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# Seizing the Highest High Ground: China's Aerospace Development and its Larger Implications

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# Seizing the Highest High Ground:
# China's Aerospace Development and its Larger Implications

**Andrew S. Erickson**

## China's Great Leap into Space

"I will gain honor for the People's Liberation Army and the Chinese nation," Lt. Col. Yang Liwei vowed on the morning of October 15, 2003 before boarding the Shenzhou V spacecraft that would take carry him through fourteen orbits around Earth and into history as the first Chinese in space. By the time Yang touched down twenty-one hours later in Inner Mongolia, China was basking in international acclaim as the third nation to launch an astronaut into space. Beijing officials announced sweeping plans to surpass some of the greatest U.S. and Russian achievements of the Space Age. This paper will address three important questions now confronting American policymakers: (1) Can China actually achieve these ambitious goals? (2) What will it mean if it does? And (3) how should America respond?

China's aerospace progress is clearly positioning it to alter the international order. "China is poised to become a true aerospace giant during the 21st century," contends Jane's. "Moreover, China is setting the stage to emerge as a truly global economic and military power by 2030 in direct competition with US, Japanese, and Russian interests."[1] China's aerospace growth is part of a larger technological transformation fueled by dramatically increased spending on research and development.[2]

## Abstract

China's rapid aerospace development excites Beijing's leadership and concerns U.S. policymakers. By contributing to China's overall military development, aerospace increases China's capacity to threaten Taiwan's democracy—and hence to challenge American influence in strategic East Asia. Through aerospace technology sales to Iran and Pakistan, China allegedly has violated the Missile Technology Control Regime (MTCR), a key U.S.-led anti-proliferation initiative.[3]

These events should not be viewed in isolation, but rather as elements of China's overall aerospace development—a potent driver of its national modernization. Aerospace development represents a critical means of increasing a nation's comprehensive national strength. Aspiring great powers therefore compete for mastery of this 'highest high ground,' forging alliances and fomenting challenges in the process. While Washington may object to some of Beijing's methods, it must nevertheless recognize that Beijing is rationally pursuing core national interests through aerospace development, the ultimate arena of great power competition.

Understanding Beijing's aerospace goals and capabilities will elucidate its geopolitical ambitions and ability to realize them. I define aerospace development as the production, integration, and utilization of military and civilian devices both for aviation and for spaceflight. The Chinese equivalent of "aerospace", háng k_ng háng ti_n, literally

"aviation space flight", clearly expresses this dual meaning. Comprehensive aerospace capability entails mastery of both.

But China's aerospace performance has thus far been lopsided. Satellite launch capabilities, a spin-off from Chinese intercontinental ballistic missile (ICBM) development, have indeed captured 10% of the global market share. Missile sales have been similarly successful. China's high demand for all types of aircraft offers opportunities to begin indigenous production at relatively low level of experience and expertise. Yet despite possessing a quarter of the world's commercial airline fleet and the third largest civilian aircraft market, normally self-reliant China has failed in its two half-hearted attempts to enter its own domestic passenger aircraft market: (1) to build a large jet airliner between 1970 and 1985, and (2) to build a regional jet in the late 1990s. Why the drive, and why the difference?

I conclude that Beijing's political goals support a program of technological development based on grand strategic, not on short-term economic, needs. Comprehensive aerospace capability is desired but has not yet been achieved. Aircraft manufacturing has taken a back seat to the more pressing priority of missile development, and thus has received inadequate resources. Not fully tested, aircraft development may yet succeed—given appropriate reforms. Achievement of high-level aircraft manufacturing capacity would solidify China's full-spectrum aerospace capabilities and would thus provide a potent foundation for its development as a great economic and military power. Failure to achieve such capacity—perhaps because of inefficiencies inherent in China's current system—could delay or even undermine its rise.

I recommend that America safeguard its aerospace lead to preserve its preeminent international position by (1) expediting export controls, (2) reconsidering the MTCR, (3) using the prospect of commercial satellite launch as leverage, and (4) improving domestic launch infrastructure.

**Beijing's Technonationalistic Agenda**

"Put politics in command," exhorted Chairman Mao Zedong in 1958. Inculcating China's masses with communist dogma, he believed, would launch a "Great Leap Forward." Mao compared China's potential to that of a uranium atom: "After the fission of the atomic nucleus of our nation, thermal energy will be released which becomes so formidable that we will be able to do what was beyond our capability before."[4]

While Mao's policies brought China closer to meltdown than the positive breakthrough he envisioned, China's new leadership hopes to coordinate a more gradual, but equally dramatic transformation. The latter is fueled not by collective activism but by economic and technological development, under the ideological aegis of 'technonationalism'—the idea that technological strength determines national power in a harshly competitive world.[5] Beijing's methods may be new, but not their motivation: using authoritarianism to transform China into a great power commanding order at home and respect abroad. China's aerospace development is a politically driven initiative to serve this larger goal. As such, it offers a revealing window into the future of China's attempt at centrally directed economic modernization. Even more than most of China's development, aerospace progress will shed light on a critical question: how much further can China advance economically without corresponding political change? Major national projects aside, it may be difficult to move beyond a certain level of technical complexity under the current system.

Chinese space projects enjoy continued priority because they address key national interests: (1) military modernization; (2) economic/technological/communications infrastructure development; (3) environmental/resource management; and (4) international status. “The Chinese government has all along regarded the space industry as an integral part of the state’s comprehensive development strategy,” explains *China’s Space Activities White Paper*. “The aims of China’s space activities are… to meet the growing demands of economic construction, national security, science and technology development and social progress, protect China’s national interests and build up [China’s] comprehensive national strength.”[6] China’s aerospace capability is thus a critical leading indicator. According to *Aviation Week & Space Technology* Senior Editor Craig Covault, China’s “space program initiatives coupled with its young engineers will really pay off in 10-20 years, giving them a powerful space program with international clout.”[7]

Beijing hopes to postpone major geopolitical competition for several decades while it focuses on internal—particularly economic—development. During that time, China’s aerospace development will foreshadow later military and geostrategic capabilities and intentions. Having recognized “that space control provides the key to military victories in modern warfare,”[8] Chinese defense analysts will focus on developing improved methods for “entering space, using space, and controlling space….”[9]

**The Great Power Development Driver**

Beijing’s aerospace focus is normal for a rising great power. All states seek security; potential great powers seek security through aerospace. Countries of significant size, population, and development level naturally compete for great power status: contingent on regional domination, it confers significant security. Regional domination hinges on military superiority, especially capacity to determine the nature of conflict and to deter it before it occurs (e.g. satellite detection of enemy military deployment followed by threats of sanctions if troops were not withdrawn). Military capacity and societal support for governmental grand strategy demand economic growth. Dual use potential of most technology unites military and economic sectors. Therefore, both current and aspiring great powers strive to seize the ‘technological high ground’.

Because great power status is a highly desirable but scarce good, it is strongly contested. Merely winning a specific conflict is insufficient; great power contestants seek to dominate, deter, and ultimately determine the rules of the game, aligning the status quo in their favor (as China’s recent space success strengthens its claim to a seat at future international space negotiations). For an established power, there is always higher ground to seize, always fear of emerging challengers. For a rising power, there is always hope that asymmetric capabilities (ideology, political control, mass mobilization, cheap labor, new technologies, or unconventional tactics) can be wielded to win better standing, with corresponding grand strategic benefits and domestic political gains.

**Geotechnological Maneuvering: The 21$^{st}$ Century Power Politics**

For most of the twentieth century, international politics was dominated by geopolitical maneuvering—competition between the capitalist and communist blocs for the support of non-aligned countries. This century's analogue is geotechnological maneuvering. As Vally Koubi explains, "interstate rivalry, especially among super powers, often takes the form of a race for technological superiority … The emphasis on military technology is bound to become more pronounced in the future as R&D becomes the main arena for interstate competition."[10] Following this geotechnological paradigm, states will continue the realist actions that have promoted their security for centuries, only this time with technological development as the decisive competitive realm.

Some scholars contend that in attempting supranational federation, Europe has transcended the realist paradigm, ushering in a new era of constructivist cooperation. In fact, however, *both* individual European nations *and* their collective organizations follow patterns analogous to those their predecessors followed at the height of European great power competition. (Consider Paris's Gaullist cultivation of Moscow and a Francophone African sphere of influence to balance against U.S. power and leverage interest-based concessions). Technology is no exception. Despite globalization, many firms rely on government support to enhance their competitiveness. (Most nations' intelligence agencies conduct economic espionage. For instance, Paris bugged its aerospace asset Air France to help French businesses).[11]

Brussels has begun federation-based geotechnological maneuvering. As the EU's latest Space Policy White Paper emphasizes, "Space technologies are set to play a key role in helping the Union achieve its main objectives: faster economic growth, job creation and industrial competitiveness, enlargement and cohesion, sustainable development and security and defence."[12] For example, given American development of the Global Positioning System (GPS), Europe had no strictly commercial need to develop its own. But Europe's $3.3 billion[13] observation-satellite project GALILEO has become a technology driver and strategic lever. China recently joined Europe's system (less likely to be manipulated during Taiwan crises), with India and Brazil to follow. Currently unable to develop indigenous systems, their first priority is to balance against reliance on America's. Whereas America has minimized contact with China's defense industry, European Union (EU) nations like France have increased cooperation and seek to lift the Tiananmen-imposed weapons embargo, in part because "China is their most effective counterweight to U.S. hegemony."[14] Such geotechnological posturing is merely a high-technology version of great power balancing.

Nor is technological development a superpower luxury. When it comes to such key national interests, all potential great powers—believing that they can only truly depend on themselves—engage in technonationalist realpolitik. Chinese satellites extend wireless telecommunications infrastructure. Indian reconnaissance helps to reclaim arable land.[15] Via satellite, Brasilia monitors American crops to strategize commodity trade.[16] Brazil "has become the first South American nation to field a fleet of surveillance and intelligence-gathering aircraft that, in addition to monitoring illegal activities and environmental damage, is bringing the government's presence to the most remote area of the Amazon."[17] Despite an August 2003 launch pad explosion that killed twenty-one of its top scientists, Brazil remains determined to master space launch vehicles (SLVs)—"for strategic national purposes."[18] "[W]e cannot expect to be given this kind of advanced, strategic technology by any other country," Space Agency director Sergio Gaudenzi emphasizes. "We have to develop it ourselves."[19]

Brasilia and Beijing have initiated an aerospace development axis to reduce their comparative vulnerabilities. China is exchanging rocket expertise for Brazilian aircraft technology—some originally developed in advanced nations like France and funded by international investors—without exposing its own aerospace sector to Western scrutiny. Already, "[i]n addition to cooperation on complete satellites, China and Brazil are cooperating in the areas of satellite technology, satellite application, and satellite components."[20]

Sino-Brazilian collaboration follows a pattern in which aspiring aerospace powers seek extra-regional development partners to increase their own regional dominance. Emerging U.S.-Indian cooperation may represent the latest manifestation of this geotechnological balancing.[21]

**The Highest High Ground**

Aerospace has represented the international geostrategic high ground since Moscow developed ICBMs, rendering America vulnerable to nuclear attack. This threat was dramatized by Sputnik's launch on October 4, 1957. Future President Lyndon Johnson emphasized: "The Roman Empire controlled the world because it could build roads. Later, when men moved to the sea, the British Empire was dominant because it had ships. Now the Communists have established a foothold in space."[22] Civilians likewise recognized the significance of aerospace success: "An April 1960 poll revealed that a plurality of people in every European nation thought the USSR to be stronger than the US. Only 25% of the British and 7% of the French envisioned Americans emerging victorious in the long run."[23]

Aerospace is 1) critical to military dominance and 2) important to overall technological development. With boundless potential for scientific advance, it promises tremendous military, economic, and political rewards. Aerospace offers established powers unprecedented opportunities to enhance their geopolitical edge. Critical to great power status today, "Space operations and activities utilizing space-based assets have broad implications for national power in peace and war… military operations in space are extensively interrelated with national and political interests, and any action in space, even minor ones, can impact the balance of wealth and power among nations."[24] Growing powers therefore naturally regard aerospace development as critical to achieving great power status, established great powers to maintaining it. Studying a nation's aerospace development therefore offers key insights into its great power ambitions and its capacity to realize them.

Technological advance imposes increasing reliance on specific software, satellites, and systems, offering aspiring great powers unprecedented opportunities to leapfrog technologies and narrow the gap vis-à-vis established competitors by asymmetrically challenging and even attacking 'linchpin' systems. Wireless technology offers China comprehensive telecommunications coverage of mountainous territory without prior landline investment. Increasing reliance on communications satellites makes America "more dependent on space than any other nation."[25] This creates concentrated targets for foreign espionage, and even weapons in wartime. 'Satellite killers' need not be advanced lasers: pebbles released in enemy orbit would likely destroy satellites before they effected countermeasures. So vast are asymmetric attack options that a U.S. government space commission concluded that "The U.S. is an attractive candidate for a 'Space Pearl Harbor'."[26]

Aerospace is even more important to great power status than developing nuclear weapons *per se*. Nuclear weapons lie at the mercy of aerospace capabilities—they cannot provide credible deterrence without effective missile- or aircraft-based delivery systems. American development of new-generation anti-aircraft weapons and even missile defense could make nuclear delivery's aerospace backbone even more important. (That is why Russia and China strongly oppose American missile defense and are developing penetration aids [PENAIDS] to limit its potential effectiveness).

Moreover, aerospace development offers larger economic and technological benefits that narrow nuclear development does not. Nuclear technology transfer cannot serve as a major source of economic development because robust international regimes regulate its weapons component, and environmental concerns limit civilian nuclear power in many developed nations. In sharp contrast, aircraft technology transfer is not directly regulated by international regimes[27] (though China advocates such limitations to ameliorate its comparative long-range bomber deficiency), and missile technology transfer is limited with only partial effectiveness. This disparity in international restrictions exists not because nations capable of coordinating and enforcing international regimes (e.g., America) value nuclear over aerospace technology, but rather because nuclear technology can be specifically defined and thus systematically controlled. By contrast, aerospace technology is so versatile in application that it is difficult to isolate: "95 percent of space technologies are dual use in nature."[28] This versatility thwarts the formulation of specific regulations. Not surprisingly, some potential great powers (e.g. Brazil and Japan) have decided not to develop nuclear weapons (at least for now), but *still* do develop aerospace capabilities.

To the extent that all-out aerospace competition does not currently characterize the international system, it is because no great power is currently capable of directly challenging America. As Vally Koubi explains, for the development of critical, non-preemptive weapons (such as the majority of those in the aerospace field), the typical pattern of competition "involves a great effort to close a technological gap, relative complacency when one has the lead, and an intense race in conditions of parity when the nations are close to developing the weapon."[29] Thus, aerospace competition intensifies when the relative capabilities of major powers come closer together, bringing the hierarchy of the international system into question. Given the stakes involved, a rapid change in one power's relative capabilities will attract the attention of its competitors even if the difference in capabilities is still large.

**Comprehensive National Strength's Leading Indicator**

Conventional wisdom declares aerospace a 'prestige' sector, implying symbol over substance. For *manned* spaceflight, this argument has merit. But *why* is aerospace achievement so prestigious? Precisely because it is an important leading indicator—and even a driver—of comprehensive national strength. In this sense, prestige represents—albeit with some lag effect—an exhaustible reservoir of national credibility.

With the partial exception of telecommunications, aerospace represents not only a key economic driver but also *the* cutting edge in systems design. Because of intense international competition and inherently high performance demands, aerospace requires some of the most advanced technological and engineering work. For China (like any aerospace power), the June 2000 issue of *Xiandai Bingqi* (Modern Weapons) magazine emphasizes, "'developing and testing a manned spacecraft… will raise levels in such areas as computers, space materials, manufacturing technology, electronic equipment, systems integration, and testing as well as being beneficial in the acquisition of experience in developing… important subsystems, all of which are vitally necessary to dual-use military/civilian projects.'"[30] Therefore, Jane's explains, "[t]he establishment of a modern, export-oriented, aerospace industry is an important indicator of the developmental level of a nation's science, technology, economic, and national defence capabilities."[31]

If aerospace prestige did not reflect larger material reality, states would use far cheaper, simpler, more reliable and populist means to achieve political gains. "One thing is certain," explains *Aerospace America*'s Ben Iannotta: "most analysts agree that China is not spending $2 billion a year on its space program just for bragging rights…."[32] As China's Commission of Technology and Industry for National Defense (COSTIND) Minister Liu Jibin emphasizes, "Space development is a reflection of comprehensive national strength."[33] Particularly attuned to this technonationalist measuring stick, Beijing regards aerospace as its most effective overall technology driver and diffusion mechanism.[34] Rather than seeking mere space spectaculars, in recent years Beijing has developed aerospace capability methodically, without overemphasizing manned spaceflight.

Even the most propagandist communist technocracies cannot render the aerospace indicator meaningless by simply 'purchasing' aerospace success. While command economies can achieve some breakthroughs via extensive development, centralization has inherent limitations. The critical test involves the Space Race. While the USSR *initially* achieved aerospace superiority in some areas, socialist centralism ultimately proved no match for America's more flexible, innovative capitalist democracy. Even during the Cold War (when capability was far easier to feign than in today's global economy) Washington and Moscow developed technology very differently. Their ideologies and production processes affected not only immediate aerospace product quality but also cost—and hence sustainability of future development.[35]

The lessons of the Space Race extend far beyond the Cold War. The Space Race provides an excellent example of how modern great powers naturally seek security through aerospace development, giving historical perspective to the initiatives of today's developing aerospace powers, such as China. It was no coincidence that Moscow faced a challenger determined to overturn its dominant aerospace status and reveal its weakness. Any two superpowers would have struggled to demonstrate superior comprehensive national strength by virtue of aerospace achievement. Indeed—while China is far from superpower status—many analysts argue that Beijing's recent aerospace progress forced President Bush to respond in his 2004 State of the Union Address with a bold initiative to send U.S. astronauts back to the moon and eventually to Mars.[36]

**The Quest for Spectrum-Wide Success**

Just as aspiring great powers naturally seek aerospace capacity in general, they also seek capacity across the entire aerospace spectrum: (1) military vs. commercial, and (2) missile/SLV vs. military/commercial aircraft.

In regard to the military/commercial dichotomy, aspiring great powers seek to wield superior aerospace weapons. They also seek to profit from selling cutting edge aerospace products. Differential success in these sectors typically stems from specific failures to develop, transfer, assimilate, or integrate technology, not on conscious decision to develop one but not the other *if* both can be accomplished simultaneously.

In regard to the missile/SLV and military/commercial aircraft dichotomy, aspiring great powers naturally seek to produce *both* of these most significant, tangible aerospace products. Lopsided achievement means military gaps and missed economic opportunities—neither of which support great power status.

A capability gap (e.g. successful development of missiles but not military aircraft) represents critical weakness *and* foregone economic opportunity. In many areas—like satellite launch—security and economic interests overlap. Failure to commercialize dual use aerospace technology suggests not only opportunity cost, but also a national technology development sector improperly structured to promote innovation and diffusion.

As explained earlier, aspiring great powers naturally regard spectrum-wide aerospace success as essential to realizing their ambitions. Puzzles demanding explanation are therefore: (1) Why might a potential great power fail to pursue maximum aerospace success? And (2) Why might a great power aspirant that prioritizes aerospace development fail to achieve spectrum-wide success?

A cursory examination of potential great powers suggests that the first question is easily answered. It is *highly abnormal* for a potential great power to become an aerospace 'underachiever' on purpose. In fact, as Figure 1 indicates (below), Japan is the only exception. I consider the EU a single entity because its aerospace development has consolidated—with other types of integration likely to follow. (While some might argue that Brazil is less powerful than another nation that I have not included, such as Canada, I earlier emphasized that—because of tendency toward balancing—great power status is *contingent on regional domination*. Whereas Canada is constrained by its bordering the world's only superpower, Brazil benefits from its dominant position on a continent of lesser powers. Naturally, Brazil has placed greater emphasis on aerospace.)

**Figure 1: Potential Great Powers' Aerospace Prioritization**

| **Potential great power** | **Does government prioritize aerospace?** | |
|---|---|---|
| | **Yes** | **No** |
| **1. USA** | X | |
| **2. EU** | X | |
| **3. Russia** | X | |
| **4. Japan** | | **X** |
| **5. China** | X | |
| **6. India** | X | |
| **7. Brazil** | X | |

While America and Japan are the most advanced industrial nations economically,[37] Japan's aerospace industry is only 1/15 that of America's[38]—clearly below capability.

Whereas Japan's auto industry is arguably the world leader, Japan's entire aerospace industry together cannot challenge Boeing, the foremost global aerospace corporation with over $50 billion in annual sales. Japan has demonstrated competence in licensed manufacturing and independent development of subsystems and electronics, but its production of launch vehicles and aircraft has long been limited, and recently subject to embarrassing failures.[39] Tokyo's reluctance to prioritize comprehensive aerospace development stems from unique historical circumstances.

The most important factors are catastrophic failure in World War II, which created international, domestic, and constitutional prohibitions on maintaining a normal Japanese military; and the subsequent U.S.-Japan alliance, which established incentives for Japan to develop economically within this restricted context. Even today, Japan's aerospace industry is prisoner to the U.S.-Japan Security Treaty, which constrains technological cooperation with other countries; and to its Constitution, which effectively limits military spending to 1% of GDP. Finally, Japan's small territory (for a potential great power) and path dependent development of cutting edge bullet train technology (while the U.S. occupation still restricted aerospace research) reduced incentives for domestic aircraft production. Japan's domestic airlines carry only 5% of world passengers.[40] But small size aside, had Japan not had its technonationalist development partially severed by defeat in World War II, it would almost certainly be an active aerospace power today. And eventually, when its domestic politics finally transcend its 20th century history, Japan will likely reenter the international competition to master aerospace.

The most interesting aerospace question today is therefore: *how to explain differential aerospace development (DAD) in great power aspirants that prioritize aerospace success?* I define success as sustained production at world-market quality (military products may not be available for sale, but potential buyers still recognize their value). Here a compelling puzzle emerges, as represented in Figure 2:

**Figure 2: Aerospace Aspirants' Differential Development**

| **Aerospace aspirant** | **Missile/SLV success** | **Military/commercial aircraft success** |
|---|---|---|
| **1. USA** | High | High |
| **2. EU** | High | High |
| **3. Russia** | High | High |
| ***5. China*** | **High** | **Low** |
| ***6. India*** | **Moderate** | **Low** |
| ***7. Brazil*** | **Low** | **High** |

This comparison demonstrates that great powers naturally seek full-spectrum aerospace success. The U.S., EU, and Russia—still the most technologically advanced great powers—have all purposely succeeded in both major aerospace subfields. Only China has also demonstrated mastery of all aspects of a comprehensive aerospace industry: (1) production of aircraft and SLV/missiles; and (2) the supporting engineering, materials, and systems.[41] But China's rocket development has far outpaced aircraft manufacturing capacity.

Why have the three developing aerospace powers—China, India, and Brazil—achieved such differing results? Why has China, a great power aspirant long ruled by technonationalists, failed to produce world-class commercial aircraft? How has Brazil, with its smaller technological base, managed to manufacture world-class commercial aircraft but not missile/SLVs?

Conventional wisdom offers no simple answers. Missiles are *not* simply easier to produce than aircraft, making some nations master the first but fail at the second. Brazil has had limited success with space launch, but through private corporation Embraer manufactures high-quality aircraft. Brazil's success is partly a function of government policy. Brasilia has (1) promulgated protectionist legislation effectively restricting foreign aircraft purchases and (2) permitted the private sector to invest heavily in Embraer. Brazil's success suggests that, with the right policies (e.g. market-based reforms), China too could enter the aircraft market; technological level would not be a barrier.

Nor is missile technology based more on physical science and engineering, whereas aircraft involve complex subsystems, making authoritarian regimes foster the former capability but stifle the latter. China does *not* favor missiles over fighter jets simply because the latter are subject to pilot decisions and political defection.[42] Soviet communism, for all its flaws, supported full-spectrum aerospace achievements. More recently, democratic India has had a similar experience to China's missile/SLV success and aircraft underachievement.

China, India, and Brazil merit detailed comparative study beyond the scope of this essay. Too long neglected by analysts, the three emerging aerospace powers' development will have a major impact on the international system. While China is the most advanced of the three, India and Brazil are emerging as regional powers. And studying China's aerospace in the context of India and Brazil's offers valuable clues about which advantages and disadvantages its development is likely to encounter as Beijing evolves politically, potentially in a democratic direction. The China-India comparison in particular will become increasingly salient. For example, the impact of India's recent Bharatiya Janata Party (BJP) to Congress Party transition on military spending and economic priorities will be relevant not only to India's aerospace industry but also to a future Chinese aerospace industry potentially relying on a government that may be more susceptible to populist pressures. India and Brazil offer evidence that democracy can further aerospace development—even if it causes reprioritization of specific programs.

## Explaining China's Differential Aerospace Development

As the most powerful and rapidly developing of the three aerospace aspirants, China is the logical focus of an in-depth case study. Figure 3 (below) offers explanations for China's uneven aerospace achievement.

**Figure 3: Alternative Explanations for China's DAD**

| Explanation | Causal Factor | Expected Result | Actual Result? |
|---|---|---|---|
| **A. Market based** | **Meeting market demand** | **1. Target profitable sector**<br>**2. Establish development regime**<br>**3. Integrate components into** | No |

| | | | |
|---|---|---|---|
| | | **marketable product** | |
| **B. Sector-sequence** | **Path-dependency** | **1. Advance sector-by-sector**<br>**2. Pattern common to other nations** | No |
| **C. Political** | **Grand strategy** | **1. Politics over economics**<br>**2. Response to leadership's domestic and international needs** | ***Yes*** |

**A market-based explanation** would suggest that business factors alone explain differential aerospace development. China's progress in each viable aerospace industry segment would follow a similar pattern. (1) China would select a target sector based on projected market opportunities (especially profitable, capacity starved sectors like satellite launch in the late 1980s and regional jet aircraft in the late 1990s). (2) China would establish a market goal-appropriate technological development regime (domestic, regional, global). (3) China would develop subsystems and components for integration into marketable products.

China's comparative success in viable industries would suggest different technological aptitudes for those respective market segments. Differing aptitudes would presumably explain differential success. If China mastered a profitable market, that achievement could be explained by aptitude. Failure to enter a profitable market would indicate prohibitive incompetence.

**A sector-sequence explanation** would emphasize path-dependency. By this logic, a nation's overall economic level would determine specific sectors' technological levels as part of a process of 'moving up' from lower- to higher-technology sectors. Perhaps some societies have advantages in complex systems integration, with implications for their sector-level attainment.[43]

Considering China's current performance, one might anticipate that aerospace aspirants would tend to develop missiles and other SLVs before developing aircraft. They might experience difficulty 'moving up' into the next market segment. China's aerospace development pattern would mirror that of other technonationalist countries like Japan. Perhaps Japan and China have not become major aircraft producers because of inability to reach appropriate sector-specific technological level.

**A political explanation** would suggest that national leaders support technological development programs based on grand strategic, not on short-term economic, needs. Grand strategy would be constrained and shaped by both (1) external strategic factors in the international system like global market structure and (2) internal factors like bureaucratic and political demands.

Especially in a (partial) command economy like China's, one would predict that strategic sectors' technological development would be politically driven and would fluctuate significantly with political changes (i.e. during the Cultural Revolution, in which even 'systems' were denounced as 'counterrevolutionary'). China would sometimes subvert short-term economic interests to fulfill political goals, including both short-term social stability and long-term national security.

**Eliminating Alternative Explanations**

Global market conditions *have* influenced China's DAD. Fortuitous market conditions assisted China's satellite launch sector entry. Western focus on more sophisticated systems (and consequent problems with the systems themselves) created market opportunity just as demand increased for a low-cost, reliable system. The 1985 *Challenger* explosion, which grounded all space shuttles just when America was planning to rely on them for satellite launch, created an opportunity for China. As in so many sectors, China captured a portion of this market (10%) with competitive pricing. In the aircraft sector, by contrast, any Chinese producer would have to challenge globally dominant firms.[44]

But China's original research and development, which ensured the rocket sector's success, *resulted from* technonationalist objectives. Capabilities were not based on inherent aptitude, but rather on choice of investment. Had China developed viable commercial aircraft, it could likewise have exploited the 1990s regional jet demand. And while over-optimistic payload projections never panned out, China has systematically developed its launch vehicle capabilities. This suggests that temporary market forces may facilitate, but do not dictate, China's strategic national goals.

SLV and aircraft production *do* have important economic differences. Higher market entry costs and barriers currently make aircraft production harder to enter than satellite launch. Aircraft production requires coordination of numerous complex subsystems, large facilities, and economies of scale—sometimes more than for SLVs. Unlike SLVs, aircraft are reusable, necessitating exacting maintenance procedures and parts networks, which require significant time and resources to establish. Given consumer preferences (passenger safety), civilian aircraft production faces additional reliability challenges. Occasional SLV launch failures may not jeopardize market share quite as quickly as civilian aircraft failures would.

But these differences in difficulty stem from differences in product application, not inherent technological challenge. Missiles are typically desired by a single type of user (a government) for single-style and -use missions (base-to-target flight). Aircraft, by contrast, often have a variety of potential users and missions, typically multiple. This complexity often imposes higher reliability requirements, but also allows for frequent tests and adjustments. A technologically capable country may surmount all these challenges if it prioritizes aircraft industry development.

Nations do not necessarily develop rockets and aircraft in specific sequence. Successful market players' varying aerospace histories suggest that, within this capital-intensive, defense-related sector, national prioritization drives development. There is no readily discernible international aerospace sector growth pattern akin to the 'flying geese' model once used to explain Japan and the Asian Tigers' postwar industrial development. Despite its mixed rocket record, Brazil has mastered commercial and even limited military aviation with world-class private corporation Embraer.

The experience of Japan's aerospace industry likewise suggests that there is no single pattern of aerospace development. As in other nations, Japan's aerospace sector growth led to a unique outcome, based on its national interests and assets. Japan's leadership in electronics has facilitated focus on avionics subsystem development and production. It is usually cheaper for Japan to buy aircraft than to produce them indigenously, and Japan lacks the foreign policy priorities to invest in either military or passenger jet production. However, Japan would have significant capacity should it choose to do so. Japan has designed and built aircraft through American and European licenses, some of which turned out better than the originals.[45]

In most aerospace areas, China follows an indigenization process that Japan long pursued (i.e. with satellite manufacturing). Japan initially bought Western devices, but gradually replaced foreign components with ones of local design. Such technology transfer-focused incrementalism is not necessarily evidence of technological ignorance, but rather of recognition that it may be efficient and affordable to invest only in a limited number of new things simultaneously.

Yet Japan and China have used similar technological processes to achieve different goals. China has emphasized launch vehicles but not yet aircraft; Japan has emphasized electronic subsystems but neither rockets nor aircraft. Indeed, while Japan is a world market leader in electronics, its space program has recently suffered failures caused in part by insufficient prioritization and funding. China's incremental aerospace development is thus neither evidence of technical incompetence nor of China's following a similar sectoral development sequence to Japan's.

In particular, sector-sequence analysis cannot explain why China's development process differs so greatly from those of other nations. To the extent that a pattern exists at all, China defies it. Reversing most industrialized nations' sequence, China typically (1) produces under license, (2) reverse engineers products, and (3) conducts advanced R&D to improve the most promising products.[46] Whereas most Western nations 'spin off' military technology into their private sectors, China generally 'spins on' commercial technology into its military sector. In fact,

China is the only country which has decided that, starting from a baseline close to zero in modern terms, its aerospace industry will manufacture everything from [microlight aircraft] to spacecraft, with a goal of internationally recognized and competitive competence…. It is also the only country which has produced large numbers of military aircraft, which even now are regarded as effective in their own right and capable of upgrading, from entirely its own resources of materials and manpower.[47]

**In China, Politics *Are* in Command**

China's post-1949 evolution suggests that political goals best explain DAD. Aerospace is a strategic sector for China: its development is critical to fulfilling Beijing's great power ambitions and represents the cutting edge of larger technological development. Political decisions, not technological capacity, made China begin satellite launch before aircraft manufacturing. Chinese politics over the last few decades has shaped SLV/aircraft DAD. China has indigenized some aerospace areas ahead of others, largely because of policy prioritized resource allocation. Aircraft initiatives are not yet pressing national priorities and hence suffer from inadequate resources, inefficient bureaucracy, and redundant employment.

Early in the Cold War, great power status hinged on atomic development. China devoted much of its limited technical resources to producing nuclear weapons. Beijing's second strategic priority was developing successful ICBMs to credibly deliver warheads, ensuring nuclear deterrence. Thus missile development became China's top aerospace priority, stunting other programs, including aircraft production.

Beijing's relative prioritization of rockets and aircraft was revealed in even starker relief during the Sino-Soviet split, the 'Great Leap Forward' and the 'Cultural Revolution.' The latter two communist debacles exacerbated resource competition by limiting overall scientific, technological, and military development—and by persecuting many of China's best thinkers. While Zhou Enlai's intervention partially insulated missile development, aircraft development suffered greatly.[48] The military importance of aircraft was recognized, but the miniscule resources available and unrealistic goals that further dispersed them devastated actual production.

Consequently, the aircraft industry's organization, and the quality of its products, have remained poor. China has not yet fully developed its aircraft production sector and must still acquire some technology from abroad. Many products that China displays at international aerospace tradeshows contain technology of Soviet origin. In recent years, China has purchased whole systems, such as Boeing/Airbus aircraft, and aircraft engines for even its few indigenous development projects.

By contrast, China's missile production is relatively well organized and capable. It is one of the few 'pockets of excellence' in China's defense industry,[49] the result of great national financial and political commitments since the 1950s. Moreover, it has become a testing ground for new management techniques with potential to revolutionize many areas of China's economy and increase 'pockets of excellence.'

China's joint ventures with Boeing and Airbus in the late 1990s failed for two non-technological reasons. (1) First, China's second major attempt at aircraft production came at a time when the international industry as a whole was under unprecedented competitive and consolidation pressure, largely because of the sudden collapse of Cold War defense spending. (2) Second, China's leading aircraft production conglomerate, Aviation Industries of China (AVIC), has not been properly structured to compete internationally because doing so would necessitate hundreds of layoffs. This suggests that such competition is not yet a pressing national priority for China.

**Aircraft Achievements May Follow**

China's overall development strategy, not insurmountable technological limitations, drives development capacity. The space success and current low aircraft production of the People's Republic of China (PRC) have not been conclusively determined by the two sectors' differing nature. Rather, PRC aircraft manufacturing capacity—not yet fully tested—may ultimately succeed. China does still seek foreign technology to close key gaps in its capabilities. Denial of such technology can still hinder the speed and efficiency of China's aerospace development, but it can no longer arrest major aspects of China's progress. Thanks to growing indigenous capacity and continued aggressive pursuit of foreign technology transfer through multiple sources, no major commercial or military technology is fully unavailable to China. China has the basic competence for all major aspects of aerospace development. Its growing economy and large domestic market would allow it to afford some startup inefficiency if it attempted to develop other strategically important sectors.

An industrializing nation with a large domestic aerospace market, such as China, must either buy a wide variety of services and products from abroad or develop its own. Developing indigenous technology and products appeals to Beijing's self-reliance ethos and appears feasible in the long run, thanks to strong domestic demand. Beijing may eventually be able to use national champion policies to supply flag carrier Air China domestically instead of through Boeing or Airbus, *if* this becomes a strategic priority. For now, however, "The focus of aerospace in China is increasingly on space rather than aircraft. This is because of the diverse payoff China sees from space in high technology, internal and external politics, management reform and the education of its youth."[50] It is also because aircraft constitute a major U.S. export to China, and China derives political benefits from using strategic purchases to reduce its overall trade imbalance with the U.S.

Beijing's investment in aerospace development is beginning to pay off in the form of a motivated, well-trained technical workforce. One of China's greatest assets is "the large number of young, highly and technically educated Chinese now entering the workforce," explains Covault.[51] As former Apollo astronaut Harrison Schmidt emphasizes, "A space agency comprising engineers and technicians in their 20s and managers in their 30s" is essential to create "the critical mass of youthful energy and imagination required for work in deep space."[52] America and Europe's aging aerospace engineering forces face increasing challenges from younger counterparts in China—and also from India and Brazil.

China's new cadre of aerospace engineers has access to all the basic resources needed to continue SLV development now and to build a strong comprehensive aerospace sector in the future. China's rapidly growing economy and positive trade balance offer Beijing resources to continue funding this development. As domestic production of civilian aircraft becomes important enough for Beijing to allocate additional resources, this aerospace sector may finally develop effectively.

Aircraft development *does* remain a long-term priority for China. China hopes to parlay technology transferred through licensed maufacturing into development and production of an indigenous domestic jetliner. In the aircraft production field, as in other areas, China will attempt first to manufacture under license through joint ventures (JVs), but then to take advantage of the resulting technology transfer to reverse engineer aircraft and ultimately—through investment in R&D—to produce its own.

Despite current plans to produce a regional jet through an international consortium, China's *immediate* success in this sector is far from guaranteed: PRC aircraft development has historically been subject to fluctuations in funding and subordinated to other policy priorities. But China has already started to climb the aircraft production ladder. PRC firms supply an increasing number of parts to Boeing and other large aircraft manufacturers: "…amongst all Boeing aircraft in service in the world, 3,100 are equipped with major spares and knockdown parts made in China."[53] As former Grumman Aerospace President Joseph Gavin emphasizes, "subcontracting is also a prerequisite for future sales."[54]

**Politics Will Determine Progress**

*Given* a strengthening economic base and effective government policies, China could extend successful aerospace development into other sub-sectors such as aircraft manufacturing. But can China's aerospace industry effectively parlay its numerous programs and diverse resources into the continuous high-volume, high-quality production needed to support full great power status?[55]

This question has great implications for both China's military and civilian production. The answer will partially depend on Beijing's policy and priorities. Beijing's substantial, sustained resource allocation has already led to significant achievements in the complex, challenging development of missiles and nuclear weapons. But the civilian aircraft industry has fallen prey to a larger pattern in which Beijing emphasizes military over civilian production, and allocates material, institutional, and human resources accordingly. A successful transition from military to commercial production is occurring in its space launch sector; China may eventually accomplish the same success with aircraft production. But becoming a world-class producer of civilian aircraft could take China several decades.

Perhaps even more important to China's economy than its space program's technological spin-offs will be management reforms—normally blocked by ideology and employment policy—considered imperative in priority endeavors with little error margin. However, such organizational progress will stall without commodification of technology that flexibly rewards individual innovation. Such organizational and human capital rationalization must penetrate China's major economic sectors—a far cry from today's restricted expression and exchange of ideas, unenforced intellectual property rights, balkanized research institute archipelago, and bureaucratic barriers.

Clearly, China's aerospace future hinges on its political future. China's aerospace progress will depend on political stability, at least in the form of continued resource allocation and economic development. To a large extent, China's future energy supply will play a role given its relevance to the overall economy. If Beijing maintains enthusiasm for aerospace development, it could realize significant progress and even become a great aerospace power by 2030, third only to America and Europe. Since aerospace development requires strong government support and an effective policy of well-funded yet competitive technological development, China's progress in this area will ultimately be at the mercy of whoever controls Beijing in coming decades. While lower-tech and even telecommunications development—both of which have *direct* commercial applications—could survive decentralization of power in China, high-level aerospace development (dependent on sustained government support) might thereby be severely undermined.

Since China's government appears vulnerable in its current form, its aerospace future will ultimately hinge on achieving a transition to a less authoritarian form of government, one that preserves economic development and technological policy priorities while encouraging increased innovation and free exchange of ideas. Perhaps a gradual 'soft landing' to a more institutionalized and representative but still nationalistic government would be most likely to support a positive future for China's aerospace industry, and hence its great power development.

**Lessons from the Space Race**

As Beijing's leaders have at least partially accepted, in many respects the Space Race was a microcosm of the Cold War. The rapid rise and eventual fall of the Soviet space program mirrored that of the Soviet Union, whose incomplete economic development had been obscured by esoteric technical achievements and American misconceptions. By losing the Space Race, the USSR exposed elements reflecting the lesser capacity and sustainability of its overall system.

The Space Race, and the Cold War superpower competition that inspired it, offers Beijing's still avowedly communist leadership a potent lesson. By overemphasizing military development and adventurism at the expense of necessary economic reforms, the Soviet Union consigned itself to the dustbin of history. According to American Institute of Aeronautics and Astronautics Executive Director Emeritus James Harford "the U.S. shuttle and the SDI program in particular seem to have escalated the USSR into competitive projects [that] surely damaged the already weak Soviet economy."[56]

Burdened with a military-industrial complex that came to consume 25% of GDP yet offered none of the U.S. Apollo program's civilian spin-offs, the USSR's once imposing command economy grew unsustainable. This was a central cause of Soviet failure and ultimate collapse, former Soviet Space Research Institute Director Roald Sagdeev concludes:

Now we know that at the time of the Cuban Missile Crisis the actual ratio of nuclear warheads with ICBM delivery vehicles between the U.S. and the USSR was 17:1. And the most remarkable thing was that was enough to deter the war. The greatest historic irony of the Cold War was that Soviet leaders did not get this message and tried to overarm themselves.[57]

China, by contrast, has thus far been careful not to overextend itself. Thanks to improved intelligence collection techniques and a more integrated international system, any national overextension would be far easier to detect today than it was during the Soviet era, making aerospace bluffs ineffective. Contrary to Cox Report anticipation of a new Cold War with China, Beijing hopes to postpone international geopolitical competition for several decades while it focuses on internal—particularly economic—development. During that time, Chinese aerospace development will foreshadow later military and geostrategic capabilities and assertiveness. It is possible that China could be goaded into some form of arms race, particularly involving Taiwan, but China's more moderate current leadership (as opposed to some older military officials) has carefully studied Moscow's example and hopes to avoid these mistakes.

Unfortunately, Beijing apparently has yet to learn a second Soviet lesson. By winning the Space Race, Washington demonstrated the greater capacity and sustainability of its federal-corporate capitalist democracy. By losing the Space Race, Moscow exposed characteristics reflecting the lesser capacity and sustainability of its communist autarchy: repressive bureaucracy, bureaucratic infighting, resource waste, non-accountability, and nepotism. In geopolitics and in space, the USSR's rapid rise and eventual decline was the product of a command economy that could produce rapid extensive growth, but failed to produce even gradual intensive growth. In short, Soviet communism lacked staying power. China has yet to prove that it can *fully* avoid this problem.

**Socialism May Yet Suffocate Success**

Whatever political challenges American aerospace development may face, it remains on extremely firm footing. By contrast, inefficiencies peculiar to China's 'socialist market economy' threaten its very economic and technological development. Of course, China does not need to become fully competitive in the U.S. market or against the most advanced American weapons to realize significant aerospace progress, but even its more modest goals are threatened by scientific and technological development dilemmas.

China's system itself is the biggest problem. Its leaders still embrace a flawed socialist paradigm, which claims that bureaucratic control and ideological conformity drive technological advances. Most nations have found the opposite to be true. Effective comprehensive reform has not yet been a priority because of its substantial short-term social and military costs. Rather than dismantle the largely obsolete 'Third Line' defense industry, which would eliminate thousands of jobs, Beijing is trying to reform the existing system. But repeated reorganizations are themselves admission that internal reform has thus far proven unsatisfactory. One source of Soviet failure was the practice of pitting design bureaus against one another to limit chief designers' power and to increase production through competition. In practice, neither objective was achieved. Beijing's leaders would do well to consider whether their plans for 'managed competition' in China's defense and strategic technology sectors are likely to transcend all these problems.

An obstacle currently plaguing China is that the over-regimented bureaucratic structure of the General Armament Department (GAD) and Commission on Science, Technology, and Industry for National Defense (COSTIND) hinders the development of an effective spin-on/spin-off process, which has worked well in Western countries.[58] According to aerospace consultant James Oberg,

A major problem for China is that their top-down and tightly-focused space management strategy is extremely brittle, and vulnerable to unpleasant surprises and unpredicted constraints. This is because space technology often cross-fertilizes, in a manner that top level management is usually incapable of foreseeing.[59]

A fundamental problem of the Soviet system was that it neither trusted nor respected many of its most intelligent innovators. China made similar mistakes concerning treatment of its scientists under Mao, especially during the Cultural Revolution. Since Deng Xiaoping implemented the Four Modernizations, however, Beijing has come to prioritize scientific development and respect scientists and their innovations. Still, there is growing disappointment within the scientific community because certain technological areas have been emphasized over basic research. And many Chinese scientists, who regard themselves as public intellectuals responsible for China's future, have been bitterly disappointed by the 1989 Tiananmen Massacre and subsequent lack of political reforms.[60]

In the end, progress in reforming the overall PRC system will set the outer limit for improvements in aerospace production. A basic reform needed for China's further technological progress is commodification of innovation. Technological achievement needs to be rewarded financially on an *individual* basis, and protected by portable copyright with laws that are actually *enforced*. Otherwise China will continue to lose talented individuals to more profitable private sector areas, foreign multinationals, and emigration. And elements of China's sprawling research institution archipelago will continue to jealously guard information and resources while relying on government subsidies or focusing solely on immediately fungible technologies (which are unlikely to improve PRC military capabilities in the short run or to fully provide for China's overall development in the long run).

**Remaining Uncertainties**

In the aerospace sector specifically, two key questions remain for U.S. analysts. (1) First, are the kinds of technologies and design/manufacturing skills that China will need if it hopes to participate in the Revolution in Military Affairs (RMA) more closely associated with the SLV/missile sector or with the development of modern jet aircraft? And, (2) has China invested too much in mastering 'yesterday's' technologies—with negative implications for its potential future military power?[61]

A related question has implications for China's broader economic development. Once the basic research was done for military reasons, has China's success in satellite launching actually been analogous to similar Chinese success with lower-end consumer goods (in which manufacturers learned to produce a basic product, and then competed solely on the basis of low prices)? By contrast, are the problems in aircraft manufacturing analogous to the difficulties that many larger State Owned Enterprises (SOEs) confront in competing in technologically sophisticated and competitive markets (e.g. the automobile industry)? Were this analogy shown to be valid, there would be little reason to believe that more government support for aircraft manufacturing would necessarily solve all problems. In this sense, it would be more appropriate to conclude that while the motivation for the initial emphasis on launch vehicles over aircraft in China was certainly caused by strategic concerns, the commercial success of satellite launching versus aircraft manufacturing involves a great deal of market forces as well.[62]

Either way, the stakes are high. Indeed, China's overall economic development, on which its aerospace development depends, remains in question. China may face economic and industrial vulnerabilities, stemming from larger challenges to China's growth. Threats to China's economy, in turn, could hinge on political risk factors. And China's growing aerospace technology competency could be undermined, stalled, or even reversed by political instability—regardless of what intrinsic benefits political change might bring.

**Chinese Aerospace Success: Larger Geotechnological Implications**

While important political changes such as democratization would strongly influence China's development, they would not necessarily cause political fragmentation or otherwise preclude realization of a 'strong country dream'. Democratization, however it materialized in the Chinese context, might in fact ultimately increase China's economic dynamism and international 'legitimacy'. More likely to slow or limit China's rise in comprehensive national strength are *existing* internal problems exacerbated by its current political system such as environmental degradation, political corruption, and lack of freedom of information and innovation.

What then would be the impact of successful Chinese full-spectrum aerospace development? Certainly it would provide sufficient economic, technological, and military force to catapult China to true great power status. China might then become East Asia's greatest power and project increasing influence abroad, while Chinese citizens enjoyed rising living standards at home.

But even such success on China's part would far from guarantee it status as America's 'peer competitor' or even as an undisputed East Asian hegemon. This is because twenty-first century geotechnological power balancing will tend to follow patterns of conventional geopolitical balancing. China's rise may cause its smaller neighbors to 'bandwagon' in deference to its superior power, but at least three nations—America, Japan, and India—are likely to 'balance' against unprecedented Chinese influence.

Most importantly—while it may decline in comprehensive national strength relative to a proliferation of secondary powers (China, Japan, India, Brazil, Russia and a consolidating Europe)—the United States will remain the world's predominant power for the foreseeable future. America will look to preserve its superpower status by ensuring that no one power can achieve exclusionary dominance in any one region. As it strives to reduce American influence—particularly military presence—in East Asia, China may emerge as America's greatest challenger in this respect. To safeguard its regional interests, America will likely enhance cooperation with two powers of sufficient size both to share America's concerns and also to have capacity to address them: Japan and India.

While largely forgotten by American strategic thinkers distracted by China's rise, Japan remains a force to be reckoned with in East Asia. The worst scenario for America would be a Sino-Japanese condominium leveraging Japan's technology with China's scale, resources, and manufacturing base. But for the foreseeable future Japan is likely to feel threatened by China's economic dynamism, human migration, growing military assertiveness (particularly maritime force strength projection, facilitating competition over resources and disputed islands), and rising nationalism. Lingering historical tensions and preoccupation with internal demographic challenges[63] will dissuade Japan from responding independently.

These factors argue for a strengthened U.S.-Japan alliance that gradually gives Japan a more equal role in military training and technological development. Such a leveraging of Japan's still potent technological base and economic resources would enhance America's aerospace development without aiding a likely adversary. It could involve the development and deployment of missile defense, satellite reconnaissance, and intelligence technologies. U.S.-Japanese cooperation would make it very difficult for China to reconfigure East Asia solely on its own terms.

A more complex and long-term yet equally significant possibility is enhanced U.S. cooperation with India. Democratic, developing, increasingly secular India is a natural American ally, especially given its cultural and strategic differences with China. India has long desired a closer partnership with America. Washington has been less enthusiastic because its need for such cooperation is less urgent, and even complicated by desire for Pakistan to support the Global War on Terror (GWOT). But if the GWOT eventually becomes less pressing and China continues its rise, America's interest in partnership with India may grow accordingly.

China, in turn, would attempt to undermine American balancing by engaging a wide variety of other powers, including Brazil, Pakistan, Iran, and Russia. Brazil could be a useful partner in aerospace development and a political ally in international fora to champion the interests of developing countries—perhaps as part of a future China-led coalition, especially if China democratizes and focuses more on its own domestic inequality. Already China's 2000 *Space Activities White Paper* states that "The cooperation between China and Brazil in the space sector has set a good example for the developing countries in 'South-South Cooperation' in the high-tech field."[64]

In return for Chinese military technology, Pakistan and Iran can offer China strategic space. Pakistan will likely continue to be a useful Indian distraction. Continued Chinese transfer of aerospace and nuclear technology, eagerly accepted by Islamabad, would complicate India's strategic environment. Potential for technological cooperation with Tehran could give China leverage vis-à-vis Washington and access to Iran's rich natural gas reserves. Cooperation with Iran and Pakistan would strengthen China's hand for the 'new great game' over geostrategic Central Asia's vital energy reserves.

Russia's position as a partner of China is more fluid. While in the near term Russia's economic malaise will continue to facilitate military sales—particularly involving aerospace technology—Russia may eventually come to fear China's aerospace (e.g. nuclear delivery) capabilities and their implications for regional influence and commercial competition. Increasing Chinese military assertiveness, and influence in Russia's Far East, may convince Moscow that facilitating Chinese aerospace development has become counterproductive. Meanwhile, East Asian bidding for Siberia's rich energy, forest, and mineral resources will give Russia alternative revenue sources and negotiating leverage. Increasing integration into Europe, which Zbigniew Brzezinski terms "Russia's only real geostrategic option,"[65] may also create new restrictions on assisting China's military. For these reasons, America is likely to promote Russia's European integration. Washington may even develop an energy partnership with Moscow to cultivate strategic ties and increase its political options in Central Asia and the Middle East.

**Conclusion: New Contenders for the Highest High Ground**

Development of comprehensive aerospace capability by sub-state actors could challenge the nation-centric dynamics articulated in this essay. Already a private firm has achieved suborbital space flight. But even the dramatic events of September 11, 2001 have not spelled the death of the nation state—particularly in the fundamental realm of security. For years to come the nation state will continue to represent the international system's organizing principle, with Europe perhaps leading a trend toward selective region-based integration. Likewise, comprehensive aerospace development will remain the province of the nation state. Aerospace is simply too critical to national security, techno-economic development, and geopolitics for nation states to willingly relinquish their monopoly. And requisite investment, industrial bases, economies of scale, and military interaction needed for full-spectrum aerospace development ensure that nation states will preserve their monopoly for some time to come.

For now then, the highest high ground of aerospace will be the goal of Europe and *nations* such as America, Russia, Japan, China, India, and Brazil. The last three nations bear particularly close examination, as they have launched rapid development that will inevitably change the very system that motivated them to initiate it. First among them will be China, whose great potential and many unresolved contradictions make the outcome uncertain and the stakes immense.

**Coping With a Changing China: Policy Recommendations**

Given America and China's tremendous future as great powers and their ideological exceptionalism (America as the democratic capitalist 'City on a Hill', China as the ancient 'Middle Kingdom'), the mere discussion of prospects for Sino-American cooperation and conflict is quickly typecast by third parties as conveying a political message. Some who wish to improve U.S.-China relations therefore seek to create a self-fulfilling prophesy by confining discussion to positive issues and intentions. This is better than the opposite extreme of escalating tensions with reckless rhetoric. But several thousand years of international relations—a study of human nature projected on its largest canvass—reveals the futility, and even the danger, of wishful thinking. After all, democratic capitalism succeeded by emphasizing the worst in people, while communist totalitarianism slaughtered millions by cynically claiming that humans yearned to be improved for their own good. International relations has made progress since the age of Thucydides, but that progress remains restricted by the same selfishness inherent in human nature that he observed.

Acknowledging that all nations have core interests for which they must compete is better than acting as if one's own self-interested actions are inherently virtuous and those of one's competitor illegitimate 'power politics'. Acknowledging that a competitor can be expected to contend for certain objectives conveys a certain enlightenment and respect. Such a realistic approach could constitute a firmer basis for U.S.-China relations, which have suffered from unrealistic expectations and the sense that the respective parties are not fully candid about their true intentions. If moderates on both sides were able to temper their optimistic statements of friendship and respect for China's progress by addressing the entire spectrum of relevant issues no matter how contentious they might be, this would shift power away from hardliners, who derive much of their influence from pointing out zero-sum 'land mines' that moderates have eschewed. Having ignored these threats to core national interests, moderates lack credibility to challenge hardliners' worst-case assumptions.

How then should U.S. policymakers approach China in a world of rapid technological development? In May 1999, Congress released the Cox Report, which alleged that American security had been endangered by (1) PRC nuclear espionage at U.S. national laboratories and (2) illicit technology transfer in conjunction with American satellite launches in China. China has a history of selling both missile technology and complete systems as well as key nuclear technologies to nations like Pakistan which Washington believes might develop and use them in a fashion (1) susceptible to terrorist acquisition and redeployment, (2) dangerously destabilizing, and/or (3) directly harmful to the national security of America and its regional allies. Moreover, Pakistan has re-transferred Chinese nuclear technology to outlaw states such as North Korea that have engaged in state-sponsored terrorism and so pose a grave threat to international security.

Washington cannot—and should not—want to stop China's overall aerospace development, which gives China incentive to continue replacing communist ideology with economic development and to become a responsible status quo power. Now that measures have been taken to secure U.S. national laboratories, Washington should focus on attempting to limit the proliferation of China's advanced nuclear technology and already significant missile technology to third nations of concern.

Technology transfer must be controlled without unnecessarily harming other American interests. A distinction must be drawn between (1) America's most sensitive nuclear weapons secrets—which should not be divulged for any amount of spying or spending—and (2) commercial dual-use exports, upon which American economic security depends. In today's world of rapidly advancing and even more rapidly circulating technology, it is usually in America's interest to keep international technology channels and scientific exchanges as significant and open as possible. Thanks to the unparalleled strength of its private sector, America is better equipped than any other nation to succeed in such an environment. In the post-Cold War era, a winning economic performance typically demands not rigid control of technology, but rather keeping a nation's industries and corporations a few product cycles ahead of their foreign competitors. It is a constant, dynamic process. No national security oriented government agency is currently capable of staying abreast of this process without negatively affecting American corporations.

As history demonstrates, America has a tendency to overestimate its rivals, particularly when they can be placed in the larger context of its moralistic exceptionalism. There is something about American foreign policy consciousness that seeks a mortal, immoral enemy, a foil for America's messianic interventionism. The need for an enemy to replace the vanquished Soviet Union has led some in Washington to select China; and to advance questionable claims concerning China's development, military posture, and capabilities to support that perception. At the same time, there are Americans who defend Beijing's behavior even when it undermines U.S. national interests, or Taiwan's democracy. To these apologists, Washington is always the aggressor, Beijing always the victim. The reality, of course, is far more complicated and rooted in laws of international relations that have not fully evolved despite centuries of human progress. What both sides need to recognize is that America and China will naturally pursue key national interests. This could engender conflict, but it also leaves substantial room for cooperation. America made many costly mistakes during the Cold War; it must not repeat them with China. American ideals are too worthy of defense to promulgate exaggerated claims in their support.

**Policy Recommendations:**

1. **Streamline State Department Export Control Division**

Technology transfer policies should be restructured so that American corporations remain as competitive as possible without compromising national security. For example, the State Department's export control division should be expanded so that it can evaluate dual-use licenses (e.g. for satellite exports) more rapidly and at the same time provide a high degree of scrutiny.

Relevant models include the U.S. Patent Office, which has had to expand operations in response to increased technological advances, and Customs and the Immigration and Naturalization Service (INS), which have had to improve security after September 11, 2001 without unduly burdening American commerce. This would require additional funding, and perhaps hiring additional personnel; but in today's security conscious America, the political will should be there. If $2.5 billion of investment in new equipment alone can make America relatively resistant to postal terrorism, does it not also make sense to improve American control of technology transfer without recreating the economic woes that seized America in the aftermath of the terrorist attacks?

Improving State's export control division would help prevent delays, during which Beijing could choose a non-American supplier. There is no point in "'endless bureaucratic thrashing' over dual-use items that are readily available from companies in other countries."[66] Western Europe and Japan's technological development and general greater willingness to work with China should convince U.S. officials that it is unrealistic to assume that America will *never* risk transferring technology. "This is not a straightforward issue," George Washington University Space Policy Institute's John Logsdon emphasizes. "As the world becomes increasingly global, trying to control technology available from multiple sources is [like] swimming upstream."[67]

2. **Adopt Multilateral Strategy to Control China's Sensitive Technology Access**

Given China's problematic nuclear and missile proliferation, a U.S. anti-proliferation task force should develop a multilateral strategy of restricting China's access to cutting-edge military technology. An effective strategy must address the crucial roles that Israel and Russia currently play. The task force should consider whether preventing the launch of satellites with U.S. content in China has a positive and substantial impact on China's adherence to missile technology transfer limitations established by the Missile Technology Control Regime (MTCR). Proliferation concerns are real, and increasingly relevant after September 11, 2001. But if U.S. allies decline to cooperate vis-à-vis China, there may be little point in banning U.S. satellites launches there. Whereas U.S. satellites will now be more carefully monitored than ever before, it seems doubtful that Europe, Russia, or Israel will maintain such technology barriers. Currently, France and Germany seek to overturn Tiananmen-imposed European restrictions on military sales, which would enable China to obtain currently unavailable advanced weapons.[68]

Although the MTCR is unlikely to be replaced soon with a more effective regime, its contradictions make full U.S.-PRC arms control agreement unlikely. While America would prefer to establish a foolproof linkage between U.S. satellite launch in China and Chinese MTCR compliance, China has already established a linkage between U.S. Taiwan Relations Act compliance and Chinese MTCR defiance. America continues to honor its obligations under the 1979 Taiwan Relations Act by supplying Taipei with defensive weapons.

China's MTCR violations may be a worthwhile price for the realization of more important U.S. objectives such as peaceful resolution of Taiwan's status, or Chinese cooperation in the more important area of nuclear proliferation. America should continue to ensure that the Taiwan question would be resolved only through peaceful means. Meanwhile, America must recognize that Taiwan's status remains a key national security concern for China, one that will engender recalcitrant policies in such areas as MTCR.

Illicit American technology transfer continues to help China. However, Israel—not American firms—is the most significant conduit. Both Israel and Russia transfer significant indigenous military technology and weapons to China. Some technology that Israel has transferred to China originated from America, where taxpayers funded its development.[69] America's economy should not suffer from sanctions imposed on U.S. firms while allies transfer technology to China unhindered. Therefore, Washington should use its strong military and aid relationship with Tel Aviv to encourage cooperation in this area, as it did in 2000 to discourage Israel from selling China a Phalcon AWACS system.

America should also use its improved relationship with Russia to persuade Moscow to transfer fewer high-technology armaments to Beijing. This could be accomplished by (1) inviting Russian firms to bid for non-sensitive NATO contracts and (2) signing long-term Russian oil and natural gas contracts as part of a larger U.S. strategy to reduce dependence on Middle Eastern oil. While Washington would like to see a more open democratic system evolve in Russia—particularly in light of recent crackdowns on opposition media outlets and the Yukos oil company—Moscow is still more aligned with U.S. interests than are most other major fossil fuel suppliers.

More generally, America needs to recognize that missile technology transfer to Beijing and from Beijing to and among third nations of concern is an issue that can only be fully addressed in a multilateral context—such as in an expanded MTCR that embraces a more representative set of member nations and better addresses issues of technological inequality and U.S. commitment to arms control.

America cannot continue to dismiss other nations' aerospace aspirations. Washington should rather attempt to co-opt potential rival aerospace development and technology transfer axes, such as that emerging between China and Brazil. Critical to accomplishing this will be acknowledgement of relevant nations' interests.

3. **Improve Satellite Launch Leverage**

Missile technology transfer concerns could be reduced if America's launch infrastructure were improved to compete more effectively with Chinese and European systems. This would enable America to attempt to use the prospect of launching its satellites in China to influence PRC nuclear and missile technology proliferation.

Launching satellites in China is not an American imperative, and can thus be used as a policy lever. Just as China tries to wield its growing market as leverage against trading partners' promulgation of unfavorable policies, America can also attempt to use China's desire for lucrative infrastructure-developing launch business to encourage greater PRC adherence to MTCR provisions. Unlike arms control negotiations with China, this process can be achieved rapidly and decisively, and will benefit America's economy. By contrast, an ongoing blanket ban on Chinese launches would remove incentive for Beijing to address U.S. concerns even as American allies *directly* supply aerospace technology.

The George W. Bush Administration has utilized launch leverage with some success, but a relatively weak launch market has prevented Washington's resolve from being fully tested. Now is the time to strengthen America's launch infrastructure so that when the market recovers Washington will not waffle and U.S. satellite manufacturers will not be unduly penalized.

**Principal Recommendation:**

4. **Improve U.S. Launch Infrastructure**

The single most promising means of preventing related problems in the future is for America to finally satisfy the Cox Report's recommendation to improve its own launch infrastructure so that more satellites can be profitably launched domestically, furthering both U.S. economic and security interests.

America's hi-tech industries should be strengthened against policy-priced competition. Many in Congress have charged that Japan floods America with 'under-priced' cars; yet few attempt to help America's satellite launch industry compete with state-subsidized counterparts in such non-market economies as China. American policy makers should recognize the need for stronger government investment both in technological development and also in such strategic infrastructure as an effective American satellite launch system. Former aerospace executive Joseph Gavin believes that Congress must face the fact that America "has failed to develop a launcher for satellites that can compete with the Europeans (Ariane) or the Chinese Long March (policy priced to be the cheapest)."[70]

For all America's launch infrastructure problems, it *does* launch satellites far more safely and reliably than does China; America is slower and more expensive largely because it expends proportionally fewer government resources in the process. A willingness in Washington to modestly increase investment in America's launch infrastructure would pay off significantly in terms of *both* U.S. economic and military security. The first Bush administration initially advocated such an upgrade, but later failed to support its implementation. The Clinton administration likewise failed to invest in improving America's commercial launch infrastructure.

The U.S. Congress should now introduce bi-partisan legislation to support the domestic launch sector. According to Florida Congressman Dave Weldon, such legislation should help America to: "…update our eastern and western [satellite launch] ranges located at Cape Canaveral Air Station in Florida and Vandenberg Air Force Base in California. …[to] ensure [funding of *actual*] range upgrades …[to make] ranges more customer-friendly" and "accessible to launch providers. …to help the industry cut through the bureaucracy at the ranges by streamlining processes and… to support the development of the Evolved Expendable Launch Vehicle" (EELV), which could drastically lower domestic launch costs.[71] Effort should be made to maximize pre-launch pad assembly, which would speed turnaround time and minimize delays.

**America's Inefficient Launch Infrastructure Requires Modernization**

Unfortunately, while promised in some form by the Clinton administration, these important improvements have yet to be fully accomplished. Heritage Foundation policy analyst Jack Spencer echoes widespread concerns in stating that "America's declining launch infrastructure" remains "too costly… based on unreliable technology" and hampered by "poor turnaround time."[72] Satellite industry representatives and independent analysts cite Air Force bureaucracy and resulting launch delays as well as the absence of a new, more cost effective American launch vehicle as serious outstanding problems. It is good that America's launch infrastructure has attracted increased government attention, but much remains to be done before American economic and national security interests are safeguarded to the standards recommended by the Cox Report five years ago. To preserve the preeminent position in the world that safeguards its security and national interests, America must put aerospace first.

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