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Defense Innovation in China: History, Lessons, and Trends

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The Evolution of the Chinese Defense Innovation System

The evolution of the defense innovation system in the People's Republic of China (PRC) has been shaped by the overall development of the country's science and technology, education, and industrial systems. The defense innovation system has experienced three stages of evolution from the perspective of civil-military integration (CMI): an initial development stage under Mao Zedong, a period of reform under Deng Xiaopeng, and an intensive push toward CMI under Jiang Zemin that continues to this day.

Initial Development: A Focus on Defense Construction (1949–1977)

The period after the new China was founded but before the beginning of the reform and opening-up era can be characterized as one of initial development of the defense innovation system. During these three decades, China faced a severe security and economic situation. The Communist Party's first generation of collective leadership, with Mao Zedong at the helm, attached greater importance to national defense priorities, although strengthening economic development was also important.

The Ministry of Heavy Industry was established following the founding of the PRC to administer central projects related to the defense industry and to organize the production of military equipment and the restructuring of military industrial enterprises. High priority was given to the development of cutting-edge defense technologies in the areas of atomic energy, aviation, and missiles in the First Five-Year Plan (1953–1957) prepared by the State Council, the First Five-Year Plan for Defense Construction developed by the Communist Party Central Military Commission (CMC), and the 1956–1967 Long-term Plan on Science and Technology Development formulated by the State Council.¹

¹ You Guangrong, “我国国防科技创新体系的历史演进 [Historical Development of Defense Technological Innovation System in China],” 国防科技 [Defense Technology] 7 (2007).

From 1953 to 1959, more than one hundred large- and medium-sized defense industrial state-owned enterprises were established, and defense industry sectors specializing in ordnance, electronics, shipbuilding, aviation, nuclear, and space were organized. A practice of building defense industrial facilities deep in the interior of China to safeguard them from the threat of outside invasion, the so-called Third Line, was developed by the country in the 1960s. As a result, a relatively complete professional defense technology industry system supported by scientific research institutes, testing facilities, and production capabilities was completed.²

China actively worked to learn from and follow the model of the Soviet Union's scientific research system during this period. As a result, highly centralized and unified management was realized in defense technology, and the defense innovation system was basically isolated from the civil innovation system. The advantages and strengths of the "Great Science" system were reflected by breakthroughs made in cutting-edge defense technologies represented by the concept of "two bombs and one satellite." However, the Chinese defense innovation system was isolated from the civil innovation system for quite a long time due to the strictures of the planned economic system.

The defense innovation system occupied a position of prominence among national innovation systems in terms of resource allocation during this stage. The Commission of Science for National Defense of the People's Republic of China was established in September 1958 to serve as a government body for unified management of defense development under the leadership of the Communist Party's Central Committee, the State Council, and the CMC.

Early Reform of the Defense Technology System: "Transfer of Military Technology to Civil Use" (1978–1991)

The Party's second generation of central collective leadership under Deng Xiaoping proposed strategic changes to the guiding ideology for defense and military build-up—a major shift from "preparing the early, great and nuclear war" to "construction in peacetime."³ It was stressed frequently that defense development must also serve economic development. Based on this major strategic adjustment, Chinese defense technology began to follow the policy of "civil-military integration; peacetime and wartime combination; army-focused, army growth based on civilian support," stressing the transfer of military technologies to civilian areas. Although the defense innovation system was in a subordinate position in terms of resource allocation, it completed the development of a second generation of military equipment. The F-8 aircraft is but one example. In addition, an intercontinental ground-to-ground missile was successfully tested, and the first nuclear-powered missile submarine was completed and put into service. The "Defense Technology Advanced Research" program and "863 Program" laid a solid technical foundation for the development of high-tech military equipment in China. However, there remained a large, and growing, gap between the overall level of Chinese military equipment and that of advanced countries all over the world.

The Chinese defense innovation system underwent frequent adjustments during this stage. In order to streamline and reduce management levels and work overlap, the Central Committee, State Council, and CMC merged the Office of the National Defense Industry and the CMC's Office of Science and Technology Equipment with the Commission of Science for National Defense, and established the Commission of Science, Technology and Industry for National Defense (COSTIND). COSTIND was subordinate to the organizational system of the CMC and under the dual leadership of the State Council and the CMC.

The defense industry witnessed a transformation from the previous administrative system, which had different military industries managed by corresponding government departments (the eight Ministries of Machine-Building,

2 Wang Rong, "加快我国国防科技创新体系建设的思考 [Ideas on Facilitating the Building of Defense Technological Innovation System in China]," 重庆社会科学 [Chongqing Social Sciences] 11 (2007).

3 Liu Huaqing, "坚定不移地沿着建设中国特色现代化军队的道路前进" [Moving Forward Unswervingly Along the Road of Building a Modernized Military with Chinese Characteristics], June 2, 2004, <http://politics.people.com.cn/GB/8198/65833/65839/66928/4514378.html>.

later reduced to seven), to the system applied in April 1988, which allowed the co-existence of government organs and military industrial group corporations. These included the Ministry of Aeronautics and Astronautics Industry, the Ministry of Machine Building and Electronics Industry, China National Nuclear Corporation, and China North Industries Group Corporation (NORINCO).

Building a Defense Innovation System Based on Comprehensive Promotion of Civil-Military Integration (1992 to Present)

Following Deng Xiaoping's 'Southern Tour' in 1992, China entered a new phase—establishing a socialist market economy system and taking the principle of “civil-military integration” as the goal of defense system innovation. The Party's third generation of central collective leadership under Jiang Zemin proposed to “guarantee defense technology and equipment construction throughout national economic and technological development for equipment development with less investment but more benefits.”⁴ During this period, the Chinese defense innovation system regained its high status in regards to resource allocation by the central government, and the sophistication of Chinese military equipment achieved an historic leap forward centered on comprehensive independent development and supported by imports.

Major adjustments were made in the systems of defense innovation and armaments management during this period. Among them, most significant adjustment was that the former civilian-military COSTIND was replaced in April 1998 by a new civilianized version that reported only to the State Council. Meanwhile, the PLA General Armament Department, based on the military elements of the COSTIND and the Equipment Department of the General Staff Department headquarters, was set up under the leadership of the CMC. On July 1, 1999, ten Chinese military-industrial enterprise groups were established through reorganization of the top five military-industrial corporations. These were the China National Nuclear Corporation, China Nuclear Engineering Group Corporation, China Aerospace Science and Technology Corporation, China Aerospace Science and Industry Corporation, China Aviation Industry Corporation I (AVIC I), China Aviation Industry Corporation II (AVIC II), China State Shipbuilding Corporation, China Shipbuilding Industry Corporation, China North Industries Group Corporation and China South Industries Group Corporation. In 2001, China Electronic Technology Corporation was founded by the former military-industrial research institute, the Ministry of Industry and Information, becoming the eleventh largest military-industrial corporation in China.

Reform and adjustment continued in the face of rebuilding the defense innovation system under market economic conditions. In 2008, China, guided by the idea of establishing the giant department system proposed at the 17th National Congress, decided to establish the Ministry of Industry and Information Technology and disband COSTIND and the Ministry of Information Industry. The State Administration of Science, Technology, and Industry for National Defense (SASTIND) was established under the new Ministry of Industry and Information Technology. In November 2008, AVIC I and AVIC II were merged into one entity, the Aviation Industry Corporation of China.

At the 15th collective learning of the Political Bureau of the Central Committee in July 2009, President Hu Jintao stressed that: it is necessary to make clear the strategic objectives, tasks, and measures for promoting the development of civil-military integration, establish and improve armaments research and production system, military personnel training system, and military security system based on civil-military integration, improve defense mobilization system, and continue to break new ground for the development of civil-military integration.⁵

4 Jiang Zemin, 论国防和军队建设 [*On National Defense and Army Building*] (Chinese People's Liberation Army Publishing House, 2003), 357–59.

5 Chairman Hu Jintao Stressed during His Presiding over the 15th Collective Learning of the Political Bureau of the Central Committee of the CPC to Develop Civil-military Integration with Chinese Characteristics and Promote Positive Interaction between Defense Building and Economic Development, <http://news.cctv.com/china/20090724/108438.shtml>.

The Structure of the Defense Innovation System

The defense innovation system is actually a complex that integrates personnel, research and production units, knowledge of science and technology (S&T), and the facilities required to meet the demands of defense and military build-up. Similarly to other countries, the Chinese defense innovation system involves the government, the military, enterprises, universities, research institutions, and supporting service systems.

The Government and the Military

The government and the military are responsible for developing strategic plans according to international situations and proposing project requirements for major weapons and equipment. This process mainly involves the department for defense management, SASTIND (attached to the Ministry of Industry and Information Technology), which represents the government; the PLA General Armament Department, which represents the military; the State-owned Assets Supervision and Administration Commission of the State Council; and military industrial enterprise groups representing enterprises. It also includes the Ministry of Science and Technology, the Ministry of Education, the National Development and Reform Commission, the National Natural Science Foundation of China (attached to the State Council), as well as the PLA's General Staff Headquarters and General Logistics Department and other related departments representing the military. As the dominant powers of defense innovation, the government and the military formulate policies on defense innovation, reform related management and operation systems, and decide how to allocate innovation resources from the perspective of national strategic management.⁶

Military Industrial Enterprises

Military industrial enterprises are considered the behavioral agent of military equipment development and are responsible for research on key and cutting-edge technologies. They are the principal body that carries out defense innovation and their main functions are to manufacture core systems and platforms, and to develop and apply advanced technologies.⁷ The key to the success of defense projects lies in the technical capacity and economic strength of military industrial enterprises as well as coordination and cooperation among them. Military industrial enterprises are generally equipped with independent research and development organizations, which are mainly responsible for developing core defense technologies, achieving technical transformation and creative application, and fulfilling such innovation tasks as tackling problems in key technologies, verifying technology integration, and developing core systems and platforms. Many research institutions also have a fundamental and applied research component.

Universities and Research Institutions

This category includes universities, military industrial universities, military academies, and research institutions attached to the State and the military. They are responsible for carrying out advanced research in defense technology, reserving scientific and technological talent for military equipment research and production, assisting military industrial enterprises in carrying out military research and production, and actively developing other military research according to end-user requirements and to their institution's comparative advantages. More and more non-defense universities and research institutions have engaged in defense technology in recent years and have participated in the study, design, manufacturing, and testing of defense projects or facilities.

6 Hou Guangming, “加强国防科技组织创新，推动寓军于民创新体系建设” [Enhancing Organizational Innovation for Defense R&D and Facilitating Development of Civil-Military Integration Innovation System], in 国防科技组织创新前沿科学问题 [The Frontiers of Organizational Innovation for Defense R&D], (Science Press, 2007).

7 Zhang Renkai, “我国国防科技创新体系建设的战略思考” [Strategic Ideas on Building Chinese Defense Technological Innovation System], 科技与经济 [Science & Technology and Economy] 12 (2007): 23–24.

Supporting Service Systems

Supporting service systems are indispensable for defense innovation. Guided by the principles of resource sharing, neutral evaluation, and whole-process guarantee, the innovation supporting service system aims to facilitate the flow of innovation elements like information, knowledge, and talents, and to provide basic technical support for defense innovation activities, decision-making, and management, such as preparation and promotion of standards, information flow and knowledge management, technical agency and achievement transformation, and intellectual property management. The defense innovation service system covers intermediaries like incubators, productivity promotion centers, appraisal and consultant agencies, professional training bodies, and science-technology information centers. As a bridge connecting all innovation bodies, the supporting service system gives full play to many comparative advantages generated during the general social division of labor. It facilitates interactions among all innovation bodies and strengthens information exchanges between the military and the public, forming a service network on an industrial scale and boosting defense innovation.

Lessons Learned

Over the past 50 years, China has not only made great achievements in areas such as “two bombs and one satellite” and manned space missions but has also laid a relatively complete foundation for the defense industry, contributing to China’s defense modernization and economic development. Valuable lessons that will contribute to further progress include the following:

Develop a Firm Strategic Will

Defense innovation primarily requires the courage and insight of leaders, a long-term innovation and development strategy, as well as the will to never give up until the goal is reached. Facing severe conditions and the weak foundation of China in the 1950s–1960s, the Party’s first generation of central collective leadership resolutely decided to strengthen defense technology development, showing very strong strategic foresight and willpower. Although the Soviet Union had withdrawn their experts and the country faced severe financial difficulties, China developed cutting-edge defense technologies unswervingly and succeeded in programs such as “two bombs and one satellite.” China’s strength in the field of defense technologies has become an important symbol for comprehensive national strength and great power status and has laid a solid foundation for innovation and development in the future.

Develop with Priorities and Overall Planning

Where and how to promote innovation needs to be carefully examined, especially when resources are limited. Overall planning and long-term accumulation of knowledge are also required to achieve innovation. Thanks a good balance of keeping priorities and enhancing basic S&T capabilities, China has achieved a relatively complete system of defense technology with limited resources, demonstrating that equal attention should be paid to the development of basic S&T capabilities and long-term knowledge and technology accumulation instead of merely focusing on a few specific projects when boosting independent defense innovation.

Develop Independent Capabilities

Defense technology is crucial to national security and the outcome of wars. Being aware that the most advanced defense technology cannot be bought, China chose to follow the road of independent research and development. Although it created challenges in the early days of the PRC, this road has guaranteed the long-term development of Chinese defense technology. Strategic requirements meant that China had to prepare long-term defense technology development plans, carry out major S&T projects, maintain stable scientific innovation teams, and persevere

in defense research and development. These achievements have promoted the sustainable development of Chinese defense technology and are beneficial to driving the development of many other S&T areas.

Harness Strong Social Mobilization Based on the “Whole Nation System”

In terms of defense technology development, China has adopted the organizational model of gathering superior forces across the country to carry out great social collaboration. The Second Ministry of Machine-Building Industry and the Seventh Ministry of Machine-Building Industry were provided with sufficient manpower and material resources, and the contributions of the whole country guaranteed the success of “two bombs and one satellite.” In terms of related supporting fields, both the best talent and the most advanced equipment were devoted to tackling the hardest problems in defense technology. The achievements of Chinese defense innovation, in this sense, should be attributed not only to the defense technology system but also to great collaboration around the country. Although China is developing socialist market economy today and is introducing market mechanisms into major defense technology projects, both the “whole nation system” and social collaboration still play decisive roles in this process.⁸

Challenges

It should also be noted that many challenges were created during the formation of the new system. Chinese defense technology is still far behind that of the developed countries in terms of independent innovation. It has failed to build an effective innovation motivation system. It is, therefore, necessary for China to face up to the existing complicated contradictions as it continues to improve defense innovation capabilities.

Management and systems: Since complete transformation of functions has not yet been achieved within government authorities for Chinese defense technology development, they are still inadequate in macro coordination and policy management and are unable to provide effective services for defense innovation development.⁹

The institutional environment for defense innovation remains to be improved. Full market competition has not yet been seen in defense innovation due to market segmentation and industrial monopoly. Market segmentation makes it difficult to realize complete integration of the capital, technology, and human resources markets, and it is also hard for industrial monopolies to introduce competitive mechanisms and other main tools of innovation. Therefore, remains difficult to bring the full internal innovation power of defense technology into play through effective competition. Although explorations have been made in Chinese defense technology in recent years, laws and policies that promote independent innovation remain to be established under market economy conditions. Lagging reforms and inflexible mechanisms are still problems restricting defense innovation.

Operating mechanisms: Achieving an integrated innovation system remains a significant stumbling block for the defense industry, and mechanisms to integrate the advanced technologies of all fields effectively remain elusive. The Chinese defense technology system is still relatively closed to employing civil technologies. Although rapid growth has been witnessed in civil technologies throughout China in recent years and some SMEs are equipped with a number of core technologies, it is still important to narrow the “information gap” between military and civil technologies to adapt to new situations and find ways to introduce advanced civil technologies into the field of defense technology.

Primitive innovation: China has played catch up with other countries in the field of defense technology for a long time without any truly original achievements. Improving original innovation capability has been on the Chinese

8 Dong Baotong, “国防科技创新的战略地位和历史经验”[Strategic Position of and Historical Experience in Defense Technological Innovation], 国防科技工业 [Defense Science and Technology Industry] 1 (2007).

9 Zhang Yuanjun, “必须消除影响国防科技创新的体制性障碍” [Systematic Obstacles Influencing Defense Technological Innovation Must Be Removed], 国防科技工业 [Defense Science and Technology Industry] 1 (2007).

agenda alongside other priorities such as growth in national power and economic and technological strength. Even so, it is essential to give more support to original innovation to guarantee the development of China's defense technology.

Equal stress on major technical projects and basic capabilities: Major technical projects are extremely critical to progress in innovation. In recent years, China has started many major technical projects (such as a new generation of hi-tech equipment, its lunar exploration program, large aircraft, and advanced nuclear power plants) and brought breakthroughs to many technical fields in a systematic manner. However, it is still difficult to meet the demands of fundamental research for Chinese defense innovation. In fact, the foundation of the Chinese defense S&T industry is innately weak. For a long time after the founding of the State, fundamental research was driven by model missions, and China's spending on fundamental research is still woefully inadequate. Recently, substantial growth has been achieved in scientific equipment research funds and basic research investment as China has paid more attention to the defense technology and equipment development; however, fundamental research investment still accounts for a smaller proportion of the total scientific equipment research funds, with limited breakthroughs made in key technical areas.

Trends in Chinese Defense Innovation

Defense technology is an important part of Chinese innovation system and is also considered a cornerstone to maintaining the national security and economic development of China. To continue to progress, China will need to build on the following trends along its defense innovation path.

Building A Defense Innovation System of Civil-Military Integration

Former Director-General of SASTIND Chen Qiufa has pointed out that the defense innovation system is an important part of any national innovation system, and building a defense innovation system of civil-military integration is the basic guarantee for promoting the independent innovation capability of the defense S&T industry and the top task for building an advanced defense S&T industry.¹⁰ Indeed, building such a system has been one of China's major goals in recent years. In March 2011, "civil-military integration" planning was listed in the outline of the Twelfth Five-Year Plan. In September 2012, the Central Committee and the State Council jointly issued "Suggestions on Deepening Scientific and Technical System Reform and Facilitating the Building of a National Innovation System," putting forward specific requirements for speeding up innovation-oriented national construction and making overall plans to build a defense innovation system of civil-military integration. Following the strategic idea of developing civil-military integration with Chinese characteristics established at the 17th National Congress, the 18th National Congress decided on a series of strategic measures from "establishing armaments research and production systems, military personnel training systems and military security systems" to "strengthening strategic plans and system and mechanism building and legislation development of civil-military integration development."¹¹ On the whole, this trend will be strengthened in the future.

Stressing Independent Innovation

Defense innovation must be enhanced by improving independent innovation capability. Increasing efforts to improve independent innovation capabilities in defense technology was stressed at the 18th National Congress, and this trend has actively been pursued in Chinese defense innovation over the past few years. As early as in 2007,

10 Chen Qiufa, "坚持创新驱动发展, 建设先进的国防科技工业" [Sticking to Innovation-driven Development to Build an Advanced Defense Science and Technology Industry], 国防科技工业 [Defense Science and Technology Industry] 11 (2012).

11 Commentator, "创新驱动, 强军富民" [Innovative Driving Force to Strengthen the Nation and Enriching the People], 国防科技工业 [Defense Science and Technology Industry] 11 (2012).

Zhang Yunchuan, then director of COSTIND, stated that it is a must for defense technology to improve its independent innovation capabilities, innovate development ideas, and strive to achieve “transformations in three respects.” First, it is necessary to transform from the mode of tracking for development to independent innovation in terms of development principle, so as to get rid of the restrictions of the tracking, research and imitating mode as soon as possible, build the concept of innovation for business, encourage exploration, master core technologies, and enhance innovation capability and stimulate creativity constantly. Second, it is critical to transform from a product-focused approach that overlooked foundations to harmonious development between products and foundations. This will require paying close attention to technology development trends, strengthening research in fundamental and cutting-edge technologies, and laying a scientific foundation for independent innovation. Third, the development mechanism should be transformed from military and civil isolation and closed development to civil-military integration. This means to drive mutual promotion and collaborative development between military and civil technologies and industries through interactions between technologies and talents and mutual transformation of S&T achievements.¹²

Building Basic Capabilities

China is keenly aware that it must strengthen its basic defense technology capabilities. It was made clear in the “Outline for the Medium and Long-term Scientific and Technological Development Plan on Defense Science and Technology Industry (2006–2020)” that it is essential to strengthen research in fundamental and cutting-edge defense technologies; deploy a number of projects in fundamental and cutting-edge defense technologies, common and key technologies, and technological base; make breakthroughs in many major fundamental, cutting-edge, and common technologies; enhance building of a high-level technological base and capabilities; shape overall strengths that can generate major technical discoveries and inventions to boost the building of fundamental capabilities; carry out capability-based technological projects according to the principles of fundamentality, integration, and promotion; facilitate industrial technology upgrades and applications; strengthen base product engineering and integration of cutting-edge technology systems, and solve basic bottlenecks that restrict hi-tech armaments research and production. Foundation enhancement is also the focus of the Twelfth Five-Year Plan for defense technology.¹³

Building Defense Innovation Systems and Mechanisms

Vigorous promotion of system and mechanism innovations will be an important trend in Chinese defense innovation. However, scientific research production and construction of weapons and equipment currently face such problems that the market mechanism remains inefficient and government administration and supervision is ineffectual. According to the Department of Civil-Military Integration Promotion of the Ministry of Industry and Information Technology, more efforts should be made to further the opening up of this market, so as to guide social resources to engage in the field of armaments research and production.

First, more efforts should be made to open up armaments research and production. This requires keeping a foothold in the national industrial base, giving priority to military products, focusing on main military-industrial bodies, and expanding the scope of coordination according to armaments development strategies and plans. Moreover, social resources should be guided to engage in capability building of military products, with general abilities further made public to introduce them to the development of civil industry and form an open, nationwide, capability development structure with classified management and orderly competition.

12 Zhang Yunchuan, 新时期国防科技工业的发展与改革 [Development and Reform of Defense Science and Technology Industry in the New Era], http://www.gov.cn/zwhd/2006-10/22/content_420113.htm.

13 Chen Qiufa, “贯彻落实”十二五”规划纲要，努力建设先进的国防科技工业” [Implementing the Outline of the “12th Five-Year Plan” and Striving for an Advanced Defense Science and Technology Industry], 国防科技工业 [Defense Science and Technology Industry] 5 (2011).

Second, the market access and exit system for military products should be improved. This requires revising the license directory of armaments research and production and releasing it publicly, establishing and improving the withdrawal system for armaments research and production, solving problems concerning security and secrecy, maintaining capabilities and transferring tasks when enterprises and public institutions withdraw from the armaments research and production system, and strengthening the coordination and convergence of the armaments research and production licensing, qualification examination, and management system targeting armaments manufacturing units, and the confidentiality, qualification examination, and certification system targeting armaments research and production units.

Third, it is critical to approve policies conducive to fair competition. This requires speeding up the issuance of supporting measures and methods regarding investment system reform in the defense S&T industry, reforming current tax policies on military products, implementing unified tax policies among enterprises and public institutions that engage in armaments research and production, and further promoting government investment administration and developing the same investment policies among enterprises and public institutions undertaking research and production of the same kind of armaments.¹⁴

Liu Jianwei, Hao Chaoyan, Zhang Xiao and Guo Huizhi also contributed to this paper. The views expressed in this paper are those of the authors and do not represent any institute, organization, or entity.

14 “坚持走中国特色军民融合式发展道路，提高国防科技工业现代化水平” [Sticking to Develop Civil-Military Integration with Chinese Characteristics to Improve the Level of Modernization of Defense Science and Technology Industry], <http://www.miit.gov.cn/n11293472/n11293832/n11294072/n11302465/14461628.html>.