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# Strategies and practices of organized scientific research in higher education: a case study of International Campus, Zhejiang University

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**Abstract:** This paper explores the shift towards organized scientific research in higher education, with a focus on International Campus of Zhejiang University. Highlighting the transition from individual to organized research efforts aligned with national strategies, the study illustrates the significant role of organized research in responding to technological advancements and addressing societal challenges. It showcases successful initiatives and addresses challenges within this paradigm, proposing strategic frameworks for enhancing research efficacy. The findings underscore the importance of interdisciplinary collaboration and strategic planning in advancing scientific innovation in alignment with global standards.

**Key words:** organized scientific research; higher education innovation; strategic research initiatives

## 1 Introduction

Currently, China's technological innovation has entered a crucial phase of strategic transformation, shifting from a past focus on catching up and patching deficiencies to emphasizing original and leading-edge scientific and technological innovation. The urgency of achieving technological self-reliance and self-strengthening, building world-class research universities, and cultivating strategic scientific and technological talents is more pressing than ever.

In August 2022, the Ministry of Education of China issued the *Several Opinions on Strengthening Organized Scientific Research in Universities to Promote High-Level Self-reliance and Self-strengthening*, aiming to make full use of the new national system's advantages to enhance organized scientific research [1].

Against this backdrop, universities in China, as a new force of technological innovation, are facing unprecedented development opportunities and challenges. Universities not only serve as the main force in basic research and the source of significant scientific and technological breakthroughs but also as an essential part of the national strategic scientific and technological capabilities. To respond to national strategic needs, universities must accelerate the development of organized and institutionalized research systems to comprehensively enhance their capabilities to solve major national scientific and technological problems. Meanwhile, universities need to strengthen collaboration with national laboratories, national research institutions, and leading technology companies, promoting the integration of innovation and industrial chains to improve the overall efficacy of the national innovation system rapidly.

The implementation of organized scientific research is a critical task for the technological innovation work of universities and an important pathway to achieve the goal of building "double first-class" institutions. This research model can transcend disciplinary boundaries, effectively integrate multidisciplinary resources, and carry out task-oriented research collaboratively. Through transformation and innovation in university research paradigms and organizational models, organized scientific research will provide broader development opportunities for universities and drive higher quality development in scientific and technological innovation.

This paper discusses the current state of organized scientific research, its development and implementation in various countries, and elaborates on the practice of organized scientific research at the International Campus of Zhejiang University.

## 2 The current studies of organized scientific research

Organized scientific research studies in Europe and the United States began in the 1950s. At that time, the American academic community reached a consensus: research universities seeking to achieve better academic performance needed to break down disciplinary barriers and make new changes in research paradigms and organizational structures. After World War II, the organizational forms of scientific research at Western research universities underwent continuous transformations, focusing more on national needs and serving the national will, creating the "big science" model characterized by multidisciplinary collaboration, substantial investment, and the necessity for expensive and complex experimental equipment. Geiger posits that interdisciplinary research centers have become the decisive factor in the expansion of university research systems after World War II and have led the development of "big science" projects [2]. Rhoten et al. believe that organized interdisciplinary research teams typically share common goals, possess a unique language of thought, resource sharing, interaction, and a sense of cultural identity, existing in both corporeal and virtual forms [3]. In December 2020, the United States National Academy of Sciences published the report *The Endless Frontier: The Next 75 Years in Science*, which incorporated "organized scientific research" into future scientific and technological planning [4].

Research in China on this subject started relatively late. In May 2012, the Ministry of Education launched the *Program for Enhancing Innovation Ability of Higher Education Institutions*, also known as the "2011 Plan", aimed at enhancing the innovation capacity of higher education institutions. Guided by the "2011 Plan" and the theoretical framework of collaborative innovation, the academic community in China has paid close attention to exploring diverse models of collaborative innovation adapted to different needs. However, there has been relatively less theoretical research on organized scientific research, and a consensus on its definition has yet to be reached. Zhao Hongguang suggests that organized scientific and technological activities refer to scientific and technological activities carried out within a specific organizational system to achieve set goals, including government-organized, enterprise-organized, and joint government-enterprise scientific activities in various organizational forms [5]. Yu Yangtao et al. believe that organized innovation refers to conducting scientific and technological innovation activities in a planned and organized manner through institutionalized and systemic construction [6]. Pan Jiaofeng et al. have studied the evolution of scientific research models and introduced the concept of "organized basic research", clarifying its three principles of development: orientation towards scientific goals; free exploration as the fundamental form of scientific activity; and scientists leading the endeavor [7]. Qiu Yong et al. note that Tsinghua University focuses on major real-world issues, serves significant national needs, and comprehensively enhances the university's capability to contribute to national strategic science and technology, proposing significant initiatives to advance organized scientific research [8].

## 3 Development and implementation of organized scientific research in various countries

### 3.1 The situation in developed countries

In modern times, Italy, UK, France, Germany and the US have successively been recognized as world centers for science and technology, largely due to their vigorous support for scientific and educational causes. Countries like US, Germany, and Japan have gained advanced practical experience in building an innovative system, perfecting structural mechanisms and carrying out organized scientific research, and these experiences are valuable for China to adopt.

The US "Manhattan Project" fully exemplified the advantage of a "national system". This large-scale, highly systematic project gathered the best nuclear scientists of that time from the Western countries, with over 100,000 people in the organization, which lasted for three years at a total cost of $2.5 billion, and successfully led to the advancements in fundamental particle physics theories [9]. The *American National Science Foundation Development Strategic Plan (2022-2026)* proposes three key areas in the next four years: expanding science frontiers and scientific innovation, ensuring the extensive applicability and inclusivity of science and technology, and emerging as a leader among global research enterprises. The document also specifically outlines future key areas of study: climate and clean energy research; emerging industry research, including manufacturing, wireless technology, biotechnology, quantum science and engineering, artificial intelligence, semiconductors; infrastructure for scientific research (data collection, processing, and analysis); and people, technology, and change (information and communication technology, robotics, societal conflict and change, biological and non-biological ageing, and emergencies) [10].

The "Horizon Europe's first strategic plan 2021-2024: Commission sets research and innovation priorities for a sustainable future" as a European framework for research and innovation, strengthens the EU's knowledge base through cutting-edge research, promotes breakthrough innovation, and supports the development of innovative solutions. The plan explicitly proposes to invest in research and innovation directions of considerable strategic significance, such as accelerating and guiding digital and green transformations, managing sustainable natural resources, ensuring a clean and healthy environment, making the EU a digital, circular, climate-neutral, and sustainable economy, and creating a more resilient, inclusive, and democratic European society [11].

Russia has implemented the "National Technology Plan", directed by the Department of Education and Science, with a cross-departmental working group consisting of innovative subjects such as technology enterprises, top universities, research centers, large commercial associations, scholars, and professional groups which have broken through the entire innovation chain of research, production, and operation, resulting in the combined development of science, technology, and economy [12].

The development and success of the Max Planck Society in Germany fully reflect the importance of establishing mechanisms for technological innovation cooperation. This research organization focuses on three major fields: biology and medicine, physical and chemical technologies, and humanities. It has a world-class academic status through its extensive experience in cooperation with top universities, research institutions, and its participation in international collaborations [13].

Japan adopts a system of collaboration between academia, industry, and government, in which the government plays a leading role, promoting cooperation between universities, research institutions, scholars, and entrepreneurs. This further enhances the innovation capability of universities, accelerates the process of turning scientific research results into real productive forces, better activates the function of the national innovation system, and improves the performance of scientific and technological innovation.

The study of successful cases abroad reveals that organized scientific research more profoundly reflects the national will and closely links societal needs with the development of research universities. By innovating core systems and adjusting organizational structure, deploying the coordinated synergy of the government, universities, research institutions, and enterprises, and establishing goal-oriented, collaborative problem-solving, performance management, and open sharing operational mechanisms are the experiences derived from the aforementioned countries in implementing organized scientific research.

3.2 The situation in China

Since 1949, the organization model for scientific research management in China can be broadly divided into six stages.

The first stage, the 1950s: In the early years of the People's Republic of China, amidst the urgent need for revival post-establishment, China modeled after the Soviet Union in managing science and education to quickly restore the national economy and construct the industrial system. Universities were categorized under relevant administrative departments. During the 1952 college and department restructuring, some comprehensive universities were split into several industry-specific institutions, carrying out research tasks disseminated through top-down approaches within different industrial sectors, primarily oriented around major engineering projects, such as the ten major buildings for the National Day parade in 1959.

The second stage, the 1960s to 1970s: Faced with significant changes in the international situation, high-end defense technology R&D became an important task in the field of science and technology. The most seminal projects were the development of the atomic bomb, hydrogen bomb, and artificial satellite--China's "Two Bombs, One Satellite". Despite the challenging economic and social development, these projects, driven by self-reliance and independent research, significantly boosted China's international status and self-confidence, alongside dramatically propelling the country's overall scientific and technological level, particularly in defense technology.

The third stage, the 1980s: With the advancement of the Reform and Opening-Up policy and major changes in both international and domestic arenas under the philosophy that "economic construction is the center" and "science and technology constitute a primary productive force", substantial reforms were undertaken in China's science and technology system. Notable milestones included the establishment of the National Natural Science Foundation of China in 1985, and the initiation of the 863 Program targeting world-class high-tech development in March 1986. These major reforms primarily focused on changing the funding model for scientific research, introducing a competitive and open system, and orienting research work towards the global frontier.

The fourth stage, the 1990s: With the further deepening of reforms and significant changes in China's external environment, the nation was increasingly recognizing the fundamental role of basic research in all high-tech developments. Initiatives were taken both to conduct foundational theoretical research and to achieve breakthroughs in applied engineering technologies. In 1994, the establishment of the Chinese Academy of Engineering fostered an excellent environment for the development of engineering technologies. In 1997, the 973 Program was launched to lay a foundation for future technological developments. To enhance the overall capabilities and international competitiveness of China's universities, significant initiatives like the 211 and 985 projects came into effect around the turn of the century. These programs and reforms had a profound and lasting impact on China's research management and organization model.

The fifth stage, the 2000s: In response to a series of significant technological needs faced by economic and social development, targeted breakthroughs in key fields and issues were necessary. The nation established several major scientific and technological projects and talent programs, such as the National Major Science and Technology Projects, the Thousand Talents Plan, and the Ten Thousand Talents Plan, significantly influencing China's research management and organization model. A large number of high-profile scientific and technological achievements were produced, playing an important role in economic and social development. For example, the High-Speed Rail Project elevated China to an international leadership position in this domain, becoming a proud asset for foreign economic cooperation.

The sixth stage, the 2010s: As the country entered a new period of development with a significant increase in research funding and overlapping science and technology programs, the state aimed to enhance the efficiency and quality of science and technology funding by reshaping the supporting landscape. Previously separate science and technology plans were integrated into the "National Key R&D Programs" managed by the Ministry of Science and Technology, emphasizing "large organizations, big collaborations, and performance management" in R&D.

With rapid economic and social development and significant changes in both domestic and international environments, practical needs continue to drive rapid changes in China's research management and organization model. Especially in the 14th Five-Year Plan period, the state emphasizes the implementation of "science and technology development strategy", marking the increasingly critical role of science and technology in national development. Accelerating the exploration of research management and organization models that fit the characteristics of the new era, embody China's unique features, and promote a rapid enhancement of scientific and technological levels has become urgent. Since 2016, a series of documents related to organized scientific research has been released by national ministries. In August 2022, the Ministry of Education issued the *Several Opinions on Strengthening Organized Scientific Research in Universities to Promote High-Level Self-Reliance and Self-Strengthening*. Universities, research institutions, and scientific management departments have initiated preliminary explorations in the reform of the scientific research management system and mechanism, with organized scientific research playing a significant role in practice.

## 4 Organized scientific research in Chinese universities

Unorganized and organized scientific research are the two primary paradigms of scientific research in Chinese universities. Both paradigms exhibit clear heterogeneity in their logical foundations, operational mechanisms, and value proposition.

Unorganized scientific research doesn't have a clear application-oriented goal, and researchers mainly conduct research based on their interests or towards advancing disciplinary knowledge. It confines itself within the boundaries of disciplines and universities, aimed at enriching or expanding the disciplinary knowledge system without considering the economic value or application scenarios of scientific research.

Organized scientific research operates under the guidance of explicit tasks (mainly national major scientific research tasks) and through government funding and policy support, organizes university research resources in a transdisciplinary manner to complete state-designated scientific research tasks. The goal of organized scientific research is not only to achieve breakthroughs from "0 to 1" but also to promote the market application of research results from "1 to 10 to 100".

For universities, both research paradigms have their advantages and applicable scenarios, and bias towards either would affect the comprehensive competitiveness and creativity of universities. Particularly in specific basic theoretical research fields, free exploration based on scholars' academic ideals is still required. However, in a knowledge society, neither universities nor individual scholars can stand aloof from changes in the external world. Both are inevitably drawn into the competition of academic capitalism. As the efficiency and benefits of organized scientific research become apparent, it will gradually become the mainstream paradigm of university research.

Taking Tsinghua University as an example, Tsinghua has always been focusing on serving national major needs and employed an organized research model in tackling major scientific research tasks. The Institute of Nuclear and New Energy Technology at Tsinghua University has always adhered to a research organization model of "large team tackling key issues with multidisciplinary crossover". After three generations of researchers, hundreds of teachers, and over 30 years of hard work, the world's first inherently safe modular high-temperature gas-cooled reactor (HTGR) nuclear power plant, which was co-developed and built with Huaneng and CNNC, was connected to the grid for power generation in

December 2021. This marked a leap in China's technological capacity from "following", "running alongside" to "leading the pack" in this area. Academician Wang Dazhong, the leader of the team, received the National Highest Science and Technology Award 2020. After the outbreak of the COVID-19 pandemic, Tsinghua quickly organized 18 research teams to fight against the epidemic, working in parallel and collaboration on COVID-19 detection, treatment, and prevention, and achieved several internationally leading, emergency-practical results. Professor Zhang Linqi's team developed China's first anti-COVID-19 antibody drug, which has been granted emergency approval by the National Medical Products Administration. On July 7, 2022, the first batch of antibody drugs were released for commercial use. Academician Cheng Jing's team developed a mobile laboratory for nucleic acid testing that can complete sample testing within 45 minutes. Academician Rao Zihe's team was the first in the world to discover and reconstruct the complete structure of the coronavirus transcription and replication complex, providing key support for developing broad-spectrum anti-coronavirus drugs. In addition, Tsinghua has established the Vanke School of Public Health to conduct cutting-edge research on major global public health issues.

Taking Shanghai Jiao Tong University (SJTU) as another example, SJTU has focused on enhancing organized scientific research with "three focuses". The first is to focus on key areas and strengthen research planning and layout. Around the national strategic objectives, SJTU has built "Concentrated Tackling Zones", implemented plans like "Big Ocean", "Big Health," and "Big Information", forming a full-chain, systematic research development pattern from "Science - Engineering - Industry". The second is to focus on innovation and development, perfecting the construction of the research system, exploring "Big Research" administrative system reforms, and establishing vertical and horizontal cooperation, project quality management, academic achievement transformation departments, covering the full range and chain of research processes, continuously improving research planning, organization, guidance, coordination, and management capabilities. The third focus is on enhancing efficiency and invigorating the research team, issuing documents such as *On the Implementation of Greater Autonomy in Scientific Research Management*, which give team leaders greater control and decision-making rights over research funding, talent recommendation, and technical routes, so as to fully mobilize the enthusiasm and creativity of high-level talents.

## 5 Organized scientific research at International Campus of Zhejiang University

Organized scientific research can simply be understood as similar to a "national system", which concentrates strength and advantages to accomplish significant tasks. However, it is crucial to specify which significant tasks to focus on, what forces and advantages to concentrate, and who can accomplish these tasks. Addressing these questions is key to advancing organized scientific research in universities. As an example, at the International Campus of Zhejiang University, referred to hereafter as the "International Campus", organized scientific research initiatives revolve around "four aims" and are conducted through research projects, public platforms, talent teams, and academic activities.

Firstly, focusing on key areas and organizing research projects. The International Campus has initiated scientific research themed around Human Space X, which targets "Elderly Body Health Technology" with the aim of creating an intelligent living space for human survival. This includes constructing an all-around intelligent health service ecosystem integrating "perception, interaction, and rehabilitation". It endeavors to dignify human life from 60 to 100 years old through extracorporeal, superficial, and intracorporeal diagnostics and treatments. It has an independent organizational operation mechanism, revolving around the Human Space X theme, covering various fields such as biotechnology, device design, new material development, component integration, industrial design, intelligent manufacturing, perceptual computing, artificial intelligence, etc. The project is divided into three directions - extracorporeal "living spaces + driving spaces" for intelligent perception and assistance, superficial "sleeping spaces + wearable spaces" for intelligent perception and intervention, and intracorporeal for the regeneration and rehabilitation of bodily tissues and organs. The project is led by the dean of the International Campus, with each direction having a designated leader, and several sub-projects funded by the International Campus has been initiated to conduct themed scientific research.

Secondly, focusing on common needs and building public platforms. "To do a good job, one must first sharpen one's tools". Large public scientific research platforms and scientific devices can accommodate research equipment from different disciplines, providing a natural environment for interdisciplinary academic exchanges and creating favorable conditions for new ideas and technologies. The International Campus houses three colleges and 11 international research centers with diverse research directions such as medicine, biology, engineering, informatics, materials science, and business studies. To mitigate fragmentation and inefficiency in scientific and technological research platforms, the International Campus established three campus-level public technology platforms: the Micro-Nano Public Platform, the High-Performance Computing Public Platform, and the Animal Experiment Platform, effectively addressing some common research needs across similar disciplines. The public technology platforms of the International Campus are fully open to external entities, significantly enhancing regional innovation capability and supporting high-quality business development.

Thirdly, aiming for international excellence and building talent teams. Strengthening organized scientific research is key, and building a talent team is critical. The International Campus, through years of exploration with local governments, has formed an effective talent attraction and cultivation model, providing a solid foundation for organized scientific research. Actively cooperating with Haining city to create an international innovation ecosystem, it aims to forge a high ground for the integration of science, education, and cities. To construct a "masters + platform + project" mutual attraction talent model, it has established over one billion yuan in funds for the construction of an international cooperative education pilot zone and 3.5 billion yuan in venture capital funds such as the Jia Lake Dream Fund and the Haining Science and Technology Achievement Transformation Fund to support technology incubation and achievement transformation. Setting up overseas innovation centers in London and Silicon Valley, it attracts global talents, gathering high-level talents including eight foreign academicians from the US National Academy of Engineering and the Royal Society, and 154 young scientists from 15 countries. Three foreign talents were selected for the provincial "Top Talent" team. Deepening the construction of the international cooperative education pilot zone and establishing the Haining Talent Science and Innovation Group, a multi-entity mechanism for scientific and technological achievement transformation, talent introduction, evaluation, and incentive has been built to construct a full-chain scientific research innovation system that "influences Haining, radiates the province, and faces the world".

Lastly, focusing on frontier dynamics and organizing academic activities. The International Campus independently hosts three major academic activity brands, providing platforms for Principal Investigators (PIs) to exchange and cooperate in various dimensions and manners. First of all, the "Spark" series events, organized by the Young Teachers Committee of the International Campus and supported by the campus union, aim to promote exchanges among research staff at the International Campus, inspire interdisciplinary collaboration, including Spark Salon (focused on research sharing by PIs from the campus), Spark Seminar (focused on research sharing by external PIs), and Spark Night (focused on career planning for PIs). Secondly, the Jia Lake Salon, hosted by the Department of Scientific Research and Technology Transfer at the International Campus, aims to foster a positive academic atmosphere, promote the transformation of scientific research achievements, and strengthen communication between professors and the local industry. The salon periodically invites external guests to share technology transfer, achievement transformation, and industrial application. Thirdly, the Young Scholars Community, an academic organization autonomously initiated by young scholars at the International

Campus, aims to promote interdisciplinary and exploratory scientific research, facilitate cross-innovation among PIs and students from different colleges and research centers, nurture interdisciplinary teams, and cultivate external resource expansion capabilities. It explores a new model of scientific and educational collaboration for the International Campus, creating an exchange platform with "innovative passion, cross-interest, and geek spirit", and fostering an endogenous interdisciplinary model at the International Campus.

## 6 Conclusion

Based on the evolution and related exploratory practices of organized scientific research, it can be summarized that organized scientific research should encompass the following two aspects:

Firstly, it should tightly align with major national and industrial strategies and demands, carrying out organized fundamental research that resolves cutting-edge scientific issues, key technological problems, and academic matters related to talent cultivation and associated with crucial strategic needs. The core value of organized scientific research is to transform significant national strategic needs and revolutionary advancements in industry-forward-looking technologies into academic issues and crucial technological problems that align with the forefront of global science and technology. The aim is to concentrate elite forces on original innovation and key core technology challenges, generate more major strategic outcomes, and achieve more "from 0 to 1" original innovation breakthroughs. Therefore, within the scope of areas where there is significant discipline accumulation and academic foundation, it is essential to explore the formation of a number of optimized structural research teams, led by strategic scientists. Organized fundamental research is not simply collaboration but the formation of task-oriented teams that change the previously project-driven horizontal organizational structure into an internal research organization structure which is led by tasks, driven by needs, and characterized by a matrix of intersecting vertical and horizontal axes. This structure aims to truly enable interwoven operations, as well as cluster development of research resources, and aid in the deep fusion of disciplines. According to the needs of organized basic research tasks, it is necessary to break down the administrative, disciplinary, and academic barriers of the existing organizational structure and evolve into research teams or research centers driven by research goals and project tasks, forming the best operational mechanisms for organized fundamental research characterized by "building task platforms, gathering efficient teams, undertaking significant projects, and producing excellent outcomes". Additionally, a cooperative mechanism integrating industry, academics, and research with government and society, which allows for beneficial and smooth communication, is the external mechanism for the constant implementation of organized fundamental research. Organized basic research is targeted, goal-oriented, focused, and precise in its research development planning. Therefore, it is necessary to continuously undertake significant demands from the government, society, and the industry, organize more advantageous resources and forces, strengthen technology challenges and research, to generate more original and strategic significant results and develop cutting-edge new technologies. Simultaneously, an open mechanism that facilitates regular international exchanges is necessary for organized basic research to target international scientific and technological frontiers, serving as an important way to learn, reference, exchange, absorb, and assimilate leading foreign scientific achievements and advanced technologies. It is key to strengthen external cooperation, connecting relevant units, attracting diversified investment, highlighting the principal role of enterprise innovation, and compensating for any deficiencies in major scientific research platform conditions. Creating conditions to initiate and cultivate international large-scale scientific projects will realize high-level organized basic research.

Secondly, there is a need to conduct organized scientific research activities. Although the International Campus has already explored research projects, public platforms, talent teams, and academic activities, yielding certain achievements, the scientific research projects at the International Campus still exhibit issues such as low levels, dispersed teams, and insufficient funding. Its research forms are more self-explorative organizational models, lacking in alignment with national strategic needs or remaining at a passive acceptance level, without establishing an effective approach to actively respond to national strategies and industry demands. This presents a challenge for organized scientific research guided by national strategic needs; there is "effort without a place to use it". Therefore, it is imperative to construct an "organized" scientific research mechanism that integrates all processes and elements throughout. This involves strengthening decision-making leadership, with decision-making bodies of various educational institutions regularly studying and including it as an important matter in the high-quality construction of an international cooperative education pilot zone. It is essential to organize and refine the scientific frontiers and key core issues that are oriented towards the industry, and actively seek to participate in the preparation of national major scientific technological mission guidelines to form an early advantage. Based on distinctive disciplinary advantages, we should integrate superior scientific research forces, carry out joint challenges, including establishing interdisciplinary research platforms within the International Campus and creating research cooperation platforms jointly with external entities. Continuous improvement of the scientific and technological innovation system and mechanism, enhancing mechanisms such as "posting rewards for commanders" and "projects + project leaders" are necessary. Improvement of project organization and quality assurance mechanisms, strengthening project quality assurance system construction, and establishing a comprehensive quality assurance management system for significant projects oriented towards quality and contribution are essential. Finally, the scientific research management department should undergo further transformations, shifting its focus from administrative services to a pivotal "hub" role in comprehensive management and decision-making. This transition should involve proactive planning, effective team organization, service support functions, and more.

## Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.


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## References


[1] Ministry of Education of the People's Republic of China. *Several Opinions on Strengthening Organized Scientific Research in Universities to Promote a High Level of Self-reliance and Self-strengthening.* The Official Website of the Ministry of Education of the People's Republic of China [EB/OL]. /2023-04-04. http://www.moe.gov.cn/jyb_xwfb/gzdt_gzdt/s5987/202208/t20220829_656091.html.

[2] Geiger RL. 1990. Organized research units--their role in the development of university research. *The Journal of Higher Education*, Ohio State University Press, 61(1): 1-19.

[3] Rhoten D, Parker A. 2004. Risks and rewards of an interdisciplinary research path. *Science, American Association for the Advancement of Science*, 306 (5704): 2046.

[4] National Academies of Sciences, Engineering, and Medicine. 2020. *The Endless Frontier: The Next 75 Years in Science*. The National Academies Press.

[5] Zhao HG. 2002. Preliminary exploration of the development strategy of organized technological activities in China. *China Soft Science*, 10: 83-87.

[6] Yu YT, Zhu DY. 2009. *An Introduction to the Practicalities of Management Science*. Wuhan University Press.

[7] Pan JF, Lu X, Wang GH. 2021. Evolution of scientific research patterns: organized basic research. Journal *of Chinese Academy of Sciences*, 36(12): 1395-1403.

[8] Qiu Y, Zhao EN. 2020. Enhancing the scientific and technological capability to serve national strategy. *People's Daily*, 011.

[9] Hu YF. 2018. The Manhattan Project and American Wartime Economic Control. Liaoning University.

[10] The National Science Foundation 2022-2026 Strategic Plan, nsf22068. 2022. The U.S. National Science Foundation.

[11] European Union. 2021. Horizon Europe's first strategic plan 2021-2024: Commission sets research and innovation priorities for a sustainable future. European Union.

[12] Zhang LJ. 2018. Analysis of Russia's practice of promoting scientific and technological innovation through PPP model: a case study of the national technology plan. *Research on Science and Technology Management*, 38(17): 42-47.

[13] Zheng JL, Ye XW, Fan Q, et al. 2018. Research on the scientific innovation mechanism of the Max Planck society in Germany. *World Science-Technology R & D*, 40(6): 627-633.