



# On optimization of civil-military coordinated development mechanism of defense science, Technology and industry in major countries

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**Abstract.** The national defense science, technology and industry is an important material and technical basis for a country's national defense construction and security. With the gradual advance of the new round of the military reform, the major countries in the world are striving to promote the competitiveness of the defense science, technology and industry in order to win their development opportunities. The military civilian coordinated development is the only way to enhance the competitiveness of the national defense science, technology and industry. The optimized military civilian cooperation mechanism of the national defense science, technology and industry can make the military civilian cooperation development of the national defense science, technology and industry in an adaptive state. When the external conditions are uncertain, it can automatically respond quickly to achieve the optimal goal. Therefore, the major countries in the world have taken measures to optimize their national defense science, technology and industry military civilian coordinated development mechanism. The mechanism consists of four elements: the competition mechanism is the core, the evaluation mechanism is the key, the supervision mechanism is the guarantee, and the incentive mechanism is the driving force. The United States, Russia, the United Kingdom, Japan and other countries have their own characteristics and experience in optimizing the military civilian coordinated development mechanism of their national defense science, technology and industry. These characteristics and experiences enlighten us that in optimizing the mechanism of coordinated development of the defense science, technology and industry, we need to strengthen the leadership system, attach importance to the construction of the legal system, and reflect Chinese characteristics.

**Keywords:** Defense science, technology and industry, Civil-military coordination, Mechanism, Optimization.

## 1 Introduction

The defense science, technology and industry is a national strategic industry, an important material and technological foundation for the national defense construction and national security, as well as an important symbol and embodiment of the comprehensive national strength and the great power status. It is not only the most direct material and technological basis for the change of the war form, but also an important pillar for a country to win the military confrontation and the market competition. It also represents the overall industrial level of a country and is an important indicator of the competition between countries.[1] It is precisely based on the strategic position of the defense science and technology industry that enhancing its competitiveness has become the common pursuit of all countries in the world. Especially with the gradual advance of the new round of the military reform, many countries have paid great attention to the improvement of the competitiveness of the defense science, technology and industry in order to win the development opportunity and strive for the initiative.

The coordinated development between the military and civilian is the only way for the countries to enhance the competitiveness of the national defense science, technology and industry. By breaking the boundary between the military and civilian use and putting the development of the defense science, technology and industry in the base of the entire national economy, the military-civilian coordinated development not only expands and consolidates the base of the defense science, technology and industry, but also contributes to the development of the national economy and enhances the independent innovation capability of the defense science, technology and industry.[2] Now, with the rapid development of the science and technology, many new and high technologies that are crucial to the military affairs, such as the Internet of Things, the big data, the artificial intelligence, the advanced materials and advanced manufacturing technologies, have become increasingly obvious driven by the civilian market. The boundaries between the military technology and the civilian technology are increasingly blurred, and the military technology and the civilian technology are developing in an increasingly coordinated direction. The military civilian coordinated development, with its unique strategic advantages, is increasingly becoming the goal orientation of the construction and development of the national defense science, technology and industry around the world.

The mechanism is the basis of the actual operation of the system development, and plays a fundamental and fundamental role in the system. The mechanism of the civil-military cooperative development of the defense science, technology and industry refers to the relationship and function of each component element and operation link in the system of the civil-military cooperative development of the defense science, technology and industry. The optimized military civilian cooperation mechanism of the national defense science, technology and industry can make the military civilian cooperation development of the national defense science, technology and industry in an adaptive state. When the external conditions are uncertain, it can automatically respond quickly, adjust the original strategies and measures, and achieve the optimal goal. It is precisely on this basis that the major countries have taken measures to optimize the mechanism of the coordinated development between the military and civilian sectors of

the defense science, technology and industry, and have achieved significant economic, military and social benefits in order to enhance the competitiveness of the defense science, technology and industry, promote the leapfrog development of the weapons and equipment, and achieve the healthy and rapid development of the national economy. So, on the basis of revealing the composition elements and operation mechanism of the mechanism of the civil-military synergistic development of the defense science, technology and industry, this paper summarizes the practices and experiences of optimizing the mechanism of the civil-military synergistic development of the defense science, technology and industry in major countries, and on this basis discusses the enlightenments of these practices and experiences to China.

## **2 Elements and operation mechanism of military-civilian cooperative development mechanism of defense science, technology and industry**

### **2.1 Elements of military-civilian cooperative development mechanism of defense science, technology and industry**

From the perspective of connection and movement, the military civilian coordinated development mechanism of the defense science, technology and industry contains several problems. The First is how to make all kinds of the enterprises, including the civil enterprises, have the opportunity to participate in the military research and production, and it is a problem of breaking the monopoly of the traditional military enterprises on military production and establishing a competition mechanism. The second is how to make all kinds of the enterprises, including the civilian enterprises, have the power to produce the military products, and it is an incentive mechanism to establish the problem. The third is how to make the military production activities of all kinds of the enterprises, including the civilian enterprises, meet the military needs, and it is a problem of establishing a supervision mechanism. The last is how to objectively evaluate the effect of the various enterprises, including the civilian enterprises engaged in the military scientific research and production activities, so as to provide a basis for adjusting the corresponding policies, so that all kinds of the enterprises can better participate in the military scientific research and the production activities, and it is a problem of establishing an evaluation mechanism.[3]

The competition mechanism is to change the way of the allocating resources solely by the administrative means under the planned economy system, and to select the task undertaking units through the appropriate competition in the military scientific research and production, so as to break the closed monopoly. The evaluation mechanism is based on the scientific technical and economic analysis and evaluation of the key military projects to determine the implementation plan, and the establishment of a strict responsibility system, to strictly manage and evaluate the whole process of the project implementation and to prevent the risks. The supervision mechanism is to put the military research, the production, the construction, the procurement, the service and other aspects of the work under the strict supervision, timely understanding of the real

situation, find and correct various problems. The incentive mechanism means that effective the policies and measures should be adopted to stimulate and mobilize the enthusiasm of the relevant units and individuals to undertake the military tasks and promote the smooth development of the weapons and equipment.

## **2.2 operation mechanism of military-civilian cooperative development mechanism of defense science, technology and industry**

In the four mechanisms above, the competition is the core, the evaluation is the key, the supervision is the guarantee and the incentive is the power. Without the establishment of the competition mechanism, it is impossible to bring the national defense construction into the national economic construction without breaking the closed monopoly of the national defense science, technology and industry. Without the establishment of the evaluation mechanism, it is impossible to objectively evaluate the effect of various subjects participating in the military scientific research and production, and the corresponding policies may lack scientific basis. Without the establishment of the supervision mechanism, it is impossible to regulate the behavior of various subjects and make them act in accordance with the requirements of the military economy. And without the establishment of the incentive mechanism, we cannot mobilize the enthusiasm of all kinds of subjects to participate in the military scientific research and production activities. To bring the national defense construction into the national economic construction and let all kinds of the enterprises, including the civil enterprises, engage in the military research and production activities, on the one hand, we should open the door to them, on the other hand, we should ensure that their behavior is standardized and meets the needs. The establishment of the four-mechanism is the guarantee to achieve these two points.

## **3 Main practices and experiences of world's major countries in optimizing civil-military coordinated development mechanism of defense science, technology and industry**

### **3.1 Main practices and experience of United States**

The United States is the first country to propose the coordinated development of the defense technology, industry, military and civilian. In recent decades, the United States has adopted a series of policies and measures to achieve the military civilian integration by optimizing the military civilian coordinated development mechanism of the defense science, technology and industry. The first is to focus on promoting the civil military integration through the promulgation and formulation of laws and regulations. Since 1990, the US Congress has passed a series of important bills and policies, such as the National Defense Authorization Act and the Federal Acquisition Reform Act, to encourage the acquisition of the technologies and products from the civilian enterprises, and strive to build a national science, technology and industry base for the integration

of the military and the civilian.[4] The second is to set up the functional organizations to implement and manage the major issues related to the coordinated development of the defense-related science, technology and industry. In the United States, the main institutions responsible for promoting the coordinated development of the defense science, technology, industry, military and civilian development at the macro-control level include the Congress, the President's National Council on Science and Technology, and the President's Bureau of Science and Technology Policy. In addition, the Deputy Secretary of Defense, the Defense Advanced Research Projects Agency and the Technology Transfer Office of the Ministry of Defense are responsible for the implementation of the science and technology programs. The third is to open the industrial chains and innovation entities that integrate the military and civilian sectors. There are a large number of the military-civilian enterprises in the United States. With the encouragement and support of the government, they operate in accordance with the laws of the market economy and produce the military goods whenever there is a demand for them and civilian goods whenever there is a demand for them. At present, almost all the weapons development, research and production projects of the US Department of Defense are carried out by the military-civilian defense technology and industry enterprises through contracts. The fourth is to improve the foundation of the defense science, technology and industry for the military-civilian integration. In the early 1990s, the U.S. government promoted the reform of the defense science, technology and industry, and proposed to integrate the U.S. defense science, technology and industry base into a larger civil industry base. Guided by the reform of the defense procurement, the U.S. government guided the reorganization and merger of the defense industry enterprises, formed a centralized advantage, played a market role, broke the boundaries between the military and the civilian in terms of market, technology, standards, laws and regulations, and constantly optimized the defense science, technology and industry base of the military civilian integration.

In order to digest and absorb the surplus national defense production capacity, the United States vigorously promotes the policy of transferring the military production to the civilian production, timely transfers the military science and technology to the civilian fields, promotes the civilian and marketization of the military science and technology, and improves the transformation and reuse of idle national defense assets. Through the implementation of the military civilian integration of the defense science, technology and industry, the U.S. economy has grown steadily at an average annual rate of 2.7%, driving the United States into the New Economy Era. [5] By the end of the 20th century, the United States had basically achieved the integration of the military research and production with the national industrial base.

It is precisely because of the path of the military civilian integration of the defense science, technology and industry, and the optimized coordinated development of the U.S. defense science, technology and industry between the military and civilian has made the economy and the military interact and promote each other on the whole. By virtue of the advantages of the coordinated development of the military and civilian sectors, the United States has been able to give full play to the radiating and driving role of the military technology in the national economy and maintain a strong momentum of the economic development. Some technologies developed for the military purposes,

such as the Apollo moon landing project, the information superhighway project, and the missile defense project, have produced a huge driving effect after being transferred to the civilian use, which has greatly promoted the development of the national economy.

### **3.2 Russia's main practices and experience**

During the Cold War, the Soviet Union established a large-scale defense science, technology and industry system that separated the military from the civilian based on the purpose of gaining military advantage over the United States. Its defense science and technology industry and civil industry are basically in a state of "two skins". The economy and military are separated into systems and operate in a closed manner. The military investment only produces military benefits, and the economic investment only produces economic benefits. As a result, the military industry isolated from the civil industry has become an underfed "monster". As a result, the Soviet Union spent a lot of valuable resources that should have been used for the economic development, which eventually led to the collapse of the national economy.<sup>[6]</sup>

After the disintegration of the Soviet Union, Russia earnestly summarized the historical lessons in this regard, reformed the defense science, technology and industry system with the national will, and insisted on putting the coordinated development of the defense science, technology and industry between the military and the civilian in a strategic position, the Special Plan for the Transformation of the National Defense Industry of the Russian Federation from 1995 to 1997, the Special Plan for the Transformation of the National Defense Industry from Military to Civilian and Restructuring from 1998 to 2000, the Reform and Development Plan for the National Defense Industry of Russia from 2001 to 2006, and the Development Strategy for the Russian Aviation Industry before 2015 have been formulated successively.

The Russian President's Science and Technology Policy Committee has specially formulated a detailed plan for the development of "dual-use technologies", and has determined a series of the key development projects for the dual-use technologies, including the microelectronics, the optoelectronic devices, the artificial intelligence systems, the aerodynamic systems, the nuclear technology, etc. In addition, Russia has also established a number of super large military civilian cooperative financial industrial groups that closely integrate the scientific research, design, testing, production, sales and financing. After more than 20 years of the practice of "shifting the military production to the civilian production", while Russia continues to maintain its strong military strength, its national economy has also developed rapidly, and its overall national strength has also been greatly improved.

### **3.3 UK's main practices and experience**

After the end of the Cold War, the overall military and civilian development has also become the basic development strategy of UK's defense technology industry. In 1999, the British Ministry of Defense established the National Defense Technology Transformation Agency under the former National Defense Identification and Research

Agency to focus on the civil technology serving the national defense science and technology. In terms of the utilization of the civil scientific research institutions, the British government encourages the advanced civil scientific research institutions to participate in the military technology development by increasing the number and amount of defense scientific research contracts with the civil scientific research institutions.

In order to promote the transfer of the military technology to the civilian use, the British Ministry of Defense has also implemented a series of the military to the civilian programs, including the “Extrade Partmental Research Program”, the “Private Fund Initiative”, the “Strategic Alliance Program”, and established some dual-use technology centers, such as the Structural Materials Center, the System and Software Engineering Center, and the Supercomputer Center. [7] In order to promote the development of the dual-use technologies, in February 2001, the British Ministry of Defense also issued the National Defense Science and Technology Innovation Strategy for the 21st Century. The military civilian coordinated development strategy of the defense science and technology industry has not only become an important means for Britain to improve its defense science and technology level and competitiveness, but also laid a solid foundation for its ability to develop and produce the weapons and equipment with superior quality and performance to its competitors and strong affordability in economy.

### **3.4 Japan’s main practices and experience**

Japan is a typical military-civilian integration country. There are almost no independent state-owned military enterprises in the strict sense in Japan. Its production system of the national defense science, technology and industry is a production system that thoroughly integrates the normative construction into the economic construction. As a result of adopting the development model of the military and civilian integration, Japan actually has huge potential for the national defense, which can be quickly converted into the national defense capability.<sup>[8]</sup> Most Japanese military enterprises can produce the civilian products at the same time as the military products. After mastering the military technology, they can also be used in the production of the civilian products, which not only enhances the competitiveness of the enterprises, but also promotes the development of the national economy.

In the process of promoting the coordinated development of the defense science, technology and industry, Japan attaches great importance to establishing and improving the mechanism for the development of the dual-use technologies and the mutual transformation of such technologies. The Japanese Defense Agency pointed out that the development of the dual-use technology can not only reduce the risk of the national investment, reduce the cost of the weapons and equipment, but also contribute to the stability of the defense technology and industry enterprises themselves. In defense procurement, Japan attaches great importance to the defense contracts as a means to actively support small and medium-sized enterprises and encourage them to develop advanced technologies with civilian or dual-use military and civil applications, so as to make full use of the achievements in the civil field to serve the national defense con-

struction. Japan has also established the systems for evaluation and review, and expanded the civilian goods ordering, so as to promote the development of the dual-use technologies and their mutual transformation.

## **4 Inspiration to China from the experience of major countries in optimizing mechanism of military civilian coordinated development of defense science, technology and industry**

### **4.1 Optimizing mechanism of military civilian coordinated development of national defense science, technology and industry requiring strengthening leadership system**

Throughout the world's major military powers' main approaches to optimizing the military civilian coordinated development mechanism of the defense science, technology and industry are promoted by a strong organizational leadership system which covers the national legislatures, the administrative organs, the judicial organs and even the private industry associations, the integrating decision-making power, the executive power and the consultation power. On the one hand, the existing organizations should be entrusted with the relevant powers and responsibilities to optimize the mechanism of the military civilian coordinated development of the defense science, technology and industry; On the other hand, the establishment of a new organization is specifically responsible for the coordination and implementation of the matters related to optimizing the military civilian coordinated development mechanism of the defense science, technology and industry. Now China is in an important period of economic and social transformation, and the reform of the administrative institutions has not achieved significant results. The old leadership system has formed a greater resistance to the implementation of the mechanism of optimizing the coordinated development of the defense science, technology and industry between the military and the civilian. Therefore, for China, optimizing the mechanism of the military civilian coordinated development of the defense science, technology and industry requires strengthening the leadership system.

### **4.2 Optimizing mechanism of military civilian coordinated development of national defense science, technology and industry requiring attaching importance to legal construction**

Strengthening the legal system is the common experience of the world's major military powers in optimizing the civil-military cooperative development mechanism of the defense science, technology and industry, which is not only the concrete embodiment of the modern spirit of the rule of law, but also the objective requirement of optimizing the civil-military cooperative development mechanism of the defense science, technology and industry. Optimizing the mechanism of the military-civilian coordinated development of the defense science, technology and industry is related to the growth



and decline of the country's military strength and the development of the national economy, so we must adhere to the rule of law. In addition, the optimization of the military-civilian cooperative development mechanism of the defense science, technology and industry is bound to encounter various obstacles, the shackles of the inherent system, the influence of backward ideas, and even the resistance of vested interests. And the most fundamental and effective countermeasure to overcome these difficulties is to perfect and optimize the legal system construction of the military-civilian cooperative development mechanism of the defense science, technology and industry. On the one hand, the law makes the optimization of the defense science, technology and industry military-civilian coordinated development mechanism gain legitimacy status, on the other hand, the state machinery as a backing to ensure the implementation of the optimization of the defense science, technology and industry military-civilian coordinated development mechanism. China is a socialist country under the rule of law and adheres to the rule of law. Therefore, to optimize the military-civilian coordinated development mechanism of the defense science, technology and industry, we need to attach importance to the construction of the legal system and bring it into the track of the rule of law.

#### **4.3 Optimizing mechanism of military civilian coordinated development of national defense science, technology and industry requiring reflecting Chinese characteristics**

Although the specific practices of the major countries to optimize their military civilian coordinated development mechanism of the defense science, technology and industry have something in common, they all reflect the characteristics of their own countries, rather than copying the practices of others. The civil enterprises and technologies are very developed in America, so it can promote the application of the civil technical standards in the military field. And Russia's civilian technology is obviously behind the military technology, so its mechanism of optimizing the coordinated development of the defense science, technology and industry between the military and the civilian is more to apply the military technology to the civilian production to solve the supply problem of necessities. China should take the road of integrating the economic construction and the national defense construction with Chinese characteristics, and promote the military reform with Chinese characteristics. China's comprehensive national strength has been significantly enhanced, and it can play a pivotal role in more international affairs. In the process of optimizing the military civilian coordinated development mechanism of the defense science, technology, and industry, China must take into account its national conditions and reflect Chinese characteristics.

## **5 Conclusion**

In essence, there is no insurmountable gap between "military" and "civilian". Under the background of the coordinated development of the military and civil technology, it is beneficial to optimize the mechanism of the coordinated development of the military

and civil technology. However, it should be noted that, on the one hand, due to the different national conditions of each country, the mechanisms chosen for the military civilian coordinated development are different. Even the same country will have different mechanisms at different stages of development. Therefore, how to optimize the military civilian coordinated development mechanism ultimately depends on such factors as the country's international environment, the national development strategy, the military strategy, the economic strategy, the science and technology strategy and the cultural strategy. On the other hand, since the coordinated development of the defense science, technology and industry between the military and the civilian is a national behavior, whether the mechanism optimization of the coordinated development between the military and the civilian can be carried out smoothly or not depends on the strength and behavior of the military, national defense departments and civil industry departments alone. From a grand strategic perspective, the key to ensure the smooth implementation of the strategy of optimizing the military civilian coordinated development mechanism of the defense science, technology and industry is to make decisions and arrangements at the national level, and the military and civilian sides jointly organize and work together to promote it.

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