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Research Priorities and Priority-setting in China

by

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VINNOVA´s foreword

VINNOVA is the Swedish Governmental Agency for Innovation Systems and has a mission to promote sustainable growth by funding needs-driven research and developing effective innovation systems. The principles and institutional mechanisms utilised in setting priorities for public financing of research and development are crucial aspects of any country's research and innovation system. As an input to the development of its own strategies and positions, VINNOVA has decided to commission in-depth studies of the prioritisation mechanisms in the US, China and Japan and in the EU's Framework Programmes. Welcoming open discussions on issues relating to priority-setting and hoping that the studies may also be of interest to other institutions in Sweden and internationally, these are published in English and made generally available. The project is managed by Göran Pagels-Fick at VINNOVA's Strategy Development Division.

This report covers priority-setting in China and was written by Liu Li, an associate professor at the Center for Science, Technology and Society of Tsinghua University in Beijing. Liu Li is executive director of its Research Unit for Science, Technology, Innovation and Policy. He has recently published a book "The Basic Research Policy: Its Theory and Practice1" and has written about "The Evolution of China's Science and Technology Policy, 1975-2007" for OECD. He was a visiting researcher at Fraunhofer Institute of Systems and Innovation Research in Germany from 2005-2006, and at Berlin Institute of Technology (TU Berlin) from Jan-Mar 2009.

Priority-setting in China mainly emphasises the strategic demand and frontiers of world S&T. It underscores the importance of combining top-down and bottom-up perspectives in the Chinese processes. There is a colourful Chinese expression to describe this approach, translated "go forward with your head in the clouds and your feet on the ground." The Chinese research funding system has transformed itself from previous follow-up, imitation and catch-up phases to the present 10th Five Year Plan emphasising the development of knowledge to support indigenous innovation.

It is interesting to learn about the processes and mechanisms of a political system which differs from the settings of the other VINNOVA studies covering the US, Japan and the EU. There are striking similarities in the tasks involved in creating simultaneous top-down and bottom-up learning and support.

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[1] Beijing: Tsinghua University Press, 2007,

The figures which characterise the Chinese research, education and development arena are impressive in their magnitude. There are 1,792 universities and colleges, of which 678 have R&D activities. Of these, 49 have science parks and host 95 State Key Labs. There are 3,901 public research institutes with 563,151 employees and 6,775 corporate R&D labs... Developments in China will have significant impact on the global R&D arena.

VINNOVA, November 2009

Göran Marklund
Director and Head of Strategy Development Division

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1 Introduction

"The [Chinese] system is non-transparent and difficult to study."
Magnus Breidne, Swedish Science Technology Attaché in China.
From "Research Priorities with Chinese Characteristics"[2]

China has a long tradition of setting research (and development) priorities, as expressed in the Medium and Long-Term Plan for Science and Technology (MLP), the Five-Year Plan for Science and Technology (FYP) and the National Science and Technology Programmes (*guojia keji jihua*). The current MLP for 2006-2020 encourages indigenous innovation (*zizhu chuangxin*), to raise gross expenditure on R&D (GERD) of the gross domestic product (GDP) to 2.5% by 2020 from 1.30% in 2005. The MLP unveiled the research priorities in detail[3]:

- 68 priority themes in the 11 priority fields;
- 16 mega-engineering projects (*zhongda zhuanxiang*, the official translation is National S&T Major Project[4]) in advanced numeric-controlled machinery and basic manufacturing technology; control and treatment of AIDS, hepatitis and other major diseases; core electronic components, high-end generic chips and basic software; drug innovation and development; and extra large-scale integrated circuit manufacturing and techniques.
- Eight cutting-edge technological areas: biotechnology, IT, new materials technology, advanced manufacturing technology, advanced energy, marine technologies, laser and aerospace technology.
- Eight cutting-edge scientific areas: cognitive science, deep structure of matter, core mathematical themes, Earth system processes and resources, environmental and disaster effects, the chemistry of creation and transformation of matter, quantitative study of the process of life and systems integration and condensed matter and new effects - scientific experiments and observation methods, techniques and equipment innovation.
- Four mega-science projects in protein research, quantum modulation research, nanoscience, growth and reproduction.

[2] iva.ntier.se/upload/Verksamhet/Projekt/Magnus%20Breidne_%20China.pdf
[3] Brief description in: OECD (2008, p.124).
[4] http://www.nmp.gov.cn/

These research priorities are also reflected in the following National Science and Technology Programmes: the National High-tech R&D Programme (Programme 863), the National Programme on Key Basic Research Projects (Programme 973), the National Science Foundation Programmes, the Knowledge Innovation System Programme, the recently established Mega-Engineering Programme and the Mega-Scientific Research Programme.

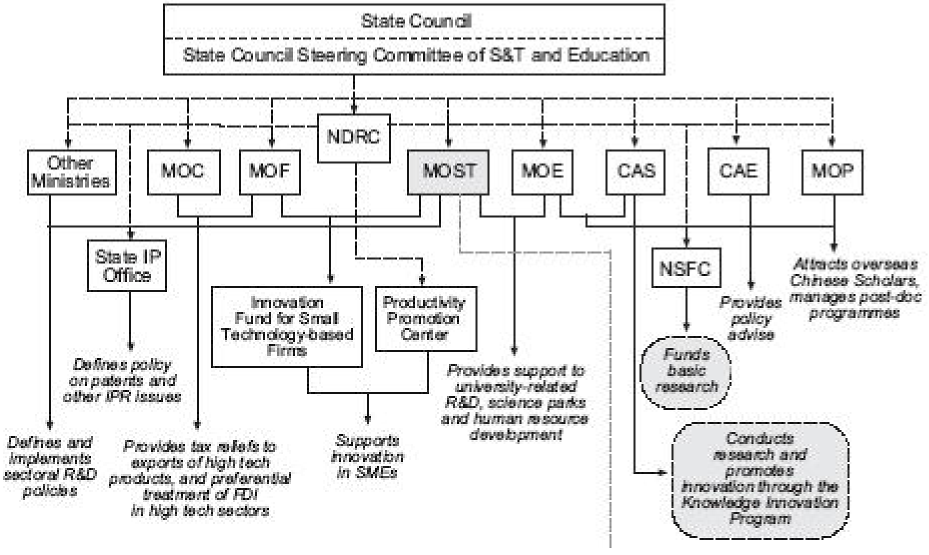
The Chinese government has launched strong stimulus packages in the current context of global financial crisis, including science and technology policy adjustment.

This report will offer an overview of the research priorities and priority-setting processes in China (with some case studies). It will also analyse Chinese S&T reactions to the global financial crisis. Some lessons can be drawn from the Chinese experience.

2 An Overview of Chinese Science and Technology

2.1 The Governance Structure of Chinese S&T[5]

After 30 years of economic reform, the Chinese S&T system is centralised, as per the Soviet model of the 1950s and quite different from the pluralistic system of the US. The governance structure of Chinese S&T is accurately depicted by OECD below. However, what the structure lacks is the CCPCC (the Central Committee of Chinese Communist Party)[6], which is higher than the State Council. The topmost S&T policy is issued by the CCPCC, or the CCPCC and the State Council. The Party's S&T is also the national policy.



Source: OECD, p. 428

[5] OECD, p. 429.
[6] For information about CCPCC, see:
http://en.wikipedia.org/wiki/Central_Committee_of_the_Communist_Party_of_China

NDRC:	National Development and Reform Commission
MOST:	Ministry of Science and Technology
MOC:	Ministry of Commence
MOF:	Ministry of Finance;
MOE:	Ministry of Education
MOP:	Ministry of Personnel
CAS:	Chinese Academy of Sciences
CAE:	Chinese Academy of Engineering
NSFC:	National Natural Science Foundation of China

The State Council is the highest-ranking governmental policy-making body in China and has ultimate decision-making power for S&T and innovation policy. The Steering Committee of Science, Technology and Education of the State Council has a powerful role in coordinating significant decision making.

National Development and Reform Commission

This has many important functions and is known as the "small State Council". Its main functions are[7]:

1 Formulating and implementing strategies of national economic and social development, annual plans, medium and long-term development plans. Submitting the national economic and social development plan to the National People‘s Congress on behalf of the State Council.

2 Monitoring macroeconomic and social development trend and provide forecast, warning and information guidance.

3 Summarising and analysing the fiscal and financial situation, participating in the formulation of fiscal, monetary and land policies and formulating and implementing price policies.

4 Directing, promoting and coordinating the restructuring of the economic system. Studying major issues concerning the restructuring of economic systems and opening up to the outside world. Formulating plans for the comprehensive restructuring of economic systems, coordinating plans for dedicated economic restructuring and coordinating important dedicated economic restructuring plans in conjunction with other agencies. Guiding pilot projects of economic system restructuring and working in experimental reform zones.

[7] http://en.ndrc.gov.cn/mfndrc/default.htm

Pushing forward strategic economic restructuring. Organising the formulation of comprehensive industrial policies. Coordinating key issues in the development of primary, secondary and tertiary industries as well as balancing and coordinating industrial development with relevant plans, major policies and national economic and social development plans.

Functions of the Ministry of Science and Technology (MOST)[8]

1 Responsibility for drawing up S&T development plans and policies, drafting related laws, regulations and departmental rules and guaranteeing implementation.

2 Responsibility for drafting the National Basic Research Programme, the National High-tech R&D Programme and the S&T Enabling Programme.

3 Teaming up with other organisations in scheme demonstration, assessment, acceptance and policymaking of major S&T special projects and providing advice on major changes.

4 Compiling and implementing plans for national laboratories, innovative research bases, national S&T programmes and research conditions so as to promote infrastructure-building and resource-sharing.

5 Formulation and supervision of S&T plans according to policies, drafting policies on hi-tech commercialisation in conjunction with other departments and guiding the national high-tech industrial development zones.

6 Drawing up policies and measurements to enhance rural and social progress in S&T, thus improving the national livelihood.

7 Issuing policies to encourage synergies between enterprise, universities and research institutes, promoting the application and demonstration of scientific discoveries and technological inventions and improving the innovative capacity of enterprise.

8 Proposing institutional reforms and supervising establishment and restructuring of research institutes.

9 Responsibility for budgeting, final accounting and supervision of S&T funds. Also, proposing major policies and measures to relevant departments on the rational allocation of S&T resources.

10 Responsibility for appraising the National S&T Award, drawing up plans on S&T talent team-building and proposing policies.

11 Drafting plans and policies on science popularisation, technological market and S&T intermediaries. It is also responsible for issuing confidential measures and managing S&T assessments and statistics.

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[8] http://www.most.gov.cn/eng/organization/Mission/index.htm

12 Drawing up policies on S&T cooperation and exchange through bilateral and multilateral channels, guiding relevant departments and local governments in international interaction, appointing and supervising S&T diplomats and facilitating aid to and from China.

13 Undertaking other tasks assigned by the State Council.

The main academic organisations such as the Chinese Academy of Sciences (CAS), the Chinese Academy of Social Sciences (CASS) and the Chinese Academy of Engineering (CAE)5 are directly under the State Council. They are thus on the same hierarchical level as the ministries.

There is a certain overlap between the civil and the military R&D system, especially in areas such as shipbuilding and aerospace technologies, formerly administered by the Commission for S&T for Defence Industry (COSTIND). This became a department in the newly created Ministry for Industry and Informatization in March 2008.

2.2 The Research System

2.2.1 Public Research Sector

There are 3,901 public research institutes (PRIs) (as of 2005), with 563,151 employees, of which 455,901 are S&T personnel (and of which 215,263 are R&D personnel). The intramural R&D expenditure of these institutes is RMB 51.31 billion[9] and they host 58 State Key Labs.

There were nearly 6,000 PRIs affiliated to the ministries in the early 1990s. Many of them were transformed into enterprises after 1998. In 1998, the State Council launched a major government reform abolishing 10 industry line ministries, including the Ministry of Electricity, Ministry of Coal, Ministry of Machinery Industry and Ministry of Chemical Industry. [10]The government planned to transform 242 R&D institutes affiliated to the 10 ministries into corporate enterprises. Supported by preferential policies from the government, these 242 PRIs were converted into enterprises. Subsequently, hundreds of PRIs and state-owned public welfare research institutes affiliated to ministries were reformed into enterprises. [11] This PRI reform was intended to strengthen the link between science and industry and build an enterprise-centred innovation system.

Though the PRIs had been downsized, their outputs increased where it concerned matters such as patents. PRI patent applications increased from 969 in 1994 to 1,413 in

[9] OECD, p. 163.
[10] OECD, p. 428.
[11] OECD, p. 161.

1999 and 6,726 in 2005. Patents granted also increased from about 350 per year between 1994 and 1998 and rapidly increased after 1999 to 2,423 in 2005.[12]

One of the most important public research organisations is the Chinese Academy of Sciences (see section 7). In addition, there are Public Research Institutes affiliated to the ministries, such as the Chinese Academy of Agricultural Sciences (CAAS)[13], Chinese Academy of Forestry (CAF)[14,] China Academy of Railway Sciences (CARS)[15] and China Geological Survey (CGS)[16].

2.2.2 Universities

There are 1,792 universities and colleges, of which 678 have R&D activities. Of these, 49 have science parks and host 95 State Key Labs (as of 2005).[17] Again, of these, 59 have graduate schools.

Higher education is developing rapidly mainly of its support by Programmes 211 and 985 (creating world-class universities) and the national R&D programmes. About two thirds of total R&D expenditure in the higher education sector is concentrated on the top 50 universities.[18]

A few top universities such as Tsinghua and Peking University are strong in both research and entrepreneurial activities. They are active in creating their own enterprises, science parks, transferring technological results and establishing links with industry and local government.

2.2.3 Industrial R&D

Corporate R&D Centres of Chinese Firms

There are 6,775 corporate R&D labs among the 28,567 domestic large and medium-sized firms[19]. There 248,813 small firms, of which 22,307 with S&T activities. [20]

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[12] OECD, p.171.
[13] http://www.caas.net.cn/engforcaas/intrduction.htm
[14] http://www.forestry.ac.cn/newcaf/english/main1.cfm
[15] http://cars.rails.com.cn/
[16] http://old.cgs.gov.cn/Ev/english.htm
[17] OECD, p. 56.
[18] OECD, p. 63.
[19] The criteria defining Large, Medium and Small firms are according to different sectors: Industrial, Building, Wholesales, Retails, Transportation, Postal communications, Hotel and Catering. In the industrial sector, large firms are: over 2,000 employees, sales of over RMB 300,000,000, total assets of over RMB 400,000,000. Medium firms are: 300-2,000 employees, sales of RMB 30,000,000-300,000,000, total assets of: RMB 40,000,000-400,000,000. Small firms are: under 300 employees, sales of under RMB 30,000,000, total assets of under RMB 40,000,000. www.sdsgzw.gov.cn/document/.../20080805204733984596.doc (in Chinese).
[20] OECD, p.56.

Some pioneering enterprises have established overseas R&D centres. Huawei for example, a telecommunications firm, has R&D centres in Sweden (Stockholm), India (Bangalore), the Netherlands, Russia (Moscow) and the US (Dallas, Silicon Valley).

Another telecommunications firm, ZTE, has centres in Sweden and India. Haier, an IT and electronics firm, has centres in Germany, the US and India. Foton Motor, an automotive firm, has centres in Japan, Germany and Taiwan.[21]

State Industrial R&D Corporations

Hundreds of public research institutes had been transformed into corporate enterprises. Two examples are the China Academy of Machinery Science and Technology22and China Iron & Steel Research Institute Group[23].

MNCs' R&D Centres

China has become an attractive location for MNCs' R&D activities mainly due to the rapidly growing market and skilled R&D human resources in China. According to one estimate, there were about 350-450 foreign R&D centres by early 2007.[24]

The MNCs with R&D centres in China come mainly from the US, Europe, Japan and Korea. These centres are mainly in the ICT, automotive, chemical and medical sectors and are geographically concentrated in Beijing and Shanghai.

Foreign public research institutes are emerging in China, such as Fraunhofer Gesellschaft (FhG, Germany), Helmholtz-Association of German Research Centers and VTT Technical Research Center (Finland).[25]

2.3 Medium-and-Long Term Plans for Science and Technology: A Brief History

Since following the Soviet model of socialism in the 1950s, the People's Republic of China has had the tradition of planning the development of science and technology as well as economic and social development, using the Plan policy instrument (*jihua*, or *guihua*[26]). This comprises both the Medium and Long-Term Plan and the Five-Year Plan.

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[21] OECD, P 289.
[22] http://www.cam.com.cn/. No English version.
[23] http://www.cisri.cn/en/
[24] Schwaag Serger, S., 2007. in OECD, p.27.
[25] For more detail on their activities in China, see: OECD (2008), pp.294-296.
[26] There is a difference between *gui* and *jiahua*, as Cong Cao, Richard P. Suttmeier and Denis Fred Simon point out. *Guihua* implies a strategic, comprehensive and long-term development plan. By contrast, the Chinese *jihua*, also translated as "plan", suggests contents and procedures for an action before its implementation. Cong Cao, Richard P. Suttmeier and Denis Fred Simon, China's 15-Year Science and Technology Plan, Physics Today, December 2006, p.42.

To date, China has drafted and issued eight national science and technology Medium and Long-Term Strategic Plans.

The first and most successful plan was the Long-Term Plan (1956-1967). Priority areas were atomic energy and bombs, missiles, rockets and semiconductors. The plan was deemed to have fulfilled its goals in 1962, five years early.

The second plan was for 1963-1972. This was ended by the Cultural Revolution (1966-1976).

The third plan was for 1978-1985. This “Great Leap” plan was too ambitious to be implemented and was soon radically adjusted.

The fourth plan was for 1986-2000, and achieved good results.

The fifth plan comprised the Ten-Year Plan (1991-2000) and eighth Five-Year Plan.

The sixth plan comprised the ninth Five-year Plan and a Long-Term Plan running until 2010. This plan was drafted back in 1994, but not approved by the State Council Steering Committee of S&T and Education for public release. [27]

The seventh plan comprised the S&T and Education Special Plan and the tenth Five-Year National Economic and Social Development Plan.

The eighth and latest plan is the National S&T Strategic Plan (2006-2020), a detailed analysis of which appears in the following section.

2.4 National R&D Programmes

China has a centralised system of national R&D programmes. These are mainly designed and implemented by MOST.

The National R&D programmes run by MOST are:

Three core programmes (the National Key Technologies R&D and Programmes 863 and 973) and two group programmes (Construction of S&T Infrastructures and Construction of the S&T Industrialisation Environment). [28]

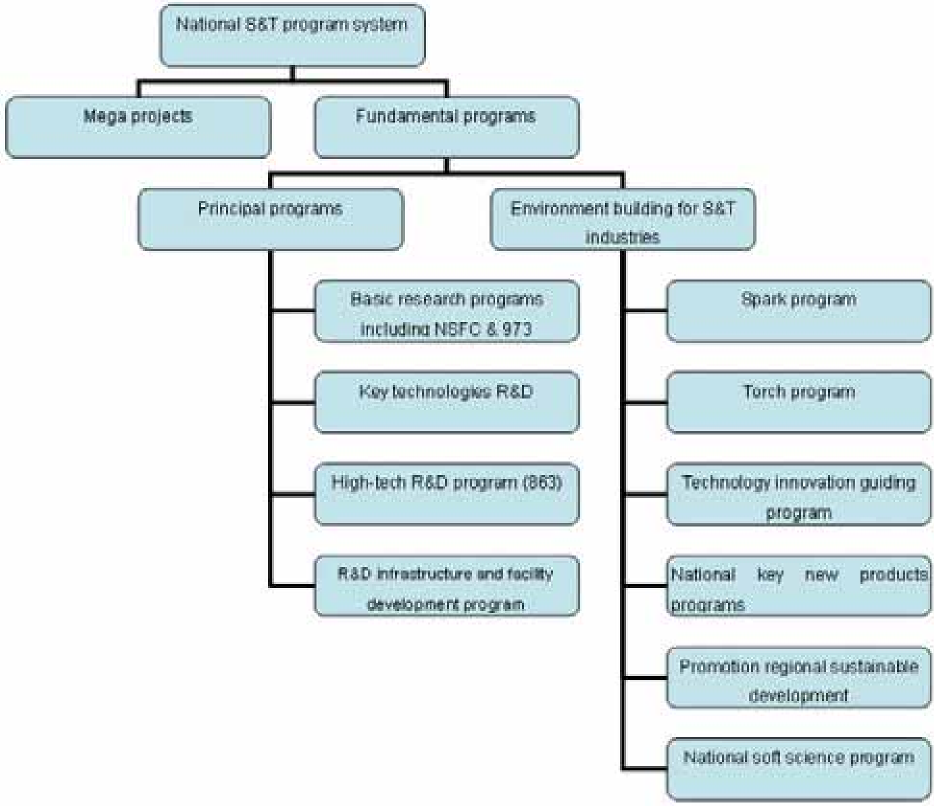
NSFC runs the National Science Foundation.

CAS runs the Knowledge Innovation Programme.

The Mega-Engineering Project and Mega-Science Project were introduced into the national R&D programme system following the MLP in 2006. An overview of Chinese national R&D programmes is given below. Some of these programmes and their priority areas will be described later on.

[27] http://www.most.cn/kjgh/lskjgh/

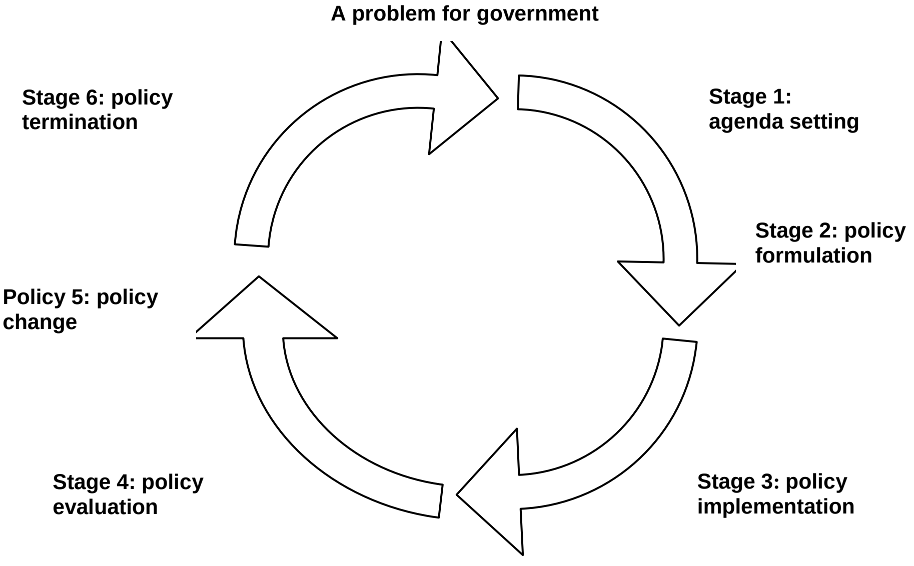
[28] For a general description in English, see OECD (2008), pp. 459-472.


National S&T program system
Mega projects
Fundamental programs
Principal programs
Environment building for S&T industries
Basic research programs including NSFC & 973
Key technologies R&D
High-tech R&D program (863)
R&D infrastructure and facility development program
Spark program
Torch program
Technology innovation guiding program
National key new products programs
Promotion regional sustainable development
National soft science program

3 Useful Analytical Framework

3.1 Policymaking model

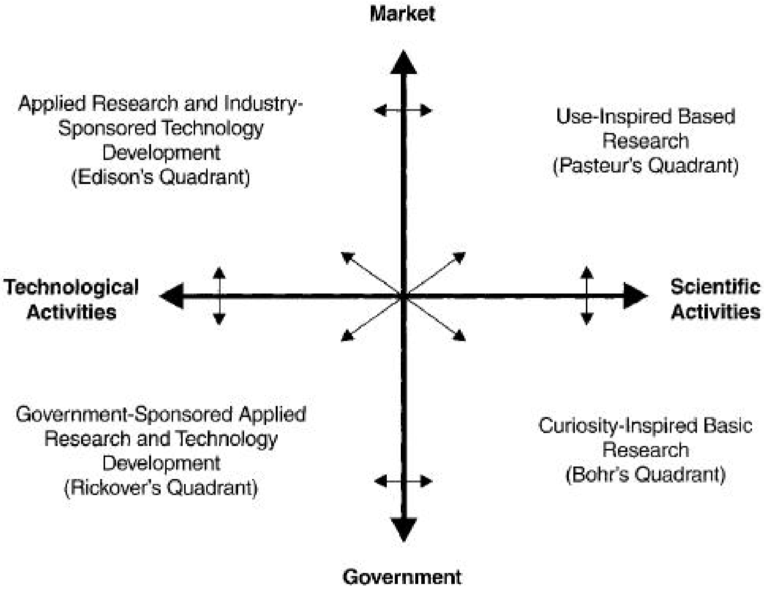
The policy cycle model will be used in the report to analyse the process of policymaking.



Lester, J.P., J. Stewart, Jr., 2004. Public policy: an evolutionary perspective. China Renmin University Press. P.5

3.2 Taxonomy of Science and Technology

Quadrant model of organisation of scientific research and technology development



Source: Ruttan, V.W., 2001. Technology, Growth and Development: An Induced Innovation Perspective. New York, Oxford University Press p. 537

In China, the science foundation projects mainly belong in Bohr's Quadrant. Programme 973 belongs in Pasteur's Quadrant and Programme 863, the Mega-Engineering projects, belongs in Rickover's Quadrant.

3.3 S&T priority: Levels and system

Observing the Chinese S&T priority areas, one can find different levels of priority:

- Ideological level: the Scientific Concept of Development, the Harmonious Society
- National strategy level: Indigenous Innovation Strategy changed from the catch-up strategy.
- S&T priority at MLP level
- S&T priority at national S&T programme level
- S&T priority at research organisation level (Chinese Academy of Sciences, Universities etc).

All these constitute a system of S&T priority. Our focus in this report is on S&T priority at MLP level and S&T priority at national S&T programme level. The national

S&T programmes have their own priorities, but will be geared to serving the S&T priorities set by the MLP.

3.4 Priority-setting Model

Baark (1998) formulated a four-policy cultural model of S&T policymaking in China. He argued that the reforms and formation of science and technology policy in China reflect the conflicts and tensions that have unfolded between these policy cultures on the various levels or layers of the national science and technology policy system.

	Bureaucratic	Economic	Academic	Civic
Developmental goals	*National strength and security*	*Economic growth*	*Expansion of knowledge*	*Better society*
Doctrine of policy making	*Interventionist*	*Liberalist*	*Autonomy*	*Participation*
Preferred policy instruments	*Planning, "picking winners"*	*Market forces, commercialization*	*Peer review, institution-building*	*Public debate, technology assessment*
Fundamental ethos	*Authoritarian, hierarchical*	*Entrepreneurial*	*Scientistic*	*Populist*
Interest group constituency	*Defense sector, industrial ministries*	*New technology firms, enterprise managers*	*Research institutes, universities*	*Student movement, dissident journalists*

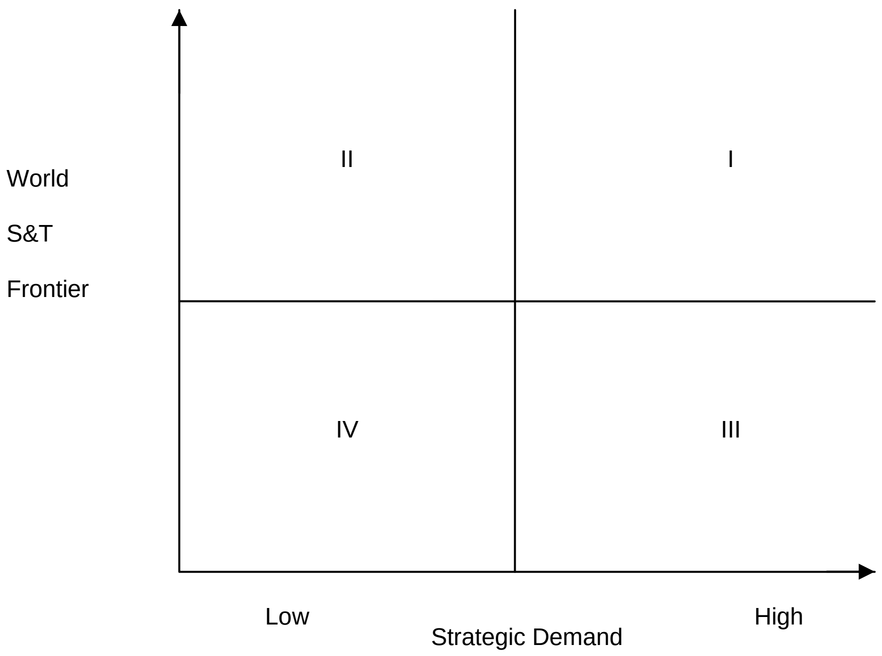
Source: Baark, E., 1998. The Making of Science and Technology Policy in China, International Journal of Technology Management, 21 (1/2), 1-21)

We can say that priority-setting is a process in which stakeholders and actors with policy cultures negotiate, bargain and seek consensus. Note that the public is just beginning to participate in policymaking and priority-setting in China.

Priority-selection is a research topic of policy studies. For example, Zhang Wei et al (2006) discuss the selection of priority in a discipline[29]. Han Yu et al (1997) discussed the methodology of priority-setting in basic research. [30]In the formation process of the MLP in 2005, some policy researchers suggested in 2005 that the key principle for selecting the priority field and direction should be to serve national strategic goals and national strategic benefits.

[29] Zhang Wei et al (2006). Study and application of the method of priority-setting in science and technology research. Studies in Science of Science. Vol.24, No. 6.
[30] Han Yu et al., (1997) Science Research Management, Vol.18, no.2.

This author observes a consensus between the scientific community and the policymakers that Chinese S&T should be *dingtian lidi* (顶天立地for which IDRC's (1995) translation is "go forward with your head in the clouds and your feet on the ground"). *Dingtian* means being at the frontier of world S&T and *lidi* means Chinese S&T should be orientated to economic and social demands. Thus we can formulate the following figure:



Priority-setting in China mainly emphasises the strategic demand and the frontier of world S&T. Different national R&D programmes put a different emphasis on strategic demand and the frontier of world S&T. For example, the National Natural Science Foundation Programme and Mega-Science Projects mainly emphasise the dimension of the frontier of world science. The Mega-Engineering Projects emphasise both the frontier of world S&T and strategic demand.

We will see the consensus seeking in the following studies of policymaking, priority making and the national R&D programmes establishing.

4 Policymaking of the MLP 2006-2020

The complete MLP consists of the MLP outline (*guihua gangyao*), the complementary policy measures (*peitao zhengce*) and the complementary policy implementation details (*shishi xize*[31]).

4.1 The policymaking process of MLP

Before the agenda of drafting the Medium and Long-term Strategic Plan for the Development of Science and Technology (MLP for short) was set by the 16th CCP Congress in 2002, some famous scientists wrote a letter to the top Chinese leadership asking them to draft an MLP. The Ministry of Science and Technology and other ministries held many meetings discussing the issue. Shortly thereafter, there was an election of the Party and government leadership. Drawing up the MLP was left to the new leadership[32], of which Wen Jiabao is Premier.

The new State Council decided to draft the MLP at a meeting in March 2003. In May, the Premier chaired the first meeting of the Steering Committee of S&T and Education, and the MLP work plan proposed by MOST was passed.

The MLP was released by the State Council in February 2006 in conjunction with a decision on implementing the Medium and Long-term Strategic Plan for the Development of Science and Technology and Improving Indigenous Innovation Capability by the CCPCC and State Council.

The MLP-making process can be roughly classified into four phases:

Phase 1: organisational preparation for MLP

The leading group was established in June 2003, consisting of Premier Wen Jiabao as leader and the State Council Secretary (*guowu weiyuan*) Chen Zhili as deputy leader plus senior level officials from 23 ministries and ministry-level organisations, including the Minister for MOST and Director-General of CAS. In addition to the leading group, an expert consultation group for the overall strategy for the MLP was formed and approved by the State Council. This group consisted of some 20 senior scientists in China, including Zhou Guanzhao (physicist and Chairman of CAST), Song Jian (former Minister of MOST), Zhu Guanya, Wang Xuan (a professor at Peking University and founder of the Laser Typing System).

[31] Schwaag Serger, Sylvia and Maguns Breidne (2007) translated *shishi xize* as the 99 supporting policies.

[32] Interviews, 2008 Aug, Huangshan city.

Phase 2: Strategic Studies

In June 2003, 20 key S&T issues were identified and commissioned for study:

- Overall strategy for medium to long-term S&T development
- S&T system reform and a national innovation system
- Modern manufacturing, S&T development
- Agricultural science and technology
- Energy, resources and ocean S&T
- Transportation S&T
- Modern services industry S&T
- Population and health S&T
- Public security S&T
- Ecology, environmental protection and recycled economy S&T
- Urban development and urbanisation S&T
- National defence S&T
- Strategic high technology and industrialisation of high and new technology
- Basic science
- Conditions, platforms and infrastructures for S&T development
- Human resources for S&T
- Input and management models for S&T
- Law and policies for S&T development
- Culture for innovation and S&T popularisation
- Regional S&T development.[33]

The process of strategic studies was open (except for the national defence issue) and over 2,000 scientists, engineers, policy experts, corporate executives, officials from universities, ministries and corporations took part. There were many workshops for exchanging progress research reports.

MLP making were even open to the international community. The Leading Group Office for MLPs held a workshop with international experts who attended the Multi-S&T Minister Forum in Shenzheng, Guangdong Province in October and held the international MLP forum in Beijing in November 2003.

[33] Translations are mainly drawn from Cao, Cong, Suttmeier, Richard P., Simon, Denis Fred, Physics Today, 00319228, Dec 2006, vol. 59, Issue 12, 38-43 and Schwaag Serger, Sylvia and Maguns Breidne, 2007.

Unlike former S&T plans, the Leading Group Office for the MLPs created a website for public participation, collecting ideas and suggestions from the general public.

Since April 2004, interim strategic research reports have been sent for consultation to the CAS, CAE and Chinese Academy of Social Sciences.

In this sense, generating MLPs is a good practice for the scientification and democratisation of decision-making (China is striving towards this goal).

The final research reports on the 20 issues were requested with almost the same structure. Firstly, the international situation. Secondly, the domestic situation and demand. Thirdly, problems needing to be solved, policy suggestions and proposals for priority projects. [34]

Following the conclusion of strategic studies of the projects, the final results were reported to Premier Wen Jiabao. At the State Council meeting on 20th August 2004, he claimed that strategic studies had achieved the expected goals.

Phase 3: Drafting process

Following the conclusion of strategic studies, a draft group from the government, MOST institutes and Tsinghua University began writing the MLP, mainly based on the research results of the strategic studies. They reviewed the strategic research reports, selected priority tasks, collected comments and feedback from the senior leaders and stakeholders and spent a lot of time finding the best descriptive language. The drafting process largely remained black-box and was covert. The final draft of the MLP took a year and went through 12 revisions.

Phase 4: Ratification

Chaired by Wen Jiabao in June 2005, the executive meeting reviewed the (draft) MLP and asked for complementary policy measures to be drafted for the MLP, as it was not sufficiently concrete or focused[35].

Soon after that the Politburo meeting in June chaired by Hu Jintao, General Secretary of the CCP, reviewed the MLP draft.

The complementary policy measures for implementation of the MPL were reviewed and passed in principle at the State Council Executive Meeting of 21st December, 2005.

A national S&T conference was held in January 2006 with the main task of implementing the MLP. The President and Premier delivered important speeches. President Hu Jintao pledged to make China "an innovation-orientated country" and

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[34] Magnus Breidne, the Swedish Science technology attaché in China, knew about this. See: Research Priorities with Chinese Characteristics,
iva.ntier.se/upload/Verksamhet/Projekt/Magnus%20Breidne_%20China.pdf

[35] Schwaag Serger, Sylvia and Maguns Breidne, 2007 p.150.

improve indigenous innovation (*zizhu chuangxin*). The MLP was published in February 2006.

4.2 Policymaking Process for MLP Complementary Policy

The MLP complementary policy was generally abbreviated to 60 points (60 *tiao*). It contains 10 sections: S&T investment, tax incentives, financial support, government procurement, technology transfer from abroad (*yinjin*), assimilation and secondary innovation, IPR, S&T human resources, education and science popularisation, S&T innovation platform and coordination.

These measures emphasise: raising the scale of R&D investment; making effective use of public funding; improving Chinese firms' absorptive capability and innovation capability through tax incentives and government procurement; developing indigenous technology and China-dominated technical standards; enhancing human resources in science and technology by improving the university system and attracting expatriate Chinese back to China.

Zhang Xiaoqiang, Deputy Director of the National Development and Reform Commission (NDRC), announced the policymaking process. [36]

When the MLP was at the strategic studies phase, there was discussion about drafting a complementary policy for the MLP. After conclusion of the strategic studies and the MLP had entered its drafting phase, the Leading Group Office for the MLP proposed the drafting of a complementary policy. This was explicitly proposed by Premier Wen at a State Council executive meeting in June 2005. The Politburo meeting in June also discussed it.

Under coordination of the MLP Leading Group Office, MOST, NDRC, Ministry of Finance, Ministry of Personnel and the China Central Bank became responsible for relevant issues. Twelve research groups were formed, with some 200 researchers from 23 ministries or ministry-equivalent organisations working on a draft of the complementary MLP policy.[37]

In August 2005, The Deputy Director, Zhang Xiaoqiang and the Vice Minister of MOST, Li Xueyong, formed an investigation group with high-level officials from 13 ministries, to collect suggestions from enterprises in Shenzhen, Qiangdao and Shanghai. There is a formal mechanism for the government to respond to the needs of

[36] Jiemi Guojia Zhongchangqi kexue he jishu Guihua Gangyao Peitao zhengce chutai qianhou. Website: http://business.sohu.com/20060718/n244317556.shtml, accessed May 2009
[37] The Policy system of encouraging indigenous innovation is emerging, see: http://policy.tech110.net/html/article_382222_2.html

industrial sectors. The government goes to visit industrial managers as well as inviting them to Beijing to gather suggestions.

The draft underwent many revisions. In September 2005, the framework draft was changed almost to its final version.

The complementary policy measures for implementing the MPL were reviewed and passed in principle at the State Council Executive Meeting on December 21st 2005.

The Complementary Policy was publicly issued soon after the MLP in February 2006 and is more operationable than the MLP.

4.3 Policymaking Process of Complementary Policy Implementation Details

The (draft) complementary policy and the (draft) MLP were reviewed at the National S&T Conference in January 2006. It was thought that the Complementary Policy was "in principle" and not concrete enough. In fact, Article 59 of the Complementary Policy states that the implementation details are to be formulated by the relevant departments.

Sylvia Schwaag Serger and Maguns Breidne (2007)[38] described the process in detail.

In April 2006 and following the February 2006 presentation of the plan, the State Council presented the first batch of a "consolidated list of rules for implementing supporting policies for the 'outline of the national Medium and Long-term Planning for development of science and technology' formulated by the relevant department." [39]For each of the 99 supporting policies, one lead ministry or government institution and one person within that lead institution is assigned responsibility for its implementation. The designated person is generally at vice-ministerial level or (in at least one case) ministerial level. The list indicates institutions alongside the lead one, tasked with assisting implementation of the policy, as well as indicating the completion deadline.

Although varying in terms of scope or level of detail - ranging from advising on attracting more overseas talent to delivering a "national industrial technology policy"- these supporting policies are all concrete policy tools or action plans for implementation of overall objectives.

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[38] The following mainly drawn from: Schwaag Serger, Sylvia and Maguns Breidne (2007). China's fifteen-year plan for science and technology: an assessment. Asia Policy, No.4 (July 2007), 1350164.

[39] State Council of the People's Republic of China, "*Guowuyuan youguan bumen fuze zhidingdeguojia zhongchangqi kexue he jishu fazhan guihua gangyao peitao zhengce shishi xize zongbiao*" [Consolidated List of the Rules for Implementation of the Supporting Policies for the "Outline of theNational Medium and Long-term Planning for Development of Science and Technology" Formulated by the Relevant Department], 2006 u http://www.gov.cn/gongbao/content/2006/content_310755 htm.

Prime responsibility for implementing the largest number of supporting policies goes to the National Development and Reform Commission (NDRC) with 29 policies, followed by the Ministry of Finance with 21 (or 25 if the State Administration of Taxation is included), MOST with 17 support policies and the Ministry of Education with nine. NDRC and the Ministry of Finance have lead roles not only by merit of a large number of supporting policies but also in implementing what are arguably some of the pillars of the new long-term plan. Thus, NDRC is charged with strengthening innovation in SMEs and devising a plan for special projects promoting independent innovation capabilities. The Ministry of Finance is responsible for designing fiscal incentives aimed at increasing R&D and innovation in enterprises as well as drafting public procurement policies aimed at promoting independent innovation.

The Implementation details were originally to contain 99 points, but were ultimately changed, ending up at 76 points. [40]

4.4 Brief Summary of and Comments on drawing up MLPs

- Generally speaking, the MLP process is open and transparent especially in the strategic studies phase. However, the results of these strategic studies - the research reports - remain confidential. The draft phase is secretive and remains a black box. One can say that the whole process is a grey box, rather than a white or black one.
- The MLP process comprises bottom-up and top-down feedback.
- The MLP process is a scientific decision-making process. Many experts participated in the strategic studies but empirical analysis needs to be improved.
- The MLP process is a democratic decision-making process. Many stakeholders from various scientific, governmental and industrial groups participated in the process. Even the general public is encouraged to participate.
- Critics suggest that policymakers should pay more attention to suggestions from industry and invite more industrial managers (from both state-owned enterprises and SMEs) to participate in the policymaking process.[41]
- The problem is that the process involves few experts with opposing opinions. Still, opposing voices can be heard from US-based Chinese scientists, see Nature 2004 (supplement China Voices II).

[40] The Policy system to encourage indigenous innovation is emerging, at: http://policy.tech110.net/html/article_382222_2.html

[41] Wu Yishan, Three suggestions on S&T policymaking, Guangming Daily, 2007-05-14 http://www.gmw.cn/01gmrb/2007-05/14/content_605455.htm

- The MLP is a government document (mandate). It would be better if the MLP were reviewed and be legislated in the form of an ACT by the People’s Congress.
- The MLP process is efficient.

(The government ministries adapt MLP implementation when changes occur, such as the financial crisis).

5 Research priorities in the MLP and the 11TH FYP

Too many priorities were proposed in the strategic studies phase of the MLP process. However, resources and funding are limited, so final priorities must be selected. The principles of selecting priorities were discussed, established at high-level meetings and finally reflected in the MLP. The priorities were chosen roughly according to these principles, but not exactly. [42]One interview said the priorities had been the result of "bargaining" (*taojia huanjia*). [43]

5.1 Strategic Priorities of S&T (*zhanlue zhongdian*)

1. Developing energy, water resources and environmental protection must be given priority so as to solve the most challenging bottleneck of economic and social development.
2. Taking the opportunities that the upgrading of ICT and the rapid development of material S&T, acquire the core technologies in the manufacture and ICT sectors with own (*zizhu*) intellectual property rights.
3. Giving the biotechnology priority so that future high-tech industry can catch up.
4. Speeding up the development of space and marine technology.
5. Strengthening fundamental sciences and frontier technology research, with a focus on multi-disciplinary research. (Article II-3).

5.2 Priority fields (*zhongdian lingyu*) and the Priority theme (*youxian zhuti*)

A priority field is defined in the MLP as those industries needing priority development and the urgent support of science and technology.

The MLP determined 11 priority fields relevant to national economical and social developments: Energy, water and mineral resources, environment, agriculture, manufacturing, transport, information technology, public health, urbanisation, public security and national defence.

[42] Interview, April 2009.
[43] Interview, April 2009

In fact, all these 11 priority fields were among the 20 key issues of the strategic studies phase.

A priority theme is defined in the MLP as technological groups in priority fields and needing development for specific tasks (goals), with a sound technological basis and able to make breakthroughs in the near future.

The principles for determining a priority theme are whose technologies which are:

- Conducive to solving the bottlenecks and improving capacity for sustainable economic development.
- Conducive to mastering the key (*guanjian*) technologies and generic technologies and improving the core competence of industries.
- Conducive to solving major public interest S&T problems and improving the Capacity of public services.
- Conducive to developing dual technologies (military and civil) and improving national defence capacity.

The MLP sets out 68 priority themes in the 11 priority fields.

5.3 Mega-Engineering Projects (*zhongda zhuanxiang*)

Mega-engineering projects, priority themes targeting the national goals, have been picked out from among major strategic products, key generic technologies and major engineering efforts.

The basic principles are:

- Close links with the major demands of economic and social developments, nurturing strategic industries so that they have their own core intellectual property rights and improve their indigenous innovation capability.
- Emphasising those key generic technologies which will improve industrial competitiveness as a whole and drive improvement.
- Solving the most challenging bottlenecks in economic and social developments.
- Linking civil and military uses of major strategic significance to national security and national strength generally.
- Suitability to national contexts and affordability.

According to the principles of targeting high-tech development, upgrading traditional industries, solving bottlenecks, improving public health and safeguarding national defence, it has been decided under the MLP to launch the 16 mega-engineering projects in strategic industries like ICT, biotechnology, energy, resources and the health sector as well as in dual-use and national defence technologies. These are:

- Core electronic components
- High-end generic chips and basic software
- Extra large-scale integrated circuit manufacturing and techniques
- Next generation wireless mobile communication
- Advanced numeric-controlled machinery and basic manufacturing technology
- Large-scale oil, gas and coal mining
- Advanced large-scale pressured-water reactors
- High temperature gas-cooled reactors
- Water pollution control and treatment
- New transgenic biological varieties
- Drug innovation and development
- Control and treatment of AIDS, hepatitis and other major diseases
- Giant planes
- High-definition earth observation
- Manned aerospace
- Moon exploration

5.3.1 Two Projects which failed to make the list of mega-engineering projects (but still got government support)

ITER (China) Project[44]

The ITER (International Thermonuclear Experimental Reactor) China project was said to be on the candidate list of mega-engineering projects in the MLP. However the ITER project was not selected. According to Prof. He Zuoxiu, a theoretical physicist and CAS academician (the highest scientific standing in China), ITER was deleted from the candidate of mega-engineering projects in order to give face[45] to us, the academics. In about 2005, He Zuoxiu and other 40 CAS academicians wrote a letter directly to the central government, objecting to China's participation in the ITER because they thought there would be little hope of the nuclear fusion technology being put to practical use and that ITER research was too costly.

Although ITER was not on the list of mega-engineering projects, China participated officially in the ITER project in 2006. In Oct 2008, the China Executive Centre for

[44] Mainly from: Jia Hepeng, ITER: narrowing missing from the mega-engineering projects, Science News (bi-weekly), No.1, 2009., pp. 30-31.
[45] The Chinese attach great significance to not losing face.

ITER was set up under a former vice-minister of MOST. China will invest RMB 10 billion in the ITER, equivalent to the funding of a mega-engineering project.

National Citizens' Scientific Literacy Action Plan

The strategic studies research group for key issue number 20 (Culture for innovation and S&T popularisation) proposed a mega-project called the "National Citizens' Science Popularisation Action Plan" (later renamed the "National Citizens' Scientific Literacy Action Plan"). At the same time, the China Association of Science and Technology (CAST, responsible for popularising science in China) and other ministries were researching and drafting the National Citizens' Scientific Literacy Action Plan.

In the spring of 2004, the National Political Consultation Members, Xu Shan Yan (Vice Chairman of CAST) and 10 other members proposed a bill (*ti'an*) to the National Congress of People Delegates (*Renda*) and the National Congress of Political Consultation (*Zhengxie*) putting the "National Citizens' Scientific Literacy Action Plan" on the list of mega-projects in the MLP. They also published the bill in a journal, China S&T Industry (no.3, 2005).

The bill was transferred to MOST, which replied formally (and diplomatically)[46]. MOST said the State Council will launch an independent programme for improving national scientific literacy.

In March 2006, the State Council published the National Citizens' Scientific Literacy Action Plan just after publishing the MLP in February 2006.

5.4 Cutting-edge technologies

The principles of selecting cutting-edge technologies are that they should:

- Represent the developmental direction of world-class technology.
- Drive the formation and development of emerging industries in China.
- Be conducive to industrial upgrade, allowing leapfrogging.
- Have a talent base and an R&D base.

The MLP selects the biotechnology, IT, new materials technology, advanced manufacturing technology, advanced energy, marine technologies, laser and aerospace technology.

Eight cutting-edge scientific areas:

Principles:

- Driving development of the basic sciences

[46] http://www.most.gov.cn/ztzl/lhztbd/taya/200503/t20050302_19409.htm

- Being a good research basis
- Representing national strength and characteristics
- Being conducive to improving China's position in the world.

The eight cutting-edge scientific areas selected:

Cognitive science; deep structure of matter; core mathematics themes; Earth system processes and resources; the environmental and disaster effects; chemistry of creation and transformation of matter; quantitative study of the process of life and systems integration; condensed matter and new effects, scientific experiments and observation methods, techniques and equipment innovation.

5.5 Mega-Science Projects (zhongda kexue yanjiu jihua)

In contrast with the mega-engineering project, the principles for selecting the mega-science projects are not specifically stated in the MLP. It says that based on the trend of the world science development and major strategic demand in China, the MLP selects those research directions which will lead future development, drive the development of S&T, improve sustainable innovation capacity and where China has excellent research groups.

The MLP selects four mega-science projects, including protein research, quantum modulation research, nanoscience and technology, growth and reproduction. According to one interviewee, the four mega-science projects were the result of a repeated consensus-seeking process and assessment according to China's existing research base and major strategic demand[47].

The research priorities were implemented in the five year plan and in the national S&T programmes (both the older ones and the newly established ones).

5.6 Priorities in the 11th Five Year Plan for Science and Technology (2006-2010)

In October 2005, CCPCC proposed drafting the 11th Five Year (2006-2010) Plan for Economic and Social Development.[48] MOST was responsible for the 11th Five Year Plan for Science and Technology. It was published in October 2006[49] and aimed at implementing the MLP.

The Priority tasks stated in the FYP were:

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[47] Interview, Beijing, July 2007.
[48] Full text of the proposal at: http://news.xinhuanet.com/politics/2005-10/18/content_3640318.htm
[49] Full text at: http://www.most.gov.cn/kjbgz/200704/t20070424_43326.htm

- Targeting strategic goals, implementing mega-engineering projects.
- Facing urgent demands, tackling key technologies and including these in the energy, resources and environmental protection fields; key generic industrial technologies; socially-related and public interest technologies; promoting industrialisation of high-technology and appropriate advanced technologies.
- Mastering the future development, mobilising frontier technology and basic research.
- Strengthening the sharing mechanism, constructing the infrastructure and the S&T platform.
- Implementing the talent strategy, building S&T human resources.
- Building good climate, strengthening the popularisation of science and the innovation culture.
- Building an enterprise-centred innovation system with Chinese characteristics.

5.7 Foresight and Priority-Setting

The Foresight study has been introduced into and practiced in China. The CAS Institute of Policy and Management conducted a technology foresight of China towards 2020, using a large-scale Delphi survey of 2,000 experts[50]. 737 technology topics of importance to China were selected in eight research fields and 200 of the most important technological topics were selected from among them.

According to one interviewee, this foresight report had been sent to leaders of the CAS, the government departments and the provinces. The report may have impacted upon them.

MOST's Chinese Academy of Science and Technology for Development (CASTED, formerly the National Research Center for Science and Technology for Development (NRCSTD))[51], of which the Minister of Science and Technology of China is the president, also conducted a technology foresight. In 2002, CASTED commissioned the Foresight project from MOST publishing its results in 2004 under the China S&T Literature Press: China's Report of Technology Foresight 2003：ICT, Biotechnology and New Materials. A series of technology foresight reports has been published since then:

China's Report of Technology Foresight 2004: Energy, Resources and Environment and Advanced Manufacture (in 2005);

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[50] The research project group: Technology Foresight of China Towards 2020, Science Press, 2006.
[51] http://www.casted.org.cn/web/index.php?ChannelID=64

China's Report of Technology Foresight 2003-2005 (in 2006)

China's Report of Technology Foresight 2005-2006 (in 2006)

China's Report of Technology Foresight 2006-2007 (in 2008).

According to one interviewee, China's report of Technology Foresight 2003 had been sent to the leaders of the strategic studies for the 20 issues. The same interviewee said that priority areas in the MLP were quite consistent with those in China's Report of Technology Foresight.

President Hu Jintao even mentioned the technology foresight in his 2004 speech to the Congress of CAS and CAE Academicians. [52]

One can reasonably conclude that the technology foresight impacts priority-setting in China. The OECD (2008, p.442) believes that 'several foresight studies …… provide useful input into planning and prioritisation process'.

[52] Hu Jintao's speech to the Congress of CAS and CAE Academicians, 2004. http://www.people.com.cn/GB/shizheng/1024/2541494.html

6 The National S&T Programmes and their Priority Areas

6.1 Key Technologies R&D Programme[53]

Initiated in 1982, the Key Technologies R&D Programme is the first national S&T programme in China. Its goal is to address major S&T issues in national economic construction and social development and it was to accomplish the following six major tasks during the 10th Five-year Plan period:

1 Promoting in-depth agro-product processing by developing a number of key technologies and products for sustainable agricultural development.

2 Developing common key technologies for basic and pillar industries. Also, speeding up the application of IT and other high technologies in traditional industries.

3 Accelerating the development of ICT and other high technologies, along with related industrial development, to render technical support to the informatisation of the financial sector and the national economy.

4 Developing key technologies in urban environmental pollution control, pushing forward the rational utilisation of water resources; developing and demonstrating technologies for the improvement of regional ecology and environment; intensifying technical research in exploration and the development of oil and gas fields; establishing technical supporting systems for disaster prevention and mitigation.

5 Developing key technologies in the traditional Chinese medicine (TCM) industry to secure its world-leading position.

6 Intensifying research into major public welfare technologies; intensifying research into technical standards and measurements to facilitate the establishment of China's technical standardisation system.

The Programme launched two projects dedicated to facilitating China's Western Development Strategy and hosting the Olympic Games in 2008.

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53 http://www.most.gov.cn/eng/programmes1/200610/t20061009_36224.htm; see also OECD, 2008, p.459.

6.2 Programme 863 (National High-Tech R&D Programme)

6.2.1 The policymaking process

Programme 863 is still running into 11th FYP and will run into the 12th FYP. The following is a historical background of 863.

In 1986, to meet the global challenges of the new technological revolution and competition and considering the US's Strategic Defense Initiatives and Europe's EUREAKA Programme, four Chinese scientists, WANG Daheng, WANG Ganchang, YANG Jiachi and CHEN Fangyun, jointly wrote a letter to China's national leaders, proposing to accelerate China's high-tech development. In March, Deng Xiaoping personally approved the National High-tech R&D Programme; Programme 863 .

From April to September, 1986, the State Council mobilised hundreds of experts to draft the Outline for Development of High Technology. This drafting process was highly secretive[54]. In October, the Politburo reviewed and passed the Outline and on 18th November, the CCPCC and State Council published it.

Its priority areas are ICT, biotechnology and agriculture, new materials, advanced manufacture and automation and energy, resources and environmental technologies. During the 10th FYP, the goal of Programme 863 was transitioned from follow-up, imitation and catch-up to indigenous innovation.

6.2.2 Implementation during the 10th Five-Year Plan[55]

During the 10th Five-year Plan, the Programme addressed a number of cutting-edge high-tech issues of strategic importance and foresight. These were:

1. Developing key technologies for the construction of China's information infrastructure.
2. Developing key biological, agricultural and pharmaceutical technologies to improve the welfare of the Chinese people.
3. Mastering key new materials and advanced manufacturing technologies to boost industrial competitiveness.

Programme 863 attaches importance to developing nanomaterials and other new materials plus related technologies for the development of aviation, the Maglev train, information storage and access. This was in order to meet the major demand for national security and economic development by utilising China's characteristic resources of environment and technical strength. As a result of advanced manufacturing technologies catering for the agile globalised manufacturing of the 21st Century, the

[54] Interview, July 2008, Huangshan City.
[55] http://www.most.gov.cn/eng/programmes1/200610/t20061009_36225.htm

Programme will develop advanced integrated manufacturing systems and common key technologies leading to the development and upgrading of China's manufacturing industry.

4 Achieving breakthroughs in key technologies for environmental protection, resources and energy development to serve the sustainable development of our society.

6.2.3 Development Priorities

Development priorities have been categorised into Priority Projects and Key Projects.

Priority Projects are guided by encouraging innovation, obtaining IPR proprietorship and addressing key technological issues. Priority Projects conduct R&D in 19 subjects which offer the most significant impact on enhancing China's overall national strengths. These subjects span six priority high-tech fields in the civil sector, including IT, biotechnology and advanced agricultural technology, advanced materials technology, advanced manufacturing and automation technology, energy technology and resource and environment technology.

Key Projects are centred on major systems and projects and guided by pooling resources to address significant high-tech issues in line with the demands of major national strategies, the market and application. These issues bear strategic significance on China's high-tech development and participation in international competition. They will facilitate the formation of new sources of economic growth exemplified by internationally competitive industrial clusters. They are also crucial elements in enhancing the competitive edge of major industries, facilitating industrial upgrades, developing China's own features of high technologies and realising "leapfrog" progress in the high-tech field.

6.3 Programme 973 (National Key Basic Research Programme of China) and its Management

6.3.1 The policymaking process

The Political Consultation Conference (*Zhengxie* for short) is a political body of the Chinese political system[56]. Political Consultation members are generally successful scientists, engineers, intellectuals and businessmen belonging to non-Communist parties or democratic parties. They usually take the opportunities of the conferences to provide policy suggestions to the Government. Programme 973 is one such case.

[56] For a brief description of the Chinese political system, see OECD, 2008, pp. 428-429.

In March 1997, China's national leaders including the then Premier Li Peng, participated in an S&T session of the Political Consultation Conference. Some scientists complained that basic research in China was being ignored and not getting adequate funding. Premier Li Peng proposed launching a programme in support of key national basic research. The party group of the S&T Commission gave great attention to the proposal, convened many meetings to discuss the issue and consulted many senior scientists and leaders of relevant ministries. The party group of the Commission drafted an outline report on strengthening key basic research.

In June, the then Director of the S&T Commission (later MOST), Ms Zhu Lilan presented the outline report at the S&T Steering Group (later the Steering Group for S&T and Education) meeting. The Steering Group decided that the S&T Commission was responsible for determining the national key basic research programme. The then Party General Secretary, Jiang Zemin, supported this proposal.

The S&T Commission convened many consulting meetings and invited participation from many scientists and engineers from various research fields as well as management experts (and leaders) from relevant departments. The draft was sent to CAS, CAE, the Ministry of Education and NSFC for consultation.

In the early 1998, The S&T Commission held a "Major Demands" workshop with 160 experts from various fields.

In May 1998, The S&T Commission held a workshop on the key basic research programme. The main participants were the university presidents, directors of public research institutes and senior scientists.

The S&T Commission decided to establish an expert consultation group with 19 senior scientists to review and monitor the programme. A joint office for the programme was set up between the S&T Commission and NSFC.

The National Key Basic Research Programme (Programme 973) was officially launched at the end of 1998.

6.3.2 Orientation and priorities

Programme 973 organises and implements key projects to meet national strategic needs, based on the existing basic research programmes conducted by the National Natural Science Foundation and early-stage basic research key projects. The strategic objective of the Programme is to mobilise China's scientific talents in conducting innovative research on major scientific issues in:

- agriculture,
- energy,
- information,

- resources and environment,
- population and health,
- materials,
- multidisciplinary and frontier science areas.

6.3.3 Objectives and Tasks

The strategic objectives of Programme 973 are to strengthen original innovation and address important scientific issues concerning national economic and social development on a deeper level and with wider scope. This is to improve China's capacity for independent innovation and provide scientific support for the future development of the country.

The first objective is to conduct multidisciplinary comprehensive research and provide theoretical and scientific foundations to settle important scientific issues regarding the development of the national economy, society and science itself in the fields of agriculture, energy, information, resources and environment, population and health and materials etc.

The second objective is to deploy relevant, important and exploratory frontline basic research.

The third objective is to nurture a number of outstanding people highly qualified and creative scientific personnel to meet the development requirements of the 21st Century.

The fourth objective is to build a group of high-level scientific and technological assignments for the country, thus forming interdisciplinary scientific research centres.

6.3.4 Organisation and Management

1 Project management

Projects under the Programme adopt a system led by a chief scientist and team leaders. Budgetary management consists of total subcontract budgeting, process control and total cost accounting. This combination brings about an organic combination of management system and budgetary pattern, thus creating a sound and innovation-friendly environment.

2 Management mechanism combining government decisions and expert consultation

Set up a high-level advisory group of senior experts in charge of consultancy, assessment and supervision of the Programme to ensure it is scientifically, democratically and fairly implemented.

3 Strengthening process management and establishing supervisory mechanisms for project operation.

Practising the “2+3” management pattern. After two years of operation, a project receives a mid-term evaluation to determine its development plan for the following three years. Advisory groups in specific fields are put in place to follow up and manage the project’s progress whilst providing advice and suggestions to the Ministry of Science and Technology. This facilitates the smooth realisation of prescribed goals.

Overall Deployment of Programme 973

Since Programme 973’s inception, 133 projects had been conducted by the end of 2002, including 17 projects in the agricultural sector, 15 in energy, 18 in information, 24 in resources and environment, 21 in population and health, 19 in materials and 19 in synthesis and frontier science.

175 chief scientists had been appointed for the projects and made financial investments of RMB 2.5 billion in the 9th Five-Year Plan.

Programme 973 not only involves the largest investment from central government among China‘s basic research programmes since the founding of New China, but also comprises single projects with the largest investment by the Chinese government. On average, every single project (each lasting about five years) enjoys strong support of up to RMB 20-30 million over five years.

Launched in 1991, the State fundamental Research Key Programme (Pandeng Programme) was integrated into Programme 973 in 1997 and terminated in 2000 (although Programme 973 continues.)

Programme 973 is open to the EU. The PRC/EU Cooperation comes under Implementation Regulation 973 - PRC/EU Cooperation under the Framework of the National Basic Research Programme (DRAFT).

6.4 Newly established programme: Mega-Science Projects (*zhongda kexue yanjiu jihua*)

The MLP selects four mega science projects, including protein research, quantum modulation research, nanoscience and technology, growth and reproduction.

It was newly established with publication of the MLP in 2006 and operates from the offices of Programme 973, MOST.

6.5 Mega-Engineering Projects[57]: 690 billion by 2020

According to an official of MOST, RMB 690 billion will be invested in the nine civil mega-engineering projects by 2020, of which RMB 200 billion will come from central

[57] http://www.nmp.gov.cn/

government funding, RMB 100 billion from provincial funding and other funds from relevant enterprises.[58]

6.6 National Natural Science Foundation: supporting basic research

The Natural Science Foundation of China (NSFC) was created in 1986 as a product of the reform of the S&T system. In 2007, the State Council promulgated the Regulations on the National Natural Science Fund[59], which came into force on 1st April, 2007. This was a significant event for China's scientific and technological legal system and basic research in the country.

The National Natural Science Foundation of China (NSFC) is a public institution directly under the State Council and responsible for managing the National Natural Science Fund.[60]

The financial resources of the National Natural Science Foundation of China come mainly from financial appropriations from central government. At the same time, the National Natural Science Foundation of China accepts donations from domestic and foreign individuals, legal entities or other organisations.

The National Natural Science Foundation of China effectively uses the National Natural Science Fund, supports basic research, upholds free exploration, plays a guiding role, identifies and cultivates scientific and technological talents and promotes scientific and technological advances plus coordinated economic and social development. Its responsibilities are[61]:

- Formulating and implementing funding plans to: support basic research and cultivate scientific and technological talents; accept project applications; organise expert evaluations; manage funded projects; promote the effective allocation of research resources; create an environment conducive to innovation.
- Cooperating with state administrative departments in charge of science and technology to draw up state principles, policies and plans for developing basic research; providing advice on major national issues concerning the development of science and technology.
- Conducting work designated by the State Council and related departments and coordinating with related institutions to conduct funding activities.

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[58] http://www.sciencenet.cn/htmlnews/2008/11/213754.html
[59] The full text is at: http://www.nsfc.gov.cn/english/05rl/index.html
[60] http://www.nsfc.gov.cn/english/04ct/01.html
[61] Foreword at: http://www.nsfc.gov.cn/english/06gp/index.html

- The programme structure of NSFC now consists of three main systems: the Research Programme, the Talent-Training Programme and the Environment Construction Programme.
- The Research Programme comprises such categories as the General Programme, Key Programme, Major Programme, Major Research Plan etc.
- The guiding principles of the investment are balance, coordination and sustainable development, so the share of the investment in different disciplines has also remained the same for the past 20 years (1986-2008).

The National Natural Science Foundation is considered the most fair and transparent funding among all of China’s national S&T programmes.

7 Chinese Academy of Sciences (CAS): KIP and priorities

7.1 Chinese Academy of Sciences (CAS)[62]

CAS was established in Beijing in 1949 based on the former Academia Sinica and Peiping Academy of Sciences. Currently (as of 2007) [63], there are six Academic Divisions, 91 scientific research institutes, one university, one graduate school and five documentation and information centres, 20-plus supporting units and 200-plus science and technology enterprises (See Figure: the organisation charter). Mainly based in Beijing, CAS has 12 branches in Shanghai, Nanjing, Hefei, Changchun, Shenyang, Wuhan, Guangzhou, Chengdu, Kunming, Xi‘an, Lanzhou and Xinjiang.

CAS has a total of over 54,500 staff, 40,200 of whom are scientific personnel (as of 2007). CAS has 17,700 female employees, accounting for about 32.5% of the total.

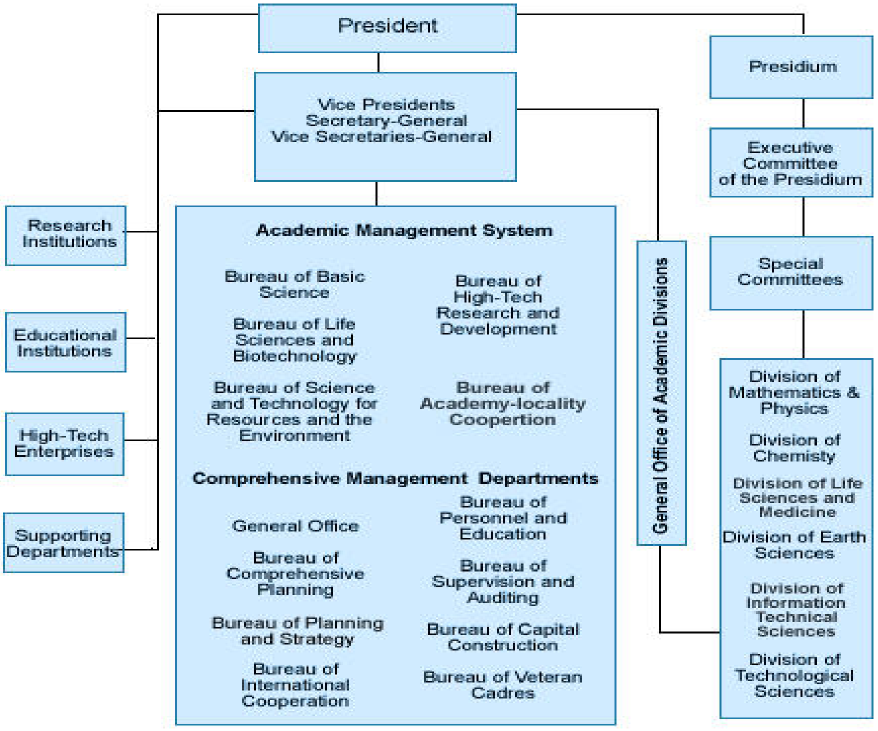
CAS’s mission is to: conduct research in basic and technological sciences; undertake nationwide integrated surveys on natural resources and ecological environment; provide the country with scientific data and advice for governmental decision-making and undertake government-assigned projects in regard to key S&T problems in the process of social and economic development; initiate personnel training; and promote China‘s high-tech enterprises by its active involvement in these areas.

CAS’s vision is to strive to build itself into a scientific research base at advanced international level, a base for fostering and bringing on advanced S&T talents and a basis for promoting the development of China‘s new and high-tech industries. By 2010, CAS will have about 80 national institutes noted for their powerful capacities in S&T innovation and sustainable development or with distinctive features. Of these, 30 will become internationally acknowledged, high-level research institutions and three to five will be world-class.

CAS’s operational guidelines include catering for national strategic demands and aiming at world science frontiers. Efforts will be made to promote original innovation in scientific research and the innovation and integration of key technologies. This is to scale the heights of world science and technology and make fundamental, strategic and forward-looking contributions to China‘s economic reconstruction, national security and sustainable development.

[62] Mainly drawn from the CAS English website: http://english.cas.cn/
[63] Data updated based on CAS Key Statistical Data (in Chinese), http://www.cas.ac.cn/html/Books/O6121/b1/2008/11.pdf

CAS organisational Charter



Source: CAS Key Statistical Data (in Chinese, http://www.cas.ac.cn/html/Books/O6121/b1/2008/11.pdf)

R&D expenditure by CAS has increased rapidly. In 2007, it was RMB 12.5 billion, of which 33% was basic research, 57.0% applied research and 14.2% development.

CAS's dramatic development in quantity and quality have mainly been supported by the Knowledge Innovation Programme (KIP - see following section).

7.2 CAS Knowledge Innovation Programme (KIP) [64]

7.2.1 The policy process

In the second half of 1997, CAS submitted a report to the Party Central Committee and State Council entitled "Striving to Build Up a National Innovation System to Meet the

[64] http://english.cas.cn/eng2003/page/KIP.asp

Knowledge-Based Economy Era".[65] In February of 1998, the then Chinese President Jiang Zeming gave his instruction in reply: "The Chinese Academy of Sciences has made some proposals and also has a research team. I think support should be given to the Academy to work out some pilot projects, advancing one step ahead of others, in an effort to build up our own innovation system". On 9th June 1998, the first meeting of the Leading Group for Science & Education under the State Council was convened to ratify implementation of the CAS pilot project for KIP. In June 1998, the CAS Pilot Project was formally launched.

7.2.2 KIP: a profile

The pilot project for the Knowledge Innovation Programme (KIP) was formally initiated in 1998 and will be completed by 2010. It can be divided into three phases: the Initial Phase (1998 - 2000); the Phase of All-round Implementation (2001 - 2005); and the Phase of Optimisation (2006 - 2010).

Overall Planning for the KIP pilot project[66]

Under the KIP pilot project, CAS's overall plan for its development was as follows:

1 To restructure about 80 national institutes which have powerful S&T innovation capacity, sustainable development and distinctive features. Thirty of them will become internationally acknowledged, high-level research institutions and three to five will be world-class. These will form the country's knowledge and technology innovation bases up to advanced world level.

a In regard to basic science, this has been targeted at cutting-edge research in some important and strategic areas and achieving creative scientific results of international significance. The overall research level of basic science in China is thus enhanced and China's proportional contribution to the scientific development of the modern world is enlarged.

b In respect of high technology, outstanding research results are to be achieved in areas such as information, biology, advanced materials and manufacturing, new energy sources, space and oceanology, which can promote industrial development in China and make breakthroughs in research work with independently owned intellectual property rights.

c In respect of natural resources, the environment and ecology, its aim is to provide reliable S&T support to national and regional sustainable development. Also to take an indispensible creative research position in the study of earth systems and

[65] An insider's story: the new leadership, Premier Zhu Rongji, decided to invest in CAS. CAS had to undergo a legitimate process.

[66] http://english.cas.cn/eng2003/news/detailnewsb.asp?InfoNo=20965

global environmental change, as well as the nurture and rational utilisation of biological resources.

2 A vigorous training system for high-level S&T personnel will be formed, open to the public and closely linked to the development of scientific research and high technology. This is expected to become a significant national base for the training and nurturing of competent S&T talents.

3 CAS will become China‘s major incubator for the development of high-tech industries by establishing an optimised system and mechanism for the transfer of S&T innovation results and providing the country with research achievements and outstanding scientific personnel on a constant basis.

4 To further strengthen the role of the Academic Divisions of CAS both as the nation‘s highest academic institution in natural science and its top advisory body on S&T issues, making it a major source of ideas for the government in devising important S&T policies and decisions. The integrated advantages of CAS will be fully brought to bear and great emphasis placed on integrating natural sciences, engineering and social sciences. This is an effort to make CAS a national think-tank providing high-quality scientific consultations and deliberations on the strategies and policies on China’s economic and social development and national S&T advancement.

5 To build CAS into a prominent base and source of modern scientific civilisation and innovation culture in China. This can be achieved by: disseminating scientific knowledge, spirit and methodology throughout society; adopting open and networked methods; taking full advantage of the abundant knowledge resources and research facilities at the Academy; and providing effective support and services to S&T innovation activities.

6 To build up CAS as a major representative of China in the international scientific community through further opening to the outside world. To this end, diverse high-level international cooperation and exchanges will be developed in the Academy and active participation in international S&T competition and cooperation and gaining access to international S&T resources promoted.

7.3 Research priorities in CAS

CAS responded to national policy priorities and research priorities identified the MLP and established 10 mission objectives.[67] CAS can apply competitively for all the programmes (Chapters 5 and 6) and earns a large portion of the programmes.

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[67] Richard P. Suttmeier, Cong Cao1, Denis Fred Simon PRIORITIES AND FUNDING: “Knowledge Innovation” and the Chinese Academy of SciencesScience 7th April 2006: vol. 312. no. 5770, pp. 58 – 59.

PRIORITY MISSION AREAS FOR CAS
Information technology
Optical electronics, space science and technology
Advanced energy technologies
Materials science, nanotechnology, advanced manufacturing
Population, health, medical innovation
Advanced industrial biotechnology
Sustainable agriculture
Ecology, environmental protection
Natural resources, ocean technologies
Comprehensive research relying on mega-science facilities

Source: Richard P. Suttmeier, Cong Cao, Denis Fred Simon, PRIORITIES AND FUNDING:"Knowledge Innovation" and the Chinese Academy of Sciences, Science 7th April 2006:Vol. 312. no. 5770, pp. 58 – 59

8 Impact of the financial Crisis' on S&T: Launch of Mega-Engineering Projects Earlier Than Scheduled

8.1 An overview

The financial crisis has captured the attention of scholars, departmental leaders and central government leaders.

Crisis, in Chinese is *weiji* (危机), indicating both danger and opportunity. Lu Yongxiang, president of CAS believes the financial crisis will bring new opportunity for Chinese S&T and that financial crises in history have usually generated radical S&T innovation[68]. Mei Yonghong, a middle-ranking official at MOST in charge of the Department of Policy and Regulations, wrote about indigenous innovation and enlarged domestic demand. The suggestion was for more investment in knowledge generation and diffusion, speeding up the mega-engineering projects and developing the low-carbon economy and bio economy.

MOST held a workshop on how S&T support helps cope with the financial crisis on 1st February 2009. The 258 participants were middle-ranking and more senior officials, the heads of the provincial S&T departments and CEOs of large state-owned enterprises.

The Chinese government has reacted to the financial crisis quickly and proactively. China has launched active policy package to ensure economic growth. Premier Wen Jiabao stated this policy package at the Davos World Economic Forum Annual Meeting 2009 and at the University of Cambridge:

Firstly, launch of the "Four Trillion" Programme. The Chinese Government has announced a two-year investment programme which, through spending, will generate a total investment of RMB 4 trillion nationwide, equivalent to 16% of China's GDP in 2007. The money will mainly go into government-subsidised housing, projects related to the wellbeing of rural residents, the construction of railway and other infrastructural projects, social development programmes, environmental protection and post-earthquake recovery and reconstruction.

Secondly, the launch of a rejuvenation programme for 10 key industries, including automobiles, iron and steel, shipping, the petrochemical industry, textiles, light industry, coloured metals, equipment manufacture, electronics and information and

[68] http://lw.xinhuanet.com/htm/content_4291.htm

logistics. The government is taking economic and technological measures to boost energy conservation and reduce emissions as well as encouraging and supporting the extensive application of new technologies, techniques, equipment and materials plus the development of marketable products by enterprise.

Thirdly, stepping up implementation of the 16 mega-engineering projects including core electronic devices, development and use of nuclear energy and advanced numerically-controlled machine tools.

Fourthly, raising the level of social security. The Chinese government believes that science and technology are of fundamental importance in overcoming the financial crisis. Accordingly, the government is adopting science and technology measures. State Councillor Liu Yandong described these at the Beijing International S&T industry Expo in May, 2009 as follows:[69]

Firstly, provide scientific and technological support to the 10 key industries rejuvenation programme.

Secondly, implementing the 16 mega-engineering projects to boost the domestic demand and to ensure growth.

Thirdly, supporting enterprises to improve their indigenous innovation capability.

Fourthly, promoting the high-tech industry cluster.

Fifthly, strengthening the building of S&T human resources and attracting high-level overseas Chinese talents to return to China.

MOST proposed the "Provide S&T Support to Cope with the Financial Crisis" programme, including implementation of mega-engineering projects earlier than planned.

CAS launched its "Scientific and Technological Innovation Action Plan to Cope with the Financial Crisis and Support Economic Development"[70] including: building pilot programmes (such as a broadband wireless media (BWM) network) and commercial application of major S&T results (laser display technology).

The "Thousand Overseas High-Level Talents" Programme was launched and implemented in 2009, attracting people back to working for China. [71]

In the context of H1N1 influenza, there has been mention of China launching a mega-research and development project on the disease. [72]

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[69] http://www.cnetnews.com.cn/2009/0519/1369625.shtml (in Chinese).
[70] http://www.cas.cn/10000/10010/10005/10001/10008/2009/133177.htm
[71] Jane Qiu, China targets top talent from overseas, 28 January 2009 Nature 457, 522 (2009).
[72] http://www.sciencenet.cn/htmlnews/2009/5/219637.html

8.2 Launch of the mega-engineering projects earlier than scheduled

In reaction to the financial crisis, central government launch the mega-engineering projects. As recently as 13th May, 2009, Premier Wenjia chaired the State Council executive meeting to discuss speeding up implementation of the mega-engineering projects. The meeting announced that central government will invest RMB 32.8 billion this year and RMB 30 billion in 2010 in the 11 mega-engineering projects:

- Core electronic components.
- High-end generic chips and basic software.
- Extra large-scale integrated circuit manufacturing and techniques.
- Next-generation wireless mobile communication.
- Advanced numerically-controlled machinery and basic manufacturing technology.
- Large-scale oil, gas and coal mining.
- Water pollution control and treatment.
- New transgenic biological varieties.
- Drug innovation and development.
- Control and treatment of AIDS, hepatitis and other major diseases.
- Giant planes.[73]

8.3 A Mega-Engineering project case: Drug Innovation and Development[74]

The mega-engineering project, Drug Innovation and Development was officially launched on 5th May, 2009. RMB 5.3 billion will be invested in the project.

The mega-project will be divided into 970 projects. The first phase of 121 projects has been agreed, with funding of RMB 1 billion and the second phase of 849 projects will soon be launched with funding of RMB 4.3 billion. 15,000 experts will participate in these projects.

The CAE academician and Vice Director of the People’s Delegate Congress, Prof. Sang Guowei, is the chief of the mega-project.

According to the Minister of MOST, the goal of the 11th Five-year Plan the mega-project is for:

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[73] http://www.nmp.gov.cn/tpxw/200903/t20090314_1105.htm
[74] http://www.sciencenet.cn/htmlnews/2009/5/218970.html

- New drugs developed by China itself to go to the international market.
- Establishment of a new drug R&D platform and base;
- Establishment of a national drug innovation system.

The project will develop new chemical drugs, new bio drugs and new Chinese traditional medicine.

9 Summary

1. The report has reviewed the process of developing the Chinese medium and long-term plan for science and technology and related policies.
2. The report has reviewed the research priorities and criteria for setting these priorities.
3. The study has revealed that policymaking and priority-setting involves a complex system of different stakeholders (governmental bodies, scientific community, industrial sectors) who are consensus-seeking. MOST and the senior scientists play key roles in the process.
4. Policymaking and priority-setting involve top-down interaction and bottom-up feedback .
5. Policymaking and priority-setting are towards scientification and democratisation. They become open and transparent.
6. The research priority-setting emphasises strategic demand and the world S&T frontier. China believes that S&T will solve the bottleneck of economic, social (and defence) development as well as meeting strategic demand.
7. Policymaking and priority-setting benefits from the foresight studies.
8. National R&D programmes have been established and constitute the most important for funding research priorities. The research priorities can get real financial support.
9. China has reacted proactively to the financial crisis and believes S&T to be effective in coping with the crisis. China has launched the mega-engineering projects earlier than scheduled and with more funding.
10. The Chinese model of policymaking and priority-setting is efficient, although it needs improvement and might learn from the practices of OECD countries.

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