

China's Nuclear Force Modernization



Lyle J. Goldstein, Editor, with Andrew S. Erickson

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Cover

The Naval War College campus on Coasters Harbor Island—a view from the south. The buildings visible on the front cover are, from left to right, McCarty Little Hall and Founders Hall (the original home of the College, now containing the Museum and offices of the Maritime History Department and the Naval War College Press). In the foreground is Dewey Field, site of June graduation exercises and summer Navy Band concerts. The light-colored rectangular objects on the front cover are Jersey barriers, installed after 9/11 (since replaced by a permanent security system).

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Foreword

The Naval War College has expanded its expertise in the Asia-Pacific Rim region in recent years largely in response to the growing significance of the region to U.S. national security. The College has actively hired prominent scholars and hosted a number of conferences, workshops, and guest speakers focusing on the problems and possibilities facing the Pacific Rim. South and Northeast Asia, after all, are home to some of the world's fastest-growing economies and close American allies, as well as several potential political and diplomatic flashpoints. Even more to the point, China is an ascending economic and military power both in the region and on the world stage. The U.S. Navy plays a leading role in maintaining stability in the region with its strong presence and ability to guard the freedom of navigation in vital sea lines of communication.

The efforts of the Asia-Pacific Rim specialists at the Naval War College in some ways represent a case of "back to the future." One of the proudest episodes in the College's history came in the 1930s when Newport played a central role in developing the military plans necessary to cope with the ascendance of another Asian economic and military power—Japan. Although we expect that wise diplomacy and national self-interest will prevent a reoccurrence of similar difficulties in the coming decades, there is no substitute for military preparedness and well-thought-out international and regional strategies for dealing with the important region. The Naval War College Press has done its part in providing its readers with many excellent articles on regional security in Asia in the *Naval War College Review*; an important book—Jonathan Pollack, editor, *Strategic Surprise? U.S.-China Relations in the Early Twenty-first Century* (released March 2004); and now Newport Paper 22.

Professor Lyle Goldstein of the Strategic Research Department of the College's Center for Naval Warfare Studies has been at the forefront of recent research into China's future. In this project he has guided a handful of naval officers through the puzzle of China's ongoing nuclear modernization programs. With the able assistance of Andrew Erickson, these sailor-scholars have examined various aspects of nuclear modernization from ballistic missile defense to nuclear command and control. In general the chapter tells a cautionary tale; the progress of China's nuclear modernization documented here should give pause to those inclined to dismiss China's military modernization. Steadily and with relatively little attention the People's Republic continues to improve its technologies and weapons systems. As the authors emphasize, no

“Rubicon” has been crossed, but potentials are already apparent that, if realized, the U.S. Navy as now constituted would find challenging indeed.

We can look forward in the coming years to still more research and analysis of China’s reemergence in global politics from the Naval War College. Professor Goldstein, his colleagues, and the students from all U.S. military services will be closely observing the changing politics, economics, and security arrangements across the Pacific in the coming years. The Naval War College Press stands ready as always to help publish such projects in the interests of the U.S. Navy, the American national security community, and interested parties across the globe.

A handwritten signature in black ink, appearing to read "Peter Dombrowski", with a stylized, flowing script.

PETER DOMBROWSKI

*Editor, Naval War College Press
Newport, Rhode Island*

Introduction

LYLE J. GOLDSTEIN

Relations between Washington and Beijing improved swiftly in the wake of the 9/11 terrorist attacks, especially in comparison to the nadir that had been reached during the April 2001 EP-3 incident.¹ This new tide of cooperation has included counterterrorism initiatives, regional partnership in such complex situations as Afghanistan and North Korea, and even some modest agreement on the importance of maintaining the status quo with respect to Taiwan's status.²

A strong foundation for this strategic cooperation is, of course, a burgeoning trade relationship, which received a further boost from China's entry into the World Trade Organization in November 2001. In 2003, trade between the United States and China amounted to \$191.7 billion, up 23.2 percent from 2002. Remarkably, the total for 2003 was more than double the figure for 1998. The United States is China's second most important trading partner nation (Japan is first).³ Many reasonable strategists, observing this data, consider armed conflict between Washington and Beijing impossible, given the economic losses that both would incur almost immediately. Unfortunately, history has not been kind to the school of theorizing, known as commercial liberalism, which holds that economic interdependence prevents conflict. Indeed, the belligerent powers prior to both world wars had achieved impressive levels of economic interdependence.⁴

Despite noteworthy progress in since 2001 in relations between the United States and the People's Republic of China (PRC), there are lingering tensions and disquieting signs that possible difficulties may loom on the horizon. Concerning the volatile Taiwan issue, assertive moves toward independence by Taipei (concerning, for example, the "peace referendum," constitutional reform, the flag, and names of diplomatic entities) in 2003–2004 prompted a series of relatively open rebukes from Washington, which seeks strict adherence to the status quo by both Taipei and Beijing.⁵ If the unexpected defeat of the pro-independence forces in the December 2004 Taiwan parliamentary elections offered hope for a stabilizing cross-Straits situation, this optimism was quickly tempered by Beijing's pronouncement that the National People's Congress

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would press ahead with “anti-secession” legislation, a step many observers saw as a precursor for a firmer line by China against Taiwan.

Even aside from this thorny issue, some sensed an increasing rivalry in the 2004 APEC (Asia-Pacific Economic Cooperation) conference. President George W. Bush’s arrival in Santiago, Chile, prompted violent public protests and a rather serious diplomatic blunder;⁶ President Hu Jintao of the PRC, in contrast, made successful visits to both Argentina and Brazil, as well as Cuba.⁷ More significantly, bilateral cooperation on the issue of North Korea also appeared to be essentially stalled in 2004. Likewise, major differences appeared to be emerging in Sino-American relations regarding policy toward Iran.⁸

Indeed, the prospect for strategic rivalry between the United States and China in the twenty-first century and beyond remains—and certainly cannot be ruled out. There is deep unease in the United States concerning Beijing’s lack of progress in the arena of political reform and a trade deficit that is said to threaten U.S. manufacturing jobs, not to mention the seemingly accelerating pace of China’s military modernization. Suspicion is also palpable on the Chinese side, where it is feared that the “War on Terror” is simply a cover for policies that justify increases in American military expenditures that could in turn enable Washington to cement its position of global hegemony. Given the persistence of these underlying tensions and suspicions, it is simply prudent for U.S. analysts to observe closely China’s military modernization and the strategic implications that could follow from its true emergence as a major power.

PRC military modernization has received ample attention during the last decade, and these studies show a pattern of increasing sophistication. However, China’s nuclear modernization is one neglected component of Beijing’s broad effort to improve its armed forces. Certainly, this is largely the result of the extreme opacity of the data available on Chinese nuclear forces and their future development. Another explanation could be perplexity concerning the overall significance of a nuclear force that is so different from that of the United States.

This study comes at an opportune moment, insofar as China’s nuclear forces appear to be on the threshold of a new qualitative level. According to the 2003–2004 issue of the *IISS Military Balance*, one brigade (eight missiles) of the long-anticipated DF-31 intercontinental ballistic missile (ICBM) is now deployed, with more presumably to follow in relatively short order.⁹ One gains some appreciation of Beijing’s perspective on the significance of this new weapons system when one realizes that the Chinese first revealed it to the world on 1 October 1999, the fiftieth anniversary of the communist state.¹⁰ While this is not the first road-mobile, solid-fuel missile deployed by China, it is the first one capable of striking the continental United States. A related major

DF-31



Source: Chinese Defence Today

development in late 2004 was the revelation in the U.S. media that the first of China's second-generation nuclear missile submarines, called Type 094, had been launched in July 2004.¹¹ As a platform for the new JL-2 submarine-launched ballistic missile (SLBM), the 094 may well be able to strike the continental United States from China's territorial waters. For China, these are very significant, if long anticipated, steps toward finally establishing credible nuclear deterrence. It is also notable, from the standpoint of China's nuclear weapons policy, that during the reform of the Central Military Commission in September 2004 the commanders of both the Second Artillery Corps and of the People's Liberation Army Navy (PLAN) were, along with the Air Force, accorded new seats the CMC, in China's highest military decision-making body.

At the same time, rather wide disagreement remains among American analysts and military strategists regarding the meaning of China's nuclear modernization for U.S.-China relations. Some have asserted that nuclear weapons are the best guarantee of peace and stability for Washington and Beijing. These weapons help to stabilize the relationship, so the logic goes, because they infuse each side with extreme caution; one close observer of Chinese nuclear strategy goes so far as to describe this condition as "nuclear peace."¹² A second school of thought holds that China's arsenal will remain relatively small and primitive. In such circumstances, Beijing's nuclear weapons would be either wholly irrelevant to U.S.-China strategic interaction or even give Washington a tool for pressuring Beijing. This rather relaxed approach was implied by a 1995 comment by Assistant Secretary of Defense Joseph Nye: "If deterrence prevented 10,000 Soviet missiles from reaching the United States, it baffles me as to why it wouldn't prevent 20 Chinese missiles from reaching Alaska."¹³

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Many analysts are considerably less sanguine, however. These include specialists on China and also experts on nuclear strategy. Thomas Christensen and Richard Betts, for example, have asked, “How would the U.S. respond if China used a nuclear weapon against elements of the 7th Fleet in the context of a Taiwan scenario?”¹⁴ Brad Roberts has conducted the most detailed and thoughtful research on this subject to date. Disturbingly, his 2001 study concludes: “It certainly also seems to be the case that nuclear deterrence would be unreliable. Given the asymmetry of stake and [China’s] willingness to bear costs, U.S. nuclear threats may simply lack credibility in many phases of [a U.S.-China] war.”¹⁵ He further observes: “In China there has been an active debate about nuclear uses that might fall below Washington’s perceived retaliation threshold. . . . In response to PRC escalation, some Chinese analysts argue that the U.S. does not have many good response options.”¹⁶

Chinese strategists have openly discussed the “nuclear shadows on high-tech warfare.” Thus, Major General Wu Jianguo, writing in the premier PLA journal *Junshi Kexue* [Military Science], observes a new “flexibility of nuclear use in actual operations.” He explains: “When countries possessing nuclear weapons and high-tech conventional weapons are involved in a war in which the conflict is intensifying, the possible use of nuclear weapons cannot be ruled out. . . . [They are] still a trump card.” In the end, he strenuously argues in favor of China’s nuclear modernization, citing Mao Zedong’s metaphor, “What is he holding in his hand? It is a knife. What is the use of a knife? It can kill a person. . . . The Chinese people also have hands, and they can hold knives too.”¹⁷

Given the concerns outlined above, this study examines select aspects of China’s nuclear modernization. It is deliberately not comprehensive. This topic is far too broad, and the available data is not sufficiently reliable to allow complete and definitive judgments at this stage. We have elected to capitalize upon our own comparative advantage—that the U.S. Naval War College (NWC) teaches some of the nation’s most promising graduate students in the field of national security studies. Unlike many comparable civilian institutions, NWC students bring with them a “hands on” understanding of military operations and strategy. This study leans heavily on the military experience of its authors.

Indeed, the backgrounds of the given students have had a major influence on the selection of topics for this study. Thus, Lieutenant Stephen Polk, USN, an aviator with extensive background in nuclear command and control (NC2), contributes the first essay, on developments in Chinese NC2. Next, Lieutenant Chris McConnaughy, USN, a submariner with experience on strategic missile boats (SSBNs), describes the significance of the recent launch of a new generation of Chinese SSBNs. The third paper, concerning the influence of China’s space program on strategic nuclear modernization, was written by

Commander Dominic DeScisciolo, USN, an air defense specialist now commanding USS *Rentz* (FFG 46) in the Pacific. The final essay, addressing the crucial topic of Chinese countermeasures against U.S. ballistic missile defense, was written by Andrew Erickson, a Princeton Ph.D. candidate with fluency in Chinese and specializing in Chinese aerospace development.

Collectively, these researchers paint a portrait of a strategic modernization program that is making steady strides. Beijing appears determined to upgrade its nuclear posture, even as it simultaneously prepares for local war under high tech conditions.

This study is intended to lay the essential foundation for further and deeper investigations into the U.S.-China nuclear relationship. In time, the issue may emerge as one of the most important quandaries confronting twenty-first-century strategists. It is undoubtedly essential to the future shape of the U.S. Navy.

A number of people and institutions were crucial to this project and its completion. First and foremost were the contributors, who did not shy away from the intimidating and complex challenge that China poses for researchers. Their determined and disciplined efforts have paid off. A secondary goal of this project was to increase awareness of China among a select group of future U.S. military leaders (including the student authors), and in this it has undoubtedly succeeded. Thanks are also due to the authors' families, who have graciously parted with their loved ones during many weekends of research and writing.

Andrew Erickson, in addition to his written contribution, superbly assisted the editor in the crucial final stages. This study additionally benefited from advice and consultation from the faculty and leadership at NWC, including Captain Richard Suttie, and Professors Stephen Downes-Martin, William Murray, Jonathan Pollack, Andrew Ross, and Peter Dombrowski. Professor Catherine Kelleher, Elizabeth Davis, and members of the NWC Press provided invaluable support as well. Finally, and crucially, this project was partially funded by the Defense Threat Reduction Agency, to which the editor expresses particular thanks.

China's Nuclear Command and Control

STEPHEN POLK

Since China became a nuclear-weapons state in 1964, the intricacies of China's nuclear forces and policies have proven mysterious to outsiders. There was only one near certainty: China would follow its own nuclear path, and one likely to depart significantly from the route taken by the superpowers during the Cold War. An independent Chinese path was clearly established with the announcement of a "no first use" policy shortly after the first test in 1964. This defensive posture would eventually place significant pressure on both superpowers, as it spawned worldwide calls to limit the costly and dangerous nuclear arms race.

But today Beijing faces a dramatically different set of choices. No longer the scrappy outsider, China is now a "nuclear insider," supporting many arms control initiatives, such as the Comprehensive Test Ban Treaty. Of much greater concern today, however, is that China no longer faces the material constraints that once obliged it to build nuclear forces on a shoestring budget. Severe financial constraints required China to make a number of unique decisions regarding the structure and operations of its nuclear forces.

By contrast, contemporary China is able to lavish sizeable resources on its military modernization program. It is suggested that the People's Liberation Army (PLA) Second Artillery Corps is "clearly a favored force of the PLA, and can be expected to grow in resources, personnel . . . and weaponry."¹ Indeed, the commander of the Second Artillery, General Jing Zhiyuan, was accorded a special seat, along with those of the Navy and Air Force, in the Central Military Commission in September 2004. Yet there is no consensus among Western analysts about where China's nuclear modernization is headed.

The three chapters that follow examine the pace of China's nuclear modernization under the sea and in space, as well as its relationship to U.S. missile defense initiatives. This chapter will systematically evaluate the overall strategic integration of China's nuclear forces, focusing on the issue of nuclear command and control (NC2). Perhaps even more than the companion papers in this volume, such an effort necessarily relies on a highly circumscribed data set. Nonetheless, there is broad consensus in security

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studies on the need for defense analyses that probe the people, institutions, and doctrines that stand behind the weapons themselves. Indeed, at a time when there are dramatically diverging estimates concerning the future dimensions of China's nuclear forces, such a "software" approach may be most appropriate.

An NC2 Primer

U.S. military doctrine defines NC2 as "the exercise of authority and direction by the President, as Commander in Chief, through established command lines, over nuclear weapon operations of military forces"² NC2 concerns not only the authority to execute nuclear operations but also the mechanism by which that authority is transferred to the forces that execute nuclear missions.

The essence of NC2, therefore, is in effect a simple network of communications links and a delineated and recognized chain of command for the devolution of power. The NC2 challenge is daunting, of course, because this network must be built to survive under the most stressful conditions imaginable—nuclear war. Indeed, NC2 is highly theoretical discipline, because no such network has ever been put to a true test.

During the Cold War, the dilemmas associated with NC2 drove each of the superpowers toward "Strangelovian" extremes of contingency planning. In the 1950s, scrambling to reduce its vulnerability to a perceived danger of a Soviet nuclear first strike, Washington built an enormous structure of early warning radars, in addition to the famous North American Air Defense (NORAD) Command at Cheyenne Mountain in Colorado. Today, in the post-11 September world, the Cheyenne Mountain facility—with blast doors that can withstand 1.5 million tons of TNT, three miles of tunnels, and fifteen large buildings, all inside a mountain atop more than a thousand large underground springs (enabling the base literally to bounce under impact)—is now enjoying a revival of sorts. However, according to the criterion that applied when it was built—ability to fight a nuclear war against the Soviet Union—the facility was virtually obsolete by the 1970s, when Soviet nuclear warheads achieved accuracy and yield sufficient to destroy it. Eventually, U.S. command and control (C2) moved away from the strategy of "digging deep" toward dispersing NC2 units throughout the United States and abroad on a rotating schedule of twenty-four-hour alert periods (often airborne). Soviet NC2 planning appears to have been no less strenuous and elaborate.³

Both sides genuinely feared the possibility of nuclear "decapitation"—that the other side might be able to accomplish a "splendid first strike," effectively disabling the adversary by surprise. The most important element of such a blow would have been strikes against political and military leadership. To kill the snake, it was reasoned, aim for the head. Such concerns were not merely military "worst-casing" or even unchecked bureaucratic

momentum; both sides did in fact actively plan to undertake preemptive first strikes—a much more “rational” strategy than attrition warfare, under nuclear conditions.

Robust nuclear command and control during the Cold War was a requirement, therefore, if only to prepare for a scenario that both sides deemed logical. The most important goal of NC2 is to enhance survivability, preserving the ability to retaliate. Only confidence that an adversary is convinced that nuclear preemption—and especially decapitation—is impossible gives assurance that it will not resort to that strategy in a crisis. Thus, successful NC2 may be viewed as an essential foundation of “second-strike” forces—that is, assured retaliation—and of strategic stability in general.

During the 1990s, academic discussion of nuclear proliferation brought forth an illuminating debate about the impact on strategic stability of potentially backward command and control arrangements in new nuclear states. Paralleling the prevailing logic of the Cold War, “proliferation pessimists” argued that unstable civil-military relations or irrational deployments could result in “hair-trigger” postures, encouraging either preemptive strikes or escalation. The “proliferation optimists” sought to allay such concerns, arguing that NC2 for small arsenals and simple nuclear strategies was much simpler than for the huge arsenals and complex strategies of the superpowers.⁴ Today, since the dimensions of China’s nuclear arsenal in some respects resemble more closely those of “emerging nuclear states” than of the superpowers, this debate remains highly relevant.

Also relevant are two specific objectives of any NC2 system. Preemptive strategies, short flight times, and immensely complicated warning networks prompted concern during the Cold War that nuclear hostilities might break out by accident. Scholars have revealed, for example, a number of potentially dangerous occurrences during the 1962 Cuban Missile Crisis—for example, a test launch of an intercontinental ballistic missile (ICBM) from Vandenberg Air Force Base without specific authorization from the Pentagon. Such an incident could have caused uncontrollable escalation, especially if the Soviets had possessed better early warning data than was the case at the time.⁵ Nuclear command and control, therefore, must minimize the risk of such inadvertent escalation. Relatedly, it must also strive to eliminate the possibility that a “rogue” commander could gain access to nuclear weapons. This problem is considered to be most serious in states with unstable civil-military relations, but the risk might be inherent in civil-military relations generally, if, as has been suggested by some scholars, military officers tend to be more inclined to offensive doctrines than their civilian counterparts.⁶

A third and final goal of any state’s NC2 is considerably more controversial—to enhance the state’s capacity for not only nuclear coercion short of use (“muscle flexing”) but also limited nuclear warfare. Nuclear muscle flexing became a common feature of

diplomacy during the Cold War. From the Berlin Crisis of 1948 to the Soviet invasion of Afghanistan in 1979, the United States frequently resorted to movements of nuclear forces, combined with presidential rhetoric, to convey its intentions and capabilities. Such weapons movements require proper coordination if they are to send exactly the right message—adequately ominous but not so threatening as to alienate world opinion or precipitate further escalation. The role of NC2 in a limited nuclear conflict would be analogous, but several orders of magnitude more important. In such circumstances, if one can imagine them, there would be an extraordinary necessity to “signal” effectively so as prevent an “all-out spasm of violence,” wherein both states launch all their weapons. For example, a limited counterforce strategy (that is, against missile launchers, etc.) could spiral out of control if “value” (that is, urban) targets were inadvertently struck instead through a failure of NC2. Under such circumstances, and depending on the magnitude of hostilities, control over one’s own forces could pose a substantial challenge.

A paradox thus emerges for the role of NC2 within strategic rivalries. On the one hand, its complete development is clearly beneficial to all parties, since it increases survivability and prevents accidents, enhancing crisis stability. But on the other hand, robust NC2 can also open the door to more complex forms of nuclear coercion, including limited war, simply by improving the overall coordination, reliability, and effectiveness of a state’s nuclear forces.

Historical Development of Chinese NC2

Chinese NC2 is a product of the broader Chinese experience with nuclear weapons, and also with command and control in wartime. In its early history, the PRC was a frequent target of nuclear coercion: first in the Korean War, subsequently during the Taiwan Strait crises, and again during the 1969 Sino-Soviet conflict. Thus, Chinese leaders had a close familiarity with nuclear threats—the limits of such pressure but also the inherent possibilities for catastrophe. It is likely that these searing experiences, so proximate to the founding of the new state, had a powerful impact on the status of nuclear weapons policy in the new state, a status today reflected in the very high profile of the Second Artillery in Chinese military modernization. In its present relation to nuclear weapons, Beijing might be compared to an adult who was abused as a child.

The PLA’s molding experiences under fire with respect to command and control should also be briefly considered. In the Korean War, the young Chinese army fought the United States to a draw, albeit at a horrendous cost in casualties. Major problems with command and control surfaced during that conflict. Mao’s inclination to direct all major operations personally despite his distance from the front (and consequent paucity of information) yielded in the spring of 1951 a debacle in which the PLA exceeded

its “culminating point” and very nearly threw away the stunning military successes of the previous winter. Other command and control failures in this conflict included inability of units to communicate and coordinate across Korea’s difficult terrain and also a basic incapacity to coordinate warfare specialties, especially artillery and logistics with infantry.

The PLA proved fairly adept at correcting these mistakes during the stalemate that followed the initial Chinese thrusts.⁷ During the next significant armed conflict that Beijing faced, a successful border war with India in 1962, improved command and control arrangements served the PLA well in combat. Senior leaders made timely and effective decisions, and regional commanders were given substantial leeway in execution, making well coordinated attacks.⁸

During the 1960s, Beijing proceeded with its nuclear weapons program mindful that it was vulnerable to decapitation. Before the development of an actual NC2 system, Marshal Nie Rongzhen, commander of the nuclear weapons project, dispersed scientists and laboratories so that they could not be eliminated in a single strike.⁹ The Second Artillery, comprising the PRC’s “strategic rocket forces,” was founded in mid-1966, just as the Cultural Revolution was plunging China into a new period of turmoil. Though the goals of the otherwise immensely wasteful “Third Front” were not entirely antithetical to effective nuclear command and control, recent research by Nathan Busch persuasively argues that great instability occurred in Chinese NC2 development during this period.¹⁰ For instance, an unprecedented test of a missile armed with a nuclear warhead on a flight path that took it over numerous population centers was executed in October 1966 under pressure from Red Guards, who supported an aggressive testing regime and dismissed the safety concerns of Nie, then *de facto* leader of the Second Artillery.¹¹ The strategic weapons test center at Lop Nur was threatened on two occasions during 1966–67 by forces external to China’s NC2 system, first by General Wang En-Mao, commander of the Xinjiang region, who had fallen into a serious dispute with Mao. The test center and its associated weapons were threatened once again when Mao’s nephew Mao Yuanxin led a group of Red Guards across the country to assault Lop Nur. Fortunately, these incidents were defused without any substantial breach.

Only three years after the Second Artillery was established, it faced a significant test in a major nuclear confrontation, the Sino-Soviet border crisis of 1969. Moscow made specific nuclear threats, backed by operational preparations detected by U.S. intelligence, strongly hinting at the possibility of exploiting the “opportunity” to destroy China’s nuclear arsenal before it could grow even more menacing. This episode remains much more murky than most other Cold War crises, making it difficult to assess the effectiveness of China’s early NC2. Preliminary evidence, however, suggests that

China's nuclear weapons infrastructure was extremely vulnerable. According to perhaps the preeminent Russian expert on the crisis today, "Soviet intelligence possessed the requisite targeting information to carry out a disarming first strike."¹² This is not terribly surprising, given that the Soviets had helped build much of China's nuclear weapons infrastructure. Indeed, a substantial portion of that infrastructure had been deliberately built near the border, so as to take full advantage of Soviet assistance programs, which were fully abandoned only in 1960. It is noteworthy that in the most detailed account published to date of the negotiations between Soviet premier Alexei Kosygin and Chinese premier Zhou Enlai that eventually resolved the crisis, Zhou did not highlight China's nuclear capability but rather "conceded that China was incapable of fighting a nuclear war because of the weakness of its arsenal."¹³ The Chinese leadership took the extreme measure of evacuating senior personnel from Beijing and other cities at the conclusion of the crisis, further suggesting the rudimentary state of the state's early warning capability and nuclear command and control.¹⁴ Indeed, the Sino-Soviet crisis of 1969 was probably a "wake-up call," following the ebullient optimism that had flowed from China's first nuclear test and subsequent successful testing regimen (which included thermonuclear detonations). This crisis appears to have brought home to PRC strategic planners the fact that tests in and of themselves do not readily translate into leverage in a severe crisis, whereas survivability and, perhaps above all, robust NC2 are crucial.

It is likely that the 1969 crisis precipitated a major effort in these areas over the course of the 1970s. According to Secretary of Defense Harold Brown, testifying before Congress in 1974, "The Chinese are clearly sensitive to the importance of second-strike capabilities and are making a considerable effort to minimize the vulnerability of their strategic offensive forces."¹⁵ One part of this effort was adopting a doctrine of "in-cave storage/preparation and out-cave erection/filling/firing" for China's medium range missiles, a step that was apparently ordered by Mao in May 1975.¹⁶ According to John Lewis and Xue Litai, by the mid-1970s, "Chinese missile commanders . . . and their leaders within official councils quietly expressed confidence that they now deployed a formidable and relatively invulnerable retaliatory arsenal."¹⁷ However, "in 1975, China dismissed the option of launch-on-warning because it was unable to build a reliable early warning system."¹⁸ Although research on large phased-array radars (LPARs) appears to have begun in 1970, the program did not yield results for more than a decade.¹⁹

The 1980s witnessed modest progress in modernizing China's nuclear deterrent. To be sure, there were some dramatic successes, such as the first successful launch of a submarine-launched ballistic missile (SLBM) in 1982. But severely depressed defense funding, reflecting Deng Xiaoping's determination to improve the Chinese economy,

meant that such improvements were being made on shoestring budgets. China succeeded in launching its first communications satellite in 1984.²⁰ The first LPAR appears to have been deployed by 1986, situated to warn of a Soviet attack.²¹ As of 1987, Beijing was still said to lack the permissive-action link (PAL) technology that is crucial for NC2.²²

The Tiananmen Square crisis in June 1989 fueled questions regarding Chinese NC2. Specifically, there were signs of major fissures within the PLA. In fact, various revered figures within the Second Artillery itself, including both Nie Rongzhen and Zhang Aiping, were said to oppose the use of force against the protesting students in the square.²³ It may have been concern about NC2 during the Tiananmen Square crisis that later prompted Chinese leaders to express interest in American PAL technology in 1994.²⁴

Chinese NC2 Today and Tomorrow

The 1990s witnessed a gradual but significant escalation in Chinese defense expenditure. It is now apparent that in that decade and subsequently, China's military modernization effort has been both broad and deep. One expert on the PLA recently suggested that in the future we will look back on the present as a period of extraordinary growth in the PLA's aptitude and capabilities.²⁵ Not surprisingly, NC2 is improving in the context of an extensive effort to revamp PLA command and control generally.

Nonetheless, it must be understood that Chinese NC2 is improving from a very low level of development—one that might be described even as primitive. For most of its history, Chinese NC2 has had a fundamentally defensive orientation, relied on man rather than technology, contended with unwieldy liquid-fueled missiles, stored warheads and weapons separately, could expect little or no warning of an attack, rarely exercised its nascent sea-based deterrent, and assumed delay and extended reaction times.

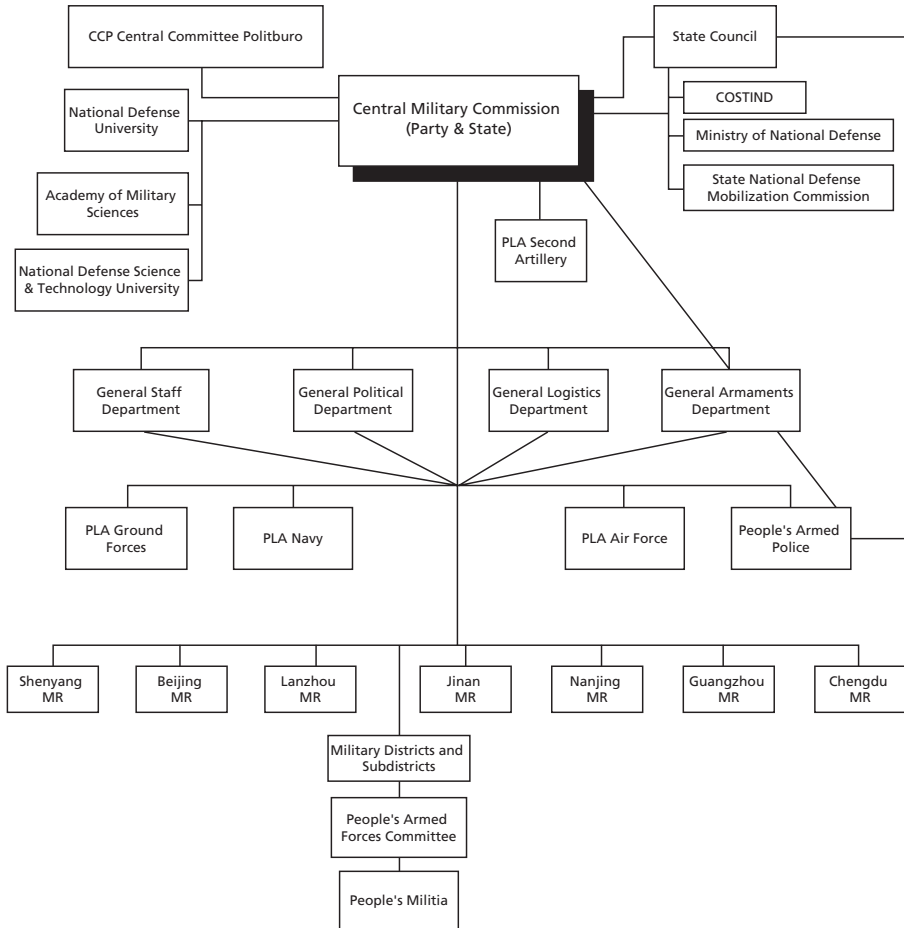
It seems, however, that most of these problems are today being solved, in the context of China's nuclear modernization. Let us now turn to the most fundamental issues currently confronting Chinese NC2.

Who Has Final Release Authority?

China's NC2 network appears to be highly centralized under the rubric of the Central Military Commission (CMC). The Second Artillery Corps is not a separate branch of the armed services, but it is said to have direct links with the CMC. Operational command, however, apparently is exercised by the General Staff Directorate (GSD). According to David Shambaugh:

It is not certain exactly how the communication to launch missiles is conveyed via the GSD, but it is believed that there are also separate and secure communications lines from the CMC to Second Artillery headquarters and thence to all launch brigades. It is also understood that a launch brigade must receive separate communications from the CMC and GSD before a launch is authorized.²⁶

The Command Structure of the People's Liberation Army



Source: "The Command Structure of the People's Liberation Army," figure in David Shambaugh, *Modernizing China's Military: Progress, Problems, and Prospects* (Berkeley: University of California Press, 2002), p. 111.

CMC offices are apparently now located on the top floor of the new downtown Beijing offices of the Ministry of Defense, which were completed in 2000.²⁷ The GSD maintains a hardened facility in Xishan (in the western suburbs of Beijing), from where the PLA leadership controls its strategic missile forces.²⁸ All operational orders originate from there.²⁹ The Second Artillery headquarters complex is located not far away, in Qinghe.³⁰ Given the increasing profile of China's sea-based deterrent (see chapter 2), it is notable that sea-based strategic systems do not seem to be under the command of the Second Artillery.³¹

In light of the heretofore rudimentary state of Chinese NC2, it is widely speculated that operational units have been given predelegated launch authority under certain

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conditions. Moreover, when time is not of the essence, there may be no operational problem with low-tech, but politically reliable, “messengers” for launch authorization. However, in terms of the chances of accidental nuclear war, such primitive NC2 procedures would be problematic.

A relatively new and potentially difficult issue concerns the continuing bifurcation of military and political elites within China’s leadership. To a large extent, this tendency simply reflects the increased professionalization of the PLA over the last two decades—an evolution that clearly tends toward more effective NC2. However, a major problem arose during 2002–2003 because China’s most senior leadership was split between the Politburo of the Central Committee, headed by President Hu Jintao, on the one hand, and the CMC, chaired by ex-President Jiang Zemin. Jiang’s retirement from the Central Military Commission in September 2004 reduced the confusion, but the Politburo remains almost entirely civilian in composition, while the CMC is almost entirely military. There is as yet no fusion of military and civilian policy makers, as in the U.S. National Security Council. This bifurcation raises profound questions for the NC2 structure, not all of which were resolved by Hu’s ascendance to chairmanship of the CMC. Apparently the differing roles of the Politburo and the CMC have caused command-and-control friction before—for example, during the 1979 war with Vietnam.³²

Alert Status

Beijing is deliberately opaque regarding all aspects of its nuclear force: quality; quantity, and alert status. What is clear, however, is that the Chinese force has been and remains significantly smaller than either the American or Soviet arsenals, even after major post–Cold War reductions by Washington and Moscow. Also Chinese nuclear weapons have traditionally been maintained on a much lower alert status.

In general, the missiles of the Second Artillery are neither fueled nor mated with nuclear warheads.³³ Many are stored in caves or in silos. The DF-4 is stored in caves but evidently cannot be fueled there, because “the skin is too thin for it to be filled with propellants in this [horizontal] position without causing serious body damage.”³⁴ The DF-5, which is

东风五号

DF-5 (East Wind)

capable of striking the United States, is stored in silos. Aside from standard hardening, these missiles are apparently protected by a large number of bogus silos that have been constructed as decoys.³⁵ The DF-5 is

propelled by storable liquid fuel, but this fuel is corrosive after twenty-four hours, for which reason the fuel is stored in tanks near the silos. Most of the Second Artillery’s current road-mobile weapons are tactical missiles. Regarding its perhaps 150 gravity bombs,

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Xia (Shrimp)

it is unclear whether they are distributed to bomber bases or kept in a central stockpile. It is well known, however, that China’s single nuclear-powered ballistic-missile submarine (SSBN), the *Xia*, has rarely sortied from port and

巨浪一号

JL-1 (Great Wave)

has never made a deterrent patrol versus the United States. To do so, it would have to deploy to the central or eastern Pacific, as its JL-1 missiles have a rather restricted range, 1,700 kilometers.³⁶

However, major weapons systems now in the final stages of testing will dramatically alter the alert status of China's nuclear forces. This "great leap" has been enabled by, on the one hand, miniaturization of the warheads, and on the other hand, by success with solid fuels. These advances have been incorporated into the new road-mobile DF-31, which the PLA is now in the early stages of fielding. A truly intercontinental missile, the longer range version DF-31A (reportedly under development) will bring the continental United States into range from China itself. Meanwhile, the extended range of a new, second-generation SLBM will allow China's new SSBNs (see chapter 2) to remain in the western Pacific, and perhaps even permit the pierside shots of which Soviet SSBNs were capable by the end of the Cold War.

Xia, in distance, with a Kilo SS



Source: Chinese Defence Today

Technology Upgrades

To network this new generation of advanced platforms, the PLA is fielding a panoply of advanced communications technology. China has the capabilities and components of a communications network: switching systems, fiber optics, satellite-to-ground and ground-to-satellite communications, microwave communications, cellular telephones, and pagers. Moreover, China has demonstrated at least partial capabilities in many important communications applications, including the ability to manufacture and deploy

[Notes](#)

communication systems.³⁷ The laying of fiber-optic lines has been an especially high priority for the PLA in recent years.³⁸ In 1997, the signal unit of the Second Artillery began preliminary deployment of digital microwave communications, further enhancing all-weather connectivity between units.³⁹ New shortwave systems are now also being deployed in the Second Artillery.⁴⁰

The Second Artillery has additionally undertaken significant efforts to develop a “paperless” network-centric system for distributing information. This process of “informatization” enables real-time monitoring of personnel, vehicles, support equipment, and weapons systems. A massive effort to educate Second Artillery cadres in computer technology has been required.⁴¹ Other expected advantages of the new system may be accelerated training activities, more efficient logistics management, faster transmission of meteorological data, and reduced personnel at storage facilities.⁴²

Communication satellites are a major priority for the PRC at present, and Chinese strategic forces will no doubt benefit from this aspect of overall command and control modernization. In 1997 China successfully launched the first of its second-generation DFH-3

东方红三号

DFH-3 (East is Red)

communications satellites. Apparently having a strong resemblance to the GE Astro Space 5000 series, this satellite represents a major improvement over its predecessors, with up to twenty-four transponders with uplink/downlink frequencies of 6/4 gigahertz and an operational life of eight years.⁴³ Beijing put its first explicitly military communications satellite into orbit in January 2000, the Feng-Huo-1 (FH-1). According to one source, the PLA “has been using

烽火一号

Feng-Huo-1 (Beacon)

the DFH series communications satellite as a part of its national C4I [command, control, communications, computers, and intelligence] systems for over a decade, but the FH series will provide new capabilities, which will allow commanders to communicate with and share data with all forces under joint command at a theater level.”⁴⁴ A follow-on generation of communication satellites will enable the PLA to “transmit tailored data . . . maps, pictures, and enemy deployments . . . to hundreds of units simultaneously . . . without the need for ground station rebroadcast.”⁴⁵

Despite these advances, there is reason to believe that communications satellite production capacity is insufficient to satisfy current and future demand. Therefore, Beijing continues to purchase foreign-built satellites and to lease capacity. In 2002 Beijing contracted with a French company to build the Apstar-6 communication satellite, which is scheduled to be launched in April 2005.⁴⁶ In addition, Israel will supply two satellites, to be received in 2005–2006.⁴⁷

Training

A revolution in PLA training has gradually become evident over the last decade. Most fundamentally, it has involved a transition from rote, scripted exercises to more objective “red-versus-blue” engagements that are designed to force commanders to adapt to circumstances on the spot, and to spur the development of new doctrine and tactics. The new approach is referred to as “confrontational training,” and it is no surprise that the elite Second Artillery has taken it up with vigor.⁴⁸

Second Artillery training appears to occur regularly under challenging conditions—for example, in remote deployment areas or at night—under the guiding philosophy, “If you fear risk on the training field, when it comes to the battlefield you might lose your head.”⁴⁹ Enhanced communications technology is playing an essential role. For example, increased connectivity has been crucial to the development of simulation technology, at a time when “10 thousand *liang* of gold is spent [for each] cannonball [that] is fired.”⁵⁰ A network or “online equipment clinic” linking maintenance battalions with research institutes and manufacturers now enables “technical personnel . . . [to] . . . review the ‘medical history’ and prescribe the right medicine” to make speedy repairs.⁵¹ There is additionally a degree of recognition in the Second Artillery that the human dimension should not be neglected in the vast effort to integrate information technology into the force. Thus, noncommissioned officers have been singled out for special attention in training regimens, and Second Artillery leaders have concerned themselves about the psychological conditioning of their troops.⁵²

A further, and essential, element of Second Artillery training is that no sharp separation exists within the corps between conventional-missile and nuclear-armed units. In other words, the same command provides both the personnel who man the conventionally tipped short-range ballistic missiles (SRBMs) opposite Taiwan and the custodians of China’s nuclear deterrent. Undoubtedly, the SRBM forces have proved an invaluable teaching resource for the nuclear forces. Mobile SRBM units have been observed to operate at high tempo and with impressive levels of proficiency, stealth, and readiness; one can reasonably assume that the lessons they learn spread rapidly and efficiently throughout the nuclear modernization process.

NC2 for SSBN Operations

To this point, this chapter has mainly addressed NC2 as a problem for the Second Artillery. However, as the next chapter will suggest, it is quite conceivable (contingent on the success of the “094” project) that the sea leg of China’s nuclear triad will receive renewed impetus in the new century. We now turn briefly to the specific problem of communicating with strategic submarines.

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DF-11 SRBMS

Source: Chinese Defence Today

A long-range submarine communications tower proved to be a major bone of contention during the Sino-Soviet dispute of the late 1950s. Mao resented as high-handedness a request by Moscow to build a naval communications facility on Chinese sovereign territory. After the Soviet technical advisers withdrew from China in 1960, however, Beijing pressed ahead with the long-wave station for its own use, using with materials and plans left behind. This facility began routine communications with PLAN submarines in mid-1965.⁵³

PRC researchers apparently made good progress in very-low-frequency (VLF) communications; Mao himself approved the construction of an extremely high-powered VLF station. Research was undertaken at Institute 722 in Wuhan, and completed in 1982; soon “the navy felt confident that its headquarters could communicate by VLF with its strategic submarines in all proposed operating zones.”⁵⁴ (Given the extremely limited operations of the *Xia* over the last two decades, however, that supposition seems doubtful.) Apparently anxious about the ability of advanced navies to home in on long transmission bursts, the PLAN also pursued “a high-powered microwave system that could communicate via space satellites.”⁵⁵ Accordingly, the General Staff and the Navy were given highest priority for satellite channels when China launched its first series of communication satellites in the mid-1980s.⁵⁶

Data on contemporary PLAN submarine communications practice is sparse. If China goes the route of other submarine powers, it is likely to pursue total redundancy for submarine command and control, relying on multiple means employing different physical principles. Extremely low frequency (ELF) communications have the advantage that messages can be received at depths of two to three hundred meters,

[Notes](#)

Mobile Satellite Communication



Source: Chinese Defence Today

maximizing submarine stealth and survivability. There are major problems with ELF in practice, however, and it is not clear that China has mastered that technology. In reality, most SSBN (peacetime) communications are, for efficiency's sake, conducted by high-frequency and very-high-frequency radio; submarines receive messages at periscope depth or by floated antennas. China will likely create a dedicated maritime aircraft squadron for communications with its submarine fleet, if it has not already done so. A lengthy profile in the Chinese journal of naval warfare, *Jianchuan Zhishi*, of the U.S.

舰船知识

Jianchuan Zhishi (Shipping Knowledge)

“Take Charge and Move Out” (TACAMO) air fleet, which supports American SSBN operations, supports the general conclusion that Beijing is determined to perfect its communications with its submarine fleet, as it launches a new generation of nuclear vessels.⁵⁷

Conclusion

It is evident that China now places a high priority on the command and control of its military forces. This emphasis reflects not only careful analysis of American military successes over the last decade but also occasionally painful lessons from China's own military history. Having a special sensitivity on nuclear matters that undoubtedly springs from having itself been subjected to nuclear threats, Beijing is poised to adopt a more robust NC2 posture.

There are very significant unknowns, one of them whether China will make the kind of investments in early warning that would be consistent with a launch-on-warning doctrine. A plethora of new strategic platforms and capabilities (ranging from mobile, solid-fueled ICBMs to a new generation of SSBNs), intensive training, and a wide variety of new communications technologies, together imply a shift to that strategic posture.

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Certain strategic benefits of upgraded Chinese NC2 should be particularly noted. The risk of accident, launch by rogue elements, or proliferation of technology to third parties is likely to be significantly reduced under the new, more sophisticated NC2 regimen. Conceivably, a Chinese nuclear deterrent that is more in conformity with superpower or peer-competitor practices, one that moves from minimal deterrence to credible deterrence, might make Beijing more amenable to arms control and moderate in its crisis behavior, based on observing the “principles” of mutually assured destruction. What is troubling, however, is the possibility that a more muscular nuclear posture, afforded additional flexibility by enhanced command and control, could encourage Chinese proponents of nuclear coercive and even limited war-fighting strategies.

China's Undersea Nuclear Deterrent: Will the U.S. Navy Be Ready?

CHRISTOPHER MCCONNAUGHY

We will have to build nuclear submarines even if it takes us 10,000 years!

MAO ZEDONG, 1959

There is a general consensus that China is rapidly modernizing its military. However, there is no clear consensus on what this modernization means to the United States.¹ While some analysts argue that focusing on specific Chinese nuclear capabilities without looking at the nuclear strategy debate behind those capabilities is too narrow, at some point capabilities must be reviewed to assess potential threats in order to provide a solid foundation for future force structure planning.² China's newest nuclear-powered ballistic-missile submarine, known as the Type 094, is no exception. The revelation in the open press during the late fall 2004 that the first prototype had been launched in July of that year underlines the imperative for such analyses, although the boat is not yet operational;³ that is especially true given that "the advent of truly reliable SSBNs capable of regular long patrols . . . would revolutionize [China's] second strike nuclear capabilities."⁴

There are no absolutes in the world of international relations and politics. It is, therefore, prudent to ask whether the United States will be prepared to counter given weapon systems. Defense planners cannot sit on the sidelines and wait for the resolution of a debate over a potential adversary's intentions.

Under many circumstances, the deterrence provided by SSBNs is a significant and credible strategic threat. From a purely military perspective, they have the capacity, quite literally, to change the world, by exacting severe destruction on whole societies. From a geopolitical perspective, by the threat of a strike from an SSBN skilled and determined statesmen can force another state to deal with their own on a level playing field however backward their own economy and ideology may seem to the other. In other words, a credible SSBN force could translate directly into political leverage in a

[Notes](#)

U.S.-China crisis. For China's navy, "the development of nuclear-powered submarines [has been] the chief objective of [the twentieth] century."⁵ All indications are that this priority on nuclear submarines will continue and even accelerate in the twenty-first century.

The United States advertises its ballistic-missile submarine fleet as the most survivable component of its nuclear arsenal, and for good reason. Nuclear power enables ballistic-missile submarines to stay submerged for weeks and even months, the only limiting factor being food for the crew. The submerged endurance of an SSBN allows it to patrol quietly in locations known only to its commanders, greatly complicating the tracking problem for those interested in knowing where they operate.

In principle, there are two methods for neutralizing the threat from a submarine-launched ballistic missile.⁶ The first is to employ a nuclear-powered attack submarine (SSN) to track and trail an SSBN and, at the instigation of hostilities, to destroy it before it can launch its nuclear weapons. In the unlikely event of an unexpected missile launch, the SSN would immediately eliminate the SSBN to prevent further launches. This method requires having available a sufficient number of SSNs (relative to the number of the enemy's SSBNs) to devote to such an undersea warfare campaign. The second method of countering SLBMs would be to establish a ballistic-missile-defense system to destroy any missiles after their launch. Significant advantages that the SSN enjoys over a ballistic-missile-defense system in this scenario include the facts that the SSN is proven technology and does not have to contend with decoys deployed by the ballistic missile.⁷

However, only a few nations, since the demise of the Soviet Union, possess the capability to track and trail an SSBN in blue water, and no nation can guarantee the destruction of intercontinental ballistic missiles in flight.⁸ SSBNs, accordingly, when properly operated and supported, provide a very robust, highly assured second-strike—or even preemptive nuclear strike—capability. For any state that seeks to have its voice heard in the world and does not want to be subjected to nuclear coercion, SSBNs are prized commodities—albeit so expensive that they are feasible only for the most determined and advanced aspirants.

Much has been written within the last decade on China's defense modernization, as if it had only recently begun. To the contrary, while China's defense modernization has not progressed equally within all areas, and its pace has been inconsistent—with a more rapid pace seen in the last decade, due to a newly opened intellectual climate and increased economic capacity—China has been modernizing and improving its strategic nuclear forces since their inception over four decades ago. As the editors of a recent

publication on the People's Liberation Army observe, "The Chinese military is anything but stagnant."⁹

China is only now reaching the point in the development of its nuclear arsenal that it can strike globally. The present articulation of the U.S. triad recognizes that today's conventional capability—through better technology—may be able to accomplish what would have previously required a nuclear strike.¹⁰ However, the United States cannot lose sight of the fact that nations like China lack the awesome, global, conventional strike capability that the U.S. military enjoys and so still place significant emphasis on their strategic nuclear forces. China recently achieved a limited capability to threaten the continental United States from deep in the central Pacific. Now a new, more capable SSBN, with a new SLBM of far greater range and accuracy, will be able to strike the United States from the relative safety and security of proximate waters.

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Xia (Type 092, Shrimp)

Still, it is easy to discount Chinese efforts at SSBN development and the threat that they may pose.¹¹ Currently, the *Xia*—which has recently emerged from an extended overhaul—is the only operational Chinese SSBN; The 094 is expected to become operational in the next few years—contingent on the successful development of the JL-2 SLBM.¹² Nevertheless, China's defense

巨浪二号

JL-2 (Great Wave)

modernization must be viewed in terms of contemporary China, not the backward political and economic practices of the past; the China of today is not that of yesteryear. China is enjoying a relatively stable social and political environment; its economy is thriving.¹³ In contrast with the period when China built its first generation of nuclear submarines, today its defense modernization is receiving a substantial amount of assistance from Russia. Naturally, China is trying to play catch-up. The U.S. Navy already had a strong conventional submarine program when it made the decision to build nuclear-powered submarines, and only when it had a firm footing in nuclear propulsion did it embark on submarine-launched ballistic missiles. China initially tried to do it all at the same time; now, however, it has emerged from those dark days.

There has been little written on China and its ballistic-missile submarine program, which is not surprising, given its slow progress and how little information there is upon which analysts can draw. In *China's Strategic Seapower*, however, John Wilson Lewis and Xue Litai provide a remarkably detailed and insightful analysis into the extreme challenges that China's nuclear-powered submarine (both SSN and SSBN) and SLBM projects faced. Lewis and Xue's work is a neglected resource that deserves the careful attention of American naval strategists. It makes the divergence between the China of the past and that of the future acutely clear. China's capabilities are changing—from its

Type 092 SSBN

Source: Chinese Defence Today

aggressive and widely watched, overarching, defense modernization efforts to the recent introduction of its newest nuclear-powered fast attack submarine, to China's first manned space flight, to a more mobile, more secure, and more lethal nuclear strike capability. The China of tomorrow will be radically different.

China wants a secure nuclear-strike capability and to do this is investing in road-mobile ICBMs and SSBNs. In 1997, General Liu Huaqing of China's Central Military Commission stated, "Fewer than ten percent of China's land-based missiles would survive a large-scale nuclear first strike; the less vulnerable SLBMs would preserve our nuclear counterattack capabilities."¹⁴ China is

displaying a patient and steady determination to produce a modern military with a viable and credible land-mobile and undersea nuclear deterrent that is worthy of focused study.

This chapter is written in two basic sections that reflect the distinct dichotomy between the struggling China of the past and the emerging powerhouse. The first part examines the development of China's nuclear-powered submarine program and, more specifically, the development of its first SSBN, the *Xia*. Relying heavily on the path-breaking research of Lewis and Xue, it offers technical detail to illustrate the tremendous difficulties China experienced in the production of its first submarines. Some would argue that it was an exhibition of gross incompetence in the Chinese defense industry; it would be more accurate to say that these were the first faltering steps of amateurs, not outright ineptitude. It is a safe and logical bet that Chinese technology will only continue to improve. The *Xia* experience was neither a great success nor a total failure. Above all, it was a down payment on China's robust nuclear future. Although the *Xia* has, for the most part, remained alongside the pier, China is now in a position to capitalize on the investment; it now has an indigenous capability to design and construct SSBNs and their SLBMs. China's future in submarines looks bright.

The second part of the chapter is a look at what the future may bring if a Sino-U.S. maritime and nuclear rivalry becomes more intense. Accordingly, it asks whether the U.S. Navy will be prepared to resume a more aggressive strategic ASW posture in the event that China does deploy a substantial SSBN force, as has been projected. Future advances in Chinese attack submarines, improvements in the education and training of

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the People's Liberation Army Navy, the number of Chinese submarines that already exist today, the geographic constraints of the Asia-Pacific region, the decline of the U.S. Navy's antisubmarine warfare (ASW) capability, and the expected reduction in the number of American SSNs are all variables here. This chapter reaches the preliminary conclusion that the U.S. Navy will be ill prepared to execute strategic ASW against China in the coming decades unless the atrophy of its ASW assets is not only stopped but reversed.

China's First Generation SSBN: Failure or Foundation?

It is true that our country is very poor. But even a poor man needs a stick to drive away a dog.

CHINESE FOREIGN MINISTER CHEN YI, 1962

A Grand Vision

I felt that the Bureau of Ships had in the past been so restricted in their design studies by contradictory instructions concerning characteristics that it was impossible for them to produce the best submarines. . . . First, they designed a hull and then every person in the Department began to stuff it from both ends. In the old days, design became a four ring [*sic*] circus. The Bureaus of Ordnance, Engineering, Navigation and Construction and Repair all vied with one another to get their own pet projects included.¹⁵

Rear Admiral Charles B. Momsen made this statement in 1948, during the design of the USS *Albacore*, the U.S. Navy's first submarine with a teardrop-shaped hull. His observation reflects how bureaucratic organizations can unnecessarily complicate what should, ideally, be a purely scientific endeavor. China's first experiences in submarine design were different only in the extremes to which the domestic and organizational politics interfered.

The pace of the Chinese SSBN and SLBM programs has been excruciatingly slow by Western standards. On the other hand, when viewed within the context of a developing nation that at the beginning of its quest possessed only a rudimentary indigenous defense industry and no capacity for nuclear reactor, submarine, or ballistic-missile production, the performance is rather remarkable. China has built—from square one—a formidable, albeit still incomplete, military-industrial base in less than half the time that the United States and other Western powers have had to develop their own.

Great Leap, Cultural Revolution, and Third Front

The Chinese defense industry owes its existence to the SSBN and strategic weapons programs.¹⁶ In July 1958, a nuclear-powered ballistic-missile submarine project (Project 09) and submarine-launched ballistic-missile project (the JL-1, Project 05) were authorized, though China did not possess the military, industrial, or scientific capacity for

[Notes](#)

such ambitious undertakings.¹⁷ If the lack of both intellectual and physical resources were not enough, from 1958 to 1960 China had to endure Chairman Mao Zedong's misguided Great Leap Forward, in which Mao set aside all rationality in an attempt to exceed British industrial production levels within fifteen years. The social turmoil just before and during the Great Leap severely impacted the SSBN and SLBM projects, to the point that their "defense scientists and engineers were devoting less than half the day to professional work."¹⁸

On the heels of the failed Great Leap, from 1966 to 1976, came Mao's Cultural Revolution. Supported by Mao, "radicalized technicians and workers in the research organs under the [Defense Science and Technology] commission berated, persecuted, and then sundered the relations between senior scientists and leadership cadres, between the technical community and the policy makers."¹⁹ Political upheaval, social unrest, and cuts in spending were not the limits of the damage done by the Cultural Revolution. Mao, in an effort to purify the Chinese Communist Party, demanded that "reactionary leading academic figures" be tracked down.²⁰ The violence resulted in numerous casualties in the submarine and ballistic-missile research communities, including the director of Institute 703, Yao Tongbin, who was responsible for JL-1 materials testing.²¹ Mao's Cultural Revolution was to blame for the suicide and killing of personnel involved in the strategic weapons programs, lack of funding for equipment and facilities, poor working conditions and diet, the destruction of equipment, distrust in political leaders, poor quality in materials and workmanship, and outright warfare among technicians.²² In 1966, defending the premises of the Cultural Revolution, Lin Biao, Vice Chairman of the Central Committee, stated, "It stands to reason that a cultural revolution should accelerate production, and this has been borne out by the facts."²³ Quite to the contrary, China's Cultural Revolution, in addition to the enforced geographic separation of various organizations involved (as will be seen below), resulted in a ten-year stagnation of the JL-1 project.²⁴ Mao's belief "that men equipped with correct political ideas were more important in war than weapons" turned the Chinese defense industry on its head and cost China dearly.²⁵ Mao is generally regarded as a military genius—historians place him alongside the likes of Clausewitz, Sun Tzu, and Jomini—but his capability as a leader in war did not translate well into success as a statesman. With respect to national security, Mao's methods were, ironically, of greater benefit to China's potential adversaries than they were to China.

As if political, social, and economic turmoil were not enough, the research and development phases of the SSBN and SLBM projects were fraught with inefficiency and contradiction. Mao ordered the creation of a "Third Front," by which virtually the entire Chinese defense industry was moved to the interior, far from the coasts, to guard against attack.²⁶ This effort began in earnest in 1965; ultimately 483 factories and

ninety-two research academies were constructed “on the Third Front,” and 1.6 million workers were transferred to China’s interior from the coastal areas.²⁷ The economic costs and the delays resulting from the Third Front effort were staggering.

Marshal Nie Rongzhen, in overall charge of the strategic submarine and missile programs, appears to have severely underestimated their magnitude and complexity. The talent and expertise required to design and produce an SSBN is not abundant in the most technologically advanced societies today, let alone the relatively backward China of the 1960s. Nevertheless, Nie chose to pursue a competitive strategy, assigning two separate organizations to perform research and development. This diluted the small pool of scientists and engineers as well as of material resources.²⁸

From 1958 until the first successful submerged test launch of the JL-1 SLBM in 1988, the various organizations involved went through countless restructurings.²⁹ This was part of a larger pattern in which China’s political system favored organizational “solutions” for R & D problems. Yet the reorganizations were often ineffective: they failed to get to the root cause of the problem and did not produce the desired progress: “The logic of the times was to destroy the system in order to save it.”³⁰

If China has been persistent in its efforts to produce both nuclear-powered attack and ballistic-missile submarines, that desire has wavered at times. When it was recognized that design and production were not going to be speedy, some demanded that the projects be discontinued. General Luo Ruiqing, the director of the National Defense Industry Office (NDIO) wanted to see Project 09 terminated, arguing in a remarkable moment of candor that China could not produce a diesel-powered submarine, let alone a nuclear-powered one. Opposing Luo, the Chinese foreign minister, Chen Yi, argued that for the sake of national security the effort should continue, regardless of the time it required.³¹ Project 09 research continued but was downsized substantially in August 1962. Unrestricted design and production did not resume until August 1965.³²

Research and Development

Considering that China was creating its technological and industrial base from scratch, and on the back of the strategic weapons program, it is not difficult to see why the learning process was painfully long.³³

Nuclear Power. Aside from the political climate, Project 09 engineers faced daunting obstacles in the design and development of the first submarine nuclear reactor plants. The work was as problematic as one might expect an initial foray into nuclear-reactor design and construction to be. The first reactor design was completed in 1960 and then went through numerous iterations.³⁴ The two organizations tasked by Nie for reactor plant design, the Qinghua University Institute of Nuclear Energy Technology and the

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Reactor Engineering and Technology Institute (Institute 194), under the Second Ministry of Machine Building (nuclear industry), gathered what information they could on foreign designs and made separate proposals. Qinghua University promoted a design based on a German nuclear-powered ship, the *Otto Hahn*; Institute 194 favored a design based on the Soviet icebreaker *Lenin*.³⁵ The decision between the two proposals was based not on their merits and suitability for submarine operations but on the political clout of the two agencies. Institute 094 had more, and in 1965 the *Lenin* design was selected.³⁶

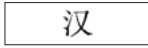
The Institute 194 designers were to encounter difficulties with, among other things, control-rod drive mechanisms, nuclear instruments, reactor instrumentation, and the steam generator.³⁷ The physics calculations were completed by hand, which required an extraordinary amount of time; they had to be repeated with each successive modification to the plant design.³⁸ The uranium-235 fuel concentration for the reactor plant was enriched to only 3 percent, meaning that the Chinese submarine would require more frequent refueling than American submarines.³⁹

The initial stages of the reactor development, under Institute 194's Reactor Engineering Research Section, were difficult at best. Working conditions were poor; worse, "young and inexperienced technical personnel . . . [were] left . . . to their own devices, without any data, experimental equipment or computers."⁴⁰ Counting on Soviet assistance, China had placed little emphasis on the development of indigenous support capability for nuclear research and manufacturing. When Soviet assistance was withdrawn in 1960, the Chinese were no longer able to focus exclusively on production and instead had to step back and try to fill the void left by the departed Soviets.

Successful operation of a prototype reactor, to verify the validity of the design, was a prerequisite to the installation of a submarine unit.⁴¹ The sense of urgency in Project 09 to get the first attack submarine to sea is amply evident in the fact that China opted to design and build prototype and submarine reactor plants simultaneously.⁴² From an engineering perspective, failure to evaluate a design properly prior to the manufacture and operation of the final product is an invitation to disaster. This is especially true in the world of nuclear engineering, as the Chinese apparently learned the hard way at an early stage.⁴³

The exact dates are unclear, but sometime around 1970 the prototype reactor was tested at its full rated power.⁴⁴ The engineers experienced difficulties with test instrumentation, pulse tube leaks, and secondary valves. Further design problems were encountered with the reactor safety set-points, which apparently caused several unwarranted automatic shutdowns.⁴⁵ The design, construction, and testing of China's first prototype nuclear reactor was to take twelve years.

China also had, from the beginning, major difficulties with the submarine reactor plant. Initial criticality of the SSN reactor plant and the maiden voyage of the attack submarine on which it was fitted, the *Han*, occurred in 1971. During sea trials (which were not completed until 1974) and thereafter, “severe problems” were encountered with the reactor plant.⁴⁶ These included high radiation exposure to the crew; leakage in the steam generator from the primary water circuit to the secondary, with the result that radiation was detected in the secondary system drains; primary system valve leakage; and steam line ruptures. These persistent problems—as well as corrosion, steam leaks from the steam generators, and defective pumps, main condensers, and main reduction gears—demonstrated that the Project 09 engineers had much to learn about materials and precision design and construction.⁴⁷ The PLAN accepted the *Han*—designated hull number 401—in August 1974, but it could hardly be considered fully operational. China incorporated design modifications in the second *Han*-class unit, hull number 402, commissioned in 1977, but many of the original problems persisted.⁴⁸



Han (Han Dynasty)

The Submarine: Hull and Interior Arrangement. The design and construction of the submarine itself was no less difficult. China decided to complete its first nuclear-powered submarines as attack boats, due to the time required to develop the JL-1 missile and an SSBN launcher system.⁴⁹ When the Soviet Union terminated its assistance in submarine design and construction, the Chinese, as in the reactor project, turned to other external sources to fill the void. Huang Xuhua, the chief designer for Project 09, summed up their attitude: “To derive nourishment from others’ experiences . . . you can get twice the result with half the effort if you know how to pick others’ brains.” (Some argue that this practice continues to this day, as is consistent with a Chinese proverb, “Stones from the other hills may serve to polish the jade of this one—advice from others may help one overcome one’s shortcomings.”)⁵⁰ Accordingly, Chinese engineers adopted the teardrop hull shape of American and Soviet nuclear submarines and chose to construct a double hull similar to those of Soviet boats.⁵¹

High-quality welding, to conjoin hull plates and attach interior and exterior equipment and fittings to the hull, is absolutely critical to the survival of a submarine. Chinese engineers and shipyard welders had serious difficulties; numerous weld failures on the hull resulted from improper welding techniques and equipment. The engineers might have been expected to determine the causes of the defective welds and provide solution to the welders, but they did not; the welders were left to conduct experiments on their own and devise a method for heat-treating steel hull plates.⁵² China’s first submarine hull, accordingly, was not a product of exceptional Chinese engineering or first-rate

ship construction; quite to the contrary, China's first nuclear submarine hull was a product of trial and error.⁵³

In keeping with the trial-and-error "principle," engineers at the Bohai Shipyard (Plant 431) did not have a sound plan to fit out the submarine. In fact, construction of the hull commenced before the layout of interior subsystems had been completed. The risk was not to the basic hull shape but to the configuration of compartments, hull openings, bulkhead penetrations, and interior supporting structures. Although limited use was made of a wooden scale model, pipefitting was completed and subsystems were installed by the "best guess" method. Not surprisingly, in view of the inevitable numerous rearrangements, the builders encountered a great degree of difficulty in calculating the boat's center of gravity and center of buoyancy.⁵⁴ In general, the manner in which the Chinese constructed their first nuclear-powered attack submarine suggests a deep urgency in the minds of the Chinese leadership, which continued to push forward regardless of unresolved technical issues.

The Submarine: Sound Silencing and Combat Systems. The stealthiness of a submarine—its ability to stay hidden from an adversary—depends a great deal on the noise it emits. The engineering, manufacture, and operation of the submarine determine how much or how little noise it will radiate into its environment. The Project 09 engineers recognized the need for silencing and took measures to limit the noise level of their submarines, such as mounting equipment on pedestals and covering the equipment with sound-absorbent material.⁵⁵ Other factors considered were the number of hull openings, flow noise through internal piping and over the hull, and screw cavitation.⁵⁶

Ideally, weapons systems are designed to meet particular needs, specified prior to construction. This was not the case in China's SSN and SSBN development. For the SSN, it was not until 1966, eight years after the decision to build the nuclear submarine, that China's Defense Science and Technology Commission identified the type's desired functions. Neither was the SSBN the product of a rational strategic debate. Mao saw in the unlimited Soviet assistance then available simply an opportunity to acquire a weapons system that might prevent other states from taking further advantage of China.⁵⁷ Failure to identify specific capabilities required of the submarines proved detrimental to their development.

One area in which this failure would manifest itself was in combat systems. Torpedoes were the *raison d'être* of SSNs. The principal mission of the an attack submarine is attack, and to carry out an attack, it requires torpedoes.⁵⁸ China's torpedo development, however, lacked focus. Gas-powered torpedoes, electric-powered torpedoes, rocket-assisted aerial torpedoes, torpedoes with passive acoustic homing, torpedoes with active and passive acoustic homing, torpedoes for surface targets, and torpedoes for

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deep-water submerged targets—all were given consideration at one point or another from the early 1960s until 1989, when China believed it had finally fielded a weapon comparable to Western torpedoes, the Yu-3.⁵⁹ As a further example, the director of China's Seventh Academy (and subsequently commander of the PLAN), Liu Huaqing, instructed his engineers "to copy a Soviet model torpedo for missions against surface targets. Although Liu's experts understood that the principal prey for the torpedoes of the future would be submarines, not surface ships, they accepted the assignment and made it one of their top priorities."⁶⁰ The consequence of this haphazard approach to the torpedo—the sine qua non of the SSN—was that the *Han* did not have a capable torpedo until 1989, fifteen years after its commissioning.⁶¹

The Ballistic Missile Submarine and the JL-1. A preliminary design for the SSBN was completed in 1967, with the intention of launching a boat in 1973.⁶² The major difference between the attack submarine and the ballistic-missile submarine, of course, was the addition of the missile compartment. For that reason, China's first SSBN encountered many of the same problems, with the reactor plant and combat systems, that the attack submarine endured in addition to those of the launching system and the SLBM itself.

By March 1964, when the JL-1 project was initiated, China had been working on missile technology for nearly eight years.⁶³ In 1967 China, perceiving the vulnerability of its fixed land-based strategic-missile systems to satellite reconnaissance, decided to focus more of its efforts on road-mobile missiles and SLBMs.⁶⁴ Today, China's basic missile technology seem fairly robust and at least moderately successful.⁶⁵ At the time, however, the crucial differences between an SLBM and a land-based missile created technological hurdles that the PLAN could not easily or quickly overcome. Like the U.S. Navy, China explored liquid fuel for its first SLBM.⁶⁶ When the Soviets withdrew, China, noting the progress of the U.S. Polaris Missile Program, decided to pursue solid-propellant technology for the JL-1. Solid rocket propellant, therefore, was one of the first obstacles the program encountered.⁶⁷

Unlike a land-based missile, an SLBM must be ejected from the missile tube underwater to a point above the surface, from a depth that can vary with each launch. Moreover, if a ballistic missile is to strike a target, its guidance system must be given the precise location from which it is being launched. For a land-based missile this is for the most part a static problem; even with a road-mobile system, technicians can determine the launch location with relative ease. In contrast, the SLBM requires dynamic information; its position is continuously changing up to the moment of launch.⁶⁸ Lastly, once the missile is above the surface, its motor must ignite. At that point, as for its land-based counterpart, guidance and flight control systems must put the missile on target with an accuracy inversely proportional to the yield of its warhead.⁶⁹

China's initial work on solid rocket propellant began in 1956; the designs for the JL-1, including the motor, were finalized in 1967.⁷⁰ As for the SSBN, the work on the JL-1 proceeded by trial and error, and it was not until 1980 that the Chinese engineers developed a satisfactory motor.⁷¹ Chinese engineers working on the project moved through a series of stages, starting with a sixty-five-millimeter-diameter design and then trying 300 mm and 654 mm approaches before settling upon the 1,400 mm design ultimately utilized in the first- and second-stage motors of the JL-1.⁷² The designers had to overcome challenges presented by the motor's chemical composition, the star-shaped hollow core needed for even burning, case-bonding of the propellant to the motor casing, plastics, high-strength steel, heat shields, adhesives, nozzles, and thrust-vector control—to name only a few problem areas.⁷³

Chinese engineers chose "to copy foreign models as best they could" for the JL-1's guidance system, but finally adopted the guidance system of the JL-1's land-based DF variant.⁷⁴ The guidance system, which used inertial navigation, was capable of in-flight course corrections only in the boost phase, not in the missile's ballistic phase.⁷⁵ China's choice to shoot the SLBM from a moving (vice a hovering, static) submarine created additional problems.⁷⁶ The flow of water over the hull during a launch sequence subjects an SLBM to forces perpendicular to the desired direction of travel. The designers apparently found that the missile could be pushed as far as sixty degrees from the vertical; they had to ensure that the launcher and the missile's flight controls could compensate for the induced error.⁷⁷ The functional gyros this required were not completed until 1976, and an adequate attitude-control system was not available until 1980.⁷⁸ Two years later, the JL-1 was successfully launched from a surfaced Golf-class submarine.⁷⁹

The End Result

As a result of such technological challenges, as well as of political and organizational upheavals, China did not conduct a successful submerged launch of the JL-1 from the *Xia* until 1988—a full thirty years after the decision to build China's first SSBN, and fifteen years after the intended launch date of the *Xia*.⁸⁰ The question remains of China's ability to effectively operate such a complex piece of machinery—especially in the face of advanced ASW forces. It is believed that the *Xia* has had very little time at sea and that, hence, its operational readiness is highly questionable.⁸¹ It seems that the years of struggle to provide China with a more secure nuclear strike capability produced in the end a submarine of marginal value, an SSBN that has been brushed off as a nonthreat.⁸²

The *Xia* itself, as a weapons platform, is much less significant than the process by which China built it, developing a physical and intellectual infrastructure that have enabled the state to continue its forward progress. The launch in December 2002 of the Type 093 attack submarine, the successor of the *Han* class, and in July 2004 of the first follow-

on to the *Xia* are telling indicators of how far China's technology has advanced—though the boats' true capabilities are likely to remain a mystery for some time.

Strategic ASW and the U.S. Navy Today

One would like to destroy these missiles or the means of launching them before they are launched, if possible, and if so launched we would like to destroy the missiles immediately and then get those that have not been launched. In other words, missile destruction is considered as associated with the antisubmarine warfare program.

ADMIRAL HOOPER

DIRECTOR OF ASW RESEARCH AND DEVELOPMENT, 1965

Strategic ASW

During the Cold War, American and Soviet submarines engaged in a high-stakes underwater contest.⁸³ Nuclear-powered attack submarines pursued ballistic-missile carrying submarines. The mission of the SSNs, in the event of hostilities between the United States and the Soviet Union, was to destroy the SSBNs—preferably before any SLBMs were launched. Owen R. Coté, Jr., labels the period of time between 1945 and 1990 the “Third Battle” of undersea forces, one in which both the United States and USSR invested heavily in undersea technology, each side trying to maintain qualitative or quantitative advantages.⁸⁴ Coté describes the little-studied topic of *strategic* antisubmarine warfare—ASW directed specifically at submerged strategic weapons carrying platforms, the SSBNs. Generally, ASW involves, as the term suggests, the detection, location, and destruction of submarines; it has been pursued in a variety of ways since the introduction of the submarine. Strategic ASW, however, is a product of the nuclear age.

Were hostilities to break out between two countries in possession of SSBNs, the goal of their respective attack submarines would be to eliminate the other's SSBNs—that is, the SSNs would be conducting strategic ASW. Conversely, the goal of the SSBNs would be to remain undetected and able to launch their SLBMs if so ordered. Strategic ASW requires SSNs to shadow SSBNs, to track them continuously, utilizing cues from such sources as satellite imagery, antisubmarine aircraft, and fixed, passive underwater acoustic arrays.⁸⁵ Since the demise of the Soviet Union, the U.S. Navy has not had to face a peer competitor underwater, and consequently its ASW skills and capabilities have atrophied.⁸⁶ They have also declined, in part, due a reduction in funding as increased emphasis is given other mission areas, such as power projection ashore.⁸⁷ Today the U.S. Navy is forcing a greater emphasis on antisubmarine warfare by the creation of a new Fleet ASW Command, but funding remains a critical issue. For example, the

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Navy recently announced that it will reduce the size of its P-3C Orion maritime patrol aircraft fleet by one-third, due to funding shortfalls, airframe fatigue, and the need to fund the next-generation ASW aircraft—the Multimission Maritime Aircraft (MMA).⁸⁸ September 2003 remarks of the Commander, Naval Submarine Forces, reflected the U.S. Navy's shift from open-ocean ASW to operations in contested littorals and to strike warfare.⁸⁹ In the words of Owen Coté, "Geopolitics and technology are conspiring to pull the Navy ashore from the sea, without eliminating the traditional and *irreducible* need for a navy that is capable of controlling the sea."⁹⁰

Scholars, analysts, and government officials all seem to believe that the years 2005–10 will see the emergence of China's newest SSBNs. It is time to give antisubmarine warfare once again the energy it had during the Cold War, to ensure that the United States has an adequate number of submarines and other ASW assets in the coming decades to ensure its security. Once the new Chinese Type 094 SSBNs become operational, world events could oblige the United States to hold them at risk of immediate destruction, as was once done against the Soviet Union, when strategic ASW was a national mission of extreme importance.⁹¹ In those years, sizeable resources were sunk into developing and deploying attack submarines, maritime patrol aircraft, surface-ship ASW capability, and undersea sound monitoring. For much of the Cold War, these resources were employed (as will be seen in more detail below) in an effort to create a barrier that would prevent Soviet SSBNs from coming close enough to the continental United States to launch a nuclear strike that would arrive on short notice. American strategic ASW capability evolved through improved technology and better operational practices that optimized all components that could be brought to bear—air, surface, and subsurface. The American civilian leadership and the Navy recognized the nature and seriousness of the threat and, accordingly, gave a high priority to strategic ASW. Today there is a danger that U.S. strategic ASW capabilities, so formidable a few decades ago, will not be up to the task if called upon again.⁹²

China's Advance

Since 1991, when the Soviet Union dissolved, the U.S. Navy has enjoyed the benefits of its Cold War investment in ASW, because there has been no serious competitor for undersea dominance. Today that situation is changing. China is gradually emerging as a serious undersea power. As U.S. ASW capability has withered, Chinese diesel submarines are becoming extremely difficult to detect and, consequently, more lethal. In the world of nuclear-powered submarines, China's technology is also improving. Unlike the notoriously noisy *Han* class, the Type 093 is estimated to be acoustically comparable to the Soviet Victor III.⁹³ Certainly, the 094 will benefit from the improvements in the 093.⁹⁴ The introduction of the Victor III in the mid-1980s, it has been argued,

marked the end of the U.S. Navy's "happy time": "The Victor III was the first Soviet submarine that surprised the Navy with its acoustic stealth, and its deployment was a harbinger of worse to come."⁹⁵ The Soviet Victor III was the forerunner of the Akula, "the first Soviet submarine that approached or achieved acoustic parity with its American contemporaries."⁹⁶

Granted, that was two decades ago; the U.S. Navy has continued since then to upgrade its own submarine technology while China is still trying to catch up. Nonetheless, it is likely that the second generation of Chinese nuclear submarines will represent a "great leap forward."

Limits, and Narrowing the Margins

There are limits to the levels of quietness and sound detection that can be achieved, due to the nature of technology and the inherently noisy environment (especially in the littorals) in which submarines operate. The improvements seen today in submarine technology today are minor compared to the enormous advances between the USS *Holland* and the USS *Los Angeles*.⁹⁷ An analogy can be drawn with advances in automobile racing cars over the last century. The world saw in the vehicle that propelled A. J. Foyt to his seventh national Indianapolis 500 car championship in 1979 major advances in performance over the cars that Henry Ford raced in the early 1900s—so it was with the *Los Angeles* and the *Holland*. However, the difference in performance between the car that A. J. Foyt drove and those raced today is minor—hundredths of a second rather than the hours that would have separated Ford and Foyt had they raced against one another. The difference between winning and losing comes down to driver experience and proficiency. Likewise, in an undersea contest between two modern submarines, experience and proficiency are likely to be the decisive factors. In a comparison between the United States and China, the U.S. Navy still has a major advantage, but, as with racing cars, occasionally a rookie pulls off a win. Barring some unforeseen technological breakthrough, the days of major advances in acoustic detection are gone; designers now tweak systems to gain that "hundredth of a second" advantage.

China's purchase of advanced Russian-built Kilo-class diesel submarines (SSK) represents much more than a mere increase in its number of attack submarines; it has afforded China the opportunity to improve the silencing and combat systems of the indigenous *Song*-class diesel boats and, surely, its new nuclear-powered boats as well.⁹⁸

宋

Song (Song Dynasty)

Unlike during its first foray in nuclear submarine design and construction, China is now receiving assistance from Russia—a great deal of it—and its SSBNs will certainly benefit.⁹⁹ Even without Russian assistance, however, advanced computer technology is widely available today. The last two decades' exponential improvement in microprocessor performance has

Kilo-Class SSK

Source: Chinese Defence Today

allowed designers rapidly to shrink margins in performance. According to the Defense Department's 2003 annual report to Congress on the PRC, "China will continue purchasing foreign technology to improve quieting, propulsion, and submarine design. China also will benefit from the maturation of its domestic submarine research and development infrastructure to achieve a capability to design and manufacture modern submarines domestically."¹⁰⁰ The Chinese defense industry that is building the 094 SSBN is without a doubt far more capable than the one that struggled with the *Xia*.

What We Know and What We Don't Know

Regarding intelligence estimates, Michael I. Handel asks, "How can anyone know, in a world of secrecy, deception, and subjective perceptions, that his estimates of the enemy's strength are correct?"¹⁰¹ Not surprisingly, estimates concerning China's future SSBNs vary considerably, but they are all in agreement that China will have an improved undersea nuclear strike capability in the very near future.¹⁰² Nonetheless, Handel's point is well taken, in the sense that the consequences of not being prepared to hold a future Chinese SSBN fleet at risk make it prudent to hedge one's bets.

If China's early SSBN and SLBM programs suffered from political and social upheaval and a lack of physical and intellectual infrastructure, this is not the case today. China enjoys political and social stability, its economy is blossoming, and the costs of the necessary infrastructure have been paid. These factors enable China to pursue, at the construction and design levels, its own highly competitive "Indy car." China is making parallel improvements in both its officer and enlisted training. Also, notably, a

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submariner, Admiral Zhang Dingfa, now leads the PLAN, which suggests that a greater emphasis will be placed on the submarine force.¹⁰³ Further, in the fall of 2004 Admiral Zhang was given a seat on the Central Military Commission, and as a result a submariner now has a voice in China's most important national security decision-making body.

The U.S. Defense Department reported in 2003 that "training and exercise activity [of the PLAN] in 2002 was robust"; exercises were conducted in the South China Sea utilizing air, surface, and subsurface assets. Close observers of China's submarine force have stated that the PLAN is in fact undergoing a training revolution—joining the rest of the PLA in moving from rote, scripted exercises to "confrontational training" that encourages innovation and on-the-spot decision making.¹⁰⁴ To become effective and potent, the PLAN submarine force needs to make regular use of instrumented ranges for weapon shots at sea, and its crews—both of attack and ballistic-missile boats—need, when not deployed, regular sessions in attack training centers in realistic simulated environments.¹⁰⁵ This would be especially important for China's SSBN crews, who currently have little, if any, time at sea. Indeed, China has established training centers where PLAN personnel, including submariners, can train ashore in their respective warfare areas.¹⁰⁶

Should Washington Be Concerned?

The increased emphasis within the U.S. submarine force on strike, special operations, and intelligence, surveillance, and reconnaissance raises the question of whether the U.S. Navy will be able to perform strategic ASW missions adequately in the future. Given enough time, however, it is easier to train than acquire an adequate force structure; therefore, the U.S. Navy's ASW forces are the real question mark. Because it is impossible to predict the future, it cannot be said with any certainty what the future holds for Sino-U.S. relations. The United States could, however, confront a China that seeks a much more prominent position on the world stage and is not willing to bend to Washington's wishes. Indeed, initiatives by the pro-independence movement in Taiwan during the winter of 2003–2004 led China once again to make very public and deliberate statements that it is willing to go to war to prevent Taiwanese independence, even if that means suffering a setback in its economy and sacrificing the 2008 Olympics, which are to be held in Beijing. This seeming willingness to bear such costs is contrary to what some analysts have argued.¹⁰⁷

It is widely agreed that a war between Taiwan and China could involve the United States, although it is entirely possible that the United States and China will never come to blows—and, yes, China's economic growth and integration into the world could lead to peaceful and prosperous coexistence between the United States and China.¹⁰⁸ Still, the cost of preparedness for strategic ASW would be minuscule compared to the

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catastrophic costs of being surprised by a potent new Chinese SSBN capability—especially in the midst of a crisis.

A Worthy Opponent?

There is a certain apparent reluctance to take the Chinese submarine force seriously. Regarding the current and future capabilities of the American submarine force vis-à-vis China, one U.S. submarine captain wrote, “You can buy the very best subs, you can study the lessons learned by others and utilize the training methods of the very best, but still it will take *many* years of internal growth to produce an effective submarine force.”¹⁰⁹ With respect to a conflict between the United States and China over Taiwan, he writes, “China could put its entire [submarine] force to sea around Taiwan and the U.S. will still be at risk to lose one or two platforms (if only to bad luck). However, our [the U.S.] submarine force alone would *easily* be able to go in and destroy the Chinese sub force.” He believes that China will not, within the next ten years have a submarine force capable of competing with the U.S. submarine force as a peer competitor although, “the [submarine] force they are building will *increase* the risk of U.S. losses . . . in the future.”¹¹⁰ Referring to a possible conflict over Taiwan and to the recent purchase of eight Kilo-class submarines, he states, “If the political will of the U.S. holds and there is a willingness to accept the loss of a few ships or submarines, then the outcome of the battle is not in question—[the United States would triumph]. But if U.S. [leaders] are not willing to have even one U.S. submarine or ship [sunk] then we have already lost the battle and they [the Chinese] might as well stop at four Kilos vice eight.”¹¹¹

The latter point, concerning losses, is an important one that deserves careful consideration in light of the impending deployment of larger, more capable Chinese SSBN fleet. It implies that were a conflict between the United States and China over Taiwan to erupt when China possesses more capable attack submarines, American SSNs and other antisubmarine assets might not be able to guarantee the safety of high-value forces, such as aircraft carriers. If the SSNs could not protect aircraft carriers, it is likely that they could not perform strategic ASW either. For that reason, though confidence in the capabilities of the U.S. submarine force is not unwarranted—it is undeniably the strongest submarine force in the world today—a note of caution is prudent and necessary.

Simply in terms of numbers alone, the entire Chinese submarine fleet—currently numbering approximately sixty-nine—could put the U.S. submarine force to the ultimate test.¹¹² Other significant complications would be knowledge of the local acoustic operating environment, the shallow water of the Chinese littorals, a hostile merchant and fishing fleet, and mines. The experience of the Royal Navy during the Falklands

War provides ample evidence of the difficulty that diesel-electric submarines represent for antisubmarine forces.

In 1982, Argentina possessed four submarines of varying capability. Only one, the *San Luis*, could conduct offensive operations against the British task force. Facing that single submarine were elements of NATO's North Atlantic ASW force, Antisubmarine Group 2, arguably one of the most experienced in the world at the time. Nonetheless, the Argentinean boats were able to conduct two attacks on the British task force (both of which failed, but only due to weapon malfunctions). Local acoustic conditions rendered British forces helpless; they released over 150 weapons but scored no hits. According to the captain of the *San Luis*, "There was no effective counter attack. I don't think that they knew we were there until they heard our torpedoes running." The implication is that every weapon expended in the British ASW effort was fired at false targets.¹¹³

The Royal Navy was fortunate in that the weapons of the lone Argentine submarine failed. In a face-off with China, odds are that not every weapon on every PLAN submarine would do so. The U.S. submarine force would be further stretched to its limits if Chinese SSBNs were involved. The United States would undoubtedly prevail, albeit at some cost, in a series of sub-on-sub engagements. If, however, China chose to threaten the United States with nuclear weapons—even if as a bluff—the U.S. Navy could have difficulty, with the number of attack submarines it is projected to have, in holding even a small Chinese SSBN force at risk.

The United States cannot afford to become overconfident in its ability to cope with China. Prominent analysts like David Shambaugh believe that China will be hard pressed to catch up to the technology of the West;¹¹⁴ certainly, China's submarine force would pose a greater threat to the U.S. Navy were its capabilities equal. However, because of the nature of undersea warfare, with its complexities and variables, and of SSBN operations in particular, China does not have to catch up with the West to be a serious threat to the United States in a conflict.¹¹⁵

Is Ballistic Missile Defense the Answer?

It will be many years before U.S. ballistic-missile defense (BMD) will be capable of providing the level of protection required to counter the Chinese nuclear forces of today, let alone those of ten or twenty years from now. The JL-2 SLBM, as well as other mobile land-based Chinese ICBMs, will have (or already have) multiple independently targeted reentry vehicles (MIRVs).¹¹⁶ Multiple warheads on each missile and the dozens of ballistic missiles that China is already capable of launching could deliver an attack that any BMD system would find exceedingly difficult to counter with 100 percent accuracy.¹¹⁷ Even were a future ballistic-missile defense system thought capable of intercepting all

attacking ballistic missiles, with their multiple warheads and decoys, it would be folly to rely on that technology alone—the United States would be putting all of its eggs in the BMD basket. Perhaps when U.S. BMD becomes a reality, American SSNs could increase its effectiveness in a conflict by containing the Chinese submarine force within a geographic area, such as the Yellow Sea, enabling the defenses to focus on that single vector. But until that time, it is incumbent upon U.S. planners to ensure that the defense against ballistic missiles is a layered one, in which strategic ASW is the first line. In the words of President John F. Kennedy, “Until technology permits the deployment of an effective defense against submarine-launched ballistic missiles, the principal measures of protection should be provided by the capability to attack prior to launch.”¹¹⁸ Kennedy advocated the ability to hold Soviet SSBNs at risk of destruction through a stronger ASW capability, and his words still have relevance today.

Will the U.S. Navy Be Ready?

Despite the advances in submarine technology and antisubmarine warfare over the past fifty years, the conclusions of a study conducted in the 1950s still hold true today. “Confronted with quiet submarines of long endurance, a sufficiently accurate means of navigation, and suitable weapons, a defense against shore bombardment by submarines becomes a huge problem. Even the partial defense of a long coastline requires a very large effort.”¹¹⁹ It would be a mistake of the greatest magnitude for the United States to allow itself to be caught shorthanded and unprepared, especially where China’s decidedly mobile and capable nuclear forces are concerned. If the United States itself does not want to be subjected to the “nuclear blackmail” that Mao complained of so bitterly, whether today or in the future, Washington must once again elevate strategic ASW to a national mission.¹²⁰

The recently retired commander of naval submarine forces, Vice Admiral John J. Grossenbacher, believes that if at least two *Virginia*-class boats are not built per year, the U.S. Navy’s fleet of SSNs will decline to thirty submarines.¹²¹ Vice Admiral Grossenbacher argues that American SSNs would then no longer be able to meet the demands placed on them. As of early 2005, leadership of the Defense Department appears to have made a definitive decision against this plan, and has opted to build a single SSN each year.¹²² In the defense arena, a significant amount of time is needed to make ideas reality. The time to begin construction of a larger, more robust fleet of nuclear-powered attack submarines has already arrived.

If relations between the United States and China deteriorate, will there be enough SSNs to maintain continuous contact with a growing fleet of Chinese SSBNs? Many factors must be considered. How many SSBNs would China be able to keep deployed simultaneously? How long would they stay deployed? Would each SSBN have two crews, like

the U.S. SSBNs, and so be able to sortie more frequently? Where would they operate from, and where would they patrol? Would the United States have assets other than SSNs that could assist in tracking them? How robust would Chinese SSBN defenses—protection by diesel or nuclear attack boats—be?

If maintenance support for its SSBN was robust and each boat had two crews, it is conceivable that China could keep four of six SSBNs deployed continuously, the remaining two undergoing maintenance between deployments.¹²³ To maintain close contact with the four deployed SSBNs, up to twenty SSNs would be required—nearly half of the current inventory.¹²⁴ Even that rough estimate illustrates that a substantial commitment would be required of a submarine community that is already turning missions away due to a lack of resources. Even if the PLAN does not make such a significant transition (from a single SSBN that rarely goes to sea to a fleet of six that stay deployed 60 percent of the time) and only one or two SSBNs were on patrol, the U.S. Navy would still require five to ten SSNs to hold them at risk.¹²⁵

China may choose to use the Yellow Sea as a bastion, in order to provide better protection for its SSBNs; that could significantly complicate matters. The Yellow Sea is, relatively speaking, extremely shallow. Shallow water places substantial restrictions on submarine maneuverability, and its poor acoustic environment degrades ASW. China would have the advantage of greater familiarity with the theater. High traffic density further restricts submarine maneuverability, to avoid collisions; it also produces high ambient noise, which makes passive acoustic detection extremely difficult at best. It would also be a challenge for the most proficient U.S. SSNs to gain access undetected to such a bastion. China can employ a barrier strategy, as the United States did during the Cold War. Existing shore-based defenses on the Yellow Sea would be to China's advantage; its aircraft would enjoy short transit times and, accordingly, longer periods on station than would U.S. aircraft, if without shore bases of their own. If China were to use the Yellow Sea as a bastion, therefore, an ability to stage naval and air ASW operations from South Korea, the Philippines, and Guam would be essential.¹²⁶

Venturing out into the Pacific or other oceans, however, would require Chinese SSBNs to be sufficiently quiet to avoid U.S. Navy ASW assets—perhaps clustered to form a barrier along the “first island chain” (an arc from the Kuriles through Japan, the Ryukyus, Taiwan, and the Philippines to the Indonesian archipelago).¹²⁷ China recognizes the threat to its nuclear deterrent posed by the ballistic-missile defense initiatives of not only the United States but also Japan and Australia.¹²⁸ China will seek to negate any advantages that the Washington and its allies may have in the region in order to maintain a credible second-strike capability.

China has reportedly begun construction of a submarine base on Hainan Island from which its SSBNs could operate in the South China Sea.¹²⁹ It would provide China's SSBNs with immediate access to the South China Sea and put them much closer to the Indian Ocean. For political reasons, basing SSBNs on Hainan Island, in its South Sea Fleet area of operations, makes sense for China, because the United States is not China's only concern in the Asia-Pacific region. Additionally, if Chinese SSBNs were to operate from two bases about 1,600 nautical miles apart, U.S. ASW assets would be denied the opportunity to concentrate in a particular area.¹³⁰ Furthermore, an additional base would afford China more pier space. Whether or not China would actually launch JL-2 SLBMs from the Indian Ocean, its SSBNs might operate there, and elsewhere, simply to complicate U.S. ballistic-missile defense and tie up more anti-submarine assets.¹³¹

During the first three decades of the Cold War, prior to introduction of the Soviet Delta SSBN, the U.S. Navy relied on a barrier strategy to detect Soviet SSBNs. Pre-Delta Soviet SSBNs were forced to pass through geographic choke points, such as the "Greenland-Iceland-U.K. Gap," in order for their SLBMs to be able to reach the United States. The barrier strategy took advantage of this weakness; fixed passive acoustic arrays, submarines, and land-based ASW aircraft made it quite successful.¹³² The Delta SSBN, however, could threaten the continental United States from Soviet territorial waters. This effectively negated the U.S. barrier strategy, since the Deltas could strike the United States without having to cross the barriers—the Deltas used bastions.¹³³ In light of the eventual deployment of possibly up to six Chinese SSBNs, the American response to the Soviet Deltas is worthy of consideration.

The Chief of Naval Operations, Admiral Elmo Zumwalt, favored an emphasis on sea control to ensure the ability to reinforce Western Europe.¹³⁴ Focusing on the defense of Western Europe, Zumwalt argued, would avoid a potentially costly diversion of naval assets to Soviet SSBN patrol areas, which could escalate a conflict between the United States and the Soviet Union from a strictly conventional to a nuclear level. The alternative viewpoint was that "an explicit attempt should be made to go forward and hold Soviet SSBNs at risk."¹³⁵ The argument was that the destruction of Soviet SSBNs would change the strategic nuclear balance and therefore possibly decrease the will of the Soviets to escalate in the event of a stalemate. Furthermore, holding the Soviet SSBNs at risk in their bastions was held to be beneficial to the U.S. mission of sea control, in that it would force the Soviet Navy to divert assets in an attempt to deny access to American SSNs—a strategy that worked during the Cold War.¹³⁶

The same logic could be applied to a conflict between China and the United States over Taiwan, but only if the United States has available sufficient strategic ASW assets to hold Chinese SSBNs at risk—which it might not in the future. If the numbers were

sufficient, however, and assuming China's SSBNs left port, knowledge that U.S. SSNs and other ASW assets were hunting them would force China to withdraw its best submarines to protect its SSBNs. Due to geography of a Taiwan conflict, the U.S. Army and Air Force would be hard pressed to join in a fight over Taiwan. Consequently, every asset that the U.S. Navy could muster to the region would be vital to success. Coté alludes to such a challenging scenario in his concluding remarks:

The most challenging scenario for the Navy is one where U.S. access to overseas bases is greatly reduced, and where the proliferation of relatively low cost and easy to use access denial weapons—such as modern diesel-electric submarines, antiship and anti-aircraft missiles, and naval mines—continues to grow. This is a world in which the Navy will have to provide a larger portion of national power projection capabilities, while also placing much more emphasis on sea control than it does now.¹³⁷

Given the modest scale of its current ASW capability, the United States would likely be completely occupied protecting its battle fleet while finding and destroying the numerous Chinese submarines—including even the low-technology platforms that the PLAN still operates. During a major conflict over Taiwan the United States would likely locate one or more carrier battle groups within operational range of Taiwan. One can imagine the “one-way conversation” that would occur when the local ASW commander told the battle-group commander that it could take weeks to eliminate the subsurface threat to his ships, due to the large number of Chinese submarines, not to mention the to submarine-laid mines that China could employ.¹³⁸ If China elects to threaten a nuclear response to U.S. “interference” in what it considers an internal issue, the battle-group commander would then presumably be forced to shift assets to strategic ASW, perhaps rendering his own capital ships even more vulnerable.

Such dire scenarios can be prevented in the future if the right force-structure planning decisions are made today. To prepare for the future and all of its conceivable threats, the U.S. Navy needs a fleet of close to seventy SSNs and enough air and surface ASW capability to support not only the missions the submarine force is already tasked with but also strategic ASW, if China does in fact build a significant undersea nuclear deterrent.¹³⁹ In testimony before the House Armed Services Committee in June 2000, the Commander Submarine Forces U.S. Pacific Fleet, Rear Admiral Albert H. Konetzni, testified that the United States needs a minimum of sixty-eight SSNs to meet current and future requirements.¹⁴⁰ If, after China begins deployment of the first of its new SSBNs, it is evident that they will adhere to the habits of the past—remain pierside, employ single crews, or stay within a defined geographic area—the American strategic ASW force structure can be adjusted as necessary. It would be much easier to cut funding and halt construction than it would be to respond suddenly to a threat, having been caught unprepared.¹⁴¹

The U.S. Navy cannot always rely on being “saved by the bell, as it has in the past.”¹⁴² Recent and upcoming advancements like the Multimission Maritime Aircraft, the Advanced Deployable System, the new Fleet ASW Command, the Littoral Combat Ship, and the May 1998 engineering test¹⁴³—to name only a few—represent significant present day and future ASW achievements but they are not the complete solution.¹⁴⁴ Force-structure planning involves identification of threats in the near, middle, and long terms; the United States has the opportunity to “get a jump” on a threat now on the horizon now, by reviving its former antisubmarine prowess. Ensuring that the U.S. Navy has the right number of SSNs and air and surface ASW assets—more than it has today—is vital to the security of the United States.

Conclusion

The development of the Chinese defense establishment over the past five decades has been excruciatingly slow and turbulent, and so was the development of China’s first SSBN. Having invested in a physical and intellectual infrastructure to create its early strategic weapons programs, China is now reaping the benefits. China now has a solid capability to design and construct SSBNs and SLBMs that are much more advanced than their predecessors.

The debate will continue on China’s true intentions, but the strategic implications of a more numerous and capable Chinese SSBN fleet are rather clear. China seeks an assured nuclear strike capability, and SSBNs are well suited to the job. Such a force would raise the risks of confronting China in a crisis and may even decrease American leverage in a given crisis, unless it can be effectively neutralized.

China has already a limited capability to threaten the continental United States, but the introduction of new, more capable submerged strategic systems with far greater range and accuracy would enable it to strike the United States from the relative safety of its own waters. The rationale behind the decision to hold Soviet SSBNs at risk in the Cold War are applicable today. By the time China’s new SSBNs are deployed, it is unlikely that the United States will have developed a totally reliable ballistic-missile defense system—especially against sophisticated countermeasures (see chapter 4 of this volume). Therefore, as in the Cold War, it is incumbent upon the U.S. Navy to equip and train itself for strategic ASW.

Will the U.S. Navy be able to resume a more aggressive strategic ASW posture in response to a new and improved fleet of Chinese SSBNs? As a result of the future advances in Chinese attack submarines, improvements in the PLAN education and training, the numerous Chinese submarines in existence today, Asian-Pacific

geography, an anemic American ASW capability that is likely to continue to decline, the U.S. Navy could be ill prepared to do so.

It is quite conceivable that strategic ASW will once again rise to the highest national importance. The period remaining before China deploys a larger number of SSBNs—within the next five years—affords the United States and its navy a vital opportunity. The United States should plan now to stop the decline in U.S. strategic ASW capability, by halting the decline in the number of SSNs, increasing SSN end-strength to at least seventy, and build up air and surface ASW capability. After all, nuclear-powered submarines, aircraft, and surface ships are cheap—compared to the cost of replacing the city of Los Angeles.¹⁴⁵

Notes

China's Space Development and Nuclear Strategy

DOMINIC DESCISCIOLO

China has recently become one of only three nations that have achieved human space flight. This considerable achievement has served China, its government, and its people on many levels, and it will continue to do so. It has symbolized to the world the technological power of a nation ascendant; it affirmed the legitimacy of China's political system some fifty-four years after the communist revolution; and it has provided China the national prestige to bring it ever closer to assuming its place among the great powers of the twenty-first century.

Another, less heralded beneficiary is the ongoing effort undertaken by Beijing to modernize its strategic nuclear capability. The military significance of the success of the Chinese civil space program—largely overseen by the People's Liberation Army—should not be underestimated. Indeed, the contemporary linkage between missile development and China's burgeoning civil and commercial space operations has deep historical roots. This civil-military nexus, common to space programs worldwide, has over a period of decades led to both direct and indirect improvements in China's strategic nuclear forces.¹ Initially, China's nuclear program drove its intercontinental-ballistic-missile delivery requirements, thereby galvanizing China's space program. Now that both programs have matured, the dynamic seems to be mutually reinforcing. Potentially significant examples of the military benefits of this symbiotic relationship include improvement in: ICBM range, accuracy, and survivability, as well as space-based intelligence, surveillance, and reconnaissance (ISR), targeting, counter-space weapons, and ballistic-missile-defense countermeasures.

One need not appeal to Sun Tzu's injunction that "all warfare is based on deception" to understand the significance of this relationship.² The theoretically civil Chinese space program—including the human space flight component—is simultaneously accelerating China's quest to modernize its strategic nuclear forces.

China's Star Rising

The launch of Shenzhou V on 14 October 2003, China's first manned space mission, brought Beijing acclaim both at home and around the globe.³

神州五号

Shenzhou V (Heavenly Vessel)

The achievement capped an extraordinary half-century effort, accelerated in the 1990s, to gain access to an exclusive club of space-faring nations that had previously comprised only the United States and the Soviet Union/Russia. This membership will help affirm China's place among the great powers of the twenty-first century. Lieutenant Colonel Yang Liwei, China's first *yuhangyuan* to venture into space, has become an instant hero;⁴ he is to an electrified

宇航员

yuhangyuan (astronaut)

Chinese public a legendary figure—on the order of Yuri Gagarin and Alan Shepard.⁵ The success of the mission, and corresponding public approval, has also provided a boost to the political legitimacy of the communist leadership at a time of considerable uncertainty regarding the party's future role in Chinese society. It has touched a deep nationalistic chord as another example of the *new* China, reborn after two centuries of decline. Internationally, its appearance on the world stage of as a third space-faring nation may be viewed as yet another indication that China, long considered backward and hopelessly outclassed, is rising.

Chinese technical and political leaders have stated repeatedly that Shenzhou will only be the beginning of an exciting future of space stations, reusable space shuttles, and missions to the moon and planets. Given the current moribund state of the U.S. civil space program in the wake of the *Columbia* shuttle disaster of 1 February 2003, and with the much downsized Russian program only a shadow of its former greatness, one can only marvel and share in the excitement of a Chinese civil space program, apparently on track and reaching for the stars.⁶

But what about the strategic implications of this putatively peaceful and scientific quest for the heavens? One need not look very far for the answer. The July 2003 appointment of General Li Jinai, director of the General Armaments Department, as the new head of the Manned Space Project provides an essential clue.⁷ In fact, lying largely out of public view is the influence exerted by the PLA over the entire civil space effort. More importantly, however, it may be the long-standing relationship between the PLA Second Artillery Corps (China's strategic rocket forces) and the civil and commercial launch and satellite programs that provides the best indication that China's success in space will inevitably contribute to the state's growing military power.

The codevelopment of launch vehicles for both military and civil purposes has a long history, dating back almost fifty years. More recently, civil space-related technologies, whether indigenously developed or purchased internationally, are spilling over into the military realm. This technology transfer has direct military applications, especially in

the arena of major ICBM improvements. Indirectly, but closely related, are improvements in space-based ISR and targeting, as well as the development of space weapons. Not surprisingly, then, while China forges ahead in space, its strategic nuclear forces have likewise undergone a modernization effort that continues unabated.

In PRC development of a robust manned space presence, are we witnessing a “grand vision for the future to explore space [that is] inspiring to the Chinese people,” as related by Huang Chunping, chief commander of rocketry for the Shenzhou project?⁸ Or are we seeing China’s attempt to gain all the military advantages of “the new high ground” (a common reference to space during the Cold War) along the lines of the Soviet manned space program of the last century? In pursuing both goals simultaneously, will China become the new “Red Star in Orbit?”⁹

This chapter addresses the linkage between the rise of the Chinese space program and the PLA’s ongoing strategic nuclear modernization program. First, the historical roots of that linkage are examined to gain a better understanding of the “spin-on/spin-off” relationship of the two programs. Second, some current examples of both direct and indirect military benefits resulting from that relationship are presented in order to appreciate more fully the military implications of China’s success in space and also to outline areas of potential future concern. Finally, current Chinese efforts will be compared to those of the American and Soviet space programs at their height in order to gain insight into the possible future course of the Chinese manned space program. This comparison will then be used shed light on the impact for China’s strategic nuclear modernization.

Linked at Birth: The Role of Qian

One can hardly appreciate the modern history of China’s ballistic missile and space development without encountering an almost larger-than-life figure—Qian Xuesen, a Chinese-born, MIT and Cal Tech–educated scholar who, deported to China in 1955 under suspicion of being a communist, was (and still is) probably the most influential personality in this story.¹⁰ Qian’s contributions to early theories on rocket aerodynamics and space travel as one of the founding members of the Jet Propulsion Laboratory in Pasadena are legendary. Other studies by him laid the foundations for development of both the U.S. Air Force and the national space programs. The ultimate loss to Washington (and gain for Beijing) of this brilliant visionary was of such magnitude that Undersecretary of the Navy Daniel Kimball declared, “I’d rather see him shot than let him go. . . . He’s worth three to five divisions anyplace.”¹¹ Echoing that sentiment was Qian’s Cal Tech–appointed attorney, Grant B. Cooper: “That the government permitted this genius, this scientific genius, to be sent to Communist China to pick his brains is one of the tragedies of this century.”¹²

Notes

Strategic Weapons Time Line

- 1955—Mao Zedong initiates nuclear weapons program
 - 1964—China detonates first atomic bomb
 - 1966—China undertakes unprecedented nuclear-armed missile test
 - 1967—China detonates first hydrogen bomb
 - 1980—First operational test of DF-5 ICBM
 - 1988—JL-1 SLBM successfully launched from Xia SSBN
 - 1995—Successful test of DF-31 ICBM
 - 2001—First submerged launch of JL-2 SLBM, from *Golf*-class submarine
 - 2003—Deployment of first brigade of DF-31 ICBMs
 - 2004—Type 094 SSBN launched; JL-2 test failure
-

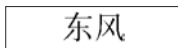
Sources: Brian Harvey, *China's Space Program—From Conception to Manned Spaceflight* (New York: Springer-Praxis, 2004) pp. 323–328; John Wilson Lewis and Xue Litai, *China Builds the Bomb* (Stanford: Stanford University Press, 1988); GlobalSecurity.org.

Back in China in 1955, Qian pledged “to do my best to help the Chinese people build up their nation.”¹³ In fact, he went to work to initiate and develop China’s ballistic missile program. One of Qian’s first recommendations to the Chinese government in 1956 was patterned on the study he had done for the U.S. Air Force for its long-term weapons development. The plan placed emphasis on atomic energy, missiles, computer science, semiconductors, electronics, and automation technology. Qian also emphasized the exploitation of foreign—especially U.S.—technical materials as guides for indigenous development. Most importantly, Qian convinced the Chinese government that missile development should take precedence over aircraft development.¹⁴

Qian became immersed in turning this plan into reality. Confronting the backwardness of China’s industrial base in the mid-1950s, Qian set about almost single-handedly to develop the science and technology infrastructure that would be critical to China’s success. He was instrumental in establishing the Fifth Academy of National Defense, China’s first institute for missile design. Today, many of the various Chinese state organs of science, technology, and industry relating to defense and space trace their lineage either directly to the Fifth Academy or to one of its sub-academies.¹⁵ Iris Chang observes:

He was capable of organizing, decades in advance, gargantuan projects involving thousands of scientists, as well as introducing the kind of engineering systems that could track the tiniest details within an organization. He played a key role in taking a primitive military establishment and transforming it into one that could deliver nuclear bombs intercontinentally; he initiated and guided numerous projects that brought China into the space age.¹⁶

The first modern missiles in China were two R-1s—Soviet copies of the German V-2—purchased in 1956. By late 1957, Qian had arranged for the delivery of the first R-2 missiles, an improved version of the R-1. Despite the 1960 break in Sino-Soviet collaboration, China succeeded that year in launching its first indigenous atmospheric-sounding rocket, the T-7. In September 1960 China launched a Soviet R-2 filled with indigenous propellant, and in November it successfully launched the first Chinese-built replica of the R-2, from the new Jiuquan launch site in the Gobi Desert.¹⁷ Building on these successes, Qian and his growing legions of personally trained engineers and technicians worked on a series of missiles, ultimately producing the Dong Feng. The initial goal, set in 1961, for the



Dong Feng (East Wind)

“DF” was a ten-thousand-kilometer-range missile capable of striking the continental United States. Beset by technical difficulties coupled with the chaos surrounding the Great Leap Forward, Qian was forced to lower the bar.¹⁸ After some initial overconfidence and overstretch, a methodical development of a series of missiles began of successively greater capabilities, each model having its own specific purpose: the DF-1 was a simply a renamed R-2, but the DF-2 would be capable of hitting Japan, the DF-3 the Philippines, the DF-4 Guam, and the DF-5 the continental United States.¹⁹

The Cultural Revolution had a severe impact on all of China’s strategic weapons programs. It is a wonder that any significant progress was achieved in this tumultuous and disruptive period. During these years the Chinese engineers conducted under political pressure one of the riskiest and most dangerous missile test launches of all time (as described in chapter 1). Barely two years after successfully detonating its first atomic weapon, on 27 October 1966 China launched a modified DF-2 intermediate-range

Space Program Time Line

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- 1955—American missile expert Qian Xuesen returns to China
 - 1960—China launches first indigenously manufactured rocket
 - 1970—PRC launches Dong Fang Hong-1, its first Earth satellite
 - 1975—PRC launches first remote sensing satellite, FSW-0
 - 1985—China offers first commercial launch services
 - 1992—Jiang Zemin approves Project 921, PRC manned spaceflight program
 - 1993—PLA Chief of Staff Chi Haotian visits Russia’s Star City, inaugurating bilateral space cooperation
 - 1999—*Shenzhou 1* prototype initiates active testing stage of manned space program
 - 2000—*Beidou 1*, first PRC navigation satellite, launched
 - 2003—*Shenzhou 5* launches Lt. Col. Yang Liwei, China’s first astronaut
-

Sources: Brian Harvey, *China’s Space Program—From Conception to Manned Spaceflight* (New York: Springer-Praxis, 2004) pp. 323–328; Globalsecurity.org.

Notes

ballistic missile (IRBM) with a live twelve-kiloton atomic warhead, which impacted in the western Xinjiang desert.²⁰ According to a communiqué, “China successfully conducted over its own territory a guided missile nuclear weapons test. The guided missile flew normally and the nuclear warhead accurately hit the target at the appointed distance, effecting a nuclear explosion.”²¹ By 1969 the deterioration of relations with the Soviet Union had reached the point of military confrontation, leading to a redesign of the DF-4 to increase its range enough to reach Moscow.²²

Qian’s technical and organizational achievements were not limited to military missile development. The Soviet launch in May 1958 of the 1.3-ton Sputnik III geophysical observatory, the third and most successful of the Sputnik series, was viewed in China as an impressive advance from the ten-kilogram Sputnik I of only seven months prior.²³ Chairman Mao’s reaction to Sputnik III prompted the creation of Project 581—to develop and launch China’s first satellite. Although the effort would take over eleven years to bear fruit, Qian’s personal leadership in the design, development, and successful launch of China’s first satellite, Dong

东方红一号

Dong Fang Hong (The East is Red)

Fang Hong (DFH-1), is undisputed. The chief result of this effort, after the satellite itself, was the coincidental development of China’s first civil (and later commercial) launch vehicles, the

Chang Zheng (CZ series). The CZ-1 evolved directly from the DF-4 IRBM (also known as the CSS-3).²⁴ On 24 April 1970, the DFH-1 was successfully launched atop a CZ-1 three-

长征

Chang Zheng (Long March)

stage booster, making China only the fifth country to conduct satellite operations.²⁵ On 1 May 1970, Qian was “hailed as a hero” by Mao amidst much fanfare in Tiananmen Square.²⁶

In the subsequent decades, China’s space program made impressive gains, in part due to the new stability that followed Deng Xiaoping’s ascendance in 1978–79. However, one of Deng’s important initiatives was to cut military spending—a factor that probably encouraged China’s missileers to examine the possibility of supplementing government funding with revenue from commercial launches. In 1985, the nearly simultaneous *Challenger* disaster and failure of Europe’s flagship Ariane booster provided new international demand for China’s launch services. Moreover, Beijing in April 1992 undertook Project 921 (a PLA designation)—the manned space program—giving additional impetus to China’s overall space efforts.²⁷ The rise of Jiang Zemin, a technocrat and confirmed space enthusiast, over the course of the 1990s also accelerated the Chinese space program.

The success of the CZ series has continued nearly unabated for over thirty years and has produced an extensive family of launch vehicles, with over twelve distinct types and more under development.²⁸ The follow-on to the CZ-1, known as the CZ-2, is the civilian, commercial version of the DF-5 (or CSS-4) ICBM; it now has a twenty-five-year

history of broad applications.²⁹ Variants can now place payloads of upward of five thousand kilograms in low earth orbit (LEO) and 2,500 kilograms in sun-synchronous orbit.³⁰ The launch vehicle chosen for the Shenzhou manned missions was the CZ-2F, a two-stage rocket with four strap-on boosters, capable of lifting over nineteen thousand pounds to LEO.³¹ This rocket has flown successfully five times since 1999, culminating in the launch of Shenzhou V. Through Qian, therefore, the launch vehicle carrying Lieutenant Colonel Yang, and with him the hopes of Project 921, can trace its lineage directly back to the earliest DF ballistic missiles. Moreover, according to Joan Johnson-Freese of the Naval War College, “The symbiotic nature of the technology and the intertwined nature of the Chinese military and civil space program allowed parallel development of a missile/launcher for dual application purposes.”³²

Notwithstanding such triumphs, China suffered a series of launch failures during the 1990s that made its commercial satellite launch industry virtually uninsurable. Subsequently, suspicions that American satellite technologies were being illegally transferred to China by U.S. satellite manufacturers led to a Congressional investigation which became known as the Cox Committee. The commission’s report, issued in May 1999, charged that China had dramatically improved its launch vehicle reliability and warhead miniaturization through a coordinated program of espionage, both in China and at American national laboratories.³³ The “Cox Report” has proven immensely controversial, receiving ample criticism from a range of scholars and policy analysts.³⁴ Much of this criticism, however, has attacked the report’s context and tone (“The [Chinese Communist Party’s]’s main aim for the civilian economy is to support . . . the aims of the PLA”) rather than disputing allegations concerning Chinese “information gathering” practices or the export-control violations for which Loral Space & Communications and the Hughes Space and Telecommunications Company ultimately paid multimillion-dollar fines.³⁵

Regardless of the Cox Report’s claims, it is worth noting that China has not suffered a major launch failure since allegedly receiving assistance from Loral and Hughes. China has become one of the global leaders in commercial satellite launchers, with over forty-seven successful attempts by October 2000.³⁶ A source of much-needed revenue for

返回式卫星

Fanhui Shi Weixing (Return Type Satellite)

China’s space program, commercial satellite launches also provide a mechanism for space cooperation (and technology acquisition) with international partners, among them Germany, France, Brazil, and countries of the former Soviet bloc. Additionally, China has fielded several series of its own sat-

风云

Fengyun (Wind and Cloud)

ellites. The DFH family of communication satellites was soon joined by the Fanhui Shi Weixing (or FSW) recoverable military reconnaissance satellites and by the Fengyun (FY) meteorological satellites.

Is it possible that one man could have an impact on such a wide scale? In fact, Qian's influence was even broader. He also had a hand in other programs of great military importance, including antiship cruise missiles, nuclear submarines, and the development of the tracking, telemetry, and control network used to monitor military, civilian, and commercial space launches.³⁷ Qian officially retired in October 1991, but his presence is still felt in both the Chinese space program and within the Second Artillery Corps. It is too easy to compare Qian Xuesen to Werner Von Braun in the United States or Sergei P. Korolev in the Soviet Union.³⁸ A more appropriate analogy might be to Admiral Hyman P. Rickover, the father of the American nuclear navy and a figure who also loomed larger than life, a presence in every aspect of the nuclear program. Of Qian's legacy, three lasting imprints on the development of China's ballistic missile and space programs have been noted:

- Confidence that China can match the West in its technological development
- Top priority for the strategic nuclear and missile industries in the defense industrial hierarchy
- A forward-looking approach, bold in its engineering ambitions, to defense science and technology strategy.³⁹

Escape Velocity: Reaping the Benefits of Interdependence

Whereas Qian Xuesen was the best-understood link in the commingled history of the development of China's space and ballistic missile programs, the "activities and tests in the former used to advance objectives in the latter" form the basis for concern today.⁴⁰ Qian and his "activities" had woven an intricate, inseparable relationship between the two programs, one that continues to reap benefits for China's strategic nuclear modernization now under way. Those military benefits have yielded direct qualitative improvements in ICBM accuracy, range, and survivability.⁴¹ In fact, two recent examples of ICBM improvements are directly attributable to this civil-military nexus.

Currently only three types of ICBMs in the Chinese inventory are capable of striking the continental United States from bases in China: two versions of the liquid-fuel DF-5 (CSS-4 Mod 1 and Mod 2) and the new solid-fuel DF-31. Though first successfully flown in September 1971, the twelve-thousand-kilometer DF-5 achieved initial operating capability only in 1981, its development and production having been prolonged to ten years by the Cultural Revolution.⁴² An improved version, the DF-5A, extends this range a thousand kilometers. Both are identical copies of what ultimately became the CZ-2C commercial booster, which was codeveloped during this period. Their single warheads and the silo-basing (and two-hour fueling) requirements were but two of shortcomings that led to the

development of the DF-31. The eight-thousand-kilometer, solid-fuel, road- (or possibly rail-) mobile DF-31 is the land-based version of the Julang 2 (JL-2) submarine-

巨浪二号

Julang 2 (Great Wave)

launched ballistic missile (see chapter 2). The missile is reported to be MIRV capable, using the smaller seven-hundred-kilogram, one-megaton warhead developed for the JL-1 SLBM developed in the 1980s.⁴³ The DF-31 is reportedly now being fielded in small numbers; a longer-range variant (twelve thousand kilometers) is in development.⁴⁴

Emerson Niou of Duke University has offered an innovative theory suggesting that Chinese strategic planners now have the elements a potential fourth delivery system, one with roots in the early satellite development program. Modern development of solid rocket motors (SRMs) in China dates back some forty years. This technology was used in the FG-2 third (upper) stage of the first CZ-1 launch vehicle, as part of the DFH-1 satellite program of the early 1970s.⁴⁵ The CZ-1D production line having recently been reopened for ostensibly civil, commercial launches, the Second Artillery Corps could replace the satellite payload on the CZ-1D with a seven-hundred-kilogram warhead. Since the CZ-1D is directly descended from the DF-4 IRBM, such combination of an FG-2 SRM third stage and JL-1 warhead would extend the range of the missile to that of an ICBM.⁴⁶ To be sure, the CZ-1D (DF-4) still possesses a liquid-fuel first stage and thus requires a fixed launch site and fueling infrastructure. However, this relatively rapid conversion and upgrade of an existing launch vehicle would provide the Second Artillery with the ability to increase dramatically the numbers of its ICBMs.

Why might such an option be important to Chinese strategic planners? Clearly, China is alarmed at U.S. efforts to deploy a ballistic-missile defense system (see chapter 4 in this volume). By rapidly expanding the ICBM force through IRBM conversion and using the MIRV capability of the DF-31, Beijing may well hope to saturate American missile defenses, to overcome the strategic impact of BMD through sheer volume, thereby preserving the deterrent quality of its force.⁴⁷

The second recent ICBM breakthrough concerns the survivability aspect of the new road-mobile DF-31. Thanks to SRM technology, the DF-31 has the mobility, with its transporter-erector launchers, to reduce its vulnerability to targeting in the earliest stages of hostilities, and even, possibly, to evade a counterstrike. This degree of second-strike capability would give Chinese strategic planners options, overcoming what is now considered the “use-or-lose” nature of the twenty or so fixed-site DF-5s.⁴⁸ Additionally, the DF-31 SRMs offer operational flexibility, not having to be fueled, like the DF-5, immediately prior to use.

The relationship between China's space program and its strategic nuclear forces effectively adds space warfare to the options before Chinese strategic planners—an option

offering a wide array of new capabilities and technologies available for exploitation. Beijing clearly appreciates the role space has played in recent conflicts—from DESERT STORM to the present day—and intends to develop space-based defense and intelligence assets to support its strategic nuclear modernization efforts. To that end, several new families of satellites are under development—including radar imaging, electronic reconnaissance, and electro-optical reconnaissance types—all of which will improve current space-based ISR capabilities.⁴⁹ Here again, cooperation with international partners under ostensibly civil frameworks has yielded another military application: “In January 2003, the Chinese launched their second Zi Yuan (ZY-2) photoreconnaissance satellite, capable of resolution in the range of ten to twenty centimeters. It is a military version of a satellite jointly developed by China and Brazil for remote sensing (the ZY-1, or China Brazil Earth Resource Satellite [CBERS])—evidence of how development of a civil program can have clear military benefit.”⁵⁰

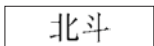
In fact, yet another Chinese product of SRM technology is the small, solid-fuel Kaituozhe 1 and 2 (KT-1/2) satellite launch vehicle, designed to provide rapid reliable



Kaituozhe 1 and 2 (Explorer)

access to space in times of crisis or increased ISR requirements.⁵¹ According to *China Defense Today*, the Kaituozhe is “possibly based on the technology of the DF-31” ICBM.⁵² Also instrumental to China’s pursuit of space influence is the development of microsatellite technology designed to reduce lift requirements sharply. It may improve China’s already demonstrated ability to place multiple satellites in orbit with a single launcher.⁵³ Moreover, a larger constellation of smaller satellites would theoretically increase individual satellite survivability in space, being less susceptible to antisatellite (ASAT) weapons.⁵⁴ Improved space-based ISR will have a significant impact on targeting for both regional and global scenarios. Combining rapid launch capability with improved ground processing capacity could allow real-time imaging that would provide decision makers much-needed information in the prehostilities phase of any conflict.⁵⁵

China is attempting to reduce its reliance on the U.S. Global Positioning System (GPS) satellite network by joining Europe’s competing Galileo project. Meanwhile, Beijing has



Beidou (Big Dipper)

developed a rudimentary two-satellite supplement to GPS known as Beidou. This may ultimately insulate the PLA against restrictions upon GPS in wartime, as well as increase the accuracy of conventional and strategic systems.

China has taken much interest in the 2001 *Report of the Commission to Assess United States National Security Space Management and Organization*, a report of a panel chaired by the current secretary of defense, Donald H. Rumsfeld. China, while officially taking a position against weaponization of space, seems nevertheless to be

developing systems that could be used in an offensive counterspace role, even conceivably for space-based missile defense.⁵⁶ According to a senior fellow at the Jamestown Foundation, “China needs to be able to deny to the United States access and use of space, as they themselves expect to be able to support their own forces.”⁵⁷ To that end, the Chinese are “seeking to minimize the space technology gap with the United States.”⁵⁸ Integral to these efforts appears, once again, to be the acquisition of foreign technology:

Beijing already may have *acquired technical assistance* that could be applied to the development of laser radars used to track and image satellites and may be seeking an advanced radar system with the capability to track satellites in low earth orbit. It may also be developing jammers that could be used against Global Positioning System (GPS) receivers. In addition, China may already possess the capability to damage, under specific conditions, optical sensors on satellites that are very vulnerable to damage by laser. Beijing may also have *acquired high-energy laser equipment and technical assistance*, which probably could be used in the development of ground-based ASAT weapons.⁵⁹

For a nation struggling with modernizing its industrial base and raising its technical standards, all the while asserting itself on the world stage, it seems only reasonable to seek foreign assistance in order to buy time to prepare its own technological base. Considering that 95 percent of space technologies are potentially dual-use, sharing technology between the space program and the military is perfectly logical.⁶⁰

Of course, codevelopment of ICBMs and civilian rockets was not invented by the Chinese. One could even argue that the real beneficiary of the civil-military overlap is the growing civilian, commercial booster family—the CZ-1 and CZ-2, derived from the DF-4 and DF-5, respectively. The early U.S. space program relied heavily on ICBM-derived launchers until purpose-built rockets like the Saturn V could be developed.⁶¹ In fact, the R-7 rocket used today by the Russians to loft Soyuz capsules to the International Space Station (ISS) is little changed from the SS-6 Sapwood ICBM booster that placed Yuri Gagarin in orbit (and in the history books) over forty years ago.

China's exploitation of space as a war-fighting medium may be simply a response to the stunning battlefield success enjoyed in recent years by the United States with space-based assets. Prudence would therefore dictate that if one expects to face a space-faring competitor like the United States, development of space weapons might be a good investment of limited resources. Nonetheless, disturbing characteristics of China's interwoven military and civil space programs remain, in three respects.

First, unlike other contemporary space programs, which relate to a country's military establishment at some level, the Chinese space program has been described as “distinct in the degree of its military involvement, the extent of its military functions, and the scale of its military significance.”⁶² As such, China's space program should be viewed not as merely related to the military but as *managed* by it (as should all activities, decisions, and events in that context).

[Notes](#)

The ZY-1 CBERS Satellite



Source: Chinese Defence Today

a space power and accrue all the benefits and prestige of that status, both domestically and internationally. Despite public proclamations of peaceful intentions—the lofty preamble to the PRC’s 2000 white paper on space is an example—the national security motive plays a major role.⁶³

When viewed in this light, the implications of China’s space program for strategic nuclear modernization now under way become clear. China’s space ambitions will continue to serve as the vehicle for the acquisition, adaptation, and application of space-related technologies for military purposes.

The New Domain of the Dragon: Shenzhou and Beyond

The first manned flight of Shenzhou on 14 October 2003—the capstone event of Project 921—was, predictably, a conservative, risk-averse, and brief (twenty-one-hour, fourteen-orbit) mission, carrying only Lieutenant Colonel Yang.⁶⁴ After all, this flight was intended simply to validate the spacecraft’s systems—or was it? According to one report, the spacecraft also deployed a “new Chinese military intelligence-gathering satellite.”⁶⁵ Is this a key mission of Project 921 (properly, the National Manned Space

Second, until indigenous Chinese technological development becomes a continuous source for cutting-edge innovations and general improvements for military and strategic systems, China will remain wedded to foreign sources. The PRC has always demonstrated a propensity to acquiring, adapting, and applying technology developed outside of China. The essentially one-way flow from foreign technology sources through civilian and commercial space applications, and ultimately to strategic nuclear modernization is likely to continue for the foreseeable future.

Third, beyond technology transfer, China clearly sees the national strategic importance of a viable space program. China desires to become

Project, now headed by General Li Jinai)? What will the follow-on Shenzhou missions be like? What will come after Shenzhou, and how will future programs relate to the overall Chinese strategy for space?

China being only the third nation to achieve human space flight, only two other space programs are available to serve as models for comparison. Both the United States and Russia (and the USSR before it) can lay claim to certain “firsts” in space. During the Cold War space race each country followed its own strategy and built a space program that was based on its respective culture, ideology, goals, capabilities, and resources. The intense competition that ensued reveals in retrospect the strengths and weaknesses of, and ultimately insight into, the two programs, and so represents a lens through which to view the nascent Chinese program. Already Project 921 has reflected characteristics of both the early American and Soviet programs in terms of appearance, methodology, aspiration, and ultimate purpose. Which program better “fits” what China is doing (and therefore might be a predictive model) is not yet clear. China may yet choose an entirely different path.

A Soviet Model

With the demise of their manned lunar-landing program in the early 1970s, the Soviets recognized the limited utility of the Soyuz capsule for living and working in space.⁶⁶ The design is highly suitable, however, as a space ferry; in that role it continues today, largely unaltered, to service the ISS. Before that, the Soviet Union used the Soyuz, once docking techniques were perfected, to ferry cosmonauts to and from the Salyut space stations. The Salyut stations of the 1970s and 1980s, centerpieces of the post-moon race Soviet manned space program, were the precursors of the highly successful Mir. Of the seven then-operational Salyuts ultimately built, Salyuts 2, 3, and 5 are commonly referred to as the “military Salyuts” for their highly secretive military surveillance roles.⁶⁷ The distinctive feature of the military Salyuts was a separate recovery module on the forward end of the spacecraft—the docking module was aft. The extra module presumably served to transfer film canisters and other forms of collected data from the station back to earth. Experience gained from the military Salyuts was more than likely applied to next-generation Soviet space-based ISR systems, both manned and unmanned.⁶⁸

The Chinese began developing the Shenzhou in the 1990s, largely with Russian assistance. Though the Chinese assert that it is an indigenous design, Shenzhou is in fact a scaled-up version of the Soyuz, capable of accommodating up to three *yuhangyuan*.⁶⁹ If they are to progress to the more ambitious projects they have announced, the Chinese are likely to outgrow the Shenzhou rapidly. Because the Shenzhou is basically of Russian design, the Chinese have also purchased the Kurs androgynous docking system

from Russia.⁷⁰ With this technology, China could conceivably dock two Shenzhous together, or one to a larger space station.

Just as its first manned spacecraft resembles a Soyuz, will China's first space station be reminiscent of a Soviet Salyut, at least in function? It is too early to tell; however, aside from the military satellite placed in orbit along with the Shenzhou capsule, an indication exists that a move in that direction is already apparent. As early as 15 February 2003, General Li Jinai's predecessor, Zhang Houying, publicly acknowledged that while no scientific experiments would be carried on board Shenzhou V, mounted on the exterior of the spacecraft would be "a CCD [charge-coupled device] transmission camera, with a ground resolution of 1.6 meters. Its main use will be in military reconnaissance."⁷¹

Space American Style

Whatever Beijing's ultimate intentions, China will have to master orbital maneuver, rendezvous, and docking. Without them the Chinese manned space program will quickly become a quaint throwback to the earliest manned space missions of the Soviets and Americans. The Chinese appear determined to apply a step-by-step, exceedingly cautious approach. In the early Soviet program, Premier Nikita Khrushchev, obsessed with timing space events for maximum political gain, frustrated his engineers (Korolev among them) by pushing for high-flying "circus acts."⁷² These events, staged for propaganda value, became the ends themselves, rather than means of achieving systematic program goals.

While international acclaim and recognition, as well as domestic politics, are surely important to them, the Chinese have modeled their program instead after the triumphant American space effort of the 1960s. The Chinese have constituted their program, assembled their infrastructure, and developed and tested their spacecraft and techniques in an incremental fashion reminiscent of Projects Mercury, Gemini, and Apollo. As illustrated by the unmanned Shenzhou launches, a logical, methodical approach marks each mission. The Chinese can be expected to carry out their ambitious program with a steadfast singularity of purpose, each phase a necessary building block to some future goal.

That individual characteristics of the Chinese space program have roots in the Soviet or American programs does not in itself portend a menacing future. China may conclude, as did the United States in the 1960s and the Soviets in the late 1970s, that a manned ISR platform in space is neither economical nor sensible in light of the advantages afforded by unmanned satellites. Additionally, although appearing to mirror the goal-oriented approach taken by the United States in its own moon quest, China may have determined that such a course would not be sustainable. The United States

expended enormous resources on Project Apollo and the race to the moon.⁷³ Economic reality may force Beijing to scale back its more grandiose space-exploration aspirations.

Yet when considered in the aggregate, these characteristics take on a new meaning. The synergy of combining civil and military functions in its manned space program might prove irresistible to Beijing. Until a robotic substitute can be developed and fielded to meet China's remote-sensing and targeting needs, its manned space program may shoulder part of this mission. It might indeed be some time before a true distinction appears between China's civil exploration of space and military exploitation of the "new high ground," if it ever does.

What of China's potential plans to land on the moon? According to Robert S. Walker, former chairman of the House Science Committee,

The Chinese have a long history of undertaking projects designed to enhance their national image. . . . [A] nation with the technological capacity to do a sustained moon program would have achieved the ability to build, integrate and utilize spacecraft. Without even ascribing any hostile intent to such a capability, our strategic planners would have to acknowledge the profound impact on the balance of power. . . . Space dominance is a twenty-first century challenge we dare not refuse.⁷⁴

The Real Legacy of Qian

China's achievement of a place among the true space-faring nations caps a half-century effort and well deserves the international acclaim that has been forthcoming. Nonetheless, the military significance of the event cannot be overlooked.

The Second Artillery Corps of the PLA is sure to benefit from the panoply of new technologies associated with this emerging capability. Each new cooperative agreement between China and any of its space partners—Russia, France, and Germany among them—means potential assistance to its nuclear modernization. It is naive to accept at face value public statements that the Chinese space program arises merely from the peaceful aspirations of a nation ascendant, seeking to expand the realm of scientific knowledge. To ignore the strategic nuclear implications of any new space breakthrough or capability—including Shenzhou—would be irresponsible.

It is not difficult to see the military implications of China's civil space program. This program is not only managed by the PLA but was born in the same cradle as the ballistic missile program, dating back to 1956. The space program certainly owes much of its early development to its older sibling, but it is now repaying the debt with interest. Further, and though it is steadily closing the technology gap with the West, China still relies on foreign technology for military modernization; the symbiotic relationship between the two programs will continue to produce net gains in the acquisition, adaptation, and application of foreign military technology. Such a gain has been recent improvement in the range, accuracy, and survivability of the ICBM force. China has

also exploited its newfound space capabilities for remote sensing, targeting, and space weapons. Its manned space program appears poised to support that exploitation as well.

Missile and space codevelopment, once indispensably led by Qian Xuesen, has endured obstacles and impediments, mainly to internal factors, over the past forty-eight years. Yet Qian's lasting legacy may be that he created the interdependence that exists between the two programs. China's relative economic prosperity and the growing scope and successes of its diplomacy (for instance, with the European Union) now place Beijing in an optimal position to reap the full benefits of that synergy. Accordingly, China today is at once reaching out into space and modernizing its strategic nuclear forces.

China's BMD Countermeasures

Breaching America's Great Wall in Space?

ANDREW S. ERICKSON

A significant component of contemporary naval transformation involves adapting the force to meet the emerging ballistic missile defense challenge.¹ With the advent of sea-based BMD, the U.S. Navy has entered a new era. One naval strategist views the advent of “missile defense task forces” within the surface warfare community as being on a par with the dramatically successful transformation of the submarine force led by Admiral Arthur W. Radford in the 1950s to embrace the strategic deterrence mission.² For this reason, maritime forces are poised to play a critical role in securing American interests from the growing threat of missile attack in a variety of regions around the globe. In Northeast Asia, the 2004 deployment of an Aegis cruiser equipped with the SM-3 (Standard Missile 3) for continuous patrol in the Sea of Japan heralded the dawn of this new chapter in naval warfare.

Northeast Asia represents a highly complex military and diplomatic environment for the United States. What impact will the U.S. Navy's BMD initiative have on the volatile region? What will be the larger geopolitical consequences of U.S. BMD as its architecture continues to evolve? BMD's significance for North Korea is frequently discussed and is relatively straightforward; it is, rather, China's reaction to American BMD, including its naval component, that will have the most profound impact on global politics in the twenty-first century.

The question of whether U.S. BMD could or should address China-related contingencies was raised by a debate in 2002 between two respected China specialists, Heritage Foundation vice president Larry Wortzel and Council on Foreign Relations senior fellow Adam Segal. Wortzel advocated constructing BMD with China in mind, arguing that “building a missile shield now will head off Chinese nuclear blackmail later.” Segal opposed building BMD specifically against China, arguing that “setting up an antimissile system aimed at the Chinese will leave the United

States less secure.”³ Three years later, the debate is increasingly salient, and it remains unresolved.

The United States has invested in BMD development sporadically since the 1950s, but with little consensus regarding its limitations or ultimate purpose. Questions of overall system effectiveness aside, the debate has centered on which nations would constitute the proper “targets” of such a system. While some of BMD’s strongest proponents contend that a robust multi-tier system is readily achievable and could ultimately protect the United States from all intercontinental missiles, many policy makers have been concerned about the costs and benefits—and even the feasibility—of defending against certain threats. Virtually all missile-defense supporters believe that it is possible to defend the United States against missiles launched from the territory of rogue states, but regarding China there is much less consensus.

This chapter addresses China’s likely countermeasures against U.S. BMD and their implications. The purpose is not to conduct a cost-benefit analysis on the merits of investing in BMD *per se* but rather to explore how current investments can be made to yield the greatest security dividends for the United States given present geopolitical realities. It begins by outlining the American BMD debate as it relates to China, reviewing the evolution of BMD and countermeasures, and considering the potential impact of ballistic missile defense on China’s nuclear strategy. There follows a detailed discussion of China’s potential BMD countermeasures and a comparison of American and Chinese missile-defense strategies. Finally, the chapter offers conclusions and policy recommendations—for the nation and the U.S. Navy.

Uncertainty in U.S. BMD Strategy

Despite China’s potentially growing importance to American nuclear strategy, its relation to missile defense remains unclear. Both the Clinton and Bush administrations have stated that American BMD is not intended to “target” China.⁴ A nascent American missile defense could not block a barrage of Russia’s several thousand ICBMs,⁵ but it could conceivably block a significant portion of the approximately thirty-two Chinese missiles currently estimated to be capable of striking the continental United States.⁶

Recent American administrations have repeatedly and energetically attempted to reassure Russia that it is not a target of U.S. ballistic missile defense.⁷ Russia has apparently acquiesced to the construction of a U.S. national missile defense system. But China’s situation is more problematic. While American policy officially states that BMD’s purpose is to protect the nation against rogue states, many believe that its ultimate purpose is to constrain China. “While Washington does not mention Chinese missiles as a justification for missile defense,” it has been pointed out, “some private analysts do.”⁸

Notes

For example, military scholar James Hentz asserts, “The U.S. NMD [national missile defense], from a strategic and deterrent perspective, is essentially about China.”⁹ *Washington Times* reporter Bill Gertz declares that

because China is sharply building up its missile forces, a U.S. national missile defense directed at countering China must be deployed as soon as possible. China has shown no willingness to curb its building of short-, medium-, and long-range missiles, and the development and deployment of American missile defense to counter them must be speeded up. The missile defenses will neutralize the key element of China’s program of power: nuclear missiles, both intercontinental and regional.¹⁰

Still other American analysts, a Chinese nuclear strategist notes, “argue that the USA should not care about China’s reactions to NMD development and deployment because China will modernize its nuclear force in any case.”¹¹

The question of whether BMD can help defend against China has also attracted the attention of Congress. In this context, Senator Jon Kyl (R-Ariz.) has reportedly declared that “China may be one of the countries that we will have to protect against one day.”¹² In May 1999 the *House of Representatives Select Committee on National Security and Military/Commercial Concerns with the People’s Republic of China*, known as the “Cox Committee,” asserted in a lengthy report that China was making rapid progress in ICBM development. Many in Washington now cite the report as evidence of the need for BMD to deter Chinese aggression.

At the same time, however, the report also emphasized Chinese advances in BMD countermeasures. The Cox Committee postulated that China seeks to threaten America’s strategic capability by developing more advanced ICBMs and, possibly, developing technology to defeat a future American missile-defense system. The vulnerability of China’s silo-based DF-5

东风五号

DF-5 (Dong Feng/East Wind)

missiles has prompted Beijing to begin developing a road-mobile, solid-propellant version, the committee asserted—as part of a larger modernization program.¹³

As the Cox Report also noted, statements by Chinese officials demonstrate that China is opposed to the development of both U.S. NMD and theater missile defense (TMD) systems (such as one to protect Taiwan) that could counter Beijing’s currently limited nuclear forces. China is already pursuing a variety of means to preserve its nuclear capability. China’s future initiatives could include expanding its ballistic missile force or developing penetration aids, maneuvering reentry vehicles (MARVs), or multiple, independently targeted reentry vehicles (MIRVs). The first would be intended to confuse a missile defense system, the second to outmaneuver it, and the third to overwhelm it.

The Cox Committee projected that “within 15 years” China could deploy an “ICBM force consisting of up to 100 ICBMs.”¹⁴ The committee further argued that “the aggressive development of a MIRV system by the PRC could permit the deployment of

upward of 1,000 thermonuclear warheads on ICBMs by 2015.”¹⁵ These new weapons, the report elaborated, require smaller warheads than China has yet deployed.

By contrast, *Countermeasures*, a detailed report produced by the Union of Concerned Scientists and the Security Studies Program of the Massachusetts Institute of Technology, contends that “the planned NMD system would not be effective against a Chinese attack” because China

has indicated that it would take steps to permit it to penetrate the planned NMD system. China would likely respond by deploying more long-range missiles capable of reaching the United States. More significantly, as the 1999 [U.S.] National Intelligence Estimate notes, China has developed numerous countermeasures. The United States must therefore expect that any Chinese ballistic missile attack—whether using existing or new missiles—would be accompanied by effective countermeasures.¹⁶

Countermeasures has been criticized by proponents of an ambitious missile defense, but it is taken seriously in China. A popular textbook on ballistic missile design written by a popular professor and published by Beijing Aerospace University Press, for example, adopts wholesale the report’s conclusions on BMD penetration methods.¹⁷ In a separate technical article, the textbook’s author concludes:

The NMD system’s interception methods reveal some inherent system flaws. These inherent flaws should be closely considered, as countermeasures are to be determined. The above-mentioned methods were only brief introductions from relevant literature abroad. In research of the NMD countermeasures, our own practice should be combined and integrated with these known measures. Only by doing so, [will] breakthroughs . . . be accomplished.¹⁸

Countermeasures was translated into Chinese and published by Beijing’s National Defense University Press the same year that it appeared in the United States.¹⁹ This seems to suggest that a new generation of top Chinese missile engineers is being taught that “‘Nothing is hard enough not to be destroyed,’ ‘Attack is always easier than defense,’ and ‘Attack is the best defense.’”²⁰

Chinese analysts have closely followed the American debate over BMD and its relationship with China policy.²¹ They are concerned about the implications for their nation’s nuclear deterrent: “By 1996 there was rising concern in many circles in China that America’s BMD strategy in Asia was being pursued as part of a covert containment policy toward China.”²² Indeed, Qinghua University strategists Wu Rui and Li Bin emphasize that “U.S. NMD deployment is a new element that concerns China about the effectiveness of its nuclear deterrence.”²³ China is therefore carefully studying America’s BMD development and appears to be actively planning a set of counterstrategies.

A Survey of BMD and Countermeasures Development

Ironically, U.S. ballistic-missile-defense deployment originated with China in mind.²⁴ The first competitive impetus for missile defense emerged in 1966, when Defense Secretary Robert McNamara announced Moscow’s deployment of the Galosh system.²⁵

Notes

President Lyndon B. Johnson felt pressured to respond, but had to acknowledge that America's available response—the SENTINEL system—could not defend adequately against Soviet ICBMs. By contrast, China, though a growing nuclear and political threat, had yet to develop ICBMs. On 18 September 1967, McNamara delivered a speech at the San Francisco Press Club that argued against the possibility of defending against Soviet missiles but for the potential to “defend against the predicted small Chinese ICBM threat and accidental launches.”²⁶

The Chinese rationale proved inadequate for President Richard M. Nixon, who delayed SENTINEL deployment in order to review nuclear programs, before approving it the next month as “SAFEGUARD.” The Senate barely approved deployment in August 1969, with Vice President Spiro Agnew casting a tie-breaking vote.

In May 1972 Washington and Moscow signed the Anti-Ballistic Missile (ABM) Treaty, which prohibited national missile defense but permitted each party two missile defense sites, each with a maximum of one hundred interceptors. In July 1974, by mutual agreement, sites were reduced to one each.

SAFEGUARD began operation in Grand Forks, North Dakota, on 1 October 1975 but was closed by the House of Representatives the following day. Three months later, the Senate concurred. In an ironic twist of fate, it was Defense Secretary Donald Rumsfeld who announced SAFEGUARD's demise, which was completed in 1978. The program had fallen victim to a growing antinuclear movement and to fears that its nuclear interceptors—themselves a potential source of fallout—would serve as a magnet for Soviet attack. The North Dakota site had been chosen because citizens of more populous areas, such as Washington, D.C., had refused to accept that risk.

It was President Ronald Reagan who resurrected NMD, rekindling a debate that continues to this day. Reagan introduced his Strategic Defense Initiative (SDI) in a dramatic speech on 23 March 1983 that surprised even members of his cabinet. On 24 April 1984, Defense Secretary Caspar Weinberger signed the Strategic Defense Initiative Organization (SDIO) charter. Reagan injected deliberate uncertainty by threatening to render the USSR's nuclear arsenal “impotent and obsolete.”²⁷ While the technical community was divided over SDI's viability, many American and Soviet politicians and citizens were convinced that it would prove workable. Some Soviet scientists may have been skeptical, but their nation's loss of the space race and its declining power deprived them of the credibility to undermine Reagan's claims. Moscow's “ABM system, the Galosh, was perceived as obsolete, while [its] economic capacity to engage in a new arms race in NMD was already deemed suspect.”²⁸

Even the potential for effective development of national missile defense arguably helped the United States to win the Cold War, by pressuring the Kremlin. But since then, the metrics have shifted. NMD is now judged primarily on its anticipated effectiveness. Unfortunately, it has evolved somewhat fitfully, because of political vicissitudes and a resulting lack of consistent vision as to its ultimate architecture and use. Phase I of the current U.S. NMD program occurred at the end of Reagan's presidency, between 1987 and 1989;²⁹ thousands of ground- and space-based interceptors were envisioned to help deter a Soviet first strike. Phase II was President George H. W. Bush's 1989–92 program for Global-Protection Against Limited Strikes (GPALS). GPALS proposed hundreds of ground- and space-based interceptors to guard against accidental or unauthorized launch. Bush also reduced the Soviet nuclear threat, by signing the START I treaty, arising from the Strategic Arms Limitation Talks with Premier Mikhail Gorbachev, on 31 July 1989, by which each nation's arsenal fell to six thousand deployed strategic warheads. The START II agreement, which Bush later signed with the Russian Federation's first president, Boris Yeltsin, further reduced deployed strategic warheads, to between three thousand and 3,500.

President Bill Clinton's two terms, corresponding to Phases III and IV, reflected both a struggle to adapt the U.S. military to a changing post–Cold War world and a pragmatic, noncommittal attitude toward missile defense. In May 1993, as if to signal a retreat from Reagan's SDI ambitions, Defense Secretary Les Aspin renamed SDIO the Ballistic Missile Defense Organization (BMDO). Phase III, known as "Technology Readiness," entailed the development of technology to expedite deployment of a ground-based system between 1993 and 1995 but without fully committing the nation to such a system. Two Chinese analysts have recently cited cost concerns as underlying the Clinton administration's hesitation to deploy NMD.³⁰

Senator Robert Dole (R-Kans.), who ran against Clinton in the 1996 presidential election, did not succeed in making the administration's lack of enthusiasm for NMD an issue.³¹ Dole was trying to build on a near success on 15 February 1995, when the House of Representatives approved legislation requiring NMD deployment as rapidly as technically possible. A similar measure failed in March 1996 because of cost. Pressure from congressional Republicans, nevertheless, prompted Clinton to devote Phase IV, from 1996 to 1999, to "Deployment Readiness," by integrating systems so as to allow possible deployment of tens of exclusively ground-based interceptors. Clinton left the decision of whether to deploy them to his successor.

President George W. Bush made NMD a 2000 campaign issue and has since withdrawn the nation from the Anti-Ballistic Missile (ABM) Treaty and pushed an ambitious multi-tier defense system designed to incorporate ultimately hundreds of ground-

based interceptors. Already partially tested by BMDO's successor, the Missile Defense Agency (MDA), the system achieved its first stage of deployment in October 2004, when six interceptors were placed in silos at Fort Greely, Alaska. Its scope, purpose, and effectiveness remain matters of heated debate.

Countermeasures Programs

In several major reports concerning BMD—such as *Countermeasures*, *The APS Study*, and *Technical Realities*, panels of distinguished physicists have argued that China and even other BMD opponents may well be able to exploit inherent asymmetries of physics to defeat BMD: “The defense faces the extremely difficult task of assessing and responding to an attack that is explicitly designed to defeat it. The attack may have characteristics quite different from anything that has been anticipated or that the defense has been tested against. And the defense will have to respond quickly and successfully the first time it is tried.”³²

American countermeasures development started around 1958 and by 1964 was consuming the equivalent of two billion dollars annually in advanced research on decoys, chaff, and other countermeasures.³³ As the Cold War subsequently threatened to heat up, the United States produced decoys for the Atlas F and Titan 2 ICBMs and for the MIRV “buses” of the Minuteman ICBM and the Poseidon submarine-launched ballistic missile. When first deployed in 1971 the Poseidon SLBM could carry as many as fourteen MIRVs, giving the U.S. Navy confidence that it could defeat Moscow's allowable hundred interceptors. The United States also developed other SLBM countermeasures, such as the Trident's Mark 500 MARV. All current U.S. ICBMs likely have countermeasure capacity.

Aware of BMD's potential weaknesses, the United Kingdom and France, like other advanced nuclear-weapons states have long pursued sophisticated countermeasures initiatives; research remains highly classified, but broad outlines have emerged. British and French countermeasures programs were more limited, being focused on Moscow. Britain's Polaris SLBMs, which entered phased retirement in 1995, employed the advanced CHEVALINE system. CHEVALINE carried two warheads and four decoys (each rocket-motored to facilitate simultaneous reentry), all six of which may have been “enclosed in gas-filled metal-coated balloons” to be released among many empty balloons. While lack of indigenous SLBM production experience ultimately caused London to seek American help in developing the system's maneuvering bus, CHEVALINE's sophistication alone is impressive. Britain's current Trident II SLBMs, the basis of its long-range missile force, may employ even more advanced countermeasures. France's single warhead S-3 intermediate-range ballistic missile and M-20 SLBM also used decoys. The

M-4 SLBM, now France's sole ballistic-missile type, carries up to six MIRVed warheads and apparently boasts "nuclear hardening and reduced radar cross sections."

Sophisticated countermeasures development has been the province of the United States, the United Kingdom, France, and Russia—as well as, to some extent, China, the related initiatives of which are addressed below. There seems to be a consensus that developing states would not likely be capable of fielding sophisticated countermeasures (not only for boost phase, the most difficult, but also for midcourse and terminal phases) without significant assistance or outright purchase from such aerospace powers as China or Russia. According to a report prepared for BMDO, in the absence of such mentoring, planners in rogue states tend to "exploit existing information . . . [;] [e]mphasize available technology . . . even if [it] is considered 'obsolete' or 'low-tech' by the West[; c]hoose simple solutions over 'high tech' ones to countermeasure requirements [;] and [a]dopt a broad range of countermeasures initially and then rely on subsequent combat experience to prove which are more effective."³⁴

Even if such states obtained them for prestige purposes, without effective testing countermeasures might prove impossible to use successfully. Few American experts seem to argue that rogue states, with their resource and technical limitations, would be capable of reliably defeating a robust, even if limited, U.S. missile defense.

Relative Countermeasure Vulnerability of BMD Phases

BMD intercept is divided into three categories: the boost, midcourse, and terminal phases of an enemy missile's flight. Some scientists and other experts are especially concerned about the possibility that U.S. BMD could be foiled in the midcourse and terminal phases. Midcourse intercept is the current focus of the evolving American NMD system and hence today the most fully developed. However, according to Richard Garwin, an experimental physicist who has assisted the U.S. government with missile defense since the 1950s, emphasis on midcourse intercept is misguided, because "the countermeasures are all too simple. The money and skill needed to implement them are trivial compared with the effort required to design, build, and care for the ICBMs themselves."³⁵ In fact, Garwin contends, America's "present missile defense approach is utterly useless against ICBMs of new or existing nuclear powers because midcourse countermeasures are so effective." To be sure, Garwin's claims may apply more to China than to (less technologically capable) rogue states. But Garwin's experience as chair of the State Department Arms Control and Nonproliferation Advisory Board from 1994 to 2001 and as a member of the Rumsfeld *Commission to Assess the Ballistic Missile Threat to the United States* in 1998 merit that his assessment be considered seriously.

Terminal phase intercept is even more problematic, because the need to distinguish between incoming missiles and decoys requires the system to wait until atmospheric reentry to attempt interception, leaving little margin for error. It requires positioning of interceptors no more than fifty kilometers from the targets they defend, potentially involving an exorbitant number of interceptors to protect even a small percentage of the nation's vulnerable sites. Also, by the time of atmospheric reentry, incoming missiles could already have deployed multiple warheads or submunitions (e.g., biological weapons). In any case intercepting nuclear weapons at this late stage could blanket American territory with fallout.

The one aspect of BMD, then, that many of its critics—including Garwin and an outspoken specialist at MIT, Professor Theodore Postol—have endorsed is boost-phase intercept, primarily because it is very difficult to use countermeasures at this stage. As Garwin points out, “credible decoys cannot be released from the ICBM while the rocket is still firing—they would soon be left behind.” The American Physical Society concludes that while “such [extremely advanced] countermeasures as multiple launch [including that of dummy missiles], maneuvering, rotation, ablative coatings, or phase shortening could be used during boost phase,” nonetheless “boost-phase systems potentially offer three important advantages: [1] the possibility of destroying missiles before they can deploy multiple warheads or submunitions, [2] the presumed difficulty of developing countermeasures, and [3] the ease of tracking the bright exhaust plumes of ICBMs in powered flight.”³⁶

Garwin believes that the APS study is “in reasonable agreement of my qualitative estimates of 1999,” which led him to “urge [BMDO] . . . to abandon the midcourse defense and assign higher priority to boost-phase intercept instead.” The approval of both Garwin and the APS study suggests that boost-phase intercept may be worthy of special consideration for future U.S. BMD systems.

BMD's Impact on China's Nuclear Strategy

China currently maintains a limited nuclear deterrent with a somewhat credible second-strike capability. This is a logical outgrowth of China's nuclear policy, announced when it detonated its first atomic bomb on 16 October 1964. China developed its nuclear capability to “prevent nuclear blackmail,” “break the superpowers' monopoly,” and also to secure great-power status. Chairman Mao Zedong's dialectical vision shaped Beijing's nuclear policy. That is, Mao condemned nuclear weapons as a “paper tiger” and vowed not to stockpile a large arsenal. He declared that “nuclear weapons and their delivery systems could not alter the basic nature of warfare or require the revision of his People's War doctrine.”³⁷ Yet he ordered for such purposes the expenditure

of resources that China scarcely had and the exploitation of technological capabilities that China would have to develop.³⁸ For much of the Cold War, China decried arms control as imperialist monopolism;³⁹ it still views many arms control agreements as inherently unequal.⁴⁰ Due to dysfunctional strategic management, “until the early 1980s, there were no scenarios, no detailed linkage of the weapons to foreign policy objectives, and no serious strategic research.”⁴¹

China has pledged never to use nuclear weapons in a first strike, and it has pointed to the comparatively small size of its nuclear arsenal as evidence that its purpose is strictly that retaliatory second strike. The inaccuracy of China’s initial ICBMs necessitated a focus on countervalue, as opposed to counterforce, targeting. Throughout most of the Cold War, including conventional hostilities with the Soviet Union in the late 1960s—during which Moscow reportedly considered surgical strikes on China’s nuclear facilities—it was far from certain that China had a fully reliable second-strike capability, given its relative paucity of weapons and their relative lack of sophistication (e.g., liquid fuel, etc.).

China’s leaders themselves were concerned that their second-strike capability might be unreliable and hence not fully credible to a potential opponent. In the short term, the People’s Liberation Army attempted to make the most of its arsenal by dispersing and concealing its ICBMs in caves and hardened silos and by constructing decoy silos. China’s long-term strategy was to modernize its nuclear arsenal and delivery systems gradually, in order not to alarm its neighbors and trigger a regional arms race. Hoping to take advantage of post-Cold War disarmament and “multipolarity” to make time for strategic modernization, Beijing adopted the ABM Treaty as a key link in its arms control strategy.

Ironically, China had come around to embracing the ABM Treaty just as the United States was about to abandon it. As the Bush administration prepared to withdraw from the ABM Treaty, China launched a diplomatic initiative to fight for its preservation.⁴² In 1999, Ambassador Sha Zukang, Ministry of Foreign Affairs Department of Arms Control and Disarmament Director General, charged that “any amendment, or abolishing of the [ABM] treaty, will lead to disastrous consequences. This will bring a halt to nuclear disarmament between the Russians and Americans, and in the future will halt multilateral [e.g., Chinese] disarmament as well.”⁴³

China’s diplomatic offensive crumbled when Russia, having few alternatives, acquiesced to American withdrawal from the ABM Treaty in June 2002 in return for fairly minor concessions.⁴⁴ On 24 May 2004, Moscow and Washington signed the Strategic Offensive Reductions Treaty, committing each side to reduce its strategic nuclear warheads to between 1,700 and 2,200 by 31 December 2012.⁴⁵ Since then, China has taken a principled

stand against missile defense but has moderated its rhetoric.⁴⁶ China's current relative silence on the issue reflects both acknowledgement of a temporary setback and of the emergence of a new calculus that if BMD cannot be prevented outright, it must be rendered harmless to China.

China contends that BMD would enable Washington to engage in "nuclear blackmail."⁴⁷ Credible U.S. BMD capabilities, if attainable, would threaten China's current limited deterrent. That could encourage China to rely even more heavily on secrecy and deception to promote nuclear deterrence, thus creating the dangerous potential for miscalculation.⁴⁸ As Chinese nuclear strategist Li Bin points out, "China will most probably maintain the policy of quantitative ambiguity as a way of protecting its nuclear deterrence until it has built up a survivable nuclear retaliatory force that relies on geographical ambiguity instead."⁴⁹ Long a practitioner itself of strategic ambiguity, Beijing views American uncertainty concerning its nuclear and aerospace power as a source of security.

Desire to retain its limited deterrent without a major increase in spending is only one reason why China officially opposes U.S. ballistic missile defense. Beijing's vocal resistance seems in fact based far more on regional concerns than on actual fear that BMD might prove effective and irrevocably neutralize China's nuclear deterrent.⁵⁰ Indeed, Li Bin contends that the United States "will not be able to build a real national missile defense capability quickly because some of the technical problems are difficult to solve."⁵¹ Another analyst emphasizes that while "NMD has its tactical defense value against 'enemy countries' other than major nuclear powers or intermediate-level nuclear countries that possess a certain long-range nuclear strike capability . . . NMD, no matter how perfect it becomes, could not truly stop a nuclear war or a nuclear strike on the US continent."⁵² Rather, China is concerned that U.S. national and theater missile-defense systems might (1) embolden Taiwan, by increasing domestic support for pro-independence leaders; (2) trigger Japanese rearmament, by involving Tokyo more closely in American military planning and missions—particularly those involving Taiwan; (3) consolidate America's hegemony, by making its deterrent more credible to current and potential allies; and (4) undermine existing arms control initiatives.⁵³

The United States has made only limited attempts to involve China in BMD policy, and these have had little success. For instance, President Bush and members of his administration have attempted to reassure China that it is not the "target" of ballistic missile defense. Immediately after President Bush's 1 May 2001 speech on BMD, and again in October 2001, Assistant Secretary of State James Kelly met with Chinese officials. Secretary of State Colin Powell met with Chinese interlocutors in July 2001. In December 2001, just before the United States formally announced its intent to withdraw from the

ABM Treaty, Assistant Secretary of State Avis Bohlen met with her Chinese counterparts. Assistant Secretary of Defense Peter Rodman followed suit in September 2002.⁵⁴ President Bush himself called Jiang Zemin (then General Secretary of the Chinese Communist Party, as well as president of the PRC and chairman of the Central Military Commission) to inform him that Washington would withdraw from the ABM Treaty and “to express interest in holding strategic stability talks.”⁵⁵ He later hosted Jiang at his ranch in Crawford, Texas. These efforts may have helped to avert the most dire Chinese suspicions, but the face-conscious Chinese government could not help noticing that Russia had received firmer assurances, from higher-level officials, sooner than China did. Furthermore, these reassurances tended to warn China that it had no reason to build up its nuclear arsenal to counter BMD without addressing the issues that might motivate precisely such a response. According to Admiral Eric McVadon (U.S. Navy, Ret.), Secretary Powell’s arguments that the U.S. missile defense system would be limited and no threat to Chinese long-range missiles was, for the Chinese, drowned out by other signals from outside (but close to) the administration and silence within it as to how the concept would evolve.⁵⁶

“Americans can insist that they mean no harm with national missile defense,” Council on Foreign Relations vice president James Lindsay and Brookings Institution scholar Michael O’Hanlon contend, “but that will not stop China and Russia from taking steps to protect their interests.”⁵⁷ In fact, new American and Russian strategic flexibility has come at China’s expense. “The Bush administration has reportedly told the Russians [that] they could MIRV . . . their missiles should they feel uncomfortable with U.S. BMD plans, and, accordingly, the Russians have effectively revoked START-II in June 2002 to allow them to place multiple warheads on their strategic missiles.”⁵⁸ China, by contrast, has enjoyed none of these reassurances and accordingly feels anxious about Washington’s and Moscow’s quests for strategic flexibility. There is increasing concern in Beijing that with the Soviet Union gone, and despite the War on Terror, China has become the new focus of American military pressure.⁵⁹

China’s ballistic missile modernization began before it assessed that the United States would deploy a missile defense, but China likely will take measures to improve its ability to defeat the defense system in order to preserve its strategic deterrent. The measures likely will include improved penetration packages for its ICBMs, an increase in the number of deployed ICBMs, and perhaps development of a multiple warhead system for an ICBM, most likely for the CSS-4.⁶⁰

In 2003 a Council on Foreign Relations task force determined that “in accordance with published CIA estimates . . . China has straightforward means available to overcome the U.S. [NMD] now planned for deployment and that China will do what is required to maintain and strengthen its nuclear deterrent.”⁶¹ A Chinese expert agrees that “China will certainly seek possible approaches that help maintain the effectiveness of its nuclear deterrent.”⁶² That is why China is already investing in countermeasures to

defeat BMD: because China “places a premium on ensuring [that] its ballistic missile force would be able to penetrate any future missile defense architecture, collection of information that would support development of effective missile defense countermeasures has a relatively high priority.”⁶³ China would prefer not to be forced into such a course of action but believes that it can maintain deterrence: “In the long run, analysts are confident that China will be able to counter BMD.”⁶⁴

China's Potential BMD Countermeasures

China's rapidly growing technological and defense industrial capabilities—particularly in aerospace—give it increasing symmetric and asymmetric options to defeat U.S. BMD. This discussion relies on open sources to address a topic on which information is severely restricted due to China's lack of transparency.

Quantitative and Prelaunch Countermeasures

China could deploy prelaunch, postlaunch, and infrastructure-targeting countermeasures. Some measures are already likely deployed, others are undergoing development and testing, and still others perhaps remain at the conceptual stage for consideration if the perceived need for them becomes sufficiently urgent. Achieving reliable capability to defeat U.S. BMD would require significant investment and testing, but China has the resources and would be likely to commit them if its nuclear deterrent were truly threatened. According to one report, the majority of Chinese policy makers support a three-fold response to American missile defense: “(1) increase the total number of warheads deployed to a level just beyond the saturation point; (2) develop MIRVs (multiple independently targetable reentry vehicles that can overwhelm missile defense); and (3) pursue other effective countermeasures to defeat the U.S. system.”⁶⁵ China has a wide variety of options to support each of these three counterstrategies.

The most straightforward course of action for China would be to continue to improve and expand its nuclear arsenal and delivery systems with the goal of saturating defenses. China has already enhanced the prelaunch survivability of its nuclear weapons by shifting to solid propellants; improving C4ISR (command, control, communications, computers, intelligence, surveillance, and reconnaissance—see chapter 1 in this volume); using camouflaged, hardened silos; and developing road-, rail-, and barge-mobile ICBMs. Possible sub-elements of this process could include increasing missile accuracy, developing a robust submarine-launched second strike (see chapter 2), and even ultimately replacing Russia as the “second nuclear power.” Chinese strategist Shen Dingli projects that a ninefold increase in Chinese ICBMs capable of hitting U.S. targets would defeat even a BMD system with a 90 percent interception rate, and at the manageable cost of several billion dollars over one or two decades.⁶⁶ According to Li

[Notes](#)

Bin, “Although the costs could be large, the buildup option cannot be ruled out. The reason for this is that the buildup option is so mathematically simple to understand and so certain to work. So, in the Chinese debate this idea would easily win some support from nontechnical people. Another advantage is that the buildup would be visible to the outside and would therefore help discourage any first strike against China.”⁶⁷

The unclassified version of the U.S. National Intelligence Council’s December 2001 report estimates that “Chinese ballistic missile forces will increase several-fold by 2015” and that by that year “Beijing’s . . . ICBM force deployed primarily against the United States . . . will number around 75 to 100 warheads.”⁶⁸ A Chinese missile buildup would facilitate, among other things, wartime launch of strikes incorporating the use of different types of missiles in “synchronized launches from a wide range of azimuths in order to stress active missile defenses and associated battle management systems.”⁶⁹

China could also conceivably increase the deterrent power of its current nuclear arsenal, by altering its nuclear doctrine. This might entail placing its forces on a higher state of alert or even abandoning its no-first-use policy in favor of “launch on warning.” China might seek to improve its nuclear weapons capabilities by slowing or reversing arms control commitments. This could entail continuing “production of fissile material for nuclear weapons. China may also fail to ratify the Comprehensive Test Ban Treaty (CTBT), particularly given the rejection of that treaty by the U.S. Senate, or may even resume nuclear testing in order to develop countermeasures to the NMD system or warheads for multiple-warhead missiles.”⁷⁰

A more radical approach, which would represent a significant problem for Washington, could be “horizontal escalation.” China’s nuclear buildup might improve not only Chinese but also—through technology transfer—Pakistani capabilities vis-à-vis India, possibly triggering a regional arms race: “Because the United States needs China’s cooperation in limiting missile proliferation, a deterioration in U.S.-China relations may also lead to an increased missile threat from other countries.”⁷¹ An antagonized China could increase the missile capabilities of rogue states like North Korea and Iran. According to a Carnegie Endowment study, China is “a major supplier of nuclear technology and equipment in the developing world, and its past behavior in the nuclear and missile fields is a significant non-proliferation concern.”⁷² Indeed, Li Bin suggests that China’s current compliance with the Missile Technology Control Regime hinges on American respect of its strategic interests.⁷³ Li and fellow Qinghua University strategist Shen Liangyin note that while unilateral export controls are popular in U.S. Congress, they typically have limited utility in halting technology transfers.⁷⁴

Postlaunch Countermeasures

A technologically advanced nation like China could deploy a wide variety of countermeasures to enhance the postlaunch survivability of its nuclear weapons. Postlaunch countermeasures, which include counter-intercept measures and penetration aids, can be combined to increase their effectiveness.

Counter-intercept measures, which are designed to prevent interceptor target engagement, include multiple warheads placed on multiple reentry vehicles (MRVs) or multiple independently targeted reentry vehicles, maneuvering reentry vehicles, and the hardening or spinning of ballistic missiles.⁷⁵ MIRVs can be placed in different trajectories by a bus platform that changes position slightly as it launches them in succession. MARVs, even more sophisticated, are capable of independently altering their trajectories even in the terminal phase. Spinning and rolling (spinning off-center) a ballistic missile makes a specific portion of it more difficult to target, complicating particularly the use against them of lasers, which may need to focus on an object for several seconds in order to destroy it. Laser cladding involves protective coatings that harden missile exteriors against laser beams.⁷⁶ Lasers are also vulnerable to smoke, which can be emitted from a canister on the missile itself.

Warhead miniaturization decreases the infrared signal of a reentry vehicle, making it much harder for an interceptor to target.⁷⁷ Miniaturization could also permit the use of MRVs and MIRVs. According to a noted American expert on the PLA, "It should probably be assumed that MRV, and quite possibly MIRV . . . research and development has been under way for some time [in China], and that the question of force size is being seriously . . . debated within Beijing's community of security strategists."⁷⁸ Indeed, Li Bin claims that "China has the capability to develop . . . MIRVs . . . but has not done so."⁷⁹ Because MRVs are easier to develop than MIRVs, "the U.S. intelligence community assesses that China could develop a multiple [reentry vehicle] RV system for the DF-5 ICBM in a few years."⁸⁰

R&D on multiple independent reentry vehicles (MIRVs) was initiated as early as 1970. . . . The current force of DF-5A missiles is deployed with single warhead[s], but in November 1983 China inaugurated a DF-5 modification program to arm these ICBMs with MIRVed warheads. Technical difficulties, however, have stalled the program. The DF-5A, able to strike targets in the continental United States (CONUS), was the designated recipient of the MIRVs, although there is no evidence that they have been deployed. Some sources claim that at least four DF-5As have already been MIRVed, though it is generally asserted that while MIRVing may occur within the next few years no DF-5s have yet been fitted with MIRVed warheads. Based on the DF-5A throw weight and warhead shroud the missile could be equipped with . . . six reentry vehicles with each RV [reentry vehicle] weighing six hundred kilograms (the size of the single warhead on the DF-21). The DF-5A second stage apparently has four vernier engines, which reportedly fire for 190 seconds after the main missile engine cuts off. Thus the DF-5A could direct a warhead bus over a fairly large arc covering an array of aim points. But the exact status of this program cannot be confirmed based on open sources.⁸¹

Penetration aids have been, and will likely continue to be, a focus of anti-BMD efforts. According to three Chinese experts, penetration aids “are inexpensive and they have a low political cost. Further, it is technically unlikely that a U.S. defense system would ever work so well that it could sort out penetration aids from warheads. That would ensure that China’s retaliatory force would remain viable.”⁸²

China has already begun to develop and test decoys to some extent. Of two major decoy variants, the simpler saturation option, decoys (such as balloons), are designed to overwhelm midcourse or terminal defenses. Deception decoys (such as fast-burn motors and boost-phase maneuvering) are designed to evade interceptor vehicles by complicating predictions of flight trajectory.⁸³ Decoys can mimic the warhead’s visual appearance or infrared signature. They can utilize active electronic countermeasures, such as radar-jamming signals. They can even physically protect the warhead from an interceptor. Exoatmospheric decoys accompany warheads during the midcourse phase, but because of their light weight they separate upon reentry; endoatmospheric decoys reenter the atmosphere with the warhead.

As American interceptor test failures in three out of nine recent tests have demonstrated, “to pick out the warhead from deliberately designed decoys is one of the most challenging problems to the development of a missile defense system.”⁸⁴ Some question whether these tests were even representative of the countermeasures challenges that NMD might face: “Basic physics argues strongly that decoys closely resembling real warheads simply cannot be distinguished from actual threats by the U.S. sensor system now in development.”⁸⁵ Li Bin states that “decoy technology is not too complicated for China. This means that the deployment of decoys is a much more efficient and simple way than MIRVs for China to defeat the NMD system.”⁸⁶ Intercept could be complicated by a combination of decoys. Chinese ICBMs could be designed to “discharge chaff just prior to releasing decoys and warheads—to prevent radars from seeing what happens during the release—or by [developing] a more sophisticated release mechanism that makes decoys and warheads indistinguishable even at the moment of separation from the bus. It is for these reasons that the decoy problem is acute, and possibly not solvable for the foreseeable future, in the case of midcourse defenses.”⁸⁷

Other postlaunch countermeasures include cold launch, trajectory manipulation, and infrared stealth. Cold launch, also known as “ejection” or “soft launch,” is a means of reducing the infrared signature of a missile by propelling it out of a silo with compressed air or other gas before engine ignition. For example, the silo-based American LGM-118A Peacekeeper missile, which is fully encased in a canister, would be “ejected by pressurized gas some fifty feet into the air before first stage ignition.”⁸⁸ In 1975, the UR-100MR/SS-17 Spanker became the first Soviet missile with a cold-launch system.⁸⁹

Even a highly effective boost-phase defense would technically be susceptible to the cold launch of missiles, which delays detection of launch slightly and thereby reduces time in which to launch an interceptor. Fortunately, cold launch may well be too difficult for rogue states to employ for the foreseeable future; only the United States, Russia, China, and South Korea have mastered it. China cold-launches the JL-1 solid-propellant SLBM;⁹⁰ in December 1998 China conducted a cold-launch test on the new DF-31 ICBM.⁹¹

Trajectory manipulation involves “depressed” and “lofted” trajectories.⁹² Depressing a missile’s trajectory means flattening its flight path, bringing the normal apex of 1,200 miles as low as sixty miles in order to minimize its time outside the atmosphere and thus its exposure to space-based and midcourse defenses. Chinese testing and modeling indicates that the trajectory of the DF-31 could be reduced from 330 miles to sixty miles, albeit with a significant loss in range.⁹³ Lofting a missile’s trajectory raises its apex altitude in order to increase reentry speed.

Finally, infrared stealth “can be implemented by several means, such as using low-emissivity coatings or a cooled shroud.”⁹⁴ Fast-burning motors shorten the duration of boost phase.

Aside from the challenges of cold launch and fast-burning motors, a boost-phase intercept system would also have extreme difficulty in defending “against missiles launched from large countries such as Russia or China,” because of the difficulty of getting American interceptor platforms close enough to launch sites in the interiors of these large continental powers.⁹⁵

Infrastructure Targeting

China might also consider targeting the U.S. BMD system’s structure directly, through antisatellite attacks, direct attack on ground-based radars, and indirect electronic attack on elements of C4ISR structure.

A successful U.S. test on 13 September 1985⁹⁶ and three follow-up tests,⁹⁷ indicated that ASAT is technically feasible. China has conducted extensive research concerning American military satellites and ASAT weapons.⁹⁸ “In the military realm, microsatellites will play an indispensable role in future information warfare,” one Chinese analyst has stated, reflecting a view widespread in China’s defense industrial sector.⁹⁹ China could exploit a variety of options to defeat space-based interceptors (a laser, for instance), such as pellet clouds, ground-based rockets, or space mines.¹⁰⁰ The *Department of Defense 2004 Annual Report on the Military Power of the PRC* states, “A Hong Kong newspaper article in January 2001 reported that China had developed and ground-tested and would soon begin space-testing an antisatellite (ASAT) system described as a ‘parasitic microsatellite.’¹⁰¹ This claim is being evaluated.”¹⁰² Such a capability would be

extremely useful to China. According to one PRC countermeasures expert, using a “‘suicide satellite’ . . . to destroy both SBIRS [Space-Based Infrared System]-high and SBIRS-low on the NMD system would paralyze its early warning and surveillance capabilities. Then preemptive attacks can be launched at each component of the defense system.”¹⁰³ Two nongovernmental analysts dismiss the source that the Pentagon report cites.¹⁰⁴ However, the majority of analysts agree that China is conducting research to enhance its space-control capacity.¹⁰⁵

Electromagnetic-pulse weapons could completely disable U.S. radars. Active electronic countermeasures include the use of devices to jam X-band and upgraded early-warning radar systems. U.S. BMD ground stations are themselves vulnerable to attack. China’s growing submarine force may permit it to use SLBMs, submarine-launched cruise missiles (SLCMs), or land-attack cruise missiles (LACMs), against radars and support facilities. China is making a concerted effort to develop the Chang Feng and Hong Niao series LACMs.¹⁰⁶

长风

Chang Feng (Long Wind)

红鸟

Hong Niao (Red Bird)

Even the best BMD system is incapable of defending land targets against SLCMs and LACMs.¹⁰⁷ A Chinese source arguing for the potential of such weapons asserts that “special forces may be trained to effectively infiltrate and destroy the [missile defense] stations.”¹⁰⁸

Both types of Chinese missiles might be susceptible to U.S. GPS jamming.¹⁰⁹ This, however, is a larger problem that Beijing is working to address—possibly through improvement and expansion of its currently rudimentary Beidou satellite navigation system.¹¹⁰

北斗

Beidou (Big Dipper)

According to *China Defense Today*, Beijing is developing Beidou “to improve the accuracy of its weapons and the situational awareness of its military forces.”¹¹¹

Chinese Countermeasures Testing and Deployment

China’s potential to deploy countermeasures to foil U.S. ballistic missile defense—while not yet proven by a vigorous testing program—has long since passed the theoretical stage. The father of modern Chinese rocketry, Qian Xuesen, first called for “the development of an advanced DF-5 warhead with penetration aids” on 4 January 1966.¹¹² Thanks to a Cold War–era need to deter the Soviet Union, with its Moscow-based BMD system, China had long ago established a record of developing and testing various BMD countermeasures to improve ICBM survivability.¹¹³ Early measures focused primarily on improving prelaunch survivability through more rapid fueling of liquid propellants and on cleverer means of concealment. These pragmatic measures periodically alternated with ambitious responses to American and Soviet advances. According to a Carnegie Endowment study, American initiation of SDI “reportedly spurred [China’s] plans to develop multiple-warhead technology. The first test of a multiple-

warhead missile took place in September 1984.”¹¹⁴ Lack of warhead miniaturization capabilities impeded deployment of MRVs or MIRVs at the time; today those capabilities should finally be within China’s grasp. Chinese experts have carefully studied Russia’s Topol-series advanced ICBMs as the model of an advanced BMD-defeating missile.¹¹⁵

China’s more recent tests suggest a trend toward a more systematic evaluation of countermeasures. CSS-5 (Dong Feng-21) Mod 1 and 2 tests in November 1995 and January 1996 apparently employed decoys, as did that of the new road-mobile DF-31 on 2 August 1999.¹¹⁶ DF-31 tests on 10 November 1995 and 10 January 1996 may have included endoatmospheric reentry decoys.¹¹⁷ A third test in November 2000 “involved decoy warheads traveling on a shorter flight path.”¹¹⁸ In July 2002 China reportedly “test-fired a medium-range missile [CSS-5, DF-21] containing [six to seven] dummy warheads designed to defeat BMD.”¹¹⁹ A Russian reporter cites the Pentagon as having observed that the missile “successfully avoided several ‘airborne destructive objects.’”¹²⁰ According to Jamestown Foundation analyst Richard Fisher, “the emergence of penetration aids all points to the [CSS-5, DF-21] as a highly survivable and accurate missile that will have the capability of defeating future American theater missile defenses.”¹²¹ A major Japanese newspaper reports that China tested the DF-21 with MIRVs in December 2002 and “has begun testing the DF-31 with multiple warheads.”¹²²

China is also known to have tested chaff and other penetration aids. Since the existence and capabilities of its countermeasures are generally highly classified, China may well have conducted other tests not reported in open sources—or even, as for component testing, observable to the U.S. military. Russian cooperation could give China access to advanced technologies specifically designed to counter an American ballistic missile defense system. There is no reason to believe that China will not be capable of improving its techniques in the future, particularly as its overall aerospace capabilities continue to advance. While it has been projected that “PRC countermeasures on longer-range ballistic missiles are unlikely to keep pace with U.S. technology,” inherent asymmetries favoring missile offense may more than compensate for any shortcomings in this regard.¹²³ Certainly American policy makers cannot afford to assume otherwise.

At the same time, Russian countermeasures technology—which has long targeted the United States, with a series of different systems—may be both most available to, and most relevant for, China. It will be important for American analysts to determine the extent to which China is gradually improving early-generation countermeasures designed to target Moscow and that to which it is actually developing innovative new countermeasures specifically to target American defenses. A sudden and intensive search for foreign expertise in a specific area might indicate that

China had run up against a technological roadblock, just as the United Kingdom suffered in developing CHEVALINE.¹²⁴

Chinese Responses to U.S. BMD Strategies

What potential PRC responses to missile defense would most threaten American interests? How will BMD affect China's strategic triad? What would be America's optimal strategy, given such realities?

U.S. BMD deployment will probably affect prioritization within China's strategic triad, by making more attractive the development of SLBMs and ICBMs. SLBMs arguably offer greater survivability. As chapter 2 of this volume emphasizes, China is rapidly improving its submarine force; an improved submarine force will allow China both to assert better control of its vast maritime periphery and to create a more effective platform for nuclear deterrence. Range improvements may allow China to develop a robust second-strike capability relying on SLBMs on board submarines hidden and protected in territorial water bastions.

As asserted above, ICBM-related improvements may offer China the potential to defeat American BMD either by saturating it or foiling it with countermeasures. If its nuclear deterrent seems vulnerable, China is likely to build up its ICBM force and possibly to multiply its effectiveness by developing the capacity to MIRV its nuclear warheads.

Strategic bombers would likely remain a lower priority for China. Aside from nuclear deterrence, China's primary strategic flashpoints are close to its current territory; also, it lacks overseas bases for power projection.¹²⁵ China's aircraft construction capabilities have thus far been modest, and China does not yet have an advanced long-range bomber to deploy. Moreover, China has not yet demonstrated the capacity to develop aircraft with stealth or electronic jamming. Therefore, bombers do not appear to be an especially promising leg of the nuclear triad for China now or for the foreseeable future.¹²⁶ A Carnegie Endowment study concludes that China is unlikely to "invest substantial resources in its airborne nuclear capability unless it is able to purchase the [advanced] T-22M Backfire [bomber] from Russia."¹²⁷ Moscow will use Backfire bombers in a joint military exercise to be held with Beijing in 2005. It may feel pressured to offer them for sale to secure Chinese aerospace purchases in light of Brussels' potential lifting of the EU arms embargo imposed on Beijing in 1989.¹²⁸

Potential Chinese responses that would be most detrimental to American interests include a major nuclear buildup to preserve the deterrent. Such a buildup might be triggered by NMD development that does not address China's core national interest in maintaining a limited deterrent. The key issue "is whether China could and would retaliate in ways that could counter or even outweigh the benefits of having missile

defense. China clearly has the means.”¹²⁹ If its limited nuclear deterrent were threatened, China would also have the motive.¹³⁰ It thus seems reasonable to conclude that

Although many Americans might desire a shield against a possible Chinese ICBM attack, it almost certainly cannot be achieved given China's ability to take measures to defeat it. Even worse, the act of trying to build NMD capability against China would worsen U.S.-China relations significantly, while increasing the odds that China would help the likes of North Korea gain [some of] the technical capability to overcome whatever U.S. missile defense system is built.¹³¹

Washington will probably not be able to use NMD to goad Beijing into Soviet-style military overextension. China's leadership has carefully studied the Cold War's outcome and is “determined to avoid the ‘overreaction to [SDI] which contributed to the downfall of the USSR.’”¹³² Rather, China's leaders acknowledge the true state of China's development, and do not hope to directly match U.S. military might in the near future.¹³³ In fact, robust BMD might even favor Chinese interests, by consuming American resources that could otherwise have been invested in such systems as submarines, for which China has only more limited and less asymmetric options. Some Chinese experts, indeed, view American national missile defense as “more of ‘a waste of U.S. effort than it is a great problem for China.’”¹³⁴ Two have concluded that America's current NMD system “would have only symbolic meaning rather than fighting capability in the real world. In the long term, some budgetary and cost problems could hinder the NMD development.”¹³⁵ Indeed, it is already rumored that MDA may suffer substantial imminent budget cuts because of competing priorities. Interviews conducted by Admiral McVadon with Chinese interlocutors in 2002 confirmed that many Chinese analysts believe “NMD will cost a lot and not work.”¹³⁶ McVadon judges that such statements seem “most likely” to reflect genuine opinions and are not merely coordinated misinformation.¹³⁷

While North Korea's ability to absorb Chinese assistance is unclear, China's long-term capabilities should not be underestimated. Whereas construction of aircraft carriers could trigger a costly reallocation of Chinese economic resources, something that Beijing has thus far studiously avoided, attempts to contain China with NMD could place the United States at a disadvantage by emphasizing expensive technology that is highly susceptible to asymmetric countermeasures—“Offense is always going to be much cheaper and less technologically demanding than defence.”¹³⁸ In fact, like the War on Terror, BMD may play a vital U.S. national security role and yet fail to enhance American capabilities vis-à-vis China—or even make them lower than they otherwise would be, by diverting resources from the Pacific theater.¹³⁹ Even if Washington does force China into an arms race, “there is no reason to believe that when the race ends, the United States will have a defense that can defeat a modernized Chinese arsenal.”¹⁴⁰

The Chinese response most favorable to the United States would be a nonresponse—that is, refusal to build up rapidly its nuclear and space weapons capabilities. But

China will not likely voluntarily restrain itself if it perceives its core national interests to be threatened.

Some might invoke China's capabilities and BMD vulnerabilities to argue against U.S. development of any sort of BMD system. But that nonresponse would be a mistake, for several reasons.¹⁴¹ First, the United States continues to face a proliferation of missile threats. Missile threats from rogue states, while not the greatest single threat to U.S. security, are increasing. Second, the low probability associated with missile threats is offset by their potentially catastrophic effect, particularly if such threats are accompanied by weapons of mass destruction. To be sure, some argue that even the most revisionist dictators are deterrable, that radical leaders are unlikely to cooperate with terrorists. They emphasize further that terrorists are unlikely to be capable of deploying WMD by missile.¹⁴² But the instability currently threatening Pakistan and continuing attempts to assassinate its leader suggest that loss of control of a nuclear arsenal is not a categorical impossibility. Third, defending against rogue state missile launch is a realistic goal. The force size and countermeasures potential of even the most capable rogue state falls far short of China's. Rogue states are likely to remain just that, because they lack China's tremendous resource, technology, and talent base.¹⁴³

Finally, while no ballistic missile defense is likely to be flawless, even a partially effective system can give American leaders significant leverage in terms of perception. Here again, China's capabilities must not be conflated with those of less advanced states. BMD could give the United States important leverage over North Korea and Iran. Unlike potential scenarios involving China, those with North Korea or Iran typically lack asymmetry of interests, thus making a U.S. threat more credible. But attempting to use BMD against China could lead to crisis instability or costly miscalculation. The nexus of the most likely potential U.S.-China crisis, Taiwan, is so important to China that Beijing would be extremely difficult to deter regardless of American capabilities. According to Li Bin, "The Taiwan issue has always been the most sensitive and important issue for the bilateral relationship and it could cause a serious confrontation between the two countries if not managed carefully. In this context, the effects of nuclear weapons cannot simply be excluded. Nuclear issues could become very important if the Sino-U.S. relationship deteriorates because of the Taiwan problem."¹⁴⁴

For all these reasons, the question for the United States should be not whether to develop BMD but how. Washington can encourage a best-case security outcome by developing a system that focuses on rogue states and eschewing a futile attempt to negate China's nuclear deterrent. Perhaps some combination of sea-based platforms and boost-phase intercept could best provide this form of security.

Removing China from the Missile Defense Calculus

This chapter offers four major propositions:

- Despite reassurances, China perceives itself to be the target of U.S. BMD.
- China fears that BMD threatens its limited nuclear deterrent, a cornerstone of its security.
- China likely has the capacity to overwhelm U.S. BMD by developing and proliferating missiles, and possibly sophisticated countermeasures as well.
- By focusing more closely on sea-based and boost-phase BMD, the United States could maximize defense against rogue states while minimizing negative Chinese responses.

American policy makers have not been able to reach consensus concerning the true utility of ballistic missile defense. If the United States is to succeed in development and deployment of such challenging technology and avoid unintended negative consequences, they would do well first to agree on BMD's purpose.

Missile defenses against China might trigger the expansion of the Chinese nuclear arsenal. It might even tempt Beijing to renounce previous arms control agreements in order to increase its strategic flexibility and opportunities for weapons testing. That suggests it would be counterproductive for the United States even to attempt to deploy defense against Chinese missiles. U.S. BMD capability, which will likely take time to perfect, is best directed not against China but against rogue states. China can meet the challenges necessary to counter BMD, and rogue states generally cannot—unless aided by a more capable power, such as China.

Based on his interviews with American experts, Chinese strategic expert Wu Rui concludes that “there are divergent views on whether U.S. NMD should be aimed at China. To convince China that NMD is not aimed at it, the United States could put some constraints over NMD capability and explain the constraints to China. This could help [to eliminate] the Chinese concern over the negative impact of NMD on China's nuclear deterrence.”¹⁴⁵ While such Chinese claims should not be accepted uncritically, the United States could realize significant benefits with such a policy. American interests might be best served by ballistic missile defenses—such as a sea-based boost-phase system—that target rogue states without threatening China's nuclear deterrent.

By making it clear that U.S. BMD does not target China per se (as the White House seems to have done with Russia), the United States might be able to minimize diplomatic fallout and to avoid an asymmetric arms race in which China would be able to ratchet up American defense spending with a far smaller investment of its own. Arguments concerning the counterproductive nature of BMD—primarily that it would

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trigger an arms race that would expend tremendous resources yet leave all parties, even the United States, less secure—would be neutralized were China removed from the equation.

Space is emerging as a new high ground of great-power competition, thus far a fairly peaceful one. Here the United States can promote its interests, but only if it acknowledges the needs of the other major players. China is the major potential obstacle to American security in space and in BMD development on earth; it is a power with an economic base and technical capabilities that cannot simply be ignored.¹⁴⁶ By addressing Chinese and Russian concerns about preserving nuclear deterrence, the United States can avoid pressuring those space powers into aggressively threatening its own wide array of space assets with ASAT and other asymmetric weapons. Washington has already begun to address Moscow's concerns concretely; now it is time to look to Beijing's as well. If the United States can reach an understanding with China in this regard, growing international opposition to missile defense—which could frustrate multilateral cooperation in such areas as counterproliferation—may be diffused.¹⁴⁷ The aerospace frontier is too important for the United States to goad China into threatening its progress there.¹⁴⁸

Russia, which has already received substantial American reassurances, lacks the resources for a significant weapons buildup. Rogue states lack the technological base and economic resources to nullify U.S. BMD. Some members of the international community might still fear that even limited ballistic missile defense could increase American propensity toward unilateralism, but this is likely to be an issue in any case. It is still the great powers, including Russia and China, that define the international system. As long as their major national security concerns are addressed, the United States is unlikely to face insurmountable international opposition to providing for its own defense needs.

Chinese propaganda periodically rails against American “hegemonism”;¹⁴⁹ as long, however, as Beijing's core security needs—such as limited deterrence and energy access—are respected, it tends to be cautious and reactive in international fora, such as the UN Security Council, that could affect U.S. interests. Also, given its modernization imperative, and with the exception of Taiwan-related initiatives, China could thereby be induced to pursue a more gradual pace of military development. The sooner that Washington agrees that BMD has limited utility against China, the sooner it will be able to focus on the real and growing missile threat posed by accidental launch, by rogue states, and even by terrorists.

To meet these larger objectives, the United States could offer China voluntary and nonbinding assurances, similar to those that it has already given to Russia, demonstrating that American ballistic missile defense has not been “sized” to China. A new focus

on boost-phase intercept would help greatly. It could pave the way for a broader series of arms control discussions, as President Bush suggested to President Jiang, to demonstrate American understanding of China's security concerns, just as the United States has briefed Chinese decision makers on its future military basing plans without giving them a veto or opening American policy to foreign debate.

In return, Chinese decision makers would be expected to understand America's need to protect itself from attack by rogue states and to constrain the latter's missile or countermeasure capabilities. It would be particularly dangerous, assuming it was technologically feasible, for China to market missiles with built-in countermeasures, which might be extremely attractive to developing states incapable of producing them indigenously.¹⁵⁰ Even absent a quid pro quo, discussion could recalibrate in a positive direction both sides' strategic positions. If progress were realized in this area, it would become a key example of strengthening the United States' own security by voluntarily limiting the nation's power to threaten others. Such restraint helped to make the twentieth century one of American global leadership, and it has an important role to play in the twenty-first century as well.¹⁵¹

The U.S. Navy's Role: Supporting Sea-Based and Boost-Phase BMD?

Many supporters of the current midcourse system deployment advocate the creation of a layered defense that will ultimately include a boost-phase component. Perhaps the best near-term solution to likely missile threats would be a BMD system that focused more closely on a combination of SM-3, submarine platforms, and boost-phase intercept. These Navy assets could offer maximum protection against rogue-state missile threats without needlessly provoking China by threatening its nuclear deterrent.

Boost-phase BMD offers manifold potential benefits. Most importantly, it targets an enemy missile in its earliest and most vulnerable flight stage, when it is most difficult to deploy countermeasures. Second, because boost-phase BMD relies on proximity to launch sites, it does not threaten China's or Russia's nuclear deterrent, concentrated in the remote interiors of those states. This seeming weakness is actually an advantage, in the sense that both powers would probably otherwise be motivated to use their vast aerospace capabilities to defeat U.S. BMD with countermeasures. Boost-phase intercept also means that any debris or fallout is more likely to fall on the offending nation rather than over the United States.

Air-based platforms may not be the best solution for boost-phase BMD. Of course, a laser travels at the speed of light, and time is at a premium during the short boost phase. Further, airborne lasers (ABLs) have made steady progress.¹⁵² But the ABL platform is vulnerable to air defenses; it is difficult to imagine how an ABL platform could

approach Chinese airspace. The laser itself is susceptible to specific countermeasures, including “coatings on offensive missile bodies that reflect rather than absorb the laser’s energy.”¹⁵³ While rogue states could find decoys like balloons too difficult to deploy, they might be able to buy protectively coated missiles from a more technologically capable country, such as China. In any case, both ABL and space-based systems are expensive to operate and resupply. A cheaper, less vulnerable sea-based platform would have considerable advantages in this respect—the “radars and missile interceptors required for defense against ICBMs are large and heavy. Placing them aboard a ship is a very cost-effective way to make them mobile.”¹⁵⁴

No longer constrained by the ABM Treaty, sea-based BMD plays to America’s strength and exploits rogue states’ weaknesses. All nations that the United States must currently defend against—particularly North Korea and Iran—are of subcontinental size and possess coastlines, rendering them vulnerable to sea-based and boost-phase BMD.¹⁵⁵ Unlike Russia and China, such states lack strong antisubmarine warfare capabilities and are unlikely to sustain the investment necessary to develop them. According to *Jane’s Defense Weekly*, Defense Department officials believe that “sea-based capabilities offer inherent advantages over fixed land systems” because “BMD ships would have the ability to manoeuvre and deploy to areas of conflict or in preparation for anticipated hostilities.”¹⁵⁶ Under international law, American vessels are free to remain indefinitely twelve nautical miles off any nation’s coast, where they can conduct electronic eavesdropping, detect missile launches, and prepare to attack. Vessels are not subject to host-nation approval, can move to avoid attack, and can be redeployed to protect against an emerging threat, such as short- or medium-range missiles appearing off U.S. coasts.

The SM-3 forms the basis of the U.S. Navy’s midcourse Aegis BMD System (previously known as “Navy Theater-Wide”). It is now based on three Aegis destroyers, the USS *Curtis Wilbur* (DDG 54), USS *John S. McCain* (DDG 56), and USS *Fitzgerald* (DDG 62).¹⁵⁷ One of them has already been deployed to the Sea of Japan to defend against North Korean missiles. SM-3 was first field-tested in June 2002, on the day that the United States withdrew from the ABM Treaty.¹⁵⁸ In a subsequent test in December 2003, the cruiser USS *Lake Erie* (CG 70) hit a target warhead with an SM-3.¹⁵⁹ The ship has now joined the Seventh Fleet.¹⁶⁰ The Pentagon has already delivered five SM-3 interceptors to the U.S. Navy and “plans to field a total of up to 30 SM-3s on Aegis ships by 2007.”¹⁶¹ SM-3 currently targets enemy missiles in midcourse, but ship-based BMD should be readily adaptable to boost-phase targeting.

SM-3 is rightly heralded as an innovative system that promises to reduce the threat posed by such rogue states as North Korea; nonetheless, the nature of its platform raises questions about its long-term utility. The proliferation of antiship cruise

missiles, even among the states of concern, suggests an increasing threat to American surface vessels in years to come.

It is much harder to find and attack a submarine, and it is much more difficult to “purchase” the requisite capabilities. While ship-based interceptors and radars are now being deployed, therefore, submarine-based intercept also merits careful consideration: According to a recent article in *Sea Power*, “You buy yourself lots of flexibility with sub[marine]s as a basing mode. You can move a lot closer to the [adversary’s launch sites]. And the closer you get, the easier it becomes to [intercept the attacking missile] in the boost-phase. That is a huge advantage.”¹⁶² Submarines can patrol with relative economy, particularly in contrast to air-based systems like ABL. Though hardly a panacea, submarines offer BMD launch platforms that are more cost-effective and reliable than many other potential platforms and stealthier than any. Trident submarines could fire several kinetic interceptors from their missile canisters, submerged or surfaced.¹⁶³ If firing while submerged, submarines could avoid a key vulnerability of other boost-phase-intercept systems—their “susceptibility to direct attack and neutralization from a state with numerous cruise missiles [e.g., Iran] or other advanced technologies.”¹⁶⁴

Maintaining reliable communication from a submerged position would be the key challenge for submarine-based BMD.¹⁶⁵ Notwithstanding the survivability of submarines, the employment of several of them backed by a surface-ship radar platform (standing off at a considerable distance) would increase efficiency and ensure redundancy of missile targeting.

While other naval platforms merit close attention, the already deployed SM-3 system is extremely promising for coping with the present missile threat. SM-3 can address specific threats without risking strategic instability in other areas. Regarding China, the versatility of sea-based BMD is already proving advantageous. As with virtually all areas of U.S. military development, Chinese sources are monitoring SM-3 development closely;¹⁶⁶ encouragingly, preliminary indications suggest they do not view SM-3 as a major threat. PRC analysts appear to have realized that, because SM-3 is deployed to the Sea of Japan and not closer to Chinese territory, it is in fact directed against North Korea. Land-based systems, for example the site now under development at Fort Greely, do not allow deterrence to be channeled so directly.

Designing BMD to pressure China would be a strategic mistake. The U.S. Navy’s SM-3, as well as follow-on sea-based BMD options, will enable the United States to target its real enemies without making new ones in the process.

Conclusion

LYLE J. GOLDSTEIN

Far from inevitable, conflict between the United States and China is, fortunately, rather unlikely, because of numerous potent constraints, the most obvious of which is a burgeoning trade relationship. Could workers and consumers or business and political elites on either side of the Pacific really accept an indefinite hiatus in or—worse yet—destruction of their livelihoods? Beyond this simple but powerful reality, Washington and Beijing appear to have found a *modus vivendi* that allows them to cooperate in important circumstances of mutual concern. After the 9/11 attacks, the Chinese political leadership quickly made it clear that Beijing would stand by Washington in its hour of need. Indeed, China appears to have taken the crucial step of counseling Pakistan to allow U.S. troops to enter the country in support of operations in Afghanistan, and it has actively supported the new regime in Kabul as well. Moreover, there is still hope that U.S.-China cooperation will prove instrumental in a lasting resolution of the ongoing nuclear crisis on the Korean Peninsula.¹

Even the nettlesome Taiwan issue may be amenable to a negotiated solution. Economic and other forms of interdependence are expanding at a prodigious rate and are having an ever greater impact on relations between the PRC and Taiwan. In 2002, some three-quarters of Taiwan's companies had investments on the mainland, totaling approximately sixty billion dollars.² Such statistics prompted one PRC official to claim exuberantly, "Our economy is our best weapon. We won't attack them. We will buy them. It's very Chinese."³ Cross-Strait marriages are becoming increasingly common; approximately thirty thousand brides went from the mainland to Taiwan in 2003, and thousands of Taiwan residents have opted to move to the PRC.⁴ Meanwhile, a "mini three links" agreement has enabled the smaller islands close to the mainland (Jinmen and Mazu) to open direct trade, transport, and postal services. And on January 29, 2005, the first direct commercial flights in fifty-five years occurred between Taiwan and mainland China. Those six flights, and another forty-two over the next three weeks, were scheduled to celebrate the Lunar New Year.⁵ Had Lian Zhan won the

March 2004 presidential elections on Taiwan (instead of losing by a razor-thin margin), he might well have embarked on a “journey of peace” to Beijing, as he had pledged during the campaign.⁶

Nonetheless, and as discussed in the introduction to this volume, Sino-American strategic rivalry in the twenty-first century remains a real possibility, and armed conflict between these two nuclear powers cannot be ruled out. Even if the volatile Taiwan issue is set aside, a variety of potential flashpoints still come readily to mind: the South China Sea, Southeast Asia, Northeast Asia, Central Asia, and even in the distant future perhaps the Middle East. Disturbingly, it is quite plausible that such a conflict could result from the actions of a variety of third parties, Taipei foremost among them.

Military institutions are bound to focus on (often low-probability) worst-case scenarios and on the doctrines and capabilities arising therefrom. This study is part of a broader analytical effort to understand the contemporary PLA and its future trajectory, accepting the broad caveat concerning the basic stability of U.S.-China relations outlined above. A second caveat is also essential—that this study in no way assumes that nuclear weapons will necessarily be employed in a U.S.-China war. Quite the contrary; the assembled papers generally view these arsenals as deterrent weapons that may be brandished to gain leverage in the midst of crises, or perhaps even to prompt deescalation during actual hostilities. Even if nuclear use seems outlandish, one can easily envision how nuclear shadows might affect decision makers in both Beijing and Washington, not to mention commanders in the theater of operations. For example, would Chinese political leaders order all-out strikes on American carrier battle groups without considering the possibility of nuclear retaliation, especially if those strikes were successful? Would American decision makers undertake major conventional strikes against targets (airfields, ports, missile bases, etc.) without regard to Chinese nuclear retaliation?

Such questions illustrate the potential importance of nuclear strategy for the possible dynamics of a U.S.-China conflict. However, war-fighting dilemmas presented by nuclear capabilities on both sides are not the major focus of this study. Instead, the papers assembled here present straightforward descriptions of several dimensions of emerging PLA nuclear capabilities. The value of such descriptions in an unclassified venue is that they significantly widen the scope of discussion concerning the strategic implications of these emerging capabilities. In other words, these capabilities merit consideration beyond the realm of military and intelligence analysts.

Chapter 1, by Lieutenant Commander Stephen Polk, U.S. Navy, described developments in PLA nuclear command and control. It provided background on the theory of [Notes](#)

nuclear command and control as it evolved during the Cold War, followed by a brief synopsis of the PLA's overall experience with military command and control generally, and NC2 specifically. Next, the paper reviewed current developments in PLA NC2, focusing on the evolving processes for release authority; on ample technology upgrades, including fiber optic, satellite, and microwave communications; and the likelihood of a more ambitious alerting posture. A crucial insight to take from Polk's review of revamped Second Artillery Corps training practices is the fact that lessons from the active and highly proficient SRBM force are likely to be disseminated quickly and efficiently into the new mobile long-range nuclear forces now being deployed. In the end, Polk concluded that while there may actually be benefits to China's moving to a nuclear posture of "credible deterrence" with robust NC2—for example, a reduced chance of accidental launch—there are also dangers, including the possibility of sophisticated PLA coercion and even limited war-fighting strategies.

The second chapter, by Lieutenant Christopher McConaughy, U.S. Navy, depicted rapid progress in China's SSBN force. The late 2004 announcement that the prototype of Type 094, the PLA Navy's second-generation SSBN, had been launched in July 2004 reinforces the importance of this detailed examination of China's efforts to develop a sea-based deterrent. The first half of this chapter was a synopsis of research by John Lewis and Xue Litai on the subject of China's first-generation SSBN, the *Xia* (Type 092). The author asserted that analysts have mischaracterized the 092 program as a complete failure. He argued instead that the arduous steps toward developing an indigenous SSBN are best viewed as an essential down payment on the research and development groundwork that underlay the likely success of the follow-on Type 094 project. The second part of the chapter explored 094's probable capabilities, basing modes, and doctrine. Special analytical attention was devoted to the notion that Beijing might adopt the Soviet "bastion" strategy of the late Cold War. The chapter concluded with a stark warning that current plans for the future U.S. submarine force may not be adequate to cope effectively with an invigorated Chinese SSBN program.

The close relationship between China's civil space program and its strategic nuclear modernization was the subject of the third chapter, by Commander Dominic DeSciociolo, U.S. Navy. The author argued that the two programs were "linked at birth," as each was profoundly influenced by the American émigré scientist Qian Xuesen, who instilled in both programs "the confidence that China can match the West in its technological development." As in other space programs, it asserted, the commingling of civil and military space and rocketry efforts is readily apparent: thus, the DF-5 ICBM is extremely similar to the CZ-2A commercial booster, and the DF-31 ICBM likely has its civilian analog in the Kaituozhe launch vehicle. Using the civil space program as a conduit for foreign technology, DeSciociolo maintained that recent

improvements in ICBM range, accuracy, and survivability may be partly attributable to the synergy between PRC civil and military space programs. Appraising the success of China's recent manned space vessel, Shenzhou V, DeSciociolo noted that General Li Jinai leads that program; further he voiced concern that the program may have direct military applications, especially in the vital realm of remote sensing. The chapter concluded with a comparative analysis of Soviet and American paths for space development, tentatively finding that China's methodical approach more closely approximates the American approach. This conclusion suggested that Beijing will become a potent future challenger to the United States in the realm of space.

The last chapter, written by Andrew Erickson, represents an attempt to fathom PRC responses to the U.S. deployment of ballistic missile defenses. Erickson found that American strategic planners are deeply divided concerning the value of U.S. BMD for China-related contingencies. Next, the author demonstrated that BMD countermeasure systems, including specifically Chinese variants, have a long history of development, reaching far back into the Cold War era. A brief review of the evolution of Chinese nuclear strategy suggested that American BMD poses a rather direct challenge to the PRC emphasis on minimal nuclear forces. The analysis subsequently revealed a plethora of options for countering U.S. ballistic missile defense that Chinese planners appear to be exploring, including especially saturation, decoys, and multiple methods for direct attack on the BMD system itself. Chinese nuclear strategists appear to have high confidence that U.S. BMD can be overwhelmed. Given the PRC's increasingly impressive defense science and technology infrastructure, the author concluded that American ballistic missile defense should focus on defending against threats from smaller, less capable rogue states, such as North Korea or Iran. Based on the efficiency, stealth, and flexibility of sea-based platforms, Erickson suggested that the U.S. Navy must play a central role in the ongoing evolution of BMD architecture.

As acknowledged in the introduction, this study makes no claim to comprehensiveness in its treatment of this subject. Instead, we have opted to make selective probes, aiming to improve knowledge in certain, rather narrow, domains of this complex subject, relying where possible on the unique professional experience and abilities of the student authors. A rather predictable, but nonetheless significant, finding of this research is the need for continued focused study. Specific analytic areas that are not treated adequately here include nuclear-tipped cruise missiles, tactical nuclear weapons, preemption strategies, nuclear threats during the 1996 crisis, Taiwan's calculations concerning nuclear weapons, and the impact of China's nuclear forces on the strategies of such critical regional players as Japan, South Korea, India, and Russia.

During the process of research, two overarching lessons emerged. First, the asymmetrical nature of the present U.S.-China nuclear relationship is unique and makes the situation rather different from that with Russia, with its several thousands of nuclear weapons, at one end of the spectrum, or with North Korea on the other. The impact of this asymmetry on nuclear rivalry in general and crisis interaction in particular deserves special study. There are some historical analogies available—including the much-studied Cuban missile crisis of 1962. The second lesson is methodological and applies to the study of China's military as a whole. A wide variety of new Chinese sources must be carefully analyzed to gain the closest possible understanding of China's ongoing military modernization. This method, if undertaken in a methodical manner, can mitigate the recognized problem of “mirror imaging,” and it can produce major research findings, such as the pathbreaking studies by John Lewis and Xue Litai, that can better inform policy.

The four papers assembled here are careful to point out continuing weaknesses in China's nuclear force (for instance, in its early warning network) and not to exaggerate the pace of the ongoing nuclear modernization (which has been, if steady, not particularly swift). Collectively, however, they demonstrate significant progress and indeed a profound upgrade in the quality, and potentially the quantity as well, of China's nuclear forces. The most potent symbols of China's transition to credible deterrence are the new DF-31 ICBM, as well as the 094 SSBN and associated JL-2 SLBM, but this study demonstrates a broad front effort that goes well beyond these two systems.

This development should not surprise anyone. After all, China has been the target of nuclear coercion more times than any other single state. The lesson that nuclear weapons have significant strategic utility is not lost on China's present leadership. Moreover, the world is faced with the challenge of integrating a rapidly transforming China—after more than two decades of stability and double-digit economic growth—into the evolving international system. Beijing, no longer constrained by momentous threats or resource austerity, now has the opportunity, for the first time in its history, to create systematically its nuclear forces and strategy it believes optimal.

Endnotes

Introduction

1. For a timely debate on this subject, see Jonathan Pollack, ed., *Strategic Surprise: U.S.-China Relations in the Early 21st Century* (Newport, R.I.: Naval War College Press, 2003).
2. See, for example, Charles Hutzler, Susan Lawrence, and Jason Dean, "China, U.S. Show Signs of Solidarity," *Wall Street Journal*, 15 December 2003.
3. The EU nations, in aggregate, displaced Japan as China's number one trading partner on May 1, 2004. "EU Becomes China's Largest Trading Partner," *People's Daily Online*, retrieved from www.chinadaily.com/English/doc/2005-01/07/content_406961.htm on February 3, 2005.
4. A good recap of the contending theories relating to trade and international conflict is available in Dale C. Copeland, "Economic Interdependence and War: A Theory of Trade Expectations," *International Security* 20 (Spring 1996), available at www.mtholyoke.edu/acad/intrel/copeland.htm.
5. Glenn Kessler, "U.S. Cautions Taiwan on Independence," *Washington Post*, 22 April 2004, p. A22.
6. See "Bush Pulls Secret Service Agent From Scuffle," CNN.com, 22 November 2004, www.cnn.com/2004/World/americas/11/20/apec.bush.security.ap/.
7. "China's Latin Business Trip," *International Herald Tribune*, 26 November 2004, available at www.ihf.com/articles/2004/11/25/opinion/edchina.html.
8. On these tensions see Dan Blumenthal, "Unhelpful China," *Washington Post*, 6 December 2004, p. 21.
9. Christopher Langton, ed., *The Military Balance 2003-04* (London: Oxford Univ. Press, 2003), p. 152.
10. Deng Jun, "Zhongguo He Liliang yu He Zhanlue" [China's Nuclear Forces and Nuclear Strategy], *Bingqi Zhishi* (May 2002), p. 41.
11. See Bill Gertz, "China Tests Ballistic Missile Submarine," *Washington Times*, 3 December 2004, available at washgintontimes.com/national/20041202-115302-2338r.htm; or Richard Fisher, "Submarine Incident Highlights Military Buildup," *Asian Wall Street Journal*, 17 November 2004.
12. See, for example, Avery Goldstein, "Great Expectations: Interpreting China's Arrival," *International Security* 22 (Winter 1997/98), pp. 71-73.
13. Remarks to the Defense Writers Group, 18 October 1995, Washington, D.C., cited in Keith B. Payne, *Deterrence in the Second Nuclear Age* (Lexington: Univ. of Kentucky, 1996), p. 41.
14. Richard K. Betts and Thomas J. Christensen, "China: Getting the Questions Right," *National Interest* 63, no. 1 (Winter 2000/01), pp. 17-29.
15. Brad Roberts, *China-U.S. Nuclear Relations: What Relationship Best Serves U.S. Interests?* IDA Paper P-2640 (Alexandria, Va.: August 2001), p. ES-3, available at www.dtra.mil/about/organization/ab_pubs.html.
16. *Ibid.*, p. 21.
17. This entire paragraph is drawn from Major General Wu Jianguo, "Nuclear Shadows on High-Tech Warfare," in *Chinese views of Future Warfare*, ed. Michael Pillsbury (Washington, D.C.: National Defense Univ. Press, 1997), pp. 137-46.

Chapter One

China's Nuclear Command and Control

1. David Shambaugh, *Modernizing China's Military: Progress, Problems, and Prospects* (Berkeley: University of California Press, 2002), p. 169.
2. See "United States Nuclear Command and Control Support," 21 August 1987, *Federation of American Scientists*, www.fas.org/nuke/guide/usa/doctrine/dod/dodd-3150_6.htm.
3. On Soviet NC2, see "Strategic Command and Control," *Federation of American Scientists*, www.fas.org/nuke/guide/russia/c3i/index.html. A more detailed description of Soviet communication and launch procedures can be found in Pavel Podvig, ed., *Russian Strategic Nuclear Forces* (Cambridge, Mass.: MIT Press, 2001), pp. 175-76, 278-82, 363-66.
4. The "pessimist" versus "optimist" debate essentially dates from Kenneth Waltz and Scott Sagan, *The Spread of Nuclear Weapons: A Debate* (New York: Norton, 1995). On the role of NC2 specifically, see also Peter Feaver, "Command and Control in Emerging Nuclear Nations," *International Security* 17 (Winter 1992/1997), pp. 160-87; David Karl, "Proliferation Pessimism and Emerging Nuclear Powers," *International Security* 21 (Winter

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- 1996/1997), pp. 87–119; and Jordan Seng, “Less Is More: The Command and Control Advantages of Minor Nuclear States,” *Security Studies* 6 (Summer 1997), pp. 50–91.
5. On this incident and others, see Scott D. Sagan, *Moving Targets: Nuclear Strategy and National Strategy* (Princeton, N.J.: Princeton Univ. Press, 1989), pp. 135–75.
 6. The debate on this tendency within security studies was initiated by Jack Snyder, “Civil-Military Relations and the Cult of the Offensive, 1914 and 1984,” *International Security* 9 (Summer 1984), pp. 108–46.
 7. Mao also took less of an interest in the conflict after the war became stalemated in mid-1951. This allowed the Chinese commander in Korea, Peng Dehuai, to bring greater coherence to command and control arrangements, which in turn increased PLA combat efficiency. This entire paragraph draws heavily on Shu Guang Zhang, “Command, Control, and the PLA’s Offensive Campaigns in Korea, 1950–51,” in Mark A. Ryan, David M. Finkelstein, and Michael A. McDevitt, eds., *Chinese Warfighting: The PLA Experience since 1949* (London: M. E. Sharpe, 2003), pp. 91–122.
 8. Cheng Feng and Larry M. Wortzel, “PLA Operational Principles and Limited War: The Sino-Indian War of 1962,” in Ryan, Finkelstein, and McDevitt, eds., *Chinese Warfighting*, pp. 190–91.
 9. Lyle J. Goldstein, “When China Was a Rogue State: The Impact of China’s Nuclear Weapons Program on U.S.-China Relations during the 1960s,” *Journal of Contemporary China* 12, no. 37 (November 2003), pp. 741–42.
 10. The “Third Front” was a massive attempt beginning in the mid-1960s to move China’s industrial plant into the interior of the country in preparation for protracted (nuclear) warfare against one or both of the superpowers. On the details of the Third Front, see Barry Naughton, “The Third Front: Defense Industrialization in the Chinese Interior,” *China Quarterly*, no. 118 (Autumn 1988), pp. 351–86.
 11. This point and the remainder of this paragraph is drawn from Nathan Busch, “What the Proliferation Debate Has Ignored: Command and Control, MPC&A, and the Case of China,” paper delivered at the 41st Annual International Studies Association Convention, Los Angeles, 14–18 March 2000, pp. 15–16, available at www.arches.uga.edu/~nbusch/ISApaper.pdf.
 12. Viktor Gobarev, paraphrased in Lyle J. Goldstein, “Do Nascent WMD Arsenals Deter? Nuclear Weapons and the Sino-Soviet Crisis of 1969,” *Political Science Quarterly* 118, no. 1 (Spring 2003), p. 70. For Gobarev’s study of the crisis, see his “Soviet Policy toward China: Developing Nuclear Weapons, 1949–1969,” *Journal of Slavic Military Studies* 12 (December 1999), pp. 1–53.
 13. Recently published observations of Soviet diplomat A. Elizavetin, discussed in Goldstein, “Do Nascent WMD Arsenals Deter?” p. 61.
 14. On the “Order No. 1” of 17 October 1969, see Roderick MacFarquhar, “The Succession to Mao and the End of Maoism,” in *The Politics of China: The Eras of Mao and Deng*, ed. Roderick MacFarquhar (New York: Cambridge Univ. Press, 1993), p. 264.
 15. Quoted in John Lewis and Xue Litai, *China Builds the Bomb* (Stanford, Calif.: Stanford Univ. Press, 1988), p. 215.
 16. Avery Goldstein, “Understanding Nuclear Proliferation: Theoretical Explanation and China’s National Experience,” *Security Studies* 2 (Spring/Summer 1993), pp. 58–59, note 58.
 17. Lewis and Xue, *China Builds the Bomb*, p. 214.
 18. Busch, “What the Proliferation Debate Has Ignored,” p. 12.
 19. See “Command and Control,” Global Security.org, www.globalsecurity.org/wmd/world/china/c3i.htm.
 20. Roger Cliff, *The Military Potential of China’s Commercial Technology* (Santa Monica, Calif.: RAND, 2001), p. 28.
 21. See “Command and Control.”
 22. Dan Caldwell, “Permissive Action Links: A Description and Proposal,” *Survival* 29, no. 3 (May/June 1987), p. 231, cited in Busch, “What the Proliferation Debate Has Ignored,” p. 14.
 23. Busch, “What the Proliferation Debate Has Ignored,” p. 18.
 24. Steve Coll and David Ottaway, “Will the United States, Russia and China Be Nuclear Partners or Rivals in the 21st Century?” *Washington Post*, 11 April 1995, p. A1, cited in Busch, “What the Proliferation Debate Has Ignored,” p. 15.
 25. Comments of David Finkelstein, presented to an Institute for National Strategic Studies (INSS) conference, “China’s Nuclear Future,” U.S. Air Force Academy, Colorado Springs, 30–31 July 2003 [hereafter INSS conference].

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26. Shambaugh, *Modernizing China's Military*, pp. 166–67.
27. *Ibid.*, p. 121.
28. Mark A. Stokes, *China's Strategic Modernization: Implications for the United States* (Carlisle, Penna.: Strategic Studies Institute, 1999), p. 45.
29. *Ibid.*, p. 46.
30. Shambaugh, *Modernizing China's Military*, p. 168.
31. Andrew N. D. Yang, "The Question of Command and Control of the Second Artillery in Time of Crisis and War," INSS conference, p. 1.
32. *Ibid.*, p. 2.
33. Bates Gill and James Mulvenon, "The Chinese Strategic Rocket Forces: Transition to Credible Deterrence," in *China and Weapons of Mass Destruction: Implications for the United States* (Washington, D.C.: National Intelligence Council, 1999), available at www.fas.org/irp/nic/china_wmd.html.
34. Lewis and Hua, "China's Ballistic Missile Programs," p. 22, cited in Busch, "What the Proliferation Debate Has Ignored," p. 11.
35. *Ibid.*, p. 12.
36. This estimate is from *Federation of American Scientists*, fas.org/nuke/guide/china/slbm/jl-1.htm.
37. Cliff, *The Military Potential of China's Commercial Technology*, p. 17.
38. See, for example, "Xinjiang Military District Helps Lay 12,000 km of Fiber Optic Cable," *Urumqi Renmin Jundui*, 15 August 2002, FBIS CPP20020925000177, or "Jiefangjun Bao Carries Photo of PLA Fiber-Optics Maintenance in the Field," *Jiefangjun Bao*, 20 November 2002, FBIS CPP20021203000224.
39. "[PRC] Command and Control," from Global Security.org, www.globalsecurity.org/wmd/world/china/c3i.htm.
40. Zhang Zingye, "Second Artillery's First Short-Wave Self-Responsive Communications System Passes Verification," *Huoqianbing Bao*, 6 April 2002, FBIS CPP2002042000287.
41. Wang Hong, Xi Xiaolei and Fan Xiangsheng, "Rush to Occupy the Vantage Point: The Engineering Corps' Experience in Informatizing Its Headquarters," *Huoqianbing Bao*, 29 May 2003, FBIS 20030624000263.
42. "Roundup of C4I Activities in PRC 11 Aug–29 November 2003," 11 August 2003, FBIS CPP20040115000164.
43. "DFH-3," Globalsecurity.org, at globalsecurity.org/space/world/china/dfh-3.htm.
44. "FH-1 Military Communications Satellite," *China Defense Today*, www.sinodefence.com/space/spacecraft/fh.asp.
45. "DFH-4 Communications Satellite," *China Defense Today*, www.sinodefence.com/space/spacecraft/fh.asp.
46. "April 2005," *Orbital Report News Agency*, retrieved from www.orbireport.com/log.html on 8 February 2005.
47. *Annual Report on The Military Power of the People's Republic of China*, Report to Congress Pursuant to the FY 2000 National Defense Authorization Act (Washington, D.C.: 28 July 2003), p. 34.
48. Zhang Xianqiu, "Second Artillery Base Improves Quality of Confrontational Training by Freeing Itself from Outmoded Ideas," *Jiefangjun Bao*, 7 May 2004, FBIS CPP20030507000047.
49. Wu Xudong and He Tianjin, "Honing the Heavenly Sword to Win," *Zhongguo Qingnian Bao*, 30 May 2002, FBIS CPP20020530000018.
50. "A Certain Base under the Second Artillery Corps Builds Network-Based Military Training Platforms," *Jiefangjun Bao*, 21 March 2003, FBIS CPP20030313000039.
51. "PLA Second Artillery Corps Sets Up Online Equipment Repair, Maintenance Workshop," *Jiefangjun Bao*, 19 March 2003, FBIS CPP20030319000050.
52. See, for example, "Wang Xiaojun and Xia Hongqing, "A Certain Brigade under the Second Artillery Force Focuses on Combined Tactical Training Exercises and Program of Training Officers and Soldiers Separately," *Jiefangjun Bao*, 13 January 2004, FBIS CPP20040113000099, and Zhang Xuanjie and Liu Jiexiang, "Second Artillery Corps Has Postgraduate Psychiatrists," *Xinhua*, 30 August 2002, FBIS CPP20020830000069.
53. John Lewis and Xue Litai, *China's Strategic Seapower* (Stanford, Calif.: Stanford Univ. Press, 1994), p. 118.
54. *Ibid.*, p. 119.
55. *Ibid.*
56. *Ibid.*

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Chapter Two

China's Undersea Nuclear Deterrent:

Will the U.S. Navy Be Ready?

1. For example, at a recent conference on "China's Nuclear Future," many of the nation's leading China military analysts had widely divergent views on the significance of recent developments within the People's Liberation Army. "China's Nuclear Future" conference, Boulder, Colorado, U.S. Air Force Institute for National Security Studies, U.S. Air Force Academy, 30–31 July 2003.

The epigraph is found in John Wilson Lewis and Xue Litai, *China's Strategic Seapower* (Stanford, Calif.: Stanford Univ. Press, 1994), p. 18.

2. Michael S. Chase and Evan S. Medeiros, "China's Evolving Nuclear Calculus: Modernization and the Doctrinal Debate" (unpublished research paper, RAND Corporation, Washington, D.C.: 2002), p. 1.
3. See Bill Gertz, "China Tests Ballistic Missile Submarine," *Washington Times*, 3 December 2004, available at washgintontimes.com/national/20041202-115302-2338r.htm; or Richard Fisher, "Submarine Incident Highlights Military Buildup," *Asian Wall Street Journal*, 17 November 2004.
4. Richard D. Fisher, "Navy Systems" in *The Impact of Foreign Weapons and Technology on the Modernization of China's People's Liberation Army*, forthcoming, p. 3.
5. Admiral Zhang Lianzhong, former commander of the PLA Navy (1988–96), quoted in Office of Naval Intelligence, *Worldwide Submarine Challenges* (Washington, D.C.: U.S. Navy Dept., 1997), p. 18.
6. An argument could be made that there are more than two methods to neutralize an SLBM in that air and surface antisubmarine assets possess an offensive antisubmarine capability. However, the assumption is that the aircraft or surface ship would have to be in the immediate vicinity of the SSBN at the time of launch and be able to detect preparations for launch. It is possible, but not likely, that an SSBN would launch its ballistic missiles in the immediate vicinity of a surface ship or aircraft. To do so would be to jeopardize the

accomplishment of its mission—that of remaining as covert as possible to continue its launch sequence. It is more likely that a U.S. SSN could remain undetected in an SSBN's baffles, enabling it to be present immediately prior to or immediately after, than it is for a hostile (to the SSBN) surface ship or aircraft to remain undetected by the SSBN and not prompt it to go elsewhere.

7. Of course, if the ballistic missile defense system was capable of destroying the missile prior to the deployment of its warheads and decoys, that is to say in the boost phase, any employed decoys would be rendered useless.
8. From 1985 to 2002, Congress has appropriated nearly \$65.7 billion dollars for ballistic missile defense and will be deploying a system with only limited capability in 2004. See "Historical Funding for BMD FY85–02," *Missile Defense Agency MDALink*, "Budget and Legislative Guidance," www.acq.osd.mil/bmdo/bmdolink/html/guide.html.
9. "The Lessons of History: The Chinese People's Liberation Army at 75," *Strategic Studies Institute*, "Regional Studies: Asia/Pacific," www.carlisle.army.mil/ssi/pubs/region.html#asia.
10. See excerpts at GlobalSecurity.org, "Nuclear Posture Review," www.globalsecurity.org/wmd/library/policy/dod/npr.htm.
11. This appeared to be the outlook of most analysts at the "China's Nuclear Future" conference.
12. The 094 project may have experienced a considerable setback during the summer of 2004 when a JL-2 suffered a testing failure. Bill Gertz, "China Tests Ballistic Missile Submarine," *Washington Times*, 3 December 2004, available at washgintontimes.com/national/20041202-115302-2338r.htm. According to *Jane's*, the Type 094 SSBN may be operational by 2008, with four to six boats to be built. They will carry eight to eighteen missiles with a range of eight thousand kilometers and one warhead, or three to eight MIRVs with decoys and penetration aids. The exact timeline may be constrained by the development of the JL-2 SLBM. See "JL-2(CSS-NX-5)," *Jane's Strategic Weapon Systems*, 3 June 2003, available, www.janes.com; also *Jane's Fighting Ships*, "China/Submarines: Strategic Missile Submarines/Introduction," 20 March 2003, www.janes.com. The 2003 *Annual Report on the Military Power of the People's Republic of China* is vague. It states that the JL-2 is

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- expected to be deployed sometime within the next decade but is not specific about the 094. U.S. Defense Dept., *Annual Report on the Military Power of the People's Republic of China* (Washington, D.C.: 2003), p. 27.
13. See, for example, "China's Economy Is No 'House of Cards,'" *Business Week Online*, 16 January 2003, available, www.businessweek.com.
 14. General Liu Huaqing quoted in Office of Naval Intelligence, *Worldwide Submarine Challenges* (Washington, D.C.: U.S. Navy Dept., 1997), p. 1.
 15. Rear Admiral Charles B. Momsen, quoted in Richard E. Winslow III, *Portsmouth-Built: Submarines of the Portsmouth Naval Shipyard* (Portsmouth, N.H.: Peter E. Randall, 1985), p. 138.

Epigraph found in Lewis and Xue, *China's Strategic Seapower*, p. 29.
 16. Lewis and Xue, *China's Strategic Seapower*, p. 20.
 17. *Ibid.*, p. 4.
 18. To illustrate further, Marshal Nie Rongzhen, who was responsible for weapons research and development of the SSBN and SLBM projects, relocated the Metal Physics Research Section of China's Institute of Atomic Energy (IAE) from Shenyang and Beijing to the Gobi Desert in Inner Mongolia to shield its workings from the effects of the Great Leap. Nie was forced to walk both sides of the fence by appearing to support the party line while at the same time insulating his workers from the impact. See Lewis and Xue, *China's Strategic Seapower*, pp. 26, 34.
 19. Financial resources were heavily impacted as well. There are examples too numerous to be recounted here of the impact of the economic devastation that resulted from the Great Leap and the Cultural Revolution on the SSBN and SLBM programs. Nevertheless, a brief illustration of what the defense establishment had to endure occurred in 1966 during the development of the JL-1 solid propellant engine. The Fourth Academy, under the Seventh Ministry, which was responsible for development of the JL-1 solid propellant engine, had to halt construction of engine test facilities in 1968 due to spending cuts that resulted in a substantial modification of the testing schedule and a two-year delay. See Lewis and Xue, *China's Strategic Seapower*, pp. 144–46.
 20. *Ibid.*, p. 146.
 21. *Ibid.*, p. 147.
 22. *Ibid.*, pp. 138, 144–45, 147–49, 162, 163.
 23. Lin Biao quoted in Michael Schoenhals, ed., *China's Cultural Revolution, 1966–1969* (Armonk, N.Y.: M. E. Sharpe, 1996), p. 11.
 24. Lewis and Xue, *China's Strategic Seapower*, p. 149.
 25. "The Lessons of History: The Chinese People's Liberation Army at 75," *Strategic Studies Institute*, "Regional Studies: Asia/Pacific," www.carlisle.army.mil/ssi/pubs/region.html#asia, 7 September 2003, p. 409.
 26. Lewis and Xue, *China's Strategic Seapower*, pp. 88–89.
 27. Massive amounts of scarce financial resources were thrown at the Third Line and after the effort was largely completed, a partial reversal occurred from 1986 to 1989 in which, "121 of the 2,000 large and medium-sized enterprises in remote mountain areas were removed to the coastal provinces" to curtail the defection of isolated and disgruntled workers from the Third Line. See David Shambaugh, *Modernizing China's Military* (Berkeley: Univ. of California Press, 2002), p. 227.
 28. Lewis and Xue, *China's Strategic Seapower*, p. 26. Under the right circumstances competition can be a positive force for developing capable, high-quality, and low-cost weapons systems. For example, the U.S. Department of Defense tasks multiple defense contractors to develop competing designs for a single weapon system. However, China simply did not have the financial strength or scientists and engineers educated in submarine and ballistic missile design to pursue a competitive strategy in its state-run defense industry.
 29. For examples see Lewis and Xue, *China's Strategic Seapower*, pp. 138–40, 162, 183, 186, 203.
 30. *Ibid.*, p. 162.
 31. Gen. Luo Ruiqing was the director of NDIO from 1961 to 1966. He was also the chief of the General Staff and secretary general of the Central Military Commission from 1959 to 1966, a member of the Central Secretariat, and the office director of the Fifteen Member Special Commission from 1962 to 1966. He was toppled during the Cultural Revolution, because he stood for a more professional and less ideological PLA. Others were involved in the debate as well, such as He Long, the director of the National Defense

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- Industrial Commission (NDIC), and Premier Zhou Enlai. See Lewis and Xue, *China's Strategic Seapower*, pp. 28–29, 246.
32. Lewis and Xue, *China's Strategic Seapower*, pp. 29, 32.
 33. As a point of comparison, the U.S. SLBM effort also suffered many growing pains in its initial stages. In the 1950s, the U.S. Navy was unable to articulate a cohesive position on ballistic missiles and, consequently, was forced to pursue a joint endeavor with the U.S. Army on the Jupiter Program as a cost-saving measure. For one year the Navy worked with the Army on the liquid-fueled Jupiter, until it recognized the need to pursue a solid-fueled option and was able to convince the Department of Defense of the rationale for pursuing a solid-fueled ballistic missile. Additionally, the Special Projects Office within the Department of the Navy, responsible for the development of the Fleet Ballistic Missile (FBM) submarine force, was considered the model of managerial success, when in fact it was not. It should be noted, however, that even though the U.S. Navy went through some growing pains with the FBM program, it was still one of the most successful weapons development programs in the history of the United States; only five years elapsed from the establishment of the Special Projects Office until the first successful submerged test launch of a Polaris in 1960. Even after the U.S. Navy had the experience of constructing its first SSBNs—the “Forty-one for Freedom”—the follow-on Ohio-class SSBNs were not without their own governmental, defense contractor, and funding problems. Overall, however, the delays in the U.S. Navy's strategic weapons programs have been minuscule in comparison to those of China. See Harvey M. Sapolsky, *The Polaris System Development* (Cambridge, Mass.: Harvard Univ. Press, 1972). For an interesting overview of the Polaris and Fleet Ballistic Missile (FBM) submarine programs see Bureau of Naval Weapons Special Projects Office, *Polaris Fleet Ballistic Missile Weapon System Fact Sheet* (Washington, D.C.: U.S. Navy Dept., 1 June 1966). For an overview of the Trident program see D. Douglas Dagleish and Larry Schweikart, *Trident* (Carbondale: Southern Illinois Univ. Press, 1984).
 34. Lewis and Xue, *China's Strategic Seapower*, p. 25.
 35. Ibid., pp. 30–31.
 36. It is interesting and somewhat ironic to note that the *Lenin* reportedly suffered in 1966 or 1967 a major reactor plant casualty—possibly a reactor meltdown—that may have killed up to thirty of its crew. More than a year after the accident, the three original reactor plants on the *Lenin* were replaced by two of a different design. It is impossible to say what the exact cause of the casualty was, even if the casualty was due to operator error, the root cause of such a major reactor accident could still be traced to plant design, since the reactor plant safety features were apparently inadequate. At the time of the accident on the *Lenin*, Sino-Soviet relations were at a low point; it is possible that the Chinese designers were unaware of flaws. It is also possible that any flaws in the *Lenin* design were completely irrelevant, since the Chinese may have used the design as a general guide rather than a specific template. China's choice was an ominous one nonetheless. (See Lewis and Xue, *China's Strategic Seapower*, p. 31.) According to *Jane's Defence Weekly*, CBS News obtained CIA documents that provided details on the *Lenin* accident. See “Soviet Submarine Accidents: New Details,” *Jane's Defence Weekly*, 19 January 1985, p. 85.
 37. Lewis and Xue, *China's Strategic Seapower*, pp. 24, 27. Control-rod drive mechanisms enable an operator to remotely insert or withdraw the control rods within the reactor core to start up the reactor, maintain criticality, or shut it down. The Chinese utilized hafnium (Hf) control rods.
 38. Lewis and Xue, *China's Strategic Seapower*, p. 27.
 39. According to one of Lewis and Xue's sources, U.S. submarines use a uranium enrichment of 93 percent. Lewis and Xue, *China's Strategic Seapower*, p. 23, p. 259 note 1.
 40. Ibid., p. 7.
 41. Deng Lique, Ma Hong, and Wu Heng, eds., *China Today: Defence Science and Technology* (in English) (Beijing: National Defence Industry Press, 1993), p. 318.
 42. Lewis and Xue, *China's Strategic Seapower*, p. 27.
 43. For a basic introduction to submarine reactor design, see “Nuclear Propulsion,” Federation of American Scientists, www.fas.org/man/dod-101/sys/ship/eng/reactor.html. The Chinese reactor was a pressurized-water reactor with separate primary and secondary systems. Primary plant pressure was 140–150 atmospheres (2,057–2,204 psi), and the fuel cells

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(which Lewis and Xue call “fuel rods”) were clad with zirconium alloy. The rated reactor power for the prototype plant was forty-eight megawatts; it was reportedly capable of twelve thousand shaft horsepower. Chinese designers evidently had some serious difficulties with the primary-to-secondary heat exchanger—the steam generator. They discussed the necessity of maintaining the integrity of both the primary and secondary systems to ensure that the radioactive primary coolant does not enter the secondary system but the only detail provided is that “the Chinese had serious problems devising a safe exchange system between the two loops. Early on they felt the iron fist of Murphy’s Law.” This suggests that in their initial reactor plant design efforts, the Chinese most likely suffered a primary-to-secondary reactor coolant leak. See Lewis and Xue, *China’s Strategic Seapower*, p. 24, and Deng, Ma, and Wu, eds., *China Today*, pp. 321–31. The prototype reactor remained in operation for nine years, from July 1970 to December 1979, for complete testing to be completed. *Ibid.*, p. 328.

44. According to Lewis and Xue, construction apparently began on the plant and facilities in early 1968, more than a year before the complete design of the prototype reactor was finalized in 1969. *China Today* states that construction began in 1965 but was delayed by the Cultural Revolution until 1968. Construction of the prototype reactor plant was said to have been completed in April 1970, with test operations beginning in May 1970; however, according to Lewis and Xue, manufacture of the fuel cells for the prototype was not begun until the summer of 1970. The fuel cells most likely were completed well before May 1970. *China Today* also lists May 1970 as the first operation of the prototype reactor. Lewis and Xue, *China’s Strategic Seapower*, p. 45; and Deng, Ma, and Wu eds., *China Today*, pp. 318, 324–26.
45. Lewis and Xue, *China’s Strategic Seapower*, pp. 43, 45.
46. *Ibid.*, pp. 106, 108, 109.
47. Lewis and Xue, *China’s Strategic Seapower*, pp. 109, 110.
48. *Ibid.*, pp. 68, 110.
49. Deng, Ma Hong, and Wu eds., *China Today*, p. 314. At the beginning of Project 09, a group of designers studied and took notes on a toy model of a U.S. Polaris SSBN which provides some insight into how little knowledge the Project 09 engineers had on submarine design and the, “somewhat unreal world in which [they] operated.” Lewis and Xue, *China’s Strategic Seapower*, p. 50.
50. Huang Xuhua, quoted in Lewis and Xue, *China’s Strategic Seapower*, p. 65; and Chinese proverb quoted by David Lai, “Learning from the Stones: A Weiqi Approach to Mastering Sun Tzu and the Chinese Way of War and Diplomacy,” Asia-Pacific Studies Group Research Seminar, Naval War College, 3 November 2003.
51. China conducted scale-model tests in a large indoor wave tank and arrived at the meaningless conclusion that “the scale-model experiments repeatedly verified the overall superiority of the more revolutionary water-drop shape, but the tests left unresolved several questions about the maneuverability and stability of a submerged submarine so configured.” That the engineers could conclude that the teardrop-shaped hull was superior without resolving the critical factors of maneuverability and stability illustrates the primitive nature of Chinese submarine design at that time. See Lewis and Xue, *China’s Strategic Seapower*, pp. 51–53, 56. The USS *Albacore* was an experimental U.S. submarine built by the Portsmouth Naval Shipyard to test, among other things, the concept of a teardrop-shaped hull. The design subordinated the performance of the surfaced submarine to that of the submerged submarine. Extensive testing resulted in greater submerged control and underwater speed records. See Winslow, *Portsmouth-Built Submarines of the Portsmouth Naval Shipyard*, p. 143, and “USS *Albacore*,” *American Society of Mechanical Engineers*, “ASME Roster of Landmarks, Sites and Collections,” www.asme.org/history/roster_a.html.
52. China had to develop nondestructive inspection techniques to verify the quality of each weld and had difficulty implementing the quality control necessary to eliminate the defects resulting from the inexperienced shipyard workers. For more specific information on welding difficulties on China’s submarines, see Lewis and Xue, *China’s Strategic Seapower*, pp. 52, 104–106, 286–87, notes 9–16.
53. Coincidentally, but not surprisingly, China’s first submarine hull was completed in 1970 on Mao’s birthday, 26 December. Lewis and Xue, *China’s Strategic Seapower*, p. 105.

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55. The effectiveness of the pedestals depends on the type of mounts used and their ability to prevent the transmission of the equipment vibration to the hull. Covering of the equipment in sound-absorbent material is of limited value, since the air between the covered equipment and the hull is a poor transmission medium for sound relative to the direct path between the equipment mounts and the hull.
56. Cavitation results from the movement of the screw (propeller) through the water, which in turn creates areas of extremely low pressure. The low pressure causes local boiling of the water, which can cause cracking, pitting, and corrosion of the screw blades, further increasing cavitation. The design, machining, speed, and cleanliness of the screw as well as the ambient water pressure (which is proportional to depth) all contribute to screw cavitation. With respect to the speed of the screw through the water, the lower the shaft RPM (SRPM), the less likely it is that cavitation will occur. The SRPM of China’s first nuclear submarine was 125 to 200, even after the engineers had already been forced to lower it due to excessive cavitation. Lewis and Xue, *China’s Strategic Seapower*, pp. 53, 109.
57. *Ibid.*, pp. 4, 67.
58. The capabilities of the torpedo are dependent on the environment and the target. The depth of the water in which the torpedo will be fired and whether or not it is intended to strike a submerged or surface target are critical variables for which designers must account.
59. Lewis and Xue state that the Yu-3 is the Chinese Sturgeon 2. According to *Jane’s Naval Weapon Systems*, the Yu-3 is equivalent to the Soviet SET-53 acoustic homing torpedo. *Jane’s Fighting Ships* states that the Yu-3 is equivalent to the Soviet SET-65E wake homing torpedo. China’s earlier torpedoes, the Yu-1, the Yu-2, the Yu-4A, and the Yu-4B were all deemed inadequate by China. See “Underwater Weapons/Russian Federation/Type 53/SAET/SET (Test-71/Test-96) TE/YU 1/YU 3/YU 4 Heavyweight Torpedoes,” *Jane’s Naval Weapon Systems*, 29 November 2002, available, www.janes.com; “Xia Class (Type 092) (SSBN)” *Jane’s Fighting Ships*, 20 March 2003, available, www.janes.com; Lewis and Xue, *China’s Strategic Seapower*, pp. 66–67.
60. Lewis and Xue, *China’s Strategic Seapower*, pp. 66–67.
61. Similarly, it was not until the mid-1980s that the *Han* was outfitted “with acceptable [navigation and communication] subsystems.” *Ibid.*, pp. 66–67, 110.
62. *Ibid.*, p. 68.
63. In 1956, Mao Zedong initiated the research on missiles capable of carrying nuclear warheads. At the time of the JL-1 project initiation the missile designation, JL-1, meant Giant Dragon No. 1 (*julong yihao*). In 1972, the meaning of the designation was changed to Giant Wave (*julang*) for political reasons. Lewis and Xue, *China’s Strategic Seapower*, pp. 130, 137.
64. *Ibid.*, p. 143.
65. National Intelligence Council, *Foreign Missile Developments and the Ballistic Missile Threat through 2015* (Washington, D.C.: 2001), p. 9.
66. In 1959, the Soviet Union sold China the designs and necessary equipment to produce its own version of the liquid-fueled Soviet SLBM, the R-11FM. However, China decided to focus first on the production of a land-based strategic weapon, to produce a nuclear strategic deterrent in less time than it would take to produce a functional SSBN. See Lewis and Xue, *China’s Strategic Seapower*, pp. 131–32.
67. Lewis and Xue, *China’s Strategic Seapower*, pp. 132–33.
68. Sapolsky, *The Polaris System Development*, p. 136.
69. For an SLBM, missile ignition does not occur immediately, as it does for a land-based missile, but after the missile is above the surface of the water. Ignition would be triggered, most likely, as a result of the negative acceleration rate sensed by the missile flight control system. As the missile reaches its highest point following missile ejection it momentarily falls back toward the surface; the missile flight control system senses this and triggers engine ignition.

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70. Lewis and Xue, *China's Strategic Seapower*, pp. 133, 143–44. See Lewis and Xue, chap. 6, for a more detailed analysis of China's solid rocket propellant development.
71. The price paid for the trial-and-error method was at times high. In 1962, a technician was killed while working with the composite propellant at Plant 845 (part of the Solid Rocket Motor institute under the Fifth Academy) in Xian, and in 1974 there were several mishaps involving the grain casting plant, the worst killing the deputy head of the plant. Lewis and Xue, *China's Strategic Seapower*, pp. 136–37, 151–52, 153.
72. *Ibid.*, pp. 136–37, 139, 141, 144, 151.
73. *Ibid.*, pp. 139, 143, 153.
74. *Ibid.*, p. 158.
75. *Ibid.*, p. 159.
76. The other option would have been to launch the SLBMs while the SSBN hovered in place. To facilitate a hovering SSBN, the ship must have a ship control system capable of making rapid adjustments in ballast by either bringing water on board or driving water into and out of variable ballast tanks. Hovering, therefore, requires technology that can automatically detect changes in ship's depth and rapidly compensate by utilizing a system of pumps and valves capable of moving massive amounts of water in a very short time. The Chinese designers developed a launch-assistance system that incorporated rails within the missile tube to compensate for the perpendicular force of the water (relative to the direction of the ejected missile); it is likely that they believed this system would be less complicated than designing a hovering system for the submarine. Lewis and Xue, *China's Strategic Seapower*, pp. 71, 174.
77. *Ibid.*, p. 155.
78. *Ibid.*, pp. 171, 175.
79. China built a Golf-class diesel-electric submarine under license from the Soviet Union. The Golf was modified to be a test platform for JL-1 missile launches; it is believed to have continued service as a test platform for the new JL-2 SLBM. (Lewis and Xue, *China's Strategic Seapower*, pp. 69, 111–15, 186, 197–200.) Beyond the challenges particular to an SLBM, China had to develop the telemetry systems for testing and tracking, as well as the tracking ships necessary to monitor the performance of the JL-1 during its flight tests.
- Lewis and Xue, *China's Strategic Seapower*, pp. 73, 171, 191–96. For a more in depth overview of the JL-1's guidance and flight control systems, function, and performance, see *ibid.*, chap. 7.
80. In 1967, when the initial design for the *Xia* was completed, Nie Rongzhen and the Defense Science and Technology Commission set the target launch date for the Project 092 submarine as 1973. Lewis and Xue, *China's Strategic Seapower*, pp. 68, 204.
81. Bernard D. Cole, *The Great Wall at Sea* (Annapolis, Md.: Naval Institute Press, 2001), 93; Shambaugh, *Modernizing China's Military*, p. 271; "NRDC Nuclear Notebook," *Bulletin of the Atomic Scientists*, "Nuclear Notebook," www.thebulletin.org/issues/nukenotes/nukenote.html.
82. At the "China's Nuclear Future" conference, several questions were posed to leading experts on the PLA about the *Xia* in one-on-one exchanges and in open forum. The general consensus was that the *Xia* did not represent a threat.
83. Epigraph quotation found in Owen R. Coté, Jr., *The Third Battle*, Newport Paper 16 (Newport, R.I.: Naval War College Press, 2003), p. 51.
84. Coté defines the First and Second Battles as World Wars I and II, respectively (*ibid.*).
85. On the U.S. Navy's fixed underwater passive acoustic (SOSUS) initiative during the Cold War, see *ibid.*, chap. 4. For the U.S. Navy's development of mobile underwater acoustic arrays, see "Advanced Deployable System Will Help Find Quiet Diesel Subs," *InsideDefense.com*, 8 February 1999, www.insidedefense.com, and "Dual-Array ADS Testing," *InsideDefense.com*, 1 December 2003, www.insidedefense.com.
86. John Morgan, "Anti-Submarine Warfare A Phoenix for the Future," *Undersea Warfare* (Fall 1998), p. 18 (Captain Morgan was the Director, Anti-Submarine Warfare Division [N84] in the Office of the Chief of Naval Operations); Capt. James E. Pillsbury, Executive Assistant to the Chairman of the Strategy and Policy Department, Naval War College, interview by author, 22 August 2003, Newport, R.I.; Coté, *The Third Battle*, p. 84.
87. "Antisubmarine Warfare after the Cold War," *MIT Security Studies Program*, "Publications, Conferences, & Symposia Page," web.mit.edu/ssp/Publications/pubs.html.

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89. Vice Admiral Kirkland H. Donald. See “VADM Donald Remarks at NDIA 2003 Joint Undersea Warfare Technical Conference,” *Commander Naval Submarine Forces*, 23 September 2003, www.sublant.navy.mil/remarks_2003NDIA.htm.
90. Coté, *The Third Battle*, p. 84 [emphasis original].
91. Ibid., p. 20.
92. In order to ensure the SSN fleet does not continue to decline in numbers, the Navy must begin in the near future to build at least two new submarines per year. Congress recently rejected a plan to build seven *Virginia*-class submarines in a five-year period. See Dale Eisman, “Congress Gives \$2 Billion for Navy Shipbuilding Plan,” *Virginian Pilot*, 30 September 2003.
93. *Worldwide Submarine Challenges*, 1997, p. 21.
94. U.S. Defense Dept., *Annual Report on the Military Power of the People’s Republic of China* (Washington, D.C.: 2003), pp. 8, 28.
95. Coté, *The Third Battle*, pp. 66–67.
96. Ibid., p. 69.
97. The USS *Holland* was the first submarine purchased by the Navy in 1900; the USS *Los Angeles* (SSN 688) was the first of a class that today represents the backbone of the U.S. submarine fleet.
98. U.S. Defense Dept., *Annual Report on the Military Power of the People’s Republic of China* (Washington, D.C.: 2003), pp. 8, 27.
99. In the 1990s, China spent nearly seven billion dollars on advanced Russian weapons systems and its purchases have continued. The contract with Russia to purchase eight Project 636 Kilo class submarines as well as other weapons systems will provide China with formidable weaponry that could, if properly utilized, present a serious challenge to the U.S. Navy. See Shambaugh, *Modernizing China’s Military*, p. 218.
100. U.S. Defense Dept., *Annual Report on the Military Power of the People’s Republic of China* (Washington, D.C.: 2003), p. 27.
101. Michael I. Handel, *Masters of War* (London: Frank Cass, 2001), p. 237.
102. As noted previously, credible reports suggest the 094 prototype was launched in July 2004. However, estimates on its initial operating capability vary considerably (see footnote 12 above). In addition, Bernard Cole states that the first 094 will not be in service until 2010 and that the JL-2 will have a range of twelve thousand kilometers. (Bernard D. Cole, *The Great Wall at Sea* [Annapolis, Md.: Naval Institute Press, 2001], p. 185.) David Shambaugh says that the 094 will be in service possibly within a decade and that it will carry sixteen JL-2 SLBMs each carrying six warheads and will have a range of eight thousand kilometers. (Shambaugh, *Modernizing China’s Military*, p. 272.) A monthly Hong Kong magazine article states that there are or will be three variants of the JL-2: the JL-2 with an 8,600 km range with four to five warheads, the JL-2A with a 12,500 km range with seven to eight warheads, and the JL-2B with a range of 14,000 km and ten warheads. (Ch’ing T’ung, “China’s First- and Second-Generation Nuclear-Powered Submarines,” *Hong Kong Kuang Chiao Ching*, 16 June 2003, FBIS CPP20030620000084.) A less credible article in the *Chinese Military Update* published by the Royal United Services Institute states that three 094 SSBNs have already been commissioned and that they may already have six 094s. (Sheng Lijun, “PLA Modernization: Tactical and Strategic Weapons for the Taiwan Strait,” *Chinese Military Update* 1, no. 3 [June 2003], p. 6.) There does seem to be some convergence in that the 094 will likely carry sixteen JL-2 SLBMs, that they will have a range between eight and twelve thousand kilometers, and that they will have MIRV.
103. For a more detailed look at the improvements China has made training its officer and enlisted personnel, see, Cole, *The Great Wall at Sea*, chap. 6.
104. Lyle Goldstein and William Murray, “Undersea Dragons: China’s Maturing Submarine Force,” *International Security* 28, no. 4 (Spring 2004), pp. 175–76.
105. Pillsbury interview.
106. Cole, *The Great Wall at Sea*, pp. 70–71.
107. Joseph Kahn, “Chinese Officers Warn That Taiwan Referendum Could Lead to War,” *New York Times on the Web*, 3 December 2003, www.nytimes.com/2003/12/03/international/asia/03CND-Chin.html?ex=1071678576&ei=1&en=b38e0023e2b245d8. A 2003 report from the *Council on Foreign*

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- Relations* states, "China's hosting of the 2008 Olympics creates an even greater need [for China] to avoid additional external tensions." ("China's Military Power," *Council on Foreign Relations*, "All Publications," www.cfr.org/pubs.php?year=2003&type=>.)
108. Visiting the United States, the Chinese premier, Wen Jiabao, and President George W. Bush were fairly united in their response to Taiwan's recent push to conduct a referendum. David Stout, "Bush Tells China's Leader He Opposes Taiwan's Referendum," *New York Times on the Web*, 9 December 2003, www.nytimes.com/2003/12/09/international/asia/09CND-Bush.html?ex=1072000124&ei=1&en=f134bf550961d0c4>.
 109. The commentary, quoted with permission, was provided to the author as a review of an unpublished draft on China's submarine force written by a colleague of the author. The U.S. submarine captain has extensive experience in both fast attack and ballistic missile submarines and wished to remain anonymous [emphasis original].
 110. Anonymous U.S. submarine captain [all emphasis original].
 111. *Ibid.*
 112. This number is derived from Christopher Langton, ed., *The Military Balance 2003–2004* (Glasgow, U.K.: Oxford Univ. Press, 2003), p. 153.
 113. "Submarines and Peacekeeping," *Journal of Military and Strategic Studies* (Spring 2000), available at www.jmss.org/2000/article3.html. An account in the U.S. Navy's *Undersea Warfare* magazine argues, "The *San Luis* operated in the vicinity of the British task force for more than a month and was a constant concern to Royal Navy commanders. Despite the deployment of five nuclear attack submarines, 24-hour per day airborne ASW operations, and expenditures of precious time, energy, and ordnance, the British never once detected the Argentine submarine." Morgan, "Anti-Submarine Warfare," p. 19.
 114. Shambaugh, *Modernizing China's Military*, p. 283.
 115. For a compelling explanation of this concept, see Thomas J. Christensen, "Posing Problems Without Catching Up: China's Rise and Challenges for U.S. Security Policy," *International Security* 25, no. 4 (Spring 2001), pp. 5–40.
 116. National Intelligence Council, *Foreign Missile Developments and the Ballistic Missile Threat through 2015* (Washington, D.C.: 2001), p. 8.
 117. For more detailed information on U.S. Ballistic Missile Defense efforts, see the Missile Defense Agency at www.acq.osd.mil/bmdo/. At the July 2003 "China's Nuclear Future" conference retired Rear Admiral Michael McDevitt of the Center for Naval Analyses, stated that he believes China is building to a "substantial force" of 250–300 road-mobile ICBMs.
 118. John F. Kennedy quoted in Coté, *The Third Battle*, p. 20.
 119. Nobska Report quoted in *ibid.*, p. 20.
 120. After China's first atomic test in 1964, Mao stated that the first atomic test, "marked the bankruptcy of the imperialists' policy of nuclear monopoly and nuclear blackmail, and frustrated the attempts to pressure the Chinese people into submission." Mao Zedong quoted in Lewis and Xue, *China's Strategic Seapower*, p. 150.
 121. Robert A. Hamilton, "Lack of Subs Could Slow Pace of Technology, Admiral Warns," *New London Day*, 30 September 2003, pp. A1, A3.
 122. Bryan Bender, "Navy to Cut Orders; Job Losses Seen," *Boston Globe*, 7 February 2005, p. 1.
 123. See Goldstein and Murray, "Undersea Dragons," note 109.
 124. The estimate of twenty SSNs assumes that the U.S. submarines would be easily able to locate and maintain contact with an SSBN. The estimate is based on a forty-day maintenance period, a seventy-day patrol, and two-crew manning for each SSBN, allowing four to six SSBNs to be at sea at any given time. The SSNs would be deployed for six months, with twenty days of transit or training time on either end of the deployment, and twelve months between deployments. The estimate assumes that five SSNs would normally be in-theater for four deployed SSBNs; it does not take into account nonavailability for such reasons as technical problems or medical emergencies.
 125. The number of SSNs is based on similar assumptions as the previous estimate with the change being that a lower number of SSBNs are on patrol. If the U.S. Navy were to develop armed, unmanned undersea vehicles, it is possible that the number of SSNs required in such a scenario could be reduced, but such technology could take at least two decades to mature.

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127. For the Chinese perception of "island chains," see Chris Rahman, "Defending Taiwan, and Why It Matters," *Naval War College Review* 54, no. 4 (Autumn 2001), esp. p. 73.
128. See, "Australia to Join U.S. Missile Defense System," *New York Times on the Web*, 4 December 2003, www.nytimes.com/2003/12/04/international/asia/04AUST.html?ex=1072014262&ei=1&en=f97544a85990d50e.
129. Richard Fisher, Jr., "Developing U.S.-Chinese Nuclear Naval Competition in Asia," International Assessment and Strategy Center, 16 January 2005, retrieved from www.strategycenter.net/printversion/print_pub.asp?pubID=60 on 25 January 2005.
130. Thanks to Prof. William Murray from the War Gaming Department of the Naval War College for this insight, as well as for many others.
131. Chinese SSBN operations in the Indian Ocean would preclude launch against the U.S., due to the range. However, China may choose to demonstrate its nuclear deterrent to India. To do this, its submarines would have to transit some of the busiest shipping lanes in the world.
132. For a more detailed discussion on the barrier strategy, see Coté, *The Third Battle*.
133. *Ibid.*, pp. 63–64.
134. *Ibid.*, p. 64.
135. *Ibid.*
136. The ASW debate that occurred as a result of the Soviet deployment of its Delta SSBNs is covered in *ibid.*, pp. 64–65.
137. *Ibid.*, p. 86.
138. *Ibid.*, p. 82.
139. Brad Roberts of the Institute for Defense Analyses sees China's nuclear future as more mobile, more penetrable, more accurate, and capable of surprise. ("China's Nuclear Future" conference.) A more robust fleet of Chinese SSBNs and the JL-2 SLBM are consistent with all of these. China wants an assured second-strike capability that is less vulnerable to U.S. precision conventional strike and nuclear attack. For this reason, an investment in a larger fleet of SSBNs is highly plausible, and there is little reason to doubt it.
140. "Statement of RADM Albert H. Konetzni, U.S. Navy Commander, Submarine Force United States Pacific Fleet before the House Armed Services Committee Procurement Subcommittee Submarine Force Structure and Modernization Plans Hearing 27 June 2000," *Federation of American Scientists*, "Military Affairs in Congress: 2000," www.fas.org/man/congress/2000/index.html. From the U.S. Navy's *Undersea Warfare* magazine: "The new challenge is becoming clearer, and it is time to shift gears. . . . [T]he Defense Planning Guidance (DPG) and the Navy's Long-Range Planning Objectives — also call for a robust ASW capability that links warfare requirements to the real dangers and vulnerabilities introduced by the proliferation of next-generation submarines." Morgan, "Anti-Submarine Warfare," p. 20.
141. Thanks to Capt. Dan Farson of the Navy Warfare Development Command (NWDC) for his thoughtful critique and suggestions.
142. Coté characterizes the ability of the Navy to keep pace with ASW development during the first, second, and third battles as having been "saved by the bell." See Coté, *The Third Battle*, pp. 2, 78.
143. See "Ship Antisubmarine Warfare Readiness/Effectiveness Measuring (SHAREM)," retrieved from www.globalsecurity.org/military/ops/sharem.htm on 8 February 2005.
144. While these advancements are positive, there remain many negatives for U.S. ASW capability. The MMA aircraft, if it remains on schedule, will not be available until 2013 at the earliest. Additionally, S-3 Vikings that in the past were devoted almost exclusively to ASW now function as aerial refueling aircraft. The SOSUS system capability has been severely downgraded, and the number of ASW-capable surface combatants is being drastically reduced. Without an easily identifiable threat to the United States, the tendency in force planning

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is to build weapons systems capable of performing multiple missions—the Littoral Combat Ship and the SSGN are good examples. The disadvantage to this approach is that crews that operate these weapons platforms are not afforded the opportunity to specialize and excel at specific mission areas, such as ASW. For a more complete discussion on U.S. ASW capability, see Goldstein and Murray, “Undersea Dragons.”

145. This is a reference to remarks, sometimes regarded as a nuclear threat, by Gen. Xiong Guangkai offered to former State and Defense Department official Charles W. Freeman, Jr., in December 1995. On this event, see James Mann, *About Face: A History of America's Curious Relationship with China, from Nixon to Clinton* (New York: Vintage Books, 2000), p. 334.

Chapter Three

China's Space Development and Nuclear Strategy

1. The military implications of this nexus are thoroughly discussed in William C. Martel and Toshi Yoshihara, “Averting a Sino-U.S. Space Race,” *Washington Quarterly* 26 (Autumn 2003), pp. 21–23.
2. Samuel B. Griffith, trans., *Sun Tzu: The Art of War* (London: Oxford Univ. Press, 1963), p. 66.
3. “Shenzhou” is the name apparently given to the spacecraft by former President Jiang Zemin.
4. There are three major terms used to describe China's astronauts. The one used in this chapter, *yuhangyuan* (宇航员), or “astronaut,” is the official term used by the PRC government and media. A second mainland Chinese term, apparently of academic origin in the 1970s, is *hangtianyuan* (航天员), or “spaceflight person.” A third term, *taikongren* (太空人), or “space person,” is more commonly used in Taiwan and among overseas Chinese. *Taikongren* has been anglicized into “taikonaut.” For more information, see Brian Harvey, *China's Space Program: From Conception to Manned Space Flight* (New York: Springer Praxis, 2004), p. 251.
5. *Yuhangyuan* are to China as are “astronauts” to the Americans and “cosmonauts” to the Russians.
6. It is worth noting, however, that approximately one year after the Columbia tragedy, President George W. Bush announced an ambitious new program to explore the possibility of a manned mission to Mars. See www.whitehouse.gov/news/releases/2004/01/20040114-1.html.
7. Peng Hai-lei, “Shenzhou V Spacecraft Will Leave the Factory As Planned; Li Jinai Is Appointed as Commander-in-Chief of China's Manned Space Project,” *Wen Wei Po*, 24 July 2003, FBIS CPP20030725000088.
8. Ted Anthony, “China Plans to Launch Manned Flight in 2003,” on the website of Space.com, 2 January 2003, at www.space.com/missionlaunches/china_manned_030102.html/p. 2.
9. See James E. Oberg, *Red Star in Orbit* (New York: Random House, 1981). It is the seminal work by America's foremost space watcher on the Soviet space program (and its military underpinnings) at the height of the Cold War.
10. See Iris Chang, *Thread of the Silkworm* (New York: Basic Books, 1995), and William L. Ryan and Sam Summerlin, *The China Cloud* (Boston: Little, Brown, 1967). This statement does not constitute an attempt to denigrate the vital role of other major decision makers, especially that of Marshal Nie Rongzhen, who oversaw all aspects of China's nuclear weapons programs. On Nie, see Evan A. Feigenbaum, *China's Techno-Warriors: National Security and Strategic Competition from the Nuclear to the Information Age* (Stanford, Calif.: Stanford Univ. Press, 2003). In addition, Qian was aided in his efforts by an elite of foreign-trained scientists and engineers.
11. Ryan and Summerlin, *The China Cloud*, p. 88.
12. Chang, *Thread of the Silkworm*, p. 198.
13. *Ibid.*, p. 199.
14. Mark A. Stokes, *China's Strategic Modernization: Implications for the United States* (Carlisle, Penna.: Strategic Studies Institute, 1999), p. 170, available at www.fas.org/nuke/guide/china/doctrine/chinamod.pdf.
15. Joan Johnson-Freese, *The Chinese Space Program: A Mystery within a Maze* (Malabar, Fla.: Krieger 1998), pp. 65–66.
16. Chang, *Thread of the Silkworm*, p. 229.
17. *Ibid.*, 218–19.
18. John Wilson Lewis and Hua Di, “China's Ballistic Missile Programs: Technologies, Strategies, Goals,” *International Security* 17, no. 2 (Fall 1992), p. 14.
19. Chang, *Thread of the Silkworm*, p. 221.

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21. Ryan and Summerlin, *The China Cloud*, p. 237.
22. Lewis and Di, "China's Ballistic Missile Programs," p. 17.
23. Phillip Clark, *The Soviet Manned Space Program* (New York: Orion Books 1988), p. 13.
24. Johnson-Freese, *The Chinese Space Program*, p. 47.
25. The other four countries capable of satellite operations in 1970 were the United States, the Soviet Union, France, and Japan.
26. Chang, *Thread of the Silkworm*, p. 227.
27. Tian Zhaoyun and Xi Qixin, "Launching Shenzhou 3 Is a Preview of Sending Astronauts into Space," Liaowang, 1 April 2002, cited in Brian Harvey, *China's Space Program: From Conception to Manned Space Flight* (New York: Springer Praxis, 2004), p. 247.
28. Mark Wade, "China," Astronautix.com, 4 March 2003, www.astronautix.com/articles/china.htm, p. 2.
29. Johnson-Freese, *The Chinese Space Program*, pp. 49–50.
30. Kathryn L. Gauthier, *China as Peer or Competitor? Trends in Nuclear Weapons, Space, and Information Warfare*, Maxwell Paper 18 (Maxwell Air Force Base, Ala.: Air Univ. Press, July 1999), p. 12.
31. "Space Policy Project: CZ-2F Space Launch," *Federation of American Scientists*, "World Space Guide," 12 May 2000, www.fas.org/spp/guide/china/launch/cz-2f.htm.
32. Johnson-Freese, *The Chinese Space Program*, p. 49.
33. The full text of the report is available at www.fas.org/spp/starwars/congress/1999_r/cox.
34. See, for example, Jonathan D. Pollack, "The Cox Report's 'Dirty Little Secret,'" *Arms Control Today* (April/May 1999), pp. 26–35; and Alastair Iain Johnston, W. K. H. Panofsky, Marco Di Capua, Lewis R. Franklin, and M. M. May, eds., *The Cox Committee Report: An Assessment* (Stanford, Calif.: Center for International Security and Cooperation, 1999).
35. See www.fas.org/spp/starwars/congress/1999_r/cox/ch1bod.htm.
36. Wade, "China," p. 2.
37. Chang, *Thread of the Silkworm*, pp. 224–25.
38. Werner Von Braun is commonly referred to as the visionary behind NASA in the race to the Moon; Sergei P. Korolev was his counterpart in the Soviet Union, the legendary chief designer responsible for Sputnik and the first manned missions during the same period.
39. Stokes, *China's Strategic Modernization*, pp. 171–72.
40. Gauthier, "China as Peer Competitor?" p. 16.
41. Ibid., p. 16.
42. "Chinese Defense Today: Intercontinental Ballistic Missile (ICBM)," Sinodefence.com, at www.sinodefence.com/nuclear/icbm/default.asp.
43. "DF-31: China Nuclear Forces," *Federation of American Scientists (FAS)*, fas.org/nuke/guide/china/icbm/df-31.htm.
44. Ibid. One brigade of eight missile launchers is said to be operational. Christopher Langton, ed., *The Military Balance 2004–05* (London: Oxford Univ. Press, 2004), p. 170.
45. Ye Dingyou, Zhang Dexiong, "Progress in Solid Rocket Technology," *Zhongguo Hengtian*, 1 December 2002, pp. 24–27, FBIS CPP20030213000194.
46. Emerson Niu (Duke University), "Nuclear Deterrence over Taiwan," 21 July 2003, paper presented to the "China's Nuclear Future" conference, Boulder, Colorado, U.S. Air Force Institute for National Security Studies, U.S. Air Force Academy, 31–31 July 2003, pp. 10–11.
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52. "KT-1, 2 Space Launch Vehicle," *China Defense Today*, available at www.sinodefence.com/space/launchvehicle/kt1.asp.

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53. Harvey, *China's Space Program*, p. 327. It must be emphasized, however, that this technical feat—accomplished on 20 September 1981—did not prove that China “possessed or was actively pursuing MIRV technology. In fact, that launch tested neither a MRV nor a MIRV. The lift capacity of the launcher, a modified DF-5, was simply too large to carry just one or two small scientific satellites. However, the carrier's nose cone was too small to contain three of them, and the launch crews had to put one of the three in the tail-deck of the second stage.” John Wilson Lewis and Hua Di, “China's Ballistic Missile Programs: Technologies, Strategies, Goals,” *International Security* 17, no. 2 (Autumn, 1992), p. 22.
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70. “China in Space: China's Astronauts,” *Space Today Online*, 2003, www.spacetoday.org/China/ChinaTaikonauts.html.
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Chapter Four

Chinese BMD Countermeasures:

Breaching America's Great Wall in Space?

1. According to U.S. policy, BMD is a comprehensive term encompassing all missile defense. This paper concerns nuclear strategy, however, and will therefore focus more heavily on the strategic context of national missile defense (NMD), as opposed to theater missile defense (TMD). For this reason, I will use the term TMD only to describe instances in which TMD would engender different strategic considerations than would NMD.
2. William Murray, Associate Professor, U.S. Naval War College, “The Strategic Surface Ship,” 2004, unpublished manuscript.
3. Larry M. Wortzel, “Should The United States Counter China's Missile Buildup? Yes,” *Insight Magazine*, 13 May 2002; and Adam

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 20. He Linshu, *Solid Ballistic Missile Design*, p. 90.
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 22. Brad Roberts, *China and Ballistic Missile Defense: 1955 to 2002 and Beyond* (Alexandria, Va.: Institute for Defense Analyses, September 2003), p. 20.
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 26. David N. Schwartz, "Past and Present: The Historical Legacy," in *Ballistic Missile Defense*, ed. Ashton B. Carter and David N. Schwartz

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 116. Sessler et al., "Countermeasures," p. 37.
 117. "DF-31," available at www.globalsecurity.org/wmd/world/china/df-31.htm.
 118. Robert S. Norris and Hans M. Kristensen, "Chinese Nuclear Forces, 2003," *Bulletin of the Atomic Scientists*, available at www.thebulletin.org/article_nn.php?art_ofn=nd03norris. Norris and Kristensen also cite page 8 of the Central Intelligence Agency, National Intelligence Council's December 2001 Foreign Missile Developments and the Ballistic Missile Threat through 2015" as stating that "Chinese pursuit of multiple RV capability for its mobile ICBMs . . . and SLBMs would encounter significant technical hurdles and would be costly." However, in this 2003 report they also conclude that "Given the significant problems China has had with the Xia, deployment of a Project 094 submarine and its new missile is many years away." In fact, China deployed its first 094 submarine in 2004. This indicates China's capacity for sudden technical developments that Western analysts failed to anticipate.
 119. Urayama, "China Debates Missile Defence," p. 133. Figure of six to seven from Bill Gertz, "China Tests Arms Designed to Fool Defense Systems," *Washington Times*, 23 July 2002, p. 1.
 120. Vladimir Urban, "Anti-Missile Umbrella for Sale: Russia May Take Advantage of the New Cycle of the Arms Race," *Novye Izvestia*, 16 October 2002.
 121. Gertz, "China Tests Arms Designed to Fool Defense Systems," p. 1.

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122. Hiroyuki Sugiyama, "China Tests Multiple-Warhead Missiles: New ICBMs to Be Deployed," *Daily Yomiuri* (in English), 7 February 2003, FBIS JPP20030207000154.
123. Stokes, "Chinese Ballistic Missile Forces," p. 142.
124. For more information on *Chevaline* and its challenges, see Sessler et al., "Countermeasures," p. 148.
125. Moreover, Chinese bombers would presumably have to fly over Philippine, Russian, or Japanese air space—although improved LACMs could make China more confident about such overflight.
126. Indeed, some analysts predict that even the United States may find it advantageous for long-range missiles to assume bombers' responsibilities as opponents' air defenses continue to improve.
127. Joseph Cirincione et al., *Deadly Arsenals*, p. 144.
128. "Russia, China Tighten Security Links," *China Daily*, 3 February 2005.
129. Lindsay and O'Hanlon, *Defending America*, p. 128.
130. For a Chinese argument in support of this point, see 李彬 [Li Bin], 美国打算怎么运用它的核武器? [How Will the U.S. Make Use of Its Nuclear Weapons?], 世界知识 [World Affairs], no. 7 (2002), pp.16–17.
131. Lindsay and O'Hanlon, *Defending America*, p. 130.
132. Freedman and Gray, "Implications of Missile Defense," p. 346.
133. 王辑思 [Wang Jisi], 苏美争霸的历史教训和美中国的崛起新道路 [The Historic Lesson of the U.S.-Soviet Contest for Hegemony and China's Peaceful Rise], in 中国和平崛起新道路 [China's Peaceful Rise: The New Path] (Beijing: 中共中央党校国际战略研究所 [Central Committee of the CCP Party School International Strategy Research Institute], April 2004).
134. Freedman and Gray, "The Implications of Missile Defense for Northeast Asia," p. 346.
135. 刘志伟, 李彬 [Liu Zhiwei and Li Bin], 美国NMD的费用问题以及部署前景 [U.S. NMD Expenses and Its Future Deployment], 现代国际关系 [Contemporary International Relations], no. 1 (2003), p. 33.
136. Eric McVadon, "Chinese Reactions," p. 177.
137. Ibid.
138. Urayama, "China Debates Missile Defence," p. 129.
139. For examples of the Iraq and terror wars' negative impact on U.S. Pacific capabilities, see Bryan Bender, "Arms Reductions, Troop Increase Eyed: War's Toll Prompts Shift in Priorities," *Boston Globe*, 17 December 2004, p. 1.
140. Lindsay and O'Hanlon, *Defending America*, pp. 21–22.
141. Contrary to what some critics have asserted, BMD investment is not inherently unwise. The significant funding required for BMD also represents an investment in the vitality of America's defense industrial sector—particularly its aerospace component—which needs a degree of freedom to engage in basic research without the shortsighted constraint of quarterly earnings reports. BMD proponents are correct to emphasize that research can produce unintended successes just as an American program to maintain military communication in the event of nuclear war (ARPANet) led to the creation of the Internet. Such continuity is especially important in a competitive economy that lacks the long-term manufacturing stability of its European and East Asian counterparts. The United States suffers from a government-industry disconnect in which Congress insists on annual funding in a manner that tends to undermine long-lead expenditures. By galvanizing aerospace development in a manner relevant to U.S. national security, judicious missile defense funding can help to further the technological development on which America's global position depends.
142. For a Chinese perspective that seems to endorse these anti-NMD arguments, see 周宝根 [Zhou Baogen], 九一一对国际军备控制的影响 [The Impact of Sept 11 on Global Arms Control], 联合早报 [Zaobao Online], 29 October 2001.
143. Resources are finite, and technological transformation would probably require freedom of thought and innovation that if even attainable might necessitate reform of rogue states' authoritarian governments in a manner that would decrease their threat to the United States.
144. Li Bin, "The Impact of U.S. NMD."
145. 吴锐 [Wu Rui], 美国安全精英对中国核问题的认知 [American Perspectives about Chinese Nuclear Policy: Report of the Interviews in Washington, DC], Institute of International Studies, Tsinghua University, Beijing, June 2003.

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147. Chinese sources frequently cite “unilateralism,” presumably on the part of the United States, as being a major factor in frustrating arms control. See, for example, Li Bin and Liu Zhiwei, “The Contribution of Arms Control to Fighting Nuclear Terrorism,” *Disarmament Forum*, 2003, no. 2, pp. 17–22; Wang Guosheng and Li Wei, “U.S. Comprehensively Adjusts Nuclear Strategy,” *Jiefangjun Bao* (in Chinese), 30 January 2002, p. 12, FBIS CPP20020130000076.
148. For a Chinese analysis supporting the notion that China’s space warfare capabilities will be influenced by the threat that China perceives from the United States, see 李彬 [Li Bin], 外空战的后果 [The Consequences of a Space War], Paper presented at the Pugwash Workshop on Preserving the Non-Weaponization of Space, Castellon de la Plana, Spain, May 2003.
149. The Chinese term for “hegemonism” is *bà quán zhǔ yì* (霸权主义).
150. For instance, anti-laser reflective coatings.
151. For an eloquent explanation of this apparent contradiction, see Joseph S. Nye, Jr., *The Paradox of American Power: Why the World’s Only Superpower Can’t Go It Alone* (New York: Oxford Univ. Press, 2002).
152. “Airborne Laser Expected to Achieve Key Goal ‘Very Soon,’” *Aerospace Daily & Defense Report*, 17 November 2004.
153. Lindsay and O’Hanlon, *Defending America*, p. 111. For a detailed Chinese analysis of anti-laser countermeasures, see Gu Lixiang, “PRC S&T: U.S. Boost Phase Laser Interception Technology and Countermeasures,” *Daodan yu Hangtian Yunzai Jishu* (in Chinese), 10 April 2003, pp. 25–32, FBIS CPP20030625000147.
154. Hans Binnendijk and George Stewart, “Toward Missile Defenses from the Sea,” *Washington Quarterly* 25, no. 3 (Summer 2002), p. 197.
155. For more details on targeting North Korea and Iran, see Congressional Budget Office, “Alternatives for Boost-Phase Missile Defense,” July 2004, available at www.cbo.gov/showdoc.cfm?index=5679&sequence=1.
156. Michael Sirak, “Sea-Based Ballistic Missile Defense: The ‘Standard’ Response,” *Jane’s Defense Weekly*, 30 October 2002.
157. Nancy Montgomery, “New Job for 7th Fleet: Missile Patrol in Sea of Japan,” *Pacific Stars and Stripes*, 12 September 2004.
158. “U.S. Conducts Ship-Based Missile Test; Withdraws from ABM Treaty,” *Xinhua* (in English), 14 June 2002, FBIS CPP 20020614000042.
159. Montgomery, “New Job For 7th Fleet.”
160. Nancy Montgomery, “USS *Lake Erie* Makes Its Presence Known in Pacific Waters,” *Pacific Stars and Stripes*, 25 October 2004.
161. “U.S. Navy Gets Interceptors for Sea-Based Missile Defense,” *Aerospace Daily & Defense Report*, 21 December 2004.
162. Rick Barnard, “Subs: Best Basing Mode for Boost-Phase Defense?” *Sea Power* (October 2003), available at www.navyleague.org/sea_power/oct_03_27.php.
163. In another example of submarines’ versatility and enduring relevance to post–Cold War conflicts, conversion of Trident SSBNs into guided-missile submarines (SSGNs) could also enable them to carry up to 154 Tomahawk cruise missiles each, delivering precision guided missions (PGMs) with a combination of stealth and cost-effectiveness.
164. Lindsay and O’Hanlon, *Defending America*, p. 108.
165. BMD requires accurate, high-volume, sustained communication. If current wire antennas cannot handle the flow and overcome problems of sporadic wave immersion, submarine commanders would have to rely on rigid bridge-top antennas. Roughly the height of the bridge itself when fully extended, the eight-inch-wide antenna would have to protrude three to ten feet above the water to receive uninterrupted signals. A related complication is that the Trident submarine is not designed to stay at periscope depth for extended periods of time. The low-pressure area formed above the missile deck could pull the submarine to the surface—that is, broach. Alternatively, the submarine could surface, but this could cause instability in fixed position. Of course, a surfaced submarine would be less stealthy and more vulnerable to attack.

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Abbreviations

ABL	airborne laser
ABM	Anti-Ballistic Missile (Treaty)
APEC	Asia-Pacific Economic Cooperation (Organization)
ASAT	antisatellite
ASW	antisubmarine warfare
BMD	ballistic-missile defense
BMDO	Ballistic Missile Defense Organization
CMC	Central Military Commission
C2	command and control
C4I	command, control, communications, computers, and intelligence
C4ISR	command, control, communications, computers, intelligence, surveillance, and reconnaissance
ELF	extremely low frequency
GPALS	Global-Protection Against Limited Strikes (program)
GPS	Global Positioning System
GSD	(Chinese) General Staff Directorate
ICBM	intercontinental ballistic missile
IRBM	intermediate-range ballistic missile
ISR	intelligence, surveillance, and reconnaissance
ISS	International Space Station
LACM	land-attack cruise missile
LEO	low earth orbit
LPAR	large phased-array radar

MARV	maneuvering reentry vehicle
MDA	Missile Defense Agency
MIRV	multiple independently targeted reentry vehicle
MMA	Multimission Maritime Aircraft
MRV	multiple reentry vehicles
NDIO	National Defense Industry Office
NC2	nuclear command and control
PAL	permissive action link
PLA	People's Liberation Army
PLAN	People's Liberation Army Navy
PRC	People's Republic of China
RV	reentry vehicle
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Organization
SLBM	submarine-launched ballistic missile
SLCM	submarine-launched cruise missile
SM-3	Standard Missile 3
SRBM	short-range ballistic missile
SRM	solid rocket motor
SSBN	nuclear-powered ballistic-missile submarine
SSK	hunter-killer (diesel-powered) submarine
SSN	nuclear-powered attack submarine
START (I, II)	Strategic Arms Limitation Talks (treaties)
TMD	theater missile defense
VLF	very low frequency
WMD	weapons of mass destruction

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