Science and Technology Trends

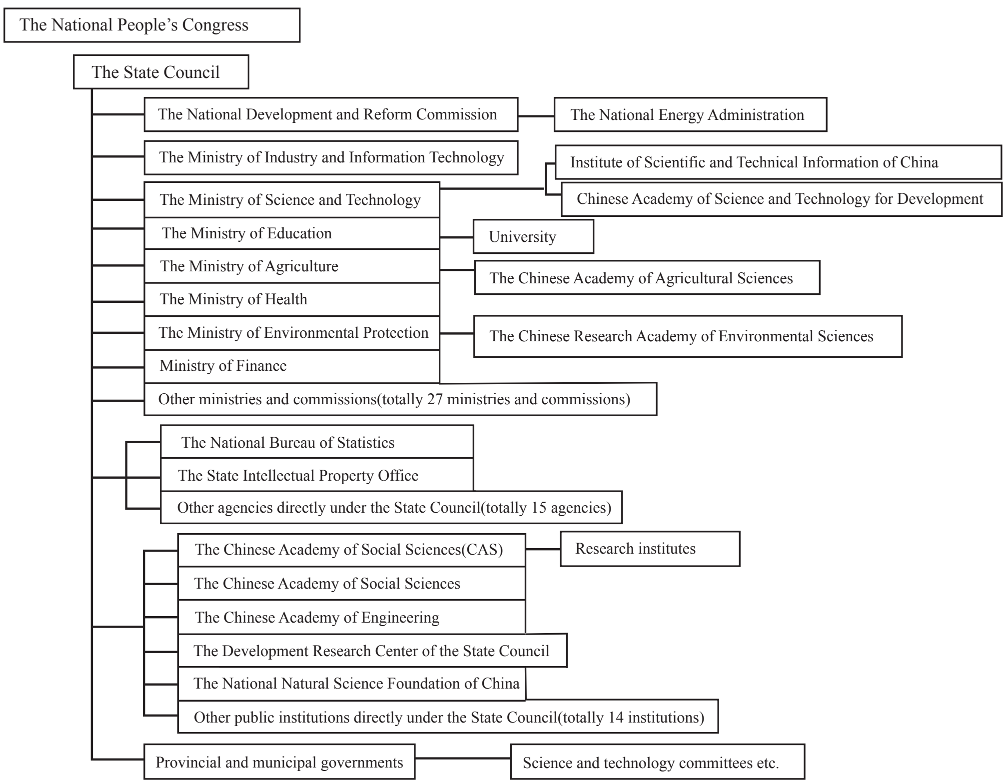
Issues on Government Research Institutes in Asia

CHINA

Young-Ju Mo[1]

1. Science and Technology Policy System

China's leading science and technology policy-making departments mainly include the Ministry of Science and Technology and the National Natural Science Foundation of China. In addition to the policy-making institutions directly under the Ministry of Science and Technology and the Chinese Academy of Sciences (CAS), various research institutes and other agencies are also involved in the formulation and assessment of science and technology policies.



Source: Gunhong Research (2011.1)

Figure 1 Science and technology policy system

[1]*Gun Hong Research & Company, Chaoyang District, Beijing, 100026, China*
E-mail: moyoungju@gmail.com

The main functions of the Ministry of Science and Technology include: leading the formulation of science and technology development plans and policies; organizing the formulation of national key basic research plans, high-tech research development plans and technology support plans and preparing and implementing science and technology base programs such as national key laboratories etc.

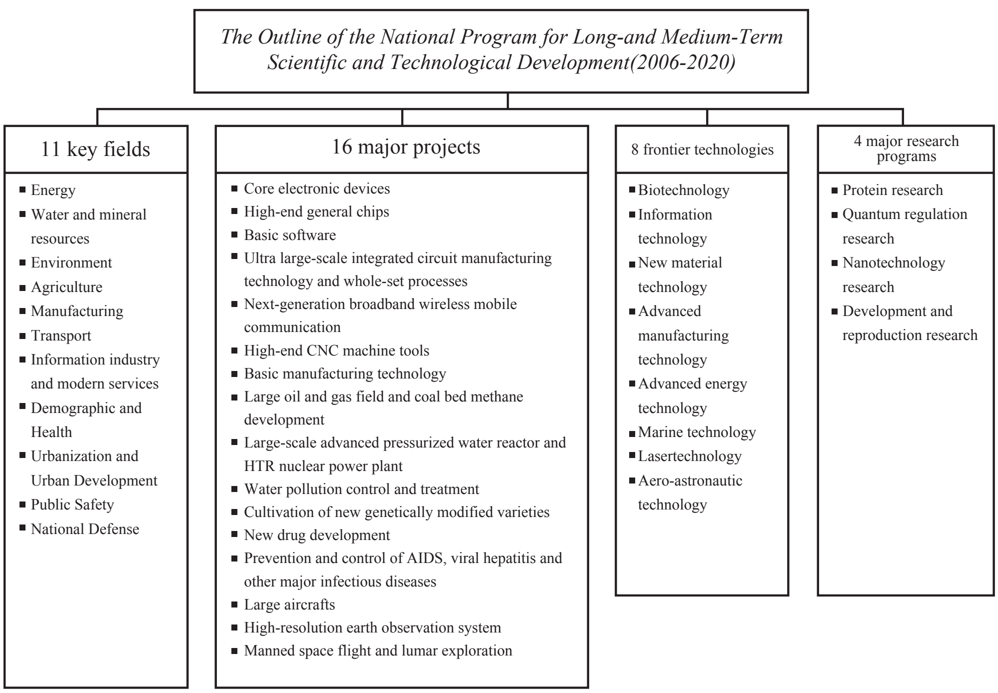
The main functions of the National Natural Science Foundation, an organization directly under the State Council responsible for the management of national natural science funds, include: cooperating with the state administrative department of science and technology to formulate basic research policies and planning for national development; establishing contact with other national government departments to manage science and technology, funding agencies and academic organizations and conducting international cooperation.

CAS is a leading academic institution and comprehensive research and development center in natural science, technological science and high-tech innovation. It has 12 branches, 100 research institutes, over 100 national key laboratories and engineering centers and nearly 1,000 field observation stations. It currently has 50,000 staff members and 687 academicians.

CAS is engaged in basic research, strategic high-tech research and related research on sustainable economic and social development.

It focuses on scientific research and education, carries out training of senior personnel for technological innovation and entrepreneurship, and provides national macro decision-making advice. In addition, it has invested in more than 430 scientific and technological enterprises (including those that have been restructured) in 11 industries, including 8 listed companies.

The Chinese Academy of Engineering is engaged in research, consulting and assessment on major construction projects and development strategies in high-tech industries, and provides direction and advice on development priorities and focus of investment for the central and local governments.



Source: The Outline of the National Program for Long- and Medium-Term Scientific and Technological Development (2006-2020) (Feb. 2006)

Figure 2 The outline of the national program for long- and medium-term scientific and technological development (2006-2020)

2. Scientific Research System

The cornerstone of China's current science and technology strategy is *The Outline of the National Program for Long- and Medium-Term Scientific and Technological Development* (2006-2020) issued on February 9, 2006 and the Plan for Scientific and Technologic Development during the 12^{th} Five-year Plan Period.

The Outline of the National Program for Long- and Medium-Term Scientific and Technological Development (2006-2020) has specified 11 key fields, 16 major projects, 8 frontier technologies[1)] and 4 major scientific research programs as the main technical development focus during 2006-2020.

The Plan for Scientific and Technologic Development during the 12^{th} Five-year Plan Period will be formally issued after it is reviewed and adopted at the National People's Congress held in March 2011, and the development plan for information industry, high-tech industry, aerospace, energy, environmental protection, medicine, agriculture and other key industries will also be implemented during the 12^{th} Five-year Plan Period.

China has established a sound science and technology system and has launched, among others, a series of systems such as the Basic Research Program, National Science and Technology Support Program, High-Tech Research and Development Program, National R&D Infrastructure and Facility Development Program and policy guidance programs to promote China’s scientific and technological level.

In the next phase (before 2020 at least), these systems will also be present in scientific and technological development plans in China, and their main roles and functions are not expected to greatly change, with only their names slightly modified to meet the needs of economic, social and technological development.

Table 1 S&T program system

National High-Tech Research and Development Program (863 Programs)
A scientific and technologic program with specific national objectives mainly supported by the central government funding, its main tasks include: resolving strategic, frontier and forward-looking high-tech issues related to national long-term development and national security, promoting the development of high technologies with independent intellectual property rights, cultivating growing points of high-tech industry, and striving to achieve leapfrog development to meet the third strategic objective of the State (reaching the level of a moderately developed country by the end of the mid-21^{st} century).
National Science and Technology Support Program
This program is a national scientific and technological program focusing on solving the major economic and social development issues to meet targets for economic and social development.
National Program on Key Basic Research Projects (973 Program)
The main aim of this program, implemented by the Ministry of Science and Technology, is to strengthen creative innovation.
National R&D Infrastructure and Facility Development Program
This program, an important part of the National Innovation System and a basic support system to serve overall scientific and technological progress and technological innovation, mainly consists of large scientific instruments and research experimental bases, natural S&T resource conservation and utilization systems, scientific data and literature resource sharing service networks, public service platforms for scientific and technological achievements transformation, material and information systems such as network technology environment and institutional systems focusing on sharing and professional and technical personnel.

1) They refer to major technologies with forward-looking, pioneering and exploratory roles in the high-tech sector, and they are important bases for upgrading to high technologies and development of emerging industries in future.

Table 1 S&T program system (cont'd)

Policy guidance programs and special projects	
Spark Program	This program, designed to popularize modern technologies in rural areas to stimulate rural development and raise agricultural income through scientific and technological progress, is an important part of China's national economic and social development plans and S&T development plans.
Torch Program	This program, which guides the promotion of high-tech industries, was approved by the Chinese government in August 1988 and implemented by the Ministry of Science and Technology.
Technological Innovation Program	This is a systematic project to integrate resources of related S&T programs (special projects), guide and support the pooling of factors of innovation into enterprises, and step up efforts to establish a market-oriented system for technological innovation in which enterprises play the leading role and which integrates the efforts of enterprises, universities and research institutes.
National New Products Program	This policy guiding program aims to promote new product development and scientific and technological achievement transformation and industrialization through policy guidance and support, accelerate the construction of S&T industrial environment, promote technological progress, improve technological innovation capacity of enterprises, promote the optimization and upgrading of China's industrial structure and adjust product structure to enhance the international competitiveness of Chinese products.
S&T Promotion Initiative for Regional Sustainable Development	This initiative aims to comprehensively enhance China's sustainable development capacity and promote China's sustainable development in experimental areas as important carriers, improve the government's scientific decision-making and management capacity, and strengthen transformation and integrated applications of scientific and technological achievements.
National Soft Science Research Program	As an important part of the National Science and Technology Program, this program integrates multi-category, multi-disciplinary knowledge in natural science and social science and engineering technology to support the formulation of major policies for economic and social development.
Miscellaneous	
International Science and Technology Cooperation Program	Under this program, a number of international scientific and technological cooperation projects that have strategic significance in improving China's national scientific and technological innovation, promoting industrialization of high technologies and accelerating international cooperation are selected, and international cooperative research and development of these projects are arranged and supported to promote domestic research and development and technological innovation.
National key laboratories	These serve as important bases for the State to organize high-level basic research and applied basic research, gather and cultivate outstanding scientists, and carry out high-level academic exchanges.
National engineering research centers	The centers aim to promote industrialization of scientific and technological achievements to meet the need of scale production of enterprises and promote the rise of new industries and upgrading of traditional industries.
Innovation Fund For Technology-Based Firms	Established by the State Council, this is a special government fund to support technological innovation of technology-based SMEs.

Source: Gunhong Research (2011.1)

2.1 The Number of Government Research Institutions

Since China started to restructure government research institutions into enterprises and classified their management, the number of government research institutions has gradually declined. In terms of coverage, the research institutions withdrawn have been from industrial sectors and market-oriented research fields, and their technological tasks are more concentrated in the fields of basic science, strategic high technology and social welfare.

In 2009, there were 3,707 research institutions nationwide, of which 283 (7.6%;) were in the field of natural science, 1,293 (34.9%) in agricultural science; 314 (8.5%) in pharmaceutical sciences; 1,172 (31.6%) in engineering and technology science; and 645 (17.4%) in the humanities and social sciences.

2.2 R&D Personnel

In 2009, there were 323,000 R&D employees in research institutions across the country, including 252,000 R&D workers with a university degree or above, accounting for 78.0%, and 103,000 female employees, accounting for 31.9%.

In 2009, the number of full-time equivalent R&D personnel (based on actual working time) was 277,000, of whom 173,000 (62.2%) were researchers. The number of full-time equivalent R&D personnel rose by 21.3% since 2000.

By type of R&D activity, there were 41,000 (14.7%) employees in basis research; 103,000 (37.1%) in applied research; and 134,000 (48.2%) in experimental development. The number of full-time equivalent employees in basic research, applied research and experimental development increased by 64.8%, 37.7% and 3.2% respectively, since 2000.

Regionally, the number of full-time equivalent R&D employees in the eastern regions was 154,000 (55.7%) person-year, 56,000 (20.0%) person-year in the central regions, and 67,000 (24.3%) person-year in the western regions (see Table 2 R&D personnel by region).

2.3 R&D Expenditure

In 2009, the R&D expenditure of research institutions in the whole country was 99.59 billion yuan, 3.9 times higher than that in 2000, representing an annual average increase of 16.2%.

By type of R&D activity, the expenditure on basic research was 11.06 billion yuan (11.1%), applied research was 35.09 billion yuan (35.2%) and experimental development was 53.44 billion yuan (53.7%). The expenditure on basic research, applied research and experimental development was 4.4 times, 5.3 times and 3.2 times higher than that in 2000, respectively.

By source of funding, government funding amounted to 84.95 billion yuan, (85.3%); enterprise funding amounted to 2.98 billion yuan (3.0%); foreign capital amounted to 420 million yuan (0.4%) and other funds amounted to 11.24 billion yuan (11.3%).

By region, the R&D expenditures for the eastern regions, central regions and western regions totaled 60.66 billion yuan (60.9%), 14.65 billion yuan (14.7%) and 24.28 billion yuan (24.4%), respectively (see Table 3 for R&D expenditure by region).

Table 2 R&D personnel by region

Region	R&D Personnel Full-time Equivalent (person-year)	Region	R&D Personnel Full-time Equivalent (person-year)	Region	R&D Personnel Full-time Equivalent (person-year)
Nationwide	277,183	Zhejiang	4,048	Chongqing	2,470
Beijing	71,729	Anhui	5,793	Sichuan	18,287
Tianjin	6,138	Fujian	2,496	Guizhou	2,164
Hebei	5,763	Jiangxi	3,881	Yunnan	4,624
Shanxi	4,888	Shandong	8,133	Tibet	403
Inner Mongolia	3,045	Henan	9,102	Shaanxi	24,748
Liaoning	11,049	Hubei	12,349	Gansu	5,313
Jilin	6,065	Hunan	6,288	Qinghai	550
Heilongjiang	7,148	Guangdong	6,735	Ningxia	357
Shanghai	21,980	Guangxi	2,789	Xinjiang	2,547
Jiangsu	15,605	Hainan	696		

Source: Bulletin on Major data of the Second National R&D Resource Checking (2010.11)

Table 3 R&D expenditure by region

Region	R&D expenditure (RMB100 million)	Region	R&D expenditure (RMB100 million)	Region	R&D expenditure (RMB100 million)
Nationwide	995.95	Zhejiang	12.85	Chongqing	6.75
Beijing	321.70	Anhui	20.74	Sichuan	91.00
Tianjin	18.14	Fujian	6.11	Guizhou	3.69
Hebei	23.24	Jiangxi	7.46	Yunnan	12.88
Shanxi	9.41	Shandong	22.14	Tibet	0.54
Inner Mongolia	5.31	Henan	20.28	Shaanxi	99.90
Liaoning	31.19	Hubei	39.99	Gansu	12.08
Jilin	16.55	Hunan	11.48	Qinghai	1.04
Heilongjiang	20.60	Guangdong	17.60	Ningxia	0.49
Shanghai	86.95	Guangxi	5.32	Xinjiang	3.85
Jiangsu	64.23	Hainan	2.44		

Source: Bulletin on Major data of the Second National R&D Resource Checking (2010.11)

By industry, the R&D expenditure of research institutions in scientific research, technical services and geological prospecting was 84.64 billion yuan (85.0%) while that for agriculture, forestry, animal husbandry and fishery was 7.02 billion yuan (7.0%).

Table 4 R&D expenditure by industry

Industry	R&D Expenditure (RMB10,000)	Percentage in total R&D Expenditure (%)
Total	9,959,481	—
Agriculture, forestry, animal husbandry and fishery	701,503	7.04
Mining	7,344	0.07
Manufacturing	189,824	1.91
Power, gas and water production and supply	31,102	0.31
Building	16,656	0.17
Transport, storage and postal	46,051	0.46
Information transmission, computer services and software	68,875	0.69
Finance	709	0.01
Leasing and commercial services	224	0.00
Scientific research, technical services and geological prospecting	8,463,971	84.98
Water conservancy, environment and public facility management	138,270	1.39
Education	8,092	0.08
Health, social security and social welfare	219,178	2.20
Culture, sports and entertainment	22,391	0.22
Others	45,291	0.45

Source: Bulletin on Major data of the Second National R&D Resource Checking (2010.11)

2.4 R&D Projects

In 2009, research institutions nationwide launched 61,000 R&D projects and the number of full-time equivalent R&D workers participating in these projects was 237,000, an 11.8% increase over 2000; the expenditure on these projects was 57.98 billion yuan, 2.7 times higher than 2000. The per capita expenditure on these projects was 245,000 yuan per capita/person-year, 2.4 times higher than that in 2000.

By discipline, expenditure on the projects broke down as follows: natural science, 8.1 billion yuan, (14.0%); agricultural science, 3.64 billion yuan (6.3%); medical science, 1.61 billion yuan (2.8%); engineering and technical science, 43.68 billion yuan (75.3%); and humanity and social sciences, 950 million yuan (1.6%).

By project origin, expenditure broke down as follows: national R&D projects, 45.18 billion yuan (77.9%); local R&D projects, 3.17 billion yuan (5.5%); enterprise R&D projects, 2.14 billion yuan (3.7%); self-initiated projects by research institutions, 2.17 billion yuan (3.7%); R&D projects by international entities, 690 million yuan (1.2%); and miscellaneous projects, 4.63 billion yuan (8.0%).

By form of cooperation, expenditure was as follows: projects independently accomplished by research institutions, 44.63 billion yuan (77.0%); cooperation projects with independent domestic research institutions, 6.32 billion yuan (10.9%); cooperation projects with domestic universities, 2.02 billion yuan (3.5%); and miscellaneous forms of cooperation projects, 5.01 billion yuan (8.6%).

2.5 R&D Output

In 2009, 138,000 scientific papers and 4,788 books were published by research institutions nationwide, up 40.1% and 27.0%, respectively, over 2000.

In 2009, research institutions nationwide applied for 15,773 patents, including 12,361 patent for inventions, which was 5.5 times and 7.1 times greater, respectively, than those in 2000; invention patent applications accounted for 78.4% of all patent applications, a 17.7% increase over 2000. In 2009, the number of patents granted to research institutions nationwide was 6,391, of which 4,077 were invention patents, accounting for 63.8%.

3. Major problems, Issues and Challenges of Government Research Institutes

According to the research data of the Technical and Economic Research Department of the Development Research Center of the State Council, the major problems facing Chinese government research institutions are as follows:

First, scientific and technological capacity in various aspects is self-contained and therefore decentralized and redundant, leading to a low overall operating efficiency. The scientific and technological innovation capacity in the field of social welfare is especially weak. This is mainly reflected in 1) insufficient cooperation among research institutes, universities and enterprises, and deficient convergence in innovation in all aspects; 2) unshared scientific and technological resources (e.g., duplicate major research infrastructure facilities were purchased and under-utilized) and 3) duplicated research projects, resulting in waste of limited resources.

Second, macro-management is seriously fragmented, leading to decentralization of scientific and technological resources, duplicate institutions, repetitive project application and low utilization efficiency of funds. There are a wide range of research institutions of a similar nature, such as state key laboratories, national engineering research centers, national engineering and technological research centers, technology research centers of key enterprises, high-tech industrial bases, and national technology transfer centers.

Third, project management stresses immediate results over long-term goals and project establishment over process management. From project establishment to acceptance, there is insufficient supervision and inspection as even the rare inspection is often a mere formality. Scientific and technologic program review and inspection is mainly based on published papers, patent applications or short-term economic benefits. As scientific and technological programs involve many fields, and with rapid technical progress, project selection and approval involve many technologies. In addition, as there is limited manpower in integrated government management, it is difficult to accurately grasp the development trends of technology and markets.

Fourth, the selection, establishment and acceptance of scientific and technology programs are mainly carried out by expert assessment and decision making. On the one hand, due to the absence of a unified mechanism for responsibility, power and interest, the experts are not responsible for their review results and there has been fraud and academic corruption in some projects that have been reviewed and appraised by experts. On the other hand, experts often attach more importance to technical factors and lack market knowledge and the ability to judge. Consequently, standards for establishing scientific and technology projects attach more importance to technological advances, while take little or inaccurate market factors into consideration. This is one of the causes for the low rate of implementation of the achievements of scientific and technologic projects.

Fifth, there is misalignment between science and technology and the economy, between research and development activities and achievement industrialization, between independent R&D and imported technologies and between technological introduction and technological assimilation.

References

Lv Wei (2010), How difficult is it to build an innovation-oriented country?

Ministry of Science and Technology (2010), Bulletin on Major data of the Second National R&D Resource Checking