

PART FOUR

General Technology and Supporting Policies

Chapter 11

China's Development of Unmanned Vehicles

Hsiao-Huang Shu, Jyh-Shyang Sheu*

I. Introduction

China has established the world's largest UAV (a drone or remotely piloted aircraft [RPA]) industry with extensive exports to other countries for both military and non-military tasks. It has also become the world's largest exporter of military UAVs, with its signature models, the Wing Loong and Rainbow Series UAV. Over 300 UAVs were exported to 15 countries in 2015-2020. Chinese UAVs are used by some countries in the Middle East and North Africa to assassinate rebel armies, guerrillas, and opponents and stabilize political power.¹ Although the precision and warfare performance of China-made UAVs are inferior to U.S.-made UAVs, they are cheap and popular with third-world customers. However, UAVs suffer a heavy toll as any ground troop can strike them down with certain anti-aircraft capabilities.²

* Hsiao-Huang Shu, Associate Research Fellow, Division of Chinese Politics, Military and Warfighting Concepts, Institute for National Defense and Security Research; Jyh-Shyang Sheu, Assistant Research Fellow, Division of Chinese Politics, Military and Warfighting Concepts, Institute for National Defense and Security Research.

¹ "China is the Largest Exporter of UAVs, Helping Totalitarian Nations to Suppress Democracy. Expert: Lowering of Threshold for Wars," *Apple News*, April 29, 2021, <https://tw.appledaily.com/international/20210429/IO3UC2F7SZDUVKQUKE67YKP42U/>.

² "China is the Largest Exporter of UAVs, Helping Totalitarian Nations to Suppress Democracy. Expert: Lowering of Threshold for Wars," same as the previous note.

II. Development of UAVs in China

1. UAV Development and Problems Encountered

In recent years, China has been investing heavily in developing a variety of UAVs for surveillance, targeting, and attacks and in constructing complex UAV infrastructure facilities. National organizations are responsible for the UAV development and requirement specifications, while industries are tasked with the design, R&D, and manufacturing. The number of UAV users in military forces is also increasing. China's UAV systems enhance its precision strike capability within a long range of 3,000 kilometers. Further, new UAVs come with reduced Radar Cross Section (RCS) for better survivability in high-threat environments.³

In developing UAVs, China also uses various civil technologies, such as speedy obstacle avoidance, target identification and tracking, low, slow, and small detection for complex urban environments, agile response, and links for control.

In 2020 when COVID-19 caused multiple lockdowns in China, many local governments (e.g., Chongqing City) purchased UAVs for emergency operations. These UAVs deliver goods with precision in targeted areas and quickly meet the needs for medical supplies under the command of the smart control system. Relevant technologies include UAV position monitoring, automatic task allocation and arrangement, reporting back of onsite situations, flight surveillance, and emergency control. These technologies also help in military tasks, such as warzone logistics and supplies.

China also has reconnaissance- and strike-integrated UAVs and AI-driven UAVs for automatic flights, the Loyal Wingman concept, and swarm UAVs. In addition, it may also combine UAVs with AI. Hundreds of stealth UAVs may initiate attacks even when communication is cut off or interrupted. Further, China is also likely

³ "The Chinese People's Liberation Army's Unmanned Aerial Vehicle Project: Organizational Capacities and Operational Capabilities," *Project 2049*, March 11, 2013, <https://project2049.net/2013/03/11/the-chinese-peoples-liberation-armys-unmanned-aerial-vehicle-project-organizational-capacities-and-operational-capabilities/>.

to use UAVs for electronic warfare or equipment of electromagnetic pulse pods.⁴ China's massive export of UAVs also raises the concern of whether these drones are used to assist espionage activities. The U.S. Department of the Interior ordered to ground over 800 UAVs in 2019 because they were either made in China or with China-made parts. The U.S. Cyber Security and Infrastructure Security Agency also issued warnings and expressed its concern for the increasing number of China-made UAVs used by U.S. government organizations.⁵ The U.S. Army in 2017 forbade the use of DJI UAVs and indicated that it did not use DJI products on the battlefield. The U.S. Department of Defense also authorized 130 military bases to strike down private and commercial UAVs that may pose potential threats.⁶ In 2019, the Trump administration ordered the U.S. Department of Defense to ground all China-made UAVs. However, the reliance on Chinese UAVs remains. Although the U.S. Department of Defense already spent USD13 million to develop alternatives, the costs are 8 to 14 times higher than similar-grade Chinese products, while their performance is inferior. Hence, this shows the difficulty of the U.S. in ridding its reliance on Chinese technology, given the absence of U.S.-made substitutes.⁷

2. Development of UAV for Military Use

At the 70th Anniversary of the Founding of The People's Republic of China in 2019, China presented multiple new weapons, including the GJ-11 stealth UAV and WZ-8 supersonic UAV. At the 2021 China International Aviation & Aerospace Exhibition, only the GJ-11 model was displayed to exhibit its configuration. Also showcased at the exhibition was the Tianshao UAV with a flush antenna, whose

⁴ "Did Chinese Scientists Just Bring Down an Unmanned Plane with an Electromagnetic Pulse Weapon?," *South China Morning Post*, August 26, 2021, <https://www.scmp.com/news/china/science/article/3146380/did-chinese-scientists-just-bring-down-unmanned-plane>.

⁵ "Worried about China's Espionage Activities, U.S. Government Grounds 800 UAVs," *BBC Chinese*, November 1, 2019, <https://www.bbc.com/zhongwen/trad/world-50258687>.

⁶ "Why U.S. Military Stops Using Chinese DJI UAVs?," *BBC Chinese*, <https://www.bbc.com/zhongwen/trad/chinese-news-40860075>.

⁷ "Pentagon Drones '8 to 14 Times' Costlier than Banned Chinese Craft," *Financial Times*, July 19, 2021, <https://www.ft.com/content/dd2e936e-5934-49f1-8aa6-29dea9a41b18>.

sensors are flatly attached to the vehicle body to maintain the stealth design. On the other hand, the Rainbow-6 UAV adopts jet propulsion and comes in a stealth configuration, capable of great heights and speeds. During long flights, UAVs can implement reconnaissance, surveillance, and strike missions.⁸

The GJ-11 is a UCAV (unmanned combat aerial vehicle), likely to be the stealth version in service based on Lijian launched in 2013. It looks like the U.S. X-47B with full wings and a weapon bay and can maintain stealth and attack targets by penetrating the enemy’s anti-aircraft defense. The GJ-11 may be equipped on aircraft carriers or amphibious assault ships and automatically take off and land. Manned fighter aircraft, such as the J-20, serve as loyal wingman by supporting highly threatening tasks.⁹ The GJ-11 was jointly developed by Shenyang Aircraft Corp., Shenyang Aerospace University, and Hongdu Aviation Industry Group under code 601S. Code 601 refers to Shenyang Aircraft Corp. Academy No. 601, while code S refers to Shenyang Aerospace University.¹⁰

The Dark Sword, developed by Shenyang Aircraft Corp., is a supersonic UAV with a stealth design and front wings. It is believed to have a super-cruise capability. There was a report in 2016 saying that China was validating the hypersonic UAV with a flight speed of up to 4 Mach.¹¹ It is unknown whether this has been replaced by the WZ-8 or secretly continued as it was.

The WZ-8 was also displayed at the 70th Anniversary of the Founding of The People’s Republic of China in 2019. Its model name is either DR-8 or WZ-8, similar to the D-21 supersonic reconnaissance UAV developed by the U.S. Air Force in the 1960s. The U.S. once conducted reconnaissance with D-21 drones on China’s nuclear test but lost one D-21. The complete remains of this D-21 were found by China. The WZ-8 can provide the PLA with a wide range of

⁸ “China’s Gigantic Twin-engine, Long-endurance Armed UAV Emerges,” *Inceptive Mind*, September 26, 2021, <https://www.inceptivemind.com/china-ch-6-gigantic-twin-engine-long-endurance-armed-uav-emerges/21344/>.

⁹ “J-20 Fighter and GJ-11 UAV as China’s Golden Partner of a Stealth Sword,” *China Times*, September 5, 2021, <https://www.chinatimes.com/realtimenews/20210905003282-260409?chdtv>.

¹⁰ “Gongji-11 (GJ-11) Sharp Sword/Lijian,” *Global Security.org*, <https://www.globalsecurity.org/military/world/china/lijian.htm>.

¹¹ “Dark Sword (An-Jian/Anjian),” *Global Security.org*, <https://www.globalsecurity.org/military/world/china/anjian.htm>.

reconnaissance capabilities. It can track the U.S. carrier battle group in the South China Sea or the Western Pacific to provide target-oriented information for anti-ship ballistic missiles. Its maximum speed is 4,000 km per hour, and its operating radius can reach Guam.¹²

Wing Loong, another Chinese military UAV developed by the Aviation Industry Corporation of China, Ltd., looks like the U.S. MQ-9 Reaper with two tail wings leaning outward. Satellite antennas are installed inside its head fairing. Further, the Wing Loong UAV can carry various reconnaissance and electronic warfare equipment and air-to-surface missiles for attack missions—having both reconnaissance and attack capabilities. In terms of UAV design and R&D competencies, China is only next to the U.S. and Israel, yet better than Russia. Some Chinese UAV performances are even comparable to the major UAVs used by the U.S. Armed Forces. The mass production models may be exported to countries like Uzbekistan and the United Arab Emirates.

The Rainbow series was developed by the China Aerospace Science and Technology Corp. (CASC) Academy No. 11. It shares a similar look with the Wing Loong UAV, with the confirmation resembling the U.S. MQ-9 UAV. The tail wings are in a V shape, and the propellers are at the back in order to free up the head space for the avionic cabin. The Rainbow-4's wingspan is 18 meters. It has the highest payload and the best flight performance among all China-made UAV models. It is said to be even more advanced than Wing Loong, which can loiter for 30 hours for tasks such as border patrols, island protection, anti-terrorist combats, and emergency communications.

China is also using large UAVs for ocean patrols, reconnaissance, and gray-area conflicts by harassing the airspace of neighboring countries. On August 24, 2021, the TB-001 large UAV was found to be on a mission in the East China Sea and above the waters near the Ryukyu Islands. The TB-001, developed by the Tengdeng Technology Company, is the largest UAV publicized by China to this date. Its wingspan is 20 meters, and its range can reach 6,000 kilometers at the cruising

¹² "BZK-008 CH-91 WZ-8 Hypersonic Drone Testbed," *Global Security.org*, <https://www.globalsecurity.org/military/world/china/bzk-008.htm>.

altitude of 8,000 meters.¹³ On August 25, one BZK005 UAV flew from the East China Sea to the Western Pacific. As the PLA's first large and long-endurance UAV, its newest improvement can perform attacks to the ocean and the land and BVLOS (beyond visual line of sight) tasks based on satellite navigation or collection of multiple intelligences.¹⁴

3. State-operated and Civilian UAV Industries

With the highly competitive Chinese market for UAV system designs and a large number of R&D organizations, the PLA has many options to choose from in developing the best designs according to task requirements. Military UAV tasks include intelligence, surveillance, reconnaissance, precision strike, electronic warfare, communications relays, and target relays for long-range missiles by transmitting data via satellites. Non-war tasks include national security, resource exploration, and ocean patrols. Chinese satellites can also work with various UAVs by navigating long-distance flights and enabling intelligence surveillance and reconnaissance on battlefields, which greatly enhance the use cases of UAVs.

The Chinese UAV is rather sizable, consisting of aviation and aerospace universities, state-owned enterprises, and private companies. Among the leading academic institutions is the Unmanned System Research Institute of Northwestern Polytechnical University (365 Institute), the first organization engaged in the UAV development in China since 1958. It is part of the National Defense Technology Research Institute under Northwestern Polytechnical University. Its UAV products include the ASN-106 and the ASN-209. The Institute of Unmanned Systems of Beihang University is responsible for the BK-005 and Changying projects. On the other hand, the Nanjing University of Aeronautics and Astronautics Unmanned Air Vehicle Institute handle the design of the Chang Kong UAV and the BZK-002

¹³ "China-made Attack UAVs Appear in the East China Sea. Heated Competition among China, the U.S. and Russia in UAV Development," *Tech News*, August 26, 2021, <https://technews.tw/2021/08/26/chinese-tb001-ucav-shows-up-at-east-sea-marking-the-increasing-competition-of-large-uav-market/>.

¹⁴ "Japanese Military Aircrafts Took off for Three Consecutive Days, to Conduct Emergency Interception of Three Chinese Military UAVs," *Voice of America*, August 28, 2021, <https://www.voacantonese.com/a/Japanese-fighters-intercept-three-Chinese-drones-in-as-many-days-20210827/6018758.html>.

unmanned helicopter.

When it comes to state-owned military companies, the Aviation Industry Corporation of China is closely affiliated with Beihang University. Its subordinates, including Guizhou Aircraft Industry Corp., Shenyang Aircraft Corp., Cheng Du Aircraft Group Co., Ltd., Xi An Aircraft Industry Group Co., and Weifang Tianxiang Airlines Industry Co., Ltd., work on UAV development projects. The China National Aero-Technology Import & Export Corp. (CATIC) overseas the export of UAVs. Meanwhile, the Aviation Industry Corporation of China plays the role of the Chinese UAV industry's leader or system integrator. The Guizhou Aircraft Industry Corp., established in 2011, is a site dedicated to UAV production, testing, and services. It also has a UAV research center in Anshun, Guangzhou.

The Cheng Du Aircraft Group Co., Ltd. is responsible for the R&D of the Wing Loong UAV, as well as large UAVs similar to the U.S. Global Hawk. On the other hand, the Shenyang Aircraft Corp. is tasked with designing large-sized unmanned combat aerial vehicles (UCAVs) by remodeling the J-6 fighter aircraft or developing a new generation of advanced UCAVs. It is also a leader in the R&D of stealth technology, whose stealth UAV product is the Dark Sword. Further, the Xi An Aircraft Industry Group Co. develops and tests the V750 unmanned helicopter for civil and army tactical purposes, with customers including the Chinese navy. The company's most special unit is the Xi'an Automatic Flight Control Research Institute.

The China Aerospace Science and Industry Corporation (CASIC) is another military and industrial organization, whose Academy No. 3 is the R&D and design unit for cruise missiles. However, similar technologies are shared for UAVs. It has developed Haiying, Yaoying, Tengfei, Daofeng, and the WJ600 series, including Yaoying-2 and Tengfei-8 (1-2 kg payload), Yaoying-3 and Tengfei-5 (5 kg payload), Daofeng-460, Yaoying-1, and WJ600 (15-130 kg payload). These series of UAVs come in light, small, and medium sizes to perform tasks, such as national land surveying and mapping, ocean guards, power line monitoring, forest fire prevention, and police patrols. Academy No. 3 has established a complete UAV supply chain from overall design, structure, motor systems to navigation, data

links, and payloads.¹⁵

Academy No. 9 and No. 11 under the China Aerospace Science and Technology Corp. (CASC) are also UAV development units. Academy No. 9 is responsible for microelectronics and orientation, navigation, and control systems by developing UAV sensors and communications relay technologies. On the other hand, Academy No. 11 is in charge of aerodynamic force tests, and its main product is the Rainbow series. The China Electronic Technology Corporation (CETC) develops electronic subsystems, sensor payloads, and electronic warfare equipment. Its Academy of UAV System Research and Development is responsible for UAVs in electronic warfare by developing platforms for high altitudes and long loitering hours with a stealth design. Academy No. 38 deals with the development of mashed communications and intelligence processing systems in order to handle synthetic aperture radar (SAR) payloads for UAVs. The Electronic Engineering Institute of the PLA is one of the spearhead research organizations for UAV tactics and electronic warfare, whose research projects include the interference of moving targets.¹⁶

There is also a comprehensive UAV supply chain (including motors, flight control systems, sensors, and servers) for the civil market. The civil market can be divided into the consumer and the industrial segments for aerial photography, logistics & transportation, and environmental monitoring.¹⁷ The best-known private UAV company is DJI—the world's largest producer in 2020, with an 80% market share.¹⁸ Small companies, such as Tenden, AOSSCI, Star, TIM, and Ewatt, also apply many innovative concepts and show the potential in serving military purposes. For example, AOSSCI's X-Shift and X-Chimera are both in a three-piece airframe design with four rotary wings on the exterior and an integrated electric

¹⁵ "China Aerospace Science & Industry Corp. Launches Haiying UAV Brand," *people.cn-Technology channel*, November 13, 2012, <http://scitech.people.com.cn/BIG5/n/2012/1113/c1007-19569150.html>.

¹⁶ Ian M. Easton and L.C. Russel Hsiao, "The Chinese People's Liberation Army's Unmanned Aerial Vehicle Project: Organizational Capacities and Operational Capabilities," *Project 2049 Institute*, March 11, 2013.

¹⁷ "2021 Full UAV Supply Chain and Market Analysis in China from Upstream to Downstream," *AskCI*, July 16, 2021, <https://www.gushiciku.cn/dl/0zEmp/zh-tw>.

¹⁸ "Analysis of DJI in 2020—80% and 70% Market Share in the World and in China, Respectively," *Sohu*, October 19, 2020, https://www.sohu.com/a/425778418_114835.

propulsion. In addition to UAV production, Ewatt also provides ground stations, fleet management, application, and training. Apart from transportation, this type of UAV has a wide range of use cases, including law enforcement, disaster recuses, environmental protection, photography, and surveying/ mapping.

III. Unmanned Systems for Special Purposes

1. Suicide Drones for Attack Missions

It is also necessary to keep a close eye on the development of suicide drones (i.e., loitering munition) in recent years. With similar equipment gradually attracting wide attention, it has highly caught the interest of the PLA. Further, with the launch of the ASN-301 anti-radiation drone in 2017, China successfully copied Israel's Harpy anti-radiation drone¹⁹ obtained in the 1990s. The CH-901 suicide drone has been in the PLA's service for years. This suicide drone at a weight of 9 kilograms was displayed in 2017 at the People's Revolution Military Museum, integrated with a 4x4 Mengshi vehicle. The vehicle was equipped with eight launchers for the CH-901 model and four smaller launchers for fixed-wing drones.²⁰ In October 2020, a video from the China Electronic Technology Corp. (CETC) showed the likely CH-901 suicide drone further integrated with a 6x6 CTL181A Mengshi motor vehicle. There is a row of 48 UAV launchers on the vehicle. Once launched, the UAVs form into a group to simulate attacks on simulated targets. Similar launch systems can also be used on navy vessels or amphibious warships for different requirements.²¹

As China's UAV industry is highly developed, multiple UAV systems of different concepts often show up at exhibitions. New UAV concepts from other countries usually see Chinese copycats soon after their debut—this is no exception

¹⁹ Ami Rojkes Dombe, "China Unveils a Harpy-Type Loitering Minution," *Israel Defense*, March 1, 2017, <https://www.israeldefense.co.il/en/node/28716>.

²⁰ Jeffrey Lin and P.W. Singer, "Come See China's New Hexacopters and Self-detonating Drones," *Popular Science*, July 31, 2017, <https://www.popsci.com/china-new-drones-army-hexacopters/>.

²¹ Andrew Tate, "China Likely to Deploy New Multiple UAV Launcher in Near Future," *Jane's Defence Weekly*, October 21, 2020.

for suicide drones. The CH-817 micro attack UAV that appeared at the China International Aviation & Aerospace Exhibition in September 2021 is a small dual-propeller drone with a weight of mere 850 grams. Each CH-817 may not be formidable, and the loitering hours are limited. If the swarm technique achieves good progress, this type of light and compact equipment can be released in large numbers in different ways to attack soldiers and important figures or infiltrate and attack high-value but vulnerable equipment such as fighter aircraft. Although whether the PLA adopts this mechanism is yet to be seen, it is still necessary to watch early the potential threat that similar systems may cause in the future.

2. Unmanned Ground Vehicle (UGV)

Unmanned ground vehicles (UGVs) have been increasingly observed in the reports on the PLA equipment in recent years. It is not a new piece of equipment for the PLA, as Chinese military companies have showcased UGV products at many military exhibitions. It also seems that the PLA has been catching up over the past years. On April 13, 2020, the Eastern Theater of the PLA, in its Weibo account, announced the adoption of NORINCO's Sharp Claw I UGV. The report from China Central Television (CCTV) on the same day also indicated that the PLA Rocket Force had started using a large, crane-like robot to assist in the loading of missiles.²² Sharp Claw I is a crawler-type lightweight UGV used for tracking, reconnaissance, and attacking. It is equipped with optical sensors and a 7.62mm cabin. On January 6, 2021, China Central Television (CCTV), in its video for the "new year opening instructions", also disclosed the footage of the Eastern Theater, showing the PLA's use of UGV and training of infantry troops. The UGV presented is a crawler-type, installed with dual launchers for 35mm grenades and electro-optical/infrared (EO/IR) sensors.²³ This discovery suggests that the PLA ground force is gradually stepping up the validation, training, and application of UGVs. However, the two small UGVs shown to date are both equipped with light

²² Gabriel Dominguez and Juan Ju, "Norinco's Sharp Claw I UGV in Service with Chinese Army," *Jane's Defence Weekly*, April 15, 2020.

²³ Gabriel Dominguez and Melanie Rovey, "PLAGF Unit in Eastern Theatre Command Deploying New Tracked UGV," *Jane's Defence Weekly*, January 7, 2021.

weaponry and sensor systems, implying that they are probably still serving support roles to ground troops—a contract with Russians who seek to use UGVs as the main battlefield equipment by carrying large weapons.

That said, the footage in 2018 from China Central Television (CCTV) shows that the PLA was remotely controlling a Type 59 Main Battle Tank. It also claimed that the PLA was testing active navigation and positioning, surveillance, machine cognition, deep learning, control drive, and remote control technology. This type of vehicle can be used for reconnaissance by fire or as an unmanned war vehicle.²⁴ Therefore, it is possible that similar technologies are applied for the R&D of large and unmanned war vehicles, or the unmanned technology is used to enhance the battlefield value of old-fashioned war vehicles in the future.

IV. Conclusion

China's UAV industry is a global leader, with exports and market shares both the highest in the world. Many government agencies and private organizations use China-made products. However, this triggers the concern for data leakage or spy activities in the competition and confrontation between great powers. However, whether it is possible to reduce the overall reliance on Chinese products depends on whether the outside supply chains can replace them. China-made UAVs are exported to third-world countries and used for real battles. In recent years, China has developed many UAVs, such as stealth unmanned combat aerial vehicles (UCAVs), supersonic UAVs, and reconnaissance- and strike-integrated UAVs for special purposes (e.g., Loyal Wingman, swarm tactics, electronic warfare). Thus, China's military use of UAVs poses a new challenge for air defense to Taiwan and other neighboring countries.

²⁴ Kelvin Wong, "Robot Wars: Asia Pacific Countries Pursue Robotics for Future Ground Combat," *Jane's International Defence Review*, February 22, 2019.

