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MARITIME STRATEGY SERIES

Cost-Imposing Strategies
A Brief Primer

By Thomas G. Mahnken

Center for a New American Security

About this Series

Maritime tensions in the East and South China Seas have raised significant questions about the long-term peace and stability that has enabled Asia's economic rise over the last several decades. While these disputes are longstanding, recent years have seen attempts to unilaterally change the status quo through tailored coercion that falls short of war. These activities do not appear to be abating despite growing international concern. While policy efforts to alleviate tensions must include engagement and binding, a comprehensive approach must include countering coercive moves by imposing costs on bad behavior. This series aims to explore various types and facets of strategies to deter, deny and impose costs on provocative behavior in maritime Asia. Hopefully these papers will, jointly and severally, generate new thinking on how to both maintain security and build order across the Indo-Pacific region.

Cover Image

President Barack Obama and President Xi Jinping of the People's Republic of China walk on the grounds of the Annenberg Retreat at Sunnylands in Rancho Mirage, Calif., before their bilateral meeting on June 8, 2013.

(PETE SOUZA/ Official White House Photo)

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About the Author

Thomas G. Mahnken is a Senior Research Professor at the Philip Merrill Center for Strategic Studies at Johns Hopkins Paul H. Nitze School of Advanced and International Studies and Jerome Levy Chair of Economic Geography and National Security at the U.S. Naval War College.

INTRODUCTION

By Thomas G. Mahnken

The topic of how the United States can more effectively bring its strengths to bear in peacetime against competitors such as China has received renewed attention in recent years.[1] Several trends have brought on the current interest in so-called competitive strategies. The rise of China, and particularly China's investment in weapons and military doctrine aimed at blunting the ability of the United States to project power into the Western Pacific, is shifting the military balance in the region and potentially beyond in ways unfavorable to the United States. For example, the 2001 *Quadrennial Defense Review Report* listed a set of emerging strategic and operational challenges that demanded attention, including: protecting critical bases of operations, assuring information systems in the face of attack, projecting and sustaining U.S. forces in distant anti-access or area-denial environments and defeating such threats, denying enemies sanctuary through persistent surveillance and high-volume precision firepower, and enhancing the survivability of space systems and supporting infrastructure.[2] In the years after the publication of the report, the military balance has shifted away from the United States in each of these areas.

The United States faces constraints upon its ability to respond to this trend, including more than a decade of focus on counterinsurgency and limited funding of the types of capabilities that would be of greatest relevance to deterring or countering China, despite bipartisan calls to do so.[3] Indeed, there is a limited recognition that the United States is in a long-term competition with China, and even more limited willingness to discuss publicly the requirements of such a competition.[4]

The premium on strategic thinking is increasing as the U.S. margin of superiority is decreasing. As threats to the United States, its allies and its interests grow, the need to shape China's choices and deter aggression grows as well. This paper

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offers a framework for thinking about a family of long-term peacetime strategies known as cost-imposing strategies. It begins by describing the concept of competitive strategies, of which cost-imposing strategies are a part. It goes on to lay out the criteria that strategists and policymakers should consider in formulating a competitive strategy. The paper then describes the variety of costs that such a strategy may seek to impose upon a competitor. It concludes with some thoughts on how to evaluate the success of such a strategy.

I.THINKING ABOUT COMPETITIVE STRATEGIES

Even though the term "competitive strategies" entered into the U.S. Defense Department lexicon in the 1970s, the concept is quite old.[5] History contains a number of cases of long-term peacetime competitions, including those between Athens and Sparta in the third century B.C., France and Great Britain from the 18th to the 19th centuries, Germany and Great Britain in the 19th and 20th centuries, the United States and Great Britain in the 19th and early 20th centuries, the United States and Japan during the first half of the 20th century and the United States and the Soviet Union during the second half of the 20th century. Some, such as the Anglo-American rivalry, ended amicably. Others, such as the Anglo-German competition, led to war. Still others, such as the U.S.-Soviet competition, yielded conflicts on the periphery and an armed and sometimes uneasy peace between the central actors.

Similarly, cost-imposing strategies have long formed part of the repertoire of competitors. Many of the protagonists in past long-term competitions pursued conscious strategies to impose costs upon their rivals in peacetime in furtherance of their objectives. For example, from 1898 to 1914, Great Britain developed and executed a naval modernization program that sought, among other things, to impose considerable costs upon Germany as the litter sought to respond.[6] During the Cold War, the United States pursued a number of strategies against the Soviet Union that were meant to impose costs of various kinds on Moscow, including the Army and Air Force's development of AirLand Battle beginning in the 1970s, the Navy's Maritime Strategy of the 1980s, the development of stealth aircraft and the Strategic Defense Initiative.[7]

More recently, America's adversaries have pursued cost-imposing strategies against the United States. Al Qaeda's September 11, 2001, terrorist attacks, and the responses to them, resulted in considerable costs. Such costs go beyond the physical destruction of the attacks on the World Trade Center and the Pentagon and the disruption of the economic life of the nation, to include the subsequent costs of transportation security initiatives and the time and efficiency costs that flow from them. Cyberattacks on U.S. government networks that have triggered the development and deployment of increasing layers of security have similarly yielded considerable costs, to include that of developing and fielding cybersecurity capabilities as well as the efficiency losses associated with such security measures.

China's development of so-called anti-access/area-denial capabilities (which the Chinese refer to as "counterintervention" capabilities) is imposing considerable costs as well. China's development and fielding of conventional ballistic missiles of sufficient range and accuracy to hold at risk U.S. air bases in Japan and beyond will force the United States to harden and disperse its basing infrastructure.[8] Development of anti-ship ballistic missiles such as the DF-21D is forcing the U.S. Navy to invest in countermeasures and potentially new operational concepts.[9] And Beijing's development of anti-satellite weaponry will cause the United States to invest in capabilities to safeguard its space-based systems or find alternatives to them.

At the outset, it is important to situate cost-imposing strategies within the larger realm of strategy. At a fundamental level, strategy is strategy; any modifiers are less important than the noun they modify. Strategy has to do with how a state or other political actor arrays its resources in space and time in order to achieve its political objectives against a competitor.[10] In other words, strategy represents the way an actor seeks to achieve political objectives against a competitor. The key features of any strategy are rationality (the existence of political objectives and a plan to achieve them) and interaction with a competitor who seeks at the very least to achieve different objectives if not to thwart the strategist's ability to achieve its aims.[11]

Cost-imposing strategies follow the logic of strategy, albeit in a particular context. They are a particular family of strategy that can be pursued in peacetime to achieve limited political aims.[12] Each of these aspects deserves consideration.

Cost-imposing strategies are generally pursued to achieve limited aims.[13] They are meant to change a competitor's decisionmaking calculus and thus its strategic behavior. They do not seek the overthrow of an adversary. In this regard, the competitive strategy that the United States pursued against the Soviet Union succeeded beyond the wildest imaginations of even the strategy's most enthusiastic supporters.[14]

Cost-imposing strategies unfold in peacetime. Strategy in peace differs from that in war in several ways. First, cost-imposing strategies can, and often do, involve the use of military assets but focus on the latent use of force to deter or coerce rather than to defeat competitors. Peacetime strategy focuses on when and how a state reveals its research, development and acquisition of new capabilities; what a state chooses to acquire; when and how it deploys those capabilities; and how it trains with them. As a result, peacetime strategy leads to trade-offs that are not present in time of war. For example, governments face the decision as to whether to reveal military capabilities in order to deter or influence a competitor, or to conceal them in order to preserve their operational effectiveness in a future conflict.

Second, strategy in peacetime occurs with a greater sense of uncertainty than in war. As Sir Michael Howard famously wrote nearly half a century ago, planning in peacetime is akin to navigating a ship through a thick fog of peace.[15] Third, statesmen and soldiers operating in peacetime generally have a much lower tolerance for risk than they might in war. As a result, they often shy away from actions that could be seen as provocative for fear of exacerbating tensions with a competitor. Finally, it takes longer to determine the effects of one's strategy in peacetime than in wartime. Whereas the impact of one's actions on the battlefield manifests itself in hours, days, weeks or months, the impact of peacetime actions often does not become apparent for years or more.

As Bradford A. Lee has written, cost-imposing strategies are one family of peacetime competitive strategy. They seek to convince an adversary that the costs of continued competition or conflict are prohibitively high and that accommodation is a more attractive option. Cost-imposing strategies may seek to have any number of effects upon a competitor. They may, for example, seek to dissuade or deter a competitor from engaging in actions that are disruptive or threatening by convincing the competitor that they are too costly, are ineffective or will prove counterproductive. Such strategies may alternatively seek to channel a competitor into engaging in activities that are inoffensive or wasteful.

A second family of competitive strategies includes strategies of denial, which seek to prevent a competitor from being able to translate its operational means into the political ends that it seeks. A third approach is to attack a competitor's strategy by inducing it to engage in strategically self-defeating behavior. A final family seeks to attack a competitor's political system by forcing the competitor to face the prospect of political dissolution or concession.[16]

II. CONSIDERATIONS FOR FORMULATING AND IMPLEMENTING A COST-IMPOSING STRATEGY

Six considerations should govern the development and implementation of a competitive strategy, such as that of cost imposition, in peacetime.

First, the strategy must be aimed at a concrete adversary with whom one interacts. One cannot develop strategy against an abstraction. Rather, strategy, in peace and in war, needs to be aimed at a particular adversary. Indeed, an understanding of the competitor's aims, strengths, weaknesses and proclivities is central to strategic effectiveness.

Second, in order to develop, implement and monitor a strategy, one must possess sufficient information to assess its effectiveness, or at the least to safeguard against undesirable second-order effects. In this regard, the motto of the strategist should mirror that of the physician: First, do no harm.

Developing and implementing a competitive strategy is predicated upon at least a first-order understanding of one's own enduring strengths and weaknesses, and those of the competitor. This is necessary to ensure at least a reasonable chance that one's actions will elicit the response that one seeks, or at least to narrow the range of potential competitor response.

The information requirements of successful strategy should not be underestimated. During the Cold War, the United States' national security bureaucracy was almost singularly focused on the Soviet Union. The U.S. government and philanthropic foundations undertook a wide variety of programs to build intellectual capital regarding the Soviet Union.[17] The United States collected and translated Soviet military writings and made them widely available to the U.S. officer corps.[18] Moreover, the U.S. intelligence community undertook a range of sometimes highly risky operations to gain deep insight into Soviet decisionmaking.[19] Despite all these efforts, it took several decades for the United States to gain a deep and nuanced understanding of Soviet decisionmaking.

Today, there is no comparable effort to understand China or other competitors, even though China is in many ways a much more open competitor than the Soviet Union was. For example, whereas Soviet writings about future warfare were often classified, Chinese doctrinal publications are available for purchase in bookstores in China and on the Internet. However, whereas the U.S. government translated and disseminated Soviet writings on warfare, comparable Chinese doctrinal publications are not broadly available. As a result, discussion of Chinese doctrine is often limited to the small subset of defense analysts who are fluent in Mandarin.

Third, an effective strategy should take into account (and even exploit) the basic but often overlooked fact that both sides in a competition possess limited resources. Indeed, the fact of limited resources – monetary, human and technological – and the costs associated with them are central to cost-imposing strategies. Specifically, cost-imposing strategies can most fruitfully be pursued when one has an understanding of those constraints as well as ways to exacerbate them. These may include constraints within a state's defense sector as well as the trade-off between defense and other forms of government spending.

Statesmen are painfully aware of the limitations under which they labor, while also tending to discount or ignore the constraints that others face in pursuing their aims. Good strategy takes advantage of them.

Fourth, effective strategy should take into account the basic fact that both sides in a competition are not unitary actors, but rather bureaucratic entities that have their own preferences, proclivities and cultures that frequently lead to performance that diverges considerably from the optimal.

This insight applies to both sides. To succeed, a strategy must navigate the proponent's own bureaucratic terrain before it has a hope of affecting a competitor's bureaucracy. Put another way, strategies that rely upon one's own military services doing things that they do not want to do are unlikely to succeed. Conversely, strategies that match the preferences and proclivities of one's own military to the competitor are more likely to attain success.

For planning purposes it is useful to think of a competition as an interactive three-move sequence made up of an initial action, a competitor's responses to it and the initiator's subsequent counteraction.

Fifth, such a strategy should exploit time and make it a virtue. That is, it should consider not only *what* actions the state should take, but also *when*, with the latter timed to achieve the maximum effect. Time costs are important and may translate into deterrent effects. Cost-imposing strategies, in concert with strategies of denial, should seek to frustrate and delay competitors from achieving capabilities that are dangerous and disruptive. For example, the United States, its allies and its friends might consider deploying anti-access capabilities of their own to frustrate Chinese attempts to project power.[20] An anti-access approach would, for example, help Taiwan deter Chinese coercion and aggression.[21]

Finally, such strategies should account for interaction. Strategists must never forget that they do not seek to impose their will upon an inanimate object, but rather a thinking competitor that is pursuing its own aims. Competitors will respond to moves, often at times and in ways that one may not expect. Indeed, all actors should be expected to seek to drive the competition in ways that favor them and disfavor their adversaries.

As a result, for planning purposes it is useful to think of a competition as an interactive three-move sequence made up of an initial action, a competitor's responses to it and the initiator's subsequent counteraction. The initial action should seek to elicit a response from the adversary – to dissuade it from undesirable actions or channel its behavior in ways that are favorable to the first mover. The initiator should undertake that action with at least a first-order sense of how the competitor may (or perhaps must) respond. However, the actual nature and timing of the competitor's response will give additional information about the competition and should make subsequent counteraction even more effective. Indeed, that counteraction should take account, and advantage, of the competitor's response.

III. THE VARIETY OF TOOLS FOR COST IMPOSITION

A cost-imposing strategy should take advantage of a broad portfolio of economic, military and diplomatic instruments to impose costs upon a competitor.

Economic Costs

Imposing economic costs is what generally comes to mind first when "cost imposition" is mentioned. This is often caricatured as "outspending" an adversary. However, economic cost imposition has a number of discrete facets involving financial, labor and technological inputs that deserve separate discussion. Moreover, a state's ability to absorb economic costs will likely depend upon its economic potential, the government's ability to extract resources and the relationship between state and society. It is one thing to impose costs upon a competitor with a weakening economy, such as the Soviet Union during the late Cold War or North Korea today; it is quite another to do so upon a competitor with a growing economy, such as China today.

MONETARY COSTS

Monetary cost imposition involves inducing a competitor to spend money on capabilities that are expensive, hopefully to the extent that it creates trade-offs with other spending priorities. The great power battleship competition from 1898 to 1914 is an example of a strategic arms dynamic in which monetary cost imposition featured prominently. Throughout the period, Britain was able to leverage enduring advantages in battleship technology, naval construction and manpower, combined with a nimble and relatively opaque planning and resourcing process, to maintain naval superiority over Imperial Germany. Along the way, Britain imposed considerable costs upon Germany. To make matters worse for Berlin, expenditures on the German navy represented opportunity costs for the modernization of the German army.[22]

A complementary approach is to make a military capability obsolescent, forcing a competitor to invest in a new generation of technology to reclaim that capability. For example, the British government's decision to launch the *Dreadnought* in 1906 rendered previous generations of battleships obsolete. Similarly, the U.S. government's decision to develop and field low-observable ("stealth") aircraft during the late Cold War rendered existing air defense systems obsolete.

HUMAN RESOURCES COSTS

It may also be possible to induce an adversary to overtax critical human resources, such as scientists or engineers. Skilled people are always at a premium, particularly in developing states, and depriving a competitor of those skills would, at the very least, cost time and money to address. Efforts to assassinate or co-opt a developing country's military scientists in an attempt to prevent it from acquiring advanced weaponry would be an example of this technique. For example, in the 1980s, Israel is alleged to have been involved in the assassination of the arms designer Gerald Bull, who was working for Saddam Hussein's government on developing a long-range artillery piece that would have threatened Israel.[23] If true, such an effort to deny Iraq access to critical skills could be considered a cost-imposing strategy.

TECHNOLOGY COSTS

It may also be possible to impose costs by restricting access to foreign technology and forcing a state to undertake costly technology development indigenously. Indeed, the main rationales behind technology transfer restrictions are to deny countries of concern access to advanced military technology and, failing that, to make the acquisition of such technologies difficult and expensive. During the late Cold War, the United States quite explicitly used technology transfer restrictions to impose costs on the Soviet Union.[24]

Such instruments may, and most often are, used in concert. It is worthwhile thinking about what a cost-imposing strategy against Iran's nuclear program might look like. It might, for example, include efforts to destroy or damage facilities associated with Iran's nuclear program through sabotage (monetary cost imposition), a campaign to assassinate Iranian nuclear scientists (human resources costs) and an attempt to deny Iran access to the technology needed to acquire fissile material and fashion it into nuclear devices (technology costs).[25]

Military Costs

Cost imposition occurs not only through economic, but also through military means.

EFFICIENCY COSTS

One form of military cost imposition revolves around forcing or inducing a competitor to do things less efficiently than it otherwise would have done. Cyberattacks that have yielded the need for encryption and restrictions on data transfer, for example, represent the imposition of efficiency costs.

EFFECTIVENESS COSTS

Another approach to military cost imposition aims to cause a competitor to do things that are less effective than it otherwise would have done. This can be seen throughout history in the development of countermeasures to existing weapons, followed by successive efforts to counter them. Pushed to the extreme, in some cases it has been possible to render an existing weapon obsolescent or obsolete.

Various forms of military cost imposition can be seen in the U.S. Air Force's pursuit of manned penetrating bombers against Soviet air defenses during the Cold War. During the early Cold War, U.S. bombers planned to operate at high altitude. Beginning in the late 1950s, however, the Strategic Air Command shifted to low-altitude attack tactics and eventually deployed aircraft such as the FB-111 and B-1 bombers that were optimized for low-altitude attack as well as weapons, such as the *Hound Dog* air-to-surface missile (ASM) and short-range attack missile (SRAM), that were designed to allow bombers to launch attacks outside the range of Soviet surface-to-air missiles (SAMs). When, beginning in the late 1970s, the Soviets began responding to such moves by deploying aircraft and SAMs designed to shoot down low-altitude bombers and cruise missiles, the United States began deploying stealthy aircraft such as the F-117 attack aircraft and B-2 bomber. Throughout most of the period, the United States was able to dictate the scope and pace of the competition.

Cyberattacks that have yielded the need for encryption and restrictions on data transfer, for example, represent the imposition of efficiency costs.

Such an approach inflicted a variety of costs upon the Soviet Union. First, the Air Force's pursuit of manned penetrating bombers inflicted monetary costs on the Soviet Union by forcing it to acquire air defenses against high-altitude bombers in the 1950s, low-altitude bombers beginning in the 1960s and stealthy bombers beginning in the 1980s. Each of these moves made previous investments in air defense irrelevant or obsolete. According to one accounting, it cost the Soviet Union $120 billion to counter U.S. manned penetrating bombers over the course of the Cold War. The United States also forced the Soviet Union to bear technological costs by forcing the Soviet aerospace industry to invest first in look-down/shoot-down target acquisition systems and later counterstealth technologies.

The U.S. bomber program confronted the Soviet leadership with a series of trade-offs. For example, resources allocated to the service responsible for the strategic air defense of the Soviet Union, PVO Strany, could not be allocated to other services or missions. Similarly, resources devoted to strategic air defense could not be devoted to offensive missions. These included the deployment of more than 10,000 SAMs, tens of thousands of air defense artillery systems and 15 varieties of air defense interceptors. In addition, the Soviet Union built the MiG-25 *Foxbat* air defense interceptor to counter the XB-70 *Valkyrie* bomber, which the United States never deployed.[26]

Political or Diplomatic Costs

Perhaps most pervasive, but also most ephemeral, are attempts to impose political or diplomatic costs upon a competitor. Demarches and United Nations resolutions represent efforts to do this. For example, virtually all the world's spacefaring nations démarched the Chinese government in the wake of China's January 2007 direct-ascent anti-satellite (ASAT) test, which created thousands of pieces of space debris and posed a threat to space navigation. Similarly, many governments démarched Beijing in the wake of its announcement of an air defense identification zone (ADIZ) in the East China Sea in November 2013.

IV. CONCLUSION: ASSESSING THE EFFECTIVENESS OF COST-IMPOSING STRATEGIES

There are several ways to measure the effectiveness of a competitive strategy over time. One way is by measuring the costs that it imposes on the competitor across the dimensions described above. A successful strategy should impose costs out of proportion with the expenditure required to do so. That is, the strategist should exploit imbalances in the strategist's favor. Ultimately, a good strategy should impose costs on a competitor sufficient to affect its decisionmaking calculus and, over time, change its strategic behavior.

Another measure of effectiveness involves strategic options. A successful strategy should increase the range of competitive options available to the initiator and constrain those available to the target. A successful strategy should make the most disruptive and dangerous options unattractive to the competitor while at the same time increasing the options open to the strategist.

A final set of measures has to do with initiative. The side that is implementing a successful strategy should possess the initiative in the competition, controlling its pace and scope while forcing its competitor to react to it.

Viewed against these criteria, recent American strategic performance has been poor. In recent years the United States has found itself on the wrong side of cost-imposing strategies inflicted upon it by China. Moreover, Chinese military modernization is constraining the strategic options open to the United States at the same time that China is gaining a larger set of options. And in a number of key areas, the United States has lost the initiative in the competition and is reacting to Chinese moves rather than setting the scope and pace of the competition.

The United States can, and should, do better. Analogies to the past are always imperfect, and those to the U.S.-Soviet competition during the Cold War have limited value. Still, to the extent that the analogy holds, the current situation is more akin to that of the 1950s than the 1980s. That is, the United States is still in the early stages of formulating a strategy for the long term. To improve its strategic performance, the U.S. national security community needs to devote effort to identifying enduring U.S. strengths and weaknesses and those of key competitors such as China.[27] The United States also needs to develop an understanding of its ability to impose costs, as well as competitors' sensitivity to them. Furthermore, the United States should develop approaches that encompass all levers at its disposal to dissuade Beijing from undesirable actions or channel its behavior in ways that are favorable to the United States.

Finally, the United States needs to plan for an interactive competition. History shows that peacetime competitions are long-term, lasting decades. Moreover, whether the United States realizes it or not, China has been competing with it for some time. The United States can expect this to continue whether or not it consciously chooses to pursue a competitive strategy. The ultimate issue for U.S. policymakers is thus not whether to compete, but whether to do so consciously in a way that advances U.S. interests. Both history and strategic logic suggest that the formulation and implementation of a thoughtful long-term strategy can only improve U.S. strategic performance.

ENDNOTES

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6. See, for example, Matthew S. Seligmann, "The Anglo-German Naval Race, 1898-1914," in *Arms Races in International Politics,* eds. Thomas G. Mahnken, Joseph A. Maiolo and David Stevenson (Oxford: Oxford University Press, forthcoming).

7. Thomas G. Mahnken, "The Reagan administration's strategy toward the Soviet Union," in *Successful Strategies: Triumphing in War and Peace from Antiquity to the Present,* eds. Williamson Murray and Richard Hart Sinnreich (Cambridge: Cambridge University Press, 2014), 403-431.

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10. For an overview of definitions of strategy, see Barry D. Watts, "Barriers to Acting Strategically: Why Strategy Is So Difficult," in Mahnken, *Competitive Strategies for the 21st Century: Theory, History, and Practice*, 47-50.

11. Bradford A. Lee, "Strategic Interaction: Theory and History for Practitioners," in Mahnken, *Competitive Strategies for the 21st Century: Theory, History, and Practice*, 28-32.

12. Although it is, of course, possible to impose costs in wartime, the present discussion is limited to peacetime applications of cost imposition.

13. As Carl von Clausewitz wrote: "War can be of two kinds, in the sense that either the objective is to *overthrow the enemy* — to render him politically helpless or militarily impotent, thus forcing him to sign whatever peace we please; or *merely to occupy some of his frontier districts* so that we can annex them or use them for bargaining at the peace negotiations. Transitions from one type to the other will of course recur in my treatment; but the fact that the aims of the two types are quite different must be clear at all times, and their points of irreconcilability brought out." Carl von Clausewitz, *On War*, edited and translated by Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1989), 69.

14. Mahnken, "The Reagan administration's strategy toward the Soviet Union," 419.

15. Michael Howard, "Military Science in an Age of Peace," *Journal of the Royal United Services Institute for Defence Studies,* 119 no. 1 (March 1974), 4.

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26. Thomas G. Mahnken, *Technology and the American Way of War Since 1945* (New York: Columbia University Press, 2008), 163-164.

27. On Chinese proclivities, see Michael Pillsbury, "The Sixteen Fears: China's Strategic Psychology," *Survival,* 54 no. 5 (October-November 2012), 149-182.

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Center for a New American Security
1152 15th Street, NW
Suite 950
Washington, DC 20005

TEL 202.457.9400
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Production Notes

Paper recycling is reprocessing waste paper fibers back into a usable paper product.

Soy ink is a helpful component in paper recycling. It helps in this process because the soy ink can be removed more easily than regular ink and can be taken out of paper during the de-inking process of recycling. This allows the recycled paper to have less damage to its paper fibers and have a brighter appearance. The waste that is left from the soy ink during the de-inking process is not hazardous and it can be treated easily through the development of modern processes.

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Center for a New American Security

STRONG, PRAGMATIC AND PRINCIPLED
NATIONAL SECURITY AND DEFENSE POLICIES

1152 15th Street, NW
Suite 950
Washington, DC 20005

TEL 202.457.9400
FAX 202.457.9401
EMAIL info@cnas.org

www.cnas.org

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