Development and Reform of Defense Science and Technology Decision-Making Advisory Work in China: Postprint

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Abstract

Abstract: [Purpose/Significance] Defense technology decision-making consultation work constitutes an important component of China's defense S&T work and national decision-making consultation work, possessing profound historical accumulation and distinctive Chinese characteristics. Relevant research provides important insights for the development of China' s decision-making consultation undertaking. [Methods/Process] Using historical research and other methods, this study analyzes the developmental history and characteristics of China' s defense technology decision-making consultation work across four periods: initial establishment, exploratory innovation, stable development, and deepening reform; examines its major contributions, principal features, and historical experiences; and proposes several recommendations and measures for the transformation and innovation of China' s defense technology decision-making consultation work under new circumstances. [Results/Conclusion] China' s defense technology decision-making consultation work has made major contributions to breakthroughs in cutting-edge defense technologies such as the "Two Bombs, One Satellite," the establishment of defense S&T institutions, the building of defense S&T undertakings, and the formulation of defense S&T strategic planning. Its principal features include close integration with defense S&T research and engineering, adherence to centralized and unified military-civilian leadership, implementation of the "Three Systems," and respect for scientists and technical experts. It has accumulated historical experiences including high-level attention from decision-makers, concentrating resources to accomplish major tasks, systematic forces, and scientific management. In the new era, efforts should be made to strengthen policy and regulation guidance, flatten decision-making institutions, adopt market-oriented development concepts, form alliance-based consultation forces, implement intelligent tools and means, achieve autonomous operation and management, and quantify consultation benefits.

Full Text

The Development and Reform of China' s National Defense Science and Technology Decision-Making Consultation

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Abstract

[**Purpose/Significance**] The national defense science and technology decision-making consultation (NDSTDC) constitutes a vital component of China' s national defense science and technology (NDST) enterprise and national decision-making consultation framework, possessing substantial historical depth and distinct Chinese characteristics. Research in this domain offers valuable insights for advancing China' s decision-making consultation endeavors.

[**Method/Process**] Employing historical research methodologies, this paper analyzes the evolution and characteristics of China' s NDSTDC across four distinct periods: preliminary establishment, exploratory innovation, steady development, and deepening reform. It examines the significant contributions, principal features, and historical experiences of China' s NDSTDC, and proposes recommendations for innovation and reform under new circumstances.

[**Result/Conclusion**] China' s NDSTDC has made major contributions to breakthroughs in cutting-edge defense technologies such as the "Two Bombs, One Satellite" program, the establishment of NDST institutions, the creation of the NDST enterprise, and the formulation of NDST strategic planning. Its primary characteristics include: deep integration with defense research and engineering projects; adherence to centralized and unified military-civilian leadership; implementation of the "three institutional systems"; and consistent respect for scientists and technical experts. Historical experiences accumulated include: leadership prioritization, leveraging collective strength for major undertakings, systematic organizational capacity, and scientific management. In the new era, NDSTDC should prioritize: advanced policy and regulatory frameworks, flattened decision-making structures, market-oriented development concepts, allied organizational strength, intelligent tools and methods, autonomous operational management, and measurable consultation effectiveness.

Keywords: scientific decision-making; research advisory service; national defense system; think tank; civil-military integration

1 Overview of China' s National Defense Science and Technology Decision-Making Consultation

National defense science and technology decision-making consultation primarily refers to research and advisory services provided to defense and military science

and technology decision-making departments on major issues concerning NDST development. It represents a core component of the national defense decision-making consultation system and a crucial supporting force for national defense and military construction [1]. As a highly complex and integrated systems engineering endeavor, NDSTDC exhibits not only the comprehensive, strategic, and holistic attributes common to decision-making consultation, but also distinctive features such as adversarial nature, confidentiality, and forward-looking orientation. It is intimately connected with NDST development while also involving political, military, diplomatic, industrial, economic, and cultural domains. The work encompasses both policy advisory activities in strategy, management, technology, information, and industry, as well as research-oriented practical work including policy and regulation interpretation, strategic development formulation, planning and program evaluation, technology forecasting and assessment, and project guidance and review. It comprises not only institutions engaged in technology R&D, NDST management, intelligence, systems demonstration, staff support, and education and training, but also covers think tanks, expert consultation organizations, professional societies and associations, research institutes, and universities involved in NDST and related fields [1].

Since the 1950s, China has gradually established a scientific, rational, and comprehensive institutional and operational system for NDSTDC, making significant contributions to breakthroughs in cutting-edge technologies such as the "Two Bombs, One Satellite," the Galaxy supercomputer, "trump card" weapons, and manned spaceflight programs. This has forged a unique character and style distinct from other consultation work, marked by pronounced Chinese characteristics and defense originality, exerting profound influence on both the NDST enterprise and national decision-making consultation. Due to historical confidentiality requirements and the special military-related nature of the work, NDSTDC has not received widespread academic attention, and systematic in-depth research remains scarce, representing a treasure trove yet to be fully explored in the decision-making consultation field.

To clarify the historical characteristics and patterns of China' s NDSTDC and support its development, this paper draws on public historical materials and previous research. From an academic perspective, it employs historical and empirical research methods to analyze the developmental trajectory and features of NDSTDC, summarize its major contributions, principal characteristics, and historical experiences, and finally explore approaches and measures for advancing its reform and innovation under current circumstances.

2 Development History and Characteristics of China' s NDSTDC

Without decision-making institutions, there would be no demand for decision-making consultation. China' s NDSTDC has grown and developed alongside NDST construction and changes in the NDST leadership and decision-making system. Analyzed through historical periodization, its development can be

divided into four stages: preliminary establishment, exploratory innovation, steady development, and deepening reform.

2.1 Preliminary Establishment Period (1951–1956)

In the early years of the People' s Republic, China' s NDST foundation was extremely weak, essentially starting from scratch with only legacy arsenals from the old regime and no modern NDST to speak of. As NDST and defense industry leadership and decision-making institutions were gradually established, NDSTDC emerged accordingly.

2.1.1 Gradual Establishment of National-Level NDST Leadership and Decision-Making Institutions China' s NDST and defense industry originated from the ordnance industry. On January 4, 1951, to strengthen leadership over ordnance production and construction, the Central Military Commission established the Ordnance Industry Committee [2]. Created as an emergency leadership body to meet the needs of military production for the Korean War, it represented China' s first central-level coordinating leadership institution for defense science, technology, and production [2-3]. On April 17, 1951, the state promulgated the "Decision on Aviation Industry Construction," establishing the Aviation Industry Management Committee to strengthen unified leadership over military aviation industry and aviation weapons and equipment [4]. In July 1955, to develop China' s cutting-edge defense industry and strengthen leadership over the atomic bomb program, the Central Committee formed a three-person group consisting of Chen Yun, Nie Rongzhen, and Bo Yibo to oversee nuclear program decision-making [2]. These leadership institutions provided the foundation and primary service targets for establishing NDSTDC.

2.1.2 Soviet Advisors and Experts Played Important Guidance and Consultation Roles A severe problem facing socialist construction at that time was the shortage of scientific and technical personnel. Party and state leaders attached great importance to this issue, repeatedly urging the Soviet Union to dispatch professional technical personnel to assist China. According to statistics, from 1950 to 1953, over 1,100 Soviet experts were dispatched to China; by the end of 1953, 741 had returned, while 342 remained in factories and mining enterprises, including more than 200 experts in NDST and defense industry-related fields [5]. Soviet advisors and experts participated not only in national planning and program formulation but also in cutting-edge technology R&D and factory construction projects, playing roles in guidance, coordination, consultation, and technical support. They made major contributions to early-stage defense cutting-edge technology R&D and prompted China to establish its own decision-making consultation capacity.

This period represented the initial preparatory stage of consultation work, with sporadic activities gradually emerging. Key characteristics included: the gradual establishment of a number of decision-making institutions, which formed the

foundation for NDSTDC, though specialized consultation institutions and forces had yet to be created; limited and scattered decision-making demands related to technology R&D and major engineering development; and Soviet advisors and experts serving as exemplary guides for establishing consultation work—a distinctive feature of this initial phase. The weak NDST foundation resulted in a difficult start for NDSTDC, yet the strong demand for developing defense cutting-edge technologies foreshadowed greater opportunities ahead.

2.2 Exploratory Innovation Period (1956–1982)

In 1956, following the recommendations of renowned scientist Qian Xuesen, the Ministry of National Defense established the Aviation Industry Committee and the Fifth Research Academy, marking the beginning of a new era of continuous exploratory innovation for NDSTDC in an arduous environment.

2.2.1 Expert Recommendations Directly Influenced Leadership Institution Formation and Missile Industry Establishment Following the Korean War, the Central Committee decided to vigorously develop cutting-edge defense technologies such as atomic bombs and missiles, presenting a major historical opportunity for NDSTDC. On February 27, 1956, Qian Xuesen submitted the "Opinions on Establishing China's Defense Aviation Industry" to the State Council, drawing central and military commission attention to missile development [6]. Subsequently, on March 14, Zhou Enlai listened to Qian Xuesen's vision for developing China's missile technology and decided to establish the missile and aviation science research leadership institution—the Ministry of National Defense Aviation Industry Committee (referred to as the "Aviation Committee"), with Nie Rongzhen as director [2]. On October 8, China's first missile research institution, the Ministry of National Defense Fifth Research Academy (referred to as the "Fifth Academy"), was established, with Qian Xuesen as president [2]. These two landmark events were unprecedented in new China's history: scientists' recommendations directly served as the primary basis for establishing defense science and technology leadership and research institutions and creating the defense science and technology industry. The Aviation Committee and Fifth Academy represented defense science and technology leadership and management research institutions with deep scientist participation in their construction and leadership, incubating numerous original innovations and institutional prototypes for NDSTDC.

2.2.2 Large-Scale Expert Participation in Formulating the First Science and Technology Development Plan In January 1956, to organize the formulation of the 1956–1967 science and technology long-range plan, the State Council established the Science Planning Committee as a permanent high-level coordinating body for science and technology, specifically leading national science and technology development planning. On March 12, Nie Rongzhen signed and issued the "Opinions on Defense Research Projects in the Twelve-Year Science Plan," China's first relatively systematic weapons and equipment

development plan and the first large-scale, organized, systematic research and consultation task in the defense science and technology field [2]. In April, the Science Planning Committee assembled over 600 outstanding science and technology experts nationwide to formulate new China's first science and technology development plan. In the military industry sector, personnel from the Ministry of National Defense Aviation Committee, the General Staff Equipment Planning Department, and the Defense Industry Department jointly formulated the weapons and equipment development plan [2][7]. This marked the first time new China mobilized expert resources on a large scale to research and formulate a science and technology development plan, allowing experts from various industries and fields to fully exert their research and consultation roles. On May 21, to formulate military research work plans, Zhang Aiping submitted the "Preliminary Opinions on Establishing Scientific Research Work Within the Military" to the Central Military Commission, which was approved in June [8]. Thereafter, military scientific research work gradually developed, and research consultation work began to enter a formal track. By October, the "1956–1967 Science and Technology Development Long-Range Plan Outline" was essentially completed [2], signifying that China's NDST expert-intensive research consultation work had achieved initial results.

2.2.3 Establishment of Specialized NDST Leadership and Decision-Making Institutions On October 16, 1958, the Central Committee approved the Central Military Commission's "Report on Reorganizing the Ministry of National Defense Aviation Industry Committee into the Ministry of National Defense National Defense Science and Technology Committee." Based on the Aviation Committee, the Ministry of National Defense National Defense Science and Technology Committee (referred to as the "National Defense Science and Technology Commission") was established, with Nie Rongzhen as director. It served as a staff department for the Party Central Committee, State Council, and Central Military Commission to uniformly organize NDST and strategic weapons research [2]. In November, the State Science and Technology Commission (referred to as the "State Science and Technology Commission") was formed through the merger of the Science Planning Committee and the State Technical Commission, overseeing national science and technology policies, with Nie Rongzhen concurrently serving as director [2]. In April 1959, the Ministry of National Defense Fifth Academy was integrated into the National Defense Science and Technology Commission, with the new commission exercising comprehensive leadership over NDST work. Practice proved that establishing the National Defense Science and Technology Commission to achieve unified leadership over NDST work accelerated NDST development [2]. On January 5, 1960, the Central Committee decided to establish the National Defense Industry Commission as the business leadership organ for the State Council and Central Military Commission to uniformly coordinate national defense industrial production and construction [2]. On November 14, 1977, to address issues such as overlapping institutions, intersecting functions, and multiple management heads, the Cen-

tral Committee established the Central Military Commission Military Science and Technology Equipment Committee (referred to as the "Science and Equipment Commission") to unify leadership over defense science and technology research and defense industrial production [8]. These institutions served not only as NDST leadership and decision-making organs but also as staff organs for the Party Central Committee, State Council, and Central Military Commission. Their establishment gradually achieved unified leadership over NDST and promoted the establishment and improvement of the NDSTDC system.

2.2.4 Establishment of the Science and Technology Committee and Professional Groups In 1960, with Nie Rongzhen' s support, the Ministry of National Defense Fifth Academy established professional groups composed primarily of experts in scientific and technological fields to leverage the "brain trust"role of expert collectives—a form that continues to this day [9]. On July 12, 1961, to further strengthen the role of scientific and technical experts and technical leadership, Qian Xuesen proposed to Nie Rongzhen the establishment of the Ministry of National Defense Fifth Academy Science and Technology Committee (referred to as the "Science and Technology Committee") as the technical "senior advisor" to the Fifth Academy. Responsible for researching technical issues related to model development, it would provide recommendations and consultation to the Party committee and administrative leadership. This new technical consultation organizational form received full affirmation from National Defense Science and Technology Commission Director Nie Rongzhen [9-10]. On February 2, 1962, the Fifth Academy Science and Technology Committee was formally established, with 16 professional groups subordinate to it. These professional groups formulated scientific research plans and arranged pre-research projects according to model mission requirements [9-10]. The establishment of the Science and Technology Committee provided Party and government leaders with effective channels for scientific and democratic decision-making, particularly strengthening pre-research to provide adequate technical reserves for entering model engineering development. This model was later widely promoted across NDST industrial fronts and government agencies [10].

2.2.5 Establishment of Technical and Administrative Dual Command Line System In the early days of the Ministry of National Defense Fifth Academy, leadership at all levels did not fully recognize the importance of scientific management. Only after the failure of China' s first near-medium range missile launch did management receive proper attention [10]. To standardize scientific research work, on November 8, 1962, the Fifth Academy promulgated and implemented the "Interim Regulations of the Ministry of National Defense Fifth Research Academy," proposing the establishment of an effective dual command line system in model development: first, a technical command line led by chief designers, primarily consisting of a four-tier designer system comprising chief designers, deputy chief designers, director designers, and chief component designers, with each model establishing a corresponding designer system focused

on model and engineering development; second, an administrative command line led by administrative command, composed of three tiers—strategic decision-making, decision management, and organization implementation—responsible for organizational command and scheduling of several models [10]. The technical line held decision-making authority on technical matters while providing consultation and recommendation proposals to the administrative command line. The two systems formed an engineering organization and management system that was mutually coordinated and supportive while having clear division of labor and mutual checks and balances. In 1977, National Defense Science and Technology Commission Director Zhang Aiping further developed the dual command line system by establishing the chief designer system and chief scheduling command system: the chief designer system, composed of scientists, was a cross-establishment, cross-departmental technical command system responsible for development technical design and scientific research project tackling; the chief scheduling command system was responsible for planning and scheduling, organizational command, and financial and material support, fully supporting the chief designer system and absolutely not allowed to shake, interfere with, or influence the will, plans, and actions of the chief designer system [8]. The dual command line system represents a major creation in China' s NDST field and a complete and effective scientific management system in the world scientific community, which many scientists still praise and deeply miss [8].

During this period, NDSTDC began exploratory innovation, gradually forming a system and maturing. Key characteristics included: gradual stabilization of NDST decision-making organs and departments, increasingly achieving centralized and unified leadership and organic integration with national science and technology work; decision-making consultation work shifting from initial scattered, unconscious activities toward systematic and proactive directions; and within the NDST system, the innovation of organizational management forms such as the Science and Technology Committee, professional groups, and technical-administrative dual command lines—unique creations in NDSTDC.

2.3 Steady Development Period (1982–2016)

The establishment of the National Defense Science, Technology and Industry Commission in 1982 marked the maturation and stabilization of China' s NDST decision-making system, signaling that NDSTDC had entered a formal track and formed a complete and stable force system.

2.3.1 Establishment of the National Defense Science, Technology and Industry Commission and Its Science and Technology Committee On May 10, 1982, the State Council and Central Military Commission approved the "Request for Instructions on Adjusting the Management System of National Defense Science, Technology and Industry." The National Defense Science and Technology Commission, the National Defense Industry Office, and the Science and Equipment Commission Office of the Central Military Commission were

merged to form the National Defense Science, Technology and Industry Commission (referred to as the "National Defense Science, Technology and Industry Commission"), officially established on July 29. It served as the supreme command for the Central Military Commission in charge of weapons and equipment development, research, testing, finalization, and production [8-9]. From then on, China' s cutting-edge and conventional weapons research and production had a core and supreme institution for unified leadership, planning, deployment, and coordination, playing a positive role in NDST industrial development. At the end of the 20th century, as the worldwide new military revolution surged, to accelerate weapons and equipment construction, in April 1998, the Central Military Commission decided to form the General Armament Department (referred to as "General Armament") based on the National Defense Science, Technology and Industry Commission, responsible for centralized and unified leadership over military weapons and equipment construction to promote national defense and military modernization [11]. In the same year, the State Council separately established the National Defense Science, Technology and Industry Commission, primarily responsible for organizing, managing, and supervising the formulation and implementation of defense industry plans, policies, standards, and regulations, which was reorganized into the State Administration of Science, Technology and Industry for National Defense in March 2008 [12]. The evolution from the National Defense Science, Technology and Industry Commission to the General Armament, the new National Defense Science, Technology and Industry Commission, and the State Administration of Science, Technology and Industry for National Defense reflected the gradual stabilization of a centralized and unified NDST leadership and decision-making system, thereby laying the foundation for the mature development of decision-making consultation work.

On August 14, 1982, shortly after the establishment of the National Defense Science, Technology and Industry Commission, the Central Military Commission officially issued an order, approved by the Central Committee of the Communist Party, to establish the National Defense Science, Technology and Industry Commission Science and Technology Committee (referred to as the "National Defense Science, Technology and Industry Commission Science and Technology Committee"). Inspired by the experience of the Ministry of National Defense Fifth Academy Science and Technology Committee and the East China Military Region Technical Guidance Committee, Zhang Aiping decided to establish this committee, which held leadership power in science and technology development equivalent to that of National Defense Science, Technology and Industry Commission leadership, serving as a substantive organ for science and technology leadership work with 19 professional groups subordinate to it [8-9]. Its tasks included researching science and technology development directions, guidelines, and policies; proposing opinions on development planning; and presiding over and organizing model development and tactical-technical demonstration. Its members were experts, scholars, and principal cadres from all industries and sectors within the National Defense Science and Technology Commission system, including both part-time and full-time positions, with the possibility of

hiring experts with scientific accomplishments from outside the NDST industrial front. The Science and Technology Committee had a secretary-general and secretaries specifically handling its work, with administrative offices at all levels simultaneously serving as its offices. Subordinate industrial departments of the commission established their own science and technology committees following this model, accepting leadership from the commission' s Science and Technology Committee [8-9]. When the General Armament was established in 1998, it not only formed the General Armament Science and Technology Committee as a technical command and leadership institution based on the original National Defense Science, Technology and Industry Commission Science and Technology Committee but also enhanced advisory and committee member consultation forces, establishing 20 new professional groups on the basis of the original 19 [9]. The establishment, inheritance, and development of the Science and Technology Committee and professional groups represented important manifestations of the maturation of NDSTDC leadership mechanisms.

2.3.2 Formation of a Civil-Military Fusion Consultation Force System
During the 1980s and 1990s, the implementation of the "863"Program and the establishment of the Chinese Academy of Engineering marked significant achievements in NDSTDC, gradually establishing a comprehensive, multi-level, multiform civil-military fusion decision-making consultation force. On March 3, 1986, Wang Daheng and three other scientists jointly wrote to the Central Committee, proposing recommendations for tracking world strategic high-tech development. Deng Xiaoping instructed, "This matter requires decisive action and cannot be delayed." In November, the state officially launched the High-Tech Development Program (the "863" Program), with the State Science and Technology Commission and the National Defense Science, Technology and Industry Commission responsible for program formulation [9]. The first joint office meeting of the "863" Program explicitly stated that program deployment and implementation must fully leverage the role of expert committees, demonstrating full recognition of decision-making consultation work. Additionally, the establishment of the Chinese Academy of Engineering greatly strengthened NDST consultation forces. In April 1992, Zhang Guangdou and five other members of the Chinese Academy of Sciences jointly wrote to the Central Committee, recommending the establishment of a Chinese Academy of Engineering and Technology. On June 3, 1994, the Chinese Academy of Engineering was established as China' s highest honorary and consultative academic institution with engineering and technology experts as its main body [9]. The establishment of the "863" Program and the Chinese Academy of Engineering were both direct results of NDSTDC promotion and manifestations of its importance. By this point, China had formed a civil-military fusion NDSTDC force system, with the backbone consisting of the Science and Technology Committee, advisory and expert organizations, overall design institutions, technology R&D institutions, intelligence and information institutions, systems demonstration institutions, and major project-specific research and consultation organizations represented by the "863" Program, all

under the leadership of military NDST authorities. The main body included the Chinese Academy of Sciences, Chinese Academy of Engineering, China Association for Science and Technology, technical consultation institutions under state ministries, defense industry group research institutes, and universities.

During this period, after more than 30 years of accumulation, NDSTDC tended toward stability and maturity, demonstrating strong NDST innovation characteristics. The leadership and decision-making system for NDST became stable, providing favorable conditions and environment for consultation work. The Science and Technology Committee and professional group systems, formed through historical practice and testing, represented mature leadership mechanisms and organizational forms for NDSTDC. NDST consultation forces exhibited civil-military fusion, hierarchical, cross-domain, and systematic characteristics. NDSTDC had formed a pattern of stable leadership and decision-making systems, mature consultation leadership mechanisms, and systematic consultation forces, playing proactive roles in national-level major engineering projects and important institutional establishment. The more than 30 years from 1982 to the 2010s represented the sublimation, innovation, and continuation of the first 30 years of accumulation—a crucial period when NDSTDC played major roles and made significant contributions.

2.4 Deepening Reform Stage (2016–Present)

In the new era, NDSTDC faces new historical development opportunities. In January 2016, the Central Military Commission adjusted and established the Science and Technology Commission, marking the beginning of the deepening reform stage for NDSTDC.

2.4.1 Unprecedented Attention to Decision-Making Consultation Work Since the 18th Party Congress, the Party and state have attached great importance to decision-making consultation work. The 18th Party Congress report proposed: "Adhere to scientific, democratic, and law-based decision-making; improve decision-making mechanisms and procedures; and leverage the role of think tanks." President Xi Jinping pointed out: "The Central Military Commission' s own working methods also face innovation issues. We must improve deliberation, decision-making, and working mechanisms to ensure the Commission' s work is responsive and operates efficiently" [13]. In January 2015, the General Office of the CPC Central Committee and the General Office of the State Council issued the "Opinions on Strengthening the Construction of New-Type Think Tanks with Chinese Characteristics" [14]. On March 23, 2016, during his inspection of the National Defense University, President Xi Jinping emphasized the need to fully leverage the role of high-end think tanks, focusing on major issues of national security, national defense, and military construction to conduct policy research and propose countermeasures and recommendations based on the decision-making needs of the Party Central Committee and Central Military Commission [15]. On February 6, 2017, the 32nd meeting

of the Central Deep Reform Group reviewed and approved the "National Science and Technology Decision-Making Consultation System Construction Plan," placing higher demands on science and technology decision-making consultation work [16]. On March 12, 2017, President Xi Jinping emphasized promoting military development through science and technology, insisting on seeking combat effectiveness through scientific and technological innovation, and pointed out the need to "leverage the role of the expert think tank system to improve strategic planning levels" [17]. The Party Central Committee' s high attention to decision-making consultation work and think tank construction heralds new major development, reform, and opportunities for NDSTDC.

2.4.2 Adjustment and Establishment of Independent NDST Authorities With decision-making consultation work receiving significant attention and comprehensive deepening of military reform, decision-making consultation work in the defense field, particularly in NDST, is entering a reform mode. In January 2016, the Central Military Commission adjusted and established the Science and Technology Commission (referred to as the "Central Military Commission Science and Technology Commission"), primarily to strengthen NDST strategic management, promote independent innovation in NDST, and coordinate civil-military fusion development in the science and technology field. As one of the 15 functional departments of the Central Military Commission, the Science and Technology Commission serves as both a strategic and science and technology staff for the Party Central Committee and Central Military Commission and as an executor and development assistant for NDST construction [18-20]. Public information from the Ministry of National Defense website indicates that the Central Military Commission Science and Technology Commission is not only a participant, executor, promoter, and strategic manager of NDST construction and development but also the coordinating and supervisory authority for NDSTDC—a milestone in NDST development history. NDSTDC has thus entered a period of deepening reform. Similarly, on January 22, 2017, the Party Central Committee decided to establish the Central Civil-Military Integration Development Committee as a decision-making and deliberative body at the central level for major civil-military integration issues, providing unified leadership for civil-military fusion development [21], representing a major historical opportunity for consultation work.

2.4.3 Think Tanks as a New Force in Decision-Making Consultation Work Since the issuance of the "Opinions on Strengthening the Construction of New-Type Think Tanks with Chinese Characteristics," a nationwide think tank boom has emerged, with numerous new-type think tanks being established and many traditional research and consultation institutions transforming and upgrading into new-type think tanks. Many of these have become pioneers in NDST and related field think tank construction. In June 2015, the State Administration of Science, Technology and Industry for National Defense established the Defense Science, Technology and Industry Development Strategy Commit-

tee, dedicated to providing policy recommendations and consultation opinions for reform, development, and technological innovation in the defense science, technology and industry [22]. Particularly in 2016, new-type think tanks capable of serving NDST, such as the Chinese Academy of Sciences Science and Technology Strategy Consulting Research Institute, China Association for Science and Technology Science and Technology Innovation Strategy Research Institute, China Shipbuilding Industry Corporation Comprehensive Technology and Economics Institute Big Willow Defense Think Tank, and China Aerospace Science and Technology Corporation 12th Academy Qian Xuesen Think Tank, were rapidly established and became important forces in NDSTDC.

In the new situation, NDSTDC has entered a deepening reform mode and is advancing rapidly. Key characteristics include: decision-making consultation work, particularly new-type think tank construction, receiving high-level central attention, with related reforms and construction work gradually unfolding from the national top level downward, with defense, military, and science and technology fields receiving particular attention; NDSTDC-related construction and reform work rising to the national and Central Military Commission levels, demonstrating broad industry coverage, major reform measures, and strong civil-military fusion characteristics; and new-type think tanks becoming a new organizational form for decision-making consultation work, with a batch of new think tank forces emerging in the NDST field featuring broader vision, more flexible mechanisms, and unprecedented influence, triggering deeper reforms in decision-making consultation work. These characteristics represent only several recent signs; as reforms deepen, NDSTDC will demonstrate newer appearances.

[Figure 1: see original paper]

3 Contributions, Characteristics, and Experience of China' s NDSTDC

Historically, this work has not been an independent institutional enterprise nor a prominent discipline with a complete system or overall image. Nevertheless, it has made tremendous contributions to NDST development, possesses distinct Chinese characteristics and defense traits, and can provide valuable experience for decision-making consultation development.

3.1 Major Contributions

3.1.1 Facilitating Breakthroughs in Cutting-Edge Defense Technologies Such as "Two Bombs, One Satellite" The birth of NDSTDC originated from the needs of major engineering development such as the "Two Bombs, One Satellite"and cutting-edge defense technology R&D. The "Two Bombs, One Satellite" represented highly comprehensive big science projects characterized by large-scale collective scientific research, with scientist groups and technical personnel groups conducting scientific research under unified leadership, organization, and planning. As Nie Rongzhen stated, the success of the "Two

Bombs, One Satellite" was directly attributable to organizing an extraordinary team of scientists who accomplished scientific and technological breakthroughs [3]. Therefore, research and consultation by scientists and technical experts were extremely important for big science projects. History demonstrates that NDSTDC provided numerous valuable development strategies, technical intelligence information, key solutions, and major opinions and recommendations for China' s defense cutting-edge technology R&D, playing a significant role in setting correct directions, breaking through key technologies, and shortening development cycles in major project decision-making for the "Two Bombs, One Satellite," manned spaceflight, Chang' e lunar exploration program, and Galaxy supercomputer.

3.1.2 Promoting the Establishment of NDST Decision-Making Leadership and Research Institutions Over more than 60 years of development, NDSTDC has actively or passively, consciously or unconsciously, directly or indirectly promoted the establishment of NDST-related decision-making leadership and research institutions. For example, following Qian Xuesen' s recommendations, the Central Committee established the Ministry of National Defense Aviation Committee and the Fifth Academy in 1956, taking only half a month from listening to opinions to implementing decisions—numerous such cases exist. From a consultation perspective, research institution demonstration plans and expert recommendations, particularly direct recommendations from leading scientists, have had major impacts on establishing NDST-related institutions. The Central Committee has always attached particular importance to recommendations from leading scientists and has historically made decisions swiftly and decisively—a distinctive feature of NDSTDC.

3.1.3 Promoting the Establishment of NDST-Related Industries and Enterprises The Central Committee' s establishment of the Ministry of National Defense Aviation Committee and Fifth Academy in 1956 essentially created leadership and research institutions for the missile and aviation industry, thereby establishing China' s missile and aviation industry—marking the beginning of new China' s aerospace industry. In the same year, Qian Xuesen proposed accelerating the construction of a scientific and technological intelligence system with Chinese characteristics in response to comprehensive blockades imposed by Western developed countries [23]. Accordingly, Zhou Enlai instructed that specialized scientific and technological intelligence work be included in the twelve-year long-range plan as the 57th major task, directly promoting the establishment of China's scientific and technological intelligence enterprise, particularly defense science and technology intelligence [6]. Over more than 60 years, recommendations from experts and research and consultation institutions have directly contributed to the construction of many industry sectors and professional directions in China' s defense science and technology industry. This demonstrates that NDSTDC originates from science and technology R&D, rises above specific technical levels, and reaches the height of industrial and enterprise

development.

3.1.4 Promoting the Formulation of NDST Development Strategies and Plans Historically, research and consultation work has often played a key role in formulating NDST development strategies and plans. In 1956, during the formulation of the twelve-year long-range plan, the defense science and technology field organized scientists, experts, scholars, and researchers for the first time on a large scale to conduct planning work for defense research projects, a practice inherited as an effective approach and fine tradition. In the 1980s, Zhu Guangya, director of the National Defense Science, Technology and Industry Commission Science and Technology Committee, strongly advocated for research on NDST industrial development strategy, conducting eight months of discussion, exchange, and research as a comprehensive, long-term strategic study that produced a series of major achievements supporting defense strategic development [9]. In recent years, with leapfrog and disruptive science and technology development, the scientific, comprehensive, and professional nature of NDST has become more pronounced, particularly at the strategic and planning levels, making scientific research and consultation increasingly important.

3.2 Main Characteristics

3.2.1 Always Closely Integrated with Defense Research and Engineering Projects NDSTDC emerged from major engineering development such as the "Two Bombs, One Satellite"and cutting-edge defense technology R&D, determining its natural, long-lasting, and profound connection with defense research and engineering. History shows that scientists, experts, scholars, technical personnel, and research and consultation institutions are not only core components of defense research and engineering organizational systems but also important consultation forces for related decision-making, even serving as important links in the NDST decision-making chain themselves. For example, strategic scientist Qian Xuesen was the founder of China' s missile and aviation industry and a leader in NDST, while also serving as a senior think tank and strategic staff for the Party Central Committee and Central Military Commission in formulating major NDST decisions. Over more than 60 years, it has formed an inseparable connection with defense research and engineering and NDST development, growing and thriving together.

3.2.2 Always Adhering to Centralized and Unified Military-Civilian Leadership Throughout history, whenever breakthroughs in cutting-edge defense technologies were achieved and NDSTDC made major progress, it was often when NDST achieved centralized and unified leadership and military-civilian coordination and integration. From 1956 to 1959, when the Aviation Committee, Ministry of National Defense Fifth Academy, National Defense Science and Technology Commission, and State Science and Technology Commission were successively established, it was a period of major exploratory innovation. At that time, Nie Rongzhen concurrently served as head of the Central Science

Group, director of the State Science and Technology Commission, and director of the National Defense Science and Technology Commission, achieving centralized and unified leadership over the national science and technology enterprise. In 1982, following the establishment of the National Defense Science, Technology and Industry Commission, the Science and Technology Committee system was soon established. In 1998, the establishment of the General Armament realized the inheritance, development, and innovation of NDSTDC. Therefore, the development history of China' s NDSTDC essentially reflects the centralized and unified leadership system for NDST.

3.2.3 Always Implementing the Dual Command Line, Science and Technology Committee, and Professional Group Systems The Science and Technology Committee system, professional group system, dual command line system, and work systems based on these three institutions represent original innovations of China' s NDSTDC that actively adapt to NDST realities, bearing the imprint of Chinese characteristics and the NDST enterprise, and constituting an original contribution to China' s decision-making consultation work. All three systems originated during the Ministry of National Defense Fifth Academy period, matured during the National Defense Science, Technology and Industry Commission period, and were carried forward during the General Armament period. They not only run through the main development thread of China' s NDSTDC but also represent important manifestations of its characteristics and features. Currently, the three systems remain important decision-making consultation organizational forms in the defense field and are widely applied in political, economic, educational, and other domains.

3.2.4 Always Respecting the Independence and Autonomy of Scientists and Technical Experts Respecting scientists and technical experts and their independence and autonomy in academic and technical matters is a fine tradition of the NDST enterprise. As early as the Fifth Academy period, Nie Rongzhen had a profound understanding of the relationship between leadership decision-making and technical consultation: technical matters would be researched and discussed by the Science and Technology Committee experts before being approved by the Party committee; the Party committee would only approve and intervene minimally in expert discussions [2]. During the National Defense Science and Technology Commission period, Zhang Aiping instructed: the best service for scientists is to create an environment where they can fully display their talents and wisdom, allowing them to engage in their favorite work without constraints or worries but not without boundaries—meaning they always have goals to pursue, rules to follow, and collectives to rely on [8]. Because of this tradition, the NDST enterprise has always gathered first-class scientists and technical experts who form the foundation upon which this enterprise depends for survival and development.

3.3 Historical Experience

3.3.1 Leadership Attention as a Prerequisite Condition History proves that without the attention of NDST authorities, NDSTDC would not have achieved today' s accomplishments. Nie Rongzhen actively supported innovations in the Fifth Academy regarding the Science and Technology Committee, professional groups, and dual command lines, laying the foundation for organizational form innovation in this work. Zhang Aiping vigorously promoted and further improved the three organizational forms, making them institutionalized, systematic, and regularized. Zhu Guangya emphasized "persisting in improving and perfecting···the team building system of standing members, advisors, part-time members, and professional groups, and actively building strategic research platforms such as the Science and Technology Committee annual meeting, laying a solid foundation and providing strong support for the Science and Technology Committee to fully exert its role in macro planning, research guidance, and demonstration and approval" [9]. Currently, the Party Central Committee, State Council, and Central Military Commission attach even greater importance to decision-making consultation work, creating more favorable conditions and environments for its development.

3.3.2 Leveraging Collective Strength for Major Undertakings as a Core Advantage NDSTDC has never been accomplished by scattered individual efforts or by any single person alone, but rather requires collective, systematic resources, wisdom, and strength. This is determined not only by the needs of NDST development and defense research and engineering projects, and by the institutional advantages of centralized and unified leadership and decision-making systems and consultation work leadership mechanisms, as well as systematic decision-making consultation forces, but also represents a concentrated manifestation of the socialist advantage and characteristic of leveraging collective strength for major undertakings. Just as nationwide collaboration gave birth to the "Two Bombs, One Satellite," gathering the world' s talents and resources for the NDST enterprise gave birth to NDSTDC and gradually became its important advantage, which aligns with the fine tradition of respecting scientists and technical experts.

3.3.3 Systematic Organizational Strength as the Foundation NDST development itself is a systematic, continuous complex giant systems engineering project, determining that NDSTDC must adopt systems engineering thinking to establish its organizational system. Historically, the dual command lines formed administrative command and technical command systems, while the Science and Technology Committee and its expert organizations provided consultation opinions for the former and guidance and support for the latter, essentially forming a third line—the consultation and guidance line—with weaker command power but close connections to both. The leadership and decision-making institutions, the three command line systems, and military and civilian research and consultation institutions surrounding them constituted a NDST consultation force

system covering major industry sectors and professional directions, as well as major departmental institutions in both military and civilian domains, thereby establishing a solid organizational foundation.

3.3.4 Scientific Management as the Fundamental Approach When summarizing the achievements of China' s NDST enterprise, Nie Rongzhen stated: adhering to respecting objective laws and strengthening scientific management are important conditions for accelerating NDST development [3]. NDSTDC precisely follows the characteristics and laws of China' s NDST development. Under the centralized and unified leadership system of the Party Central Committee, State Council, and Central Military Commission, and within the organizational management mechanisms for large-scale defense research work, it has explored a scientific management model suited to decision-making consultation work: a relaxed environment that respects and trusts scientists and technical experts; organizational forms such as the Science and Technology Committee and professional groups; work methods that advance in coordination with defense research work; a civil-military fusion force system primarily composed of the three command lines; advanced ideological concepts represented by comprehensive wisdom and overall design departments; and a spiritual outlook of serving national defense, offering advice and suggestions, and collaborative tackling of key problems.

In October 1966, when the Central Special Committee discussed missile and nuclear weapon testing, Zhou Enlai made a philosophically profound statement: the spiritual atomic bomb transforms into a material atomic bomb, and the material atomic bomb proves the power of the spiritual atomic bomb [2]. The material atomic bomb is strategic deterrence, while the spiritual atomic bomb represents all-dimensional strategic games under the guidance of ideological weapons, as exemplified by the U.S. "Star Wars Program" during the Cold War, the "Air-Sea Battle" concept proposed in 2010, and the "Third Offset Strategy" proposed in 2014—all manifestations of spirit, thought, and wisdom games in military confrontation and national competition. In the new historical period, NDSTDC must inherit traditions, seize opportunities, forge ahead with innovation, and deepen reforms to create new-era strategic ideological weapons.

4 Recommendations for Innovation and Reform of NDSTDC

4.1 Advanced Policy and Regulatory Frameworks

Soft and hard sciences are the two "legs"of science and technology innovation and development. Currently, China has established multi-level national science and technology innovation special zones and related supporting policies and regulations. In soft science research, documents such as the "National High-End Think Tank Construction Pilot Work Plan" and the "National Science and Technology Decision-Making Consultation System Construction Plan" have essentially

established policy and regulatory "special zones," "new districts," and "pilot zones" for soft science research similar to the Shenzhen Special Economic Zone and Xiong' an New Area. In the NDST field, hard science research forces and related supporting systems have become systematic, but policy and institutional construction in soft science research such as research, evaluation, and consultation remains weak. For enterprise development, policy comes first. Drawing on the experience of establishing policy and regulation "new districts" in the state and related fields, seeking breakthroughs in systems and mechanisms, establishing high-level NDST soft science research "special zones" oriented toward research, evaluation, and consultation, and establishing and improving a comprehensive, multi-level science and technology innovation policy and regulation system are urgent priorities.

4.2 Flattened Decision-Making Institutions

The traditional advantages of NDSTDC include centralized and unified leadership, close relationships with consultation expert institutions, smooth channels, and short, flat, and fast chains. Currently, the changing world situation, rapid science and technology innovation, and swift big data intelligent networks have placed reform demands on the speed and effectiveness of decision-making consultation work. Drawing on national practices and international experience, it is recommended that at the central level and within NDST-related decision-making institutions, advisory committees (or academic committees, science and technology committees, expert committees, etc.) be established, with NDST professional committees subordinate to them to coordinate the forces and achievements of various consultation experts and institutions and directly provide NDST-related recommendations and solutions for leadership decision-making, playing a "through train" role between decision-making and research institutions. This approach can flatten decision-making institutions, reduce decision-making levels, chains, and procedures, strengthen "technical decision-making," and minimize formalism and bureaucracy.

4.3 Market-Oriented Development Concepts

In recent years, the concept of the "marketplace of ideas" has gradually gained widespread recognition among experts. The marketplace of ideas can sensitively reflect changes in supply-demand relationships and guide the effective allocation of policy knowledge production resources. As government decision-making needs gradually open up and think tank forces continue to grow, China' s marketplace of ideas will rapidly mature after the "think tank boom" of survival of the fittest, forming an ideological economic form similar to the real economy market. Naturally, NDSTDC is also a component of this and may even form relatively independent "defense thought markets" or "defense science and technology thought markets." As a market, it should operate according to open and integrated market economy concepts: first, create a fair, just, and open NDST thought market environment where capable entities can enter the mar-

ket to provide ideological products; second, establish a "Taobao-style" NDST consultation product and service matching and trading platform similar to the "All-Military Weapons and Equipment Procurement Information Network" to achieve seamless connection between decision-making needs and consultation supply, opening up the "Ren and Du meridians" of information, knowledge, and wisdom interconnectivity; third, strengthen NDST investment and financing, with government, enterprise, and social capital establishing soft topic research funds and related financing channels to guide and support consultation institutions and think tanks to become market entities in the NDST thought market; fourth, "go global and bring in," integrating with international thought markets and guiding think tanks to bring fresh air and media to the defense system.

4.4 Allied Organizational Strength

The trend toward collaboration and alliance has been one of the important characteristics of think tank construction since 2016, with regional, industry-based, thematic, and international think tank alliance organizations continuously emerging. In the NDST field, establishing systematic consultation forces is an era requirement. President Xi Jinping particularly emphasized the need to "leverage the role of the expert think tank system to improve strategic planning levels." NDST innovation and consultation research are open, collaborative, and networked complex systems engineering projects closely related to global political, economic, and science and technology development, as well as major governance issues such as international relations, military security, counter-terrorism, and populism. To gather world talents for our use and promote military development through science and technology, NDST decision-making consultation institutions should extensively connect with relevant strategic management and policy research institutions both domestically and internationally, build shared collaboration platforms covering NDST main fields, related fields, and research directions with potential value, and establish a globally oriented, jointly open "small core, large periphery, networked" research alliance, becoming an important component and innovation chain link in the NDST innovation system.

4.5 Intelligent Tools and Methods

In the 1980s and 1990s, Qian Xuesen proposed the "human-machine combination, human-centered" comprehensive wisdom engineering concept, which essentially integrates various resources, utilizes intelligent tools, obtains wisdom, assists decision-making, and accurately predicted the essence of consultation work and information technology development trends, coinciding with the philosophy of decision-making consultation tools and methods [1]. Currently, disruptive technologies such as Internet+, big data, Internet of Things, and artificial intelligence have emerged. NDSTDC must not be confined to original work models but should develop and apply new intelligent research tools to open new "opening methods" : first, management institutions should support consultation institutions in developing intelligent big data analysis research tools and meth-

ods that meet actual work needs to achieve consultation work collaboration and "crowdsourcing" ; second, consultation institutions should abandon traditional mechanical thinking, apply Internet thinking such as Zhihu and Fenda, conduct in-depth cooperation with software and Internet companies to obtain sufficient data for full-sample analysis, maximize information entropy reduction, establish data-based decision analysis models, and improve decision-making consultation efficiency; third, as comprehensive integration research methods combining qualitative and quantitative approaches become mainstream, research and deploy comprehensive integration discussion hall platforms to achieve human-machine-network combined automated, intelligent, and wisdom-based decision-making consultation technology systems as soon as possible [1].

4.6 Autonomous Operational Management

The relationship between NDST decision-making institutions and consultation experts and institutions is very close. This advantage has certain historical reasons and defense characteristics but also brings problems such as consultation experts and institutions being overly attached, lacking independence and autonomy, "position determining perspective," and "demonstrating for the sake of demonstrating" [24]. In the new era, without modern governance methods, it cannot adapt to modern intellectual needs and environmental independence. NDST decision-making consultation institutions must adapt to the characteristics and laws of modern consultation work, establish new governance structures, and maintain relative independence and high autonomy in operational management. Absolute independence does not exist in reality; what is emphasized here is that through independence and autonomy, consultation institutions can propose relatively objective, independent, and fair consultation recommendations, appropriately positioning their distance from decision-making and a detached status to avoid the awkward situation of "close means intimate, distant means estranged."

4.7 Measurable Consultation Effectiveness

The defense science and technology community and academia have rarely conducted systematic and in-depth analysis of the effects and impacts of decision-making consultation. Currently, consultation effects on decision-making are mostly evaluated through indicators such as the number of consultation reports and the number of approvals by leaders at different levels, with very little quantitative and measurable analysis of its benefits and efficiency. This is an academic and theoretical challenge but is extremely important for the development of decision-making consultation work. Scholars both domestically and internationally have explored this, but it still lags behind current decision-making consultation work development. For NDSTDC, it is possible to research and apply models and methods from economics, sociology, statistics, and policy studies, referring to measurement indicators such as decision-making benefits, military benefits, science and technology benefits, economic benefits, and social benefits,

to conduct in-depth quantitative and measurable analysis and modeling of consultation benefits, efficiency, and effectiveness [25-27], providing effective and usable evaluation methods for scientific, democratic, and law-based decision-making in the NDST field and for the development of NDST consultation work.

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Note: Figure translations are in progress. See original paper for figures.