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Promoting Organized Basic Research: Strategic Layout and Strategic Capacity in Science and Technology

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Abstract

Focusing on "organized basic research", this study reviews the main experience of major countries in promoting "organized basic research" from three aspects, namely, driving scientific and technological innovation, coordinating the strategic layout, and clarifying the division of strategic capacity in science and technology. Then, from the two perspectives, i.e., task layout of five types of "organized basic research", and main orientation of strategic capacity in science and technology of three types of institution, the study analyzes the promotion ideas of "organized basic research" in China in the new era. Finally, the study puts forward the ways to improve implementation mechanism of "organized basic research" in China from four aspects, namely, scientific problem selection mechanism, resource allocation mechanism, organizational model, and management mode.

Keywords

organized basic research; strategic layout; strategic; capacity in science and technology; implementation mechanism

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Promoting organized basic research: strategic layout and strategic capacity in science and technology

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Abstract: Focusing on "organized basic research", this study reviews the main experience of major countries in promoting "organized basic research" from three aspects, namely, driving scientific and technological innovation, coordinating the strategic layout, and clarifying the division of strategic capacity in science and technology. Then, from the two perspectives, i.e., task layout of five types of "organized basic research", and main orientation of strategic capacity in science and technology of three types of institution, the study analyzes the promotion ideas of "organized basic research" in China in the new era. Finally, the study puts forward the ways to improve implementation mechanism of "organized basic research" in China from four aspects, namely, scientific problem selection mechanism, resource allocation mechanism, organizational model, and management mode.
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Keywords: organized basic research; strategic layout; strategic capacity in science and technology; implementation mechanism

Basic research is the foundation of scientific research [1]. Earlier, basic research was driven by interest and free exploration. Later, it has gradually been fueled by demand and utilization. Now, scientific and technological (S&T) innovation holds the key to international strategic game playing [2]. As the focus of competition constantly moves forward to basic research, the state is urged to play a better role in organizing major science innovations. Organized research is opposite to scattered, ruptured, chaotic and disorganized research [3]. "Organized basic research" is a kind of new organizational framework of basic research. It upholds national strategic orientation, interdisciplinary fusion, organization and implementation of grand scientific plans and the mutual transformation between "non-applied" and "applied" science. As far as strategic layout and division are concerned, organized basic research means that the government systematically arranges the strategic layout, platform construction, resource allocation and management of basic research, guides collaboration between basic research players, and promotes the integration between demand and free exploration, so as to enhance the overall efficacy of basic research.

In the midst of the new round of S&T revolution and industrial transformation, major S&T powers have strengthened their strategic planning. As the priority of the S&T strategic layout, organized basic research mainly relies on national strategic capacity in S&T. Meanwhile, it depends on other basic research forces of the national innovation system, the modern laboratory system and the new scientific research infrastructure system.

1 Major countries' experience in promoting organized basic research

The history of science and technology shows that basic research has played a guiding role in S&T revolutions and industrial transformation. As basic research has evolved from "little science" featuring free exploration by academic institutions to "big science" featuring collaborative innovation between government-led forces and non-governmental supporting forces, the government must take advantage of resources to promote basic research to meet national major strategic demands. To this end, the government must strengthen organizational management [4], value prioritized areas, arrange S&T tasks, optimize the allocation of S&T resources, and coordinate S&T capacity. Major science powers have come up with experience in promoting science centers, talent centers and capturing leading areas in innovation. They propel organized basic research through systematic planning and sound labor division of strategic capacity in S&T. They give full play to the role of organized basic research in integrating industry, university and institute, and in promoting innovations through science and technology.

1.1 Drive S&T innovation through organized basic research

As an international practice, to promote organized basic research, countries mainly focus on strategic layout and give play to strategic capacity in S&T. Since modern times, Italy,

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the United Kingdom, France, Germany and the United States have successively become global S&T hubs, resulting from their strong national support for science and education, including basic research [5]. With the deep integration between S&T and economic and social development, an increasing number of players have participated in S&T innovations. The whole society's investment in basic research is increasing day by day, accounting for an increasing proportion of gross domestic product (GDP), and basic research becomes more and more organized. This requires the state to make infrastructure construction, strategic layout and capacity building of S&T innovations more comprehensive and integrated. Organized basic research provides the knowledge essential for the innovation of the whole society, and gives full play to the guiding role of strategic planning and governmental funds for enterprises and social funds, thus making each innovation player more innovative and efficient. Given the sound market mechanism, strict intellectual property protection and governmental organized promotion, basic research will attract the attention of scientists and entrepreneurs, resulting in a significant increase in social investment and promoting the overall S&T progress.

Domestically, organized basic research has always been the focus of China's S&T layout and strategic S&T capacity building. Shortly after its founding, the People's Republic of China established the Chinese Academy of Sciences (CAS). Gradually, China has set up a modern S&T system consisting of five research units of the CAS, universities, research units of various departments of the State Council, local research units and national defense research units [6]. The Long-term Plan for the Development of Science and Technology (1956–1967) (Revised Draft) includes the layout of theoretical research, and the 13th section is dedicated to the planning of eight basic disciplines ①. Since the reform and opening up, the state has strengthened the strategic layout of organized basic research and the building of innovation players. In 1984, the State Key Laboratory Construction Plan was implemented to reinforce the support for key scientific research bases. In 1991, the National"Climbing" Program was implemented to buttress the government's responsibility of promoting basic research. The year 1997 saw the initiation of the National Key Basic Research Program of China (973 Program). It targets state-level major strategic goals and has promoted the development of basic research in China [7]. In 1998, the Chinese government encouraged the CAS to launch the pilot Knowledge Innovation Program to build the CAS into a powerful and sustainable state-level knowledge innovation center of natural sciences and high technology serving national strategic goals and targeting international science frontiers and a science research base up to the international advanced level [8]. In 2018, the State Council issued the Several Opinions of the State Council on Comprehensively Strengthening Basic Research, stressing the integration between free exploration and demand ②. In 2020, President Xi Jinping made it clear that "for one thing basic research is expected to follow its own laws, be driven by curiosity, and uphold free exploration as well as active exchanges; for another thing, it should target major S&T issues. Laws of science should be extracted from practice. In this way, basic research and applied research is mutually promoting each other" [9]. If high-level S&T self-reliance and self-improvement are to be realized, overall arrangements must be made to promote the strategic layout of organized basic research and strategic capacity building in S&T. Free exploration should be driven and stimulated by goals. In the end, basic research and applied research is mutually reinforcing each other.

1.2 Stress the strategic layout of organized basic research

Internationally, organized basic research is the focus of the strategic layout and resource investment of basic research in various countries. Since its implementation in 2000, the United States' National Nanotechnology Initiative (NNI) has propelled nanotechnology discoveries and worked hard at nano-fabrication and nano-commercialization [10]. In September 2018, the German government issued the 7th Energy Research Programme entitled "Innovations for the Energy Transition", which focused on cross-system energy transformation and funded applied research. It offered organizational assistance to the energy research by Helmholtz Federation [11]. In June 2020, the National Science Board (NSB) of the United States released the Vision 2030, emphasizing extensive investment in basic research in key areas related to the competitiveness of the United States, such as artificial intelligence and quantum information, which are guaranteed with short-term and long-term funds to expedite the transformation from discoveries to innovations ③. In January 2021, the Russian government issued the Long-term Science and Technology Policy-Russian Priorities for Basic Research Program (2021–2030), emphasizing the establishment of an effective basic and exploratory scientific research management system to improve the effectiveness, significance and demand of scientific research results for economic and social development ④. In July 2021, India

① Outline of the Long-term Plan for the Development of Science and Technology from 1956 to 1967 (Revised Draft). [2021-11-30]. http://www.most.gov.cn/ztzl/gjzcqgy/zcqgylshg/200508/t20050831_24440.html. (in Chinese)

② The State Council of the People's Republic of China. Some opinions on strengthening basic scientific research in an all-round way. (2018-01-31). http://www.gov.cn/zhengce/content/2018-01/31/content5262539.htm. (in Chinese)

③ Zhang Q J. NSB releases Vision 2030 to ensure U.S. leadership in science and engineering. (2020-09-24). http://www.casisd.cn/zkcg/ydkb/kjzcyzxkb/2020kjzc/zczxkb_202008/202009/t20200924_5704724.html. (in Chinese)

issued the National Biotechnology Development Strategy 2021–2025: Knowledge and Innovation Drive Bio-Economy, emphasizing centralized funding for emerging biological fields and cutting-edge basic research among priorities ⑤. In a word, major countries strengthen the strategic layout of organized basic research, aiming at laying a solid scientific foundation and solid knowledge reserve for future development.

Organized basic research has always been the focus of China's S&T layout and strategic research. China conducted strategic layout and innovation player building for basic research by issuing the National Plan for Long- and Medium-Term Scientific and Technological Development (2006–2020) and the National 13th Five-Year Scientific and Technological Innovation Plan. In addition, China has implemented organized basic research by issuing the Ten-Year Action Plan for Basic Research and the National 13th Five-Year Plan for Basic Research. For example, it is stipulated in the 973 Program that those academically autonomous basic studies mainly rely on the National Natural Science Foundation of China (NSFC). Those scientific studies having a significant bearing on national economic and social development are mainly promoted through the implementation of programs. Such systematic and sustainable planning [6] and layout provide a wellspring of practical experience for China to give full play to its advantages of new system concentrating nationwide effort and resources on key undertakings, sound and innovative system and large-scale market to carry out organized basic research to further improve the overall efficacy of the national innovation system.

1.3 Define the division of strategic capacity in S&T in organized basic research

Countries try to define the division of tasks of strategic S&T capacity in organized basic research. Tech powers and major countries are equipped with state-level scientific research institutions and laboratories, which together with high-level research-oriented universities and leading enterprises in science and technology constitute national strategic S&T capacity. They promote organized basic research through the division of labor. Take Germany as an example [12], it has a well-defined system for division of labor for basic research. Research-oriented universities, characterized by broad disciplines and their superiority in talent cultivation, are devoted to basic disciplines and theoretical research. They are funded by the German Research Foundation (Die Deutsche Forschungsgemeinschaft in German). The Max Planck Society (Die Max-Planck-Gesellschaft in German) prioritizes basic research on frontier interdisciplinary integration. About 90% of its funds come from the German federal government and state governments. The Helmholtz Association of German Research Centers relies on large-scale scientific facilities to carry out national strategic and interdisciplinary forward-looking basic research. About 70% of its funds come from the German federal government and state governments. Other institutions and scientific organizations were grouped into the Leibniz Association, which focuses on task-oriented and application-based basic research. About 70% of its funds come from the German federal government and state governments. The Fraunhofer Society (Fraunhofer-Gesellschaft in German) is committed to applied research and advanced technology research and development (R&D). Only about 30% of its funds come from the German federal government and state governments. A few leading enterprises in science and technology invest in and carry out applied basic research.

The development pattern of basic research in China and the structure of national strategic S&T capacity are undergoing profound changes. Shortly after the People's Republic of China was founded, China's basic research personnel and funds flocked to the CAS. With the improvement of the country's comprehensive strength, the investment in basic research continues to increase, which is manifested in personnel and funds. In 2001, the personnel of government-owned research institutions accounted for 30.2% of the country's total, and their funds accounted for 60.4% of the country's total, while the personnel of colleges and universities accounted for 64.7% of the country's total, and their funds accounted for 34.2% of the country's total. 2019 witnessed the proportion of personnel in government-affiliated research institutions drop to 23.5% of the whole country and the proportion of funds drop to 38.2%, and witnessed the proportion of personnel in colleges and universities rise to 68.1% of the whole country and the proportion of funds rise to 54.1% [13]. A diversified pattern has been shaped. Steps are quickened to build state-level laboratories, major S&T infrastructure and reorganize national key laboratories to foster a modern laboratory system and a major S&T infrastructure system, which will lay a solid foundation for the overall promotion of organized basic research. As the institutional and systematic strategic capacity in S&T, national research institutions are actively carrying out organized and strategic demand-oriented basic research. Making full use of their superiority in basic discipline foundation and talent training to conduct frontier basic research in an organized manner, high-level research-oriented universities are stepping up efforts to build first-class disciplines and world-class talents. An increasing number of leading S&T enterprises now

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④ Jia X Q. Russia releases basic research plan by 2030. (2021-05-21). http: //www.casisd.cn/zkcg/ydkb/kjzcyzxkb/kjzczxkb2021/zczxkb202103/202105/t20210521_6036090.html. (in Chinese)

⑤ Xu L. The Ministry of Science & Technology Government of India issued National Biotechnology Development Strategy 2021-2025: Knowledge and Innovation Drive Bio-economy. (2021-11-10). http: //www.casisd.cn/zkcg/ydkb/kjqykb/2021kjqykb/kjqykb_20211110/202111/t20211110_6248425.html. (in Chinese)

approach unexplored areas. Relying on the market and the platform, they are engaged in organized and application-oriented basic research to expedite the modernization of the industrial chain.

2 The promotion ideas of organized basic research in China in the new period

In 2020, China entered the ranks of innovative countries in due course, embarking on a new path of building a tech power. The new century presents unprecedented opportunities. Geared to the new century, China is committed to realizing its dream of revitalizing the Chinese nation. Our priority is to seize the initiative to carry out organized basic research. We will envision our strategic layout and strategic capacity building in science and technology for the next 30 years. In the future, demand orientation and free exploration are expected to become closely integrated with each other to set the stage for China to become a global leader in innovation by 2035 and grow into a world-class tech power by 2050. Innovation participants are advised to bring into play their uniqueness, engage in their chief business and undertake their responsibilities, to improve the entire efficacy of the basic research system by perfecting its systematic layout and pushing forward reforms as a whole.

2.1 Map out organized basic research based on task features

To fulfill the strategic S&T tasks stated in the Outline of the 14th Five-Year Plan (2021-2025) for National Economic and Social Development and the Long-Range Objectives Through the Year 2035 of the People's Republic of China [14], we must map out organized basic research based on types of tasks. We will formulate and implement strategic scientific programs and scientific projects in the basic and core areas concerning national security and development, and carry out pioneering and strategic national projects in frontier fields. Based on the urgent and long-term needs of the country, we will concentrate our advantageous resources to make breakthroughs in core technologies. We will redouble our efforts in data-driven science, instrument science and big data science, create new scientific research methods and means, and develop basic research featuring major S&T infrastructure construction, high-end scientific instruments and facilities and the development and utilization of S&T data.

(1) Carry out organized research on the integration of frontier and interdisciplinary sciences. Key universities and major research institutes will constitute the leading forces. We will target global frontier sciences and focus on unexplored domains. To this end, we will organize a number of gifted talents, and equip them with first-class laboratories and science research environment favorable for free exploration. Such design is set to achieve significant original scientific breakthroughs up to the Nobel-prize level, and produce world-class science gurus. In this process, major research institutions will serve as core members. They are oriented toward frontier, interdisciplinary, key and superior areas. They will manage to make precise predictions of science development trends in an organized way. They are expected to deliver a batch of major and original achievements in frontier, interdisciplinary and superior areas. International science innovation centers and comprehensive national science centers will play a major role too. They will organize innovation integration across domains in the directions of information technology, biotechnology, nano-science, and cognition technology so as to breed, trigger and release the multiplier effect of cluster innovation [15]. Frontier and interdisciplinary platforms such as modernized laboratories are made full use of to reinforce the coordination between multiple players and disciplines in the hope of making first-class frontier research findings and addressing a number of complex interdisciplinary issues.

(2) Carry out organized integrated research on science, technology and engineering. Major science research institutes and leading science enterprises are the leading light in this regard. Such research targets major national needs, economy, people's life and health. It is centered on major S&T issues affecting economic, social development and national security. It is a kind of organized research aimed at solving problems and upholding application. Directed and systematic science basic research should be scaled up. Breakthroughs should be made in the underlying science principles of core technology to provide a theoretical and technological foundation for modern engineering and subversive innovation. Such research should be spearheaded by leading science enterprises, major science research institutes, national technological innovation centers and national engineering laboratories. Technical science and key technology should mutually reinforce each other. Relevant major tasks, significant innovation platforms and talent building should be coordinated and integrated with each other. Hence, China's technical science research becomes more strategic and systematic, basic research findings with bright application prospects can be achieved, and the modern S&T system can be enriched.

(3) Carry out basic research underpinned by major S&T infrastructure. Large scientific and experimental devices and major S&T infrastructure are of great value to the country. By April 2020, the National Development and Reform Commission had laid out 55 national major S&T facilities ⑥ In the future, we should rely on the intensive advantages in

⑥ Xu W N. The NDRC has made clear the scope of "new infrastructure" and will focus on four aspects of work. (2020-04-20). http://finance.people.com.cn/n1/2020/0420/c1004-31680443.html. (in Chinese)

major S&T infrastructure of international S&T innovation centers and comprehensive national science centers to build large scientific research centers and high-level basic research bases with interdisciplinary integration, openness and sharing. Relying on regional S&T innovation centers to build medium-sized S&T infrastructure clusters, we should give full play to their platform role in training and gathering strategic S&T talents, promoting frontier, interdisciplinary and international S&T exchanges and cooperation, and avoid the imbalance in the spatial layout of innovation. We should make forward-looking and systematic layouts so that all players can use modernized laboratories and the major S&T facility system to carry out organized basic research, thus shaping a new basic research innovation ecology that is connected and well-distributed.

(4) Carry out basic research based on long-term, sustainable and systematic data accumulation. Data are the foundation of basic research. Some basic research needs long-term, sustainable and systematic data accumulation, such as S&T supporting China's ecological screens, deep space, deep sea and polar observation. In this respect, major S&T institutes constitute the primary forces and continuously support basic work that is of strategic significance to the comprehensive and long-term development of basic research and needs long-term accumulation. For example, we need to further advance data science, build science research information infrastructures such as big data centers for literature and science, and continuously monitor, observe, collect, analyze and collate basic science data and materials; set up a science research resource bank, collect and preserve specimens, germplasm resources, experimental material resources, human genes, etc.; build national workstations (networks) for field observation and research and various scientific research stations to provide high-quality science data for basic research in various fields, ensure the safety and resilience of the science data system, and improve the sharing level and utilization efficiency.

(5) Carry out basic research on the development of scientific instruments and facilities. The supply of high-end scientific instruments, inspection equipment and scientific research software underpins basic research. In this regard, major scientific research institutes and key universities play an important role. Full play should be given to the existing S&T conditions and the role of high-end equipment, integrate the strength of superior S&T enterprises, and make instrument science refined and strong. We should map out the layout of R&D bases for high-end research instruments and facilities, improve the independent R&D and application systems of high-end research instruments and facilities, actively plan the R&D tasks of major national scientific instruments and facilities, strengthen the basic research related to the R&D of high-end research instruments and facilities, scientific research reagents, core devices, inspection and testing equipment and scientific research software, and enhance the ability to guarantee the basic S&T conditions.

2.2 Promote organized basic research according to institutional characteristics

China's basic research has laid a solid foundation and is leaping from quantity to quality. However, the original innovation ability is still weak and the key core technologies are still subject to foreign constraints. It is clearly stated in the Outline of the 14th Five-Year Plan (2021–2025) for National Economic and Social Development and the Long-Range Objectives Through the Year 2035 that the proportion of investment in basic research to total R&D budgets will increase to 8% and above [19], which will lay a solid material foundation for basic research. The basic research system is a holistic system composed of players, links, levels and fields of basic research mutually linking each other. The key is to give full play to the leading role of the national strategic capacity in S&T, speed up the creation of the original innovation source, and the breakthrough in key technical and scientific areas. Up till now, China has had more than 3,000 scientific research institutions, more than 3,000 colleges and universities, and 130,000 industrial enterprises above designated size undertaking R&D activities. Among them, some institutions and organizations constitute national strategic S&T capacity, for they can undertake major S&T innovation tasks related to the long-term and overall national economic and social development and national security and they are conducive to comprehensively fostering new development advantages. National laboratories, national scientific research institutions, high-level research-oriented universities and leading enterprises in science and technology are the core forces to undertake the task of organized basic research. It is necessary to clarify the division of tasks and strengthen open cooperation in accordance with their own advantages.

(1) National laboratories and national scientific research institutions focus on strategic and systematic organized basic research. In line with the requirements of "four orientations", they rely on major S&T infrastructure and a modern laboratory system to keep abreast with world S&T development, adapt to the missions and tasks put forward by China's development for science and technology, carry out interdisciplinary forward-looking basic research driven by major S&T issues, and address major S&T problems affecting the overall development and long-term interests of the country. Institutional superiority should be given play to and the research should target national strategic needs and frontier science issues. The strength of multiple disciplines should be integrated to perform large-scale frontier and interdisciplinary research in an organized manner. These state-level laboratories and institutions undertake strategic basic research and technical science research, focusing on the grand projects, major tasks, key technologies, and fundamental problems.

Big data science and instrument science are to be developed. Systematic and big data-driven basic research based on long-term, sustainable and systematic data accumulation should be carried out. Large-scale high-end scientific instruments and facilities are to be developed. More strategic and key major S&T achievements are expected to be made.

(2) High-level research-oriented universities focus on frontier and exploratory organized basic research. High-level research-oriented universities, owing to their solid basic research and interdisciplinary advantages, can simultaneously develop science (as the primary productive force), train talents (as the primary human resources), and enhance innovation (as the primary driving force), thus playing a key role in basic research and making significant breakthroughs in science and technology. They prioritize medium-and-small frontier and interdisciplinary research and pioneer technology. Frontier exploration should accommodate national strategic goals and tasks. Basic discipline research centers and frontier science centers should be made full use of to train top students in basic disciplines, attract the best students and teachers to commit themselves to curiosity-driven basic research. Based on discipline data accumulation, efforts should be stepped up for exploratory and reserve basic research, as well as the R&D of medium and small-sized high-end instruments and facilities, materials and software.

(3) Leading S&T enterprises focus on market-driven and applied organized basic research. Leading S&T enterprises, with great advantages in market demand, integrated innovation and organization platforms, work with state-level research institutes and high-level research-oriented universities to build frontier basic research institutions and innovation consortium, through which they carry out frontier, interdisciplinary research, technical science, and applied basic research that promise market prospects. In this way, science, enterprise, industry, and economy flourish simultaneously. Leading S&T enterprises work as the spearhead. They assembly innovation resources to build cross-domain, coordinated, and intensive industrial applied research bases, where they carry out applied research based on accumulated industrial data, scale up the development of scientific instruments and facilities, materials and software promising a market prospect. All their efforts aim to improve the upgrade of the industrial base and modernization of the industrial chains.

3 Improve the implementation mechanism of organized basic research in China

It will be a systematic project to enhance organized basic research to come up with original innovations and strengthen innovation at the source. Government-industry-university-institute collaboration targeting national strategic needs and frontier science is to continue. The strategic layout and S&T force layout are to be optimized. A scientific, sound and optimized scientific problem selection mechanism and resource allocation mechanism, organizational model and management mode are to be shaped up. Strategic S&T forces are guided to establish a foothold on their own, concentrate on their own strength, take up their own responsibilities, undertake the assigned national strategic S&T tasks, produce significant achievements and innovative talents.

3.1 Establish an organized scientific problem selection mechanism for basic research

Measures should be made to establish strategic planning, decision-making, implementation, and consultation mechanisms to avoid duplication of major tasks. We should establish both top-down and bottom-up scientific problem selection mechanisms geared to the “four orientations”. High-end think tanks such as the CAS, the Chinese Academy of Engineering, and the China Association for Science and Technology are expected to play well their functional and leading roles. Aiming at discipline frontier trend, S&T trend, economic development, social progress and national security, which meet a country’s long-term demand and strategic layout, these think tanks are expected to gain insights into national S&T strategies and basic research strategies, make sustainable strategic research on discipline development and frontier trend judgment, regularly generalize major scientific issues and key technological issues. Scientists and industrial experts should be organized in scientific, standard and efficient ways to study S&T development trends at home and abroad and the channels to conduct organized basic research. To this end, they are advised to adopt systematic and holistic mentality, quantitative and qualitative research methods. National strategic S&T forces are directed to undertake strategic tasks conforming to their job responsibility, domain, superiority in talent and platform in accordance with their selected scientific issues, and draw on each other’s strengths while focusing on their own main responsibilities.

3.2 Build a resource allocation mechanism integrating both scientists and tasks

In nature, basic research is exploratory and uncertain. The key to organized basic research lies in coordinating and optimizing resource allocation, maintaining, attracting and pooling quality talents. Long-term and stable support will go to targeted people or tasks. Mission-driven designated and systematic basic research will be scaled up. Efforts should be made to ensure that the path and the methodology of scientific research are independent. Meanwhile, we must guarantee that a few distinguished scientists enjoy the autonomy for selecting scientific topics. We must firmly believe that distinguished scientists can independently explore new directions. There are two ways to integrate scientists and tasks. First, we must identify and endorse challenging programs or

the ones that meet the great demands of society, and then magnetize and pool a number of quality talents. Second, we must identify the gifted and talented in science and fully support their research on major S&T problems or frontier exploration.

3.3 Establish stable, diverse and open organizational models

In accordance with the strategic layout and institutional positioning, we must beef up and entrench stable and diversified financial support to make sure that various players can focus on their major responsibilities. Long-term and stable funding will go to scientifically argued major projects, outstanding teams and key bases. Different disciplines, domains and institutions are guided to integrate with each other, promoting thorough industry-university-institute integration and fusion development of science, technology, and engineering. Programs should be arranged in response to national strategic needs. A new type of research organization, where researchers can work either independently or jointly ⑦ should be established. The systematic layout should be made for major S&T infrastructure, scientific data center and computing platform, national public inspection and testing platform, germplasm resource bank, and field stations, which should be further opened for sharing and international cooperation. In the future, innovation platforms should be clustered, large-scale, open and region-based. All kinds of laboratories and scientific research bases should be upgraded to be digital and smart. International mega-science programs and projects should be planned for large-scale, complex, and global basic research tasks, enhancing China's appeal to worldwide innovation resources and talents.

3.4 Build a coordinated, precise and flexible management mode

We should come up with management modes for basic research accommodating to the reform of science research paradigms. While exercising macro-management, we should "streamline administration and delegate power, improve regulations, and upgrade services" in the fields of S&T. Specifically, more autonomy should be granted to science research institutions in terms of layout, composition and resource allocation. Strategic scientists, research teams and personnel can be given more autonomy for innovation undertakings. Based on the major strategic layout and the positioning of strategic capacity in S&T, we should work to improve the systems and mechanisms concerning long-term evaluation, promotion, performance-based reward and supporting services. We should carry out flexible management. For one thing, we should give credit to those researchers who are engrossed in research against temptations and are bold to try unexplored areas. For another thing, we encourage researchers to make concerted efforts to tackle knotty problems [16], thus activating the enthusiasm of various innovation players. Well-defined major strategic tasks can be implemented in phases, during each of which talents with the potential as strategic scientists can lead the team successively, thus boosting the ongoing upsurge of strategic S&T talents.

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