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CHINA AEROSPACE STUDIES INSTITUTE

In Their Own Words:

How Will the Form of Air Warfare Change in the Future?

Translations from Chinese source documents

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CHINA AEROSPACE STUDIES INSTITUTE

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Translators' Notes

By Derek Solen

The following article, "How Will the Form of Air Warfare Change in the Future?" was published in September 2025 in the Military Forum section of *Liberation Army News*.[1] This newspaper is the mouthpiece of the Chinese Communist Party's Central Military Commission, which is equivalent to the U.S. Department of Defense. Despite its name, Military Forum is not an open forum; it is a section in which the Chinese People's Liberation Army (PLA) regularly disseminates intellectual ideas about warfare that it regards as correct—or, at least, not incorrect. Therefore, Military Forum's articles have the imprimatur of orthodoxy without necessarily being doctrinal. This article was published in Military Forum's special section "Study Military Affairs, Study Warfare, Study War," which tends to carry articles that are clearly meant to be studied by all servicemen and so convey more authority than the others in the section. The affiliation of the article's author, Chai Shan, is unknown, but he previously proposed a redefinition of the concept of control of the air that was published in the same special section in Military Forum in 2022.[2]

The PLA rarely publishes articles about air warfare in *Liberation Army News*, so whatever is published is worthy of attention regardless of its content. Chai's article attempts to identify the factors influencing the evolution of air warfare and then predicts how those will influence the evolution of air warfare. Chai makes the commonplace prediction that unmanned systems will play a greater role and that smart munitions will become more prominent. However, he does not predict that autonomous unmanned systems will replace manned systems. Instead, he predicts that artificial intelligence will enable air forces to operate as adaptable, geographically distributed networks converging effects across domains, particularly those generated by stealth aircraft and hypersonic missiles, but with information operations as a major force multiplier in air operations.

Analysts of the PLA will find nothing novel in this article; others may only be surprised to find that Chai's vision of future air warfare would not be out of place in American military journals. That itself may be the value of this article: to show that the PLA is moving along with

trends in military affairs that may have been initiated by the U.S. military but that nevertheless set the benchmark for victory in future wars. Perhaps unconsciously, we have thrown down the gauntlet. It behooves us to know that we are not alone in our pursuit of the capabilities and tactics that we at least hope will ensure victory in a future war with a peer.

How Will the Form of Air Warfare Change in the Future?

[未来空战形态怎么变]

By Chai Shan [柴山]

EDITOR'S NOTE

With technology's swift and ferocious development and the accelerated evolution of the world's military revolutions, the military struggle in the aerospace domain is taking great strides towards informationization and intelligentization[.][i] Old theories of air warfare are ceaselessly being weeded out and replaced with new ones, so new concepts of air warfare and ideas about warfare such as penetrating counterair operations, agile combat employment, pulsed operations, operations in the air littoral, etc., debut successively and are guiding the development of air warfare's form. In particular, the practice of air warfare in several clashes that have occurred in the world in the past several years has caused people to pay more attention to change in the future form of air warfare. How will future air warfare develop? The answer can be found in the historical laws governing the evolution of warfare.

THE SPIRALING ASCENT OF AIR WARFARE'S FORM THROUGH GENERATIONAL TRANSITION

Surveying mankind's history of air warfare, although it only has little more than one hundred years, the form of air warfare has evolved time and again, presenting the evolutionary laws of spiraling ascent and generational transition.

The era of mechanization: fight of maneuvers within visual range. The characteristics of its overall form are displayed by both combatants' aircraft executing maneuvers and fighting within visual range in a three-dimensional battlespace. The form of warfare has one-on-one dogfighting, combat by groups of multiple formations of aircraft, and combat by formations of multiple types of aircraft. Among these, one-on-one aerial combat is the basic form of air warfare in the era of mechanization, manifesting itself in the mutual pursuit and tangle between

[i] "Informationization" or "informatization" are direct translations of 信息化 (*xinxihua*), which refers to the application of the information technologies that developed between the 1970s and the 1990s. "Intelligentization" is a direct translation of the word 智能化 (*zhinenghua*), which literally means to "make intelligent" or "make smart" in the sense that a smartphone is "smart." It lacks a narrower definition than that, but it can be understood as the application of technological advancements emerging since the 1990s and particularly since 2000, advancements in internet technology and in artificial intelligence, etc., the latter being prominent in discussions of "intelligentization."

both [combatants] fighting to gain an advantageous firing position. Usually, after both pilots see the opponent with their own eyes, they give full play to their aircraft's maneuverability and conduct various violent maneuvers, occupy an advantageous attack position, [then] ensure their own aircraft's nose or onboard weapons are first to be aimed and first to be fired. Combat by groups of formations of aircraft originates in World War I and manifests itself with the adoption of formations of aircraft to conduct aerial combat. Formations successively went through three stages of "small, big, and small[.]" Initially, the foundational small formations of two aircraft, three aircraft, and four aircraft, etc., were often adopted, and then this gradually developed into combat by multiple formations and large formations[.] During the heyday, the scale of formations reached numbers greater than 1,000 aircraft. In the 1950s, with the vast improvement of aircraft maneuverability and onboard weapons' firepower, the scale of formations began to shrink, restoring small-formation operations. With the appearance of specialized types of aircraft, a form of combined operations involving multiple types of aircraft began to emerge, one that manifested itself in operations by mixed groups of multiple types of aircraft as well as in combined operations. Initially, there was cooperation among combat aircraft such as fighters, reconnaissance aircraft, bombers, and attack aircraft, etc., [but] in the 1950s support and sustainment aircraft such as tankers, electronic jamming aircraft, and airborne early warning aircraft matured and were acquired one after another, so combat aircraft began forming groups and fighting together with support aircraft.

The era of informationization: multi-dimensional, cross-domain precision operations. Its overall characteristics manifest themselves in both combatants utilizing onboard informationized weaponry, conducting multi-dimensional, cross-domain precision operations. The form of air warfare presents itself in beyond-visual-range aerial combat, stealth air warfare, and system-of-systems air warfare. Among these, beyond-visual-range aerial combat is the basic form of aerial combat in the informationized era. It manifests itself in the pilot relying on advanced onboard radar to complete the discovery of targets beyond visual range and to track and lock onto them, conducting beyond-visual-range precision strikes by firing air-to-air missiles towards the targets. Stealth air warfare derives from the appearance of stealth aircraft, and nowadays it has already become the mainstream developmental direction of air warfare's form[.] The combat forms [of stealth air warfare] are divided into stealth penetration of defenses and stealth aerial combat. Stealth penetration of defenses utilizes an aircraft's low observability to penetrate the opponent's air defense system, entering inside the enemy's defensive zone to conduct an aerial raid; stealth aerial combat utilizes an aircraft's stealthiness to shorten the distance at which the aircraft can be detected by an opponent, thereby realizing a unidirectional, long-distance strike advantage for one's own side. At present, system-of-systems air warfare is still developing, and it manifests itself in all [elements of] air power forming an operational network with C4ISR systems at the center, realizing the sharing of information and cooperative combat. With the development of technologies such as cloud computing and the internet of things, each aerial combat system has begun to exhibit functional decoupling,[ii] direct connections between units [as in components of the system], and dynamic reorganization, and air warfare systems of systems are exhibiting a trend of "decentralization." System-of-systems aerial combat may become the basic form of future air warfare.

[ii] This likely refers to the practice of isolating functions of a system from each other and the system architecture itself, thereby making changes to the system easier as well as enhancing the resiliency of the system.

Grasping the Factors Influencing the Iterative Evolution of Air Warfare's Form

The evolution of air warfare's form is the result of synergy among the three large influencing factors of the development of technology, the innovation of theory, and the identification of the mechanisms for victory.

Technological development is the core factor driving the evolution of air warfare's form. Air warfare is naturally technological, and the impetus at the base of the development of air warfare's form is technological development. First, technological development raises the capabilities of weapons and equipment, changing the form of air warfare. The development of engine technology has changed the speed of aircraft and the altitude [at which they can fly], causing changes in the altitude and the distance at which aerial combat [is conducted]; changes to the structures of wings and fuselages have increased the maneuverability of aircraft, causing changes in the fighting techniques of aerial combat; the development of onboard weapons technology has raised the destructive power of aerial combat, expanding the distance at which kills [can be achieved], causing changes in the scale of formations and the distance at which aerial combat is conducted. Next, technological development has expanded the boundaries of missions, breaking new ground in the form of air warfare. With the development of air-to-ground weapons, aircraft expanded into the missions of bombing and supporting operations on land and at sea, producing forms of air warfare such as defense penetration and surprise attack as well as surface strike; with the development of precision strike technology, aircraft have expanded into the missions of striking vital targets and sensitive targets, producing the "surgical" strike combat form. Again, new technology delivered new aircraft, weapons, and equipment, bringing about new forms of air warfare. Stealth technology, onboard radar technology, and aircraft-to-aircraft communications technology all produced unmanned aerial vehicles, stealth aircraft, active electronically scanned array radar, and aircraft-to-aircraft datalinks, which then brought about new forms of air warfare such as stealth air warfare, unmanned aerial vehicle operations, electronic warfare, and distributed air warfare.

The innovation of theory is the key factor driving the evolution of air warfare's form. The innovation of theory is the product of the synthesis of forward-looking thought and praxis [the practical application of said thought.] It pulls along and guides the development of air warfare's form. First, forward-looking thought pulls the development of air warfare's form along. Works such as *Command of the Air* all looked ahead and predicted the position and effect of aircraft as well as the ways and methods of their employment, leading air warfare to become practical and to enter the battlefield; the "Five Rings" target theory [Warden's Five Rings] conducted forward-looking thought about aerial strikes against targets, leading the method of air warfare to change from [attacking] ring by ring to directly attacking the "center of gravity." Next, the digestion of praxis propelled the development of air warfare's form. Germany's "father of aerial combat" Oswald Boelcke proposed "Eight Principles of Aerial Combat," changing hitherto unmethodical dogfighting by single aircraft[.] [Boelcke] pointed out the principles of cooperation among multiple aircraft in aerial combat, driving the development of aerial combat from single aircraft to multiple aircraft. The principle of the concentrated use of aviation forces changed the ways in which aviation forces were subordinated and used, making air power realize unified command and concentrated use. Again, military strategy guided the development of air

warfare's form. In the 1960s the USSR adopted the "active offense" strategy, and under the guidance of this doctrine, "concentrated surprise attack" became an important form of air warfare for the Soviet Union's aviation forces; the strategic concept of "global vigilance," "global reach," and "global power" that the U.S. Air Force proposed makes the long-range raid the primary form of air warfare for the U.S. Air Force.

The identification of the mechanisms for victory is the leading factor driving the evolution of air warfare's form. The identification of the mechanisms for victory is a deep understanding of the laws for achieving victory in aerial combat, and it determines the direction in which air warfare's form evolves. On one hand, the identification of the mechanisms for victory determines the form of air warfare. Having identified the mechanism for victory in aerial combat in the era of mechanization was that high maneuverability and strong firepower achieve effective kills, air warfare's form in the mechanization era evolved throughout around the demonstration of the effects of the four elements of air warfare: "speed, altitude, maneuver, and firepower;" having identified the mechanism for victory in aerial combat in the era of informationization is that "information superiority forms decision-making superiority, leading to superiority in action," informationized aerial combat has evolved and developed throughout around the three elements of "information, maneuver, and firepower," thereby realizing [the idea of] "finding the enemy [before he finds you], acting before the enemy, and opening fire before the enemy." On the other hand, the identification of the mechanisms for victory optimizes the form of air warfare. There is a process of progressively deepening understanding for the mechanisms for victory, and in this process, the form of air warfare is optimized as understanding deepens. Beyond-visual-range precision strike is born of the employment of information's precision[;] stealth combat is born of the employment of information's timeliness[;] and system-of-systems combat is born of the employment of information sharing.

Forecasting the Direction in which the Future Form of Air Warfare Will Evolve and Develop

The future form of air warfare is ultimately and inevitably intelligentized aerial combat[.] Combat weapons and equipment will form system clusters with primarily intelligentized unmanned combat systems in the lead, and will realize independent, self-adaptable, and self-coordinating intelligentized system-of-systems operations under the control of artificial intelligence decision-making and management systems. However, as one can tell from the history and experience of the evolution of air warfare's form, this will be a long developmental process, and speaking from the processes of technological development and theoretical innovation as well as the identification of the mechanisms for victory, future air warfare will evolve in the direction of unmanned [weapons platforms], autonomous [weapons platforms], distributed [operations], and swarms.

Limited autonomous aerial combat with the form of teaming between manned and unmanned aircraft as the main actor. Unmanned aircraft will serve as wingmen to manned aircraft and will execute aerial combat missions by the form of manned-unmanned formations. Unmanned aircraft will serve as manned aircraft's systems for sensing the situation, as systems expanding [the manned aircraft's] onboard weapons, as well as [serve as] escorts and

wingmen, and they will cooperate with manned aircraft to conduct limited autonomous combat under the command of manned aircraft. With the support of smart unmanned technology as well as aircraft-to-aircraft high-speed communications and control technology, and under the guidance of operations theory such as "loyal wingman" and "manned-unmanned teaming," etc., this form of aerial combat is already starting to germinate, and the configuration of [such] combat formations has already been effectively verified.

Distributed aerial combat with stealth, hypersonic [propulsion], and beyond-visual-range attacks as the primary means. Stealth aircraft carrying long-range, air-launched stealth missiles and hypersonic missiles will become operational endpoints within an aerospace system-of-systems network, where they will disperse and deploy across a broad area, widely participating in each operational stage of reconnoiter, search, strike, and assess [akin to "find, fix, finish, and assess"], and with the support of integrated aerospace sensing systems, they will execute long-range strikes against the enemy from outside visual range. With the continuous development of long-range, air-launched missile technology and the maturation of technologies such as the functional decoupling of weapons platforms, etc., this way of combat could make a major appearance in future aerial combat, [but] it has already [begun to] take shape for aerial combat in recent, limited clashes.

Networked swarm aerial combat with self-organization, self-adaptation, and self-collaboration all as characteristics. With large-scale, intelligentized unmanned aerial vehicles and munitions as the primary combat force, and with mobile internet technology realizing dynamic interconnection, [unmanned aerial vehicles and munitions] will become smart swarms that are organized according to the functions of reconnaissance, jamming, and strike[.] In the process of combat, based on the situation in the battlespace and the targets to be attacked, they will dynamically adjust task assignments and cooperative tactics, autonomously select targets to strike, and on their own initiative adapt to the battlespace environment and dynamically reconstitute functional cooperation. The present development of this form of air warfare is fast and ferocious[.] Concepts such as "swarms" and "networking among smart munitions," etc., have become widely known, and have even been applied in recent clashes, [so] although we are still at an early stage, these have even achieved significant results in battle. With smart unmanned platforms' increased maturity, truly unmanned, networked swarm operations will soon make their appearance.

Cross-domain air warfare with physical domains as the foundation and the information domain as the key. The weapons and equipment for air warfare appear in the physical domains[;] combat power is released in the physical and information domains[;] the effect of combat efficiency influences the opponent's cognition. Aerial combat actions with "striking vital points" firepower warfare and "pretending to be foolish while smart" information warfare as primary characteristics, as well as air warfare system of systems, by executing "hard kills" against the enemy's key smart weapons and equipment as well as "soft kills" by methods such as deep fakes, algorithmic fog, virus infections, etc., will make the enemy's cognitive environment complex, ultimately causing the cognitive collapse and degradation of the enemy's air warfare system of systems. This form of air warfare is now still in the making and being designed[.]

Its intelligentized hypersonic munitions, advanced battle management systems, and other such key technology are rapidly developing together with operational theories like "decision-centric warfare," "mosaic warfare," and "algorithmic warfare," and in the not-too-distant future they could appear on the battlefield.

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ENDNOTES

[1] 柴山 [Chai Shan], "未来空战形态怎么变" [How Will the Form of Air Warfare Change in the Future?], 解放军报 [Liberation Army News], September 16, 2025, accessed September 16, 2025, http://www.81.cn/szb_223187/szbxq/index.html?paperName=jfjb&paperDate=2025-09-16&paperNumber=07&articleid=963410.

[2] Derek Solen, "The PLA Reconceptualizes Control of the Air," *China Brief* 23, no. 13 (July 21, 2023), accessed December 18, 2025, https://jamestown.org/the-pla-reconceptualizes-control-of-the-air/.