Chapter VIII

The Chinese are clearly inculcating the idea that science is exciting and important, and that's why they, as a whole - they're graduating four times as many engineers as we are, and that's just happened over the last 20 years…
Bill Gates (NPR Radio interview, Morning Edition, 29 Apr, 2005)

8. Science and Technology

The smooth running of China's S&T system and, indeed, the economy as a whole, can be impacted by unstable domestic developments and unexpected external shocks.[1275]

External links:

Institute Links: http://www.most.gov.cn/eng/

Wikipedia:
https://en.wikipedia.org/wiki/Ministry_of_Science_and_Technology_(China)

Alternate Labels:

Aliases: State Science and Technology Commission
Acronyms: MOST

Relationships:

Parent Institutes: State Council of the People's Republic of China
Child Institutes:

- Beijing Municipal Science & Technology Commision
- China National Center for Biotechnology Development
- Chinese Academy of Science and Technology for Development
- Institute of Scientific and Technical Information of China
- National Center for Science and Technology Evaluation
- Shaanxi Science and Technology Department[1276]

Minister of Science and Technology Wang Zhigang

Title: CCP Central Committee Member; Minister of Science and Technology; Party Secretary, Ministry of Science and Technology Party Leadership Group

[1275] China in UNESCO Science Report: Towards 2030" covering China's Section (Pg 621-641) authored by Cong Cao published in 2015, Paris UNESCO, available online at URL:
https://unesdoc.unesco.org/ark:/48223/pf0000235406/PDF/235406eng.pdf.multi
[1276] GRID, Ministry of Science and Technology of the People's Republic of China: grid.424020.0
https://grid.ac/institutes/grid.424020.0

Wang Zhigang

Wang Zhigang serves as minister and party secretary of the Ministry of Science and Technology (MOST), a position he has held since March 2018. Wang had previously served as vice minister of MOST since April 2011, and served as the ministry's party secretary since 2012. He has been a member of the CCP Central Committee since 2012.

Wang Zhigang was born in 1957 and is from Anhui Province. Wang holds a doctorate in management from Tsinghua University, and is a researcher-level senior engineer. Wang spent his early career in state research institutes and state-owned technology companies. He joined China Electronics Technology Group Corporation (CETC) in 2002 as deputy general manager and became general manager and party secretary the next year. From 2008 to 2011, he served as general manager and deputy party secretary of CETC, positions he held until joining MOST.[1277]

Development of S&T

The PRC was formed in 1949 after a major turmoil. In order to develop and rise from the economic condition, China chose the path of 'self-sufficiency' by developing capital goods industry rather than developing 'labour intensive and low capital industries'. The Chinese leadership through Mao Zedong, and later, Deng Xiaoping, through their support for technological development, tied S&T to ideological and political efforts for the development of the country. This made S&T as one of the four areas of modernization in China, which would support the other three, namely agriculture, industry and military. The S&T developments to follow can be divided into four distinct phases: creation of heavy industries (from 1949 to 1959); economic stagnation and ideological domination of technology projects (from 1959 to the end of the Cultural revolution in 1976); building of a research base and the gradual shift to market-oriented, product-driven research (from 1976 to 2001) and the ongoing effort for development of high technology industries, the nascent green technology and innovation (Campbell, 2013). In order to ensure success of their reforms, the S&T policy has been subjected to various changes in both policy and legal regime such that the S&T policy remains 'under construction' to date (Rongping, 2005).

Current S&T Policy

The current S&T policy of China is based on four pillars with priority research areas of new energy, new materials, environmental protection and modern agricultural technologies. The policy sets both quantitative and qualitative targets to be met by 2020. The quantitative targets include the investment of 2.5 per cent of GDP in R&D; reducing China's dependence on imported technologies to 30 per cent; increasing the contribution to economic growth made by technological advances to 60 per cent; joining the world's top five countries in terms of the number of patents granted for domestic inventions and citations in international science papers. The qualitative targets include the promotion of indigenous (Chinese origin) innovation; the achievement of major scientific

[1277] The US-China Business Council: Minister of Science and Technology Wang Zhigang https://www.uschina.org/minister-science-and-technology-wang-zhigang

breakthroughs in targeted areas and making enterprises the driving force of the innovation system. These four pillars are discussed in the subsequent paragraphs.

1. Initiated in 2006 by building on the important policy initiatives of the last 25 years, the 15-year Medium- to Long-Term Plan for the Development of Science and Technology (2006–2020) (MLP, 2006) or the MLP aims to make China into an 'innovation-oriented society' by the year 2020 and a world leader in S&T by 2050. The MLP addresses the four critical problems in China's S&T development, namely, China's dismal record of innovation in commercial technologies; managing social needs (in areas as energy, water and resource utilization, environment protection and public health) through increasingly sophisticated technology; providing for technological innovations for the national defence and matching the quantitative gains in Chinese research with qualitative gains by improving the standard of science in China and to attract Chinese scientists to develop in and for China (Cong, Suttmeier, & Fred, 2006). Like China's previous policies, MLP too continues with the understanding that innovation can be steered by the government. It fails to tackle less tangible and more complex issues such as deficits in social capital, institution-building and building an innovation-friendly environment (Schwaag-Serger, 2007).

2. The Five-year S&T Development Plan or the 13th Five-year Plan on Science, Technology and Innovation, initiated in 2016, focuses on carrying out the innovation-driven development strategy, supporting the supply-side structural reform and creating innovation-driven development models (Newsletter, 2016). The Plan sets out 12 targets, including increasing the contribution of scientific and technological progress from 55.3 per cent to 60 per cent of economic growth and the proportion of output generated by knowledge-intensive services to the GDP from 15.6 per cent to 20 per cent.

3. The Internet Plus action plan, officially unveiled in the 2015 'Government Work Report' (SESEC III, 2015), aims at integrating all industries, including traditional industries. This integration is to use Internet and Information and Communication Technologies (ICT) by integrating mobile Internet, cloud computing, big data and Internet of things with modern manufacturing industry sectors.

4. Made in China (MIC) 2025 (Kennedy, 2015) seeks to bring about a change for China from being a low-end manufacturer to gaining know-how and becoming a high-end producer of goods by achieving leadership in robotics, information technology and clean energy. In order to raise the domestic content of core components and materials to 40 per cent by 2020 and 70 per cent by 2025 and become self-sufficient with an ability to compete in the international market, both direct and indirect State support would be used. The focus of MIC is on the entire manufacturing process, including innovation and market mechanisms (technical standards—domestic, self-declared and international and strengthening IPR protection) with benchmarks as 2013 and 2015 and goals for 2020 and 2025, respectively.

Reforms Due to the S&T Policy

The S&T policy over the years has brought about many reforms in China. These reforms were primarily aimed at reducing or eliminating State funding for research; encouraging formalization of technology markets and encouraging the merging of research institutes and enterprises. The policies that were unleashed gave the perception that S&T was like any other commodity that could be bought and sold in the market. This changed the way S&T had been traditionally viewed in society. The areas these reforms targeted included the powers of decision making in government-owned research institutions, the financial policy, business innovation and market competition mechanism, legislative policies and the human resource policy.[1278]

Science and Technology Policies and Regulations

- Technology Contract Law of the People's Republic of China[1279]
- Product Quality Law of the People's Republic of China[1280]
- Copyright Law of the People's Republic of China[1281]
- Patent Law of The People's Republic of China[1282]
- The Trademark Law of The People's Republic of China[1283]

[1278] Excerpts from article titled "China's Policy on Science and Technology: Implications for the Next Industrial Transition" written by Nitin Agarwala and Rana Divyank Chaudhary published in June 2019, available online at URL: https://www.researchgate.net/publication/334102104_China's_Policy_on_Science_and_Technology_Implications_for_the_Next_Industrial_Transition

[1279] Consulate General of the People's Republic of China in San Francisco, "Technology Contract Law of The People's Republic of China (1987/6/23)", Adopted on June 23, 1987 by the 21st Session of the Standing Committee of the 6th National People's Congress, available online at URL: http://www.chinaconsulatesf.org/eng/kj/wjfg/t43950.htm

[1280] Consulate General of the People's Republic of China in San Francisco, "Product Quality Law of The People's Republic of China (1993.2.22)", Adopted at the 30th Meeting of the Standing Committee of the Seventh National People's Congress on February 22, 1993, promulgated by Order No. 71 of the President of the People's Republic of China on February 22, 1993, and effective as of September 1, 1993, available online at URL: http://www.chinaconsulatesf.org/eng/kj/wjfg/t43949.htm

[1281] Consulate General of the People's Republic of China in San Francisco, "Copyright Law of The People's Republic of China (1990/9/7)", Law adopted at the Fifteenth Session of the Standing Committee of the Seventh National People's Congress on September 7, 1990, available online at URL: http://www.chinaconsulatesf.org/eng/kj/wjfg/t43948.htm

[1282] Consulate General of the People's Republic of China in San Francisco, "Patent Law of The People's Republic of China (1992/9/4)", Adopted at the 4th Session of the Standing Committee of the Sixth National People's Congress on March 12, 1984 .Amended by the Decision Regarding the Revision of the Patent Law of the People's Republic of China, adopted at the 27th Session of the Standing Committee of the Seventh National People's Congress on September 4, 1992, available online at URL: http://www.chinaconsulatesf.org/eng/kj/wjfg/t43947.htm

[1283] Consulate General of the People's Republic of China in San Francisco, "The Trademark Law of The People's Republic of China (1993/2/22)", Adopted at the 24th Session of the Standing Committee of the Fifth National People's Congress on August 23, l982, and amended according to the "Decision on the Revision of the 'Trademark Law of the People's Republic of China", adopted at the 30th Session of the Standing Committee of the Seventh National People's Congress on February 22, 1993, available online at URL: http://www.chinaconsulatesf.org/eng/kj/wjfg/t43946.htm

Outline of the National Medium and Long-Term Science and Technology Development Plan (2006-2020)

On February 9, 2006 the State Council presented its plan to strengthen China's scientific and technological (S&T) progress in the coming fifteen years.[1284] The announcement of the plan was eagerly awaited both within and outside of China for several reasons. This announcement marks not only China's first long-term plan in the new century but also the first plan China presented since becoming a member of the World Trade Organization (WTO) and since President Hu Jintao and Prime Minister Wen Jiabao came to power in 2003. For the international community, the plan indicates how Beijing aims to strengthen China's future economic and technical development undoubtedly having a profound impact on the rest of the world. The plan warrants careful analysis because it reflects Beijing's ambitions to make China one of the world's most important knowledge bases. Also of importance is that the plan contains an explicit target to reduce China's dependence on foreign research and development as well as to use public procurement to strengthen China's domestic industry. Additionally, rather than using the word jihua (plan) which had been used for previous long-term strategies the State Council made a point of using the word guihua, or long-term "program," distancing the plan from the notion of a traditional "plan economy." In practice, however, many government offices including the homepage of the Ministry of Science and Technology (MOST) still refer to the long-term "plan".[1285]

The official title of the plan is "**The National Program 2006–2020 for the Development of Science and Technology in the Medium and Long Term**" (Guojia zhong changqi kexue he jishu fazhan guihua gangyao 2006–2020). In typical Chinese fashion, the government summarizes the plan with four sets of four characters representing four concepts: independence (autonomy or indigenous development) innovation, breakthrough, national development, and future. Speaking at the Fourth National Conference on Science and Technology on January 9, 2006 Wen Jiabao summarized the plan's ultimate goals for China to achieve by 2020:

- to develop technologies related to energy and water resources and environmental protection
- to master core technologies in information technology (IT) and production technology
- to catch up with the most advanced nations in selected areas within biotechnology
- to raise the pace of development in space and aviation technology as well as oceanology
- to strengthen both basic and strategic research. [1286]

[1284] Xinhua News Agency dated February 9, 2006 titled "Outline of the National Medium- and Long-Term Science and Technology Development Plan (2006-2020)" available online at URL: http://www.gov.cn/jrzg/2006-02/09/content_183787.htm
As referred in article titled "China's Fifteen-Year Plan for Science and Technology: An Assessment" written by Sylvia, Schwaag Serger published in Asia Policy Journal, Number 4, (July 2007), Pg: 135–164, LUND University, Sweden, available online at URL: https://lucris.lub.lu.se/ws/files/5663330/1388869.pdf
[1285] Excerpt from article titled "China's Fifteen-Year Plan for Science and Technology: An Assessment" written by Sylvia, Schwaag Serger published in Asia Policy Journal, Number 4, (July 2007), Pg: 137, LUND University, Sweden, available online at URL: https://lucris.lub.lu.se/ws/files/5663330/1388869.pdf
[1286] "Innovation 'Motive Power for Development,'" Chinese Government's Official Web Portal, January 11, 2006, http://www.gov.cn/english/2006-01/11/content_220696.htm.

- The plan is also characterized by tendencies toward so-called techno nationalism. One concrete objective aims to reduce China's dependence on foreign technology to less than 30% (the current figure is 60%).[1287]

Other Developments of S&T

Xinhua News Item dated **July 20, 2016 Titled "China to become innovation powerhouse by 2020"** mentioned that Premier Li Keqiang urges deepening reform and encouraging the enthusiasm of scientific and technological workers to build China into an innovation-driven country and a leading power in science and technology at the national conference on science and technology on May 30, 2016. It further added that China aims to become an innovation powerhouse by 2020, according to a newly adopted national plan on scientific and technological innovation during the 13th Five-Year Plan (2016-2020). The plan was passed at the State Council executive meeting on July 20, chaired by Premier Li Keqiang. "This is the first sub-plan under the 13th Five-Year Plan that was held for discussion, which fully demonstrates that we're giving top priority to innovation," Premier Li said. According to the plan, China is to further advance its global ranking in innovation competence, with the country's combined efforts in enhancing original innovation, building key science innovation parks, and attracting top-tier science and technology researchers. The Ministry of Science and Technology spent two years drafting the plan and sought suggestions from related departments during the process. According to the new plan, China will start implementing a series of key scientific and technological innovation projects. The plan also stressed research emphasis on areas that will contribute to China's industrial upgrading and new economy, including modern agriculture, clean and efficient energy, and mobile telecommunication. Innovation zones will be established according to the plan, with Beijing and Shanghai pioneering the effort. "Science and technology innovation should always keep a close eye on their application," Premier Li said.

The government has, since 2013, repeatedly highlighted the importance of innovation, providing support and encouraging mass innovation and business start-ups. Innovation is of vital importance as the economy is shifting from one driven by investment and manufacturing to one more consumption-based and service-focused. Figures from the National Bureau of Statistics show that in the first half of 2016, consumption contributed 73.4 percent to national GDP growth. Business start-ups in China with innovative ideas and investment have been flourishing in recent years. Some indigenous innovations have greatly changed people's lives, such as the mobile messaging app We Chat, offering a user experience that can rival international competitors.

The plan also singles out measures to tackle particular obstacles that have long been hindering science and technological innovation, such as a more systematic technological

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As referred in article titled "China's Fifteen-Year Plan for Science and Technology: An Assessment" written by Sylvia, Schwaag Serger published in Asia Policy Journal, Number 4, (July 2007), Pg: 145, LUND University, Sweden, available online at URL: https://lucris.lub.lu.se/ws/files/5663330/1388869.pdf

[1287] Zhongping Lin, "The Influence of MNCs upon China's Independent Innovation Capacity," Zhongguo keji touzi [China Venture Capital], May 2006, 40–43, http://www.cvcht.com/

As referred in As referred in article titled "China's Fifteen-Year Plan for Science and Technology: An Assessment" written by Sylvia, Schwaag Serger published in Asia Policy Journal, Number 4, (July 2007), Pg: 162, LUND University, Sweden, available online at URL: https://lucris.lub.lu.se/ws/files/5663330/1388869.pdf

transfer from research institutions to companies, reform of the management system for science and technology, better coordination to improve resource distribution as well as IPR protection. “The case for overhauling science and research systems and generating greater enthusiasm among science and technology researchers is very strong if we mean to enable true breakthroughs in innovation,” Premier Li said.[1288]

The Chinese people have been inspired by the famous saying three decades ago: "Science and technology are primary productive forces," and are now promoting innovation to achieve continuous development. Over the past few years, the Chinese have been inspired by the country's landmark achievements in science and technology. China successfully cloned macaques from somatic cells, launched the world's first quantum satellite and quantum experiments at space scale, and created the **world's fastest supercomputers Sunway TaihuLight and Tianhe-2**. There were 3.87 million scientists and researchers across China in 2016.

China has set the aim of becoming an "innovation nation" by 2020, an international leader in innovation by 2030, and **a world powerhouse in scientific and technological innovation by 2050.** Cities nationwide are also joining the race. Guiyang, capital of Southwest China's Guizhou province, has become a pioneer in the application of big data technology, using cloud computing to develop modern agriculture. Shenzhen in South China's Guangdong province, the pioneer city in innovation for the past 40 years, has set the goal to become a world-class sustainable innovative city by 2035. The Global Innovation Index has shown that China rose three places to 22nd on the list of the world's most innovative nations in 2017, the only middle-income country to join the top 25 innovative economies.[1289]

Another **China Daily** News item dated **May 17, 2017** Titled **“Tianhe-3 to offer faster, sharper data processing”** reported that China is stepping up research and development of the **Tianhe-3 supercomputer**, which aims to be 10 times faster than the current world leader, as it strives to meet the country's growing needs for more accurate and efficient computing capabilities.

The Tianhe-3 is designed as the world's first prototype exascale supercomputer, which means it can make a quintillion (1 followed by 18 zeros) calculations per second, and is intended to arm the country's manufacturers and government with greater speed, precision and scope for research. The supercomputer will be applied in such fields as the analysis of smog distribution, airplane designs, oil surveying and the development of artificial intelligence. The United States is working on an exascale supercomputer, but its prototype will not appear until 2023. Japan is building a machine that can make 130 quadrillion calculations per second, which could surpass Sunway TaihuLight. Wang Gang, an associate professor at the College of Computer Science and Technology of Jilin University, said China's supercomputers are chiefly used to assist scientific research, which need to process a huge amount of information within a short time span. "But as the Tianhe-3 improves AI capabilities, it will not only calculate faster but also smarter. It will

[1288] Xinhua News Item dated July 20, 2016 Titled “China to become innovation powerhouse by 2020” edited by Zhang Yue, available online at URL:
http://english.www.gov.cn/premier/news/2016/07/20/content_281475398183151.htm

[1289] Excerpts from China Daily News Item dated March 13, 2018 titled “ Innovation key to make Chinese growth more innovative, competitive” available online at URL:
http://www.chinadaily.com.cn/a/201803/13/WS5aa7377ea3106e7dcc1414cf.html

therefore have greater potential in terms of commercial application," Wang said. Wang is working on a deep-learning project for autonomous driving. He has used the Sunway Taihu Light supercomputer to assist his research, and expects the Tianhe-3 to be more helpful.[1290]

Shine Agency News Item dated **March 05, 2020** titled **"5G said to create 3 million jobs by 2025"** reported that China's 5G network and related investment will hit 3.5 trillion Yuan (US$504 billion) and create 3 million jobs by 2025 to become a catalyst and key part of the national economy, a researcher with China's top industry regulator said. By 2025, direct investment in 5G network construction will hit 1.2 trillion Yuan. The 5G network upgrade on industrial Internet spending will hit 500 billion Yuan by 2025, as well as upgrade in other industries such as transportation, energy and agriculture, which will take total 5G-related investment to 3.5 trillion Yuan by 2025, said the China Academy of Information and Communications Technology (CAICT) , a research organization under the ministry.

It will fuel smart and digitalized business transformation and boost economic development in a more innovation-driven way, said Wang Zhiqin, CAICT's vice director. China's 5G industry will directly create over 3 million jobs by 2025, with booming and new information consumption services valued at over 8.3 trillion Yuan. The 5G-fueled services will include high-definition video and virtual reality services. The 5G network offers users 20 to 50 times faster Internet access compared with current 4G networks, with much lower latency. China Mobile, China Unicom and China Telecom are speeding up 5G network construction nationwide to offer better coverage. China Mobile plans to build 300,000 5G base stations nationwide to cover all cities in China in 2020. In Shanghai, 5G services have been available since November. In February, China Mobile's Shanghai branch offered upgraded services in hospitals and online classrooms. For example, it has adopted a new device called Easy Macro 3.0 to offer smooth 4G and 5G signals in Punan Hospital in the Pudong New Area, a front in the COVID-19 fight.[1291]

China produced more than twice as many materials science papers than the next most-prolific country, the United States, in 2017. The country enjoys strong academic collaborations nationally and internationally, as well as a focus on applied and medical sciences when it comes to the materials being made. Funding for materials science in China has quadrupled since 2008. Learn how the country is using its strength in materials to advance knowledge and to solve many of its domestic problems including its ageing population and its polluted manufacturing sector.[1292]

8.1 Historical

In ancient China, the three most mature technologies were ceramic as the Chinese Pottery, textile as Chinese Silk, and architecture as Great Wall of China; the four great

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[1290] Excerpts from China Daily News item dated May 17, 2017 Titled "Tianhe-3 to offer faster, sharper data processing", written by Zhang Min and Ma Si, available online at URL: http://www.chinadaily.com.cn/a/201705/17/WS59bbe667a310ded8ac18af84.html

[1291] Shine Agency News Item dated March 05, 2020 titled "5G said to create 3 million jobs by 2025", written by Rich Zhu, available online at URL: https://www.shine.cn/biz/tech/2003053539/

[1292] Nature Research Journal's spotlight titled "Material Research in China," dated March 20, 2019, available online at URL: https://www.nature.com/collections/ibhfgfdhjb