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USING THE LAND TO CONTROL THE SEA?

Chinese Analysts Consider the Antiship Ballistic Missile

Andrew S. Erickson and David D. Yang

For China, the ability to prevent a U.S. carrier strike group from intervening in the event of a Taiwan Strait crisis is critical. Beijing's immediate strategic concerns have been defined with a high level of clarity. The Chinese are interested in achieving an antiship ballistic missile (ASBM) capability because it offers them the prospect of limiting the ability of other nations, particularly the United States, to exert military influence on China's maritime periphery, which contains several disputed zones of core strategic importance to Beijing. ASBMs are regarded as a means by which technologically limited developing countries can overcome by asymmetric means their qualitative inferiority in conventional combat platforms, because the gap between offense and defense is the greatest here.

Today, China may be closer than ever to attaining this capability. In addition to numerous outside reports suggesting Chinese efforts in this area, technical and operationally focused discussions on the topic are appearing in increasing numbers and in a widening array of Chinese sources, some clearly authoritative. This suggests that China may be close to testing and fielding an ASBM system—a weapon that no other country currently possesses, since the United States relinquished a distantly related capability in 1988. In the view of Chinese and Western analysts, even the mere perception that China might have realized an ASBM capability could represent a paradigm shift,

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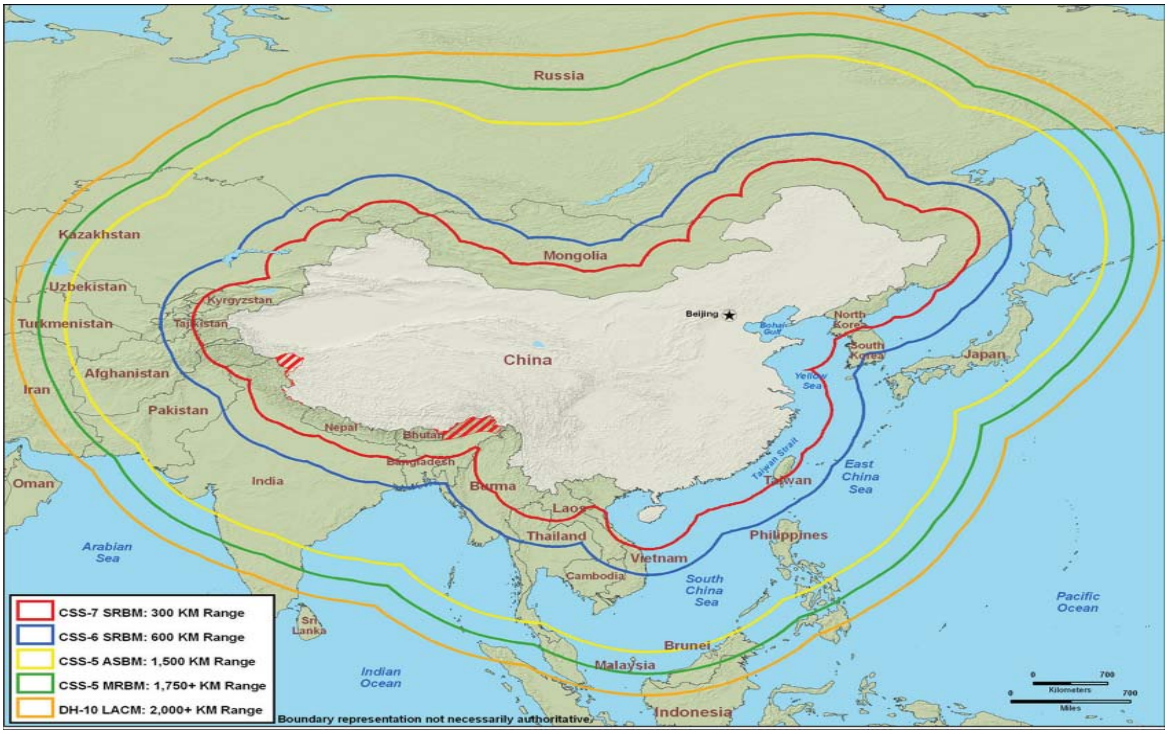
with profound consequences for deterrence, military operations, arms control, and the balance of power in the western Pacific.

Although open sources do not claim that China currently has a proven ASBM capability, U.S. government sources have stated consistently that Beijing is developing an ASBM based on a variant of the land-based DF-21/CSS-5 medium-range ballistic missile (MRBM). The DF-21's 1,500-kilometer-plus range could hold ships at risk in a large maritime area, far beyond Taiwan and into the western Pacific.[1] According to a 2006 unclassified assessment by the U.S. Office of Naval Intelligence, "China is equipping theater ballistic missiles [TBMs] with maneuvering reentry vehicles (MaRVs) with radar or IR [infrared] seekers to provide the accuracy necessary to attack a ship at sea."[2] If viable, such missiles, with "high-reentry speed (Mach 10–12) [and] radical maneuvers," would be extraordinarily difficult to defend against, whatever ballistic missile defense the United States might deploy.[3] Targeting a carrier with submunitions could enable China to render it operationally ineffective without sinking it, thereby achieving its objectives with a (perceived) lower risk of escalation. If not countered effectively, the very impression of such a risk might deter carrier strike groups from entering the region in the first place (figure 1).

FIGURE 1
MAXIMUM RANGE OF A DF-21/CSS-5 ASBM FROM LAUNCH LOCATIONS IN MAINLAND CHINA



Note the large area potentially covered, far beyond Taiwan and the first island chain into the western Pacific. This covers nearly all the maritime areas in which China has disputed claims, and provides a substantial strategic buffer zone for most. As published in Office of the Secretary of Defense, *Military Power of the People's Republic of China 2009, Annual Report to Congress,* p. 29.

China has also been working on a sophisticated network of ground- and space-based sensors, including over-the-horizon radars and electronic signals detection equipment. While finding an aircraft carrier has been likened to finding a needle in a haystack, this particular needle has a large radar cross section, emits radio waves, and is surrounded by airplanes. Simply looking for the biggest radar reflection to target will tend to locate the largest ship—and the largest ship will usually be an aircraft carrier.[4]

While the ASBM issue has been discussed for nearly a decade in Chinese official reports and commentaries in various venues, it has only recently garnered widespread public attention in the United States, primarily in reaction to two Chinese articles;[5] these articles were recently translated, posted, and analyzed on an influential blog affiliated with the U.S. Naval Institute, then covered widely by the media.[6] But these articles represent merely the tip of a much larger iceberg. In what follows, we will survey open-source Chinese writings on ASBMs to investigate and assess Chinese views on developing, fielding, and ultimately (in a worst-case scenario) using such a system.

EARLY CONCEPTIONS

For over three decades, Chinese leaders and strategists have been thinking of using land-based missiles to hit threatening targets at sea. In 1972, Vice Premier Zhang Chunqiao had significant influence over China's national decision making as one of the Gang of Four, a faction led by Chairman Mao Zedong's wife, Jiang Qing. In an important speech in April of that year he declared, "We are continentalists. Now guided missiles are well developed. Installed on shore, they can hit any target, and there is no need to build a big navy."[7] By focusing on a specific missile technology, as China had done so successfully since the 1950s, Zhang apparently believed, it would be possible to achieve a transformative strategic effect while devoting China's limited resources to more pressing priorities. Zhang's political career did not survive Mao's passing, and in the ensuing decades China took significant steps toward building the "big navy" that Zhang decried. Meanwhile, however, ballistic missile development remained a key Chinese focus. The American MaRVed Pershing II TBM—deployed in 1983—was studied intensively by the Chinese beginning in the late 1970s, with over fifty related commentaries appearing on this subject.[8] Such articles faded from more serious technical publications by the early 1990s, possibly because of the retirement of the Pershing IIs following ratification of the U.S.-Soviet Intermediate-Range Nuclear Forces (INF) Treaty in May 1988, as well as any efforts to avoid drawing attention to Chinese application of such technology. In any case, the Pershing II inspired Chinese research in this area and has been cited in Chinese sources as influencing the development of China's family of ballistic missiles.[9]

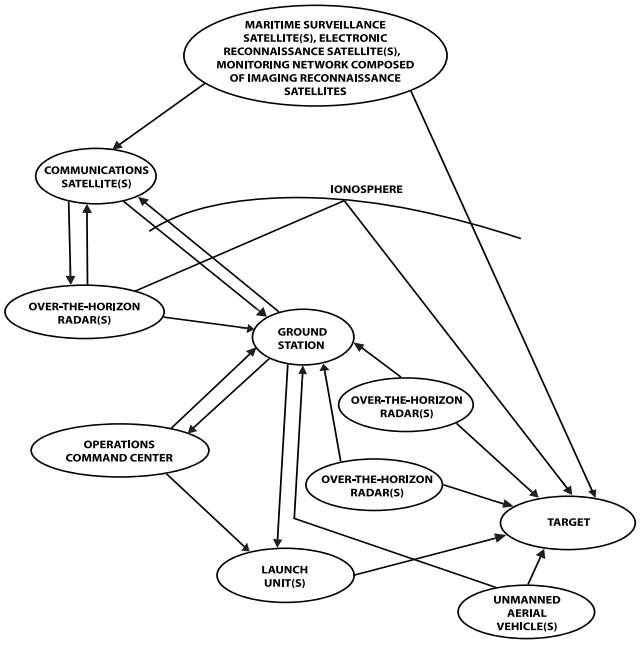
In recent years, Beijing has sought to threaten credibly U.S. military access to strategically vital areas along China's maritime periphery, particularly those surrounding Taiwan. Despite progress toward this end, however, Chinese naval and maritime analysts have written consistently that their nation's naval capabilities are still insufficient to address critical operational threats. Civilian leaders appear to have supported substantial naval development in keeping with China's commercial maritime revolution but continue to prioritize national economic development over military expansion and wish to avoid emulating Soviet mistakes by devoting an unsustainable portion of national resources to the latter. For all these reasons, a widespread but targeted military modernization effort is under way that draws on earlier People's Liberation Army (PLA) traditions of pursuing military objectives from a position of relative weakness. As part of this larger effort, a more balanced version of Zhang's "vision" of ground-launched antiship missile development is apparently being pursued. What must be emphasized is that the idea of striking a ship from land is not new and that the idea of "using the land to control the sea" (以陆制海) in this way is very appealing to China, given its geostrategic situation.[10]

This effort has assumed new urgency as part of a larger effort to deter U.S. carrier strike groups from intervening in a potential conflict over Taiwan. If China deploys a successful ASBM in the near future, rapid progress in its development will be traced in part to the 1995–96 Taiwan Strait crisis, which further underscored Chinese feelings of helplessness against American naval power. The deployment of the USS *Nimitz* (CVN 68) and *Independence* (CV 62) carrier battle groups in response to Chinese missile tests and military exercises in the Taiwan Strait was a move that China could not counter.[11] We cannot know at this time how the events of 1995–96 affected the precise calculations of Chinese leaders, but they seem to have given a major boost to PLA development in general, and PLA Navy (PLAN) development in particular.[12] Moreover, there is specific evidence that a new impetus was given to ASBM-related research and development at this time (figure 2). As Colonel Larry Wortzel (Ret.), U.S. Army attaché in Beijing from 1995 to 1997, recently testified, "The first time a senior Chinese military officer of the General Staff Department mentioned ballistic missiles attacking carriers was after our two carriers showed up, and he put his arm around my shoulder and said we're going to sink your carriers with ballistic missiles, and we had a long conversation about it. I don't know if they were doing research before that, but . . . the first time it got thrown in my face was 1996."[13]

DISCUSSIONS OF ASBMS IN THE CHINESE LITERATURE: AN OVERVIEW

Given the sensitivity of the issue, relevant statements on ASBM development by top Chinese leaders are currently lacking. But there are ample data to consider

FIGURE 2
CHINESE CONCEPTION OF ASBM TARGET DETECTION AND TRACKING, CA. 2000



SCHEMATIC DIAGRAM OF TARGET RECONNAISSANCE AND LOCATION SYSTEM

Source: Chen Haidong et al., "Study of a Guidance Scheme for Reentry Vehicles Attacking Slowly Moving Targets," p. 6, fig. 1.

at other levels. Chinese writings on ASBMs in the open-source literature can be divided into three broad categories. In descending level of authoritativeness, these include

1. PLA doctrinal publications describing how ASBMs might be used in operational scenarios
2. Specialized technical analyses of specific aspects of such weapons and their supporting infrastructure
3. Generalist deliberations and didactic discussions on the technical and operational feasibility of such weapons.

The first category comprises official military doctrinal publications. These sources of guidance for PLA personnel illustrate how PLA analysts are thinking about using ASBMs in actual operational scenarios. They are typically written by leading scholars at institutions of professional military education, under the editorial guidance of high-ranking active-duty officers, or sometimes by retired officers themselves. Several doctrinal publications of the PLA as a whole and of the Second Artillery Corps (China's strategic missile force) discuss a variety of ways in which to use conventional ballistic missiles to deter carrier strike

groups (CSGs). This demonstrates that such a possibility is taken seriously by the PLA and suggests that relevant programs are under development, though it leaves unclear to what extent the PLA has mastered the necessary technical and operational capabilities.

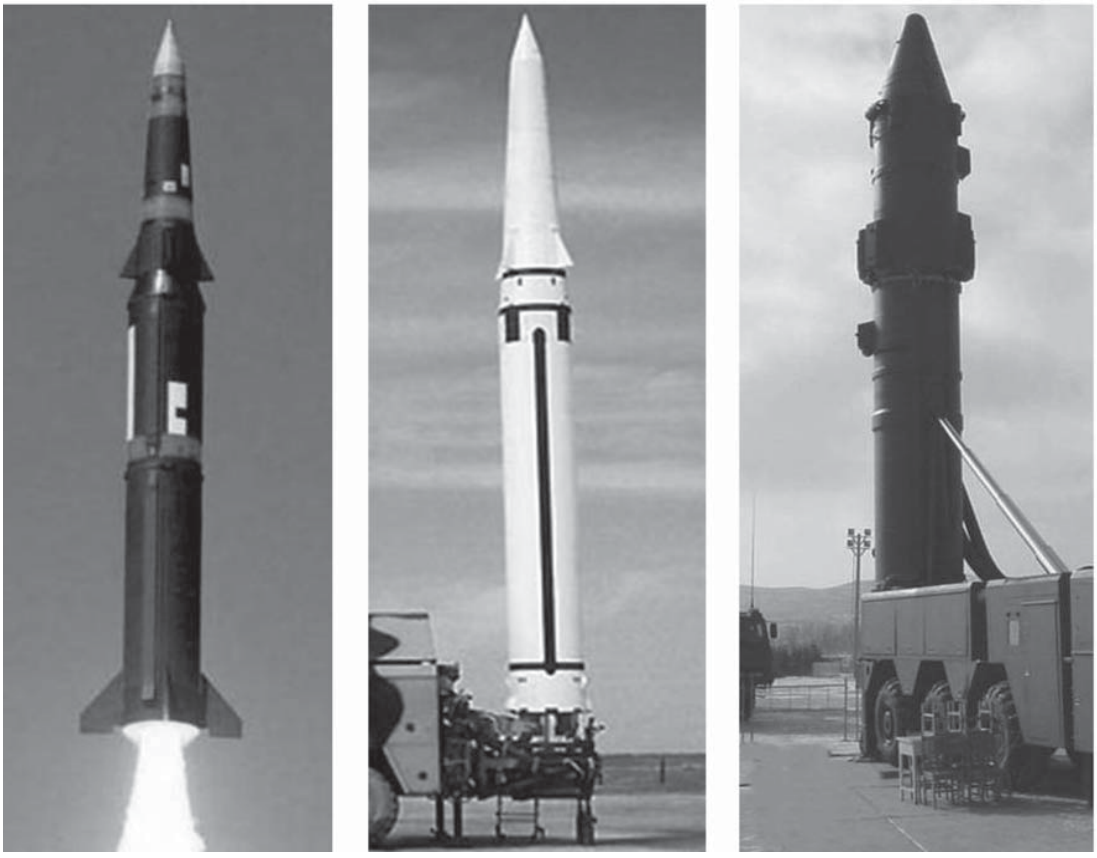
The second category consists of focused technical analyses of specific systems and operations both explicitly and potentially relevant to ASBMs, such as calculations of the maneuvering range of reentry vehicles;[14] another example is the suppression of sea-surface backscattering for maritime surveillance radars.[15] These are written by military and civilian technical analysts, whose names and institutions are typically identified, for an audience in their relevant subfields. Compared to articles on other existing weapons systems (e.g., antiship cruise missiles [ASCMs]), these tend to be theoretical papers utilizing mathematical models, and it is not clear how readily they can be translated into concrete engineering solutions. But some analysts claim that the theories involved have indeed been proved correct, and actual solutions may be contained in other documents. Together, these first two categories of sources offer good indicators that China is pursuing ASBM development seriously; sophisticated intellectual work in doctrine and technology would underpin any such efforts.

The third category consists of generalist deliberations on the feasibility of such weapons. These are written by a variety of naval and maritime analysts (many unidentified), for a broad range of military, defense industrial, and popular audiences, some perhaps for educational purposes. Tremendous disagreement can be encountered in these sources, even on fundamental issues; they demonstrate a range of opinion and debate. More than a few contain technical errors and mistaken assumptions; many, however, offer very specific details.[16] The authoritativeness of these sources is frequently difficult to determine, although many of the commentators are clearly technical experts.[17]

While there are clearly differences among the sources, then, it is important to note that areas exist that they all collectively treat as conventional wisdom, issues on which there is no disagreement regardless of forum, institutional affiliation, or individual viewpoint. Chinese commentators agree that an ASBM, if it is to be developed, would be based on an upgraded version of an existing Chinese MRBM, such as the DF-21/CSS-5.[18] A DF-21D variant is reportedly closest to an antiship version;[19] some Chinese writings say this of the C version;[20] others refer to future modifications (e.g., a DF-21E).[21] The prototype for such a weapon is generally held to be the Pershing II TBM; this is an unusual instance in which Chinese analysts do not see Russia as a model for weapons development. At a strategic level, Chinese assessments generally concur that ASBMs, if realized in practice, would offer a variety of operational effects and value for Chinese maritime strategy—particularly vis-à-vis Taiwan. If this vision were

achieved, it could impose significant restrictions on U.S. naval operations during a Taiwan crisis, especially as there are complementary discussions in Chinese writings about holding U.S. theater land bases—such as those on Okinawa—at risk. Acknowledgment in Taiwan and the United States of such a change in the military balance, Chinese observers believe, would deter Taiwan independence and encourage cross-strait reintegration on Beijing's terms. Finally, there is also general agreement as to which are the key technical challenges, including target acquisition and terminal guidance.[22] To be sure, there is little discussion in the Chinese literature about specific Chinese capabilities in these areas, only general statements of feasibility and implicit assumptions in doctrinal publications that ASBMs are available for use or will be soon.

FIGURE 3
SIMILAR TECHNOLOGY? AMERICA'S PERSHING II AND CHINA'S DF-15/CSS-6 AND DF-21/CSS-5 MISSILES



According to Chinese sources, a Chinese DF-21 ASBM would be based in part on the U.S. Pershing II (left), as is the DF-15 short-range ballistic missile (center). The U.S. Pershing II has adjustable control fins on its reentry vehicle for terminal maneuver. Positively identified photos of a CSS-5 outside its launch canister are not known to exist. But the DF-15B missile pictured here has a reentry vehicle virtually identical to the Pershing II's. Based on the strong visual resemblance, it is possible that the DF-15B employs terminal maneuvering technology similar to that of the Pershing II. The reentry vehicle that China obviously has here could easily be mated with a variant of the DF-21/CSS-5 booster (right), which might then produce an effective ASBM. (Photos used with permission from China Defense Forum)

Doctrinal Sources

Apparently authoritative doctrinal writings already describe in some detail how ASBMs might be employed. Such references have been hitherto ignored in Western scholarship; this is a case of potentially important information hiding in plain sight. There are volumes devoted to missions for the Second Artillery as part of PLA joint doctrine; the authors were unable to find any doctrinal writings suggesting that other services (e.g., the PLAN) would be responsible for using conventional ballistic missiles to hit targets at sea.[23]

Three volumes deserve special scrutiny as perhaps the most authoritative writings available on PLA doctrine concerning the use of ballistic missiles in operational and tactical scenarios.[24] Of these, *The Science of Campaigns* and *The Science of Second Artillery Campaigns* have each been "printed and distributed to all military forces, colleges, and universities as a training and learning reference."[25]

The Science of Campaigns was written by researchers at China's National Defense University. The 2006 edition, more sophisticated and joint in orientation than its 2000 predecessor, offers a basic overview of conditions under which conventional ballistic missiles might be used to "implement sea blockades" and "capture localized campaign sea dominance" by "implementing missile firepower assault or firepower harassment attacks against important targets that the enemy depends on for . . . sea-based maneuvering." This would typically be done as part of a joint campaign with such organizations as the PLAN and the PLA Air Force, with which there is supposed to be "extremely close coordination," although in unspecified contingencies the Second Artillery might operate independently. Practical aspects, such as the imperative to "react rapidly" and "control the rate of missile consumption," are emphasized to support a sophisticated strategy aimed at "apply[ing] great psychological pressure on the enemy" and making him think "that no rules apply, thereby achieving the maximum effectiveness."[26]

Even more relevant and sophisticated is *The Science of Second Artillery Campaigns*. Published by the PLA Press in March 2004 (but completed in May 2003), it likely serves as a high-level professional military education handbook for campaign-level command personnel in the Second Artillery and the PLA in general. Its chief editor and his deputy have considerable credibility and expertise as top PLA officials. The foreword by the headquarters of the PLA General Staff further indicates that this book is the institutional position of the PLA as a whole and hence has been accepted by China's civilian leadership, at least in general terms.[27]

How does the Second Artillery conceive of using ASBMs in operational scenarios? The 406-page document describes the use of ASBMs against carriers

in some detail and without suggesting that such an approach is aspirational or beset with insurmountable difficulties. In fact, in introducing the section describing their potential employment, it states that "conventional missile strike groups" should be used as an "assassin's mace" (or silver bullet)—a term commonly used in both PLA and less authoritative documents to describe weapons that match Chinese strengths with an enemy's weaknesses.[28]

The Science of Second Artillery Campaigns states that the Second Artillery will work with the PLAN to "execute focused naval blockades" and "achieve command of the seas."[29] Approaching enemy CSGs are envisioned to be the principal maritime targets, but "large vessels or large ship formations" more broadly are mentioned as well.[30] Coordination and precision are seen as essential for "deterring and blocking enemy carrier strike groups";[31] such "operational activities need to be coordinated without the slightest difference in time."[32] Coordination with the PLAN is also emphasized in the location of sea targets, as well as with regard to the notification and demarcation of blockade areas: "the naval intelligence department should 'relay promptly' the information obtained by its reconnaissance about enemy ship activities to the Second Artillery campaign large formation."[33] In particular, "information regarding carrier battle groups . . . should be gathered on a real time basis."[34] Potential sources of "real-time target intelligence" include "military reconnaissance satellites, domestic and foreign remote sensing satellites, and established satellite reconnaissance target image information processing systems."[35] While ASBMs are not mentioned explicitly in this context, the need for "further real-time intelligence on the dynamic target" to be obtained through "various measures and multiple channels" is recognized vis-à-vis cruise missiles.[36]

A two-page section describes five ways to use ASBMs against carrier strike groups, a centerpiece of "military intervention by a powerful enemy" and thus the proper "focal point for attacks."[37] Such tactics as firing intimidation salvos, destroying shipborne aircraft with submunitions, or disabling with electromagnetic pulses the sensor systems of Aegis destroyers are designed to make CSGs retreat or render them inoperable. More specifically, this passage of the Second Artillery doctrine describes

- "Firepower harassment [strikes]" (火力袭扰), which involve hitting "carrier battle groups."
- "Frontal firepower deterrence" (前方火力慑阻), which involves firing intimidation salvos in front of a CSG's advance "to serve as a warning."
- "Flank firepower expulsion" (翼侧火力驱赶), which combines interception of a CSG by PLAN forces with intimidation salvos "launched toward the

enemy carrier battle group opposite our relatively threatened flank" to force it away from the vulnerable area.

- "Concentrated fire assault" (集火突击), which entails targeting the carrier as a center of flight operations: "When many carrier-borne aircraft are used in continuous air strikes against our coast, in order to halt the powerful air raids, the enemy's core carrier should be struck as with a 'heavy hammer.' The conventional missile forces should be a select group carrying sensitive penetrating submunitions and, using the 'concentrated firepower assault' method, a wide-coverage strike against the enemy's core carrier should be executed, striving to destroy the enemy's carrier-borne planes, the control tower [island] and other easily damaged and vital positions."
- "Information assault" (信息攻击), which entails attacking the carrier strike group's command and control system electromagnetically to disable it: "Directed against the enemy's command and control system or weak links in the Aegis system, conventional missiles carrying antiradiation submunitions or electromagnetic pulse (EMP) submunitions can be used when enemy radar is being used and their command systems are working, with antiradiation submunitions striking radar stations and EMP submunitions paralyzing the enemy's command and control system."[38]

A third document, *Intimidation Warfare,* edited by Lieutenant General Zhao Xijun, Second Artillery deputy commander from 1996 to 2003, echoes many of the statements on strategic signaling outlined in *Science of Second Artillery Campaigns*. It sheds additional light on China's possible calculus and tactics in various scenarios. Zhao's team emphasizes the value of demonstration training, tests, and other measures to influence the enemy, in part by influencing media coverage.[39]

Zhao's team also suggests four methods to deter enemy ships without hitting them directly. "Proximity . . . sea deterrence strike" involves test launches that impact near a sea-based target. "Two-flanked convergence proximity (or critical) deterrence strike [两翼夹击抵近 (临界) 威慑打击]" involves launching two or more missiles to bracket or encircle a target. "Island crossing attack deterrence strike [越岛攻击威慑打击]" exploits the psychological impact of missiles overflying "strategic targets" when fighting an enemy controlling an island (e.g., Taiwan?). "Proximity aircraft carrier deterrence strike [抵近航空威慑打击]" involves "the launching of missiles toward the flanks or the front of the aircraft carrier battle groups that have entered one's territorial waters, [to] demonstrate one's ability and resolve to implement destructive strikes against the aircraft carrier, thereby producing psychological shocks in the enemy and forcing it to leave one's territorial waters."[40]

Particularly noteworthy of the wide variety of uses suggested for ASBMs against carriers and possibly other surface vessels in this publication and in *Science of Second Artillery Campaigns* is that at least several would appear to place less of a premium on warhead accuracy, depending on how literally such concepts as bracketing and encirclement are interpreted. Rather, missile range and defense penetration capability would seem to be the key factors. If a MaRV were known to defeat terminal defenses and a demonstration shot defeated the SM-3 interceptor,* only guidance failure would seem to stand in the way of a successful Chinese strike.

Science of Second Artillery Campaigns states that TBMs extend the Second Artillery's strike range, and it seems to assume that the Second Artillery would have ASBM inventory sufficient to permit numerous warning shots. Horizontal escalation in the short run, it argues implicitly, can achieve de-escalation in the long run. Although the Second Artillery's view is that such tactics would be effective, unless it were communicated effectively ahead of time that these were merely warning shots, they could easily be misinterpreted as failed attempts to strike the target and thus have the exact opposite result of China's intent—that is, escalation instead of de-escalation. This potential problem is addressed, in a fashion, in *Science of Second Artillery Campaigns:* one section emphasizes the need for "no-fly" and "restricted navigation zones" and calls for the use of "very precise missiles in order to prevent errors in precision or losing control of the missile when it is in flight such that it enters enemy territory (or an enemy-occupied island), or such that it directly strikes an enemy aircraft carrier." Otherwise, such errors "could cause the nature of deterrence to change, giving the enemy an excuse to use force."[41]

Technical Sources

Having considered how the Second Artillery thinks about using ASBMs, it is time to examine in detail possible approaches to, and technical challenges in, developing them. The Second Artillery dominates available technical ASBM assessments, implying that it may largely control any Chinese ASBM programs. As the PLA's strategic rocket force, with "equal attention devoted to" (and the vast majority of its recent acquisitions in) conventional forces, and 78.2 percent of its cadres now holding bachelor's degrees or above, it would seem the logical choice to handle such a challenging new mission.[42] The vast majority of available technical articles devoted explicitly to ASBM issues are authored in full or in part by individuals associated with the Second Artillery Engineering College in Xi'an, suggesting that this institution may be playing a major role in developing ASBM-related programs. Technical analyses also come from civilian institutions in

* The RIM-161 naval surface-launched anti–ballistic missile interceptor, a variant of the U.S. Navy's Standard Missile (SM) series.

Xi'an, itself a major defense industry hub, as well, implying some division of intellectual labor.[43] The most prolific contributor is the PLA-uniformed civilian Tan Shoulin, a leading professor at the Second Artillery Engineering College in the Department of Command and Support, who advises master's students and specializes in "missile weapon firepower applications."

Second in institutional prominence is the Second Artillery Equipment Department, in Beijing—with some related publication by the Second Artillery Equipment Research Institute as well. Such involvement may suggest that some degree of procurement, or at least active consideration thereof, is under way. Occasional participation can also be seen from individuals associated with units presumably associated with Second Artillery bases. Such strategic locations as Taiyuan, with its Military Representative Office in Factory 247, also make appearances. Academic institutions in other places—such as the National University of Defense Science and Technology in Changsha and the Beijing Institute of Technology's School of Aerospace Science and Engineering—appear to make contributions as well.

Chinese researchers are studying the problems of target tracking and terminal guidance associated with ASBMs. Technical studies, such as a recent paper by State Oceanic Administration scientists on using synthetic-aperture radar to detect surface ships, suggest that the Chinese have developed substantial expertise in the use of such hardware.[44] A recent paper by researchers at Dalian Naval Academy offers a regimen of tests and data fusion to "achieve our goals of monitoring and identifying ships in large-scale sea areas by using space-borne optical sensors."[45] A study by researchers at Beijing Institute of Technology simulates terminal targeting of a moving aircraft carrier using adjoint equations and nondimensional analysis but states that guidance precision-enhancing technologies still need to be developed.[46] A mathematical study by researchers at the Second Artillery Engineering College appears designed to demonstrate conceptual feasibility.[47] Researchers at the Second Artillery Engineering College and Second Artillery Base 55, Unit 96311, Huaihua (Jingzhou), offer a theoretical exploration of the ability of TBMs with terminal-phase guidance and maneuvering capabilities to attack aircraft carriers.[48]

Researchers at the Second Artillery Engineering College and the National Defense Science and Technology University offer a mathematical model of a type of terminal guidance, based on a prediction model of a carrier's movement. Modeling suggests that this method can allow warhead precision to achieve a CEP* of about twelve meters under the most ideal conditions.[49]

* Circular error probability—broadly, the distance from an aim point within which a missile has a 50 percent probability of striking.

In a related paper, researchers at the Second Artillery Engineering College and the Second Artillery Equipment Department present a model for predicting the movement of a CSG that can provide targeting information for land-based TBMs. For the needs of TBM targeting, it would be sufficient to provide predictions with a precision measured in kilometers within a time frame of "tens of minutes." The paper demonstrates the feasibility of such a forecast system and provides two maps depicting the notional location of an aircraft carrier south-southeast of Taiwan, at the latitude of Hainan Island.[50]

How to cause maximum damage to a carrier most effectively is another common research topic.[51] For example, a PhD and a master's student at the Second Artillery Engineering College offer a theoretical model for calculating damage effects on large targets with many components—say, a carrier strike group.[52] The discussions in a large proportion of technical articles focus on the delivery of submunitions by homing ballistic missiles to disable flight operations from carriers, while not addressing directly the problems of target acquisition and guidance. Research on submunitions appears to be extremely widespread and sophisticated, with many writings on how to use them against carrier-based aircraft and against runways at air bases (e.g., those of Taiwan). A pathbreaking U.S. article by William S. Murray provides compelling evidence that the Second Artillery has already developed considerable competence in the latter mission.[53]

Defeating U.S. ballistic missile defense (BMD) is also seen by many Chinese researchers as essential to attacking a carrier strike group successfully, and it has attracted considerable study.[54] Researchers at the Second Artillery Engineering College offer a theoretical model of reentry-vehicle maneuvering using "moving mass center" control methods. This involves changing the center of gravity of a warhead by adjusting movable masses within the warhead, thereby modifying its atmospheric flight path. The aerodynamic profile of the warhead would remain unchanged, and the method can be used in conjunction with fins and other conventional control surfaces.[55]

Technical experts working on technical solutions are focused on very narrow, specific issues. One wonders, however, whether their political leaders have "gamed out" the scenarios and considered the consequences as technical capabilities progress. The danger with a lopsided focus is that without a proper understanding of the potential strategic risks involved, technical achievements can have dangerous consequences. According to some interpretations, China's 11 January 2007 antisatellite test offers a cautionary example of Beijing's civilian leadership approving the trial of a weapon long in development without understanding fully its scope or strategic ramifications.[56]

Whatever the exact strategic calculations (or lack thereof) of the political leadership (authoritative sources are silent on the point), the ASBM issue has been vigorously debated by Chinese commentators in various unofficial venues. Some of these individuals may be privy to internal deliberations or even play roles in shaping policy, particularly in specialized subject areas. When politics or bureaucratic maneuvering comes to the fore, they may become caught up in larger competitions of ideas. But even the views of those not directly involved in the policy process often matter; their ideas may inform policy makers directly or even be adopted. Some analyses may well be informed by parallel debates in official circles, and even be designed to help justify or "socialize" already established policies—for instance, through didactic exploration of important concepts. For that, we turn to the generalist literature.

Generalist Literature

Though, as we have seen, the doctrinal literature is the most demonstrably authoritative category of open-source writings, with technical literature often roughly equivalent, care must be taken in extrapolating actual capabilities from these sources. Available Second Artillery technical articles and mathematical feasibility studies devoted explicitly to ASBM issues do not detail concrete Chinese capabilities.[57] Even doctrine may reflect aspirations or projected capabilities rather than the existence of hardware and infrastructure. In fact, Chinese doctrinal publications often discuss theoretical capabilities as if they existed, which U.S. joint publications typically do not.

For all these reasons, it is useful to examine the less clearly authoritative but more diverse and detailed generalist literature, with its widespread debate on all major aspects of ASBM development and employment, for indications of challenges and dilemmas that China might face. Regardless of the actual status of Chinese ASBM development, these opinions matter: perfecting and deploying such a weapon would entail resolving a wide variety of complexities and policy considerations and transcending many industrial and bureaucratic boundaries. Any remaining challenges in the technical data fusion required for ASBM guidance and targeting may pale in comparison to the bureaucratic "data fusion" needed if such a program is to succeed over time and such a weapon is to function effectively in combat.[58]

Strategic Rationale and Scenarios. There is broad (though not complete) consistency in the generalist literature concerning the operational effects of ASBMs and their potential value for Chinese maritime strategy writ large. Antiship ballistic missiles are promoted as a means to overcome conventional inferiority (by exploiting technological asymmetry), deter intervention, give China more maneuvering space, and offer both escalation control and an "assassin's mace" for victory if deterrence fails.

Of supreme importance to Beijing is Taiwan's political status. At the strategic level, Beijing seeks to deter Taipei from declaring independence, progressively constrain its political space, and encourage eventual reunification, with a wide variety of hard- and soft-power tools. Tactical ballistic missiles are thought by one analyst to offer China a "third" alternative to the risk of engaging in outright attack, on one hand, and the limitations of soft power, on the other. Termed "attacking without entering," a TBM campaign is seen by this observer as increasing China's strategic options while limiting Taiwan's.[59] In addition to their psychological and deterrent effects, ASBMs (as a category of tactical ballistic missiles) are believed to offer China a way to exert hard-power pressure and convey strategic signals in scenarios that do not rise to the level of war. This would seem in concert with Chinese strategic writings, which often express considerable confidence that China can manage strategic escalation in measured increments with a high degree of certainty. At the operational level, facing the possibility of intervention by a technologically more advanced navy in the event of a Taiwan conflict, the PLA seeks an asymmetric "silver bullet" that will (ideally) forestall intervention in the first place or, in a worst-case scenario, offer the ability to attack platforms that are perceived to threaten China. Antiship ballistic missiles promise to further this strategy at far lower cost than force-on-force approaches. Three PLA officers from the Second Artillery Command College declare that "guided missile forces are the silver bullet for achieving victory in limited high-technology war."[60]

A professor and a student at the Air Force Engineering Academy evoke an analogous concept when they write that ballistic missiles enjoy a higher probability of penetration than other antiaccess weapons: "Tactical ballistic missiles" have become "the 'poor country's atom bomb.'"[61]

In addition, TBMs are regarded by their proponents as an important instrument in China's overall strategic tool kit. One of the most nuanced analyses on the issue, an article published in the China Shipbuilding Industry Corporation (CSIC) journal *Shipborne Weapons,* states that tactical missiles "provide China with more maneuvering space for military and political strategic operations on its eastern, maritime flank."[62] More specifically, the creation of a

> tactical ballistic missile maritime strike system . . . will establish for China in any high-intensity conflict in its coastal waters an asymmetry, in its favor, in the deliverance of firepower and so will remedy to some extent China's qualitative inferiority in traditional naval platforms. Further, the existence of this asymmetry would set up for both sides a psychological "upper limit" on the scale of conflict. This would enable both parties to return more easily "to rationality," thereby creating more space for maneuver in the resolution of maritime conflicts.[63]

Skeptics writing in another CSIC publication, *Modern Ships,* by contrast, reject both of these points, arguing that ASBMs offer limited power-projection capabilities, are highly escalatory if employed, and might in fact trigger nuclear retaliation.[64]

How Chinese strategists assess the impact of ASBMs for various conflict scenarios is far more difficult to evaluate. Few articles address this topic. One that does states that "the PLA must use all of its electronic warfare and reconnaissance assets properly, must neutralize enemy antimissile systems and missile sensor systems, and should use electronic jamming on the enemy fleet. Such combined kinetic and electronic attacks help the PLA attack an enemy fleet . . . with a combination of explosive, antiradiation, and fake warheads to deceive enemy radar and sensor systems and defeat a deployed battle group or one in port."[65]

A 2007 article offers a minutely detailed scenario of a notional attack sequence. But it is divorced from larger strategic events, based on some questionable assumptions, and written by a journalist with no professional background in defense affairs.[66] No known sources mention directly any scenarios beyond Taiwan.

In any case, the concept hinges on technical feasibility (the subject of the next section of this article). Chinese discussions of ASBM employment typically center on their use to deny U.S. carrier strike groups access to waters relevant to a Taiwan conflict, presumably to the east of the island, and hence to the airspace over the strait and even over the island itself. The idea seems to be to hold carriers back through deterrence and to attack them if they come forward.

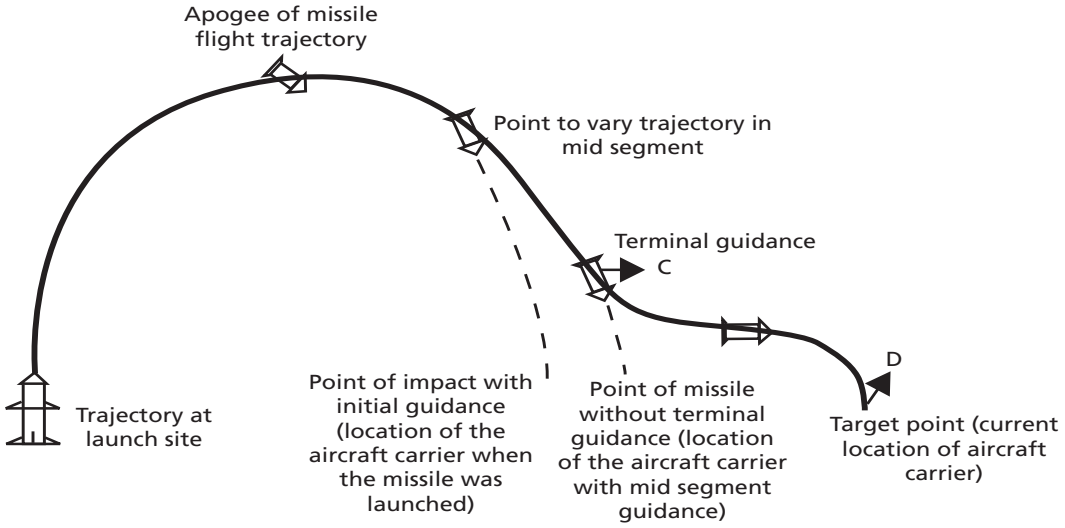
At the same time, ASBMs are recognized to have significant limitations, even potential dangers. According to one analyst, they "cannot replace aircraft carriers, submarines, and other traditional naval weapons": they "can be used to destroy enemy forces at sea but not to achieve absolute sea control, let alone to project maritime power."[67] Two writers in *Modern Ships* go much farther, declaring that while ASBMs are technically possible, their employment in practice is fraught with difficulties. These can be overcome, in their view, if one is dealing with a minor power, but not with a superpower like the United States.[68] One claim they make, as have others, is that reducing the speed of the warhead in the terminal reentry phase in order to operate its guidance radar makes it more vulnerable to anti–ballistic missile interceptors. To some extent this depends on one's assessment of the maneuverability of the warhead in its terminal entry phase, but the authors of the *Modern Ships* article are highly skeptical. They acknowledge that the problem may be overcome to some extent in a saturated attack, but they insist that the Aegis defense system is designed to deal with just that. They also point to the relatively high costs of ballistic missiles. Further,

they suggest that the use of ballistic missiles in a saturation attack would "likely lead to the scenario described by ancient Chinese strategists, in which the weapon in question becomes unusable in practice" because its use would be highly escalatory: "Apply little force, and no real harm can be done to the enemy; apply great force, and the first harm is done to the self."[69]

Even if ASBMs were indeed successfully developed, by virtue of an overwhelming investment of resources and energy, the *Modern Ships* authors contend, a critical problem would remain: whether anyone would dare use such weapons in an actual conflict scenario.[70] The authors seem to suggest that while conventional tactical missiles could be used against Taiwan with little risk, their employment against U.S. carriers would immediately create a grave political problem: "Since the introduction of nuclear weapons, all the major nuclear powers have developed ballistic missile warning systems against possible nuclear attacks, and there has not been a single precedent of a major nuclear power attacking another with ballistic missiles."[71] As no technology today is capable of distinguishing between a conventional and a nuclear warhead prior to detonation upon impact, the authors worry that any ballistic-missile attack against another nuclear power might activate its strategic retaliation mechanisms and trigger a nuclear conflict. The *Modern Ships* authors emphasize that in any conflict scenario, the extreme psychological duress to which the military personnel of both sides would be subjected would make it particularly dangerous to employ ballistic missiles, as any small mistake in judgment might trigger a nuclear Armageddon.[72] Even absent any misperception, sinking a ship that is a symbol of American power and has a crew of thousands could provoke a very serious response. Of course, elements of the PLA, and even their civilian leaders in a crisis, might be less cautious than these analysts. Another writer, having reviewed their performance in battle since the 1960s, concludes that TBMs are indeed, as others have argued, an "assassin's mace," a silver bullet.[73] A Chinese interlocutor has told one of the present authors that the Second Artillery is itself considering placing nuclear and conventional warheads interchangeably on the same types of missiles—for example, the DF-21—so that they will "possess both nuclear and conventional [核常兼备]" capabilities. This last may be evidence of open debate, of manipulation of American opinion, or of sensitization of the United States to operational implications. If the latter, there is a clear risk of misperceptions in the event of launch in a conflict.

The question of operational control is not addressed directly in the open sources, but the content of doctrinal publications, the large number of Second Artillery officers writing on the topic, and the current responsibility of that arm for the vast majority of nuclear and conventional ballistic missiles suggest that the Second Artillery is likely to have sole responsibility for ground-based ASBMs.

FIGURE 4
SCHEMATIC DIAGRAM OF ASBM FLIGHT TRAJECTORY WITH MIDCOURSE AND TERMINAL GUIDANCE



Note the depiction of control fins on the reentry vehicle, which would be critical to steering the ASBM through terminal maneuvers to evade countermeasures and home in on a moving target. This makes an ASBM different from most ballistic missiles, which have a fixed trajectory. Published by individuals affiliated with the Second Artillery Engineering College and a Second Artillery base in a Chinese technical journal.

Source: Tan Shoulin, Zhang Daqiao, and Diao Guoxiu, "Determination and Evaluation of Effective Range for Terminal Guidance Ballistic Missile(s) Attacking Aircraft Carrier(s)," pp. 6–9, republished in Office of the Secretary of Defense, *Military Power of the People's Republic of China 2009, Annual Report to Congress,* p. 21.

(The possibility of rivalry and divergence of viewpoints that may result between the Second Artillery and the PLAN will be addressed later in this article.)

Technological Feasibility: Convergence and Divergence of Views. Chinese doctrinal debates about the utility of ASBMs are closely related to widespread disagreements over their technical feasibility. Analysts generally concur that five major technical challenges must be surmounted to achieve a functioning ASBM: detection, tracking, penetration of target defenses, hitting a moving target, and causing sufficient damage (figure 4).

Detection: Pessimists claim that carriers are too small relative to the potential search area to be easily detected by satellite images. Optimists maintain that carriers—with their broad constellation of electromagnetic signals—can be detected in a variety of ways, such as with space-borne sensors.

Tracking: Skeptics maintain that requisite satellite coverage is unattainable, as are sufficient naval vessels and surveillance craft, as well as overseas bases for signals intelligence. They believe that China's other tracking methods are inadequate, even in aggregate. Strangely, they seem to overlook the possibility that China's combination of land-based radars and satellites—perhaps augmented temporarily with deployment of unmanned aerial vehicles and launches of (micro)satellites—might be sufficient to track and target carrier strike groups within a certain zone off China's coastal waters from which it believed essential

to exclude them in combat.[74] Both Chinese and Western sources, for instance, suggest that China already has relevant over-the-horizon (OTH) backscatter sky-wave and OTH surface-wave radars.[75]

Target defense penetration: The claims of skeptics that slowing the warhead for terminal guidance makes it prohibitively vulnerable to interception seem unpersuasive based on known physics principles. A wide variety of Chinese sources suggest using multiaxis saturation attacks (e.g., involving submarine-launched cruise missiles as well) to overwhelm CSG defenses, apparently without acknowledging the difficulty of coordinating them.

Hitting a moving target: How to strike a CSG that moves during the processes of location, data transmission, and ASBM delivery? Skeptics contend that ballistic missiles are less accurate than cruise missiles and that while a ballistic missile's trajectory is fixed, its target is mobile and may escape between launch and impact. But researchers at the Second Artillery Engineering College maintain that as long as the initial ASBM trajectory is reasonably accurate, appropriate homing corrections can be made. Other researchers suggest improving precision with passive radiation homing and by activating terminal guidance at higher altitude to allow the seeker to scan a larger sea area. One researcher recommends selecting opportune moments for attack: "Even a tiger takes a nap [老虎也有打盹的时候]."[76] Thus, they contend, carriers can be targeted when flight operations or at-sea replenishment impede their mobility.

Causing sufficient damage: While a few experts make a show of detailing carrier damage-control equipment, one wonders from their tone if they are not being a bit disingenuous. The conventional wisdom seems to be that a multiaxis saturation attack (to defeat defenses) or submunitions (to distribute damage), delivered accurately, can achieve a mission kill by targeting critical exposed areas, such as the carrier's aircraft, island, or C4ISR* equipment.

ASSESSMENTS

Available Chinese literature follows a logical pattern of ever-widening concentric circles of awareness and, to a lesser extent, involvement. This supports the axiom that the longer something goes on, the more likely people are to hear about it. At the center, authoritative PLA publications assume an (eventual?) ASBM capability. Farther out, a variety of institutes are working to validate specific concepts and perhaps also technologies to support such a capability. Beyond these inner circles, a wide range of individuals, whose access to internal information probably varies markedly, are beginning to weigh in with diverse opinions and institutional interests. Few writers in the generalist literature make a balanced, nonpartisan argument along the lines that ASBMs are feasible but

* Command, control, communications, computers, intelligence, surveillance, and reconnaissance.

a bad idea or a good idea but technically infeasible. This suggests a general pattern of institutional biases and competition, with individuals favoring precisely the outcomes that would benefit their organizations most. These opinions and interests matter. Many of the projections of technological "hurdles" outlined above are either demonstrably pessimistic or will likely be obviated anyway over the next few years as China continues its rapid aerospace development. Rather, China's ASBM future may be a policy, not a technical, question. For now, as capabilities are being developed, technical discussion is being elevated to strategic discussion, but that could well change if Beijing's leaders ask one day: Now that we have an ASBM capability, what can we do with it?

Nonetheless, debate continues in China's generalist literature over the technical feasibility of ASBM operations, with only two writers claiming directly that China has ASBM capabilities.[77] This may suggest that there is ongoing disagreement in China concerning how to develop these weapons at present and how they could best be placed into operation. Now that China has what could be termed a public and military-intellectual complex, organizations, analysts and policy entrepreneurs may be jockeying for position in an attempt to influence the course of decision making on the part of at least two of China's armed services, its military leadership, and ultimately its civilian authorities.

The overall discussion seen so far is best characterized as "contentious." The three technical challenges most consistently emphasized are real-time satellite reconnaissance, target tracking in terminal reentry, and terminal maneuvering. Some problems that are presented as insurmountable by some analysts are approached more sanguinely by others. Foreign subject-matter experts could glean significant insights from the multitude of relevant Chinese technical studies.

Particularly noteworthy is that direct claims of existing Chinese capabilities in these areas are extremely limited. In other words, the focus of the discussion is on feasibility rather than actual Chinese capabilities. Researchers at the Second Artillery Engineering College make a variety of feasibility claims, in one instance stating specifically that the technical hurdles to successful ASBM employment have already been resolved, but they cite English-language technical papers as authority for this particular point (though they use sophisticated Chinese sources to support other details of their argument).[78] Again, they emphasize technical feasibility without reference to current Chinese capabilities. It is likely that some Chinese authors do not know what those capabilities actually are, while others cannot say.

Several other issues, though not directly addressed by the Chinese authors surveyed, may merit further attention.

Possible Interservice Rivalry

A noticeable pattern in the tone of ASBM analyses may be interpreted as signs of Second Artillery–PLAN bureaucratic competition. Momentum, direction, and contention about programs may reflect diverse institutional interests. The Second Artillery produces many technical analyses, but not a single one appears pessimistic. Articles written by analysts and students associated with the Second Artillery tend to take the feasibility of ASBM development for granted, perhaps because an ASBM program would be (or now is) controlled by the Second Artillery, thereby furthering its institutional interests.

By contrast, the vast majority of analyses affiliated with the PLAN and the state shipbuilding industry suggest that ASBM development is technically problematic or that use would have dangerous unintended consequences.[79] Perhaps this is because ground-launched ASBMs would not be controlled by the navy and could divert resources otherwise earmarked for naval development. The PLAN may also be lobbying hard to begin serious aircraft carrier development of its own and does not want this effort undermined by constant emphasis on carrier vulnerabilities—which have played a major role in previous Chinese carrier discussions, at least at the generalist level. We may thus be witnessing some elements of Chinese bureaucratic resource-allocation politics, cloaked in strategic debate and the flag.

In an interesting suggestion of at least some cooperation between the Second Artillery and the PLAN on antiship ballistic missiles, however, an individual from the Navy Representative Office in Chengdu, Sichuan, is a coauthor with researchers from the Second Artillery Engineering College on two ASBM-specific articles. This is precisely the sort of interaction that one would expect if the Second Artillery were charged with directly developing and testing an ASBM, in which case the PLAN would second representatives to relevant Second Artillery facilities to make sure that weapons produced addressed PLAN needs.[80] Moreover, such PLAN-affiliated institutions as the Dalian Naval Academy and the State Oceanographic Administration conduct extensive research on related topics like ship detection and tracking.

Pressing questions remain, however. What role would the PLAN play in operations that clearly affect its geographic area of responsibility? How would joint operations be coordinated among the Second Artillery, the PLAN, and other services—particularly given the PLA's previous limited ability in joint operations?

Cost-Effectiveness

Beijing's actual development and deployment of ASBMs, and implications for any bureaucratic competition between the Second Artillery and the PLAN, will

also hinge on decision makers' perceptions of their relative efficacy and cost-effectiveness (e.g., vis-à-vis cruise missiles), as well as their marginal development cost. The relative cost-effectiveness of various antiaccess weapons can be derived from both physical principles and Western and Soviet experience, both of which have been widely discussed in open literature.

Many Chinese analysts have regarded such traditional weapons as attack submarines and antiship cruise missiles as the primary weapons against carriers, with no more than cursory references to ASBMs. Other Chinese sources claim that cruise missiles are superior to ballistic missiles for certain missions, particularly in terms of general use, agility, and target selection. According to the U.S. defense analyst Thomas Mahnken, cruise missiles have many advantages over ballistic missiles for a country like China: they are cheaper, it is easier to make them highly accurate, they require simpler launch platforms and support equipment, and they "approach their targets from different azimuths than ballistic missiles [and] hug the ground."[81] Further, cruise missiles can be delivered by aircraft, as well as by ships, submarines, and ground launchers.

ASBM advocates make several strong points, however. Cruise missiles have a variety of disadvantages, including the much longer time of flight (with obvious targeting implications); the need to fly long ranges at high altitudes, where they are much more vulnerable to being shot down; conversely, low operational ceilings at long ranges (thus making it harder to fly over mountains, such as Taiwan's); shorter maximum ranges than ballistic missiles; and difficulty in identifying targets correctly. In an interesting example of PLAN-affiliated individuals claiming that ASBMs have advantages, researchers from the Naval Aeronautical Engineering Academy use mathematical analysis to calculate that "when using ballistic missiles to carry out attack operations on [naval vessel formations], the probability of penetration can reach 95%." This is a much higher success rate than those they calculate for cruise missiles.[82]

Antiship cruise missiles must often be fired from aircraft, surface vessels, or submarines that approach close to enemy forces to compensate for reduced range. This, and their relatively long flight times, increases their vulnerability (albeit less so for submarine launches), and hence also their cost. However, the ASCM shooters themselves are not necessarily more expensive just because they are vulnerable and might be lost in combat; some (e.g., the Type 022 *Houbei* missile catamaran) are likely considered disposable, with loss in combat assumed. A mobile land-based ASBM, though requiring substantial development and infrastructure investment, would be much less vulnerable to destruction before launch. Two Chinese observers estimate the unit cost of an ASBM and its launcher to be $5–$10.5 million—several times that of the most expensive U.S.

cruise missiles if their launch platform is not included, but far less than the cost of interceptors to defeat it.[83]

Other Chinese authors have addressed the cost-effectiveness issue only in passing. One analyst insists that cost-effectiveness should not be understood along conventional lines in such conflict scenarios and that if the technology is indeed feasible, the cost issue will not necessarily be so salient.[84] The discussion is often interwoven with analyses of which weapons can best target aircraft carriers. Here, the primary comparison is between ASBMs and cruise missiles. One analyst states that "ballistic missiles, given the same tactical parameters, offer more outstanding penetration capability and cost-effectiveness than cruise missiles," both of which are superior to aircraft in this regard.[85] This assessment is augmented by another observer, who states that "supersonic antiship guided missiles that use ramjet engines are not very useful due to their restricted ranges." Moreover, "it will be very difficult to surpass or even catch up to the United States and Russia in developing cruise missiles. Thus, it will be very difficult for our cruise missiles to become a deadly weapon to carry out fatal attacks against aircraft carrier formations."[86] Chinese planners may therefore favor development of ASBMs as a means of "poor man's sea denial," over such complex, expensive approaches as a fleet of aircraft carriers and accompanying long-range aircraft.[87]

A Coercive Quarantine?

Synthesizing the considerations above, it is possible that to the extent that tactical ballistic missiles are employed as antiship weapons, they would most likely be used as part of a multiservice combined-arms operation, as an added component of a saturation attack to overwhelm the carrier's defensive systems. For this purpose, targeting precision would not be as important, and the more general Chinese tradition of numbers over accuracy could be employed to good effect. While coordinating such an attack would be complex and difficult, there could be significant benefits if such issues could be surmounted. If a carrier detected an incoming ballistic missile, it would likely engage it with its air-defense assets regardless of the attacking missile's presumed accuracy. This could divert carrier defense systems from other threats, such as other ASBMs or simultaneous cruise missile volleys, and perhaps exhaust scarce interceptors. To escape this problem, carriers may opt to stay out of the range of the TBMs. As one analyst writing in the *Kanwa Asian Defense Review* puts it, "For the Chinese military forces, the practical significance of striking the aircraft carrier lies in that the attacks can play the role of 'coercive [quarantine]' even if the missiles cannot [always] accurately hit the targets, that is, to keep the U.S. aircraft carrier battle groups out of the Taiwan Strait combat theater."[88]

Messages for the U.S. Military?

How and to what extent might Beijing be seeking to influence strategic communications regarding ASBMs? Information manipulation should certainly be expected; discussion is likely regulated to send a desired signal. This is in keeping with the attention to deception and perception management outlined in a variety of PLA publications, including *Science of Second Artillery Campaigns*.[89] Within such a conception, different explanations for Chinese writings on ASBMs are possible; to the extent that they are manipulated, they could represent, respectively, a highly cost-effective partial deterrent until the capability is fully realized, a reflection of ongoing ambivalence and debate, a targeted effort to obscure actual capabilities, or a statement of conditional intent.

Strategic articles might well be manipulated to obscure or divert attention from an extant capability or one in rapid development. Consider the sheer volume of highly specific Chinese technical writings from a wide variety of important civilian and military institutes over the past decade—seemingly on all areas of direct relevance to ASBM development and even use—virtually all of them stating that various component capabilities are either under development or at least technically feasible. Manipulating a few strategic articles in journals known to be read outside China, by comparison, might be a particularly effective instrument in an information campaign. It is even possible that there is an effort to send a measured signal—that China may be preparing certain capabilities but has not yet made definitive plans for their deployment, the actual realization of which will be calibrated in response to American strategic actions (e.g., vis-à-vis Taiwan).

In any case, should its capabilities be developed sufficiently, Beijing might emulate former Second Artillery deputy commander Lieutenant General Zhao Xijun's logic and reveal a dramatic weapon test to the world—with or without advance warning—in some way geared to influencing official and public opinion in the United States, Taiwan, and Japan. Such an unprecedented public demonstration could be used to signal either growing Chinese power during a time of stability or Beijing's resolve in a time of diplomatic tension or crisis.[90] Alternatively, unpublicized flight tests could be conducted to deter foreign militaries without alarming foreign publics (though classified information might ultimately be leaked to them).

In any case, some sort of flight tests would be necessary to generate Chinese confidence in ASBM capabilities. The fact of a hit, however manipulated and revealed, could change the strategic equation—much as the efficacy of the 20–21 July 1921 test-bombing of the battleship *Ostfriesland* was hotly contested by the U.S. Navy (and remains debated to this day) yet altered service budgets immediately and helped catalyze development of what later became the U.S. Air Force.

Is there today a Chinese equivalent of Brigadier General Billy Mitchell eager to promote such a test to further the cause of Second Artillery and China's pioneering of new ways of war?

However the Chinese internal debate on ASBM development progresses, the strategic stakes will be high; this will be a debate worth following.

IMPLICATIONS

While there is ongoing disagreement as to their feasibility and efficacy, the idea of developing antiship ballistic missiles is clearly appealing to many in China, particularly in the Second Artillery. Any successful Chinese deployment of ASBMs would likely influence PLA thinking by

- Reinforcing continental approaches to maritime security—"using the land to control the sea"
- Reinforcing centralized approaches to command
- Increasing emphasis on multiaxis saturation attacks
- Increasing confidence in China's ability to restrict U.S. Navy operations, and to control escalation.

All does not hinge on putative ASBM capability: demonstration of other antiaccess capabilities (e.g., streaming antiship cruise missile attacks) that a technologically capable nation like China is clearly capable of mastering could have substantial effect. But ASBMs pose a threat qualitatively different from that of antiship cruise missiles: the United States has not had decades to address the problem, interception is far more complex and time sensitive, and launch platforms cannot be targeted ("shooting the archer instead of the arrow") without contemplating highly escalatory strikes in mainland China.

Chinese leaders do not seek war. Rather, they want to defend what they perceive to be their nation's core territorial interests and to ensure a stable environment for domestic economic development. If they develop an ASBM, then, they would likely hope that it could prevent U.S. projection of military power in ways that were inimical to China's interests. They would thus hope to achieve deterrence without going to war. That said, America has its own national interests, including maintaining freedom of navigation, reassuring such key regional allies as Japan and South Korea, preserving peace in the Taiwan Strait, and safeguarding Taiwan's democracy. A demonstrated Chinese ASBM capability, particularly if the Chinese side failed to offer explanations and reassurances, could threaten these interests and be strategically destabilizing. This would necessitate American development and demonstration of robust countermeasures that Beijing would come to regret.[91]

Herein lies one more way in which Chinese open-source discussions of ASBMs are significant, and must be addressed. Chinese public intellectuals are often tasked by their government with making unofficial statements to gauge international response to potential initiatives, as was the case in December 2008 before a far more positive historic first—the PLAN's counterpiracy deployment to the Gulf of Aden. If some Chinese are currently sending such "trial balloons" with regard to ASBM development, but U.S. interlocutors appear to be unaware, distracted, or indifferent, this will only strengthen the hand of those pushing such programs forward. Measured expression of U.S. concern, resolve, and capability, on the other hand, might influence Chinese decision-making regarding ASBM development in a more positive direction—for example, by informing and empowering the voices of government organizations with more to lose than the Second Artillery in provoking the United States—or at least slow the pace to give time for a more measured reaction. Just as American policy makers must now discuss how best to prepare for this potential capability, they should work to ensure that their Chinese counterparts have an analogous policy debate—in parallel to the ongoing debate in open sources regarding whether China should develop and deploy an ASBM, and the doctrinal and usage implications if it does. While China will ultimately keep its own counsel, like any nation, such efforts should at least ensure that any decisions in favor of ASBM development are made with full awareness of the contingent costs, risks, and consequences. To facilitate this process, two areas require particular investment of political and human capital:

- Increased research to understand the trajectory of both Chinese ASBM efforts and the attendant policy discourse[92]
- Bilateral strategic dialogue at all levels (particularly tracks 1.5 and 2).

Responding to the unprecedented strategic challenge presented by an ASBM capability would require the American military and civilian leadership to face hard truths, and continue to develop innovative new capabilities. The United States has many options here, and it must be prepared to exercise them. The most perilous approach would be to neglect such military innovation while continuing to insist that the United States maintained its ability to keep the peace, when in fact the military capabilities that underpin that ability were diminishing, at least in a relative sense. Such a discrepancy between rhetoric and reality would erode America's regional credibility and fuel Chinese overconfidence. The prospect of documenting that discrepancy publicly might motivate China to conduct a demonstration of an ASBM; a successful test could create the impression that American power-projection capabilities—and the regional credibility that depends on them—had been dramatically diminished. Managing the proper response to this potential

"game changer" will demand close scrutiny from scholars, analysts, and policy makers alike, as it will critically influence America's place in the Pacific for decades to come.

NOTES

The views expressed in this article are solely those of the authors and in no way represent the policies or estimates of the RAND Corporation, the U.S. Navy, or any other organization of the U.S. government. It is based only on open sources. Quotations and analyses are from Chinese authors unless otherwise indicated. The authors thank Dennis Blasko, Michael Chase, Peter Dombrowski, David Finkelstein, Joseph Gavin, Jr., Lyle Goldstein, Kristen Gunness, Craig Koerner, Carnes Lord, William Murray, Jonathan Pollack, Kevin Pollpeter, Robert Rubel, Christopher Weuve, Christopher Yeaw, and Toshi Yoshihara for their incisive comments. A brief, preliminary version of the present argument appeared as "On the Verge of a Game-Changer: A Chinese Antiship Ballistic Missile Could Alter the Rules in the Pacific and Place U.S. Navy Carrier Strike Groups in Jeopardy," U.S. Naval Institute *Proceedings* 135, no. 3 (May 2009), pp. 26–32.

1. Office of the Secretary of Defense, *Military Power of the People's Republic of China 2009,* Annual Report to Congress (Washington, D.C.: 2009), p. 29. The National Air and Space Intelligence Center adds in its latest report that the "CSS-5 ASBM," while "not yet deployed," has two stages. Based on commonly used missile nomenclature, the reentry vehicle would not be counted as one of the stages. NASIC, "Ballistic and Cruise Missile Threat," April 2009, NASIC-1031-0985-09, p. 17.
2. U.S. Navy Dept., *Seapower Questions on the Chinese Submarine Force* (Washington, D.C.: Office of Naval Intelligence, 20 December 2006), available at www.fas.org/.
3. See, for example, Rear Adm. Eric A. McVadon, USN (Ret.), "China's Maturing Navy," *Naval War College Review* 59, no. 2 (Spring 2006), available at www.nwc.navy.mil/press/. For quotation, see *The People's Liberation Army Navy: A Modern Navy with Chinese Characteristics* (Suitland, Md.: Office of Naval Intelligence, July 2009), p. 26.
4. This assumes that prelaunch targeting was good. Active radar is the most likely ASBM sensor, because it can penetrate through clouds.
5. See 邱贞玮 [Qiu Zhenwei], "中国反舰弹道导弹作战过程" [Operational Process of the Chinese Antiship Ballistic Missile] and "中国反船弹道导弹发展研讨" [A Discussion of China's Development of an Antiship Ballistic Missile], postings on blog.huanqiu.com/. The author, a twenty-eight-year-old with an undergraduate degree, a military affairs columnist for one of China's popular news blogs, seems reasonably knowledgeable but lacks documented professional experience in either the military or the defense industry and is best thought of as a journalist. On Qiu's blog, unattributed Chinese-language comments state that he is an amateur and that his postings are fraught with errors and excessively speculative. In particular, many "netizens" state that Qiu's assumptions are based on technical hurdles that cannot be surmounted in the near future. Qiu has previously published an article very similar to the first of the two postings mentioned above: 邱贞玮, 龙海燕 [Qiu Zhenwei and Long Haiyan], "930 秒--中国反舰弹道导弹发展探讨 (作战假想)" [930 Seconds: A Discussion about the Development of Chinese Antiship Ballistic Missiles (Combat Scenario)], 现代舰船 [Modern Ships], no. 280, 01B (January 2007), pp. 27–34. These two related writings lack citations and cannot be corroborated. By contrast, Qiu's "Discussion" posting provides extensive citations, which the present authors have examined and find reasonable. It is thus cited extensively here, while Qiu's other two writings are not.
6. "PLAN ASBM Development," 28 March 2009 posting on informationdissemination

.blogspot.com/; "Report: Chinese Develop Special 'Kill Weapon' to Destroy U.S. Aircraft Carriers: Advanced Missile Poses Substantial New Threat for U.S. Navy," *U.S. Naval Institute,* 31 March 2009, www.usni.org/forthemedia/.

7. Xinhua*,* 14 March 1977, E1–E2, cited in John Wilson Lewis and Xue Litai, *China's Strategic Seapower: The Politics of Force Modernization in the Nuclear Age* (Stanford, Calif.: Stanford Univ. Press, 1994), p. 223.

8. These gradually shifted from basic overviews and translations of foreign media reports to detailed program analyses and finally technical research, by identified experts in Chinese government academies, that would seem to have potential application to China's own programs. See, for example, 康家仁 [Kang Jiaren], "潘兴 II 精确末制导技术分析" [An Analysis of the Pershing II's Precision Terminal Guidance Technology], 导弹与航天运载技术 [Missiles and Space Vehicles], no. 12 (1991); 刘祥林, 三院35所; 高级工程师 [Liu Xianglin, Senior Engineer, Third Academy, 35th Institute], "雷达区域相关匹配技术及其在潘兴 II 战术地地导弹末制导上的应用" [Radar Area Correlation Matching Technology and Its Use in the Pershing II Tactical Ground-to-Ground Missile's Terminal Guidance and Control], 飞航导弹 [Winged Missiles Journal], no. 5 (1989); 王笃士, 航天部一院十三所 [Wang Dushi, Ministry of Spaceflight, First Department, 13th Institute], "潘兴 II 导弹制导方案的选择及其启示" [The Selection of the Pershing II Missile's Guidance and Control Plan and Its Inspiration], 战术导弹技术 [Tactical Missile Technology], no. 3 (1987); 张德雄 [Zhang Dexiong], "潘兴—2导弹第三次试飞部分成功" [The Pershing II Missile's Third Test Flight Is Partially Successful], 固体火箭技术 [Journal of Solid Rocket Technology], no. 1 (1983); 宋志勇 [Song Zhiyong], "潘兴—2导弹第一次试飞失败" [The Pershing II Missile's First Test Flight Fails], *Journal of Solid Rocket Technology,* no. 1 (1983); "为 '潘兴' 导弹试验的制导装置" [The Control and Guidance Installation for the "Pershing" Missile Test], *Winged Missiles Journal,* no. 2 (1976).

9. These include the DF-15C, DF-21, and "DF-25." Qiu, "Discussion"; "Special Dispatch: 'Aces' in 'Dongfeng' Family: Miniaturization, Solidification, and Mobility," *Ta Kung Pao,* 2 October 1999, p. A11, OSC FTS19991114000862.

10. For direct application of this concept to Chinese ASBM development, see 王伟 [Wang Wei], "战术弹道导弹对中国海洋战略体系的影响" [The Effect of Tactical Ballistic Missiles on the Maritime Strategy System of China], 舰载武器 [Shipborne Weapons], no. 84 (August 2006), pp. 12–15, reprinted as Danling Cacioppo, trans., *Naval War College Review* 61, no. 3 (Summer 2008), pp. 133–40.

11. In July–August 1995 and March 1996, concerns about President Lee Deng-hui's furthering of measures that it associated with Taiwan independence led Beijing to order missile tests and other military exercises near the strait. In response, Washington dispatched *Nimitz* through the strait in December 1995 and the *Independence* and *Nimitz* battle groups toward the region in March 1996.

12. The undisputable result is the many new platforms and weapons systems that began to appear in the early 2000s. Asymmetric in nature and antiaccess in focus, they clearly match Chinese strengths against weaknesses inherent in U.S. CSGs and other power-projection platforms. They are difficult to counter, in the view of the authors, because they target specific characteristics and limitations inherent in immutable physical laws and thus place the United States on the "wrong end of physics."

13. For testimony, see "Panel II: Strategic Impact of PLA Naval Modernization," "Hearing on the Implications of China's Naval Modernization for the United States," *U.S.-China Economic and Security Review Commission,* 11 June 2009, www.uscc.gov. For research and development, see Qiu, "Discussion"; 陈海东, 余梦伦, 辛万青, 李军辉, 北京宇航系统工程设计部 [Chen Haidong, Yu Menglun, Xin Wanqing, Li Junhui, Beijing Institute of Astronautical Systems Engineering], and 曾庆湘, 北京特种机电研究所 [Zeng Qingxiang, Beijing Institute of Special Mechanical and Electronic Devices], "再入飞行器攻击慢速目标的制导方案研究" [Study for a Guidance Scheme of Reentry Vehicles Attacking Slowly Moving Targets], *Missiles and Space Vehicles,* no. 6 (2000), pp. 5–9; Richard D. Fisher, Jr., "China's Missile Threat," *Wall Street Journal,* 30 December 1996.

14. 谭守林, 张大巧, 第二炮兵工程学院 [Tan Shoulin and Zhang Daqiao, Second Artillery Engineering College] and 刁国修, 中国人民解放军96311部队 [Diao Guoxiu, PLA Unit 96311, Huaihua], "弹道导弹打击航空母舰末制导有效区的确定与评估" [Determination and Evaluation of Effective Range for Terminal-Guidance Ballistic Missile(s) Attacking Aircraft Carrier(s)], 指挥控制与仿真 [Command Control and Simulation] 28, no. 4 (August 2006), p. 9.
15. Qiu Dishan, Zhang Lining, and Zhu Jianghan, "Study of Task Process of Maritime Target Surveillance, Its Modeling Method," *Military Operations Research and Systems Engineering* (December 2007).
16. 王辉, 田劲松, 张莉英 [Wang Hui, Tian Jinsong, and Zhang Liying], 廊坊陆军导弹学院, 廊坊 [Langfang Army Missile Institute, Langfang, Hebei], "基于飞行时间的弹道导弹火力控制" [Research on Fire Control of Ballistic Missile Based on Flight Time], 火力与指挥控制 [Fire Control and Command Control] 30, no. 2 (April 2005), pp. 85–87, 91.
17. While some of these sources are official publications of the PLAN, others are affiliated with China's state shipbuilding industry and other non-PLA organizations.
18. Some sources also mention the DF-15.
19. U.S. Defense Dept., "DoD Background Briefing," news transcript, 25 March 2009 available at www.defenselink.mil/.
20. 火飞, 罗世伟 [Huo Fei and Luo Shiwei], "无弓之箭--反航母弹道导弹效能及实用化评估" [Arrows without Bows: An Evaluation of the Effectiveness and Employment of Anti–Aircraft Carrier Ballistic Missiles], *Modern Ships,* no. 325 (April 2008), p. 23.
21. Qiu Zhenwei and Long Haiyan, "930 Seconds," pp. 27–34.
22. 主特人: 海军军事学术研究所研究员 李杰 [Special Moderator: Li Jie, Researcher, Naval Military Studies Research Institute], "弹道导弹是航母的'克星'吗? (上)" [Are Ballistic Missiles a "Silver Bullet" against Aircraft Carriers? (Part 1 of 2)], 当代海军 [Modern Navy] (February 2008), pp. 42–44, and "弹道导弹是航母的'克星'吗? (下)" [Are Ballistic Missiles a "Silver Bullet" against Aircraft Carriers? (Part 2 of 2)], *Modern Navy* (March 2008), pp. 50–52.
23. The Second Artillery was poised to capitalize on leadership support for ASBM development and would likely control any ASBMs that China develops. In fact, it had assumed significant conventional missions for the first time around 1993, perhaps as part of an effort to grow institutionally in an area that was not limited by arms-control agreements or a civilian leadership concerned with China's international image with regard to nuclear weapons. Notably, the service published what appears to be a conceptual feasibility study in 2003. 黄洪福 [Huang Hongfu], 第二炮兵科学技术委员会 [Scientific and Technological Committee of the Second Artillery Corps], "常规弹道导弹打击航母编队的设想" [Envisaging of Using Conventional Ballistic Missiles to Strike Aircraft Carrier Formation(s)], 科技研究 [Scientific and Technological Research] (2003) (1), pp. 6–8, cited in 李新其, 毕义明, 李红霞, 第二炮兵工程学院 [Li Xinqi, Bi Yiming, and Li Hongxia, Second Artillery Engineering College], "海上机动目标的运动预测模型及精度分析" [Movement Forecast Model and Precision Analysis on Maneuvering Targets on the Sea], *Fire Control and Command Control* 30, no. 4 (August 2005), p. 37.
24. These volumes satisfy generally accepted metrics for determining authoritativeness as developed by analysts in the Center for Naval Analyses (CNA)'s China Studies Division. *Science of Second Artillery Campaigns,* for instance, was published by the PLA Press, on a topic well within its purview, for the purpose of distribution throughout the PLA as high-level teaching material. The PLA-wide nature of the enterprise can be seen in assistance provided by the Directorate of Operations of the General Staff Department, the Department of Campaign and Tactical Studies of the Academy of Military Science, the National Defense University, the navy, the air force, and the Department of Operations of the Second Artillery Corps. The work of the editors and that of the Second Artillery Command College professors who drafted the actual chapters under their guidance had been reviewed by at least twelve "leaders and experts," including Maj. Gen. Wu Zhenghong, director of the Campaign and Tactical Studies Department at the Academy of Military Science. The present authors are indebted to

David Finkelstein, director of CNA China Studies in Alexandria, Va., for his guidance concerning these issues.

25. Statement by the headquarters of the PLA General Staff. 于际训 [Yu Jixun], 中国人民解放军第二炮兵 [People's Liberation Army Second Artillery Corps], 第二炮兵战役学 [The Science of Second Artillery Campaigns] (Beijing: 解放军出版社 [PLA Press], 2004), p. 3. These volumes represent, respectively, the efforts of the PLA as a whole and of the Second Artillery to operationalize their roles vis-à-vis the *New Generation Operations Regulations* approved by President Jiang Zemin in 1999, which were themselves based on the *National Military Strategic Guidelines for the New Period* assigned to the PLA in 1993. These guidelines are distilled in at least six manual-like publications that are authoritative but unavailable to scholars. *Science of Campaigns* is based on "The Essentials of Joint Campaigns of the People's Liberation Army" (联合战役刚要); *Science of Second Artillery Campaigns* is based on this and on "The Essentials of Campaigns of the People's Liberation Army Second Artillery Corps" (第二炮兵战役刚要), as well as on the mission of "dual deterrence and dual operations" (双重威慑, 双重作战). The above-mentioned volumes thus offer irreplaceable insights into these critical but inaccessible PLA documents. "Interview with General Chief of Staff Fu Quanyou by Staff Reporter: 'Earnestly Implement Operation Decrees and Continue to Enhance Capacity to Win Wars,'" *Liberation Army Daily,* 25 February 1999, p. 1, OSC FTS19990318002173; David M. Finkelstein, "Thinking about the PLA's 'Revolution in Doctrinal Affairs,'" in *China's Revolution in Doctrinal Affairs: Emerging Trends in the Operational Art of the Chinese People's Liberation Army,* ed. James Mulvenon and David Finkelstein (Alexandria, Va.: Center for Naval Analyses, 2002), pp. 10–18; Brad Roberts, "Strategic Deterrence beyond Taiwan," in *Beyond the Strait: PLA Missions Other than Taiwan,* ed. Roy Kamphausen, David Lai, and Andrew Scobell (Carlisle, Pa.: U.S. Army War College, 2008), pp. 174–77.
26. 战役学 [The Science of Campaigns] (Beijing: National Defense Univ. Press, May 2006), "Chapter 31: Introduction," pp. 616–28, and "Chapter 32: The Second Artillery Conventional Missile Assault Campaign," pp. 629–36.
27. Lt. Gen. Yu Jixun is a Second Artillery deputy commander and currently serves as the service's chief of staff. Maj. Gen. Li Tilin is commandant of the Second Artillery Command College. This is clearly not their personal opinions but rather the collective institutional viewpoint of the Second Artillery; "PLA Second Artillery," not their names, appears on the book's front cover and spine. The book thus represents the best theoretical work by the PLA's best thinkers on this subject. It suggests that the Second Artillery is thinking seriously about ways to use ASBMs against U.S. CSGs, at least at the conceptual level, and that, consequently, related research and development has high-level approval from China's military and civilian leadership (at least in a general sense).
28. Yu Jixun, *Science of Second Artillery Campaigns,* p. 395.
29. Ibid., pp. 140, 320–21, for "execute focused naval blockades," and 140, 317–18, for "achieve command of the seas."
30. Ibid., p. 141.
31. Ibid., p. 392.
32. Ibid., p. 191.
33. Ibid., p. 160.
34. Ibid., p. 218.
35. Ibid.
36. Ibid., pp. 218–19.
37. Ibid., p. 401.
38. Ibid., pp. 401–402. For an unidentified warhead diagram from a Chinese Internet site, with an "电磁脉冲/电磁干扰防护层 electromagnetic pulse/electromagnetic jamming protection layer," see www.wforum.com/.
39. "When the enemy aircraft carrier battle group enters one's territorial waters, stern warnings, such as the willingness to employ conventional missile weapons to implement fire strike(s) against important targets so as to maintain national unity and defend sovereign territorial waters, can be issued to the enemy through diplomacy, broadcasting, television news, and other paths, so as to contain and deter the enemy's actions." Zhao Xijun, ed., 慑战--导弹威慑纵横谈

[Intimidation Warfare: A Comprehensive Discussion on Missile Deterrence] (Beijing: National Defense Univ. Press, May 2005), p. 188.

40. Ibid., pp. 190–91. For very similar wording, see Yu Jixun, *Science of Second Artillery Campaigns,* pp. 292–93.

41. Yu Jixun, *Science of Second Artillery Campaigns,* p. 293.

42. 靖志远, 中央军委委员, 第二炮兵司令员; 彭小枫 第二炮兵政治委员 [Gen. Jing Zhiyuan, Central Military Commission member and Commander; Peng Xiaofeng, Political Commissar; Second Artillery Corps], "建设中国特色的战略导弹部队" [Building a Strategic Missile Force with Chinese Characteristics], 求实 [Seeking Truth], no. 3 (February 2009), available at www.qsjournal.com.cn/.

43. 吴超, 龚翠玲, 宋万杰, 吴顺君; 西安电子科技大学雷达型号处理国家重点实验室 [Wu Chao, Gong Cuiling, Song Wanjie, and Wu Shunjun; National Laboratory of Signal Processing, Xi'an Electronic Technology University], "船舶目标实时一维距离像研究" [A Study of the Real-Time Range Profile of Maritime Targets], 现代雷达 [Modern Radar] 30, no. 7 (July 2008), pp. 56–59.

44. 王隽, 杨劲松, 黄韦艮, 王贺, 陈鹏 [Wang Juan, Yang Jinsong, Huang Weigen, Wang He, and Chen Peng], 卫星海洋环境动力学国家重点实验室, 国家海洋局, 第二海洋研究所, 杭州 [State Key Laboratory of Satellite Ocean Environmental Dynamics, Second Institute of Oceanography, State Oceanic Administration, Hangzhou], "多视处理对SAR船只探测的影响" [The Impact of Multi-look Processing on Synthetic-Aperture-Radar Ship Detection], 遥感学报 [Journal of Remote Sensing] 12, no. 13 (May 2008), pp. 399–404.

45. 张宇, 张永刚, 王华, 张旭 [Zhang Yu, Zhang Yonggang, Wang Hua, and Zhang Xu], 海军大连舰艇学院 军事海洋系 [Department of Military Oceanography, Dalian Naval Academy], "两类水体中船舶含气泡尾迹海水表观光学特性的测量与分析" [Measurement and Analysis of Seawater Apparent Optical Properties of Ship Wakes with Bubbles in Case-II Waters], *Journal of Remote Sensing* 12, no. 1 (January 2008), pp. 15–22.

46. 张宏, 祁载康, 刘雄飞, 北京理工大学宇航科学技术学院 [Zhang Hong, Qi Zaikang, and Liu Xiongfei, Beijing Institute of Technology, School of Aerospace Science and Engineering], and 苗建松, 驻247厂军事代表室 [Miao Jiansong, Military Representative Office, Factory 247, Taiyuan], "战术弹道导弹打击航母的末制导精度研究" [Research on Terminal Guidance Precision of Tactical Ballistic Missile(s) Attacking Aircraft Carrier(s)], 弹箭与制导学报 [Journal of Projectiles, Rockets, Missiles and Guidance] 28, no. 5 (2008), pp. 1–4.

47. Li Xinqi, Bi Yiming, and Li Hongxia, "Movement Forecast Model and Precision Analysis on Maneuvering Targets on the Sea," pp. 35–37.

48. Tan Shoulin, Zhang Daqiao, and Diao Guoxiu, "Determination and Evaluation of Effective Range for Terminal-Guidance Ballistic Missile(s) Attacking Aircraft Carrier(s)," pp. 6–9.

49. Ibid., pp. 1–5.

50. 谭守林, 李新其, 唐保国 [Tan Shoulin, Li Xinqi, and Tang Baoguo], "组合建模的航母战斗群威胁预警方法" [Threat Precaution Simulation of the Carrier Fighting Group on the Sea Based on the Combination Model-Building Method], *Command Control and Simulation* 32, no. 3 (March 2007), pp. 37–40.

51. 李新其, 王明海, 第二炮兵工程学院作战保障系 [Li Xinqi and Wang Minghai, Operations Safeguard Department, Second Artillery Command College], "弹道导弹对大型水面舰艇的毁伤评估模型" [An Evaluation Model of Damage to Large Surface Vessels by Ballistic Missiles], 电光与控制 [Electronic Optics and Control] 15, no. 1 (January 2008), pp. 51–55.

52. 李新其, 卢江仁 [Li Xinqi and Lu Jiangren], 第二炮兵工程学院 [Second Artillery Engineering College], "系统目标毁伤效果指标建模方法探讨" [Study on Modeling of Damage Effect Index of System Target(s)], *Command Control and Simulation* 29, no. 5 (October 2007).

53. William S. Murray, "Revisiting Taiwan's Defense Strategy," *Naval War College Review* 61, no. 3 (Summer 2008), pp. 13–38. See also David A. Shlapak et al., *A Question of Balance: Political Context and Military Aspects of the China-Taiwan Dispute* (Santa Monica, Calif.: RAND, 2009), pp. 31–51.

54. 曹西征, 郭立红, 杨丽梅, 中国科学院长春光学精密机械与物理研究所; 吉林长春130033中国科学院研究生院; 北京100039; 吉林长春130033 [Cao Xizheng, 1, 2; Guo Lihong, 1; Yang Limei, 1, 2; 1. Changchun Institute of Optics, Fine Mechanics and Physics, the Chinese Academy of Sciences, Changchun; 2. Graduate School of the Chinese Academy of Sciences], "战术弹道导弹再入段红外辐射特性分析" [Infrared Radiation Characteristics Analysis of Tactical Ballistic Missiles during Reentry], 光电工程 [Opto-electronic Engineering] 33, no. 9 (September 2006), pp. 23–26.

55. 唐健, 张合新 [Tang Jian and Zhang Hexin], 第二炮兵工程学院 [Second Artillery Engineering College], "变质心弹道导弹攻击航母分析" [Analysis of Attacking an Aircraft Carrier with a Moving Mass Center Surface-to-Surface Missile], *Command Control and Simulation* 29, no. 5 (October 2007).

56. Gregory Kulacki and Jeffrey G. Lewis, "Understanding China's Antisatellite Test," *Nonproliferation Review* 15, no. 2 (2008), pp. 335–47.

57. They are published by a relatively small group of individuals in versions with substantially overlapping content in different journals, when one might instead expect to see work from different individuals working on different components of a large project. Even if this does not constitute an attempt to influence foreigners, it might still reflect championing of programs that could be expected to benefit the Second Artillery, as well as jockeying for publicity among researchers.

58. The latter would require the rapid, seamless transmission of information among the relevant organizational entities, each operating on the basis of a mutually recognized jurisdictional and procedural authority. The number of authorities in the decision-making loop would likely have implications for how rapidly an ASBM could be launched after a relevant target was detected.

59. Wang Wei, "Effect of Tactical Ballistic Missiles," p. 135.

60. Ge Xinliu, Mao Guanghong, and Yu Bo, "信息战中导弹部队面临的问题与对策" [Problems Faced by Guided Missile Forces in Information Warfare Conditions and Their Countermeasures], in Military Science Editorial Group, 我军信息战问题研究 [Research Questions about Information Warfare in the PLA] (Beijing: National Defense Univ. Press, 1999), pp. 188–89, cited in Larry Wortzel, "PLA Command, Control, and Targeting Architectures: Theory, Doctrine, and Warfighting Applications," in *Right-Sizing the People's Liberation Army: Exploring the Contours of China's Military,* ed. Roy Kamphausen and Andrew Scobell (Carlisle, Pa.: U.S. Army War College, 2007), p. 211.

61. 赵建东, 赵英俊 [Zhao Jiandong and Zhao Yingjun, Missile Science Institute, Air Force Engineering Academy], "21世纪防空的关键--反导" [The Key to Air Defense in the 21st Century: Antimissile], *Winged Missiles Journal* (June 2007), pp. 12–16.

62. Wang Wei, "Effect of Tactical Ballistic Missiles," p. 135.

63. Ibid.

64. Huo Fei and Luo Shiwei, "Arrows without Bows," p. 28.

65. Ge Xinliu, Mao Guanghong, and Yu Bo, "Problems Faced by Guided Missile Forces," cited in Wortzel, "PLA Command, Control, and Targeting Architectures," p. 210.

66. Qiu Zhenwei and a coauthor state that by 2010 the Second Artillery Corps will control one ASBM brigade, armed with DF-21E ASBMs. In Qiu's scenario, the PLA tracks three approaching U.S. CSGs with synthetic-aperture-radar/optical reconnaissance satellites, 2,500–3,500-kilometer sky-wave OTH radar, and "land listening stations." U.S. attempts at interference only improve targeting. PLA forces obtain the carrier's position from "radio signals transmitted when communicating via [Link 16]" and confirm it from "signals emitted by the air search radar, air control radar, and aircraft approach guidance radar." DF-21E ASBMs are launched in two wave attacks with "a special incendiary agent and additive, as well as the dispersal of gas in the sky above" to reduce the initial infrared signature. A "third-stage rocket engine" gives the ASBMs a depressed trajectory, "with multiple peaks" and "increasingly violent maneuvers," that is "extended by 300 km and dropped by 10 km." To compensate for the fact that the homing "antenna window"

remains open, the warheads are further concealed by a cooled shroud, balloon decoys, and symmetrical spinning, thereby defeating SM-3 interceptors. To eliminate inaccuracy of 15–42 km on a 1,100 km flight using aerodynamic flight forces to extend range, "high-altitude homing" is conducted through "radio command amendments" from satellites (including ones recently launched to support military operations), "unmanned reconnaissance aircraft," multimode "microwave radiometers," and sky-wave/passive radar. This is followed by "terminal infrared image homing," during which the warheads adopt an "unpredictable swinging trajectory," thereby "easily evading air defense missiles." Twelve and a half minutes after launch, the first four DF-21E ASBMs strike the targeted CSG destroyers, either "sinking the ships or inflicting severe damage to their ammunition warehouses and engine rooms." Three minutes later, a second salvo strikes the three aircraft carriers. The author maintains that "a conservative set of ASBM data has been used for this scenario; for example, the hypothetical [radar cross section] of the warhead was 0.001 square meters, the warheads did not electronically jam the data link of the radar or intercept missile . . . [or] the GPS navigation of the intercept missile, many missiles were not launched simultaneously to create confusion, and antiship missiles did not attack the destroyers that had given up their air defense capabilities." While stating that "in the foreseeable future, there will be many ways to shoot down antiship ballistic missiles that use countermeasures," due to advances in missile tracking capabilities and interceptors, the author cites many "weaknesses of the U.S. military's entire system" and concludes that "at the very minimum, the aggressor will hold the advantage prior to 2020." Qiu Zhenwei and Long Haiyan, "930 Seconds," pp. 27–34. Further details are provided by the same author, in one of the recent Internet postings mentioned at the beginning of this article. Qiu, "Operational Process."

67. Wang Wei, "Effect of Tactical Ballistic Missiles," pp. 133–40.

68. Huo Fei and Luo Shiwei, "Arrows without Bows," p. 27.

69. Quoted in ibid.

70. Ibid., p. 28.

71. Ibid., pp. 27–28.

72. Ibid., p. 28.

73. "震撼战场的'抛物线攻击'--战术弹道导弹在实战中德表现" [The "Parabolic Attack"of the Shock Battlefield], 现代兵器 [Modern Weapons] (May 2001), pp. 38–40.

74. Moreover, given the likely duration of an ASBM engagement, an ASBM might not even need to "track" in a strict sense of the term, depending on the scale of search parameters. If it were known that a carrier were within a given area, and the seeker window were larger than the conceivable distance the carrier could travel in the time between detection of its position and ASBM launch, real-time target tracking prelaunch and data relay thereafter might not be so important. This could simplify things immensely; the seeker could cover everything via terminal homing. For (micro)satellites, see Qiu, "Discussion."

75. Sean O'Connor, "OTH Radar and the ASBM Threat," 11 November 2008 posting on geimint.blogspot.com/. OTH radar also plays a major role in the scenario developed in Qiu Zhenwei and Long Haiyan, "930 Seconds," pp. 27–34. See also Qiu, "Discussion."

76. Li Jie, "Are Ballistic Missiles a 'Silver Bullet' against Aircraft Carriers? (Part 2 of 2)," p. 52.

77. See Qiu, "Operational Process" and "Discussion"; Qiu Zhenwei and Long Haiyan, "930 Seconds," pp. 27–34.

78. 李新其, 牛国华, 王明海, 第二炮兵工程学院 作战保障系 [Li Xinqi, Niu Guohua, Wang Minghai, Department of Operational Support, Second Artillery Engineering College], and 骆明君, 四川成都海军代表室 [Luo Mingjun, Navy Representative at Chengdu], "子母弹对航空母舰舰载机群毁伤计算的像素仿真法" [Pixel-Simulation Study on the Damage Efficiency of Attacking Carrier-Based Aircraft Groups with Submunitions], 系统仿真学报 [Journal of System Simulation] 20, no. 11 (August 2008), pp. 3062–64.

79. Huo Fei and Luo Shiwei, "Arrows without Bows," pp. 23–25.

80. See, for example, Li Xinqi et al., "Pixel-Simulation Study," pp. 3062–64.

81. Thomas G. Mahnken, *The Cruise Missile Challenge* (Washington, D.C.: Center for Strategic and Budgetary Assessments, 2005), p. 42.

82. The original Chinese equivalent of the English quotation cited in text is "当采用弹道导弹实施攻顶作战时, 其突防概率可达0.95." See 许诚, 李永胜, 孙锦 [Xu Cheng, Li Yongsheng, and Sun Jin], 海军航空工程学院204教研室, 山东烟台 [Teaching and Research Section 204, Naval Aeronautical Engineering Institute, Yantai], "基于MARKOV过程的反舰导弹突防舰艇编队能力评估" [An Evaluation of the Ability of Anti-ship Missiles to Penetrate Naval Vessel Formations Based on Markov Queueing Theory], 飞行力学 [Flight Dynamics] 27, no. 2 (April 2009), p. 95. A cruise missile approaches its target from a low, head-on position (whereas a ballistic missile approaches from overhead). Its target is thus set against an air background, facilitating detection. But lack of an overhead view of the target complicates target classification.

83. For cost estimate, see Qiu and Long, cited in, but not the authors of, the online-journal posting "China's Anti-ship Ballistic Missile Program: Checkmate for Taiwan?" *Taiwan Link,* 17 June 2009, www.thetaiwanlink.blogspot.com/. Maritime surveillance is useful for all attack platforms, so there might be a broad-based rationale for overall improvements that would support ASBM operations.

84. Wang Wei, "Effect of Tactical Ballistic Missiles," pp. 133–40.

85. Ibid.

86. Wang Zaigang, "Nemeses of Aircraft Carriers," 舰船知识 [Naval and Merchant Ships] (February 2005).

87. For Western research on this subject, see Bernard Fox, Michael Boito, John C. Graser, and Obaid Younossi, *Test and Evaluation Trends and Costs for Aircraft and Guided Weapons* (Arlington, Va.: RAND, 2004).

88. Jeff Chen, "How Will PLA Second Artillery Force Strike Aircraft Carrier?" *Kanwa Asian Defense Review,* no. 36 (October 2007).

89. Yu Jixun, *Science of Second Artillery Campaigns,* pp. 281, 288.

90. Precisely such a course of action is suggested in *Science of Second Artillery Campaigns,* as part of "Campaign Deterrence Methods": "Pressure of public opinion is exerted primarily through the following methods. First, issue news and announcements about new types of missile weaponry. Second, release pictures of the situations in missile force exercise to the foreign media. Third, issue stern warnings to the enemy that we will carry out missile strikes. In accordance with the needs of missile force campaign deterrence, one can adopt the forms of television news and announcements, the Internet, and one can hold press conferences. At suitable times, one can release information about new types of missiles. . . . When a strong enemy's carrier strike group invades our maritime territory and when it directly uses military force to engage in a military intervention, we can communicate to the enemy, through the use of diplomatic, broadcast, television news, and other channels, that the use of conventional missile weaponry in fire strikes against the enemy's nuclear aircraft carrier will not be removed from possibility." Ibid., p. 283. While a full-up test would be preferable to generate confidence in the system's performance, considerable progress could be made short of such an action. As one expert notes, China could "conduct separate tests for the guidance package, flight vehicle, and attitude control system. Chinese references note [the] possibility of using hardware in the loop or other simulation to test an ASBM guidance system." See "Checkmate for Taiwan?"

91. For further areas of concern, see Andrew Erickson, "Facing a New Missile Threat from China (Op-Ed): How the U.S. Should Respond to China's Development of Anti-ship Ballistic Missile Systems," *CBS News,* 28 May 2009, www.cbsnews.com/.

92. For preliminary research in this area, see Andrew Erickson, "Chinese ASBM Development: Knowns and Unknowns," Jamestown *China Brief,* 24 June 2009, pp. 4–8, www.jamestown.org/.