"Flying Shark" Gaining Altitude: Will the J-15 Improve China's Maritime Air Warfare Ability?

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General Chen Bingde, Chief of Staff of the People's Liberation Army (PLA), has just been quoted as confirming that a Chinese "aircraft carrier is under construction now." According to *Global Times*, "This is the first time the PLA has officially acknowledged the existence of a Chinese aircraft carrier."[i] General Chen is likely referring to a future indigenously constructed Chinese aircraft carrier, which U.S. government sources have projected will be operational sometime after 2015. As U.S. Department of Defense projected in 2010: "Analysts in and out of government project that China will not have an operational, domestically produced carrier and associated ships before 2015. However, changes in China's shipbuilding capability and degree of foreign assistance to the program could alter those projections."[ii] Meanwhile, however, China is already preparing the refitted ski jump carrier *Varyag*, purchased from Ukraine in 1998 and brought to Dalian Shipyard in 2002, to go to sea.

Given these developments, it is time to analyze the first carrier-based aircraft that China will employ: the new J-15 "Flying Shark" carrier-based heavy fighter-bomber. Pictures of the J-15 have been appearing for almost two years and a video of it flying has been on YouTube for about a year,[iii] so the sudden surge of attention to the aircraft likely comes because *Varyag* (renamed "*Shilang*," according to some Chinese sources) could begin sea trials as early as this summer. (Chinese Internet sources frequently mention 1 July 2011 as a potential date, though a knowledgeable Chinese expert with whom one of the authors has spoken cautions that the exact date is impossible to predict given the uncertainties inherent in systems development and integration).

As currently configured and supported, the J-15 is no "great leap forward," but is nevertheless triggering concern among regional nations because it indicates rapid improvement in Chinese naval aviation and suggests Chinese determination to supplement current anti-access/area denial (A2/AD) approaches by developing some form of regional blue water presence beyond the First Island Chain. (This demarcation, envisioned by Chinese strategists such as former PLA Navy/PLAN commander Admiral Liu Huaqing, extends through Japan, Taiwan, the Philippines, and Malaysia, and encompasses the three "Near Seas": Yellow, East China, and South China. They regard it as both a "benchmark" of PLAN progress and a "barrier" fortified with foreign military facilities.) The J-15's initial role will be linked to, and limited by, its first operational platform: a "starter carrier" to project a bit of power, confer prestige on a rising great power, and master basic procedures.

What's happening now?

On 24 April 2011, Chinese Internet sources posted new photos of a J-15 sitting outside a hangar at the airfield of the No. 112 Factory of Shenyang Aircraft Corporation (SAC). First assembled at SAC in 2008, J-15 prototypes reportedly made their maiden flight on 31 August 2009 and their first takeoff from a land-based simulated ski jump on 6 May 2010 at China Flight Test Establishment (CFTE), Yanliang Air Base, Shaanxi Province.[iv]

The J-15, which has an airframe closely resembling that of the Russian Su-33, boasts more advanced, indigenously made avionics, including a wide-angle holographic Heads-Up Display (HUD);[v] as well as more complex trailing-edge double-slotted flaps.[vi] Small canard foreplanes and enlarged folding wings enhance low-speed handling. A

shortened tailcone helps to avoid tail-strike during high angle of attack (AoA) landing. An arresting hook helps shorten landing distance, and strengthened landing gear with twin nose wheels helps absorb impact. The J-15 is likely to have similar avionics, radar, and weapons capabilities to the land-based J-11B, which itself emulates the Su-27SK, albeit with improvements in precisely these areas, as well as to the airframe. The airframe changes might include structural reinforcements to support arrested landings in the tailhook, wing/body attachments, and wing/weapon pylon attachment areas.

The lack of a second seat for a Naval Flight Officer (NFO) to operate the avionics and radar suite in the images of the J-15 currently available on Chinese websites suggests that the PLA believes its electronics suite is sufficiently integrated and automated to require only one person to operate all the plane's functions, including navigation and targeting. This is normal practice for carrier aircraft: most U.S. Navy F/A-18s are single seat, as are most Russian Su-27s and derivatives. Modern weapons systems are highly automated and can be operated well by a single pilot. Two seats are used primarily in order to operate in bad weather at low altitudes and when the systems cannot be as automated, as in the EA-18 Growler electronic warfare airplane. The J-15 is single seat because a) this is normal for carrier aircraft, and b) a crewed aircraft would give up too much performance at takeoff from the ski jump.

China's push to refurbish "*Shilang*" could potentially reunite the basic Su-33 airframe with the ski jump carrier from which it was originally designed to fly. PLAN Aviation has reportedly conducted a test flight on land using a ski jump. Google Earth and Internet photos suggest that the cities of Huludao and Xi'an have ski jump runway-style pilot training facilities, with two sets of arresting gear also present at Huludao. This ski jump approach, while it may help launch China into the deck aviation field, will limit significantly whatever performance parameters the J-15 achieves.

What it means

The J-15's emergence offers potential capabilities that are noteworthy because China is starting from such a low baseline in naval aviation that virtually any progress could make a big difference. It means that when the J-15 becomes operational (potentially by 2014), PLAN Aviation will have a carrier-based airframe with relatively advanced sensors and electronics, the maneuverability to be a credible close-in fighter, and even the potential range and payload to be a serious strike platform for use against maritime and terrestrial targets—*if* China develops its naval aerial refueling capabilities significantly. The J-15 has a retractable refueling probe that is likely derived from that of the Su-30MKK, but overall this is an area in which China has yet to demonstrate notable progress. For now, it would seem to be dependent on land-based tankers as launch of tankers (or buddy-to-buddy refueling, which adds significant weight, making ski jump-launching difficult of not impossible) would have to rely on shore-based tankers until China develops or acquires catapults.

As for potential mission applications, the J-15 is a large aircraft and likely has a normal takeoff weight in the 25 tonne range, which is roughly similar to that of America's now-retired F-14 *Tomcat*. It remains to be seen precisely what capabilities the J-15's avionics suite possesses, but if they can support a ground attack mission (the tricky part might be targeting radar with land and ocean seek/guidance modes), the J-15 will have two primary uses in a future Chinese carrier group, with a third role of providing air cover as necessary during future operations to protect and/or evacuate Chinese citizens threatened by violence in Africa and other regions.

If properly equipped, supported, and employed—and these are significant "ifs"—the J-15 could affect the regional military balance substantially, as it likely exceeds or matches the aerodynamic capabilities of virtually all fighter aircraft currently operated by regional militaries, with the exception of the U.S. F-22 Raptor. If China is able to eventually employ an effective indigenous active electronically scanned array (AESA) radar in the J-15, it could potentially come close to approximating the electronic capabilities of the F/A-18 E/F *Super Hornet*, the U.S. Navy's primary strike fighter. AESA radars offer stealth and high jamming-resistance and the potential ability to track and engage cruise missiles such as the Tomahawk; they could possibly be used in electronic countermeasures (ECM) applications as well. While too many variables remain at this time to determine precisely how the J-15 will contribute to China's "system of systems" of military capabilities, its very existence suggests for the first time the possibility of China developing serious maritime aviation capabilities—a prospect that would have regional implications. In fact, there is already a substantial likelihood that the J-15's existence will prompt China's maritime neighbors to purchase

additional late-generation fighter aircraft.

One concrete example of a fighter program that the J-15 could influence is the F-35B, which currently faces possible cancellation or cuts. The F-35B's short takeoff and vertical landing (STOVL) capabilities would make it the only aircraft that the Japan Maritime Self-Defense Force (JMSDF) would be able to operate off of its *Hyuga*-class helicopter destroyers. As early as the late 1980s, parts of the JMSDF have sought to incorporate fighters into their destroyer operations as a way to enhance defense against bombers and anti-ship cruise missile (ASCMs).[vii] Rising perceptions of threats from carrier-based Chinese J-15s could sharpen Japanese interest in acquiring a meaningful number of F-35Bs.

The F-35B's attractiveness is enhanced by the fact that with its STOVL characteristics, it would also be deployable in case of a first strike on Japanese/U.S. airbases on Okinawa, or other areas such as Guam, that led to damaging or loss of runways. As such, planners could use the F-35B as the core of a "centralized battle-management, decentralized air asset staging" concept that could help counter the risk that the PLA's growing, highly accurate ballistic missile arsenal poses to airfields in the region. The question would be the range of Okinawa or Guam from the area of operations as the F-35B in STOVL mode suffers from the same kind of limitations that the J-15 would suffer when operating from a ski jump.

Possible J-15 missions

While the Flying Shark's capabilities remain uncertain, its potential is significant. If deployed effectively, it could offer China new options for combat air patrol (CAP) and maritime strike.

Long-range CAP. The Sukhoi *Flanker*/J-11/J-15 basic design features high internal fuel capacity and allows for a substantial operational radius, given the Su-27's genesis as a Soviet long-range interceptor with a roughly 10 tonne internal fuel load. Even with the reduction in fuel and weapons loadout imposed by a ski jump launch, it is reasonable to assume that a J-15's combat radius could extend as far as 700 km from the carrier, particularly if the buddy tanking capability is included, which can add more than 300 km of operational radius, according to Carlo Kopp of *Airpower Australia*. (This would be provided by a buddy pod, an external store generally containing a hose and drogue system that allows one aircraft to transfer fuel to another). The J-15 will likely be able to carry China's PL-12 air-to-air missile, adding an additional 100km to its reach out range. Currently, China's longest-range maritime air cover in blue water situations comes from the 200 km-range HHQ-9 naval surface to air missile.

When the J-15 is deployed, it could help push potential foes much further away from a Chinese carrier given that the range of most potential opponents' air-launched anti-ship weapons is 300km or less. Organic fighter cover would be vital for maritime security missions located far enough from land to preclude land-based air support. Chinese fighters would likely be at a significant numerical disadvantage in any confrontations involving the U.S. Navy, but J-15s armed with the PL-12 air-to-air missile, which has similar performance parameters to the Russian R-77 and US AIM-120A Advanced Medium-Range Air-to-Air Missile (AMRAAM), would nonetheless have to be taken very seriously by potential opponents. In a close-in fight, the J-15, which likely has a 10% better thrust-to-weight ratio and 25% lower wing loading than the F/A-18 *Super Hornet* (the mainstay U.S. Navy fighter for a long time to come), could be a dangerous foe. More powerful versions of the indigenous WS-10 turbofan engine, as China is able to develop them, would improve the J-15's aerodynamic performance.

***Maritime strike/anti-ship missions*.** If armed and able to launch successfully with the Kh-31 supersonic anti-ship missile or the indigenous YJ-82 supersonic ASCM, carrier-based J-15s could credibly hold surface platforms within 500 km of the Chinese carrier group at risk. We base this assessment on the 200+ km range of the air-launched YJ-83 ASCM, which could give PLAN aviators in J-15s the ability to trade fuel for weapons in a weight-restricted ski jump takeoff scenario. This would add an additional threat dimension for which fleet commanders would have to account. Existing Chinese surface combatants and submarines launching late-model ASCMs like the *Klub* pose a very serious threat to surface vessels, but they take much longer to move into firing positions and thus can be more easily accounted for by planners and air defense personnel (though submarines might be difficult to detect if operated quietly).

Whereas a *Kilo*-class diesel submarine or future nuclear attack submarine (e.g., Type 095) or a Type 054 frigate could require hours to close to ASCM firing range with a surface ship several hundred km from a Chinese carrier group, a J-15 strike package could cover the distance in minutes, giving Chinese commanders much greater tactical flexibility. China's growing space-based intelligence, surveillance, and reconnaissance (ISR) capabilities will help facilitate the J-15's maritime strike potential.

One creative way in which the PLA might attempt maximize the impact of deck aviation in a regional conflict would be to "lily pad" by launching a number of fully loaded J-15s from coastal airbases, aerially refuel them within the protective envelope of land- and carrier-based fighter aircraft, and subsequently use the carrier(s) for airplane recovery after the first-strike mission with a full weapons loadout. The carrier(s) could then potentially generate successive, more lightly-loaded sorties from their ski-jumps. The aircraft might then refuel just enough to get back within tanking range from home base. The U.S. did a form of this in the 1973 Yom Kippur War, ferrying A-4 *Skyhawk*s to Israel via a series of carriers in the Atlantic and Mediterranean.

At longer ranges the strike package would be subject to significant tradeoffs, possibly limited by the need to designate some aircraft as buddy tankers and the need for retaining fighters for CAP, lest the carrier be left open to air attack. J-15s on an anti-ship mission would also be vulnerable to attack by opposing fighters if operating against U.S. forces.

Ski jump carriers: no great leap forward

Regardless of the J-15's specific capabilities, however, it is likely to be limited severely by the deck aviation platform from which it operates. For the foreseeable future, this would seem to be a ski jump, as seen on the ex-*Varyag*. As a former carrier aviator at the U.S. Naval War College emphasizes, a ski jump design imposes significant restrictions; such carriers have very limited operational capability. Using a ski-jump does not allow an aircraft to approach maximum take-off weight, and even then it requires maximum thrust to keep it in the air at less than 100 mph when it hits the end of the jump. The only aircraft that can use a ski jump effectively is a high thrust-to-weight jet like the Su-33, and then without much load. Ski jump launch cannot produce sufficient lift to allow full gross weight takeoffs. Vertical and/or short take-off and landing (V/STOL) jets like the *Harrier* or F-35B obtain benefit from a ski jump, which lets them carry more load that if they took off vertically or using a straight deck. But China currently lacks V/STOL capabilities.

One of the great operational limitations of a ski jump carrier is that it must depend on helicopters to provide the essential capability of airborne early warning (AEW). Compounding matters, helicopters are one of the PLAN's greatest areas of weakness; its fleet remains extremely small and underdeveloped. It appears that the PLAN may employ Ka-31 AEW helicopters imported from Russia until it can develop an adequate indigenous platform, perhaps based on the Z-8. As long as the PLAN operates ski jump carriers, therefore, it is unclear how much the air group on the carrier will contribute to the overall ISR picture, since ISR aircraft are typically underpowered relative to their weight and sophisticated versions would have difficulty launching via ski jump.

A Chinese carrier likely will not be launching anything but J-15s, because a plane with near 1:1 thrust to weight ratio is required to do anything but fall after leaving the ski jump. A Chinese ski jump carrier, then, will not be operating robust fixed-wing ISR assets like the U.S. Navy's E-2 *Hawkeye* or S-3 *Viking*, which could not launch safely from it, and it does not possess their equivalents in any case. Nor could it safely launch a heavily-loaded twin-engine cargo aircraft like the C-2 *Greyhound*, which is likewise dependent on catapult launch. Thus, even if China had three carriers in the fleet, up from zero today, PLAN Aviation would still be a primarily land-based air force; how it will (or will not) integrate with the PLA Air Force remains a key uncertainty. Nor can a ski jump carrier operate tankers, whose aerial refueling is essential for extending naval aircraft range. The U.S. Navy used to deck-launch S-2*Tracker*s, fully outfitted with anti-submarine warfare (ASW) gear, but the carrier had to be producing considerable wind over the deck to accomplish this; typically, a catapult was used.

For these reasons, Chinese ski jump carriers simply cannot be used in any of the combat roles that U.S. Navy carriers have performed. At best, they could provide limited air cover for amphibious forces and some close air

support, akin to what U.S. Marine Corps *Harrier*s have long provided. Ski jump carriers derive most of their combat power from helicopters or from deck-launched ASCMs. Any fighters they carry would have little or no capability to man distant combat air patrol (CAP) stations, so for defense, they would either rely solely on surface-to-air missiles (SAMs) or perhaps alert interceptors. However, given the limited amount of AEW they would have, the alert interceptors would be largely undefended once they went over the radar horizon.

Conclusion

While a new step for China and an important indicator, the J-15 is limited in capability; its launch platform even more so. It is important not to overstate the land attack and anti-ship potential of the J-15 airframe flying off of short take off but arrested recovery (STOBAR) carriers such as "*Shilang*," particularly against large U.S. military facilities like Guam and Diego Garcia. Even if J-15s could get off the deck with a reasonable weapons load, their range would be greatly reduced—it would be significantly less coming off of the ski jump than for comparable U.S. aircraft coming off catapults. China could in theory refuel planes in the air (assuming China buys or develops a buddy pod) but this sort of "operational triage" would reduce the air group by turning a significant number of fighters into tankers. Employed in isolation, buddy pods are of limited utility (and might not be all that launch-able from ski jumps in the first place).

To obtain significantly extended range it is necessary to use large tankers, which the U.S. Air Force (USAF) employs extensively, but China lacks. Fuel is the heaviest thing an aircraft carries, it seems unlikely that a ski jump- launched J-15 with a buddy pod would have significant ability to provision other fighters. Even a catapult launched F-18 with a buddy store only has about 4,000 lb of fuel to transfer. Given the limitations on number of aircraft carried and the takeoff weight limits of ski jump launched aircraft, "*Shilang*" could not generate operationally significant numbers of sorties unless the game was to get one or two aircraft into a strike firing position. Essentially, they would just be able to do aerial sniping against weakly armed opponents. Combined with the need to hold some jets back for defense, then, Chinese planners would face with a very difficult choice—attack at longer ranges with a greatly reduced strike package (probably insufficient to seriously damage a large target), or bring the carrier in close to get more aircraft on target and expose the entire carrier group to greater risk.

While a first-generation Chinese carrier would not represent a threat to U.S. ships and facilities in the way that the U.S. uses carriers, however, it could nevertheless be employed to provide significantly increased air defense to a group of surface ships in order to get them within ASCM range of a U.S. carrier group, or—should the Chinese develop a naval land attack cruise missile (LACM)—to get the LACM shooters within range of a key U.S. base. The same is true of ASW protection in theory, although this might be done better by additional destroyer-based helicopters, with which China has more experience and which would not offer such a large, consolidated, and easily detectable target set.

In addition, while a Chinese carrier group would not last very long in a head-to-head confrontation with the U.S. Navy, the very existence of a Chinese carrier capability, even a limited one, would potentially exert significant pressure on China's South China Sea neighbors to settle maritime disputes in ways favorable to China. If regional leaders perceive "*Shilang*" as a confirmation of waxing Chinese naval power and something that erodes the credibility of U.S. security guarantees, this could potentially prompt Vietnam, Malaysia, and others to seek bilateral accommodation with China.

Aside from a focused worst-case mission to damage a very specific target at the risk of limited operational effectiveness and high friendly losses then, the J-15's development is part of a long-term PLAN Aviation effort to "dip its toe" in the water in order to build more robust capabilities in the long run. The oceans are vast and promising, but the water can be cold and the salt often stings.

Remaining issues & challenges.

1) Since ski jump launches reduce an aircraft's potential fuel and weapons payload relative to catapult launches, it will be telling to see if China's future indigenous carrier hulls employ a catapult launch instead. For operations outside of the range of China's handful of land-based large tanker aircraft (i.e., essentially the entire strategic zone between

the straits of Hormuz and Malacca), this will greatly limit combat effectiveness since J-15s launched from the carriers will be able to carry fewer weapons and can only rely on their internal fuel stores. Even in local contingencies, Chinese forces would quickly face a shortage of tankers, particularly given China's trouble acquiring the IL-78s needed to refuel *Flanker*-derivative planes like the J-15.

2) A related question concerns the ability of the plane's landing gear to absorb the impact of landing. The heavier the machine at landing, the more stress on the airframe. If a pilot lands too fast or the arresting gear is set for the wrong weight, then the hook could come off the airplane or the arresting gear engines could be ruined. Cross deck pendants (flexible steel arresting cables/wires strung across the carrier deck to catch the arresting hook of an incoming aircraft) do break, but rarely. When they do, due mostly to a faulty swedge fitting (where the pendant attaches on each side to the wires that go down into the engines) or poor quality assurance in pendant fabrication, the results are gruesome. Many people on deck are killed and maimed, not to mention the damage to aircraft.

3) To function at maximum combat effectiveness, carrier-based fighters need AEW and tanker support. The U.S. and French Navies use variants of the E-2 *Hawkeye* to provide AEW capability. The tanker issue may prove more challenging for operations beyond China's immediate region. U.S. naval aviators typically rely on USAF tankers operating from forward bases in the Middle East and other regions to support them during expeditionary air operations. China would need to negotiate access agreements of some type to deploy tankers to support any possible future operations in the Western Indian Ocean and Northeastern Africa.

4) One question that will affect the J-15's combat potential directly is: will China deploy more advanced, longer-range air-to-air and air-launched anti-ship missiles in the next few years? If China can build a sufficiently robust ISR and targeting chain, missiles in the class of Russia's 300km-range *Novator* K-100 or *Vympel* R-37 and *BrahMos*-class air-launched ASCMs (~300 km range) would help compensate for range restrictions induced by lower fuel payloads during ski jump operations. This would be in keeping with China's larger "missile-centric" approach.

5) If China plans to fully indigenize J-15 production, it will need to have the domestically made WS-10 turbofan engine or other variant attain world-class reliability standards to enable safe and confident over water operation. *Global Times* claims that Aviation Industry Corporation of China (AVIC) is series-producing WS-10 engines for the J-11B, but other sources indicate that reliability issues remain, which is a major safety issue for an overwater aircraft. The engines would also need to be made salt water-resistant to allow marine operation. Many analysts believe the J-15 is now using Russian-made AL-31 engines, which China is able to refit and overhaul on its own. Aeroengine development is among the greatest technological challenges for any aerospace power, and China has yet to demonstrate top-tier indigenous production capabilities here.

6) What types of follow-on modifications might SAC make to the J-15 as it moves toward becoming operational? We think it is realistic to expect modifications including thrust vectoring engine nozzles similar to those found on other *Flanker*-derived aircraft and changes to engine intakes and other structures to reduce radar cross section. The aircraft's avionics suite will almost certainly become more capable over the next 5 years.

7) How many J-15s will PLAN Aviation acquire? Deploying a carrier with a full component of highly capable strike fighters sends a very different strategic message than deploying a carrier outfitted primarily with helicopters.

8) It will be interesting see if Chengdu Aircraft Industry Group promotes a follow-on version of the slightly-navalized variant of its J-10 fighter that it has already developed—perhaps as an alternative or supplement to SAC's J-15. This assumes, of course, that the J-10 can be turned into a successful carrier fighter. The U.S. examined just such a possibility with the F-16, it turned out to not be a suitable design. Rumors about a carrier-capable J-10 have circulated on the Chinese Internet for years, but open sources have not yet offered concrete evidence of such a development. Delta-wing canard fighters can operate from a carrier, although they may require substantial strengthening in order to withstand the rigors of arrested landings and possibly catapult launches if China's future carriers move away from ski jumps. This can sometimes make a fighter too heavy, as exemplified by BAE Systems' proposed navalized Eurofighter *Typhoon*, which can operate from ski jump carriers but would be too heavy relative to competitors if it were beefed up for catapult operations. In a positive example, the French *Rafale C* is an effective,

combat proven aircraft with successful land- and carrier-based versions. A competitive twin engine naval J-10 using Russian RD33 engines or the WS-13 turbofan China has developed for the FC-1/J-17 export fighter would likely have aerodynamic characteristics similar to the *Rafale*.

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Works Cited

[i] Liu Chang, "PLA Chief Confirms Vessel is 'Under Construction'," *Global Times*, 8 June 2011, http://military.globaltimes.cn/china/2011-06/662887.html.

[ii] *Military and Security Developments Involving the People's Republic of China 2010* , Annual Report to Congress (Washington, DC: Office of the Secretary of Defense, August 16, 2010), 48.

[iii] "J-15 Next-Generation Carrier-based Fighter Caught on Camera," *YouTube*, http://www.youtube.com/watch?v=trYUWQvKees.

[iv] "J-15 Flying Shark," *Chinese Military Aviation*, http://cnair.top81.cn/J-10_J-11_FC-1.htm.

[v] "New Shipborne Navy Jet Fighter Makes Waves Among Analysts," *Global Times*, April 25, 2011,

http://military.globaltimes.cn/china/2011-04/648200.html

[vi] David A. Fulghum, "New Chinese Ship-Based Fighter Progresses," *Aviation Week*,27April2011, http://www.aviationweek.com/aw/generic/story.jsp?channel=defense&id=news/asd/2011/04/27/02.xml&headline=New%20Chinese%20Ship-Based%20Fighter%20Progresses&next=10.

[vii] Yoji Koda, VADM (ret.), "A New Carrier Race: Strategy, Force Planning, and JS Hyuga," Naval War College Review (Sumer 2011): 46.