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Beijing's Aerospace Revolution

Short-Range Opportunities, Long-Range Challenges

CHINA HAS ENTERED the second decade of the twenty-first century as a global economic and political power with growing regional military capabilities. Of all great powers, China has both the most uncertain political future and the greatest potential to influence global affairs. To support power projection overseas, both for national prestige and for limited missions beyond Taiwan, China must continue military growth and extend the range of its aerospace power. A major uncertainty remains: how far will China's military operate beyond its shores?

To probe the implications of China's progress in air and space, this chapter will begin by establishing the importance of aerospace development, followed by highlighting the most significant developments in China's aerospace revolution. It will subsequently examine Chinese theories of aerospace and their relevance to naval warfare. Finally, it will offer implications for China's maritime development and its significance for the U.S. Navy.

Major findings of the chapter include the following:

- China is achieving a rapid, if uneven, revolution in aerospace capabilities.
- These capabilities are mainly divided among China's Second Artillery, air force, and navy. There is likely to be competition among the services for control of new forces (e.g., space) as they emerge. China has method-

ically developed and acquired technologies that target limitations in the physics of high-technology warfare, placing high-end competitors (e.g., the U.S. Navy) on the costly end of an asymmetric arms race.

- In addition to widespread incremental improvements, China is on the verge of achieving several potentially "game changing" breakthroughs (particularly antiship ballistic missiles, or ASBMs, but also streaming cruise missile attacks and the application of satellite navigation).
- Such achievements will radically improve the People's Liberation Army's (PLA) antiaccess/area denial (A2/AD) capabilities by allowing it to hold at risk a wide variety of enemy surface- and air-based assets were they to enter strategically vital zones on China's contested maritime periphery in the event of conflict.
- Ongoing challenges include deficiencies in human capital; realism of training, hardware, and operations; and C4ISR (command, control, communications, computers, intelligence, surveillance, and reconnaissance).
- China can mitigate these limitations for kinetic operations around Taiwan and in its maritime periphery, and potentially for nonkinetic peacetime operations further afield.
- Conducting high-intensity wartime operations in contested environments beyond Taiwan would require major qualitative and quantitative improvements, particularly in aerospace.
- The biggest strategic question for U.S. military planners is whether China will choose to develop the aerospace capabilities to support major kinetic force projection beyond the first island chain, and if so, how.

Why Aerospace?

Since the end of World War II, full-spectrum aerospace development has been an objective indicator of comprehensive national power among great powers. Aerospace development may be defined as the production, integration, and utilization of military and civilian devices for both aviation and spaceflight. While air and space systems have their respective fundamental differences, a nation's overall attainment of comprehensive aerospace capability requires mastery of both aspects, which are increasingly interrelated.

China's methodical, relatively comprehensive aerospace development is proportionate to its rising comprehensive national power, and thus serves as a useful indicator of its future trajectory in the international system. China offers

a prime example of differential aerospace development: its aerospace performance, while significant in aggregate, has thus far been lopsided. Lopsided aerospace achievement means military gaps and missed economic and strategic technological opportunities, neither of which supports great power status.

While it shares certain commonalities, Beijing's aerospace development trajectory differs from the experiences of many other aspiring and established powers (see tables 1 and 2). By the Cold War's end, China had already become the first developing nation to achieve some form of full-spectrum aerospace development. In several areas, China has achieved capabilities of great strategic significance, such as advanced ballistic and cruise missiles and increasingly advanced satellites. Taken together, these developments can be properly termed a "revolution" because, in aggregate, they significantly boost China's technological level, military capabilities, and international position.

Table 1: China's Full-Spectrum Aerospace Development

Aerospace Aspirant	Missile/SLV Success	Satellite Success	Military/Commercial Aircraft Success
1. USA	High	High	High
2. EU	High	High	High
3. Russia/USSR	High	High	High
4. China	High	High	Medium, rising
5. India	Moderate	Moderate	Low
6. Brazil	Low	Low	High

Table 2: Subcomponents of China's Differential Aerospace Development

Sector	Resources	Activity	Technology	Incentives	Institutions
Rockets	High	High	High	Medium	High
Satellites	High	Medium	Medium–High	Medium	High
Aircraft	Medium, rising	Medium, rising	Medium, rising	Medium, rising	Medium, rising

Revolution or Evolution?

The amount of sophisticated Western scholarship focused on China's aerospace development is small, and works tend to be specialized. Most significantly, despite the importance of the interrelation between Beijing's efforts in the critical aerospace and maritime spheres, there has never been a large-scale attempt to consider this nexus. An updated, comprehensive study of China's aerospace development and its maritime implications is in order, in part because the tremendous changes of the past few years have eclipsed many existing studies, as well as U.S. government estimates. According to Vice Admiral David Dorsett, deputy chief of naval operations for information dominance, "we have been pretty consistent in underestimating the delivery and IOC [initial operational capability] of Chinese technology, weapons systems." And that outpacing of respected analysis by recent developments is itself a sign of revolutionary, not evolutionary, change.

Defining Revolution

According to Eliot Cohen's criteria, a military revolution would

- "change the appearance of combat;
- [change] the structure of armies;
- lead to the rise of new military elites; [and]
- alter countries' power position."[1]

Equally important is what is *not* required to realize a military revolution. According to Cohen and Andrew F. Krepinevich, there is

- no need for comprehensive cutting-edge aerospace capacity;
- no need to be a superpower;
- no need to be symmetric; and
- no need to do it all at once.[2]

Let us now analyze the Chinese case. As Barry Posen contends, America's preeminent position in the international system hinges on its ability to command the global commons by dominating and exploiting the sea, air, and space for military purposes.[3] This prevents regional powers from denying the U.S. military access to any economically or strategically important maritime spaces.[4] However, recent Chinese aerospace improvements may allow Beijing to deny Washington the military use of critical areas in the Western Pacific and the South China Sea, which the United States and its regional allies have long conceived as part of the global commons. The PLA—long unable to engage in many military

activities because of serious aerospace technology limitations—is now poised to promote China's interests beyond its immediate shores.

Key Chinese Aerospace Trends

It is worth highlighting strategically significant trends in Chinese aerospace development. When projecting possible trajectories for future Chinese capabilities, rate of change and scope of effort is more important than extant capabilities (which are limited in some cases). Table 3 offers a visual representation of this effort.

Hardware

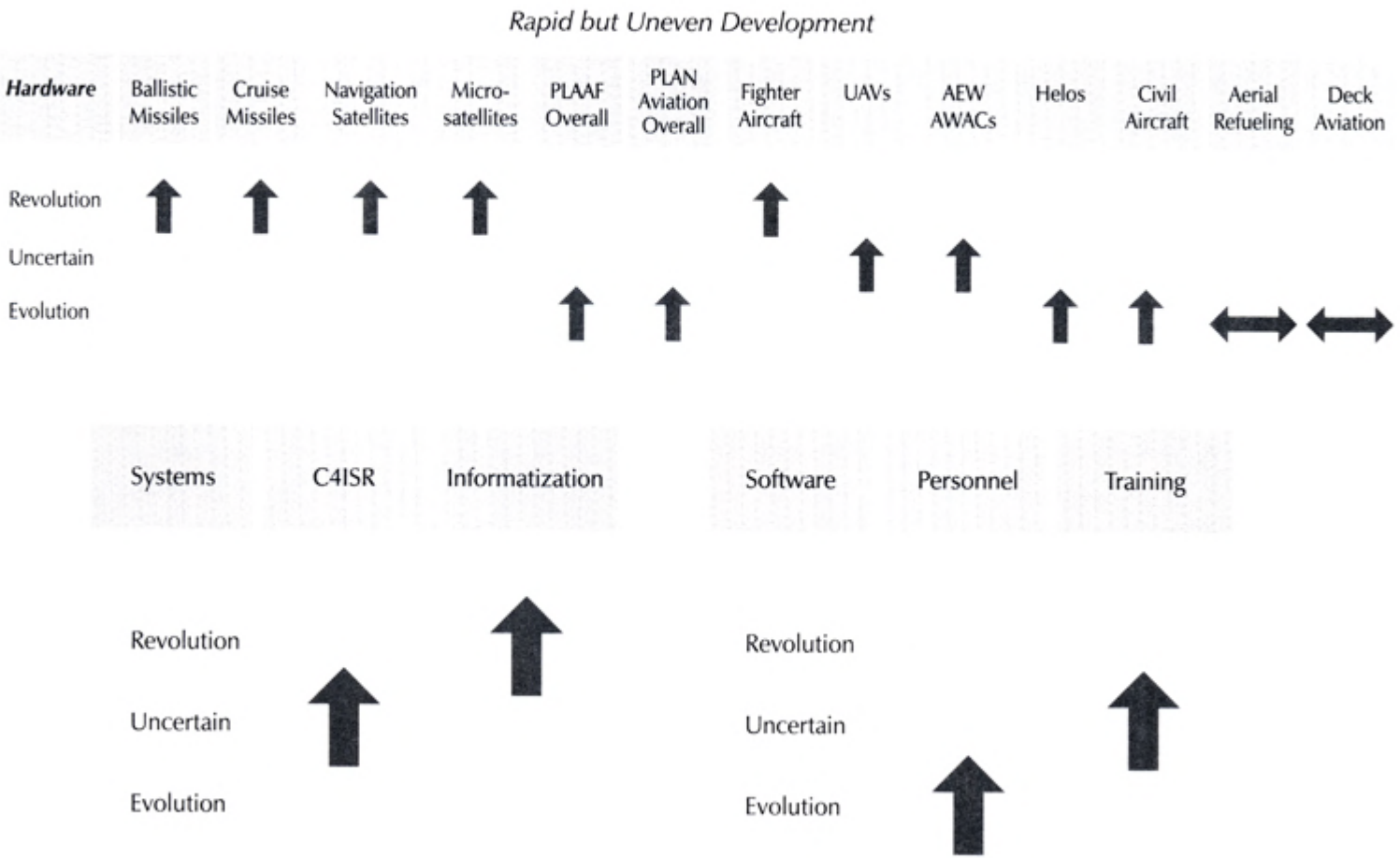
Over the past decade China has developed, acquired, and upgraded platforms, weapons systems, and supporting architecture. While progress is uneven, it is beginning to acquire significant—and even unique—capabilities in selected areas and to achieve breakthroughs that have surprised many observers.

Ballistic and Cruise Missiles

According to the Department of Defense (DoD), "China has the most active land-based ballistic and cruise missile program in the world."[5] As its earliest area of aerospace development, dating from the late 1950s, and arguably its most organized and capable, China has produced a full range of missiles. Three emerging types of ballistic missiles stand out in particular. In 2007 China demonstrated a direct ascent antisatellite (ASAT) capability; in 2010 it demonstrated an antiballistic missile (ABM) capability. China is also developing the capability to target U.S. ships with ASBMs, which could be difficult to defend against. China's DF-21D ASBM reached the equivalent of initial operational capability (IOC) in December 2010 and is supported by a broad-based, sophisticated ISR architecture.[6] According to China's *Global Times*, an estimated intermediate-range conventional missile with a range of roughly 4,000 km is under development (scheduled for deployment in 2015). This would enable the Second Artillery to launch conventional strikes against targets as far away as Guam.

China's 1,050–1,150 CSS-6/DF-15 and CSS-7/DF-11 SRBMs deployed opposite Taiwan offer a precision-guided munitions (PGM) capability without the costly investment in more-complex manned aircraft.[7] Short-range ballistic missiles (SRBMs) can render Taiwan's airfields inoperable and destroy infrastructure nodes, disrupting Taiwan's ability to support its economy and military. Land-attack cruise missiles (LACMs) such as the indigenous DH-10 also

Table 3: Notional Direction and Rate of Change in Selected Hardware, Software, and Systems Capabilities



have the potential to complicate Taiwan's capacity to use its previously superior air force to thwart Chinese attack options. China has also developed antiship cruise missiles (ASCMs) with improved guidance and satellite navigation capabilities, providing multiaxis firepower against targets at sea.

Navigation, Maritime Surveillance, and Microsatellites

Beijing's satellite capabilities, while far from cutting edge in many respects, are improving rapidly due to standardization and quality control. The achievement of reliable indigenous satellite navigation, high-quality real-time satellite imagery and target-locating data, and microsatellites with space control capabilities would enhance Chinese intelligence, surveillance, and reconnaissance (ISR) capabilities and be significant "game changers" for the PLA.

Satellite navigation differentiates friendly and enemy forces by offering reliable positioning signals. China is developing its own indigenous Beidou satellite navigation system; three are currently deployed to support operations on China's immediate maritime periphery. Within the next ten years, China will deploy a thirty-five-satellite (five geostationary, thirty medium earth orbit) constellation—called Beidou-2/Compass—to provide much-improved accuracy and support broader operations; seven have been launched thus far.

China launched its first maritime observation satellite, Haiyang-1A, in 2002, which monitored ocean water color and temperature. In 2007 China launched a follow-on satellite, HY-1B, with double its predecessor's data capacity, to survey its maritime periphery, including the East and South China seas. A total of fifteen additional Haiyang satellites are planned in three sets to be launched in 2012, 2017, and 2022. Likewise relevant to maritime surveillance will be China's Huanjing disaster/environmental monitoring constellation, envisioned to contain eight satellites capable of visible, infrared, multispectral, and synthetic aperture radar imaging.

China produces increasingly sophisticated micro (10–100 kg) and small (100–500 kg) satellites. Mission-optimized standardized platforms ("buses") will quite literally constitute the backbone of China's future microsatellites, thereby reducing costs and enhancing quality control and reliability—part of a larger trend in China's dual-use military technological projects.

PLAAF and PLAN Aviation

China has begun to achieve comprehensive domestic aviation production capabilities by focusing on "informatizing" (improving with information technology and networks) its air force by upgrading to modern avionics and developing new systems for future-generation fighters. China's military aircraft are

outfitted with a variety of increasingly advanced weapons systems, although the country still relies heavily on imports from Russia and technological challenges still remain, particularly mastery of modern engine technology.

People's Liberation Army Air Force (PLAAF) and People's Liberation Army Navy (PLAN) aviation forces currently possess twenty-three hundred operational combat aircraft.[8] Efforts to render the PLAAF more capable of offensive missions include an aggressive procurement program, refit and modernization of the air force bomber fleet, and renewed domestic defense industrial renovation to assemble a stable of advanced fighter aircraft, including the imported Su-27 and Su-30; the domestically produced J-11; the domestically developed J-10 and J-20; and advanced air-defense systems.

Recent equipment upgrades and improved doctrine and training will improve China's prospects for conducting effective joint operations between PLAAF and PLAN aviation. For instance, Sukhoi has developed an improved naval aviation–specialized variant of its Su-30 for the PLAN. The twenty-four received by the PLAN so far have improved engines and combat radius, new radar, antiship strike capability, and an improved electronic warfare and countermeasures suite.[9] Maritime strike missions are increasing in importance and China's fifth-generation J-20 stealth fighter, first flight-tested on 11 January 2011, may have an important role to play. The resulting inventory of modern aircraft and associated weapons are increasing China's ability to achieve air superiority over the Taiwan Strait and permanently shift the balance of military power toward the PRC.

Helicopters

In contrast to recent improvements in fixed-wing aviation, helicopters remain an area of evolution, not revolution. Most platforms in China's disproportionately small but growing fleet (roughly seven hundred to eight hundred in the PLA and more than one hundred in the PLAN) are either imports or copies of foreign models. China Helicopter Research and Development Institute has developed an indigenous WZ-10 advanced attack helicopter, with possible army and transport variants.

Unmanned Aerial Vehicles (UAVs)

Having observed the U.S. military's use of UAVs and drones, China is purchasing foreign models, transforming former piloted aircraft into unmanned combat aerial vehicles (UCAVs), and developing indigenous variants.

Deck Aviation Developments

Aircraft carriers are likely needed for the PLAN to move "beyond Taiwan" to genuine maritime power projection capabilities. The U.S. Office of Naval Intelligence estimates that "the PRC will likely have an operational, domestically produced carrier sometime after 2015."[10] Hull construction is likely to begin earlier, and China's ex-Ukrainian *Varyag* is already being refitted as a training platform. Scott Bray, senior intelligence officer-China, ONI, predicts that China will use deck aviation to "protect Chinese sea lanes, shipping, and enforc[e] maritime claims."[11] To date, however, Beijing has made greater progress in analyzing and targeting enemy carriers than in building its own.

Software

Chinese planners realize that rapidly improving equipment is useless without corresponding improvement in human performance. Aerospace success requires highly skilled and educated personnel, particularly with specific technical capabilities. But building human capital takes much more time, investment, and careful management than does platform acquisition.

Personnel and Training

Since the 1990s, increasingly realistic training and organizational reforms (including downsizing of personnel, streamlining of bureaucratic structures, and reconfiguration of logistics and maintenance) facilitate modernization of China's aerospace forces. Facilities, faculty, curricula, and research at PLA educational institutions are being improved, in part through increased funding and even monetary rewards.

Officers of unprecedented caliber are being recruited. Increasing the number of civilian-college-graduated officers through the National Defense Student Program is raising technical capabilities and may permit consolidation and merger of other PLAAF and PLAN aviation institutions (while raising new service culture challenges). The enlisted corps is being similarly improved. Pilots with a greater level of higher education (military and civilian) are being recruited, and higher performance in challenging situations is already being attributed to their higher theoretical and technical knowledge. The quality and education level of noncommissioned officers remains a problem, however, necessitating remedial education. Cultivating sufficient numbers of experienced combat pilots remains challenging.

The PLA has gradually increased its technological research and development, military and educational exchanges, attaché offices abroad (though few have PLAAF attachés), and has conducted a variety of joint exercises with Russia and Western nations. Aerospace-relevant services (e.g., the PLAAF and Second Artillery) are receiving a larger proportion of PLA personnel and funding as the PLA is transformed into a leaner, more technology-intensive force through successive personnel reductions (particularly of the ground forces).

C4ISR

China's emerging ISR network promises to radically improve the targeting and information processing capabilities of the PLAN. This critical linchpin, according to Larry Wortzel, promises to give the PLA unprecedented ability to "provide real-time support for joint military operations" on or near China's territory "with communications and data relay satellites" but still "lacks a comprehensive set of data transfer systems."[12]

The Aerospace-Maritime Theoretical Connection

Strategists in the West and in China have developed a relatively coherent theory of sea power, reinforced by top naval and military leadership. In recent years a broadly analogous but far less developed set of theories has emerged among Chinese aerospace thinkers. This doctrinal theorizing connects future air and sea warfare but often in a rather superficial manner that fails to explore potential contradictions and may still be largely aspirational in nature.

Central Military Commission (CMC) chairman Hu Jintao requires the PLA "to not only pay close attention to the interests of national survival, but also national development interests; not only safeguard the security of national territory, territorial waters, and airspace, but also safeguard electromagnetic space, outer space, the ocean, and other aspects of national security."[13] But sea, air, and space power theories and their prospects for more sophisticated linkage remain effectively subordinate to a PLA legacy that, while changing rapidly, retains strong ground force roots.

Aerospace capabilities underpin China's current military capabilities. According to DoD, "PLA doctrine does not appear to contemplate space operations as an operational 'campaign' on its own; rather, space operations form an integral component of all campaigns."[14] To some extent, the relative immaturity of Chinese aerospace theory can be traced to the PLAAF's slowness to be granted its own strategy. Whereas the PLA's overarching "active defense" strat-

egy was implemented in the 1930s and the CMC approved a subordinate "offshore defense" strategy for the PLAN in 1985, the PLAAF's "空天一体化，攻防兼备 [integrated air and space, simultaneous offensive and defensive operations]" equivalent was not approved until 2004 (when PLAAF, PLAN, and Second Artillery representatives joined the CMC), even though it had been proposed as early as 1987. This, and lingering resistance by ground force elements, has complicated the PLAAF's efforts to transcend its historical missions of air defense and supporting ground forces.

To meet Beijing's military objectives with its new, increasingly sophisticated platforms, the PLAAF is undergoing a doctrinal and institutional revolution, setting itself up to be the best placed of all services to assume authority over China's growing military space assets. On the doctrinal front, there is an unprecedented focus on offensive operations, based in part on ongoing improvements in long-range "air strike, air and missile defense, early warning and reconnaissance, and strategic projection."[15] Jointness is increasingly emphasized (though actual results appear to lag).

There is not yet any clear evidence in open publications that the PLA has formally adopted space theory, doctrine, missions, or regulations in the informatization process. Even the "integrated air and space" component of its strategy has generated little public clarification, with one CMC general office member stating that "there is no consensus on what 'integrated' means in China."[16] It would appear that China has moved beyond the traditional land-sea-air warfare zone demarcation to think in a more sophisticated fashion about how to integrate zones of warfare and how to achieve superiority in each—but not necessarily in a kinetic fashion.

Strategic Context: Implications for the U.S. Navy

The Chinese aerospace revolution outlined here has different implications in three geographic areas: (1) It is most relevant in the Taiwan Strait, where it has already reversed the balance of military power. (2) It is very significant in China's "near seas" (the Yellow Sea and East and South China seas), where it is shifting the regional balance of power. (3) It has some significance in the global maritime and aerospace commons, where its direct and indirect effects will be felt in years to come.

Sea Denial: Taiwan and Maritime Periphery

In the event of a Taiwan Strait crisis, China seeks to deny the United States and any regional allies access to the East Asian littoral to ensure its ability to influence Taiwan militarily. The East China Sea is an important part of this equation, but it presents particular challenges for China because existing capabilities and alliances (e.g., that between the United States and Japan) complicate antiaccess efforts. The South China Sea, at least until recently, has been a more permissive environment for China.

At present, China's submarine-focused navy and still-limited air and naval aviation forces can only support a more limited strategy of sea denial and offensive counterair as opposed to outright control. This access denial strategy is ever-more potent, however, thanks to a vast and growing inventory of short-range ballistic and cruise missiles deployed in coastal units and on a variety of air, surface, and undersea platforms. Long-range ballistic missiles, which already undergird China's increasingly diverse and sophisticated land- and sea-based nuclear deterrent, may greatly strengthen the antiaccess equation if a conventional version can be made to target surface vessels successfully. Additionally, the Second Artillery and airborne platforms controlled by the other services have a wide range of missiles capable of either threatening or striking Taiwan and surrounding areas.

Overall, U.S. qualitative and even numerical superiority in advanced platforms and systems is of limited relevance for two reasons. First, the platforms most likely to be employed are those that are based within immediate striking distance at the outbreak of war; here China inherently enjoys theater concentration while U.S. platforms are dispersed globally. Second, aircraft sent to the theater need airfields from which to operate; here U.S. regional options are limited and vulnerable to Chinese missile attack. Guam is almost 2,600 km from Taiwan. Okinawa is closer, but there is no guarantee that Japan would allow tactical aircraft to be operated from its airfields, which in any case are within range of China's SRBM forces.

Here it must be emphasized that antiaccess affords China a strategic defensive posture along interior lines. The PLA can mitigate ongoing challenges in command and control and target deconfliction by employing landlines, high-power line-of-sight communications, advanced planning, and geographic and temporal segregation. Its strength is relative to its objective, and here China may be capable of achieving its goals. China need not keep pace with the United States technologically for its incremental developments to have disproportionate impact and potentially deny U.S. access to portions of the global commons. The United States is inherently exposed because it operates offen-

sively on exterior lines and must maintain technological superiority to reduce this vulnerability.

Beyond Taiwan? A Question of Aerospace Power Projection

A fundamental question for U.S. military planners today is whether (and if so, when) the PLA will project power beyond the East Asian littoral. Given its lack of overseas bases and limited unrefueled range of its aircraft, the PLA is far from such a capability. In DoD's estimation, "while remaining focused on Taiwan as a primary mission, China will, by 2020, lay the foundation for a force able to accomplish broader regional and global objectives. By the latter half of this decade, it is likely that China will be able to project and sustain a modest sized force . . . in low-intensity operations far from China."[17]

As a growing number of Chinese military analysts advocate, Beijing may gradually change its policy against overseas military facilities. If China acquires or builds sufficient aircraft carriers and escort vessels to maintain an operationally relevant presence at sea, this might indicate an ambition to conduct some form of regional operations. The PLAN would face a steep learning curve in carrier operations, however, since air operations are particularly dependent on effective C4ISR, which may be difficult to attain far from China's territory, where information assurance is more elusive.

The PLA might also use air and space power to support ocean surveillance and targeting (e.g., antisubmarine warfare), particularly over the horizon. This would require mastering the developments in air- and space-based platforms and C4ISR needed to support significant military operations far from the many facilities on or near China's shores. These very systems might become more vulnerable to electronic, computer network, and kinetic attacks; satellite communications and long-range signals might be jammed or geolocated. This might finally place PLA forces at the costly end of some of the very asymmetric arms races from which they are benefitting closer to mainland China.

It remains unclear what future PLA aerospace-enabled power projection might look like. Will it focus on kinetic destruction (actual kill) or merely nonkinetic denial of use (mission kill)? Space is itself a potential battle space but also a potential enabler of nonkinetic power projection in the electromagnetic, cyber, and public opinion realms. It is possible that China is developing a concept of power projection very different from that of the United States.

Key Factors

China's maritime military posture is currently based on A2/AD and appears to have well-thought-out acquisition programs to achieve antiaccess

in the near seas and perhaps eventually beyond. In attempting to consolidate its regional position, China is engaging in activities that threaten to marginalize U.S. power there and make it particularly difficult and costly for the United States to intervene militarily, particularly at a time when the United States is committed geostrategically in the Middle East and Southwest Asia and faces increasing budgetary challenges at home.

Much will depend on how Chinese decision makers decide to use the potent capabilities that aerospace affords, however. Space-based information assets are increasingly linked to shooting assets (e.g., aircraft, surface, and undersea vessels). Aerospace capabilities thus give military and civilian leaders more flexible deterrent options and the ability to fine tune operations—capabilities valuable to any leaders and perhaps especially those of China. While aerospace capabilities have the potential to enable more sophisticated decision making, it is unclear to what extent this will actually occur. This is because China has yet to reform fundamentally its government decision-making system, which is particularly unsuited to responding rapidly to crises.

Conclusion

Beijing's emphasis on, and partial success in, aerospace development are in keeping with its substantial, rising comprehensive national power. Chinese aerospace capabilities are improving in a rapid, broad-based fashion that can properly be described as a "revolution"—albeit from a low baseline and uneven in present realization. Translating new hardware into operational capabilities is a complex process. We are likely to witness a larger pattern in which China rapidly deploys hardware that is formidable in technical parameters but whose actual combat performance, while improving quickly, remains unclear. China's mastery of critical components of many processes will have significant implications for Beijing's ability to manage its maritime periphery and to challenge U.S. hegemony.

Since successful aerospace development requires sustained government support, any future political instability could threaten China's present aerospace development trajectory. This aspect of China's future hinges on too many variables to allow for accurate prediction. What is clear is that China's current leadership appears determined to pursue aerospace development consistent with its increasing national power. Just as China was not dissuaded from naval development (e.g., of submarines) in the recent past by American dominance in that area, Beijing also seems determined to develop a major presence in air and space.

While conflict is not foreordained and interaction and cooperation should be pursued as feasible, this challenge cannot be ignored. Given the extended period through which carrier strike groups (CSGs) have served as the nucleus of U.S. military power projection, the appearance of credible threats to the CSG will force a significant rethinking of U.S. approaches to warfare and might even end seven decades of carrier-centrism in the Navy. That some experts have minimized the latter possibly would only increase the impact on U.S. planning should such a change come materialize.

To the extent that the United States fails to deploy adequate countermeasures, China's growing aerospace capabilities will improve substantially the PLA's ability to hold at risk and potentially destabilize U.S. naval platforms in the Western Pacific. However, as China's military becomes increasingly reliant on satellites, and the United States further develops relevant countermeasures, its own vulnerabilities increase. A resulting increase in bilateral surveillance and early warning as well as strategic symmetry could thus ultimately enhance the great and growing chances that the two great powers avoid devastating conflict.

This volume probes how Beijing's aerospace revolution will impact the U.S. Navy and other services, including

- Beijing's aerospace strategy and how it relates to its maritime strategy;
- the respective strategic and commercial payoffs to investing resources in various aerospace areas;
- key technological hurdles and how to surmount them;
- services that might control China's various aerospace capabilities; and
- analysis of what China needs to support and use advanced aerospace systems.

The United States must closely study China's aerospace trajectory and plan accordingly.

Notes

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CHINESE AEROSPACE POWER

Evolving Maritime Roles

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"China's air and space development is an area of significant interest for the U.S. Navy. This book elucidates the critical linkage between China's military aerospace and maritime capabilities. Whereas China's rapid progress has already rendered many other studies obsolete, this volume connects the latest 'data point' dots and puts them in strategic context. Navy leaders and planners should read it today."

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ANDREW F. KREPINEVICH JR., president of the Center for Strategic and Budgetary Assessments and author of *7 Deadly Scenarios: A Military Futurist Explores War in the 21st Century*

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POLITICAL SCIENCE • INTERNATIONAL RELATIONS

"An excellent and very readable overview of China's impressive advances in almost every aspect of air and space operations. Not only have the Chinese developed impressive technical capabilities, they have also given careful thought to the operational concepts associated with them. This is a must read for anyone concerned about American or Chinese military affairs."

COL. JOHN A. WARDEN III, USAF (RET.),
Gulf War I planner, president of Venturist,
Inc., and author of *The Air Campaign* and
Winning in Fast Time

China's aircraft carrier program is already making major waves well before the first ship has even been completed. Undoubtedly, this development heralds a new era in Chinese national security policy. While *Chinese Aerospace Power* presents substantial new insight on that particular question, its main focus is decidedly broader in scope. This book offers a comprehensive survey of Chinese aerospace developments, concentrating on areas of potential strategic significance previously unexplored in Western scholarship. It also links these developments to the vast maritime battlespace of the Asia-Pacific region and highlights the consequent implications for the U.S. military, particularly the U.S. Navy.

The possibility of a future Chinese expeditionary force operating off Africa under the protective umbrella of carrier aircraft is not without consequence for the global strategic balance. However, a simpler set of aerospace systems, from microsatellites to unmanned aerial vehicles to ballistic and cruise missiles, is already challenging U.S. maritime dominance in East Asia. Cumulatively, progress in all major aerospace dimensions by various elements of the People's Liberation Army Navy (PLAN) signifies a new period in which Chinese forces are now decidedly altering the complexion of the military balance in the East Asian littoral.

While many articles and books have previously been written on Chinese aerospace development and many more discuss future U.S. naval strategy in the Asia-Pacific region, no other book connects the two

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issues, simultaneously evaluating the Chinese aerospace challenge and its implications for U.S. naval strategy.

This is the fifth book in the series "Studies in Chinese Maritime Development" published jointly by the China Maritime Studies Institute and the Naval Institute Press:

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China, the United States, and 21st Century Sea Power. Edited by Andrew S. Erickson, Lyle J. Goldstein, and Nan Li. ISBN 978-1-59114-243-0

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Chinese Aerospace Power

Evolving Maritime Roles

Edited by Andrew S. Erickson and Lyle J. Goldstein

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Foreword

IT HAS BEEN MORE than thirty years since the United States established formal diplomatic relations with the People's Republic of China (PRC), yet those relations remain ambiguous and perplexing. The U.S. government seeks to encourage the PRC's evolution into a responsible stakeholder on the world stage, especially in the Pacific, while the Department of Defense strives to balance military-to-military interaction with the PLA and yet still maintain credible deterrence against China's rapidly increasing military capability.

The chapters that follow address the reality of the emergence of the People's Liberation Army (and People's Liberation Army Navy) as a modern, complex military. They are not intended to assuage either hawks or doves on the controversial issue of China; rather, they provide a broad and objective assessment of Chinese aerospace and maritime power by professional researchers who take their analyses with the utmost seriousness. This is important work.

Is war with China possible? Regrettably, yes. Acknowledging that unfortunate fact and ensuring that the United States is sufficiently prepared to prevent and deter such a conflict is what this volume is about. The most essential work being done today is the broad effort to avoid conflict with the PRC without compromising our national principles. Global economic challenges are daunting, but the threat of a nuclear-enabled Iran and North Korea, or terrorists with weapons of mass destruction, pale in comparison to the potential devastation that might occur if war erupts between the United States and China. Beyond imperiling the

survival of Taiwan, war with China would cause broader physical and economic destruction and could very well spiral into a lengthy global conflict.

The surest way to limit that potential is to mature the relationship between the United States and China, which is currently stuck in the molasses of its modern origins. It is an elaborate ballet of protocol and protest, pirouetting around the status of Taiwan. We must find a way beyond the false formalities of our special relationship with the PRC. To build on the hopeful signs of the first year of the Ma Ying-jeou government and PRC–Taiwan interaction, I suggest the following: the United States government should stress at every turn that U.S. involvement with Taiwan is good for the PRC. During the government of Chen Shui-bian, U.S. pressure on Chen was key to keeping his actions away from PRC red lines. My experience in dealing with Beijing suggests that a candid and direct approach to diplomacy can yield practical solutions to the delicate problems in U.S.–China relations.

Most fundamentally, we should assess PRC military modernization in objective terms for what we know it is—a significant build up in capability well beyond defensive requirements. Special attention needs to be focused on China's undersea capabilities and also its new prowess in the domain of electronic warfare. Moreover, it is crucial that we avoid the presumption that we can know Beijing's intent. We do not know, and we cannot. We must assess the quality of China's hand without trying to predict how Beijing will ultimately play its cards. We are duty bound to continuously evaluate the military balance, considerations of readiness and risk, and the potential for engagement and deterrence.

Those who ignore the lessons of history may be condemned to repeat it, but those who turn a blind eye to the realities of the present, for example by underestimating China's dramatically enhanced aerospace and maritime power, are assuming irresponsible risks for our nation.

LIEUTENANT GENERAL DANIEL P. LEAF, USAF (RET.)

Lyle J. Goldstein

Introduction

CHINA'S AIRCRAFT CARRIER program is making major waves well before the first ship is completed. Undoubtedly, this development heralds a new era in Chinese national security policy. While the present volume presents substantial new insights on that particular question, its focus is decidedly broader in scope. This book instead aspires to offer a comprehensive survey of Chinese aerospace developments, with a focus particularly on areas of potential strategic significance previously unexplored in Western scholarship. It then seeks to link these developments to the vast maritime battle space of the Asia-Pacific region and consequent implications for the U.S. military, particularly the Navy.

Whether some hypothetical future Chinese expeditionary force operating off Africa a decade or two from now does so under the protective umbrella of carrier aircraft is not without consequence for the global strategic balance. But a relatively simpler set of aerospace systems, from microsatellites to unmanned aerial vehicles to ballistic and cruise missiles, are challenging U.S. maritime dominance in East Asia today. Cumulatively, progress in all major aerospace dimensions by various elements of the People's Liberation Army (PLA) heralds a new period in which Chinese forces are now decidedly altering the complexion of the military balance in the East Asian littoral.

Faced with such rapid developments in Chinese aerospace development, the U.S. Naval War College's China Maritime Studies Institute (CMSI) assembled a group of technical specialists—U.S. Air Force (USAF) and U.S.

Navy operators, and regional experts on—10–11 December 2008 for its fourth annual conference, "Evolving Maritime Roles for Chinese Aerospace Power." Most of the chapters herein were presented initially as papers at that conference, and were subsequently revised substantially to address recent events. A select group of chapters was added to take advantage of the authors' cutting-edge knowledge of key subject areas. The chapters are designed to offer a wide range of perspectives because constructive academic dialogue and debate is at the heart of CMSI's analytical philosophy. They may be read sequentially or individually, depending on the reader's interest.

CMSI is the first undertaking of its kind outside of China. Established in 2006 to increase knowledge and understanding of the maritime dimensions of China's rise, it supports the research needs of the U.S. Navy. Based at the Naval War College in Newport, Rhode Island, CMSI is located at the nexus of academic, policy, and operational communities. In addition to an annual conference and regular research seminars at the college, the institute focuses on intensive research into China's future maritime development, based principally on the ever-growing array of Chinese-language primary sources.

CMSI has developed a record of discussing and analyzing in depth the most advanced areas of Chinese naval development; CMSI's 2005 conference, for example, discussed "China's Future Nuclear Submarine Force." The institute has also been at the forefront of developing a positive working relationship between the U.S. and Chinese navies, hosting in 2007 a conference on "Defining a Maritime Partnership with China." At every step, CMSI has striven to add objectivity and data-based analysis to inform the U.S. Navy's approach to China. In that spirit, this volume, like its four predecessors, contains many chapters that draw extensively on original Chinese-language sources, many not previously cited outside China. Numerous articles and books have been written on Chinese aerospace development, and many more discuss future U.S. naval strategy in the Asia-Pacific region. But no other volume connects the two issues, simultaneously evaluating the Chinese aerospace challenge and its implications for U.S. naval strategy.

This volume is divided into six thematic sections. The first section establishes the maritime context for China's rapid aerospace development. Andrew S. Erickson leads off with a survey of current developments and concludes that "Chinese aerospace capabilities are improving in a rapid, broad-based fashion that can properly be described as a 'revolution.'" Mark A. Stokes and Ian Easton follow with an in-depth analysis of both the organizational underpinnings of China's aerospace development and its regional implications. They find that, "largely driven by a Taiwan scenario, mainland China's capacity to

conduct a successful aerospace campaign to swiftly gain a decisive air advantage is surpassing defenses that its neighbors, including Taiwan, Japan, perhaps India, and even U.S. forces operating in the Western Pacific, can field." Wayne A. Ulman reveals that "all indicators point to the continued improvement of both the PLAAF and PLA naval aviation over the next decade, to the point where China will have one of the world's foremost air forces by 2020." Kevin Pollpeter concludes the section by exploring Chinese writings that reveal "an ambitious plan to fully integrate space into Chinese warfighting," with an understanding that this approach could "hold an [adversary's] economy hostage and . . . undermine an opponent's will."

The second section surveys the roles for Chinese aerospace assets in promoting Chinese intelligence, surveillance, and reconnaissance (ISR) and in denying these capabilities to China's potential adversaries in conflict, as well as corresponding maritime implications. Anthony J. Mastalir surveys China's space development, including especially its 11 January 2007 antisatellite (ASAT) test, and concludes that if Beijing's approach in this sensitive domain is not to become the twenty-first century equivalent of the destabilizing German dreadnoughts, then Washington requires a more comprehensive approach to space policy regarding China. Peter A. Dutton discusses China's new initiative to restrict military operations in the airspace over its exclusive economic zone (EEZ), concluding that such efforts must be strongly contested because "information is inherently stabilizing," so that such operations are actually very much in China's own national interest. Richard D. Fisher Jr.'s analysis reveals yet another Chinese ISR capability, noting that "the PLA has apparently committed to investing in a world-class unmanned [aerial vehicle] systems capability," as suggested by the more than twenty-five prototypes or major projects that were unveiled at China's 2010 Zhuhai Airshow. Garth Hekler's extensive research in Chinese sources reveals a similarly robust Chinese effort in the areas of both defensive and offensive airborne electronic warfare—another key element of the evolving ISR environment along the East Asian littoral.

The third section considers prospective maritime missions that might develop further in the future as the result of advances in Chinese aerospace. Dennis J. Blasko investigates helicopter development in the PLA and finds that this process is "still in the rudimentary phase" though the "force is expanding in size and scope of its missions." Lyle J. Goldstein, Miguel Martinez, and William S. Murray address a related theme, Chinese airborne antisubmarine warfare (ASW), and likewise conclude that Chinese capabilities are not robust—with the caveat that China's navy seems to be prioritizing airborne ASW given the amount of ongoing research in this area evident in Chinese

sources. Similar limitations are evident in the development of China's aerial refueling capabilities, according to the chapter by Gabriel Collins, Michael McGauvran, and Timothy White, who conclude that "even major AR [aerial refueling] improvements over the next ten to fifteen years will not give the PLA a capacity resembling the global power projection capability the United States has with its more than four hundred tankers." Nan Li and Christopher Weuve take up the issue of Chinese aircraft carrier development. Noting the possible options that Beijing might pursue, they determine that various necessary conditions appear to have been met, including endorsement by the central leadership, affordability, a concise naval strategy incorporating the new platforms, and the availability of the requisite technologies. Daniel J. Kostecka surveys the potential spectrum of Chinese deck aviation development. He concludes that "between now and 2020, the acquisition of aircraft carriers will afford the PLAN the capacity to conduct force projection operations in East Asia."

Section four of this volume examines the emerging threat from Chinese prowess in fielding advanced cruise missiles. Roger Cliff begins by surveying the latest developments in capabilities, doctrine, and missions for China's air forces. He finds that "China's air forces have made substantial strides over the past decade" and "have the potential to present a significant obstacle to U.S. success in such a conflict." Kevin Lanzit and David Chen evaluate the maritime strike mission among China's air forces and note that China already has 570 strike aircraft, which are armed with lethal antiship cruise missiles and capable of operating 1,200 km or more from China's coast. Andrew S. Erickson and Jingdong Yuan describe these missiles in detail, observing that China is no longer reliant on Russia to deploy these advanced weapons. Michael S. Chase focuses on the latest dimension of the cruise missile threat, arguing that major progress in Chinese land-attack cruise missiles could allow Beijing "to at least partially address the asymmetry in conventional strategic warfare capabilities that currently prevents the PLA from retaliating in kind if the United States launches conventional attacks against targets on the Chinese mainland."

First among Chinese antiaccess/area denial systems in potential strategic significance is China's DF-21D antiship ballistic missile (ASBM), which Admiral Robert Willard, commander, U.S. Pacific Command, declared in December 2010 to have reached the equivalent of initial operational capability.[1] The vital issue of Chinese ASBM development is addressed in section five of the present volume. Ron Christman describes the conventional force of the PLA Second Artillery Corps as seven times larger than the nuclear forces component of the service. Andrew S. Erickson and David D. Yang probe the writings of Chinese analysts concerning China's emerging ASBM capability and

conclude that this concept has a long and well-developed history in Chinese strategic thought. Toshi Yoshihara examines Chinese perspectives on the ballistic missile defense architecture and finds that China views Aegis missile defense systems as a highly lucrative target for striking U.S. Navy carrier strike groups (CSGs) in a conflict scenario. Paul S. Giarra then evaluates the implications of Chinese ASBM development for the U.S. Navy and comes to the stark conclusion that the deployment of an effective ASBM by China could alter naval warfare to an extraordinary extent, comparable to the introduction of aircraft and submarines in the twentieth century.

Concluding chapters in section six develop more comprehensive assessments. Eric Hagt develops the sobering assessment that "time (and money) appears to be on China's side. Although the United States will remain the dominant military power at the global scale for decades to come, in the regional context of Taiwan, China's near seas, or even within the second island chain, the demands for power projection are far less onerous for China." James R. Holmes posits that "since the dawn of carrier warfare, U.S. naval strategy has viewed command of the air as a prerequisite for surface fleet operations" and asserts that this assumption is increasingly questionable regarding any possible conflict in the East Asian littoral. Larry M. Wortzel judges that the "U.S. Navy and Air Force . . . will likely be hindered in carrying out some . . . missions in the Western Pacific, particularly within proximity of China." Xiaoming Zhang and Sean D. McClung argue that much improvement is needed in U.S. studies of Chinese air and space power, which is "being transformed." They demonstrate that the PLAAF faces challenges both in upgrading its own forces and in competing with the General Armament Department and the Second Artillery Corps for ownership of space-based platforms: "Given the PLAAF's limited ownership and control of space assets, Chinese military theorists have recommended that the service concentrate on building facilitie s and institutions to receive satellite services for communication, weather, navigation, and global positioning." Jeff Hagen evaluates the implications of China's growing aerospace capabilities on U.S. influence in the Asia-Pacific region, and suggests a variety of countermeasures, including "increas[ing] the number of air bases and their hardness; solidify[ing] regional basing arrangements; improv[ing] long-range strike capability; increas[ing] operational coordination between the U.S. Air Force and U.S. Navy; continu[ing] modernization of [the] fighter force; [and,] to the greatest extent possible, encourag[ing] Taiwan and other partners to pursue defensive systems that are more survivable and effective against attack." In his concluding chapter, Eric A. McVadon carefully weighs the motivations behind, and implications of, Beijing's aerospace development.

While he is careful to note the substantial areas in which the United States and China share interests and may build on them further, he also emphasizes that the U.S. Navy and fellow services should make substantial, "innovative" preparations to ensure that their forces do not become outmoded. For instance, "the pending development of maritime UAVs such as the land-based broad-area maritime surveillance (BAMS) UAV- and carrier-based unmanned combat air system (UCAS)" can ameliorate the risk to the CSG or other units posed by the MaRVed MRBMs under development by China.

For now, it is hardly controversial to conclude that revolutionary change is under way in the skies above the East Asian littoral. China's space technology prowess, as demonstrated by its 2007 ASAT test and suggested by rapid progress in microsatellite development, poses a major challenge to heavy U.S. reliance on space capabilities. China's growing inventory of strike aircraft is complemented by newly advanced weaponry and ISR capabilities to support those aircraft. The breadth of this effort is demonstrated by Beijing's efforts in the legal arena to establish greater control of the airspace in its EEZ. The potential deployment of ASBMs is most troubling, however, since this weapon has the potential to render surface forces in the region all but obsolete in a single stroke.

At the same time, this balanced assessment acknowledges that certain real limitations continue to hinder China's aspirations in the aerospace domain, especially as they pertain to the maritime strategic balance. For example, Chinese aircraft have to date lacked reliable, indigenously built jet engines. Moreover, it should be noted that certain Chinese advances in aerospace technologies, processes, and systems (e.g., aerial refueling, as it gradually advances; and increasing reliance on such space-based assets as the emerging Compass satellite navigation-positioning system) may also open up new vulnerabilities to adversary countermeasures. Most fundamentally, the point is made by many contributors that China's naval air arm, like Chinese aviation in general, remains the "poor cousin" of Chinese aerospace, and progress has been moderate or even slow in developing key areas (e.g., doctrine for integrated aerospace operations in the maritime domain).

A key finding of this volume and also the December 2008 conference is that the U.S. armed forces as a whole must come to grips with enhanced Chinese long-range precision-strike capabilities that are now coming to fruition and that pose a significant threat to forces in the Western Pacific theater. The development of such capabilities as the ASBM strongly suggest that America's future fleet must reduce its vulnerability to long-range strike, with an emphasis on undersea capabilities as well as unmanned systems in order to preserve survivability in a more challenging threat environ-

ment. Additionally, evolving Chinese aerospace capabilities raise the salience of deterrence initiatives as well as the imperative to develop effective crisis-management mechanisms, not to mention a robust, long-term cooperative engagement strategy. Although American and Chinese aspirations for the twenty-first century are not so different, creativity and determination are nevertheless required to find ways to cooperate in meaningful ways on the seas and in the air and space above them. Indeed, many at the 2008 conference suggested that enhanced military-to-military engagement could reduce the mistrust that might fuel arms racing in the aerospace dimension.

The editors of this volume wish to thank, above all, the researchers who have contributed to it. Here it must be emphasized that all opinions expressed in this book are those of the authors and editors alone and in no way represent the policies or estimates of the U.S. Navy or any other organization of the U.S. government. We also are tremendously grateful to those who helped to organize the December 2008 conference, including especially Dalton Alexander, Leah Averitt, Gigi Davis, Julia Gage, Christina Hartley, Albert Lawton, Jim Lewis, Debbie Maddix, Brian Pagel, and Michael Sherlock. CMSI wishes to thank Raytheon Integrated Defense Systems for its support of the conference through a generous gift to the Naval War College Foundation. Timely and thorough assistance from key members of the Naval War College's Information Resources Department, including Mike Carroll, Neil Davis, Luke Desrochers, Dave Fields, Kerrie Hull, John Neves, and Rodham Smith, was essential to enabling Andrew S. Erickson to edit the manuscript from Seoul, South Korea; as were facilities generously provided there by Major Christopher M. Heber, USAF, and Major Cheree S. Kochen, USAF. The support of Naval War College leadership has been critical to the success of CMSI and in enabling the creation of research products such as the present volume. Finally, we wish to thank Naval Institute Press for its professionalism and dedication in publication of the series "Studies in Chinese Maritime Development," of which this is the fifth volume.

Notes

1. Andrew S. Erickson, "China's Anti-Ship Ballistic Missile (ASBM) Reaches Equivalent of 'Initial Operational Capability' (IOC)—Where It's Going and What it Means," *China Analysis from Original Sources*, 4 January 2011, http://www.andrewerickson.com/2011/01/china%E2%80%99s-anti-ship-ballistic-missile-asbm-reaches-equivalent-of-%E2%80%9Cinitial-operational-capability%E2%80%9D-ioc%E2%80%94where-it%E2%80%99s-going-and-what-it-means/.