CHINA'S NATIONAL INNOVATION SYSTEM AND INNOVATION POLICY

BY

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I BACKGROUND

China is currently in transition from a planning-oriented economy to a market-oriented economy, and the associated reforms have necessitated changes in the science and technology (S&T) system as well. The purpose of these changes is not reform *per se* but the reconstruction of China's National Innovation System (NIS). China has a national research and development (R&D) programme, which is important for the country's S&T development and for the structuring of NIS.

II NATIONAL S&T DECISION-MAKING SYSTEM

China had a State Council of Science and Technology till 1998, when the Ministry of Science and Technology (MOST) was established. The State Science and Education Leading Group, headed by the Prime Minister, was established in the same year. There are nine members in the group – MOST, the Ministry of Education, the Ministry of Finance, the Ministry of Industry and Information Technology, the Ministry of Agriculture, the National Development and Reform Commission, Chinese Academy of Sciences, Chinese Academy of Engineering and the Natural Science Foundation Commission. All these ministries' organizations are directly connected with S&T development, besides the Ministry of Health and the Ministry of Environment Protection. Ensuring coordination among all these ministries and organizations has necessitated a large amount of work.

Each of China's more than 30 provinces has its own Bureau of Science and Technology, Bureau of Education and so on. So, for S&T administration, China has an inter-ministry system at the national level, and province-level and county-level systems at local government levels.

III MEDIUM AND LONG-TERM S&T DEVELOPMENT PLAN (2006-2020)

In 2006, China issued its Medium and Long-term S&T Development Plan. The work on this had started in 2004, when more than 2,000 experts were organized into 10 groups to work on the Plan. The main objectives of the Plan were to: appreciably improve innovation capability; significantly enhance S&T level to promote economic and social development and maintain national security; noticeably increase comprehensive strength in basic research and frontier technology development, and attain a series of high-level achievements; and become one of the innovative countries by 2020.

The guiding principles behind the S&T Development Plan were:

- Home-grown innovation – enhancing original innovation, integrated innovation, and re-innovation based on assimilation and absorption of imported technology, in order to improve national innovation capability;
- Leapfrogging in priority fields – select and concentrate efforts in key areas of relative strength and advantage linked to the national economy and people's livelihood as well as national security, to strive for breakthroughs and realize leapfrogging developments;

- Enabling development – strive for breakthroughs in key, enabling technologies that are urgently needed for the sustainable and coordinated economic and social development; and
- Leading the future – have a vision in deploying resources for frontier technologies and basic research, which would, in turn, create new market demands and new industries expected to lead the future economic growth and social development.

The overall deployment of resources under this S&T Development Plan was to be as follows:

- Identify priority areas to raise the overall S&T support capability – 11 priority areas, 68 priority topics;
- Implement special major projects with national objectives, leading to leapfrogging development or bridging a gap – 16 special major projects;
- Respond to future challenges, promote frontier technologies and basic research, ensure sustained innovative capability and lead future economic and social development – 27 frontier technologies in 8 fields, and 18 basic scientific issues as priorities; and
- Deepen the S&T system reform by perfecting relevant policies and measures, increasing S&T investment, strengthening the build-up of S&T talents and promoting the construction of NIS.

Along with the S&T Development Plan, China also issued a Matching Policy Package that comprised 60 policies on various aspects covering:

- R&D investment;
- Tax incentive;
- Support from the financial sector;
- Public procurement;
- Technology importation, digestion, absorption and re-innovation;
- Creation and protection of intellectual property rights (IPRs);
- Human resource development;
- Education and promotion of public understanding of science;
- Innovation base and platform; and
- Planning and coordination.

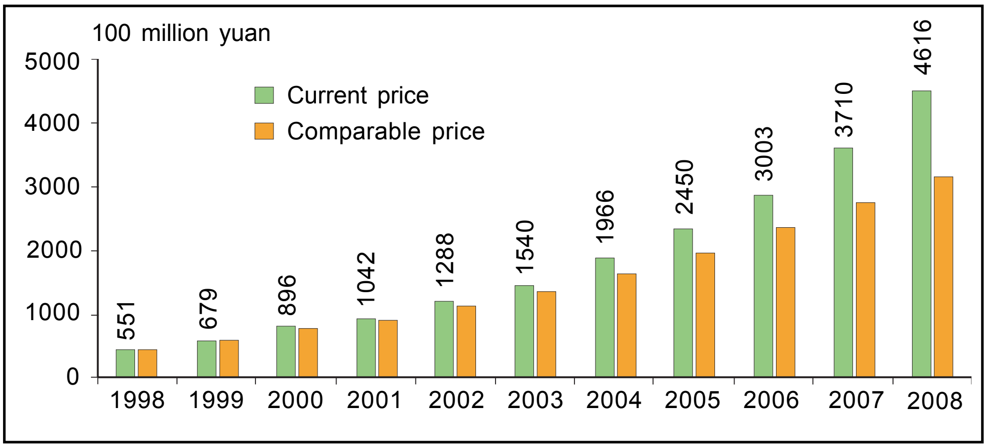
More than 15 ministries and organizations were involved in issuing these policies.

IV CURRENT S&T SITUATION

The effects of the S&T Development Plan are now beginning to become apparent. For instance, China's R&D expenditure in 2008 crossed 460 billion yuan (Figure 4), from about 55 billion yuan in 1998. The R&D expenditure in 2008 was about 1.6 per cent of the gross domestic product (GDP), and the target is to touch 2.5 per cent of the GDP by 2020.

Human resources development in S&T also has seen notable increases. The number of R&D personnel almost reached the 2 million mark in 2008 (Table 1). However, in

Figure 4: China's expenditure on R&D



terms of qualitative levels, the country's S&T human resources are yet to attain international levels. This issue is being addressed currently through specific programmes under the Medium and Long-term Human Resources Development Plan launched in 2010.

The numbers of patents applied for and granted have also seen steady increases over the last decade (Figure 5). In 2008, the total number of patent applications stood at 828,000, while the number of patents granted was about half of that (412,000). The number of papers presented in international journals by Chinese scientists has been increasing over the years, with the total number registered in 2008 by the Science Citation Index (SCI), Index to Scientific & Technical Proceedings (ISTP) and Engineering Index (EI) touching 271,000 (Table 2).

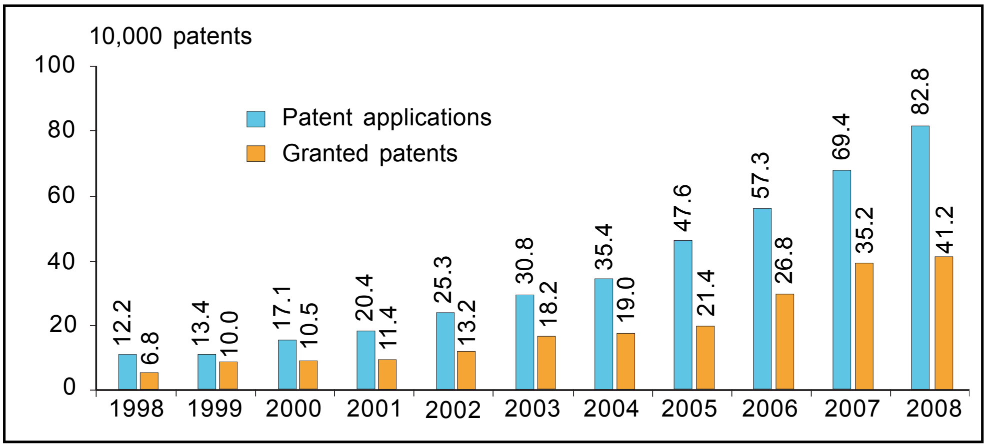
Table 1: Number of R&D personnel

Human resources	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
S&T personnel (10,000 persons)	328.4	348.1	381.5	413.2	454.4	496.7
R&D personnel (10,000 person-years)	109.5	115.3	136.5	150.2	173.6	196.5
Scientists & engineers (10,000 person-years)	86.2	92.6	111.9	122.4	142.3	159.2

Table 2: Number of papers published by Chinese scientists (10,000 papers)

Index	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Science Citation Index Index (SCI)	328.4	348.1	381.5	413.2	454.4	496.7
Engineering Index (EI)	109.5	115.3	136.5	150.2	173.6	196.5
Index to Scientific & Technical Proceedings (ISTP)	86.2	92.6	111.9	122.4	142.3	159.2

Figure 5: Numbers of patents applied for and patents granted



A. Major issues

- Enterprises are not principal players in technological innovation because their innovative capability remains weak;
- The S&T sector is compartmentalized, resulting in dispersion and duplication of efforts and low overall performance level. S&T innovation capability in the public sector is especially weak;
- S&T resources allocation pattern and evaluation system are not effective for the new S&T development and government mandate; and
- Mechanisms for rewarding outstanding personnel and encouraging innovation and pioneering activities are not established.

VI NATIONAL INNOVATION SYSTEM IN CHINA

The objective for deepening S&T system reform is to advance and enhance the construction of an NIS with Chinese characteristics. China's NIS is a social system, with the government playing an important role. Market mechanism plays a basic role in resource allocation. Various players in the NIS maintain close links and interact with one another regularly.

A. Reform of S&T sectors

The current tasks for reform of the S&T sectors are discussed below. The first is to support and encourage enterprises to become the main player in technological innovation. Five approaches are suggested for this task:

- Allow economic and S&T policies to play a guiding role in order to enable enterprises to become the major R&D spender;
- Reform the modality of S&T programmes to enable enterprises to undertake national R&D missions;

- Perfect the technology transfer mechanism to facilitate the integration and application of industrial technologies;
- Accelerate the establishment of a modern enterprise system so as to enhance the innate drive for enterprise technology innovation; and
- Create a fine innovation environment to spur innovative activities in small and medium enterprises (SMEs).

The second task is to deepen institutional reform and establish a modern research institution system. This is to be achieved through the following steps:

- Strengthen the capacity building of research institutions (under the national public institutions such as Chinese Academy of Sciences, Chinese Academy of Medicine and Chinese Academy of Environmental Protection) in keeping with the terms of reference defined by the state;
- Establish a stable S&T investment mechanism designed to support innovation activities in research institutes;
- Establish an operational mechanism conducive to original innovation in research institutes;
- Establish a system to assess the overall innovation capability of research institutes; and
- Put in place an effective mechanism for opening up and collaboration.

Advancing the S&T management system reform is the third task for reforming the S&T sectors. Four sub-tasks are identified for this:

- Create a national S&T decision-making mechanism and constantly improve it;
- Establish and improve a macro S&T coordination mechanism at the national level;
- Reform the S&T review and evaluation system so as to reflect principles of fairness, impartiality, openness and encouragement for competition; and
- Reform the S&T achievements evaluation and award system.

B. Construction of an NIS

The construction of an NIS would cover five sub-systems – technology innovation system, knowledge innovation system, defence S&T innovation system, regional innovation systems and S&T service agency system – that are separate but linked to each other, even overlapping in some cases.

The technology innovation system is conceived to be:

- Enterprise-led;
- A combination of enterprises, universities and research institutes; and
- A breakthrough point for the full-fledged construction of NIS.

The knowledge innovation system is viewed as:

- Promoting collaboration and resource sharing between research institutes and universities; and

- Developing high-level basic science and frontier technology bases (through strengthening the construction of public scientific research institutions and developing research universities).

The defence S&T innovation system is envisaged to:

- Promote the close combination of civilian and defence S&T results; and
- Strengthen the development of dual-use technologies.

Regional innovation systems are required because of the large territory that China covers and the acute differences that exist among different regions in terms of resources available and the degree of development achieved. The plan for this sub-system is to:

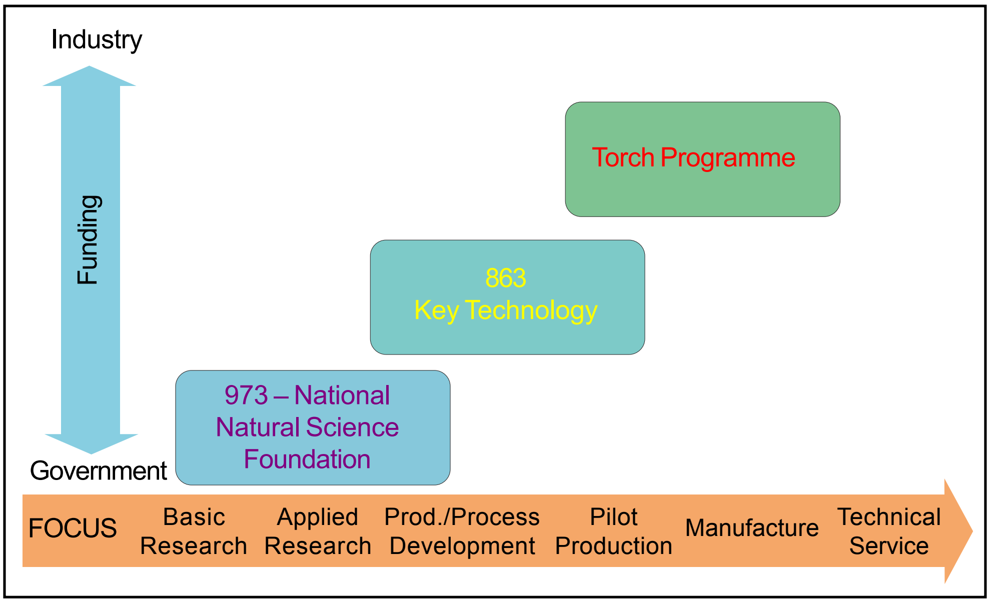
- Establish regional innovation systems with diverse characteristics and strengths;
- Deepen the reform of the local S&T system; and
- Promote combination of S&T forces at the central and local levels.

The S&T service agency system is an important sub-system that would provide services such as technology transfer. The plan for this sub-system involves:

- Establishing a socialized, networked S&T service agency system;
- Nurturing and developing S&T service agencies;
- Taking full advantage of the important roles played by universities, research institutes, and social organizations and groups in providing S&T services; and
- Guiding S&T service organizations in the direction of professionalism, scale and standardization.

VII NATIONAL R&D PROGRAMMES SYSTEM

Figure 6: National R&D Programmes System's operational framework



The National R&D Programmes System comprises two components: Major Special S&T Projects and National S&T Programmes. Major Special S&T Projects are specific projects (such as manufacture of large passenger aircrafts) identified in the Plan. National S&T Programmes are regular programmes that range from basic research to applied research (such as National Key Technologies R&D Programme and National Science and Technology Infrastructure Programme), and include prototyping of products. There will also be a National S&T Personnel Programme from 2011. Figure 6 depicts the operational framework of the National R&D Programmes System.

Currently, there are 68 priority subjects in 11 priority areas (energy, water and mineral resources, environment, agriculture, manufacturing, transportation, information industry and modern service industry, population and health, urbanization and city development, public security, and national defence). Biotechnology, information technology, new material technology, advanced manufacturing technology, advanced energy technology, marine technology, laser technology, and space and aviation technology are designated as “Frontier Technology Research Areas” and cover 27 subjects. These are under the National High-Tech R&D Programme (“863” Programme) launched in March 1986.

The basic research is conducted under the auspices of the National Natural Science Foundation, and the National Basic Research Programme (“973” Programme) launched in March 1997.

Currently, there are 16 Major Special S&T Projects, some of which are aimed at developing strategic products and some at improving key technologies. Most of them have been initiated in recent years, and include the following:

- Core electronic devices;
- High-end generic chips and software;
- Super large-scale integrated circuit manufacturing technology and associated techniques;
- Next-generation broadband mobile telecommunications;
- High-end computer numerical control machine tools and basic manufacturing technology;
- Development of large oil-gas fields and coal-bed methane;
- Large-scale advanced pressurized water reactor and high-temperature gas-coolant reactor;
- Water body contamination control and treatment;
- New genetically modified varieties;
- Innovative drugs development;
- Prevention and treatment of major infectious diseases such as HIV/AIDS and viral hepatitis;
- Large passenger aircrafts;
- High-resolution Earth observation systems; and
- Manned space flights and the moon probe.