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Chinese System of Science & Technology and Cooperation in Science & Technology between Thailand and China[1]

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Abstract

This paper intends to fill a gap in the literature on the past performance and future development of cooperation in science and technology (S&T) between China and one of its Southeast Asian neighbours, Thailand. It is divided into two parts: the first part looks at the system of science and technology in China. After an introduction on China's position in science and technology *vis-à-vis* leading countries of the world, it then presents: 1) the organizational structure of Chinese S&T system in terms of major players and sources of funds, 2) its vision for the future, 3) its leading sectors, and 4) its geographic distribution. The second part of the paper discusses the cooperation in S&T between Thailand and China. It covers: 1) key players and mechanism of international S&T cooperation in China, 2) sources of research and development (R&D) funds in Thailand, and 3) major mechanism and areas of S&T cooperation between Thailand and China. The strategic values of S&T cooperation between the two countries are found to be: 1) China as a source of funds and technology, 2) strength of Thailand in selected areas, such as agriculture and medicine, 3) common problems in economic and social development to be resolved by S&T, and 4) position of Thailand as a gateway towards continental ASEAN. The paper concludes that the past performance of S&T cooperation has laid down a strong foundation for the future. The strategic values of S&T cooperation can be fully realized with the development of promising sectors in strategic locations with prospective partners and through potential mechanisms.

Keywords: *cooperation in science and technology, China, Thailand*

1. The Motives of China Proposing the 21st Century Maritime Silk Road

Economic relationship between Thailand and China has attracted increasing attention in the literature, especially in light of industrial capacity cooperation

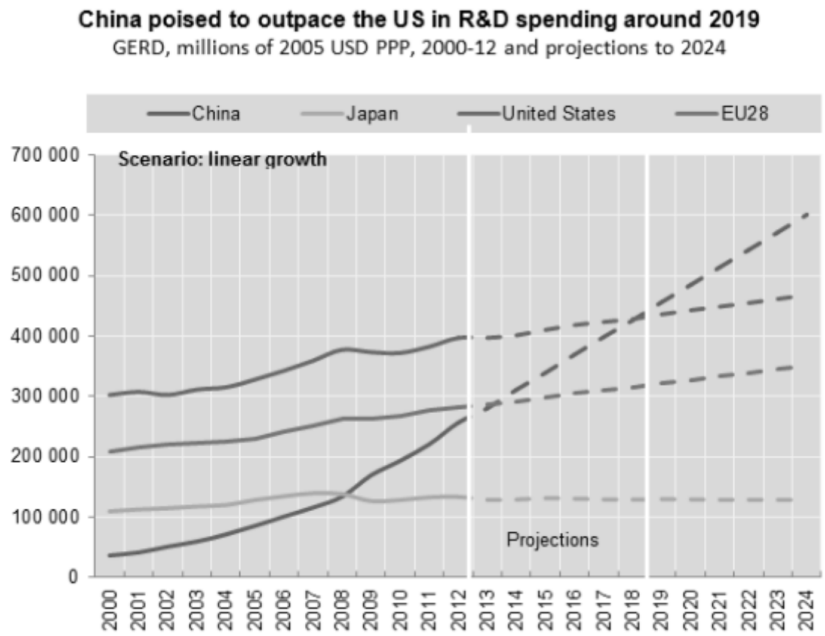
between China and ASEAN and the Chinese One Belt One Road initiative. There is also increasing interest in the innovation capability of Chinese firms (Yip and McKern, 2016). One less covered area, however, is the cooperation in science and technology (S&T) between the two countries. This paper intends to fill this gap with an analysis on its past performance and suggestions for future development.

2. Part I: System of Science and Technology in China

2.1. China as a Rising Power in the World of S&T

China is a rising power in the world of S&T. On the input side, it spent US$220 billion or 2.1% of its gross domestic product (GDP) on R&D in 2015. According to a report by the Organisation for Economic Co-operation and Development (OECD), the size of China's R&D expenditure is second in the world in purchasing power parity (PPP) term and is expected to surpass the USA in 2019 (Figure 1). China also has the most R&D human resource in the world, with 1.52 million FTE (full time equivalent) R&D researchers (Table 1), even though its R&D researchers per 10,000 employment still lags behind leading countries in the world (CASTED, 2015).[2]

Figure 1 Gross Expenditure on R&D of China



Source: *OECD Science, Technology and Industry Outlook 2014*.

Table 1 R&D Human Resource in China and Thailand*

Country	*R&D Researcher FTE (mil.)*	*R&D Researcher /10,000 employment*
China	1.52	19.7
USA	1.27	87.4
Japan	0.68	104.7
Russia	0.44	62.2
Germany	0.36	84.2
South Korea	0.35	134.9
Thailand	0.06	9.0

Note: * 2014 figures, except for Thailand which is for year 2012.
Source: *OECD Science, Technology and Industry Outlook 2014* and Ministry of Science and Technology (MOST), Thailand.

On the output side, China is one of the frontrunners in terms of patent for invention and SCI (Science Citation Index). In 2015, it ranked among the top 2 in the world in SCI in seven subject areas (Agriculture, Chemistry, Computer, Engineering, Material Science, Mathematics and Pharmaceutical). It is also ranked No. 1 in terms of patent application and No. 2 in terms of patent granted among all countries for patents registered in China.[3]

2.2. The Structure of Chinese S&T System

The S&T system in China can be understood in terms of its major players and sources of funds.

2.2.1. Major Players

The major players in the S&T ecosystem spans from national and provincial level units, cross-unit platforms, to enterprises, universities and research institutes. At the national level, the top policy maker is "The Leading Group of National Science and Education" (国家科技教育领导小组), a cross ministry steering group chaired by the Prime Minister. While the Ministry of Science & Technology (MOST) (科技部), makes plans, issues policies and regulations on S&T of the civil side, the State Administration of S&T & Industry for National Defense (SASTIND) (国家国防科工局) plans and regulates R&D and related industry on the side of national defence.

Besides MOST and SASTIND, other ministries and commissions such as the Ministry of Education and Ministry of Industry & Information also manage S&T resources under their jurisdiction.[4] Other important

organizations at the national level may also include the Chinese Academy of Science (CAS) (中国科学院), Chinese Academy of Engineering (CAE) (中国工程院), and China Association of Science & Technology (CAST) (中国科协). The CAS which plays a very important role in S&T cooperation between Thailand and China is China's highest academic body in science, with 12 local academies and 114 research institutes.[5] The CAE, on the other hand, is the highest honorary and consulting body for engineering. Similar to CAS, it has a fellow (院士) system. However it does not have its own research institutes. The CAST is a public organization for S&T workers in China.

Most national level organizations have their subordinate units at the provincial and local level, such as the Department of S&T at provincial and municipal levels reporting to MOST, and local academies of CAS. At the grassroots level, S&T resources are distributed in three groups: (1) state-owned universities, research institutes reporting to MOST, SASTIND, other ministries and commissions, CAS, provincial or local governments, (2) state-owned enterprises especially those qualified as High & New Technology Enterprises (HNTE),[6] (3) the private sector: private universities, private research institutes and private firms that qualified as HNTE.

Some enterprises, universities and research institutes are certified to set up cross unit platforms such as State Key Laboratory (国家重点实验室) for R&D activities and State Incubator (国家级孵化器) for turning innovation into business startup. Another kind of platform is the State High & New Technology (HNT) Industry Development Zone (国家高新技术产业开发区) set up by provincial or local governments, where special policy incentives are given to qualified HNT firms.

2.2.2. Sources of Funds

There used to be two major sources of funds for R&D at the national level: a) various funds from the S&T Plan of MOST (科技部科技计划) (Table 2), and b) "National Natural Science Foundation" (NNSF) (国家自然科学基金) (Table 3).

In 2015, these funds were consolidated into a system of five categories, namely: (1) National Natural Science Foundation (国家自然科学基金), (2) State S&T Special Program (国家科技重大专项), (3) State Key R&D Plan (国家重点研发计划), (4) Technology Innovation Guidance Special Program (技术创新引导专项), and (5) Base & Talent Special Program (基地和人才专项).[7]

Other sources of funds include: departments of the central government beside MOST, provincial and local governments, self-raised funds by universities, research institutes and enterprises, as well as foreign funds from international projects.

Table 2 Structure of Funding in the S&T Plan of MOST

Category	*Program*
State Program	国家科技重大专项 State S&T Major Project 国家重点基础研究发展计划 (973) State Basic Research Program (973) 国家高技术研究发展计划 (863) State High Technology Research and Development Program (863) 国家科技支撑计划 The State Key Technology R&D Program 国家国际科技合作计划 State International S&T Cooperation
Policy Guidance Program	星火计划 Spark Program (rural development) 火炬计划 Torch Program (commercialization) 国家重点新产品计划 State Key New Product Program 国家软科学研究计划 State Soft Science Research Program
S&T Innovation Base Program	国家（重点）实验室 State Key Laboratory 国家科技基础条件平台 State ST Basic Platform 国家工程技术研究中心 State Engineering Technology Research Centers
Other Special Funds	科技型中小企业技术创新基金 S&T Oriented SME Technology Innovation Fund 科研院所技术开发研究专项资金 Technology Development Fund for Research Institute 农业科技成果转化资金 Fund for Application of Research Findings in Agriculture 科技富民强县专项行动计划 Specific Project for Enriching People and Strengthening County Economy with ST 科技基础性工作专项 Specific Project for S&T Infrastructure 国家磁约束核聚变能发展研究 State Research on Magnetic Confinement Fusion 国家重大科学仪器设备开发专项 State Special Project for Key Scientific Instrument & Equipment 科技惠民计划 Special Funds for S&T Program of Public Wellbeing

Source: S&T Plan of MOST, China.

Table 3 Structure of National Natural Science Foundation (NNSF)

Program	*No. of Projects*
面上项目 General Project	16709
重点项目 Key Project	625
重大项目 Big Project	20
重大研究计划项目 Big Research Plan	420
重点国际（地区）合作研究项目 Key International Cooperation	105
人才项目系列的青年科学基金项目 Youth Science Foundation	16155
地区科学基金项目 Regional Science Foundation	2829
优秀青年科学基金项目 Excellent Youth Science Foundation	400
国家杰出青年科学基金项目 State Distinguished Youth	198
创新研究群体项目 Innovation Group	38
海外及港澳学者合作研究基金项目 Oversea Scholar	136
国家重大科研仪器研制项目 State Key Equipment	5
联合基金项目 Joint Foundation	580
外国青年学者研究基金项目 Foreign Youth Foundation	107
国际（地区）组织间合作交流项目 International Organizations	384

Source: National Natural Science Foundation (NNSF), China 2013.

2.3. The Vision for the Future

It is interesting to note how the above mentioned policy makers and practitioners in Chinese S&T system would view its future direction. Such a vision for the future is laid out in two important policy documents.

The first document is the State Council "Outline of National Mid & Long Term Development Plan for S&T 2006-2020" (国家中长期科学和技术发展规划纲要) published in 2006. It sets out 11 main areas (e.g. energy, water and mineral resources), 13 major programs (e.g. core electronic devices, high-end generic chips and basic software), and 8 cutting-edge technologies (e.g. biotechnology and information technology) (Table 4) for S&T development in China.

The second is the one recently issued by the Central Committee of CPC and State Council in 2016: "Outline of National Strategy for Innovation Driven Development (国家创新驱动发展战略纲要)". It envisages a three step development strategy with three milestones: to build China as an "innovation oriented country" in 2020, a "leading innovation oriented country" in 2030 and a "world power of S&T innovation" in 2050 (Table 5).

Table 4 Main Areas, Major Programs, and Technology in Development Plan for S&T 2006-2020

11 Main Areas	1) 能源 Energy 2) 水和矿产资源 Water and Mineral Resources 3) 环境 Environment 4) 农业 Agriculture 5) 制造业 Manufacturing Industry 6) 交通运输业 Transportation Sector 7) 信息产业及现代服务业 Information Industry and Modern Service Industry 8) 人口与健康 Population and Health 9) 城镇化与城市发展 Urbanization and City Development 10) 公共安全 Public Security 11) 国防 National Defense
13 Major Programs	1) 核高基 Core Electronic Devices, High-end Generic Chips Basic Software 2) 大规模集成电路装备 Super Large-scale Integrated Circuit 3) 新一代宽带移动通信 Next Generation Broadband Mobile Telecommunication 4) 高档数控机床制造技术 High-end Numerically Controlled Machine Tools 5) 大型油气煤层开发 Development of Large Oil-gas Fields & Coal-bed Methane 6) 大型核电站 Large Advanced Reactor Nuclear Power Station 7) 水体污染治理 Water Body Contamination Control and Treatment 8) 转基因生物新品种培育 New Genetically Modified Varieties 9) 重大新药创制 Major New Drugs Discovery 10) 重大传染病防治 Prevention and Treatment of Major Infectious Diseases 11) 大型飞机 Large Passenger Aircrafts 12) 高分辨率对地观测系统 High Resolution Earth Observation Systems 13) 载人航天与探月工程 Manned Space Flights & Moon Probe
8 Cutting-edge Technologies	1) 生物技术 Biotechnology 2) 信息技术 Information Technology 3) 新材料技术 Advanced Materials Technology 4) 先进制造技术 Advanced Manufacturing Technology 5) 先进能源技术 Advanced Energy Technology 6) 海洋技术 Marine Technology 7) 激光技术 Laser Technology 8) 空天技术 Aerospace Technology

Source: State Council: Outline of National Mid & Long Term Development Plan for S&T 2006-2020.

Table 5 Three Step Development Milestone of S&T in China

Year	*Milestone*	*Target*
2020	Innovation oriented country	A few industries in mid to high value chain R&D 2.5% of GDP, S&T contribution >60% Knowledge intensive service 20% GDP Independent innovation of key technology
2030	A leading innovation oriented country	Main industries in mid to high value chain S&T from follow-up, going side by side to leading R&D 2.8% of GDP
2050	A world power of S&T innovation	Leading in S&T and national defence World leading universities, research institutes and innovative companies

Source: Central Committee of CPC and State Council (2016), Outline of National Strategy for Innovation Driven Development.

2.4. Leading Sectors of S&T in China

China is a very unique country in S&T development. While the government expects only a few of its industries to be in the mid to high position of the value chain by 2020 in the national strategy discussed earlier, China does have quite a few world class S&T achievements. Besides the country is very quick to absorb and adept western technology in the context of the developing world. Both features make cooperation with China in S&T attractive for other developing countries like Thailand.

China's world class achievement is well summarized in a recent speech by President Xi Jinping in the national S&T innovation forum.[8] In the speech he named 10 "World Class Achievements in Basic Science" (e.g. "theory of continental origin of oil" and "artificially synthesized bovine insulin") and 13 "Breakthroughs in Technology & Engineering" (e.g. "atomic & hydrogen bomb, and satellite" and "supper hybrid rice") (Table 6).

The large treasury of S&T achievements in China could be discovered in the following database: (a) the list of five state S&T awards (国家最高科学技术奖), e.g. "State Natural Science Award", and "State Technological Innovation Award";[9] (b) database of achievements in the S&T plan of MOST, which records the achievement in the funding through the S&T plan as discussed above, classified by subject areas;[10] and (c) database of national S&T commercialization projects listed in industrial sectors.[11]

Table 6 World Class Achievements and Breakthrough in S&T in China

World Class Achievement in Basic Science (10)	Theory of continental origin of oil 陆相成油理论 Artificially synthesized bovine insulin 人工合成牛胰岛素 Theory of several complex variables 多复变函数论 High temperature superconductivity 高温超导 Neutrino Physics 中微子物理 Quantum anomalous Hall effect 量子反常霍尔效应 Nanotechnology 纳米科技 Stem-cell research 干细胞研究 Biomarkers for early diagnosis of cancer 肿瘤早期诊断标志物 Human genome sequencing 人类基因组测序
Breakthrough in Technology & Engineering (13)	Atomic & hydrogen bomb, satellite 两弹一星 Supper hybrid rice 超级杂交水稻 Chinese-character laser phototypesetting 汉字激光照排 High-performance computer 高性能计算机 Three Gorges Project 三峡工程 Manned space flight 载人航天 Lunar exploration 探月工程 Mobile communication 移动通信 Quantum communication 量子通讯 Beidou navigation 北斗导航 Manned deep submergence 载人深潜 High-speed railways 高速铁路 Aircraft carrier 航空母舰

Source: Xi Jinping, "Strive for Building a World S&T Power" (为建设世界科技强国而奋斗), Speech delivered on the National S&T Innovation Forum on 30 May 2016.

2.5. Geographic Distribution of S&T Resource in China

S&T resources in China, however, are unequally distributed geographically. For example, the top five provincial units (Guangdong, Jiangsu, Zhejiang, Shandong and Beijing) account for 51% of R&D personnel in the country (Table 7). The top five provincial units (Guangdong, Beijing, Jiangsu, Shanghai and Zhejiang) account for 54% of patent invention in the country.[12] These provincial units also accounted for the highest R&D expenditure in China (Table 8).

Table 7 R&D Personnel by Provincial Units in China

Provincial Unit	*R&D Personnel 1000*	*Provincial Unit*	*R&D Personnel 1000*
广东 Guangdong	501.7	黑龙江 Heilongjiang	62.7
江苏 Jiangsu	466.2	重庆 Chongqing	52.6
浙江 Zhejiang	311.0	山西 Shanxi	49.0
山东 Shandong	279.3	吉林 Jilin	48.0
北京 Beijing	242.2	江西 Jiangxi	43.5
上海 Shanghai	165.8	广西 Guangxi	40.7
河南 Henan	152.3	内蒙古 Inner Mongolia	37.3
湖北 Hubei	133.1	云南 Yunnan	28.5
福建 Fujian	122.5	甘肃 Gansu	25.0
安徽 Anhui	119.3	贵州 Guizhou	23.9
四川 Sichuan	109.7	新疆 Xinjiang	15.8
湖南 Hunan	103.4	宁夏 Ningxia	8.2
天津 Tianjin	100.2	海南 Hainan	7.0
辽宁 Liaoning	94.9	青海 Qinghai	4.8
陕西 Shaanxi	93.5	西藏 Tibet	1.2
河北 Hebei	89.5	TOTAL	3532.8

Source: MOST 2015, China Science and Technology Statistics Data Book 2014.

Table 8 R&D Expenditure by Provincial Units in China

Provincial Unit	*R&D exp. (billion RMB)*	*Provincial Unit*	*R&D exp. (billion RMB)*
江苏 Jiangsu	148.7	重庆 Chongqing	17.7
广东 Guangdong	144.4	黑龙江 Heilongjiang	16.5
北京 Beijing	118.5	山西 Shanxi	15.5
山东 Shandong	117.6	江西 Jiangxi	13.6
浙江 Zhejiang	81.7	吉林 Jilin	12.0
上海 Shanghai	77.7	内蒙古 Inner Mongolia	11.7
湖北 Hubei	44.6	广西 Guangxi	10.8
辽宁 Liaoning	44.6	云南 Yunnan	8.0
天津 Tianjin	42.8	甘肃 Gansu	6.7
四川 Sichuan	40.0	贵州 Guizhou	4.7
河南 Henan	35.5	新疆 Xinjiang	4.6
安徽 Anhui	35.2	宁夏 Ningxia	2.1
陕西 Shaanxi	34.3	海南 Hainan	1.5
湖南 Hunan	32.7	青海 Qinghai	1.4
福建 Fujian	31.4	西藏 Tibet	0.2
河北 Hebei	28.2	TOTAL	1184.7

Source: MOST 2015, China Science and Technology Statistics Data Book 2014.

Each provincial unit, however, has its unique potential for S&T co-operation with Thailand. It could be discovered through the three database mentioned above: (a) the list of national S&T award winner in provincial units, (b) database of achievements in the S&T plan of MOST, classified in provincial units, (c) database of national S&T commercialization projects listed in provincial units, plus (d) list of HNT development zone & HNT enterprise in provincial units (see more information on HNT in Appendix B).

3. Part II: Cooperation in S&T between Thailand and China

3.1. Key Players and Mechanism of International S&T Cooperation in China

China's position of S&T at the global stage is also strengthened by its active involvement in international S&T cooperation.

At the national level, international S&T cooperation of China is led by the Department of International Cooperation (DIC) of the Ministry of Science and Technology (MOST) (科技部合作司) and a semi-government body called the China S&T Exchange Center (CSTEC) (中国科学技术交流中心). The cooperation is carried out through two major mechanisms: funding and international cooperation base.

The major funding come through the "State International S&T Co-operation Program" (国家国际科技合作专项) of MOST. The program supported 410 projects with a total budget of RMB5 billion in 2013.[13] Another important source of fund is the "National Natural Science Foundation" (NNSF) (国家自然科学基金). For example in 2013, it supported 105 projects in the program of "Key International Cooperation" (重点国际 (地区) 合作研究项目), 136 projects in the program of "Research Foundation for Oversea Scholar" (海外及港澳学者合作研究基金项目), 107 projects in the program of "Foreign Young Scholar Foundation" (外国青年学者研究基金项目), and 384 projects in the program of "Cooperation with International Organizations" (国际（地区）组织间合作交流项目).[14] There is also an annual "International S&T Cooperation Award" (国际科学技术合作奖) among the five prestigious state awards for science and technology.[15]

Another important mechanism is the "International S&T Cooperation Base" established by local governments, enterprises, universities and research institutes and certified by MOST. They include the "International Innovation Park" (国际创新园), "International Joint Research Center" (国际联合研究中心), "International Technology Transfer Center" (国际技术转移中心), and "International S&T Cooperation Demonstration Base" (示范型国际科技合作基地) (Table 9). These bases provide space, lab & equipment and serve as platforms for international cooperation.

Table 9 International S&T Cooperation Base in China (2015)

Base	*Number*	*Example*
International Innovation Park 国际创新园	25	北京国家生物医药国际创新园 Beijing National Biological Medicine International Innovation Park, 2013 Beijing Economic Technology Development Zone
International Joint Research Center 国际联合研究中心	131	干细胞国际联合研究中心 Stem cell International Joint Research Center Peking University, 2007
International Technology Transfer Center 国际技术转移中心	34	中国-东盟国际技术转移中心 China ASEAN International Technology Transfer Center Guangxi ST Information Network Centre, 2013
International S&T Cooperation Demonstration Base 示范型国际科技合作基地	359	成都中医药大学国际科技合作基地 Chengdu University of Traditional Chinese Medicine International S&T Cooperation Base, CDUCTM, 2007

Source: Chinese International S&T Cooperation Base <http://www.cistc.com>.

3.2. Sources of R&D Funds in Thailand

From the Thai side, cooperation in S&T with China is supported by various sources of R&D funds. They include funding from the "National Research Council of Thailand" (NRCT) and "Thailand Research Fund" (TRF), autonomous agencies and public organizations of MOST (such as NSTDA, TISTR, GISTDA, and BIOTEC), other ministries (such as MUA, MOI, MOAC, and MOPH[16]), and private sectors (Table 10).

3.3. Major Mechanism and Areas of S&T Cooperation between Thailand and China

The full fledge S&T cooperation between Thailand and China can be dated back to 1978 when an inter-government joint committee was setup. Today there are two major coordination mechanisms between the countries: the Inter-Government Joint Committee and the Inter-Department Joint Committee.

The Inter-Government Joint Committee was set up in 1978 and had held 21 meetings by 2014. The counterparts are the Ministry of Science

Table 10 Selected Sources of R&D Funds in Thailand

BIOTEC	National Center for Genetic Engineering & Biotechnology (under NSTDA)
GISTDA	Geo-information & Space Technology Development Agency
HSRI	Health System Research Institute
NIA	National Innovation Agency
NRCT	National Research Council of Thailand
NSTDA	National Science & Technology Development Agency
TCELS	Thailand Center of Excellence for Life Sciences
TISTR	Thailand Institute of Science & Technology Research
TRF	Thailand Research Fund

Source: Author's compilation.

& Technology (MOST) of China and Ministry of Foreign Affairs (MOFA) of Thailand. Its recent focus includes: agriculture, energy, public health, traditional medicine, innovation, IT and scientific cooperation in the GMS (Greater Mekong Subregion). Its major instruments include joint research and personnel exchange programs.

The Inter-Department Joint Committee was set up recently in 2013 and had held three meetings by 2016. The counterparts are Ministry of Science & Technology (MOST) of both countries. Its major instruments are 6 working groups, namely, "Thailand-China Joint Research Center on Railway System", "Space Technology Application", "Technology Transfer Center", "Talented Young Scientists Program (TYSP) ", "New and Renewable Energy Cooperation", and "STI Policy Cooperation" (Table 11). The themes of the six working groups also reveal the current direction of S&T cooperation of the two countries.

Various projects of S&T cooperation between Thailand and China can be grouped in the following six clusters:

- Projects initiated by H.R.H. Princess Sirindhorn with Chinese partners such as Yunnan Observatories (YNO) and Institute of Remote Sensing Applications (IRSA) (Table 12).
- Projects of autonomous agencies and public organizations of MOST, e.g. space cooperation and satellite data sharing by GISTDA, agriculture and railway transportation by TISTR.
- Joint research projects funded by NNSF of China and NRCT/TRF of Thailand.[17]
- Projects of other ministries, e.g. MOPH or state owned enterprise (SOE).

– Projects of research institutes, e.g. Phuket Marine Biological Center (PMBC).
– Projects of private business, e.g. CP Group.

In conclusion, the major sectors of S&T cooperation between Thailand and China spreads from agriculture, new energy, public health, traditional medicine, to space technology (remote sensing), astronomy and environment. There are also initiatives for cooperation in S&T policy making which would encourage innovation and entrepreneurship.

Table 11 Working Group of the Joint Committee between MOST of Thailand and China

Working Group	*Thai Side*	*Chinese Side*
Thailand-China Joint Research Center on Railway System	Thailand Institute of Science & Technology Research (TISTR) National Science & Technology Development Agency (NSTDA) National Science Technology & Innovation Policy Office (STI)	China Southern Railway (CSR)
Space Technology Application	Geo-information & Space Technology Development Agency (GISTDA)	National Remote Sensing Center of China (NRSCC), China Centre for Resources Satellite Data and Application (CRESDA)
Technology Transfer Center	National Science & Technology Development Agency (NSTDA)	DOST Guangxi (Guangxi Academy of Science) (Guangxi ASEAN Technology Transfer Center)
Talented Young Scientists Program (TYSP)	National Science Technology & Innovation Policy Office (STI)	China Science & Technology Transfer Centre (CSTEC)
New and Renewable Energy Cooperation	National Science & Technology Development Agency (NSTDA)	DOST Guangxi
STI Policy Cooperation	National Science Technology and Innovation Policy Office (STI)	Great Wall Enterprise Institute (GEI) Chinese Academy of Science and Technology for Development (CASTED)

Source: MOST Thailand.

Table 12 Projects Initiated by H.R.H. Princess Sirindhorn

Partners in China	*Provincial Unit*
Yunnan Observatories (YNO)	Yunnan
Institute of Remote Sensing Applications (IRSA)	Beijing
Shanghai Synchrotron Radiation Facility (SSRF)	Shanghai
Institute of Computing Technology (ICT)	Beijing
Institute of Atmospheric Physics (IAP)	Beijing
Institute of Geographic Sciences & Natural Resources Research (IGSNRR)	Beijing
College of Physical Science, GUCAS	Beijing
Institute of High Energy Physics (IHEP)	Beijing
National Center for Nano-sciences & Technology	Beijing
Institute of Earth Environment	Shaanxi
Peking Union Medical College	Beijing
China Medical Board	Beijing

Source: Chulalongkorn University, 2016.

There is a reasonable spread of cooperating partners in various provincial units in China, including S&T centres in China such as Beijing and Shanghai, and southern provincial units which are close to Thailand such as Yunnan and Guangxi.

3.4. Strategic Values and Potentials for Future Cooperation

From interviews with policy makers, researchers and business practitioners in Thailand and China, it is found that the strategic values of S&T cooperation between the two countries are widely appreciated for the following reasons: 1) China is viewed as a source of funds and technology by the Thai side, 2) Thailand has strength in selected areas, such as agriculture and medicine, as viewed by the Chinese side, 3) both countries share common problems in economic and social development to be resolved by S&T, such as economic transition towards value added through innovation, and environment protection, and 4) Thailand is also attractive to Chinese partners as a hub of the AEC, a gateway towards continental ASEAN.

The past performance of S&T cooperation between the two countries has laid down a strong foundation for the future. The strategic value of S&T

cooperation between Thailand and China mentioned above can be fully realized with the development of promising sectors, in potential locations, with prospective partners and through potential mechanisms.

With reference to the 12 "Target Economic Sectors" in the "The National STI Policy & Plan 2012-2021" and recently named "10 New Engines of Growth" of Thailand 4.0 by the Thai government, potential sectors for S&T cooperation between Thailand and China are proposed as: next generation automotive, smart electronics, agriculture & biotechnology, food for the future, robotic, aviation & logistics, biofuels & biochemical, petrochemical, digital, and medicine.

Based on information on geographic distribution of S&T resources in China (see section 2.5), new locations in China for S&T cooperation should be identified, focusing on the unique feature of each provincial unit and expanding connection with the R&D rich provinces such as Guangdong, Jiangsu and Zhejiang.

Based on information on S&T system (see section 2.2), cooperation can be extended from the current partners of research institutes of CAS (Chinese Academy of Science) and universities to various platforms for research and technology transfer, private research institutes, and business sectors with patent or knowhow.

In terms of mechanism of cooperation, while maintaining the practice of personnel exchange and training, as well as joint research projects, new mechanisms may be introduced. They include platforms like joint lab, technology transfer, technology standard development, capacity building for business startup (incubator), and sharing the experience of S&T strategy and policy development.

Appendix A

Data Sources of S&T in China

There are three major sources of S&T information in China: the Ministry of S&T (MOST) (科技部), the Chinese Academy of S&T Development Strategy (CASTED) (中国科技发展战略研究院), and the National Statistics Bureau (NSB) (国家统计局) (Table A1). S&T information in the *Chinese S&T Statistics Date Book* (中国科技统计数据) is organized in terms of "human resource", "funding", "output" and "high technology" (Table A2). The "National Innovation Index" assess the innovation capability of the country in terms of "innovation input", "innovation synergy", "intellectual property" and "innovation impact" (Table A3).

Table A1 Key Sources of S&T Information in China

Source	*Name of Publication*	*Chinese Name of Publication*
MOST	Chinese S&T Statistics Date Book Annual Report of the State Program of S&T Development	中国科技统计数据 国家科技计划年度报告
CASTED	National Innovation Index Report	国家创新指数报告
NSB	Chinese S&T Statistics Yearbook Chinese High Tech Industry Statistics Yearbook	中国科技统计年鉴 中国高技术产业统计年鉴

Note: MOST – Ministry of S&T; CASTED – Chinese Academy of S&T Development Strategy 中国科技发展战略研究院; NSB – National Statistics Bureau 国家统计局.

Table A2 System of S&T Indicators in China

Category	*Details*
Human Resource	R&D personnel R&D personnel per 10,000 total employment R&D personnel by sector & type of activity R&D personnel by region Graduates by field of study Overseas Chinese students and returnees
Funding	Gross Domestic Expenditure on R&D GERD by source of funds and sector GERD by region Central and local government S&T expenditure Local government S&T expenditure by region
Output	Patent applications filed and granted by SIPO Domestic invention patents by sector Domestic S&T papers by type of institution Chinese S&T papers indexed by SCI, EI and CPCI-S
High Technology	National imports and exports of high-tech products National imports and exports of high-tech products by sectors Main economic indicators of high-tech industry by sectors National high and new technology zone

Source: MOST, *Chinese S&T Statistics Date Book*.

Table A3 Assessment of Innovation Capability of China

Category	*Details*
Innovation Input	Funding R&D Personnel R&D Institutes
Innovation Synergy	Cooperation between Production, Education & Research Resource Integration (acquisition, absorption & R&D) Joint Innovation
Intellectual Property (IP)	IP Creation IP Protection IP Usage
Innovation Impact	Value Realization (value of new product) Market Power (patent owned, PCT patent proportion) Economic & Social Development (labour productivity, energy consumption)

Source: CASTED, *National Innovation Index Report*.

Appendix B

High and New Technology Enterprises (HNTE) in China

Enterprises may be certified as HNTE based on a list of qualifications, e.g. ownership of core IP, R&D personnel as a proportion of employees, R&D expense as a proportion of annual sales, revenue from HNT products (Table B1). The HNT should also be included in the list published by MOST (Table B2). Qualified enterprises will receive tax incentives (e.g. a corporate income tax rate of 15% instead of the normal 25%, and government grants, etc.).

Table B1 List of Qualification for HNTE

Category	*Qualification for HNTE*
Ownership of core IP	From proprietary R&D, purchase, donation, acquisition, but not from licensing
Technology	Include in the catalogue of supported HNT (see Table B2)
R&D personnel	10% of enterprise's total employees (no need for college diploma)
R&D expense	5%: SME (small and medium-size enterprises) annual sales <RMB50 million, 4%: annual sales 50-200 RMB million, 3%: annual sales >200 RMB million (record of past 3 years)
Revenue	Revenue from HNT products and services not <60%
Innovation capability	Proprietary IP, Organization of R&D, Usage of S&T results, Growth indicator

Table B1 (continued)

Category	*Qualification of HNTE*
Firm registration	For more than one year
Clean Record	Clean record of safety, quality and environmental issues in the past year

Source: Ministry of Finance (MOF), State Administration of Taxation (SAT) and MOST – Administrative Measures for Certification of HNTE (2016).

Table B2 Catalogue of the HNT supported by Government

Technology	*Details*
Electronic & Information (8)	Software (12), Microelectronic (6), Computer and Network (4), Telecommunication (10), Broadcasting and TV (9), New Electronic Components (7), Information Security (8), Intelligent Transportation & Railway Transportation (6)
Biology & New Medicine (7)	Medical Biology (6), Traditional and Natural Medicine (4), Chemical Medicine (5), New Preparation (4), Medical Equipment (6), Light Industry and Chemical Biology (6), Modern Agriculture (5)
Aviation & Aerospace (2)	Aviation (6), Aerospace (8)
New Material (6)	Metal (8), Non-metal and Inorganic (5), High Molecular (6), Biological and Medical (8), Fine Chemicals (4), Materials for Art and Culture Industry (5)
Hi Tech Service (8)	R&D and Design (2), Certification and Standardization (2), IT (3), Specialized Service, IP, E-commerce and Logistics (2), Urban Management and Social Service (4), Cultural Creation (4)
New Energy & Energy Saving (4)	Renewable Clean Energy (4), Nuclear and hydrogen (2), New Energy Transform and Storage (4) High Performance Energy Saving (8)
Resource & Environment (8)	Water Pollution Control (6), Air Pollution Control (5), Solid Waste Processing and Utilization (6) Physical Pollution (2), Environment Monitoring and Emergency (4), Eco-environment protection, Clean Production and Recycling (4), Resource Exploration and Utilization (7)
Advanced Manufacturing & Automation (9)	Industrial Production Process Control (5), Production Safety (3), High Performance Intelligent Instruments and Meters (5), Advanced Manufacturing (6), New Machinery (4), Electric Power System (5), Automobile and Railway Vehicle (5), Ship and Ocean Engineering (2), Culture Industry Upgrading (2)

Source: MOF, SAT, & MOST – Administrative Measures for Certification of HNTE (2016).

Notes

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1. This paper is based on information from a consulting project conducted by the author for the Ministry of Science & Technology of Thailand.
2. For a detailed discussion on the data source of S&T in China, see Appendix A.
3. Source: Institute of Scientific and Technical Information of China (ISTIC).
4. A longer list of these other ministries and commissions may include the Ministry of Transport, Ministry of Agriculture, Ministry of Water Resources, State Forestry Administration, Ministry of Land and Resources, National Health and Family Planning Commission, etc.
5. Source: CAS website retrieved in May 2016.
6. For details of HNTE, see Appendix B.
7. Source: MOST 2015 – Plan for Deepening Reform of the Management of S&T Plan Financed by Central Budget.
8. Xi Jinping, Strive for Building a World S&T Power (为建设世界科技强国而奋斗), speech delivered on the National S&T Innovation Forum on 30 May 2016.
9. The five awards are: State Supreme ST Award (国家最高科学技术奖), State Natural Science Award (国家自然科学奖), State Technological Innovation Award (国家技术发明奖), State S&T Advancement Award (国家科学技术进步奖) and International S&T Cooperation Award (国际科学技术合作奖). The database can be accessed from the website of the National Office for S&T Awards (国家科技奖励办公室).
10. It can be accessed through the website of the National S&T Report Service (国家科技报告服务系统).
11. It can be accessed through the website of the National S&T Achievement Database (国家科技成果转化项目库).
12. Source: National Innovation Index Report 2014.
13. Source: Annual Report of the State Program of ST Development 2014.
14. Source: National Natural Science Foundation.
15. Peerasak Srinives of Thailand won the International ST Cooperation Award in 2014 for his research in bean seed, a cooperation project between Kasetsart University of Thailand and Jiangsu Academy of Agricultural Science of China.
16. MUA: Ministry of University Affairs, MOI: Ministry of Industry, MOAC: Ministry of Agriculture & Cooperation, MOPH: Ministry of Public Health.
17. For example, there are six joint research projects funded by NNSF of China and NRCT of Thailand, and five joint research projects funded by NNSF of China and TRF of Thailand. Each project lasts for three years with a funding of RMB3 million from China.

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