RED SWARM RISING:
THE STRATEGIC THREAT OF CHINESE DRONES

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Executive Summary

Chinese military drone developments are a significant threat to the U.S., and its allies and security partners throughout the Asia-Pacific Region. The Chinese military has moved aggressively in recent years to modernize its drone platforms and incorporate them into their existing military systems—and their military doctrine. China has demonstrated intent to replicate nearly all aspects of U.S. military drone capabilities, including persistent Intelligence, Surveillance and Reconnaissance (ISR); long-range flight (including beyond-line-of-sight operations); precision strike; and stealth. The country is expected to invest more than $10 billion in the next decade to produce over 41,000 land- and sea-based drone platforms. While the Chinese have a long way to go to reach the level of operational proficiency demonstrated by the U.S. military, they have started to use drones in military exercises and are seeking opportunities to employ them operationally. This focus, especially when considered alongside China’s proven, large-scale manufacturing competency, could have meaningful consequences.

The threat is not just limited to the Asia-Pacific Region: Chinese state-owned aerospace and defense companies are indiscriminately seeking customers in an attempt to capture a rapidly growing international market for armed military drones. This proliferation of drone technology will unleash strategic military capabilities worldwide that until recently have been the exclusive domain of the U.S. military and its closest allies. Emerging technology, including swarm intelligence, will challenge U.S. strategic power projection capabilities if the Chinese realize its full potential. The U.S. must take the following six steps to secure its vital interests: 1) increase vigilance of Chinese
developments, 2) safeguard drone technology from theft, 3) develop a comprehensive U.S. drone proliferation policy, 4) establish a moral precedent by being more transparent with the use of its own drones, 5) assert leadership with its regional allies and security partners, and 6) take action to prevent the Chinese from exploiting asymmetric advantages to be gained from emerging drone technology.
Introduction

“Engage people with what they expect; it is what they are able to discern and confirms their projections. It settles them into predictable patterns of response, occupying their minds while you wait for the extraordinary moment—that which they cannot anticipate.” –Sun Tzu

Chinese drones\(^1\) are an underappreciated threat to U.S. power projection capabilities, and emerging technology is poised to significantly challenge traditional U.S. approaches to warfare. China is moving quickly to capitalize on the example the U.S. military has set in recent years with its own military drones.\(^2\) Since the attacks of September 11\(^{th}\), 2001, military drones have become a U.S. weapon of choice in conflicts throughout the Middle East and Africa. Until recently, the U.S. has been an unchallenged world leader in terms of armed drone development, and has been able to shape how the technology has proliferated and been utilized. Yet as technology advances and the advantages of this type of warfare become irresistible, more countries are seeking the capabilities for themselves—including those outside the sphere of U.S. influence and control.

In light of this trend, the U.S. military is facing the chilling prospect of having its own advanced technology and methods used against it. The nation leading the list of threats is China. In recent years, the Chinese military has taken significant steps to modernize its drone platforms and incorporate them into existing systems and military doctrine. China appears intent on replicating nearly every element of the U.S. military drone program and is expected to invest more than $10 billion in the next decade to produce over 41,000 land- and sea-based drone platforms.\(^3\) Equally alarming are indications that Chinese defense
companies are moving quickly to capture the rapidly growing international market for armed drones.

The danger to the U.S. does not end there. Recent innovations in swarm intelligence—complex collective behavior achieved through simple individual actions—may soon asymmetrically threaten the U.S. military’s abilities to project power in the Asia-Pacific Region and beyond. What may have been a science fiction scenario is now poised to become the new reality in warfare: networked military drones fighting in massive, collaborative swarms. The traditional American approach of investing billions of dollars and decades of research and development for a limited number of qualitatively superior platforms may be sorely outdated in the face of a relatively low-tech, low-cost, yet quantitatively overwhelming threat. Advances in hardware and software designs, manufacturing materials, and rapid 3D printing capabilities may decisively alter how nations conceive of and amass military forces. China, with its proven, large-scale manufacturing expertise, could be a natural frontrunner in this new type of arms race and the emerging strategic threat to the U.S. could be considerable.

In light of the rapidly changing military landscape, the U.S. must take steps to preserve its power projection capabilities. America must be vigilant of Chinese developments and safeguard U.S. technology from further Chinese theft so any technological gains in this sphere remain proprietary. The U.S. can assert authority and influence into this new way of warfare by taking a more commanding lead in drone doctrine: it should develop a comprehensive U.S. drone proliferation policy and establish a more transparent moral precedent with the use of its own drones. America must assert leadership with its Asia-Pacific allies and security partners as they procure and employ this
capability so U.S. interests and values remain relevant. Finally, the U.S. must prepare for a potential adversary like China to unleash swarm intelligence on a mass scale.
In response to People’s Liberation Army (PLA) amphibious forces embarking on what appears to be an unescorted, suicide crossing of the Taiwan Strait, a nearby U.S. carrier strike group is directed to disrupt the operation. As the carrier scurries to launch its fleet of F-35 aircraft, the deck crew gradually becomes aware of a thin cloud of what looks to be small birds, or possibly large insects, approaching from the direction of the Chinese mainland. Concerned for the strike group’s safety, the ship’s captain queries his Tactical Action Officer (TAO) about potential enemy activity. “All sectors are clear,” replies the TAO, “our systems are not picking up any activity in the air, surface, or subsurface.” But the captain is not satisfied—something does not seem right. “What about the electromagnetic spectrum?” he asks. “That’s clear too,” comes the reply, “all looks normal.” Still uneasy, he asks the TAO to confirm U.S. assets are jamming China’s satellites, preventing precise ballistic and cruise missile targeting. The answer comes back in the affirmative—“Sir, the Chinese have been denied all use of the space domain.” Although the captain is still confounded by the unusual cloud, he settles back in his chair, comforted by the fact that at least his ships are invisible to the Chinese.

As the cloud envelops the carrier, deck personnel quickly realize it consists of countless miniature drones—and that each one is flashing a faint light in an indiscernible pattern. What the personnel do not know is that the flashing lights are simple codes of the precise coordinates of each ship within the carrier strike group, continually updated and relayed back through multiple strands of swarming drones to targeting officers of China’s Second Artillery Corps. Finally seeing the drones for himself, the TAO orders the laser weapon system crews to shoot down the objects, and they do their best, directing the automated system to target hundreds of the small aircraft in rapid succession. But the countermeasures are not enough—hundreds of thousands of drones remain. Moments later, the ship’s captain sees high above the streaking light from the warhead of a Chinese DF-21D anti-ship ballistic missile hurtling directly towards his position…

A. Chinese Drone Developments

China’s interest in military drones dates back to the 1950s; the country is reported to have first used them operationally for reconnaissance during their 1979 invasion of Vietnam. China initially utilized readily available, commercial technology from the international market to develop their platforms. In 1990s, their programs received a boost with the purchase of the Israeli Harpy anti-radiation drone. However, due to U.S. pressure, this partnership was short lived; likely prompting China to develop its own
programs. The country has made great strides since, especially in recent years: it has developed dozens of small-, medium-, and large-scale platforms for its own use, plus versions intended for export. Additionally, the vast majority of inexpensive, small-scale drones available for commercial and recreational purposes throughout the world (such as hand-held quadricopters) are manufactured in China. In 2014 alone, China’s top commercial drone maker sold more than 400,000 units, to say nothing of the hundreds of thousands, if not millions, of remote-control helicopters and other “drone” type toys China manufactures annually. Such devices may be innocent and are of no significant threat. However, it is clear the country is steeped in resources to draw from in the commercial/manufacturing sphere; China’s capacity to create such quantities may foreshadow strategic challenges to come.

Chinese state-owned aerospace and defense companies involved in the development and manufacture of drones have expanded rapidly in recent years. Aviation Industry Corporation of China (AVIC) and China Aerospace Science and Industry Corporation (CASIC) are notable examples. The size and sophistication of China’s platforms have also notably increased. The U.S. Department of Defense’s 2015 Annual Report to Congress about the Chinese military states, “China is advancing its development and employment of UAVs” and working to extend the range and precision strike abilities of many of its platforms. There are indications China is on the verge of larger advancements. According to the same report, “China plans to produce upwards of 41,800 land- and sea-based unmanned systems, worth about $10.5 billion, between 2014 and 2023”. How and where the Chinese intend to use these platforms may have serious repercussions for the U.S. and its allies and security partners in the Asia-Pacific Region.
It is challenging to assess China’s drone developments based on information available in the Western press. There is a substantial amount of material published—though much incorrect—based on invalid assumptions and mistranslations. For example, a single Chinese platform (or variants of the same platform) is described by several different names, so one platform seems to be many. Much of what is written amounts to little more than speculation based on how platforms appear externally, with unsubstantiated comparisons to U.S. drones. There is a dearth of independent research, and many assessments are drawn from a handful of primary news sources. Chinese defense companies are known to exhibit early drone models to the public. Then, once the military commits to a specific platform, it disappears from public view. The challenge for an outside observer is to determine if the model has vanished due to continued, secret development; or whether it has simply been cancelled. Further, many Chinese drones declared “operational” and offered for sale on the international market are conceptual models companies are seeking funding to produce.

Attempting to sort or understand Chinese drones via a platform-centric, order-of-battle methodology can be a daunting and confusing task, especially when commercial use drones are considered. It is also challenging to categorize Chinese drones to fit within the U.S. military system of tiers or classes. The American military routinely changes their tier systems, and there is little agreement among the different services about how drones should be categorized. A more informative approach is to examine Chinese platforms in terms of their ability to project power strategically. China has demonstrated intent to replicate nearly every aspect of U.S. military drone capabilities; some of their platforms seem to be copies of U.S. drones. In order to project power in significant and strategic
ways, U.S. military drones have evolved capabilities in four critical areas: persistent Intelligence, Surveillance and Reconnaissance (ISR); long-range flight (including beyond-line-of-sight operations); precision strike; and stealth. The Chinese have professed proficiency in all four of these areas with their drones. Three models in particular are worth examining in order to appreciate the progress China has made in recent years: the CH-3 Rainbow, Wing Loong, and Lijian. Although other Chinese drone models have similar specifications, these platforms demonstrate China’s intent to replicate U.S. capabilities.

The CH-3 Rainbow by the China Aerospace Science and Technology Corporation (CASC) operates via line-of-sight and according to CASC’s sales brochure, can be used for “battle zone reconnaissance, artillery fire adjustment, data-link relay, intelligence collection and electronic warfare”. The CH-3 “can be equipped with precision guided weapon [sic] to complete reconnaissance and strike missions”. CASC markets the CH-3 as compatible with the AR-1, which is a short-range, air-to-ground, semi-active laser-guided missile with a “shaped-charged armor-penetrating warhead”. The AR-1 appears indistinguishable from the U.S. AGM-114 Hellfire Missile, which is currently used on the U.S. Air Force’s two well-known drone platforms: the MQ-1 Predator and MQ-9 Reaper. At first glance, the CH-3 appears to be a cross between the U.S. Army’s RQ-7 and the U.S. Marine Corps’ Scan Eagle. All three platforms operate via line-of-sight and are capable of similar missions, though the CH-3 is larger and has longer advertised range and endurance, plus strike capability. CASC offers the CH-3 on the international market, and at least two countries, Nigeria and Pakistan, are reported not only to have purchased the aircraft, but also to be employing it operationally.
The Wing Loong, produced by Chengdu Aircraft Design & Research Institute (CADI), a division of Aviation Industry Corporation of China (AVIC), appears to be an exact copy of the U.S. Air Force's MQ-1 Predator, with one exception: the V-shaped tail planes are mounted up on the Wing Loong vs. down on the Predator. Open-source information indicates both have comparable capabilities, including beyond-line-of-sight operations made possible via space-based communication relays. The similarities may not be coincidental: the U.S. has accused China of stealing plans for some of its most advanced military equipment via cyber hacking. AVIC sales materials assert the platform is capable of durations up to 20 hours, “battlefield intelligence, surveillance and reconnaissance,” and “real-time strike on small time sensitive surface target”. AVIC promotes the Wing Loong to have roughly twice the external payload capacity of the Predator: 440 lbs. It was exhibited at the 2014 International Aviation and Aerospace Exhibition in Zhuhai, China carrying the BA-7 air-to-ground missile, the YZ-212 laser-guided bomb, the YZ-102A anti-personnel bomb, and the LS-6 miniature guided bomb, as well as externally mounted fuel tanks. This platform is currently in service with the People’s Liberation Army Air Force (PLAAF), although information on its operational use is limited. AVIC has marketed the Wing Loong to international customers since at least 2011, and is reported to have sold units to Nigeria, Egypt, and the United Arab Emirates. With a price tag of approximately $1 million, the Wing Loong is a quarter the cost of an MQ-1 Predator. Extensive range, endurance, and beyond-line-of-sight characteristics give it enhanced targeted strike capability over the CH-3.

The Lijian, or Sharp Sword, resembles a flying wing. It is visually similar to U.S. Air Force’s RQ-170 Sentinel and has been compared to the U.S. Navy’s X-47B. The Lijian is
one of a series of low-observable, flying-wing drones purported to be in development by AVIC. Little information is known about the platform, including whether it has become operational or if it carries weapons. China is reported to have first flight-tested the Lijian in November, 2013 after four years of development. A Chinese news source described it as “highly maneuverable and capable of air-to-air combat”. It is speculated China’s engineers were allowed access to the RQ-170 that crashed in Iran in 2011. Reverse engineering may have provided the Chinese valuable information about low-observable technology. The Lijian demonstrates China’s intent to match American low-observable drone characteristics, perhaps with strike capabilities like the CH-3 and Wing Loong.

Although there are many other military and civil drone platforms in development and in use in China, the Rainbow, Wing-Loong, and Lijian illustrate the progress the country has made duplicating key elements of the U.S. military drone program. While they have a long way to go to reach a U.S.-level of operational proficiency, the Chinese have started to use drones in military exercises and are actively seeking opportunities to employ them operationally. It may only be a matter of time before China is able to match the U.S. in terms of capabilities, and its ability to project power via drones. It is crucial America takes note—not only of the gains but also the speed at which they have been accomplished.

B. Chinese Drone Doctrine

U.S. military drones have seen extensive operational use since September 11th, 2001. With some exceptions, the military has been transparent about their capabilities and policy regarding their use. The U.S. publishes an “interconnected framework of doctrine, operating concepts and vision” called the *RPA Vector*, originally released in 2009 and
updated in 2014. The Vector is intended as a “strategic planning document” and “considers the long-term impacts of advanced RPA technologies and concepts and describes key future operating environments and targeted operational capabilities to better focus technology investments.”

A sizable amount of material is publicly available about official Chinese drone programs, as well, though much of the information is platform-centric and speculative about operational use. What remains challenging to discern, at least from a Western perspective, is China's official doctrine and policy regarding drones.

Much of the attention on Chinese drone development centers on the drone, but the aircraft is just the tip of the iceberg of a vast system of hardware, software and communication links. A complete understanding of the country’s capabilities must include an assessment of the ground-control component (e.g., Ground Control Station), communication links between aircraft and ground (terrestrial-based, spaced-based, or both), and how the Chinese analyze and distribute the raw Intelligence, Surveillance and Reconnaissance (ISR) products harvested by the drone’s sensors. The personnel involved in support, control, analysis and distribution are also a factor. Strategic utility of drones also requires a robust analysis, storage and distribution system, like that of the U.S. military’s Distributed Ground Control System (DGCS). While Chinese flying drones are visible and in the press, there is limited information available about these other elements, making an assessment of the entire system—and how it reveals China’s policy on the technology—a challenge.

Because Chinese drone designs appear to mimic America's, it would not be outlandish to assume the Chinese are similarly inspired by U.S. drone doctrine. While there are some indications China intends to use the platform in ways similar to America's—
though tailoring their approach to regional security challenges—there are differences. The Chinese do not seem to be pursuing a robust expeditionary capability with drone fleets. Nor or are there signals they are interested in developing a Remote Split Operations (RSO) capability (i.e., the ability to fly Chinese drones anywhere in the world from ground control stations located in China).

An emphasis of Chinese drone development appears to be on the maritime anti-access/area denial (A2/AD) mission. The Chinese have traditionally relied on a vast network of anti-ship ballistic and cruise missiles to threaten U.S. regional maritime dominance. A critical component of using missiles in this way is a robust and responsive Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) capability. A missile may hit exactly where it is aimed, but will miss the target if the original coordinates are incorrect, or if target movement is not detected and relayed to the missile after launch. Effective targeting requires the derivation of precise coordinates, updated as required and relayed to the missile until impact. It also requires a robust Battle Damage Assessment (BDA) capability: the ability to determine if the intended effects have been achieved, or if further attacks are required. The Chinese have various systems to assist with C4ISR, though they likely assume a potential adversary like the U.S. will do all it can to counter these systems.

A recent publication by the Center for the Study of Chinese Military Affairs (CSCMA) bemoans the limited analysis devoted to Chinese missile capabilities and development programs.36 Even less reporting has been devoted to Chinese military drone developments, especially with regard to how they fit within the A2/AD maritime role. There were indications, however, at the 2014 China International Aviation and Aerospace Exhibition in
Zhuhai: large murals and videos on display clearly depicted Chinese drones joined with more traditional C4ISR methods countering regional maritime threats. Chinese drones were showcased to have utility in all phases of the Find, Fix, Finish, Exploit, Analyze, and Disseminate (F3EAD) targeting process. Videos presented Chinese platforms patrolling the maritime domain and relaying enemy ship coordinates in real-time to assist missile strikes. Drones observed the missiles striking their targets and conducted real-time BDA to assist decision makers in follow-on strikes; some were shown to conduct strikes themselves. Though the murals, pamphlets, and videos were created by Chinese companies marketing their products and do not explicitly convey military doctrine, their messages offer insight into China’s strategic thinking and how drones will be utilized by their biggest customer.

C. Chinese Drone Proliferation

Besides developing a robust drone capability for their military, the Chinese also appear keen to export their designs to customers worldwide. China has a tremendous manufacturing capability: In 2011, China manufactured more than 320 million computers—about 91% of all computers made in the world that year, and 1.1 billion cell phones, about 71% of total worldwide production. This competitive advantage gives China enormous potential to make and export drones throughout the world. Unlike U.S. companies, those that are Chinese state-owned and controlled appear largely unburdened by restrictions about what types of drone technology can be exported. In addition, there seems to be little hesitation to supply any customer—despite political leanings or their stance on human rights. Chinese companies are aggressively marketing drones to almost any country with money. According to a CADI export representative in 2013, the company
has delivered the Wing Loong to three clients (reported to be Nigeria, Egypt, and the United Arab Emirates),\textsuperscript{39} with an additional “five to six nations in Africa and Asia” pondering a future purchase.\textsuperscript{40} Saudi Arabia has also been rumored to be a customer.\textsuperscript{41} It remains to be seen how these nations will use the Wing Loong in operations.

Wreckage recovered by South Korea of at least three crashed drones indicates North Korea flew Chinese SKY-09s south of the demilitarized zone. (The North Koreans deny they violated South Korean airspace)\textsuperscript{42} The SKY-09 is a surveillance drone of limited range, speed and payload capacity produced by Taiyuan Navigation Friend Aviation Technology Co. (NFAT).\textsuperscript{43} It is not known if the North Koreans purchased the platforms with the permission of the Chinese government, or obtained them through black market channels. In contrast to their worldwide marketing push, China banned exporting drones to the North Koreans in September 2013, along with many other dual-use technologies.\textsuperscript{44} It is also possible North Korea stole the plans for the SKY-09 through cyber-espionage.

The North Korean incident may have been a harmless attempt at collection or even harassment, but recent developments involving overt proliferation of weaponized Chinese drones merit examination. To date, only the U.S., U.K. and Israel are reported to have employed weapons from drones in a combat role—but with China’s push for exports, that number seems destined to increase. Two countries, Pakistan and Nigeria, are reported to possess fully operational, strike-capable fleets of Chinese CH-3 Rainbows. Pakistan recently announced it developed its own strike-capable military drone, named the Burraq. Pakistani Prime Minister Nawaz Sharif claimed the Burraq would “add a new dimension to Pakistan’s defenses.”\textsuperscript{45} Photos of about a dozen Burraqs parked in close formation were
released to the press, as well as a video purported to show the aircraft precisely striking a moving target. Sources have suggested the Burraq is in fact an imported Chinese CH-3.\textsuperscript{46}

A targeted strike capability would give the Pakistan an enhanced ability to go after dissidents in difficult-to-control regions of the country, such as the Federally Administered Tribal Areas. Saad Muhammad, a retired Pakistani Army brigadier general, explained the Burraq will make it easier to track down and kill militants: “Pakistan is going to be facing this asymmetrical warfare for years to come. There are areas where the state still does not have complete control and the enemy comes into sight for a very limited time . . . It’s very costly to keep fighter planes in the air even for an hour.”\textsuperscript{47} The Pakistani government has openly complained for years about the alleged U.S. drone targeted-strike program in Pakistan. Now that the Pakistanis have their own capability, it remains to be seen how they will employ their new weapons system.

The world became aware Nigeria was flying weaponized drones when photos of a crashed CH-3 Rainbow in the northeastern state of Borno appeared on social media websites on January 25, 2015.\textsuperscript{48} The drone was equipped with what appears to be a Chinese AR-1 laser-guided missile and a Chinese FT-5, a small-guided bomb designed for drones.\textsuperscript{49} The CH-3 is not the first Chinese drone purchased by the Nigerians. As discussed previously, it has been reported that the Nigerians have purchased the Wing Loong system. Also, an undated photo posted on a social media website in September, 2014 shows what appears to be a small fleet of Chinese M-28 “Honey Bee” helicopter drones parked discreetly behind a Nigerian Super Puma helicopter.\textsuperscript{50} Countries like the U.S. have steadfastly refused to give Nigeria access to advanced military technology out of fear it
might use the weaponry against its own citizens.\textsuperscript{51} From all appearances, Nigeria has turned to China for drone technology instead.

Chinese sales of the Wing Loong, CH-3, and M-28 to Nigeria may have been done in exchange for greater Chinese access to Nigerian oil. Although the U.S. is reported to be using its own drones in an ISR capacity against Boko Haram\textsuperscript{52} and may actually support the Nigerians using the CH-3s to kinetically target the rebels, a successful Nigerian drone strike may signal that the world—militarily, at least—has entered a different era. Cheap and easy worldwide access to targeted drone killing may be a dangerous new reality.

D. Case Study: Chinese Drone Activity in the East China Sea

Perhaps the best way to understand how China perceives and intends to use its drone capabilities is to examine a recent incident in the East China Seas. The Senkaku islands are controlled by Japan, but their claim of sovereignty is contested by China, which asserts the islands have been part of its territory since ancient times. The islands are valuable to both nations because of their undersea oil and gas reserves. The U.S. is also indirectly involved in the dispute, as it has indicated it considers the islands to be under Japanese administrative control, and therefore protected under U.S.-Japanese alliance agreements.\textsuperscript{53} On September 9, 2013, the Japanese reacted to what appeared to be a drone flying near the Senkaku islands. The Japanese Air Self-Defense Force sent combat aircraft to investigate and identified the drone as a Chinese BZK-005.\textsuperscript{54} The Chinese later confirmed the drone had been flying a routine mission near the islands and offered a statement: “China enjoys freedom of overflight in relevant waters . . . The Chinese military will organize similar routine activities in the future.”\textsuperscript{55} Japan responded to the incident by
saying they would shoot down any further drones they encountered over the islands.\textsuperscript{56} China reacted to the Japanese threat by saying they would consider a shoot-down an act of war.\textsuperscript{57}

Nations have used manned aircraft to send political messages ever since the invention of the airplane, but with drones, the stakes seem—on the surface, at least—lower. When drones crash or are shot down, only the platform is lost. There is no potential for a casualty, and the disapproving domestic constituency that follows. There is also no risk of a complicated and politically costly prisoner of war situation to develop, as when Garry Powers became a POW when the U2 he was flying was shot down over the Soviet Union. How might the political situation for the U.S. have changed if the RQ-170 it lost in Iran had contained a pilot who survived the crash and was taken prisoner by the Iranians?

Drones can keep tangible pressure on an adversary in a way cruise and ballistic missiles cannot. Mobile, long-range launchers can be relocated within a country in a threatening manner, and even tested periodically to send statements of capability and intent. Politicians can use rhetoric to hint about long-range strike capabilities, or even overtly threaten strikes. But missiles cannot visibly loiter nearby potential adversaries, or over contested territory, in an unrelenting show of force. Drones can be used to exploit political weaknesses in adversaries by maintaining pressure in a sustained and cost-effective manner. In this way, China can maintain a “presence” over contested territory, such as the Senkaku islands. Yet as “drone diplomacy” continues to mature, nations such as China risk miscalculations and escalation with their casual use.

China will likely continue to fly drones in the Asia-Pacific Region as an instrument of political dialogue. It has been speculated that this incident could signal intent for China to
use drones in a more aggressive manner. As noted in a recent Rand Corporation paper that included a Senkaku/Diaoyu Islands case study: “China’s approach….raises questions regarding the implications for potential Chinese attacks on U.S. UAVs or satellites. For example, would Chinese policymakers view PLA offensive operations against U.S. unmanned assets as likely to elicit a response similar to the threat China issued in this case?”58 It may be anticipated that other countries in the Asia-Pacific Region will use drones in a way comparable to China’s in the Senkaku islands as they develop their own capabilities. It should come as no surprise when Japanese and South Koreans use their newly purchased RQ-4s in similar roles.
PART TWO: EMERGING THREATS TO U.S. STRATEGIC INTERESTS

Kadena Air Base, 2030

A strike package of F-22s recovers from an air superiority mission over the Taiwan Strait to Kadena Air Base in Okinawa, Japan. Meanwhile, a few miles offshore of the air base, a fleet of purpose-built Chinese submarines surfaces and releases hundreds of thousands of drones that quickly swarm over the airfield. The F-22 pilots, anxious to avenge the destroyed carrier strike group, are frustrated that Chinese Chengdu J-20 and Shenyang J-31 fighters were nowhere to be seen over the Strait. The U.S. aircraft were forced to recover after reaching a bingo fuel state without achieving any air-to-air kills or even seeing a single Chinese aircraft. As the first four-ship of F-22s flies up initial over the Kadena airfield, the flight lead suddenly jerks his control stick reflexively in response to what at first appears to be a massive flock of small birds flying at pattern altitude. Each member of the formation successively breaks out of position in a futile attempt to avoid collision with the unidentified objects. All four aircraft crash after suffering from midair collisions along their wing leading edges and cockpit canopies, as well as ingesting multiple drones down their engine intakes. The remaining F-22s, as well as recovering tanker aircraft, are forced to divert to other airfields in the region, significantly disrupting operations.

After it is clear there will be no further recoveries to Kadena, many of the remaining drones robotically redirect their flight vectors toward lucrative airbase targets. Piece by piece the base is methodically destroyed by crashing drones, including the control tower, base operations, command post, radar and air base defense facilities, fuel and munitions storage facilities, as well as the runway and taxiways; plus any remaining aircraft parked on the ramp or in hangars. Some drones continue to loiter overhead, deterring any further use of the airfield. Others land on buildings or trees, preserving energy while recharging their batteries via solar panels. Base rescue efforts are hindered for months...

A. Evolving Drone Technology; Swarm Theory

Drone warfare, led primarily by the U.S. military, has made significant technological progress and operational impact over the last two decades. The attacks of September 11th, 2001 ushered in a new era of drone operations that combined enhanced ISR with precision strike. For the first time, weaponized drones were able to loiter extensively over a target area, providing decision makers with real-time situational awareness and a precision strike option. What began as a single Combat Air Patrol (CAP) over Afghanistan in 2001 has expanded to include at present 65 CAPS throughout North Africa, the Middle East, and
South Asia. What was once theory—that U.S. decision makers could strike with pinpoint accuracy anywhere on the globe with real-time intelligence while not putting any American lives at risk—has now become reality.

The U.S. Navy is poised to present what may be the next big thing in drone technology. Through a series of tests, the service has begun to foreshadow the future of warfare by linking autonomous drones together to perform collaborative missions. The Office of Naval Research (ONR) performed a demonstration on the James River in Virginia in August 2014 that showcased the effectiveness of Unmanned Surface Vessels (USVs) operating in swarm configurations to protect other Navy ships and to employ offensively against hostile vessels. The Navy calls this technology CARACaS, for Control Architecture for Robotic Agent Command and Sensing. CARACaS software is loaded onto a transportable kit and can be installed on almost any ship. In the demonstrations, 13 USVs operated autonomously to protect a Navy ship. When a simulated enemy vessel was detected, the USVs swarmed offensively to neutralize the threat. Chief of Naval Operations, Admiral Jonathan Greenert, explained “[t]his networking unmanned platforms demonstration was a cost-effective way to integrate many small, cheap, and autonomous capabilities that can significantly improve our warfighting advantage.”

Not content to rest on its laurels, in April 2015 the Navy announced it is building a system to launch up to 30 synchronized drones from a single cannon within one minute. The drones will be able to stay airborne for up to 90 minutes, and will perform defensive and offensive roles similar to CARACaS. The Navy refers to the program as Low-Cost UAV Swarming Technology, or LOCUST. While swarming drone demonstrations are not new—YouTube contains hundreds of videos showing small drones swarming together in
cooperative ways—LOCUST reveals an ambitious move by the U.S. military to weaponize swarming technology with the possible intent of one day fielding weapons systems with swarming capability. The Navy plans to demonstrate the LOCUST system next year.

Projects like CARACaS and LOCUST are impressive in their ambition and success thus far, but they do not even begin to scratch the surface of what may one day soon become a new reality in the battlespace. In a study published last year by the Center for a New American Security, Paul Scharre argues that “future military forces will fight as a swarm, with greater coordination, intelligence and speed. Autonomous and uninhabited systems will be networked and cooperative with the ability to autonomously coordinate their actions in response to events on the ground.” Scharre further contends swarm technology could be the solution to the trend of exponentially increasing military costs for fewer and fewer weapons systems. Instead of building increasingly expensive weapons systems like the F-35, Scharre suggests the solution may be for the U.S. to adapt a new paradigm that allows it to take the opposite approach—building mass quantities of sophisticated yet cheaper unmanned and autonomous platforms networked together.

B. Potential Chinese Applications of Swarm Theory

Most of what is being published today on military applications of swarm intelligence is from a U.S. perspective and offers suggestions on transforming theory into practical reality. Less attention is paid to what may happen to traditional U.S. military strengths if adversaries adapt the same technology. Scharre’s work contains a short theoretical section about enemy swarms and countermeasures, but does not offer details about specific adversaries using swarm intelligence against America. Many futurists speculate about the
“what ifs”, but few are applying their concepts to real-world scenarios like security challenges in the Asia-Pacific Region.

The genuine danger of the U.S. lagging behind trends in swarm intelligence is that a potential adversary like China could combine existing swarm technology with their core competency of manufacturing and production to create massive systems that would hinder U.S. power projection capabilities in the Asia-Pacific Region. Such systems would integrate seamlessly with existing Chinese doctrine regarding A2/AD weapons. The Chinese have invested heavily on ballistic and cruise missiles that are designed to overwhelm potential regional adversaries. Few doubt China possesses the capability to significantly punish, if not temporarily defeat, U.S. forces in the Asia-Pacific Region. Building systems of swarming drones could complement Chinese power projection capabilities and make it difficult for the U.S. or its regional allies and security partners to withstand a broader offensive. A fully developed, mass-quantity swarm system, involving air, surface, and sub-surface platforms, could in theory nullify U.S. conventional regional capabilities.

The People’s Liberation Army Air Force (PLAAF) has moved aggressively over the last two decades in a remarkable feat of modernization. According to David Shlapak, a Senior International Policy Analyst for the RAND Corporation, China’s “growing fleet of fourth-generation fighters, stockpiles of advanced air-to-air and air-to-surface weaponry, emerging AEW&C and EW capabilities, and up-to-date surface-to-air defenses represent remarkable advances in technology and capacity since 1995.”65 The Chinese intent and ability to modernize their Air Force has been clearly demonstrated; it should be assumed they are paying attention to developments in practical applications of swarm intelligence in military systems. Mark Stokes, Executive Director for the Project 2049 Institute, argues
China is keen to harness any advantage that technology may offer, as “[t]echnological diffusion constitutes an important driver for Chinese aerospace power”.66 Stokes explains:

If the technological capacity exists, the incentives to develop systems to expand the country’s aerospace power may prove irresistible. As a result, unforeseen breakthroughs in disruptive technologies and so-called trump card capabilities indeed could change strategic calculations in the Asia-Asia-Pacific region and beyond.67

Combining autonomous drone swarms with their existing inventories of cruise and ballistic missiles may be seen by the Chinese as offering a force multiplying effect worth the cost of construction.

Subtle differences between how the Chinese and U.S. perceive concepts of air superiority may offer insights into how the Chinese might develop such systems. The U.S.A.F. considers air superiority an “essential precondition to military operations.”68 Joint Publication 1-02 defines the concept as “that degree of dominance in the air battle by one force that permits the conduct of its operations at a given time and place without prohibitive interference from air and missile threats”.69 The U.S. military has benefited from air superiority for more than 60 years, with the Korean War being the last instance U.S. ground forces were lost to an enemy air force attack.70 Since at least the 1991 Gulf War, however, U.S. forces have enjoyed a much greater control of the air, one of air supremacy, which Joint Publication 1-02 defines as “that degree of air superiority wherein the opposing force is incapable of effective interference within the operational area using air and missile threats.”71 The difference between the two definitions is one of time and space. Air supremacy affords a military continuous authority over the air domain throughout the entire area of operations, whereas air superiority is limited to a specific time and place in order to facilitate the accomplishment of a specific military objective.
The Chinese also consider control of the air an essential precondition to military operations. However, they have evolved different concepts of what may be necessary based on potential threats they have encountered in the Asia-Pacific Region, primarily from the U.S. military. As China seeks to develop a more offensive capability, they must contend with a U.S. military that is accustomed to dominating the skies with complete freedom of action. According to Mark Stokes, “[f]or the PLAAF seeking to integrate more offensive roles and missions, the goal in a conflict is to gain local or limited air superiority, which permits freedom of flight over a limited area for a finite period of time.” Chinese doctrine suggests complete and continuous dominance of the air may not necessarily be an essential prerequisite to successful military operations. Many Chinese scenarios involving offensive action only require localized control of the air for a finite period of time. Once the operational objectives are accomplished, continued air superiority may not be necessary. The Chinese may also see complete denial of airspace to anyone—including their own forces—to be all that is required for the accomplishment of specific military operations. Swarming drone systems could be the key to unlocking this potential and compliment existing Chinese doctrine regarding the use of cruise and ballistic missiles to overwhelm and defeat regional enemy resistance.

The U.S.’s decades-long dominance in air supremacy may have distracted U.S. strategists from recognizing advances in technology, and previously unthinkable new possibilities. Billion-dollar programs such as a new jet fighter or bomber that take years, if not decades, to develop consume tremendous resources across the political, business, and military spheres. Considering the U.S.’s current drone costs and production timelines, the idea of thousands of swarming aircraft on a single mission seems outlandish. But when
advances in drone technology intersect with recent developments in 3D printing capability, the result may well be what Frans Johansson refers to as a breakthrough “Medici Effect.”

There are signs this future world may be rapidly becoming a present day reality. Inspired by children’s pop-up books, scientists at the Harvard Microrobotics Lab have developed a system of printing microdrones by the sheet. The “Mobee” drones are formed flat via a laser cutter, then folded into 3D shapes. By “sandwiching” multiple sheets with moveable folds and adding a power source, the scientists have been able to produce flyable microdrones. Implemented on a large scale, the concept has the potential to significantly reduce the cost and timeline required to produce drones.

Paul Scharre suggests the combination of drone and 3D printing advances could enable countries like the U.S. to field fleets literally consisting of billions of microdrones. He presents a compelling argument that the future reality of such swarming systems no longer depends on further technological advances (i.e., we are already there), but rather on whether this type of program is funded. As the U.S. repeatedly demonstrated throughout the Cold War, and continues to demonstrate with production of weapons systems like the F-35 Joint Strike Fighter, it is willing to invest significant resources to counter perceived threats to its national security. However, the Chinese may be uniquely poised to advance into this sphere faster by combining advanced drone and 3D printing technology with their existing mass production competency. Even if the U.S. is not willing or able to move swiftly into this new era of warfare, it must recognize China may be likely to do so in order to advance their interests in the Asia-Pacific Region and beyond.
PART THREE: RECOMMENDED OBJECTIVES TO SERVE U.S. STRATEGIC INTERESTS

Mainland China, 2030

A B-3 long-range stealth bomber on its operational debut ingresses towards the target area in the night sky over China. The B-3 is the successor of the B-2, produced in secret over fifteen years at a cost of more than $75 billion for 100 aircraft. U.S. forces have been pushed back beyond China’s first island chain in the conflict over the Taiwan Strait. Chinese forces landed under light resistance on Taiwan and have effectively seized control of the island. The U.S. is counting on its cutting-edge, low observable technology to strike back against the Chinese. The B-3’s targets are PLAAF drone-production plants, scattered throughout the country and buried deeply underground. U.S. intelligence sources estimate the drone facilities are capable of producing millions of small drones via 3D printers within a few hours that can be launched directly from the facilities, or transported in mobile, land- or sea-based launchers to operate in cooperative swarms. Chinese aeronautical and software engineers, led by officers of the PLAAF, tweak existing designs and programs in real time to tailor the drones to their mission prior to initiating the print and launch sequence. Drone swarms have significantly challenged the U.S. response to the Chinese invasion of Taiwan.

As the lead B-3 nears the target area, the pilots become aware of what at first appears through their night vision goggles to be small birds whizzing by the aircraft. Suddenly one of the objects collides with the B-3s leading edge, then another, chipping away small pieces of the aircraft’s stealth coating of radar-absorbing material. Moments later the B-3s defensive avionics system comes alive with warnings of acquisition and target-tracking radars, narrowing in on the aircraft’s position...

Introduction

There are steps the U.S. must take to prevent a threat to U.S. power projection capabilities in the Asia-Pacific Region. In a broad sense, the U.S. should be concerned about how the proliferation of Chinese drones may spread strategic level capabilities, which could further challenge the already complicated world order in which the U.S. military is accustomed to operating. The U.S. should also be prepared for the potential application of emerging swarm technology—especially in ways that dangerously threaten existing U.S. methods of warfare. In the current, resource-strained environment, the U.S. must prioritize its responses based on the potential impact of these threats on its national security.
A. Increase Vigilance of Chinese Developments

The U.S. must increase its awareness of how drone technology is evolving and being utilized, both by its allies and security partners, as well as potential adversaries. It would be a mistake to assume other countries will use the technology as America does, or that such capability poses no strategic threat to U.S. interests. The U.S. has made progress in recent years monitoring foreign drone developments. Dedicated units within the U.S. military and intelligence services scrutinize interest in drones, along with worldwide technological developments and operational activities. Research institutions including the RAND Corporation, the Center for a New American Security, and the Project 2049 Institute have published studies on foreign drone activities. In addition, government and private sector studies have increased understanding of how drone technology is rapidly evolving and challenging America’s traditional power projection capabilities. However, much more must be done. Foreign drone programs require far more investigation and emphasis, especially in countries such as China, which may be evolving platforms to thwart U.S. regional interests. Attention and funding on programs that examine more traditional and established foreign power projection capabilities, such as Russian surface-to-air missiles or Chinese ballistic missiles, dwarf that of foreign drone study. To be fair, existing indicators do not suggest drones are poised to take over or make obsolete conventional power projection capabilities in the immediate future. However, by ignoring that China appears to be integrating drones into existing systems and developing targeted strike systems, the U.S. risks underestimating the threat.

Increased emphasis on foreign drone study must include all elements of the programs, not just the airborne platform. Much of the recent effort to examine the
evolution of drone technology suffers from a platform-centric approach that may be distracting U.S. analysts and decision makers from discerning Chinese developments with strategic-level implications. As discussed earlier, a drone flying on an ISR mission is just one part of a much larger machine. ISR drone platforms are harvesters of raw data; significant work must be performed for an intelligence product to be created. The data must be processed into information, which then must be analyzed in order to create useable intelligence products. These products must then be disseminated to decision makers in a timely fashion. Unprocessed data, unanalyzed information, and undistributed intelligence are of no benefit to decision makers.

Even drones capable of strikes, such as the MQ-1 Predator or MQ-9 Reaper, are used primarily for ISR. Much of the attention surrounding these platforms focuses on the precision strike capability made possible by the Hellfire missile system or the GBU-12 Paveway laser guided bomb. These weapons, however, existed long before the U.S. military decided to arm drones. What has made the MQ-1 and MQ-9 so revolutionary has been their ability to combine three elements: First, the ability to broadcast raw products from the aircraft in real-time, anywhere in the world. This is made possible by the Remote Split Operations system, which utilizes a network of terrestrial and space-based communications links. Second, feeding the drone’s harvested ISR data into a robust processing, exploitation, analysis, and distribution system; made possible by the Distributed Common Ground System (DCGS). The third and final element is the drone platform itself and any weapons it may carry. This complex structure has enabled senior U.S. decision makers to maintain an unprecedented level of real-time battle space
awareness and strike control. Focusing exclusively on the airborne platforms, or the weapons onboard, distracts from a genuine appreciation of the total strategic capabilities.

Similarly, understanding the threat posed by Chinese drones requires a review of the entire system. Each element, and how the Chinese may be piecing them together, must be studied: the U.S. must increase efforts to analyze Chinese drone developments and operations, including the weaponization of their platforms. They must stay abreast of developments in Chinese communication capabilities, terrestrial and space-based. For example, Chinese development of a Remote Split Operations capability could signal a significant shift in how they intend to operate their platforms. It is also important to discern how Chinese processing, exploitation, analysis, and distribution capabilities are evolving. America must follow Chinese interest in drone technology, along with any evolutions of their drone employment doctrine. Of vital concern is any indication of interest in practical applications of swarm intelligence, or discussions of how this technology may challenge traditional U.S. military strengths. By increasing efforts to stay informed, the U.S. will be able to monitor and better respond to vulnerabilities to its regional capabilities.

**B. Safeguard U.S. Drone Technology from Foreign Theft**

It has been widely speculated the bulk of cutting-edge Chinese military drone technology being developed and fielded was stolen via cyber hacking or reverse engineered from U.S. platforms that fell into their possession through various means. Whether or not China’s denial is to be believed, protecting its most advanced military technology should be America's highest priority. The growing cyber space encompasses nearly every element of
U.S. society. The U.S. has increased efforts to tighten cyber security controls in light of recent attacks, such as North Korea’s alleged hacking of Sony Pictures Entertainment in November 2014. Yet as its defense capabilities increase, the U.S. must prioritize which elements of the cyber domain are most critical to national security. As Frederick the Great proclaimed, “He who defends everything defends nothing.” With regard to drone technology, the U.S. should consider which programs under development would pose the greatest risk to its own forces if the technology were used against it. How would the balance of power in the Asia-Pacific Region change if the PLAAF duplicated Northrop Grumman’s RQ-180 or BAE Systems’ Taranis on a large scale? Would Chinese power projection capabilities change if the PLAN equipped their Liaoning carrier, or subsequent carriers, with drones similar to Northrop Grumman’s X-47B, which has demonstrated its ability to launch and recover from a carrier, as well as air refuel? How vulnerable are U.S. forces to technology similar to the U.S. Navy’s LOCUST system? Critics may dismiss the LOCUST system as being too small in numbers and limited in range to pose a real threat, but fail to consider the consequences were the Chinese to duplicate it on a mass scale. How capable would U.S. military systems be against hundreds of thousands of drones operating autonomously—so that even if their intra-swarm communications were foiled, they would still carry out individual missions—in a coordinated attack? These are questions the U.S. must ponder as it moves to protect its proprietary technology from falling into China’s hands. The U.S. needs to carefully balance the benefits of revealing such systems to the public in an act of transparency against the disadvantages of serving up blueprints to foreign hackers. Proper protection requires defending against cyber hacks in defense industry systems, as well.
Aside from the cyber domain, America must increase efforts to prevent actual U.S. platforms from falling into the hands of potential adversaries. A U.S. Predator drone is reported to have crashed in Pakistan in September 2011. It remains unknown what happened to the debris but there is speculation the Pakistanis gave China access to the wreckage, similar to how they allowed China access to the U.S. helicopter that crashed during the May, 2011 Abbottabad raid (or so it was reported). Although early variants of the Wing Loong were in production prior to the Predator incident, China’s access to the crashed platform may have proved useful as they completed final phases of the Wing Loong’s operational testing and evaluation—or for the development of follow-on platforms.

The Predator is not the only U.S. drone that has gone missing. The U.S. may have lost an RQ-170 in December of 2011 during what was reported to be a surveillance mission to map suspected Iranian nuclear sites. Iran claims to have produced their own flyable version of the RQ-170, though video footage of the aircraft released by the Iranians reveals it to be a sub-scale mockup. China is reported to have sent experts to Iran soon after the crash in an effort to gather data on the platform, and may have taken parts of the aircraft back home. Losing an aircraft in Iran was a blow to the prestige of the U.S. drone program and a propaganda boom for the Iranians. President Obama explained during a news conference soon after the crash that the U.S. had asked the Iranians to return the RQ-170; a request the Iranians wholeheartedly rejected. The stealth characteristics of the model would be of great value to the Chinese when producing domestic versions of such drones, including the Lijian. Former Vice President Dick Chaney criticized the administration’s actions, saying the president should have ordered an airstrike to destroy the drone after it crashed, in order to prevent the technology from being exploited.
The benefits of flying advanced technology drones over hostile territory must be balanced against the risks of nullifying the technological advantages such platforms provide if they crash. Yet beyond the care and consideration of flying drones over hostile territory, the U.S. can better safeguard drone technology under development. The U.S. has been quite transparent about the existence and capabilities of some of its most advanced technology drones. Each phase of the U.S. Navy’s X-47B testing has been widely reported in the press and has resulted in an advertising bonanza for Northrop Grumman. The U.S. Navy’s LOCUST system has also been thoroughly publicized. Transparency does have advantages, especially in an age of fiscal constraint where services must compete for continued funding for platforms under development. But by broadcasting to the world details of its cutting-edge military advantages, the U.S. may be making it too easy for China and others to assess its capabilities and identify its most valuable technology to steal.

C. Develop a Comprehensive U.S. Drone Proliferation Policy

For years the U.S. has adhered to a strict policy regarding the export of military drones. The U.S. military has demonstrated the decisive role the platform can play on the battlefield, so it is perhaps inevitable other countries seek similar capabilities. Only select nations, such as the United Kingdom, France, and Italy, have been permitted to buy military drones from U.S. companies. Of those countries, only the United Kingdom has been allowed to purchase armed drones. In sharp contrast and as noted above, the Chinese are striving to gain a foothold in the rapidly growing international market for military drones; many countries throughout the Middle East and Africa have already purchased them. China appears to export their drones with a “no-strings-attached policy”—purchasing countries
are free to use drones however they see fit. Forecast International, a market researcher, estimates the 2014 value of production for military drones worldwide to be $942 million. They predict that figure will jump to $2.3 billion by 2023, and also that the Chinese company Aviation Industry Corporation of China will become the world’s biggest producer.

As China plays a more dominant role in supplying the world with drones, the U.S. must closely monitor its exports. Although the current technology and aircraft may not yet pose serious danger, the relationships and dependences that evolve between China and its client nations will keep the door open for future exports that may seriously threaten U.S. interests.

In response to the strong worldwide demand, in February, 2015 the U.S. Department of State announced a new policy for exporting armed drones. While some restrictions were kept in place, the new policy is designed to give a boost to U.S. industry while ensuring exported drones do not threaten U.S. security interests. A fact sheet released by the Department of State describes how “the United States has a responsibility to ensure that sales, transfers, and subsequent use of all U.S.-origin UAS are responsible and consistent with U.S. national security and foreign policy interests, including economic security, as well as with U.S. values and international standards.” The fact sheet lists “stringent conditions on the sale or transfer of military UAS”, including that recipients contract to end-use assurances, monitoring, and agreement to principles for proper use. In addition, drone sales above a certain dollar amount are subject to congressional scrutiny.

The new policy is an attempt to enable U.S. industry to compete on the international market and to influence how drone technology will be proliferated throughout the world.
However, no new sales have been announced since the policy change. Foreign nations considering buying from America may be dissuaded by lengthy approval timelines: U.S. companies are required to petition the government for permission to export before any deal is done. They may also be put off by the fact the U.S. government will retain control over how the drones are employed. Whatever the reason, the lack of response seems to indicate the policy is too restrictive for sales to occur on a timeline and scale that can offset Chinese drone proliferation, and that the U.S. will continue to miss opportunities to influence how the technology will be used.

Instead of eliminating all requirements, akin to the Chinese model, there is perhaps a middle ground the U.S. can exploit as it seeks to assert control over how drone capabilities will spread throughout the world. The nation must develop a more comprehensive, long-term proliferation policy that is responsive to worldwide drone interest. Instead of mandating monitoring and attempting to control how the drones will be used, the U.S. should ease restrictions to longstanding allies and countries with which it has established security relationships. Further, the U.S. must proactively market drones to its strategic partners. The country should recognize the “drone proliferation genie” is out of the bottle, and acknowledge that the existence of militarized drones throughout the world is only a matter of time.

Even if the U.S. eases export restrictions as recommended, Chinese companies can likely offer a better price for drones of apparent, similar quality. What China cannot yet compete with, however, is the practical experience U.S. drone companies possess after nearly two decades of extensive military and civilian drone operations. Defense contractors such as Lockheed Martin and General Atomics have provided holistic drone
services that reach far beyond the platform. Organizations like Insitu, the maker of Scan Eagle, have begun to offer service-oriented sales to potential customers in addition to the platforms. Instead of purchasing and maintaining hardware, customers pay for ISR services provided by Insitu-owned drones flown and maintained by Insitu employees. Potential customers of Chinese drones may not realize the scope of support and operations successful drone missions require. The Nigerian military, with their recent crash of an armed CH-3, appears to be learning the hard way. Instead of creating obstacles, the U.S. government can guide and assist U.S. industry as it seeks customers, and at the same time gain influence and strengthen its alliances. Promoting a service-based approach vs. a la carte drone sales may help safeguard the latest U.S. designs from being copied. The U.S. must review its export policy now to ensure stable and mutually beneficial relationships are formed. It will be too late for the U.S. to exert influence once Chinese companies have established marketplace dominance.

D. Establish a More Transparent Moral Precedent with U.S. Drones

As drone targeted killing capabilities begin to spread throughout the world, many nations will naturally look to the example the U.S. military has set with its own targeted killing programs. The use of U.S. military drones in this role has been one of the most successful methods used against al Qaeda and other terrorist organizations since the attacks of September 11, 2001. The U.S. has justified the use of drones in a targeted killing role by stating that capturing these terrorists is not possible, or attempting to do so would present an undue risk to U.S. personnel. The program has decimated senior enemy leadership. According to the New American Foundation website, since 2004, 2,900 al
 Qaeda, Taliban, Haqqani network, and other jihadist militants have been eliminated by U.S. drones, including more than 50 senior leaders.\textsuperscript{92} Even critics of drones concede they have had a devastating effect on al Qaeda in Pakistan. Audrey Kurth Cronin, in her July/August 2013 \textit{Foreign Affairs} article, “Why Drones Fail” notes that in Pakistan, drones have “cut the number of core al Qaeda members in the tribal areas by about 75\%”.\textsuperscript{93} Drones have emerged as the U.S. weapon of choice as it seeks to defeat al Qaeda and other terrorist organizations in “ungovernable” spaces throughout the world.

Despite relying on the technology so greatly, the U.S. government has revealed little about the drone programs and rarely speaks publicly about their existence. By maintaining secrecy, the U.S. perpetuates the impression it is conducting strikes without regard to international laws governing warfare, as well as those protecting humanitarian and international human rights. A recent exception to this silence is a speech President Obama delivered at National Defense University on May 23, 2013, where he explained his administration’s rational for targeting a U.S. citizen in Yemen. President Obama acknowledged the controversy surrounding the drone strike, and announced he had called on his administration to “review proposals to extend oversight of lethal actions outside of warzones that go beyond its reporting to Congress.”\textsuperscript{94} President Obama reviewed various possibilities for making the targeted killing programs more transparent and subject to review by outside agencies, including the judicial branch or the establishment of an independent oversight board in the executive branch—yet stopped short of announcing any new programs.

The President breached the topic again in April of 2015, when he apologized to the families of an American and Italian citizen inadvertently killed in a strike: “The United
States is a democracy, committed to openness in good times and in bad,” President Obama said. “It is a cruel and bitter truth that in the fog of war generally, and our fight against terrorists specifically, that mistakes, sometimes deadly mistakes, can occur”. A statement released by the White House explained the President “believes it is important to provide the American people with as much information as possible about our counterterrorism operations,” and that the strike had been “lawful and conducted consistent with our counterterrorism policies”. Yet no new revelations about these policies were given, and the executive branch has yet to follow up on its pledge to implement more oversight for such operations.

Because the U.S. is not telling the story, opponents of drone warfare—including jihadists—have exploited the vacuum of information to create a narrative that seems to have taken hold: that the U.S. government makes the rules up as it goes, uses drones to violate sovereignty of uncooperative governments, and haphazardly kills notable numbers of innocent civilians in strikes.

Some critics cite public statements made by Pakistani leaders that the U.S. flies drones into their airspace and kills their citizens as evidence. Yet these detractors fail to understand Pakistan’s military could easily prevent U.S. drones from entering their country—either via withholding permission at the highest levels of government, or by simply shooting them down. As U.S. House of Representative Foreign Affairs Committee member Alan Grayson stated in 2013, “[drone] strikes would not be possible if Pakistan did not facilitate them.” The unspoken truth is U.S. drone activity in Pakistan has helped that nation deal with anti-government militants their own forces have been unable to defeat. There also seems to be an implicit quid pro quo agreement where in exchange for letting
the U.S. use their airspace to go after U.S. targets, America has eliminated militants hostile to the Pakistani government.99 Further, until December 2011, the U.S. is reported to have had a base within Pakistan to maintain, launch, and recover its drones—with the full consent and support of the Pakistani government. An unfortunate border incident in December of that year, involving a clash between Pakistani and U.S. forces, likely resulted in Pakistan directing the U.S. to relocate its base to Afghanistan; yet the drone flights continued uninterrupted into Waziristan.100 Although it is understandable that the Pakistani government would seek plausible deniability for its consent, silence around a cooperative counterterrorism agreement on the part of the U.S. may mean missing an opportunity to influence the storyline—or at the very least, curb misinformation.

Another common argument that remains unchallenged by the U.S. is that for every jihadist a drone kills, ten others pop up in his place.101 These critics argue drones produce an oppressive atmosphere under which the general population cowers because they never know whether the drones circling overhead will strike. As such, the local people—young men in particular—become sympathetic with the jihadists and turn anti-drone or anti-America. Terror groups seize on this idea and bolster it with propaganda of their own: that the aircraft are indiscriminately killing civilians.102

To be fair, the case that drones create more enemies than they kill seems to have some merit,103 bolstered, among other data, by the fact the war has endured (i.e. the lack of progress demonstrates a regenerating enemy). However, Daniel Byman’s article “Why Drones Work” in the July/August 2013 issue of Foreign Affairs magazine notes many public opinion polls are carried out by anti-drone camps, and exclude people unaware of the drone program—therefore biasing results toward those who do not like it. Further, it
raises the point that anti-American sentiment existed in Waziristan long before drone strikes increased during the Obama administration: a 2007 poll found only 15% of respondents held a favorable opinion of the U.S.\textsuperscript{104}

There is also evidence to suggest civilian deaths due to drone strikes are overestimated. Studies reported by Brian Williams in \textit{Predators: The CIA's Drone War on Al Qaeda} indicate the number of civilian deaths has been exaggerated by the Pakistani media, whose stories have been picked up by Western sources. Citing case-by-case studies conducted by the Jamestown Foundation, New American Foundation, and the \textit{Long War Journal}, Williams estimates the civilian death rate is less than six percent.\textsuperscript{105} While not insignificant, these metrics contradict the notion the U.S. is indiscriminate. It is also recognized the number of collateral deaths in drone warfare is far lower than if these missions were carried out with traditional manned platforms.\textsuperscript{106}

The U.S. might quiet some anti-American propaganda and guide the future, worldwide use of drones by being more open about the benefits and methods of the drone warfare it conducts. By shying away from a more public discussion around drone programs, the U.S. misses an opportunity to establish limits and guidelines that allies, as well as potential adversaries, must recognize (if not follow) when utilizing such technology. The Obama administration should strike a middle ground where the oversight and benefits of the program are revealed while the technology, tactics and partners remain proprietary. America seems to be focused on short-term tactical benefits of its drone targeted killing programs, while ignoring the potential strategic consequences of nations like China and their clients imitating what they perceive to be a lawless program. Now is the time for the U.S. to demonstrate an ethical model for the world to follow.
E. Assert Leadership with Asia-Pacific Allies and Security Partners

The U.S. might recognize the ability of drones to contribute to military missions in new and innovative ways in regions that have not traditionally benefited from their capabilities. To date, there has been limited U.S. drone presence in the Asia-Pacific Region. RQ-4 Global Hawks have been stationed at Anderson Air Force Base since 2010 and Yokota Air Base since 2014. Despite this initial foothold, USPACOM interest in drones has been tepid; perhaps based on recent assessments of some U.S.A.F. leaders that drones are too vulnerable to survive in a contested, degraded environment. For example, while commander of Air Combat Command in 2013, General Mike Hostage publicly stated, “Predators and Reapers are useless in contested environments.”107 Critics of drone use in the Asia-Pacific Region may further contend that the area is too vast, with severe and unpredictable weather patterns, as well as congested civilian air traffic. Yet U.S. drones have overcome similar challenges in the CENTOM AOR where platforms as well as tactics, techniques and procedures (TTPs) have evolved to mitigate risks of extreme range, unpredictable weather, and congested airspace. USPACOM has instead appeared to focus on preparing for worst-case, full-scale war with potential Asia-Pacific adversaries, such as China. Anything that does not have utility in this doomsday scenario seems to have been dismissed by USPACOM leadership. Doing so may have caused the command to overlook the potential benefit of some U.S. drone systems in the region, especially in the current peacetime environment, or in possible limited scale conflicts.

In contrast to America’s apparent misgivings about the value of drones in the Asia-Pacific, its regional allies and security partners have expressed great interest in procuring
the platform for their own militaries. Both Japan and Korea have announced intentions to purchase Global Hawks from the U.S. The necessity for U.S. allies to maintain awareness throughout the Asia-Pacific Region, especially over contested areas, has increased significantly in recent years. Japan is concerned about Chinese activities in the Senkaku Islands and appreciates the real-time situational awareness such systems can provide. Although the Global Hawk is vulnerable because of its dependence on space-based communication links and does not have the ability to defend itself, it will likely prove very useful in monitoring areas of Japanese interest. South Korean Global Hawks will likely prove invaluable for monitoring North Korean military activities, potentially including nuclear weapons developments. The RQ-4 is a low-risk, low-cost option for these missions. Other regional security partners, such as Taiwan and Australia, have expressed interest in procuring their own systems. Australia recently announced a plan to send pilots to train on the MQ-9 system in New Mexico, and is rumored to be considering the purchase of eight units for use by the Royal Australian Air Force.

The U.S. must be prepared for its Asia-Pacific allies and security partners to use American procured drones in a manner that fits with their own perceptions of the security challenges they face. For example, it would not be unexpected if the Japanese begin flying the Global Hawk over contested areas in a manner similar to what the Chinese have done with their drones. Will the Chinese respond with similar “act of war” rhetoric if a Japanese drone is spotted in the area? How will the Chinese respond if the Philippines, Vietnam, Taiwan, Malaysia or Brunei begin flying drones over Chinese reclamation projects in contested areas of the Spratly Islands? Will they consider their newly constructed airfield under threat and see the incursion as an attack? How will North Koreans react if
South Korean drones are suspected to be flying north of the demilitarized zone? There is even potential for blue-on-blue drone activity over the Liancourt Rocks, a group of islands in the Sea of Japan whose ownership is disputed between Japan and South Korea.

By not asserting leadership now over questions of this kind, the U.S. risks facilitating escalations when its allies and security partners employ American made drones in careless or tactically near-sighted ways.

Regional allies and security partners are looking to the U.S. for technological and doctrinal guidance as they seek to develop their own capabilities. There currently resides limited drone expertise at the U.S. military staff level, to include USPACOM. Allies interested in learning about drone capabilities have been dispatched to operational bases such as Creech AFB in Nevada, or Beale AFB in California, where American personnel are overstressed flying tactical missions and have limited resources to advise. Further, tactical leaders at U.S. bases are not ideally suited to mentor Asia-Pacific nations about their specific challenges. America must take a strategic and assertive approach when guiding allies and partners, and consider the international context when doing so. Even if the U.S. elects not to expand its drone presence in the Asia-Pacific Region, it will be missing an opportunity by not recognizing the growing demand throughout the region and assertively partnering with its allies. Global Hawk deployments to Japan offer an opportunity to partner with the Japanese as they learn to successfully navigate such systems.

The U.S. has much to gain from its allies as they begin to employ drones. America expanded its own understanding of the potential of the MQ-9 system after the British purchased it and began flying it alongside the U.S.A.F. Royal Air Force leadership participates in daily operational debriefings with U.S.A.F. leadership, and over the years a
symbiotic relationship of trust has developed. The U.S. must nurture similar relationships with the Japanese and South Koreans, as these regional allies will likely develop new and innovative ways of employing the RQ-4 system. Similar to the British, they will bring their own strategic culture and employ the drones in perhaps unexpected ways. USPACOM leadership must realize this potential benefit and work proactively for these partnerships to develop.

F. Recognize and Prepare for the Threat of Swarm Intelligence

In addition to near-term, practical steps the U.S. can take to counter the threat of Chinese drones in the Asia-Pacific Region and beyond, U.S. policymakers must prepare for the possible consequences of China exploiting military applications of swarm intelligence and other new technologies. Although there are no indications the Chinese are moving quickly to harness this potential, the U.S. should pay special attention to any signs China is interested in aligning such technology with its existing drone programs or prodigious manufacturing capacity. America must also recognize swarm intelligence may expose vulnerabilities to its military systems and preferred methods of warfare. The U.S. emerged victorious from the Cold War in part because of a strategic decision to counter the Soviet military's quantitative superiority by developing and fielding its own qualitatively superior military equipment. Shortly after the collapse of the U.S.S.R., the world witnessed the culmination of this strategy as a technologically superior U.S. military devastated Saddam Hussein's Soviet-equipped force. U.S. preference for qualitative superiority has continued unabated ever since, although the approach may be creating strategic vulnerabilities that will jeopardize the U.S. military's ability to protect core U.S. interests. These fissures are
due to several factors including exponentially rising military equipment costs, the increasingly restrained fiscal environment, and the worldwide proliferation of military technology that was once the exclusive domain of the U.S. and its allies. U.S. policy makers should recognize how a continued reliance on fewer-but-better platforms may be exploited by a rising power like China.

The F-35 is the latest iteration of the U.S. preference for technologically superior multi-role platforms designed to defeat any potential enemy across a wide spectrum of possible future battle spaces. According to Paul Scharre in *Robotics on the Battlefield Part II: The Coming Swarm*, the continued cycle of rising costs and shrinking quantities has created a “major strategic liability”. Scharre argues that “[t]he current trend of attempting to compensate for ever-shrinking numbers of capital assets through increasingly exquisite systems is not sustainable”. Technological advances, including swarm intelligence, may render platforms like the F-35 vulnerable to overwhelming attacks of quantitative superiority. U.S.A.F. Chief of Staff General Mark Welsh has succinctly said that “[w]hen a fifth-generation fighter meets a fourth-generation fighter —[the latter] dies”. But what happens when a fifth-generation fighter meets a first-generation swarm of hundreds of thousands of readily manufactured drones, honed to evolve and instantaneously exploit discovered weaknesses within the fighters? The result is unknown, but the U.S. cannot afford to ignore this highly disruptive threat to its traditional approaches to air superiority. At a minimum, America must study the potential vulnerabilities to existing military equipment and war strategies to swarm technology.

As resources become more constrained and prices for advanced technology continue to rise, the U.S. needs to consider a new strategic approach. Besides
understanding how potential adversaries may exploit emerging swarm abilities, the U.S. should consider embracing the technology for its own purposes. Any proposed shift in the current strategic defense construct, however, must take into account ongoing investments, a service culture reluctant to change, and bureaucratic entrenchment. Instead of threatening traditional systems or causing defense spending to rise higher, the technology will need to be developed in cost-effective ways that supplement established equipment and strategies. While a radical redirection may not be politically, fiscally, or militarily feasible, the U.S. should search for ways to shift dependence away from prohibitively expensive manned platforms that take years or decades to manufacture.

One solution is to create hybrid systems consisting of manned and unmanned platforms. Such an approach would combine existing, multi-role manned systems of qualitative superiority with affordable, single-mission unmanned platforms of mass quantity. The entire system could be networked together and capable of collaborative missions. The U.S. should consider developing drones to serve as wingmen to aircraft like the F-22 and F-35. The drones could be designed to supplement air superiority or ground attack missions, allowing the irreplaceable manned assets to be preserved behind a wall of expendable drones. The drones could also serve as what Scharre describes as “missile trucks”, supplementing the combat aircraft’s limited carrying capacity. These hybrid systems may be an important first step in the eventual creation of fully unmanned and autonomous swarm systems. Integrating drones more thoroughly with manned platforms will also serve to educate military leaders of the untapped potential of the new technology, paving the way for further integration. Mass quantity swarms of inexpensively manufactured and expendable drones may ultimately prove to be the only way to protect
against adversaries employing similar systems. The U.S. military must explore ways to phase in this new technology if it intends to remain dominant in future warfare.

America should also pay attention to how technological advances in 3D printing may reveal new approaches to fielding a credible and responsive air force. Instead of relying on lengthy and expensive production timelines, the U.S. could develop printing operations that create a force in real time, specifically designed to counter the threat at hand. The system could consist of ready drone designs that are updated and tailored, and loaded with the latest algorithms prior to employment to ensure their survivability and lethality against enemy platforms. Expanding upon the tactical details of how such systems could work is beyond the scope of this paper. Rather, the discussion is to draw attention to the possibility that military applications of swarm intelligence and mass quantity 3D printing may eventually be the best chance for the U.S. to retain its dominance.

As the U.S. begins to embrace such an approach, however, it must take care to understand the unique limitations and vulnerabilities of swarm systems and swarm warfare. With no human physically in the platform, drones can fall prey to spoofing, cyber hacking, and jammed communication links. Drones that rely on space-based communication relays to operate beyond-line-sight can be defeated temporarily or permanently through kinetic and non-kinetic means. As new command and control systems necessarily evolve, military leaders must retain an appropriate degree of human oversight to prevent rapid conflict escalation as swarm systems automatically respond to threats or opportunities (the U.S. must also mentor allies who implement similar systems to ensure safeguards are in place). However, allowing drone systems a degree of autonomy, where humans do not control their every action, is necessary to unleash their
tremendous potential: machines can respond faster. Exploiting the true potential of such systems will require a paradigm shift where complete control may need to be relaxed in order to gain speed and lethality. Advances in artificial intelligence may be the crucial link that enables the best of both man and machine in this realm.\textsuperscript{119} By continuing to lead the world in terms of exploiting the full potential of drone warfare, the U.S. can stay ahead of countries like China who are poised to exploit its benefits.

**Conclusion**

Drone technological developments and doctrinal evolutions will rapidly change the way nations conceive of, procure, and employ air power. China, among other nations, has shown a strong interest in not only developing and utilizing drones, but also marketing them to international players. Even now, their use of the technology is altering the playing field, as shown in the East China Sea. The convergence of China’s manufacturing abilities, advances in swarm theory and 3-D printing, and the country’s demonstrated interest in drones may lead to a threat that could overwhelm current U.S. forces. However, if America takes steps to increase oversight of Chinese advances and shield its own cutting-edge technology from theft, the country can buy time to fortify its vulnerabilities. In the meantime, policy makers in Washington can help to establish worldwide standards around drone warfare that can influence their future use. America can also be more transparent about ongoing drone operations to dispel myths that can be damaging both domestically and abroad. By engaging and guiding allies and strategic partners on their own use of the platform, America can retain a leadership position while strengthening partnerships and refining tactics via the proliferation of best practices. To prepare for the likelihood of
swarms entering the battlefield, the U.S. must reevaluate the way it conceives of its own military might and consider investments in platforms and systems that are less expensive, faster to make, and more nimble. While these recommendations may be difficult to follow considering the cultural, bureaucratic, and systemic challenges; the U.S. would be wise to take note of the real threats on the horizon. A swarm is coming.

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1 This paper uses the more commonly accepted term “drone” vs. “Remotely Piloted Aircraft” (RPA), which is the U.S.A.F’s preferred nomenclature. The U.S.A.F takes exception to the fact that the term “drone” implies that no human pilot is controlling the platform. However, the press has largely accepted the term “drone”, and as Richard Whittle argues in Predator: The Secret Origins of the Drone Revolution, the definition has effectively evolved along with the platform and should now be embraced. Even the Commander-in Chief, President Obama, tends to use the word “drone” when speaking about them publicly, and did so during his speech on drones at National Defense University in 2013 (although he acknowledged that the military refers to them as RPAs).

2 Chinese drone developments are not just limited to aircraft. The country has also stepped up research and production of Unmanned Undersea Vehicles (UUVs) and Unmanned Surface Vessels (USVs). The strategic threat of Chinese maritime drones is in many ways similar to the threat of aerial drones, although examining these systems is beyond the scope of this paper.


4 The scholarly paper credited with the term “Swarm Intelligence” is “From Swarm Intelligence to Swarm Robotics” by Gerardo Beni in 2004. Available at <http://www.researchgate.net/profile/Gerardo_Beni/publication/221116455_From_Swarm_Intelligence_to_Swarm_Robotics/links/0912f51324c3bd5fd2000000.pdf> (Accessed May 13, 2015).


Hsu, p. 3.

Bodeen.


Office of the Secretary of Defense, p. 36.

Ibid.

For example, the Wing Loong is also referred to as the Yilong, the Pterodactyl, the Wu-Zhuang Wu-Ren-Ji, and the Gong-Ji Wu-Ren-Ji.

The USAF has outlined many of its Remotely Piloted Aircraft capabilities in USAF RPA Vector, published in 2014.

While researching this paper, I attended the 2014 International Aviation and Aerospace Exhibition in Zhuhai, Guangdong, China. Many Chinese people I spoke with at the exhibition were very open and even enthusiastic about how China has successfully copied U.S. military aircraft. The J-31 was referred to as “China’s F-35”, The Wing Loong as “China’s Predator”, and the Y-20 as “China’s C-17”. While it may be understandable that people may have used such language to help an American visitor understand Chinese aircraft, many people exhibited unmistakable national pride in their country’s ability to duplicate cutting-edge U.S. military equipment. The Chinese government has denied that it stole F-35 blueprints via cyber hacking in order to create the J-31, but the aircraft is—at least externally—almost an exact match to the F-35. The Wing Loong closely matches the MQ-1 (although the tail planes are mounted up vs. down). The Y-20 flew in an aerial demonstration at the airshow, and until it landed I assumed it was the U.S.A.F. C-17 (which was also present at the airshow). The Chinese “Sharp Sword” stealth drone (not present at Zhuhai in 2014) bears an uncanny resemblance to the RQ-170 sentinel.

U.S. military drones operate via line-of-site as well as through space-based communication links, allowing for what the USAF has termed “remote split operations”: the ability to fly drones anywhere on the planet from anywhere on the planet.


Sales brochures and other advertisements must be reviewed skeptically—even U.S. drone companies tend to overestimate their platforms’ abilities when marketing to prospective customers. I quote from Chinese sales materials to offer a perspective on how Chinese drones are being marketed to international customers.
The National Engineering and Scientific Commission (NESCOM) in Pakistan claims to have developed the Burraq indigenously, although it appears to be an exact copy of CASC’s CH-3.

“Wing Loong”, also referred to as the “Yilong”, translates to “Dragon’s Wing”. There are four variants of the Wing Loong, including the Pterosaur I, the Pterodactyl I, the WJ-1 and GJ-1.

The upward facing tail planes on the Wing Loong have caused it to be mistakenly compared to General Atomics’ MQ-9—which is significantly more advanced than the MQ-1.


AVIC Wing Loong sales brochure, Zhuhai Airshow, November 2014.


Headquarters, United States Air Force, p. iv.


Videos displayed at the Zhuhai Exhibition were predominately in English, suggesting that the aviation companies were marketing their products to an international audience vs. showcasing them for the local Chinese attendees.


44 Ibid.

45 Ibid.


47 Ibid.


51 Lin.


58 Chase, p. 5.


61 Ibid.


64 Ibid., p. 44.


66 Ibid, p. 36.

67 Ibid.


71 Joint Publication 1-02, p. 10.

72 Hallion, p. 37.


75 Scharre, p. 20.

76 Scharre, p. 20.
This assertion is based on my personal experiences as an MQ-1 and MQ-9 pilot.


98 Byman, p. 38.
101 Mazzetti, p. 6.
103 Ibid., p. 158.
104 Byman, p. 39.
110 Although known internationally as the Liancourt Rocks, they are referred to as Dokdo in South Korea, and Takeshima in Japan.
112 This assessment is based on my personal experience at Creech AFB from 2010-2014. Base leadership routinely hosts representatives from other nations who are intent on learning about drone operations.
113 Recent scholarship by Paul Scharre from the Center for a New American Security has explored this topic thoroughly. Although most of Scharre’s Robotics on the Battlefield Part II: The Coming Swarm is theoretical and does not focus on specific potential adversaries like China, many of the recommendations in this section have been influenced by his work.
114 Scharre, p. 13.
115 Scharre, p. 6.
116 Scharre, p. 6.
118 Scharre, p. 15.