistic that a $1 rise in the cost of a barrel of oil increases annual fuel costs by $31 million.[58] Yet, the cheapest price the Navy has paid for any biofuel to date is $1,123.50 per barrel.[59] Since 2007, the military has spent $61.9 million on 1.28 million gallons of biofuel, averaging more than $48 a gallon, or $2,000 a barrel, and costing taxpayers $88 million more than if conventional fuel had been purchased (fig. 4).[60] This does not include more than $30 million paid for pure research on alternative fuels and recent additional millions for biorefineries obligated under the Defense Production Act in partnership with the Departments of Energy and Agriculture.[61]

DoD Biofuels Purchases						
Date	**Contract**	**Vendor**	**Fuel**	**Gallons**	**$ Total**	**Per Gallon**
31 Aug 2009	SP0600-09-D-0519	Sustainable Oils	Camelina JP-5	40,000	2,644,000	**$66.10**
31 Aug 2009	SP4701-09-C-0040	Solazyme	Algae F-76	20,055	8,574,022	**$427.53**
1 Sep 2009	SP0600-09-D-0518	Solazyme	Algae JP-5	1,500	223,500	**$149.00**
15 Sep 2009	SP0600-09-R-0704	UOP (Cargill)	Tallow JP-8	100,000	6,400,000	**$64.00**
15 Sep 2009	SP0600-09-D-0520	Sustainable Oils	Camelina JP-8	100,526	6,715,137	**$66.80**
29 Jun 2010	SP0600-09-D-0519	Sustainable Oils	Camelina JP-5	150,000	5,167,500	**$34.45**
26 Jul 2010	SP0600-10-D-0489	Sustainable Oils	Camelina JP-8	34,950	1,349,070	**$38.60**
4 Aug 2010	SP0600-10-D-0490	Sustainable Oils	Camelina JP-8	19,672	759,339	**$38.60**
31 Aug 2010	SP0600-09-D-0520	Sustainable Oils	Camelina JP-8	100,000	3,490,000	**$34.90**
31 Aug 2010	SP0600-09-D-0517	UOP (Cargill)	Tallow JP-8	100,000	3,240,000	**$32.40**
10 Sep 2010	SP4701-10-C-0008	Solazyme	Algae F-76	75,000	5,640,000	**$75.20**
26 Aug 2011	SP4701-10-C-0008	Solazyme	Algae F-76	75,000	4,600,000	**$61.33**
23 Sep 2011	SP0600-11-R-0703	Gevo	Alcohol to JP-8	11,000	649,000	**$59.00**
30 Sep 2011	SP0600-11-D-0530	UOP	Bio JP-8	4,500	148,500	**$33.00**
30 Nov 2011	SP0600-11-R-0705	Dynamic Fuels (Tyson+Syntroleum), Solazyme	Tallow & Algae JP-5 Tallow & Algae F-76	100,000 350,000	12,037,500	**$26.75**
23 Sep 2011	DTRT5711C10058 (DoT/FAA, not DoD)	UOP	Gevo Isobutano to Jet Fuel	100	1,124,899	**$11,248.99**
2 Feb 2012	N68936-12-P-0209	Albemarle	Cobalt n-Butanol to Jet Fuel	55	245,000	**$4,454.55**
DoD Synthetic Fuels Purchases						
6 Jun 2007	SP0600-07-D-0486	Equilon	Natural Gas to Aviation Kerosene	315,000	1,075,694	**$3.41**
26 Jun 2008	SP0600-08-D-0496	SASOL	Coal to Aviation Kerosene	60,000	225,000	**$3.75**
3 Jul 2008	SP0600-08-D-0497	SASOL	Coal to Aviation Kerosene	335,000	1,306,500	**$3.90**
30 Sep 2009	SP0600-09-D-0523	PM Group	Natural Gas to Diesel	20,000	140,000	**$7.00**
DoD Bulk Contract Conventional Fuel Purchase						
FY 2010	Various		JP-8 Jet Fuel JP-4 / Jet A-1 JP-5 Jet Fuel F-76 Fuel Oil Motor Gasoline	2,296M 1,249M 541.8M 805.7M 70.7M	5,201M 2,884M 1,175M 1,816M 174.1M	**$2.26** **$2.31** **$2.17** **$2.25** **$2.46**
FY 2011	Various		JP-8 Jet Fuel JP-4 / Jet A-1 JP-5 Jet Fuel F-76 Fuel Oil Motor Gasoline	2,079M 1,246M 529.3M 875.9M 59.0M	6,478M 4,032M 1,572M 2,590M 186.6M	**$3.12** **$3.24** **$2.97** **$2.96** **$3.16**

Figure 4. DoD comparative fuel purchases

The Nation's Cost

The per-gallon price paid by the military for biofuels is only a fraction of the US government's full cost. Government officials profess grave concern at the volatility of oil prices, and economic forecasters cite statistics that a $10 rise in the price of a barrel of oil slows the US economy 0.2 percent and kills 120,000 jobs.[62] Yet, the federal government is voluntarily paying more than $10 a barrel in biofuel subsidies (fig. 5).[63] The Department of Enegy (DoE) pumped $603 million into biofuel refinery construction in 2010 as part of $7.8 billion in annual biofuels spending.[64] Despite millennia of ethanol production as a beverage, 190 years of ethanol production as a fuel, and six years of huge subsidies and blending mandates and guaranteed markets since 2005, a joule of corn ethanol energy today is still more expensive than a joule of gasoline energy. The American Automobile Association reports as of December 2012 that the mpg-corrected price of E85 ethanol at the gas pump is 40 cents a gallon higher than premium gasoline.[65] Because of mandatory blending of lower energy density ethanol in gasoline, consumers in 2010 paid $8.1 billion at the gas pump for energy that was not put into their tanks. When added to the $6.1 billion in federal subsidies given out by the US Treasury and taxpayers as ethanol tax credits, the United States paid a $14.2 billion premium in 2010 to displace 6.4 percent of its gasoline energy with ethanol—and the cheaper gasoline that was displaced was exported. [67]

Energy Source	Federal Subsidies (millions of $)	Domestic Production (million bbl of oil equivalent)	Subsidy per barrel of energy produced
Coal	$1,358	3,793	$0.36
Oil and Gas	$2,820	6,229	$0.45
Hydro	$216	437	$0.49
Nuclear	$2,499	1,451	$1.72
Geothermal	$273	36	$7.63
Biomass/fuel	$7,761	747	$10.39
Wind	$4,986	159	$31.39
Solar	$1,134	22	$52.30
Total	**$21,047**	**13,921**	**Average = $1.63**

Figure 5. US federal government energy subsidies in 2010

The Nation's Gain

A true primary energy source, like a true food source, cannot be subsidized. It must, by definition, yield many times more energy (and wealth) than it consumes, or else it is an energy sink. Critics of petroleum often claim it is subsidized, but when both sides of the balance sheet are considered, the money is revealed to be flowing the other way. All federal subsidies and tax breaks for oil and natural gas in 2010, as officially tallied across all government agencies and reported to Congress, totaled $2.82 billion, equaling 45 cents per barrel produced domestically. Against that outlay, the federal government collected $56.1 billion in oil company corporate taxes and excise taxes on retail gasoline and diesel, equaling $9.01 per barrel—a 2,000 percent return.[68] State and local governments collected similar shares in taxes and fees as well. It is not by subsidies that fossil fuels have grown to produce 82 percent of US energy, but by the merits of EROI, energy density, and power density in competition with other energy alternatives. Oil and gas are true primary energy sources that nourish rather than starve the US government and economy. Global oil and gas energy is a $3.8 trillion industry that fully subsidizes the rentier economies of 10 petro states and partially subsidizes the economies of 70 more producers.[69] In the United States alone, there are 536,000 active crude oil wells, 504,000 active natural gas wells, dozens of continent-spanning pipelines, a colossal interstate highway system, 17 million barrels-per-day of refining capacity, 160,000 gas stations, and a $1.5 trillion fraction of the global oil and gas industry that have all been funded out of oil and gas EROI margins.

Power Density and Land Use

If EROI and price were not fatal enough, the questions of land use and ultimate capacity must also be answered. Land is a finite national resource with many competing uses. Biofuel production is a terribly inefficient use of land, and this can best be illustrated with *power density*, a key metric for comparing energy sources. The 70 gallons of biodiesel per acre of soy and 500 gallons of ethanol per acre of corn are amazing agricultural achievements, but are dismal in terms of power density, and work out to only 0.069 and 0.315 W/m^2 respectively. While corn is 4.5 times better than soy, it is a factor of three below wind (1.13 W/m^2), 19 times worse than photovoltaic (PV) solar (6.0 W/m^2), and 300 times worse

than the 90 W/m^2 delivered by the average US petroleum pumpjack well on a two-acre plot of land.[70] Thirty square meters of today's cheapest PV solar panels can capture the same amount of energy per year as is in the ethanol from 10,000 square meters (2.5 acres) of cultivated switchgrass.[71] This is, coincidentally, about the same amount of land the average American family would require as biofuels pasture for each of its cars. Alternatively, that land could sustainably grow crops to feed 20 vegans or the crops and livestock to feed 2.5 meat-eating humans.[72] To replace the 28 exajoules of energy the United States uses every year just for cars, trucks, and airplanes would require more than 700 million acres of corn. This is 37 percent of the total area of the continental United States, more than all 565 million acres of forest, and more than triple the current amount of annually harvested cropland. Soy biodiesel would require 3.2 billion acres—one billion more than all US territory including Alaska. Oil palm biodiesel yields are reported to be as high as 640 gal/acre (6,000 L/ha), which exactly double the power density of corn ethanol but still fall far short of wind and solar power. As hinted earlier, algae biodiesel has the highest potential power density of any biofuel, but the predicted best case achievable, as limited by physical laws and laboratory-perfect conditions, is 6.42 W/m2—equivalent to what is produced today from the solar farm at Nellis AFB.[73] Figure 6 contrasts the land area of oil field, solar farm, wind farm, and cornfield

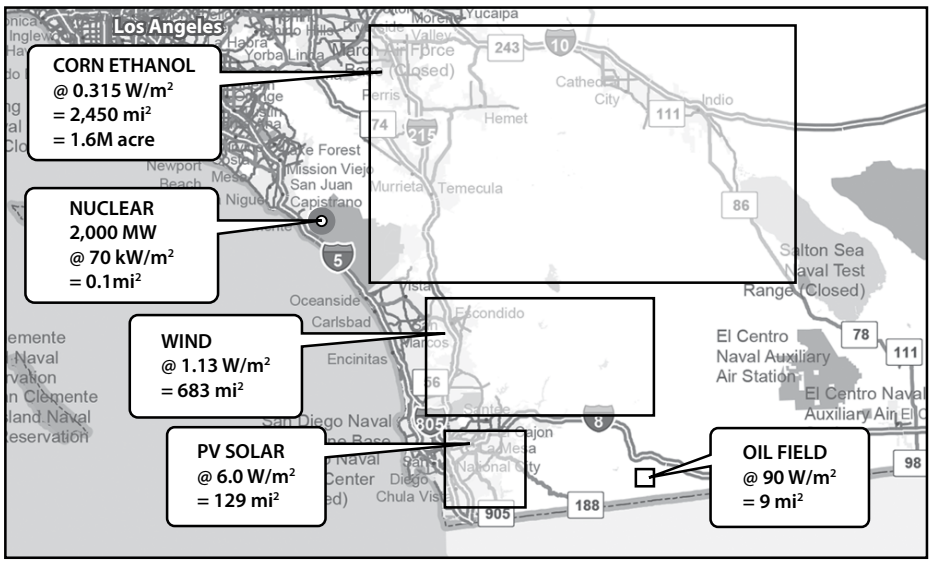

Figure 6. Power density "energy sprawl"

needed to replace the 2,000 MW of power produced by the San Onofre Nuclear Generating Station in Oceanside, California.

The high prices and environmental protections on land in developed countries make dedicating millions of acres to biofuels prohibitive, despite optimistic government studies that postulate turning most forests and arable land into agribusiness zones for biofuels.[74] Real-world economics compels energy farmers to look for cheaper cropland and water rights in less developed countries. The United States and European nations are primarily pursuing offshore land indirectly, such as through Blue Sugars' joint venture with Petrobras where Brazilian sugarcane bagasse feedstock was shipped to the United States for processing.[75] A 2010 World Bank analysis revealed that other wealthy countries, including Saudi Arabia, South Korea, and China, are pursuing a more direct strategy and have already purchased or leased more than 27 million acres of foreign land and water rights for remote cultivation of food, industrial, and biofuel crops. Chief locations for such land appropriation are Sudan, Mozambique, and Ethiopia, where millions are living hand-to-mouth on food from the UN World Food Program.[76] Even at today's small scale of production, biofuels' huge appetite for land already puts them in significant and direct competition with food production. Food must and will eventually win this competition because there is not enough suitable land for both. A recent European metastudy of 90 other studies concluded that only one-fifth of the world's energy demand could likely be met by biofuels without removing meat from the human diet or making massive land use changes beyond the 296 million acres which already must be put into cultivation to feed the population of 2050.[77]

The Competition of Fuel and Food

Around the world, cultivated food crops (corn, sugarcane, soy, palm, and various oilseeds) account for all statistically significant liquid biofuel production.[78] In 2008, world grain market prices tripled, mirroring the spike in global oil prices and proving the linkage between food calories and energy calories in the modern world. Grain prices to the poorest consumers increased as much as 50 percent, driving 8 percent more of Africa's population toward hunger and raising the world's undernourished population to approximately 850 million.[79] Today's market prices are still double what they were in 2007. Various studies of the 2008 food price spike have attributed as much as 70 percent of the increase

in corn and 100 percent of the increase in sugar prices to global diversion of food to biofuels.[80] A union of the world's preeminent food and financial assistance agencies, including the World Food Program and the Food and Agriculture Organization of the United Nations, has formally called for all G20 nations to drop their biofuels subsidies and mandates because of the impact on food prices around the world.[81] The fact is that every cultivated crop—food or nonfood—competes with every other cultivated crop for finite resources including water, land, agrichemicals, farm equipment, transportation, and financing. Putting more demand on these resources raises prices for everyone. Biofuels are becoming a huge threat to global food security, and thereby to global stability—a fact that should shape any military or political energy strategy. Many analysts now looking at the "Arab Spring" phenomenon recognize that, underlying the very real political aspirations of movements such as the revolution in Tunisia was outrage at skyrocketing food prices. What began as bread riots in Egypt due to the end of government grain subsidies became a hot-blooded revolt and coup.

As the global population sprints toward nine billion by 2050, there are 140,000 more mouths to feed every day. Food grain consumption is growing at 40 million tons per year.[82] Yet, because of enormous market-distorting subsidies, the United States today produces more corn for ethanol than for human food or cattle feed.[83] For decades past, it had surplus food crop capacity and used it to rescue other nations from famine. In 1965, Pres. Lyndon Johnson's administration shipped one-fifth of the US wheat crop to India during a devastating drought. With slack land now consumed by biofuels production, a drought such as the one that destroyed 40 percent of Russia's grain crop in 2010 would be devastating to national security—particularly because both food and fuel would be simultaneously affected. The negative consequences of biofuels on food crop production have been understood by the US government since a panel of scientists appointed by the newly formed DoE rejected gasohol for this and other sound reasons in 1980.[84] Twenty-five years later, politics trumped science with the imposition of US ethanol mixing mandates and corn ethanol subsidies. If our greater interest is truly global peace and security, US farmers should be out of the fuel business and instead increasing food production for the growing market of direct export contracts with famine-wary nations.

Biofuels versus the Environment

Despite claims of reduced GHG and pollution emissions for biofuels, the reverse is now becoming apparent. Biofuels have roughly the same tailpipe or flue gas emissions as conventional fuels, but until recently they automatically earned "green" and "reduced emissions" badges through simplistic accounting tricks that assumed all their carbon was recycled from the atmosphere and largely ignored the pollutants.[85] New, more thorough studies that consider the full fuel creation and combustion lifecycles (as in figs. 2 and 3 above) are now showing cultivated liquid biofuels to be more damaging to the environment and causing the release of more CO_2 and other greenhouse gases and pollutants per unit of energy delivered than fossil fuels.[86]

Even the overall environmental impact of adding ethanol to gasoline as an oxygenate has been shown to be negative—it does nothing to improve the emissions of US cars built since 1993, reduces the fuel economy of every gasoline vehicle, increases emissions of some smog precursors, and increases the environmental hazard of spills because of increased miscibility with water.[87] The most important change in the new studies is the proper accounting of land-use changes driven by biofuel cultivation, such as converting forests to cropland by burning. This widespread practice has been accelerated around the world by biofuels agriculture and is releasing centuries of carbon sequestered in forest biomass back into the atmosphere from these natural carbon sinks. Such burning strikes a double blow because it also destroys a dense living biome with a huge perpetual appetite for CO_2. Calculations indicate that large-scale conversion of virgin land to biofuel production has already released and continues to release so much CO_2 into the atmosphere that it may be centuries before this surge can be offset by the recycled carbon in the resulting biofuels, if at all. The continued burning of millions of acres of forest and peat lands to make room for oil palms has made Indonesia the world's third highest producer of CO_2, after the United States and China.[88]

The Water Problem

A final downside to biofuels is water demand. *Water footprint* is the term for how much fresh water is consumed or rendered unusable by a particular activity. This can happen by evaporation, by removal to inaccessible parts of the ecosystem, or by contamination with chemicals

such as industrial discharges or fertilizer runoff. Water use also represents a dimension of competition with food agriculture, but it is even more urgent and fundamental in its own right. While "peak oil" continues to be elusive (global petroleum production and proven reserves both set new record highs in 2011),[89] "peak water" has already arrived for much of the world. One third of all countries are today considered "water poor." Two of every five people do not have enough water for basic sanitation, and nearly one in five do not have enough to drink.[90] Many scientists and economists observe falling water tables and depleting aquifers due to overpumping (including the massive Central Valley and High Plains aquifers in the United States) and predict this will expand to a global water crisis before 2030.[91] Much of the Middle East and a growing number of other nations, including China, Japan, Australia, and Spain, are now dependent upon desalination of seawater for a significant fraction of their fresh water needs.[92] To put this dependence into perspective, consider that a US nuclear aircraft carrier can desalinate 400,000 gallons of water a day.[93] The current desalination demand of the world exceeds 78 million cubic meters per day with 11 percent annual growth.[94] This equates to 51,500 aircraft carriers worth of desalination capacity with 5,600 more being built each year. Saudi Arabia is currently willing to spend one liter of ethanol-equivalent energy in crude oil to desalinate 200–300 liters of water.[95] How do these economics mesh with biofuels?

Conventional gasoline has a water footprint of 2.3–4.4 liters of water per liter of ethanol-equivalent energy (L/L), including water injected into the ground for enhanced oil recovery and water used in refining.[96] In contrast, global averages for biofuels range from sugar beet ethanol (1,388 L/L) to corn ethanol (2,570 L/L) to soy biodiesel (13,676 L/L) to rapeseed biodiesel (14,201 L/L) to jatropha biodiesel (19,924 L/L).[97] Current state of the art for installed seawater desalination plants ranges from 126 to 970 liters of water per liter of ethanol-equivalent energy.[98] So, under absolute best case circumstances, sugar beet feedstock cannot produce enough ethanol fuel energy to desalinate enough water to grow a replacement crop, let alone provide leftover ethanol as fuel. Biofuels' huge dependence upon water means they are not truly a renewable fuel in any location where water is being depleted. *Not one biofuel crop is renewable in desalinated seawater*. Under the president's recently published update to Executive Order 13603 that specifies responsibilities under the Defense Production Act, the secretary of defense is now responsible

for the US water supply.[99] That should cause some reflection regarding the DoD's promotion of biofuels. When Saudi Arabia and a third of the world are willing to spend a liter of fuel for less than 1,000 liters of water, how long can others get away with spending 10,000 liters of water for one liter of biofuel?

Conclusions and Recommendations

Ultimately, biofuels are limited by the sun. If they rely exclusively on solar energy to make biomass without adding fossil fuel energy, the EROI can be high enough, but the power density will be far too low, even at maximum theoretical photosynthesis performance. If yield is boosted with fossil fuel hydrogen or carbon, fossil fuel use increases, biofuel EROI plummets and drags overall EROI with it, power density is still too low, and civilization ends up even more starved for power. One way out of this dilemma is to create a plentiful supply of hydrogen from a non–fossil fuel source. However the only prospect is to electrolyze hydrogen from water using nuclear power. If we had such a surplus of nuclear power electricity and hydrogen, we would use it directly for power, not for inefficient biomass conversion. This litany is the inescapable catch-22 of biofuels.

Converting natural gas hydrocarbons into ammonia fertilizer and then into the carbohydrates of plant biomass is a sequence of transformations that irreversibly consumes some usable energy in each step. That loss of energy can be justified if the crop being grown is food and is of greater need than the energy used to grow it. However, completing the circle by converting that plant's carbohydrate biomass back into hydrocarbons for fuel makes the whole process a futile analog of the perpetual motion machine. Improvements in technology can reduce the amount of energy lost in each conversion but cannot eliminate it. Any wood, grass, peat, bagasse, coal, natural gas, or oil will deliver much more benefit to civilization if used directly and efficiently as fuel by a consumer whose needs are compatible with its limitations, rather than by using its energy to make biofuels. As long as the preponderance of ammonia and free hydrogen and organic compounds used in agriculture are derived from petroleum and natural gas, cultivating biofuels will defy all logic. Biofuels can never be cheaper than nor replace fossil fuels while fossil fuels comprise the bulk of the energy invested to make them.

Imagine if the US military developed a weapon that could threaten millions around the world with hunger, accelerate global warming, incite widespread instability and revolution, provide our competitors and enemies with cheaper energy, and reduce America's economy to a permanent state of recession. What would be the sense and the morality of employing such a weapon? We are already building that weapon—it is our biofuels program. For the sake of our national energy strategy and global security, we must face the sober facts and reject biofuels while advocating an overall national energy strategy compatible with the laws of chemistry, physics, biology, and economics. This revised strategy must acknowledge several key aspects:

- Liquid hydrocarbons are unmatched as transportation fuel. Using hydrocarbons to process biomass into transportation fuel is detrimental to civilization's energy balance and must be avoided.
- Renewable fuels must be truly renewable in all their ingredients, and all biofuels under consideration today fail in one or more categories of water footprint, soil nutrient depletion, eutrophication, lifecycle GHG, air pollution, and overall energy balance.
- Not even today's best liquid biofuels have any prospect of simultaneously attaining the 6:1 threshold EROI necessary to support a healthy modern civilization while also achieving the massive yields per acre necessary to supplant any significant fraction of the national energy supply. Boosting yields using fossil fuel for ammonia fertilizer, pesticide and herbicide feedstock, farm equipment fuel, transportation fuel, processing plant energy, distillation energy, enzyme feedstock, or hydrotreatment hydrogen lowers EROI and undermines every clean and green energy objective.
- Government energy policies that restrict domestic development of a nation's highest EROI energy sources and fuels—such as hydropower, coal, natural gas, and petroleum—are tantamount to caps on thermodynamic efficiency, economic health, and international competitiveness. Conversely, the nations that pursue the highest EROI energy will have the greatest potential to grow their economies and have every prospect of advantage over countries limited to lower EROI sources. The US government should end subsidies and market-distorting policies that encourage low-EROI energy sources over high-EROI sources.

- Petroleum and natural gas are true primary energy sources and fuel modern agriculture. To conserve petroleum as a limited resource, it is best used directly as fuel. Use of fossil fuel energy to accelerate food crop growth may be justifiable, but its use to accelerate energy crop growth is ludicrous on its face, as the result is less overall efficiency of energy and greater net consumption of petroleum. Government policy should restrict the use of artificial ammonia-based fertilizers to food crops only.
- The price of oil, like that of any other global free-market commodity, is volatile and subject to war, politics, and speculation. However, biofuels are subject to both oil and agricultural market forces and are at the mercy of weather as well. Biofuel prices have proven as volatile as oil prices and are likely to be more so once subsidies end. In addition, it is logically indefensible to buy a $30.00 per gallon fuel over worries about the price volatility of a $3.00 per gallon fuel.
- The technologies most in need of Manhattan Project–level attention by our global security strategists and national scientific laboratories are water production and food agriculture to support the nine billion people of 2050. The government should cease funding biofuel refinery construction and instead offer incentives for enhanced food production and water desalination efficiencies.
- The best use of agricultural land and water is to produce sufficient food for the United States and a surplus for the rest of the world. This has been before and can once again be a major contribution to security and stability in the world.
- Biomass is an inefficient middleman between solar energy and fuel. A better approach is to bypass the creation of biomass completely and directly synthesize liquid fuel from sunlight. The US government should cease funding biofuel research and instead offer prizes for milestones in direct fuel photosynthesis, which is a much more worthy line of research.[100]
- The only sensible use of biomass as fuel is to harvest unfertilized biomass from unmanaged land and consume it as is (e.g., firewood), without wasteful attempts to transform it into liquid fuel.

- The best-case power density predicted for any biofuel is already attained by today's PV solar panels. The US government should cease subsidizing biofuels and instead reward improved PV solar panel performance.
- Mandating the use of higher-EROI fossil fuels to make lower-EROI biofuels requires the overall consumption of more energy to deliver the same usable power output. Current US biofuels policy is accelerating rather than decreasing the use of fossil fuels and also increasing lifecycle ecological damage and GHG emissions due to destructive global land-use change and harmful agrichemical side effects. This is the exact opposite of "clean and green." The government should set policies that favor and optimize the use of hydrocarbons for fuel and carbohydrates for food and not confuse or undermine the efficiency of either by conflating them.
- CO_2 is not the only GHG. Agriculture is the leading producer of nitrous oxide (N_2O) and a major producer of methane (CH_4), which together comprise more than 26 percent of current total atmospheric GHG effects.[101] The US government should apply any caps or levy any taxes equitably across all greenhouse gases in proportion to their global warming potentials. Any per-ton penalties imposed on CO_2 should be levied against CH_4 at 69 times the rate and against N_2O at 298 times the rate to reflect relative per-ton global warming potentials.[102]
- The US military and federal government need to rationally and legally define *renewable*, *sustainable*, and *green* and enforce empirical standards for meeting these criteria based upon rigorous lifecycle analyses. Section 526 of the Energy Independence and Security Act of 2007 specifies that the lifecycle GHG emissions of any alternative or synthetic fuel purchased by the US government must be less than or equal to such emissions from the equivalent conventional fuel produced from conventional petroleum sources.[103] In light of recent research, and in the interest of curbing global warming, the US government should reexamine all §526 certifications issued to date for biofuels and blends. Any that do not consider the full biofuel lifecycle comprising land-use change for fuel creation as well as combustion, or that neglect N_2O emissions, should be invalidated.
- Global air and long-haul transportation and agriculture are currently very dependent on fossil fuel energy. It is unlikely that physically superior combustion fuels or fertilizers will be found. If the world runs out of

> fossil fuels without an alternative source for massive amounts of energetic hydrogen and carbon, civilization also immediately runs out of transportation fuel. To the extent that fossil fuels are judged to be running out, the government should ensure there is excess electrical capacity from non–fossil fuel power plants to electrolyze sufficient quantities of hydrogen from water for transportation fuel and agricultural purposes.

We must understand that a national energy strategy is nothing less than a national survival strategy. Those who would craft such strategy or advise policymakers need to be well-grounded in chemistry, thermodynamics, biology, and economics, so they might discern the difference between promising avenues of research and perpetual motion schemes that defy physical laws and waste our nation's time and treasure. What remains is for leaders and policymakers to catch up with the science and adjust their energy and security strategies to match the objective facts. An effective energy strategy for the United States must be informed by history and science and must exploit rather than defy the laws of nature to increase energy independence and global stability. SSQ

For an extended version of this article, visit http://www.au.af.mil/au/ssq/.

Notes

1. 10 USC §2924—"Definitions" contains definitions of *energy security*, *operational energy*, and *renewable energy sources*, among others, as specified in the National Defense Authorization Act of 2012, http://www.law.cornell.edu/uscode/text/10/2924?quicktabs_8=1#quicktabs-8.

2. "How Much Petroleum Does the United States Import and from Where?" *Energy Information Administration*, 16 July 2012, http://www.eia.gov/tools/faqs/faq.cfm?id=727&t=6.

3. See James T. Bartis and Lawrence Van Bibber, *Alternative Fuels for Military Applications* (Santa Monica, CA: RAND, 2011), http://www.rand.org/pubs/monographs/MG969.html; and Dina Fine Maron, "Biofuels of No Benefit to Military—RAND," *New York Times*, 25 January 2011.

4. See James T. Bartis, *Promoting International Energy Security* (Santa Monica: RAND, 2012), http://www.rand.org/pubs/technical_reports/TR1144z1.html; and National Research Council (NRC), *Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy* (Washington: National Academies Press, 2011).

5. *Bioenergy—Chances and Limits* (Halle, GE: Nationale Akademie der Wissenschaften—Leopoldina, 2012), http://www.leopoldina.org/en/publications/detailview/?publication[publication]=433.

6. NRC Committee on the Sustainable Development of Algal Biofuels, *Sustainable Development of Algal Biofuels in the United States* (Washington: National Academies Press, 2012).

7. Organisms that have the hydrogenase uptake enzyme (HUP+), such as soil and legume root bacteria, can capture and oxidize H_2 into $2H^+ + 2e^-$ and directly harvest that energy. See Z. Dong and

D. B. Layzell, "H_2 Oxidation, O_2 Uptake and CO_2 Fixation in Hydrogen Treated Soils," *Plant and Soil* 229, no. 1 (2001): 1–12, http://www.springerlink.com/content/qp73k5770103075r/abstract/.

8. A liter of gasoline contains 116 grams of hydrogen compared to 71 grams per liter in pure liquid hydrogen.

9. Cultivated crops respond with dramatically increased yields to energy supplied by hydrogen as pure H_2 gas or as any form of the ammonia molecule including anhydrous ammonia (NH_3), the ammonium ion (NH_4^+), and urea ($(NH_2)_2CO$). In each of these molecules, the hydrogen atoms are also the energy carriers and greatly outnumber the nitrogen. Studies have shown that fertilizing with pure hydrogen gas (H_2) without adding nitrogen can greatly boost soil bacteria activity and biomass synthesis. See Dong and Layzell, "H_2 Oxidation, O_2 Uptake and CO_2 Fixation in Hydrogen Treated Soils"; and Dong et al., "Hydrogen Fertilization of Soils—Is This a Benefit of Legumes in Rotation?" *Plant, Cell and Environment* 26, no. 11 (November 2003): 1875–79. http://doi.wiley.com/10.1046/j.1365-3040.2003.01103.x. Applying ammonia fertilizer to crops that are robust nitrogen fixers such as soy still results in substantial gains. See Richard B. Ferguson et al., "Fertilizer Recommendations for Soybean," University of Nebraska Institute of Agriculture and Natural Resources, August 2006, http://www.ianrpubs.unl.edu/live/g859/build/g859.pdf. For details of how hydrogen gas and ammoniac compounds serve as fuel to plants and bacteria, see Susanne Stein et al., "Microbial Activity and Bacterial Composition of H_2-treated Soils with Net CO_2 Fixation," *Soil Biology and Biochemistry* 37, no. 10 (October 2005): 1938–45; D. C. Ducat et al., "Rewiring Hydrogenase-Dependent Redox Circuits in Cyanobacteria," *Proceedings of the National Academy of Sciences* 108, no. 10 (8 March 2011): 3941–46, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3053959/; and F. B. Simpson and R. H. Burris, "A Nitrogen Pressure of 50 Atmospheres Does Not Prevent Evolution of Hydrogen by Nitrogenase," *Science* 224, no. 4653 (8 June 1984): 1095–97, http://www.sciencemag.org/cgi/doi/10.1126/science.6585956. Once ammonia becomes available in the soil or plant roots, whether fixed by bacteria or humans, it reacts with water and oxygen and decomposes into hydrogen ions, hydrogen gas, and nitrate ions in a process known as "nitrification." These subcomponents serve as energy packages and building blocks supporting the myriad additional reactions and processes of biosynthesis. Partial oxidation of ammonia produces nitrous oxide (a GHG) and hydrogen gas: $2NH_3 + O_2 \rightarrow N_2O + H_2O + 2H_2$. Full decomposition of ammonia in water solution with oxygen produces hydrogen ions and nitrate ions and completes nitrification: $NH_3 + H_2O + 2O_2 \rightarrow 2H^+ + NO_3^- + OH^- + H_2O$.

10. Hydrogen-free sodium nitrate ($NaNO_3$) fertilizer comprised only 0.046 percent of commercial nitrogen fertilizer use in 2010. Virtually 100 percent of the 20 million tons of "nitrogen" fertilizer used annually in the United States is ammonia-based and made with hydrogen from natural gas. See "Fertilizer Use and Price," USDA Economic Research Service, 4 May 2012, http://www.ers.usda.gov/data-products/fertilizer-use-and-price.aspx.

11. Symbiotic rhizobial root bacteria get sugar from the host plant and use some of that energy and hydrogen to create NH_3 and H_2 gas and release these to the plant and into the soil. Soil bacteria metabolize the soil ammonia and H_2 and use that energy to break down soil minerals and materials such as chitin and lignin in humus into reduced carbon and mineral nutrients usable by the plant. For various aspects of the energy relationship between plants, bacteria, and ammonia, see P. Mylona, K. Pawlowski, and T. Bisseling, "Symbiotic Nitrogen Fixation," *Plant Cell*, no. 7 (July 1995): 869–85, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC160880/; Rifat Hayat et al., "Soil Beneficial Bacteria and Their Role in Plant Growth Promotion: a Review," *Annals of Microbiology* 60, no. 4 (28 August 2010): 579–98, http://rd.springer.com/article/10.1007/s13213-010-0117-1; Guido Sanguinetti et al., "MMG: a Probabilistic Tool to Identify Submodules of Metabolic Pathways," *Bioinformatics* 24, no. 8 (21 February 2008): 1078–84, http://bioinformatics.oxfordjournals.org/cgi/doi/10.1093/bioinformatics/btn066; and V. N. Matiru, and F. D. Dakora, "Potential Use of

Rhizobial Bacteria as Promoters of Plant Growth for Increased Yield in Landraces of African Cereal Crops," *African Journal of Biotechnology* 3, no. 1 (2004): 1–7, http://www.ajol.info/index.php/ajb/article/view/14908.

12. Ernst Worrell et al., *Energy Use and Energy Intensity of the US Chemical Industry*, Lawrence Berkeley National Laboratory, April 2000.

13. A. M. Blackmer et al., "Nitrogen Fertilizer Recommendations for Corn in Iowa," Iowa Cooperative Extension Service, May 1997, http://www.extension.iastate.edu/Publications/PM1714.pdf.

14. Lance Gibson and Garren Benson, "Origin, History and Uses of Corn," Iowa State University Department of Agronomy, revised January 2002, http://www.agron.iastate.edu/courses/agron212/readings/corn_history.htm.

15. W. M. Stewart et al., "The Contribution of Commercial Fertilizer Nutrients to Food Production," *Agronomy Journal* 97, no. 1 (2005): 1, https://www.agronomy.org/publications/aj/abstracts/97/1/0001.

16. The widely accepted value for *biomass accumulation efficiency*, which is the fraction of total incident solar energy converted into biomass by photosynthesis, is 0.1 percent for most terrestrial plants. Plants use a much higher fraction of the sun's energy, but most of it goes into overhead costs such as evaporating water from the leaves to perform the work of drawing up nutrients from the ground against the force of gravity. Efficiencies as high as 4 percent under special circumstances have been reported, and it may be possible to boost this to 8 percent with human reengineering of the enzymes and mechanics. However, the highest efficiencies are achieved at very low light fluxes. Photosynthesis is saturated in capacity between 20 percent and 50 percent of maximum solar irradiance, and plants suffer radiation damage at these higher levels. Gains in net biomass accumulation remain elusive. See X. G. Zhu, S. P. Long, and D. R. Ort, "What Is the Maximum Efficiency with which Photosynthesis Can Convert Solar Energy into Biomass?" *Current Opinion in Biotechnology* 19, no. 2 (April 2008): 153–59, http://linkinghub.elsevier.com/retrieve/pii/S0958166908000165; Robert E. Blankenship et al., "Comparing Photosynthetic and Photovoltaic Efficiencies and Recognizing the Potential for Improvement," *Science* 332, no. 6031 (12 May 2011): 805–9; Harmut Michel, "The Nonsense of Biofuels," *Angewandte Chemie International Edition* 51, no. 11 (12 March 2012): 2516–18, http://doi.wiley.com/10.1002/anie.201200218; and Food and Agriculture Organization of the United Nations, *Renewable Biological Systems for Alternative Sustainable Energy Production*, chap. 1: "Biological Energy Production," September 2012, http://www.fao.org/docrep/w7241e/w7241e05.htm#1.2.1. For aquatic photosynthesis, see Kristina Weyer et al., "Theoretical Maximum Algal Oil Production," *Bioenergy Research* 3, no. 2 (8 October 2009): 204–13, http://www.springerlink.com/index/10.1007/s12155-009-9046-x.

17. The National Renewable Energy Laboratory (NREL) reports that solar radiation across the spectrum delivers energy to the cloudless southwestern US desert at a rate of 7.25 kWh/m^2-day = 302 W/m^2. At the observed biomass accumulation efficiency of 0.1 percent, this equates to 0.3 W/m^2 put into plant biomass, of which only a fraction can be eventually recovered as liquid fuel. See "Concentrating Solar Resource: Direct Normal," NREL, February 2009, http://www.nrel.gov/gis/images/map_csp_us_10km_annual_feb2009.jpg.

18. Solar photovoltaic (PV) AC power density of 6.0 W/m^2 is the current real-world, best-case, annualized value for large solar farm sites in southern US latitudes. This value is based on empirical analysis of nearly five years of actual performance of the Nellis AFB solar power plant (completed December 2007, $100 million cost, 72,416 panels on 140 acres, $14MW_{pv}$ nameplate capacity, single-axis tracking array, 19 percent land coverage density, 24.5 percent capacity factor, producing 30 GWh/yr.). See "Nellis AFB Solar Power System," http://www.nellis.af.mil/shared/media/document/AFD-080117-043.pdf; and "Nellis Air Force Base," *Sunpower Performance Monitoring*, http://commercial.sunpowermonitor.com/Commercial/kiosk.aspx?id=1dd14d57-7840-4b2d-af0a-0fe0fdd5c872.

19. Other formulations of energy balance ratios include energy return on energy investment (EROEI), energy cost of energy (ECE), energy intensity ratio (EIR), and energy return on investment (ERI). EROI is the most commonly used in the literature, but there is some debate over what boundaries to apply to the formula. What is offered here is the simplest version of the concept.

20. S. A. L. M. Kooijman, *Dynamic Energy and Mass Budgets in Biological Systems* (Cambridge UK: Cambridge University Press, 2000).

21. This tipping point is also correlated with greater than 10 percent GDP expenditures on energy. See C. W. King, "Energy Intensity Ratios as Net Energy Measures of United States Energy Production and Expenditures," *Environmental Research Letters* 5, no. 4 (October 2010): 044006.

22. Charles A. S. Hall et al., "What is the Minimum EROI that a Sustainable Society Must Have?" *Energies* 2, no. 1 (January 2009): 25–47.

23. David J. Murphy and C. A. S. Hall, "Year in Review—EROI or Energy Return on (Energy) Invested," *Annals of the New York Academy of Sciences* 1185, no. 1 (January 2010): 102–18.

24. X-axis energy contributions are EIA data for 2010 reported in "Estimated U.S. Energy Use in 2010: ~98.0 Quads," Lawrence Livermore National Laboratory, 2011, https://flowcharts.llnl.gov/content/energy/energy_archive/energy_flow_2010/LLNLUSEnergy2010.png. Y-axis EROI values are depicted as ellipses to capture the range of values reported in different studies and for different sites. These values derived from the author's synthesis of published literature review including the following documents: DoE, "Fact Sheet: Energy Efficiency of Strategic Unconventional Resources," http://fossil.energy.gov/programs/reserves/npr/Energy_Efficiency_Fact_Sheet.pdf; "EROI Update: Preliminary Results Using Toe-to-Heel Air Injection," *Oil Drum*, http://www.theoildrum.com/node/5183/486247; Megan C. Guilford et al., "A New Long Term Assessment of Energy Return on Investment (EROI) for U.S. Oil and Gas Discovery and Production," *Sustainability* 3, no. 10 (October 2011): 1866–87, http://www.mdpi.com//2071-1050/3/10/1866/; Nate Hagens, "Proper Calculation of Brazilian Sugarcane EROI," *Oil Drum*, 24 March 2009; C. A. S. Hall, "Wave & Geothermal," *Oil Drum*, 14 May 2008; Hall, "Why EROI Matters," *Oil Drum*, 1 April 2008; Hall, "Provisional Results," *Oil Drum*, 8 April 2008; Hall, "Unconventional Oil: Tar Sands and Shale Oil," *Oil Drum*, 15 April 2008; Hall, "Nuclear Power," *Oil Drum*, 22 April 2008; Hall, "Solar, Wind and Hydro," *Oil Drum*, 29 April 2008; Hall et al., "What Is the Minimum EROI that a Sustainable Society Must Have?"; Hall et al. "Seeking to Understand the Reasons for Different Energy Return on Investment (EROI) Estimates for Biofuels," *Sustainability* 3, no. 12 (13 December 2011): 2413–32; Hill et al., "Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels," *Proceedings of the National Academy of Sciences* 103, no. 30 (2006): 11206; King, "Energy Intensity Ratios as Net Energy Measures of United States Energy Production and Expenditures"; King and Hall, "Relating Financial and Energy Return on Investment," *Sustainability* 3, no. 10 (11 October 2011): 1810–32; David J. Murphy, "The Energy Return on Investment Threshold," *Oil Drum*, 25 November 2011; Murphy et al., "New Perspectives on the Energy Return on (Energy) Investment (EROI) of Corn Ethanol," *Environment, Development and Sustainability* 13, no. 1 (11 July 2010): 179–202; Murphy et al., "Order from Chaos: A Preliminary Protocol for Determining the EROI of Fuels," *Sustainability* 3, no. 10 (17 October 2011): 1888–1907; Tad W. Patzek, "A First-Law Thermodynamic Analysis of the Corn-Ethanol Cycle," *Natural Resources Research* 15, no. 4 (22 February 2007): 255–70; Bruce Pile, "The Alternative Energy No One Is Thinking About," *Seeking Alpha*; David Pimentel and Tad Patzek, "Ethanol Production: Energy and Economic Issues Related to U.S. and Brazilian Sugarcane," *Natural Resources Research* 16, no. 3 (21 August 2007): 235–42; and Hosein Shapouri et al., "Estimating the Net Energy Balance of Corn Ethanol," *Agricultural Economic Report* 721 (July 1995).

25. Corn ethanol EROI values in the literature range from 0.7–1.7:1 with a median value of 1.2:1. Many metastudies have compared and contrasted multiple EROI approaches and papers.

This author judges the most thorough and authoritative individual study to be Hill et al., "Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels." This study is one of several to promulgate a value of 1.25:1 and to find that any positive energy balance was entirely dependent upon giving energy credit for co-products. The most thorough and authoritative recent metastudy surveying multiple individual corn ethanol lifecycle analyses was judged to be Murphy et al., "New Perspectives on the Energy Return on (Energy) Investment (EROI) of Corn Ethanol." This study is actually less favorable and finds a neutral 1:1 EROI. Two USDA-funded studies have found values of 1.24:1 in 1995 and 1.34:1 in 2002. Shapouri et al., "Estimating the Net Energy Balance of Corn Ethanol"; and Shapouri et al., *The Energy Balance of Corn Ethanol: An Update* (Washington: USDA, July 2002).

26. The pure corn ethanol EROI can be estimated by dividing the petroleum-corn ethanol hybrid EROI of 1.25:1 by the pure petroleum EROI of 8:1 (discussed later under "opportunity cost") to yield 0.156:1 ~ 1:6.

27. Tad Patzek, "A Probabilistic Analysis of the Switchgrass Ethanol Cycle," *Sustainability* 2, no. 10 (30 September 2010): 3158–94, http://www.mdpi.com/2071-1050/2/10/3158/.

28. M. R. Schmer et al., "Net Energy of Cellulosic Ethanol from Switchgrass," *Proceedings of the National Academy of Sciences* 105, no. 2 (15 January 2008): 464–69.

29. National Academy of Sciences, *Renewable Fuel Standard*.

30. The cellulosic ethanol sector was recently rocked by the demise of Range Fuels, the signature creation of vocal biofuels proponent Vinod Khosla and recipient of the first USDA biofuels loan guarantee of $64 million in 2010. This failure eclipsed the 2009 fraud scandal and collapse of Cello, which was the Solyndra of cellulosic ethanol.

31. Randy Schnepf and Brent D. Yacobucci, *Renewable Fuel Standard (RFS): Overview and Issues* (Washington: Congressional Research Service [CRS], 14 October 2010), http://digital.library.unt.edu/ark:/67531/metadc31329/m1/1/high_res_d/R40155_2010Oct14.pdf.

32. See "2012 RFS2 Data," Environmental Protection Agency, 19 July 2012, http://www.epa.gov/otaq/fuels/rfsdata/2012emts.htm; "Producing Sustainable Fuel Ethanol Today," Blue Sugars Corporation, http://bluesugars.com/technology-production.htm; Meghan Sapp, "Petrobras, KL Energy Extend Cellulosic Ethanol Development Agreement," *Biofuels Digest*, 26 June 2012, http://www.biofuelsdigest.com/bdigest/2012/06/26/petrobras-kl-energy-extend-cellulosic-ethanol-development-agreement/; and *Federal Register* 77 no. 5 (9 January 2012), http://www.gpo.gov/fdsys/pkg/FR-2012-01-09/html/2011-33451.htm.

33. Matthew Wald, "Companies Face Fines for Not Using Unavailable Biofuel," *New York Times*, 9 January 2012.

34. For Gevo, see Kevin Bullis, "To Survive, Some Biofuels Companies Give Up on Biofuels," *MIT Technology Review*, 21 December 2011, http://www.technologyreview.com/energy/39371/. For Amyris, see Sophie Vorrath, "Biofuels: Have the Republicans Gutted Green Fuel?" *Renew Economy*, 17 May 2012, http://reneweconomy.com.au/2012/biofuels-have-the-republicans-gutted-green-fuel-62642. For Cellana, see Jim Lane, "Shell Exits Algae as It Commences a 'Year of Choices,'" *Renewable Energy World*, 31 January 2011, http://www.renewableenergyworld.com/rea/news/article/2011/01/shell-exits-algae-as-it-commences-year-of-choices.

35. Jim Lane, "The October Surprise: BP Cancels Plans for US Cellulosic Ethanol Plant," *Renewable Energy World*, 26 October 2012, http://www.renewableenergyworld.com/rea/news/article/2012/10/the-october-surprise-bp-cancels-plans-for-us-cellulosic-ethanol-plant. As of this writing, ZeaChem Inc., founded in 2002 and recipient of $297.5 million in grants and loan guarantees from the DoE and USDA, is operating its 250,000 gal/year biorefinery in Oregon as a demonstration facility, which means the product is not commercially competitive. Logen of Canada is still operating its 1,200 gal/day cellulosic ethanol facility in

demonstration mode with total historic production since 2004 averaging less than 200 gal/day. KiOR is starting up its new 10 million gal/year biorefinery in Mississippi that investors and the EPA have been promised will deliver commercial sales and profits from competitively priced gasoline and diesel made from wood. INEOS Bio is also in the process of commissioning an 8 million gal/year commercial cellulosic ethanol plant in Florida. Already expectations for these massive capital investments are being deflated with revised names such as "commercial demonstration" or "second generation demonstration" plant floating around and profitability target dates shifting years into the future. If these huge facilities remain "demonstration plants," it will mean that, once again, the promises have not been kept. Even if they somehow achieve marginal profitability under a regime of biofuel subsidies and mixing mandates and carbon taxes, they will still face an insurmountable capacity problem because of abysmal power density.

36. See Jim Lane, "Coskata Switches Focus from Biomass to Natural Gas; To Raise $100M in Natgas-Oriented Private Placement," *Biofuels Digest*, 20 July 2012, http://www.biofuelsdigest.com/bdigest/2012/07/20/coskata-switches-from-biomass-to-natural-gas-to-raise-100m-in-natgas-oriented-private-placement/; and Kevin Bullis, "Biofuels Companies Drop Biomass and Turn to Natural Gas," *MIT Technology Review*, 30 October 2012, http://www.technologyreview.com/news/506561/biofuels-companies-drop-biomass-and-turn-to-natural-gas/.

37. Alan Shaw, former CEO of Codexis, stated that "carbohydrates are not a substitute for oil. I was wrong in that, and I admit it. [They] will never replace oil because the economics don't work. You can't take carbohydrates and convert them into hydrocarbons economically. . . . It's a death blow that that maximum yield is about 30 percent." Quoted in Bullis, "Biofuels Companies Drop Biomass."

38. *Hydrotreatment* is most often used as a collective term for a set of processes necessary to refine or upgrade biofuels into true hydrocarbons that are "drop-in" compatible substitutes for conventional hydrocarbon applications. These steps include hydrogenation, deoxygenation, cracking, isomeration, fractionation, and using additives as necessary to adjust energy density, cetane, octane, volatility, cold flow properties, and lubricity. See Carlo Munoz, Jon Van Gerpen, and Brian He, *Production of Renewable Diesel Fuel*, National Institute for Advanced Transportation Technology, University of Idaho, June 2012, http://ntl.bts.gov/lib/46000/46200/46277/KLK766_N12-08.pdf.

39. Hill et al., "Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels."

40. An EROI of 1:1 (300 GJ input vs. 317 GJ output) was reported if sun-dried product algal biomass was burned whole in a furnace extracting a thermodynamically perfect 100 percent of the HHV with no attempt to convert to a liquid fuel. See Andres F. Clarens et al., "Environmental Life Cycle Comparison of Algae to Other Bioenergy Feedstocks," *Environmental Science & Technology* 44, no. 5 (March 2010): 1813–19. A study that considered the costly biomass-to-liquid fuel conversion step found that the input energy required just to circulate the water in the cultivation ponds/tanks exceeded the biodiesel fuel energy output by a factor of seven. See Cynthia F. Murphy and David T. Allen, "Energy-Water Nexus for Mass Cultivation of Algae," *Environmental Science & Technology* 45, no. 13 (July 2011): 5861–68.

41. NRC, *Sustainable Development of Algal Biofuels in the United States*.

42. Photosynthetic stoichiometry for typical microalgae: 99.5 CO_2 + 75.5 H_2O + 7.5 $CO(NH_2)_2$ + ½ P_2O_5 (+ sunlight) –>[C_{107} H_{181} O_{45} N_{15} P] + 119.75 O_2 [carbon dioxide + water + urea + phosphate (+ sunlight) –> microalgae + oxygen]. In this case, one-sixth of the hydrogen (30 of 181 atoms) in the microalgae is from urea, not water. Most algae are grown heterotrophically with some hydrogen and carbon energy being provided in ammoniacal or saccharine form. Autotrophic algae growth requires only CO_2, water, phosphate, micronutrients, and sunlight but delivers

diminished yields. See E. D. Frank et al., *Life-Cycle Analysis of Algal Lipid Fuels with the GREET Model* (Oak Ridge, TN: DoE, August 2011), http://greet.es.anl.gov/publication-algal_lipid_fuels.

43. Robert Rapier, "Visit and Conversation with Executives at Solazyme," *Consumer Energy Report*, 23 October 2011, http://www.consumerenergyreport.com/2011/10/23/visit-and-conversation-with-executives-at-solazyme/.

44. Frank et al., *Life-Cycle Analysis*. Total energy to produce one functional unit of algae biodiesel of 2,589,441 BTU vs. 219,183 BTU to make one functional unit of conventional low-sulfur diesel = 11.8:1 ratio. Well-to-pump fossil fuel energy costs of 548,329 BTU vs. 215,388 BTU yield a ratio of 2.6:1.

45. Murphy et al., "New Perspectives on the Energy Return on (Energy) Investment (EROI) of Corn Ethanol."

46. The 8:1 petroleum fuel EROI is chosen as a conservative value from historical fluctuations within the range of 8:1 to 24:1 since 1920, per Guilford et al., "New Long Term Assessment."

47. The term *barrel of energy* is used here to represent a generic unit of energy for relative comparison purposes. The term is more specifically defined as the energy in a barrel of crude oil and has a value of 6.1306 GJ = 1.7029 MWh = 5.8106 MBTU. A barrel of crude oil has virtually the same energy content as a barrel of diesel fuel.

48. The fraction of crude oil that yields fuels vice feedstocks is based on "What a Barrel of Crude Oil Makes," *Texas Oil & Gas Association*, http://www.txoga.org/articles/308/1/WHAT-A-BARREL-OF-CRUDE-OIL-MAKES. CO_2 from fuel creation: 1 bbl x 42 gal/bbl of diesel @ 23.66 lb CO_2/gal for diesel combustion = 944 lb. The CO_2 from fuel combustion (all products): 11 bbl of crude x 42 gal/bbl x 22.99 lb CO_2/gal for crude combustion = 10,621 lb. Total CO_2: 944 lb + 10,621 lb = 11,565 lb (counting all carbon on the page = worst case). Input H_2O = 9 bbl x 42 gal/bbl x 6.6 gal/gal = 2,495 gal. The water footprint of petroleum covers all extraction and refining processes including water injection into older oil fields for secondary recovery. Maximum value of 6.6 gallons water per gallon of gasoline is used to make the calculation as conservative as possible and is based on May Wu and Yiwen Chiu, *Consumptive Water Use in the Production of Ethanol and Petroleum Gasoline—2011 Update* (2008; Oak Ridge, TN: DoE, July 2011).

49. Ksenia Galouchko, "Ethanol Follows Gasoline Higher after Iran Blocks Base Access," *Bloomberg*, 22 February 2012, http://www.bloomberg.com/news/2012-02-22/ethanol-follows-gasoline-higher-after-iran-blocks-base-access.html.

50. Fig. 3 depicts the same net energy output as fig. 2 (i.e., 8 bbl diesel equivalent). Each barrel of diesel equivalent energy input yields energy parity in 1.625 bbl of ethanol plus a 0.25 bbl diesel equivalent net energy profit in co-product DDGS. Ethanol has 0.615 times the volumetric energy density of diesel; therefore, it takes 52 bbl of ethanol to equal the energy in 32 bbl of diesel. Values of 478 gal/acre ethanol yield and 5 lb/gal of ethanol in DDGS yield are per 2008 survey of 90 dry-mill ethanol refineries as reported in Steffen Mueller, "News from Corn Ethanol: Energy Use, Co-Products, and Land Use," presentation at Near-Term Opportunities for Bio-refineries Symposium, Champaign, IL, 11–12 October 2010, http://bioenergy.illinois.edu/news/biorefinery/pp_mueller.pdf. Acreage of cornfield required : 52 bbl x 42 gal/bbl = 2,184 gal ÷ 478 gal/acre = 4.57 acre. DDGS co-product: 5 lb/gal x 2,184 gal = 10,920 lb CO_2 from fuel creation: 32 bbl x 42 gal/bbl x 23.66 lb CO_2/gal diesel = 31,799 lb. No CO_2 is charged for ethanol or DDGS consumption. Conservative calculation of CO_2-equivalent N_2O emissions (CO_2e) from corn fertilization: 2 percent of 150 lb/acre NH_3 x 4.6 acre = 13.8 lb NH_3 x 82.35 percent N mass fraction of NH_3 = 11.36 lb N ÷ 63.64 percent N mass fraction of N_2O = 17.86 lb N_2O x 298 multiplier for CO_2 warming potential equivalence = 5,321 lb CO_2e. Total CO_2e emissions: 31,799 lb CO_2 + 5,321 lb CO_2e = 37,120 lb CO_2e. H_2O for ethanol: 52 bbl x 42 gal/bbl x 1,220 gal/gal = 2.66M gal. (US average corn ethanol water footprint is 1,220 gal/gal, per Winnie Gerbens-Leenes et al., "The Water Footprint of Bioenergy,"

Proceedings of the National Academy of Sciences 106, no. 25 [3 June 2009]: 10219–23, http://www.pnas.org/cgi/doi/10.1073/pnas.0812619106). H_2O for diesel: 32 bbl x 42 gal/bbl x 6.6 gal /gal = 8,870 gal. Total H_20 = 2.66M + .009M = 2.67M gal (gasoline water footprint is 6.6 gal /gal, per Wu and Yiwen, *Consumptive Water Use*).

51. Hall et al., "Seeking to Understand the Reasons for Different Energy Return on Investment (EROI) Estimates for Biofuels."

52. *Annual Energy Review 2011* (Washington: Energy Information Agency, September 2012), http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf.

53. E. C. Sherrard and F. W. Kressman, "Review of Processes in the United States Prior to World War II," *Industrial & Engineering Chemistry* 37, no. 1 (January 1945): 5–8, http://pubs.acs.org/toc/iechad/37/1.

54. The threshold test for any candidate for primary energy source or fuel is demonstrating the ability to bootstrap itself up in scale and energy productivity without outside assistance with an EROI greater than 6:1. To be commercially competitive it must match or exceed the current national average (approximately 12:1 for the United States). A true twenty-first-century fuel must deliver enough energy profit to build up its own production and distribution infrastructure just as coal and oil did in the previous two centuries. Such a test quickly reveals that the quality of energy measured in such things as EROI, energy density, power density, and *dispatchability* (controllability of energy delivery location, time, and rate) matter just as much as total power output. Until this level of performance is achieved, the energy candidate is a research and development experiment that cannot survive without subsidy. Conversely, any energy candidate that is receiving a net subsidy is by definition not an energy source.

55. For the firmly established correlation between EROI and price, see C. W. King and C. A. S. Hall, "Relating Financial and Energy Return on Investment," *Sustainability* 3, no. 10 (October 2011): 1810–32; and Murphy et al., "New Perspectives on the Energy Return on (Energy) Investment (EROI) of Corn Ethanol."

56. An alternative source of hydrogen is electrolysis from water. This could only be done with massive new sources of electrical power. If such power were available, we would use the resulting hydrogen directly as fuel and not bother with the less-efficient process of growing biomass for conversion into biofuels.

57. *Energy for the Warfighter: Operational Energy Strategy* (Washington: DoD, May 2011), http://energy.defense.gov/Operational_Energy_Strategy.pdf.

58. David Miller, "Biofuels Conference: Secretary of the Navy Says Military Can Lead the Way in Alternative Energy," *Dispatch* (Starkville, MS), 7 October 2011, http://www.cdispatch.com/news/article.asp?aid=13418.

59. $26.75 per gallon for Dynamic Fuels biofuel x 42 gal/bbl = $1,123.50 per barrel. Highest price paid was $4,454.55 per gallon = $187,089.00 per barrel. See fig. 5 for details.

60. Contract quantity and price data are from official government websites in 2012 and tabulated by contract number in fig. 4. Sources include General Services Administration's "Federal Procurement Data System—Next Generation" search page, https://www.fpds.gov/fpdsng_cms/; *FedBizOpps* search page, https://www.fbo.gov/; "Bulk Petroleum Contract Awards," Defense Logistics Agency: Energy, http://www.energy.dla.mil/bulk_petroleum/Pages/Contract_Awards.aspx; and Defense Logistics Agency: Energy, *Fact Book: Fiscal Year 2011*, http://www.energy.dla.mil/energy_enterprise/Documents/Fact percent20Book percent20FY2011 percent20Rev.pdf.

61. Ray Mabus, Steven Chu, and Thomas J. Vilsack, "Memorandum of Understanding between the Department of the Navy and the Department of Energy and the Department of Agriculture," June 2011, http://www.rurdev.usda.gov/SupportDocuments/DPASignedMOUEnergyNavyUSDA.pdf.

62. Neelesh Nerurkar, *US Oil Imports: Context and Considerations* (Washington: CRS, April 2011).

63. See "Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2010," Energy Information Agency, July 2011, http://www.eia.gov/analysis/requests/subsidy/; and *Annual Energy Review 2011*. Subsidy amounts in table ES2 from the first reference are divided by 2010 data for US energy production for the respective forms of energy in the second reference.

64. DoE, "Energy.gov/List of Awardees," December 2011, http://energy.gov/sites/prod/files/recoveryactfunding.xls.

65. "AAA's Daily Fuel Gauge Report," American Automobile Association, 19 July 2012, http://fuelgaugereport.opisnet.com/index.asp.

66. A gallon of ethanol contains only two-thirds the energy of a gallon of gasoline; if priced at energy parity, it would be two-thirds the price. The 2010 average retail gasoline price (minus 18.4 cent/gal federal excise tax) = $2.58/gal x 2/3 = $1.72/gal (what ethanol should have cost). The 2010 average retail E85 price = $2.40/gal (what retail ethanol did cost to a close approximation). How much consumers overpaid at pump = $2.40/gal – $1.72/gal = $0.68/gal x 12 billion gallons blended in 2010 = $8.1 billion. For prices and tax credits see table 17-1 and footnotes in Office of Management and Budget, *Budget of the U.S. Government: Analytical Perspective Fiscal Year 2012* (Washington: OMB, 2011); and table A12 of "Annual Energy Outlook 2012," Energy Information Agency, June 2012, http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf.

67. Steve Hargreaves, "Gasoline: The New Big U.S. Export," *CNN Money*, 5 December 2011, http://money.cnn.com/2011/12/05/news/economy/gasoline_export/index.htm.

68. The 2009 tax data is presented by the EIA as it were the most recent available. That was a particularly bad year for IRS revenue from oil company taxes because of the economic crash; 2010 data is likely much higher. Oil companies paid $13.7 billion in corporate taxes, and consumers paid $42.4 billion in excise taxes, for a total of $56.1 billion in federal government revenues, per "EIA Financial Reporting System Survey, Form EIA-28 Schedule 5112, Analysis of Income Taxes," *Energy Information Agency*, 2009, ftp://ftp.eia.doe.gov/pub/energy.overview/frs/s5112.xls. Dividing $56.1 billion by the 6.23 billion barrels of oil and gas produced domestically in 2010 yields $9.01 per barrel. Federal excise taxes paid by consumers at the pump were 18.4 cents per gallon for gasoline and 24.4 cents per gallon for diesel.

69. "Market Cap Stock Rankings for Major Integrated Oil & Gas Industry," *YCharts*, 7 January 2013, http://ycharts.com/rankings/industries/Major%20Integrated%20Oil%20&%20Gas/market_cap.

70. See note 18 for solar power density derivation. Wind power density of 1.13 W/m^2 based on recent NREL data reporting 2.9 W/m^2 peak and 39 percent capacity factor as averaged across 2000–2009 US installations with nameplate capacity >20MW. See Paul Denholm et al., *Land-Use Requirements of Modern Wind Power Plants in the United States*, NREL, August 2009, www.nrel.gov/docs/fy09osti/45834.pdf. Corn ethanol power density of 0.315 W/m^2 based on 500 gal/acre-year, @ 76,321 BTU/gal LHV. Soy biodiesel power density of 0.069 W/m^2 based on 70 gal/acre-year @ 119,545 BTU/gal LHV. Average US crude oil well in 2011 produced 10.6 bbl/day @ 129,667 BTU/gal on a two-acre parcel of land, which equates to ~90 W/m^2. See *Annual Energy Review 2011*.

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= 6.42 W/m^2 LHV. Sapphire Energy projects it will achieve 14 gal/acre-day of algae biodiesel from 300 acres by 2014. See "In Race to Algae Fuel, Sapphire Scores Point for Open Ponds," *Sapphire Energy*, 6 September 2012, http://www.sapphireenergy.com/news-article/1135734-in-race-to-algae-fuel-sapphire. Algenol, using cyanobacteria animal algae instead of microphyte plant algae, and producing ethanol instead of lipids, recently announced it achieved 21.9 gal/acre-day of ethanol. This is equivalent to 5.6 W/m^2 and still below today's PV solar. See Paul Woods, "About Algenol," Algenol Biofuels, 27 September 2012, http://www.algenolbiofuels.com/.

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103. Energy Independence and Security Act of 2007, §526:

> No Federal agency shall enter into a contract for procurement of an alternative or synthetic fuel, including a fuel produced from nonconventional petroleum sources, for any mobility related use, other than for research or testing, unless the contract specifies that the lifecycle greenhouse gas emissions associated with the production and combustion of the fuel supplied under the contract must, on an ongoing basis, be less than or equal to such emissions from the equivalent conventional fuel produced from conventional petroleum sources. . . .
>
> No later than Oct. 1, 2015, and for each year thereafter, each Federal agency shall achieve ≥ 20 percent reduction in annual petroleum consumption and a 10 percent increase in annual alternative fuel consumption, relative to FY2005 baseline.

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