Pioneering the Construction of World-Class Scientific Research Institutions: A Study of the Governance Model Characteristics of the French National Center for Scientific Research and Its Implications (Postprint)

Authors: midsummer

Date: 2023-03-19T00:00:00+00:00

Abstract

"Taking the lead in building world-class research institutions" constitutes one of the requirements of the "Four Firsts" that General Secretary Xi Jinping proposed to the Chinese Academy of Sciences (CAS) in 2013—specifically, to be the first to achieve leapfrog development in science and technology, the first to establish a national highland of innovative talent, the first to establish a national high-level science and technology think tank, and the first to build world-class research institutions. As a national strategic scientific and technological force, CAS's initiative to take the lead in building world-class research institutions requires integrating its own practical realities while drawing upon the developmental experiences of advanced research institutions worldwide, thereby striving to modernize its scientific research governance system and governance capabilities. The French National Center for Scientific Research (CNRS), as Europe's largest basic research center, belongs to the same category of national comprehensive research institutions as CAS, and the two organizations share numerous similarities in development philosophy, developmental trajectory, disciplinary layout, and strategic orientation. This article focuses on examining CNRS's organizational and operational models, personnel systems, evaluation frameworks, and strategies for industrial collaboration and internationalization, aiming to distill characteristic experiences and patterns that contribute to improving the modern scientific research governance system, and to provide valuable insights and references for CAS's current in-depth implementation of the "Pioneering Action" plan.

Full Text

Taking the Lead in Building World-Class Scientific Research Institutions: Insights from the Governance Model of the French National Center for Scientific Research

Sheng Xia
1. Bureau of Personnel, Chinese Academy of Sciences, Beijing 100864, China
2. School of Public Policy and Management, University of Chinese Academy of Sciences, Beijing 100049, China

Abstract

"Taking the lead in building a world-class scientific research institution" represents one of the "Four Pioneering Initiatives" that General Secretary Xi Jinping proposed to the Chinese Academy of Sciences (CAS) in 2013. As a national strategic scientific and technological force, CAS must align with its own realities while drawing upon the developmental experiences of advanced global research institutions to modernize its scientific research governance system and capabilities. The French National Center for Scientific Research (CNRS), as Europe's largest basic research center, shares with CAS the status of a national comprehensive research institution. The two organizations exhibit numerous similarities in development philosophy, historical trajectory, disciplinary layout, and strategic orientation. This study examines CNRS's organizational operation model, personnel system, evaluation framework, and strategies for industrialization and internationalization, aiming to distill actionable insights that can inform the modernization of CAS's research governance system and support its in-depth implementation of the Pioneer Initiatives Plan.

Keywords: powerful nation of science and technology; world-class scientific research institution; French National Center for Scientific Research; governance mode

---

1. Introduction

The 19th National Congress of the Communist Party of China emphasized accelerating the construction of an innovative nation, strengthening the national innovation system, and reinforcing strategic scientific and technological forces, with the goal of positioning China among the front ranks of innovative countries by 2035 and building a world science and technology powerhouse by 2050. As a national strategic scientific and technological force, CAS is deeply implementing the Pioneer Initiatives Plan according to General Secretary Xi Jinping's "Three Orientations" and "Four Pioneering Initiatives" requirements. Through pioneering and systematic reforms of its scientific and technological systems and mechanisms, CAS aims to take the lead in building world-class scientific research institutions, striving to serve as the "locomotive" driving China's scientific and

technological development and leading the overall leap in national scientific and technological innovation capabilities.

Since its establishment in 1949, CAS has adhered to the principle of "revitalizing the Academy through openness." The current wave of global scientific and technological revolution and industrial transformation is gaining momentum, with countries worldwide increasing investment in scientific and technological innovation, accelerating reforms to their research systems and mechanisms, and optimizing the integration of innovation elements to seize the commanding heights of future industrial development. As the most historically established research institutions in modern science and technology history, national research organizations have played crucial roles as engines of original innovation. To take the lead in building world-class scientific research institutions, CAS should learn from the strengths of leading global research institutions and advance the modernization of its research governance system and capabilities.

France stands as one of the world's scientific and technological powers, possessing formidable scientific and technological strength in aerospace, nuclear energy applications, high-speed rail, medical and environmental protection, and high-end manufacturing. The organizational form of national research institutions with substantive features first emerged in 17th-century France. China and France share a long history of exchange and cooperation, with France being the first Western country to establish diplomatic relations with the People's Republic of China. The two nations share similarities in political philosophy, cultural thinking, and geopolitical patterns, particularly exhibiting relatively prominent centralized governance characteristics in national and social governance thinking patterns. The French National Center for Scientific Research (Centre National de la Recherche Scientifique, CNRS) is France's largest national comprehensive research institution and currently Europe's largest basic research center, covering nearly all natural sciences and humanities and social sciences. By the end of 2015, CNRS comprised 10 research institutes, 1,151 laboratories, and 31,944 employees, ranking among the world's five most innovative public research institutions in the former Thomson Reuters Intellectual Property & Science division's listings. Since its establishment in 1939, CNRS has produced 22 Nobel laureates, 12 Fields Medalists, 1 Turing Award winner, and 1 Abel Prize winner, occupying an absolutely dominant position in France's national innovation system.

Given that CNRS and CAS are both national comprehensive research institutions, this paper examines the characteristics of CNRS's organizational operation model, hoping to distill beneficial insights and recommendations for CAS's development.

---

2. Development History of CNRS

CNRS was established in October 1939, at the outbreak of World War II, when the French government urgently needed to integrate the nation's scientific and technological strengths to enhance national defense equipment capabilities and resist fascist Germany's invasion. During the war, CNRS played a pivotal role in defense-related scientific research, including nuclear weapons, radio communications, naval equipment, and wartime food substitutes. After WWII, CNRS shifted its focus from primarily defense-oriented research to cutting-edge basic research directions.

In 1966, CNRS underwent a major organizational adjustment, entering a "honeymoon period" of close cooperation with French universities through the active co-construction of joint laboratories, continuously expanding and enriching its research fields. Beginning in the 1970s, CNRS focused on addressing scientific issues closely related to socio-economic development, extending its research into industrial domains.

In 2008, CNRS released its *2020 Strategic Plan*, which explicitly defined its core functions: (1) conducting scientific research that serves scientific and technological progress and benefits national economic, social, and cultural development; (2) promoting technology transfer and transformation; (3) disseminating scientific information; (4) cultivating high-level scientific and technological talent; and (5) analyzing domestic and international scientific and technological development trends to provide robust intellectual support for national scientific and technological strategic decision-making.

---

3. Organizational Structure Model

3.1 Headquarters Organizational Structure CNRS is affiliated with France's Ministry of Higher Education, Research, and Innovation. Since its establishment, CNRS has adhered to the principle of "scientists governing the institution," with its primary leadership positions held by scientists of high reputation and influence. Its scientific research organizational architecture [Figure 1: see original paper] exhibits top-down centralized management characteristics, implementing a three-tier structure of "Headquarters—Research Institutes (Regional Delegations)—Laboratories."

The Board of Directors serves as CNRS's highest strategic decision-making body, with the Board Chair as the top leader. The Board oversees the headquarters' administrative leadership team, with the Chair also serving as the Center President—the principal leader of the administrative team. The administrative leadership comprises the Center President, Secretary-General, Chief Scientific Officer, Chief Administrative Officer, and the Delegate General for Technology Transfer Affairs.

The Center President presides over all work, with the Secretary-General assist-

ing in coordinating various functional departments. Headquarters functional departments are divided along two main lines: scientific research business and administrative affairs. The Chief Scientific Officer assists the Center President in leading research-related functional departments, such as the Bureau of Research Organization and Regional Development, the European and International Cooperation Bureau, the Innovation and Enterprise Relations Development Bureau, and the Large Facilities Management Committee, while also providing overall guidance to the ten Innovation Institutes. The Chief Administrative Officer assists in leading comprehensive administrative management departments, including the Budget and Finance Bureau, Infrastructure and Construction Bureau, Personnel Bureau, Legal Affairs Bureau, and Information Technology Bureau, while also coordinating the work of 18 regional delegations across France. The Delegate General for Technology Transfer Affairs assists the Center President in coordinating and guiding the center's industrialization efforts, co-managing the Innovation and Enterprise Relations Development Bureau and Legal Affairs Bureau.

3.2 Regional Management by Zones CNRS implements a geographically-based localized management model, currently maintaining 18 regional delegations across France. These delegations provide comprehensive functional management and support services to laboratories within their jurisdictions, including personnel management, safety and health care, budget execution supervision, and coordination with local governments and partner institutions (such as universities) for territorial cooperation agreements or technology transfer promotion.

3.3 Basic Research Units CNRS currently operates 1,151 basic research units distributed throughout France, comprising 1,018 laboratories and 133 research support service institutions, with disciplinary distributions shown in [Figure 2: see original paper]. Except for a small proportion of wholly-owned units, the vast majority (nearly 90%) adopt a "mixed establishment" model with external partners—collectively termed "mixed research units." By the end of 2015, CNRS had 950 domestic mixed research units and 35 international mixed research units.

Mixed research units are established through cooperation agreements between CNRS and external partners (primarily universities), with explicit provisions regarding personnel, funding ratios, and laboratory facilities. Personnel and research funding are generally contributed primarily by CNRS, while workspaces are typically located at partner institutions such as universities. Research outputs and intellectual property rights are clearly defined. Mixed research units uniformly bear the CNRS designation, hold unified institutional codes within CNRS, and receive dual supervision from CNRS and partner institutions (within CNRS, they generally fall under the supervision of one or more research institutes). Unit sizes range from several dozen to several hundred personnel.

The "mixed research unit" organizational model represents a major feature of CNRS's research organization system. Implemented for over half a century, it has effectively promoted the organic integration of French research institutions and universities, achieving shared domestic research and talent resources. By the end of 2015, CNRS's mixed research units accounted for approximately 30% of all physical research units in France, and partnering with CNRS to establish mixed units has become an important indicator of research qualification levels for other French scientific and educational institutions.

3.4 Innovation Institute Model To meet the demand for large-scale, interdisciplinary, and institutionalized collaborative research required for major scientific outputs, CNRS undertook significant reforms to its internal research organization and management model in 2008, consolidating ten Innovation Institutes organized by thematic scientific fields: Life Sciences, Chemistry, Ecology and Environment, Humanities and Social Sciences, Information and Interaction, Mathematics and Interaction, Physics, Engineering and Systems Sciences, National Nuclear and Particle Physics, and National Cosmic Sciences. Each Innovation Institute coordinates and guides the research activities of relevant units across France, possessing authority over laboratory personnel and funding allocation.

Innovation Institutes typically have substantial scale. For example, the Physics Innovation Institute focuses on condensed matter physics, materials, nanoscience, and theoretical physics, comprising approximately 3,000 researchers, 1,500 engineers and technicians, and 1,700 postdoctoral researchers and doctoral students. It operates 72 domestic laboratories, 14 domestic joint research groups, 3 international mixed laboratories, and 19 international collaborative laboratories, along with related large-scale scientific facilities across the country.

---

4. Personnel Management Model

4.1 Stable and Mobile Employment System By the end of 2015, CNRS employed 31,944 staff members, including 24,617 tenured employees and 7,327 contract employees. By job function, personnel are categorized into three types: researcher track (15,197), engineer track (12,495), and technical support staff track (4,252).

In 2015, CNRS had 24,617 tenured employees, comprising 11,106 researchers and 13,511 engineers and technical support personnel (including administrators). Tenured employees enjoy civil servant status with clear career development paths and stable social welfare benefits. They constitute the core backbone of CNRS's research efforts, forming a stable talent foundation that facilitates long-term, high-risk basic research.

Despite recent fiscal constraints that have prompted the French government

to reduce public sector positions and budget expenditures, CNRS's tenured positions have not been downsized like other government agencies. Between 2005 and 2015, the number of tenured research personnel remained relatively stable, as shown in [Figure 3: see original paper].

The recruitment of tenured CNRS personnel follows a strict competitive selection process. Approximately 600 tenured positions are recruited annually (about 300 researchers and 300 engineers and technical support personnel). The competition is intense, with acceptance rates ranging from 1:18 (2010) to 1:28 (2014). In 2015, the average age of recruited researchers was 34.2 years.

Non-tenured CNRS personnel are typically employed under contract without civil servant status, with 85.9% of their salaries funded by CNRS's own budget according to research needs. Applicants face no nationality restrictions, with initial contracts of up to three years and possible renewals. Postdoctoral researchers constitute the main body of mobile research personnel. By the end of 2015, CNRS hosted 3,925 postdoctoral researchers, accounting for 53.6% of all non-tenured personnel. To avoid "inbreeding," postdoctoral recruitment requires that applicants have no prior research experience in CNRS-related laboratories, with priority given to those who earned their doctoral degrees abroad. Postdoctoral contracts generally have a maximum duration of two years.

4.2 Open and Diverse Employment Model Given that 90% of CNRS's research units adopt a mixed establishment model with external universities and industry partners, its employment model features open and diverse talent cooperation. In mixed research units, CNRS's own researchers typically account for only one-third of all research personnel, while its own engineering and technical personnel represent slightly more than half of all engineers and technicians. By the end of 2015, CNRS's own personnel and partner-assigned personnel totaled 97,462 across all tracks.

CNRS encourages internal personnel mobility. Researchers may proactively apply for or be passively transferred to different research units based on evolving research directions or needs. During their tenure, researchers may also temporarily transfer to public or private research institutions, domestic or international higher education institutions, or enterprises. During such temporary assignments, the host institution pays the salary, but the researcher retains promotion rights at their original institution. Upon returning, the original institution fully restores all previous personnel rights. In some cases, researchers may retain their CNRS positions and salaries while working at domestic or international partner institutions. Although public research institutions and universities maintain their independence, their financial support all originates from the French government, allowing flexible coordination of human resource costs without additional expenses from personnel mobility. This flexible talent mechanism breaks down institutional barriers caused by affiliation differences, avoids negative impacts from dispersing high-quality human resources, facilitates integration of superior intellectual resources, and enhances inter-institutional research collaboration.

5. Personnel Evaluation and Achievement Transfer System

5.1 Professional Institutional Personnel Evaluation System The National Committee for Scientific Research (Comité National de la Recherche Scientifique, CoNRS) is a specialized evaluation body independent of CNRS's administrative system. It provides consultation on CNRS's scientific research and conducts regular evaluations of research institutions (laboratories) and personnel. CoNRS comprises one CNRS Scientific Committee, ten Institute Scientific Committees, 41 professional disciplinary committees, and five interdisciplinary committees. The professional disciplinary and interdisciplinary committees are primarily responsible for evaluating CNRS research institutions and personnel.

Each professional disciplinary committee has 21 fixed members, all authoritative experts in relevant fields. Members are appointed through a combination of "appointment and election," serving four-year terms. Approximately one-third of members are directly appointed by CNRS's supervisory ministry—the Ministry of Higher Education, Research, and Innovation—while the remaining two-thirds are elected by researchers in relevant fields. Members typically come from CNRS, external universities, industry, and even international experts.

CoNRS maintains no unified evaluation system, instead adopting qualitative and quantitative evaluation methods tailored to different disciplinary characteristics. While some quantitative metrics such as journal publication counts are used, greater emphasis is placed on qualitative assessment, including research outputs, alignment with current research contexts and policy orientations, domestic and international academic influence, research activity and valorization, graduate student training quality, and team building.

Institutions undergo project final evaluations every four years and mid-term evaluations every two years, while individuals submit annual progress reports to CoNRS. Evaluation results directly correlate with institutional retention, dissolution, or merger decisions, as well as funding support, recruitment quotas, personnel promotion, and salary adjustments for the next evaluation cycle.

5.2 "People-First" Personnel Funding Guarantee Model Despite fiscal constraints following the 2008 financial crisis, France maintained and increased funding support for national research institutions, with CNRS's budget remaining relatively stable. Between 2008 and 2014, CNRS's overall budget increased by 16%. In 2015, CNRS's total budget reached €3.3 billion, comprising stable state financial support (77%) and competitive research project contract income (23%). State financial subsidies consist of personnel salaries (82%) and other components for institutional operations, equipment, and related investments. Overall, personnel expenses account for 72.2% of CNRS's total budget expenditures.

Due to its mixed research unit operation model, CNRS also receives funding

from other partners. Tenured CNRS personnel salaries are essentially fully guaranteed by state finance, with compensation standards generally at the upper-middle level of French social average salaries , and subject to increases based on years of service and rank advancement. CNRS does not permit researchers to extract personal performance bonuses from research project funds.

5.3 Technology Achievement Transfer and Transformation France enacted the *Innovation and Research Act* in 1999, permitting researchers to establish enterprises, disseminate their research results, or provide technical support to businesses. Researchers need only report to supervisory authorities before engaging in part-time work or entrepreneurship, with individuals eligible to receive up to 50% of economic benefits from technology transfer. CNRS actively encourages researchers to promote technology transfer and transformation.

Since 1992, CNRS has established the French Innovation and Technology Transfer Limited Liability Company (FIST SA), a functional department dedicated to patent technology incubation, responsible for transferring innovative technologies to enterprises. It signs 80–100 technology transfer agreements annually with French or international companies, with 1,300 agreements currently in execution as of 2015. CNRS has also directly established or holds controlling stakes in 14 French technology acceleration and incubation companies, while creating 21 "public-private hybrid" laboratories for deep industry-research collaboration.

In 2015, CNRS launched the Enterprise Creation Accompaniment Action Plan to help researchers with promising marketable technologies establish businesses. CNRS conducts 150 industry-research cooperation training sessions annually, with experienced researchers directly imparting knowledge. Since 2011, CNRS has entered the world's top 100 innovative institutions (ranked by the former Thomson Reuters Intellectual Property & Science division based on patent applications, grants, and international influence). From 2011 to 2015, CNRS's patent applications increased by 25%, making it France's sixth-largest patent applicant (1,438 patents granted, 5,629 patent families). Since 2000, CNRS researchers have founded 1,200 technology startups employing approximately 7,000 people. To date, 80% of these startups remain operational, with some successfully going public. Leadership of these companies includes 71% from CNRS researchers or engineers and 15% from CNRS doctoral students or postdoctoral researchers. The information and communication technology sector accounts for the largest share (38%), followed by biology and health (24%), and chemistry and materials.

---

6. Internationalization Strategy

CNRS has signed researcher exchange agreements with 127 institutions across 71 countries. As of 2015, 331 international scientific research cooperation projects with CNRS were in execution. Approximately 4,600 foreign researchers conduct

exchange research at CNRS-affiliated institutions annually. CNRS dispatches about 200 personnel to international mixed laboratories for research cooperation lasting one year or more, and approximately 60,000 person-times to overseas mixed laboratories for short-term visits and exchanges.

By the end of 2015, CNRS tenured personnel included 2,318 foreign nationals (9.4% of the total), with 17% of researchers, 3.5% of engineers, and 3.5% of technical support personnel being foreign. Among newly recruited personnel each year, 34% are foreign employees. One-third of doctoral students come from 90 different countries, primarily Europe (40%), followed by Africa (21%) and Asia (21%). Nearly 60% of CNRS research articles are completed in collaboration with international partners.

A key manifestation of CNRS's internationalization strategy is establishing international mixed laboratories (UMI) abroad. By the end of 2015, CNRS had established 35 international mixed laboratories in the United States, Canada, Japan, Singapore, Chile, and other countries, in partnership with local universities or enterprises. Simultaneously, CNRS vigorously promotes its science diplomacy strategy, maintaining eight CNRS representative offices within French embassies, including in China.

---

7. Implications and Recommendations

7.1 Enhancing Capacity to Address Major Scientific Questions and Achieve Significant Research Outputs: World-Class Research Institutions Should Establish Research Organization and Management Systems that Concentrate and Integrate Innovation Elements The current global wave of scientific and technological revolution and industrial transformation is gaining momentum, with some important scientific questions and key core technologies showing signs of revolutionary breakthroughs that drive cross-disciplinary integration and collective advancement, with transformative energy continuously accumulating. Many major scientific and technological breakthroughs originate from comprehensive cross-disciplinary integration. Since 2009, CNRS has vigorously promoted reforms to its research governance system, strengthening headquarters' leadership and coordination capabilities, creating ten Innovation Institutes organized by major disciplinary fields, reinforcing flat vertical management of affiliated laboratories, enhancing management and coordination of disciplinary units, improving visibility and external openness, eliminating barriers between units to avoid redundant resource investment, and maximizing the effectiveness of research funding and instruments. This research model better leverages the advantages of comprehensive national research institutions with multi-disciplinary institutionalized team operations, ensuring cross-disciplinary, cross-field, and cross-departmental research collaboration from an organizational perspective, thereby facilitating solutions to major scientific questions and significant research outputs.

CAS is currently deepening implementation of the Pioneer Initiatives Plan, proposing that by 2030 it will form a relatively mature, dynamically adjusted, and optimized modern research institute governance system with Chinese characteristics. To this end, CAS undertook substantial reforms to its headquarters functional departments in 2013, shifting from traditional discipline-based segmented research business organization to a new model organized by the nature of research activities and disciplinary characteristics, focusing on basic frontier research, application promotion, and major project organization. Meanwhile, based on the nature and characteristics of each institute's primary innovation activities, CAS vigorously promoted institute classification reforms and optimized research layouts, classifying research institutions into "Innovation Research Institutes, Excellence Innovation Centers, Large-Scale Science Research Centers, and Characteristic Research Institutes" to integrate relevant research forces and resources, aiming to address issues of dispersed, fragmented, and low-level repetitive research.

These reform measures align with global scientific and technological development trends and the direction of modern research governance model reforms. We recommend that CAS continue adhering to the principle of "concentrating resources to accomplish major undertakings," advancing the construction of relevant "Four Types of Institutions" toward unified, efficient, and orderly substantive development, effectively integrating CAS's existing high-quality research and human resources to achieve rational and optimized allocation of various innovation elements.

7.2 Maintaining Research Orientation Toward Scientific Frontiers and National Strategic Needs: World-Class Research Institutions Should Build Moderate-Scale, Stable, and Open Employment Systems National research institutions primarily conduct research oriented toward world scientific frontiers and national strategic needs, characterized by long cycles, high investment, and high risk. To accommodate these research patterns, CNRS's employment model demonstrates three key features: First, a moderately sized core team. Tenured personnel serve as the core backbone, maintaining a stable and moderate scale from 2005 to 2015. The researcher track, for instance, remained at approximately 10,000 personnel throughout the decade. Tenured personnel undergo a highly competitive selective recruitment process, with salaries fully guaranteed by state fiscal funds. Second, balanced development of research and engineering talent. The ratio of researchers to engineers and technical personnel is 1.2:1, with minimal salary gaps between the two categories, promoting coordinated and healthy development. Third, openness and diversity. Since CNRS's basic research units are predominantly mixed establishments with universities and enterprises, nearly half of the staff come from partner institutions. Although personnel relationships belong to different supervisory departments, they work around common scientific tasks under cooperative framework guarantees, implementing personnel sharing and resource sharing to achieve win-win cooperation.

In comparison, CAS's employment model exhibits three characteristics: First, personnel funding is not fully guaranteed by state fiscal funds. CAS's employment consists primarily of "position-based employment + project-based employment," with position-based employees typically holding national public institution establishment. By 2017, CAS had 71,000 registered formal employees, including 60,000 position-based employees, but salaries for established personnel are not fully guaranteed by state fiscal funds. Position allowances and performance bonuses in the salary structure mainly come from research project funds. Principal investigators particularly face pressure to "support their teams," sometimes becoming trapped in short-term behaviors of "seeking projects without projects, and busy with evaluations when having projects," engaging in repetitive low-level research work that hinders truly science-oriented and interest-driven research organization, thereby impeding major original achievements and destabilizing the core research backbone.

Second, engineering and technical talent 队伍建设亟待加强. CAS's research activities feature large-scale scientific projects, major scientific facilities, and team-based institutionalized organization, requiring well-structured teams combining researchers, engineering and technical support personnel, and administrators. Engineering and technical personnel have long been a weak link in CAS's scientific talent pool, with a researcher-to-engineer ratio of 2.2:1 in 2017 (compared to CNRS's 1.2:1). Engineers and technicians also face significant gaps in honors, compensation, and resource allocation compared to researchers, 不利于此类人才队伍的稳定发展.

Third, a singular employment model lacking talent exchange and cooperation. While CAS has established flexible talent programs such as international teams, innovative cross-disciplinary teams, and visiting distinguished researcher programs emphasizing "not seeking ownership but seeking utilization," research work remains overwhelmingly dominated by CAS full-time employees, with the effectiveness of flexible talent utilization requiring evaluation.

In summary, we recommend that CAS, focusing on the construction of the four types of institutions, explore and establish a modern scientific research personnel management system featuring classified management, stable guarantees, advanced incentives, and orderly mobility. Strengthen stable support for core backbone talent through negotiated salary systems for key research and engineering personnel. Increase support for engineering and technical talent to enhance their sense of honor and achievement. Drawing upon CNRS's "mixed laboratory" model, establish joint laboratories with external institutions through clear rights and responsibilities agreements to work toward common goals, achieving shared intellectual and human resources, eliminating barriers, and transitioning from homogeneous competition to cooperative integration.

7.3 Stimulating Healthy Internal Competition and Orderly Development: World-Class Research Institutions Should Establish Scientific and Professional Evaluation Systems Establishing independent

and professional evaluation systems is essential for modern scientific research innovation. CNRS has established a relatively independent normalized evaluation mechanism—the French National Committee for Scientific Research—conducting regular evaluations of research institutions and personnel to ensure research direction correctness, institutional health, and effective personnel incentives. It implements peer review and interdisciplinary review by specialized committees, with members serving fixed terms and publicly disclosed names to ensure fairness and impartiality.

While CAS has established relevant disciplinary expert strategic consultation committees at the academy level and constructed classified evaluation expert databases for various projects, institutional evaluation, project review, and personnel assessment remain "task-oriented" and "temporary," without forming a relatively systematic, normalized, and professional classified evaluation mechanism. We recommend actively implementing the spirit of the central government's recently issued *Opinions on Deepening the Reform of Project Review, Talent Evaluation, and Institutional Assessment*, highlighting problem orientation, respecting inherent research laws, strengthening the construction of professional evaluation organizations, improving classified evaluation systems, and forming a CAS-characteristic scientific and technological evaluation system to enhance scientific and professional evaluation levels, ensuring healthy and cyclical development vitality for institutions and personnel.

7.4 Enhancing High-Quality Scientific and Technological Supply Capacity to Serve Socio-Economic Development: World-Class Research Institutions Should Build Deep Industry-Research Cooperation Systems CNRS attaches great importance to research "valorization," achieving positive results in serving national socio-economic development through institutional improvements, specialized agencies, and encouraging and assisting researchers in establishing enterprises. Since CAS's 2013 headquarters reform, it has established the Bureau of Science and Technology for Development, responsible for planning and managing national technology and application-oriented and major public demonstration scientific tasks, promoting CAS's scientific and technological cooperation with local governments, industries, and enterprises, and organizing special actions for technology transfer and transformation. This ensures, from a leadership and organizational perspective, that research oriented toward the national economic main battlefield proceeds in an orderly manner. Concurrently, CAS has established the Science and Technology Service Network Plan (STS Plan), mobilizing the entire academy to build a nationwide science and technology service network that facilitates the smooth transformation of the academy's labor, knowledge, and technology into social wealth, enabling value-added realization of scientific and technological achievements.

Currently, CAS has relaxed restrictions on researchers establishing enterprises according to national policies, increasing the personal benefit ratio for researchers from technology transfer. We recommend that CAS strengthen

the construction of professional talent teams and institutions for technology transfer, creating systematic and specialized technology transfer work systems while emphasizing training on industrialization knowledge, skills, and policies to fully stimulate entrepreneurship enthusiasm among various entities.

7.5 Expanding Global Scientific and Academic Influence: World-Class Research Institutions Should Build Innovation Cooperation Systems Oriented Toward the World World-class research institutions cannot achieve excellence without high-level internationalization. Currently, foreign employees constitute 9.4% of CNRS personnel compared to only 1.44% at CAS. International collaborative papers account for 60% of CNRS's total publications versus 26% at CAS. In terms of integrating global scientific and technological resources, CNRS has established 35 physical mixed research units in scientifically and technologically advanced countries such as the United States, Canada, Japan, and others, and set up eight representative offices in French embassies in developed or major developing countries, including China, to actively implement its science diplomacy strategy. While CAS has established cooperative relationships and set up research centers or observation facilities in Chile, Brazil, Myanmar, Kenya, Sri Lanka, and Thailand, its international cooperation network requires further expansion, substantive cooperation needs continuous deepening, and particularly, efforts to integrate the world's highest-quality scientific and technological resources must continue.

We recommend that CAS focus on top-tier universities and government research institutions, making the integration of high-end scientific and technological resources and talent introduction the core of cooperation. It should promote the establishment of representative offices in countries and regions where high-end talent is concentrated, accelerate the formation of an overseas talent connection network, promote the construction of several overseas joint laboratories, and build several global observation networks to achieve full utilization of the world's highest-quality research objects and conditions.

References

1. Bai Chunli. National research institutions are national strategic scientific and technological forces. *Guangming Daily*, 2013.

2. Antoine Petit. Le CNRS. [2016-12-01]. http://www.cnrs.fr/fr/le-cnrs.

3. Wu Haijun. French National Center for Scientific Research and its management system construction. *Global Science, Technology and Economy Outlook*, 2014, (2): 33-40.

4. Jian. The *2020 Strategic Plan* of the French National Center for Scientific Research. *Foreign Social Sciences*, 2009, (1): 41.

5. CNRS. *Le CNRS en chiffres*. Paris: Bureau de Presse CNRS, 2015.

6. Bureau of Development Planning, Chinese Academy of Sciences. Standards, initiation procedures, and common policies for the classification reform of CAS research institutions. [2014-11-13]. http://www.cas.cn/xw/zyxw/yw/201411/t20141113_{4251558}.shtml.

7. Peng Kefeng. "Science and Technology Service Network Plan" takes the lead in action. [2015-03-30]. http://scitech.people.com.cn/n/2015/0330/c1057-26769691.html.

8. Zhang Jie. Promoting the construction of world-class research institutions through high-level internationalization—Perspectives on world science and technology powers. *Bulletin of Chinese Academy of Sciences*, 2018, 33(1): 1-8.

Sheng Xia is Deputy Director of the Talent Projects Office, Bureau of Personnel, Chinese Academy of Sciences, and a master's student at the School of Public Policy and Management, University of Chinese Academy of Sciences. He is primarily responsible for managing academy-level talent projects including the Pioneer Initiatives "Hundred Talents Program," Wang Kuancheng Pioneer Initiatives Talent Plan, "West Light" Talent Plan, and Innovative Cross-disciplinary Teams. He participates in formulating management policies for academy-level talent programs and undertakes comprehensive tasks such as drafting policy documents for the Academy Talent Work Leading Group Office. From 2008 to 2012, he served at the Chinese Embassy in France, engaging in China-France higher education and scientific and technological exchange and cooperation affairs.

E-mail: shengxia@cashq.ac.cn

Responsible Editor: Wen Yanjie

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