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# How China is preparing for an AI-powered Future

Wilson Center

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## SUMMARY

U.S. leadership in artificial intelligence (AI) research and development (R&D) may be challenged by China's recent and centralized policy planning aimed at rapidly developing AI-related technologies. The Chinese government supports AI as a strategic area supported by high-level policies with ambitious and quantifiable targets, inter-ministry coordination, government funding for research and development, support for workforce development, and suggestions for international collaboration and expansion. Still, as a relative latecomer in the global AI race, China faces numerous challenges to implement its policy planning, including short-term skills gap and long-term institutional constraints.

## POLICY CONTEXT

Artificial intelligence is a group of disruptive technologies that automate activities associated with human thinking, including decision-making, problem solving, and learning.[1] Marked with extraordinary promises and perils, AI first captured the imaginations of academic researchers, then industry leaders, and finally of policy makers around the world.

While the U.S. leads the world in cutting-edge AI R&D, China is rapidly rising. China surpassed the U.S. in volume of AI research in 2014, including in AI-related patent registration and articles on deep learning,[2] an important subset of AI. Beijing is keen to invest in AI as "the engine of the next industrial revolution" and seeks to reduce gaps in basic research breakthroughs and high-end product development. As a manufacturing powerhouse, China is also betting on AI to help counter rising labor costs and slowing economic growth and to upgrade technology across the economy.

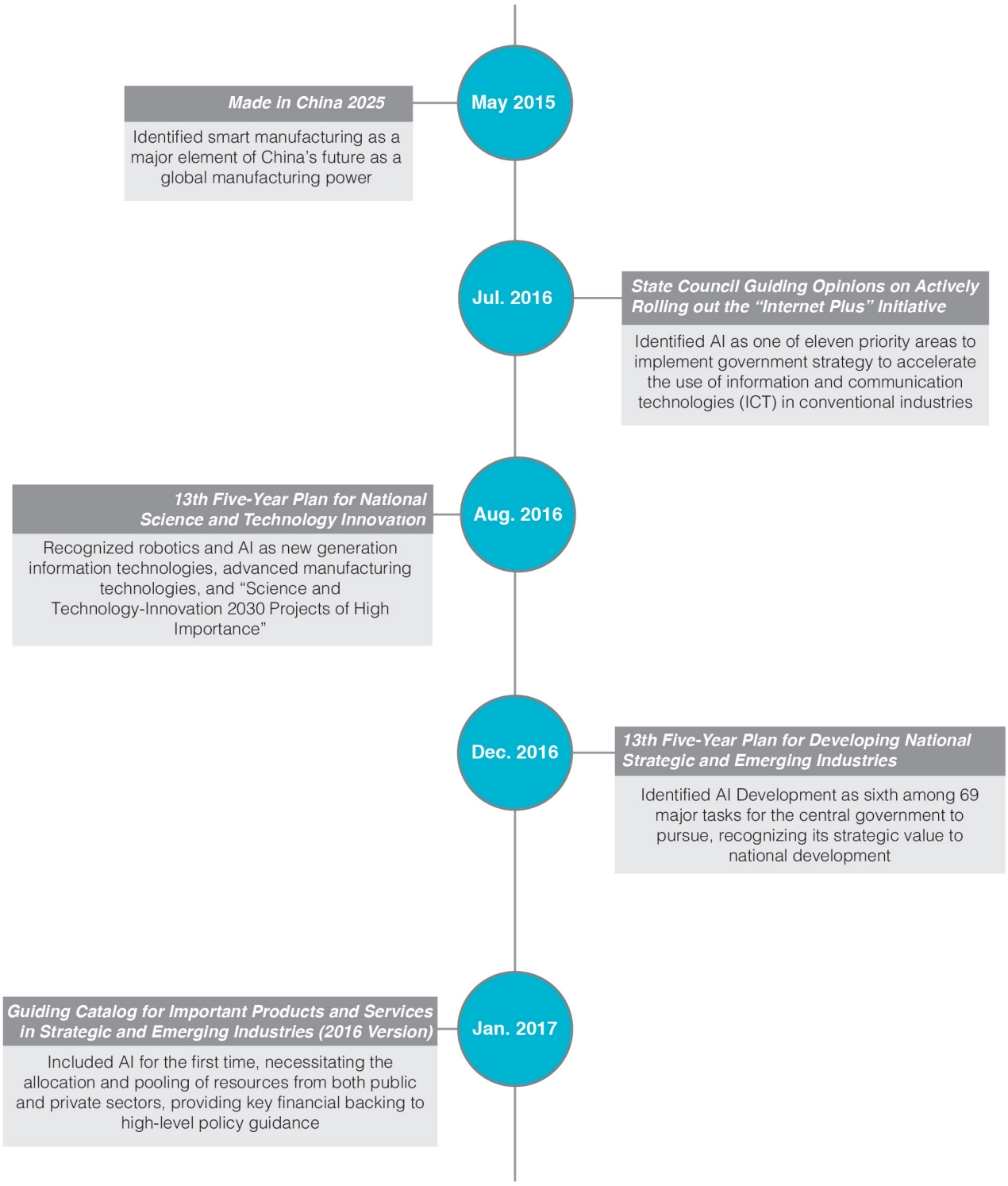
In 2017, AI made its way into the Premier's Government Work Report for the first time ever at the March annual meeting of China's "two-sessions," the National People's Congress and the Chinese People's Political Consultative Conference. Chinese Minister of Science and Technology Mr. Wan Gang announced that China will release its own AI-specific national development plan soon. With Minister Wan's promise in mind, this brief highlights important AI-related components in China's central policy planning to suggest what future guidance may look like, and to help the U.S. prepare an effective response.

## CHINA'S AI-POLICY TRAJECTORY: 2006- PRESENT

Significant Chinese policy support for AI may be traced to February 2006, when the State Council – China's cabinet – released the *National Medium- and Long-Term Plan for the Development of Science and Technology (2006-2020)*. This strategic plan laid the foundations for future AI R&D by establishing smart sensors, smart robots, and virtual reality technologies among the "frontier technologies" to prioritize for development by 2020.

In April 2012, the Ministry of Science and Technology (MOST), China's primary agency responsible for directing science and technology development, released the *12th Five-Year Plan for Intelligent Smart Manufacturing*. This five-year plan, specifically written for smart manufacturing, showed this field as a growing policy priority for MOST. Industrial robots and the Industrial Internet of Things are listed as key technologies which, if developed, could enhance China's manufacturing capability.

China's current five-year (2016-2020)[3] planning solidified AI's position as a darling child. The State Council, which carries paramount importance in Chinese policy formulation and implementation, has issued several policy directives featuring AI-related technologies. A summary of the AI-related component of each policy document is provided below.


May 2015
Made in China 2025
Identified smart manufacturing as a major element of China's future as a global manufacturing power
Jul. 2016
State Council Guiding Opinions on Actively Rolling out the "Internet Plus" Initiative
Identified AI as one of eleven priority areas to implement government strategy to accelerate the use of information and communication technologies (ICT) in conventional industries
Aug. 2016
13th Five-Year Plan for National Science and Technology Innovation
Recognized robotics and AI as new generation information technologies, advanced manufacturing technologies, and "Science and Technology-Innovation 2030 Projects of High Importance"
Dec. 2016
13th Five-Year Plan for Developing National Strategic and Emerging Industries
Identified AI Development as sixth among 69 major tasks for the central government to pursue, recognizing its strategic value to national development
Jan. 2017
Guiding Catalog for Important Products and Services in Strategic and Emerging Industries (2016 Version)
Included AI for the first time, necessitating the allocation and pooling of resources from both public and private sectors, providing key financial backing to high-level policy guidance

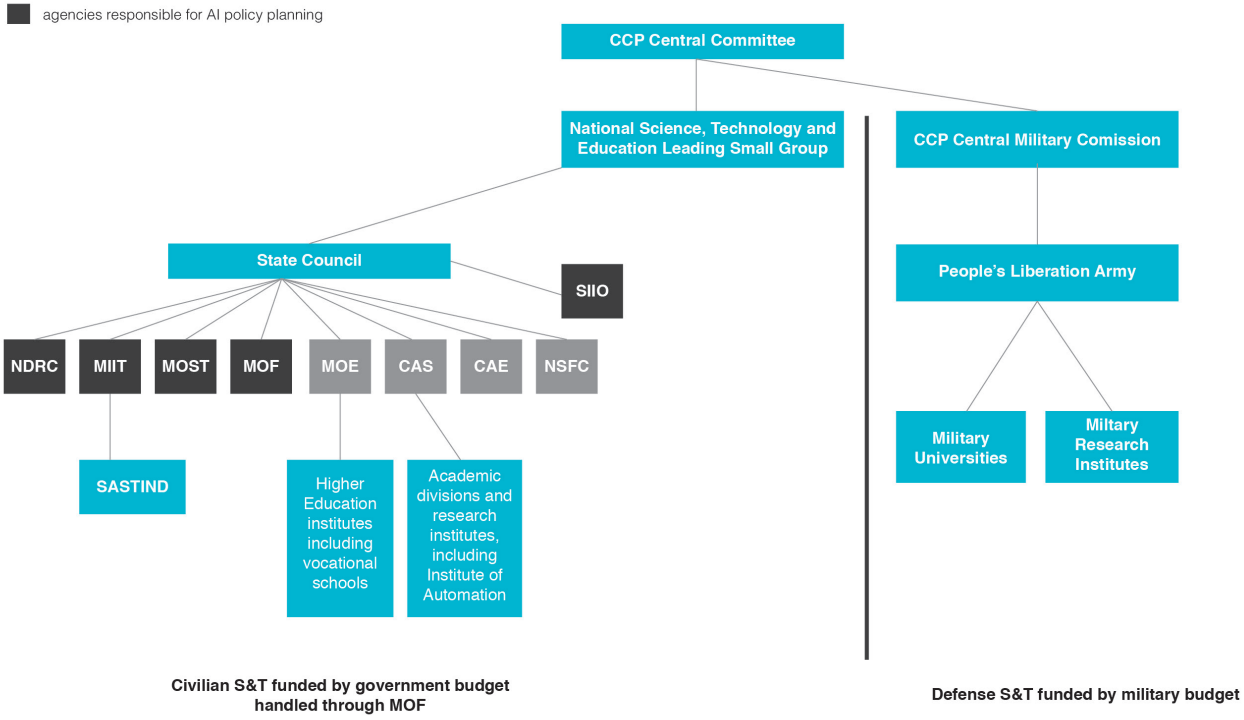
## UNDERSTANDING THE GOVERNANCE CONTEXT

Because China is a one-party state, the Chinese Communist Party (CCP) Central Committee is at the top of China's political structure. The CCP Central Committee exerts influence on civilian science and technology policy making and coordination through the **National Science, Technology and Education Leading Small Group**. This small group of party elites includes all heads of ministry-level units involved in science and technology policy within the State Council, China's top administrative body. China's Premier, who manages the State Council, chairs this Leading Small Group. The CCP Central Committee also exerts influence on defense science and technology development through the CCP Central Military Commission, which oversees China's military including all military universities and research institutes. Coordination between the civilian and defense science and technology policy making is managed through the State Administration of Science, Technology and Industry for National Defense (SASTIND), a civilian bureau under the Ministry of Industry and Information Technology.

Within the State Council, five agencies have been identified as responsible for developing and implementing central government policies in AI in the next five years, per the *13th Five-Year Plan for Developing National Strategic and Emerging Industries*.[4] Other units directly under the State Council involved in science and technology policy making include the Ministry of Education (MOE), a ministry that oversees China's educational institutions including universities and vocational schools; the Chinese Academy of Sciences (CAS), which manages more than 100 research institutes and employs more than 68,000 staff across the country (including the Institute of Automation that employs 795 researchers and 54 staff members); the Chinese Academy of Engineering (CAE), an academy of elected elite members of the engineering community that provides strategic advice to the government; and the National Natural Science Foundation of China (NSFC), an organization directly affiliated with the State Council that manages the National Natural Science Fund.

In addition, because AI-related technology development can occur across all industries, specific AI-powered products may fall under the regulatory domain of other central agencies. For instance, the Ministry of Transport (MOT) oversees China's development of transport infrastructure including smart transportation options, and it has its own research institutes. Similarly, the Ministry of Health (MOH) oversees China's health affairs and regulates all health-related technologies; it approves and regulates AI-powered diagnostic technologies. However, due to the centralized nature of Chinese governance, unlike regulation in the U.S. guidance issued by MOT, MOH, and other ministries may

be coordinated and streamlined through the State Council. Furthermore, in strategic sectors such as telecommunications, aerospace, energy and public security, state-owned enterprises (SOEs) that dominate these sectors may also influence policies on AI-related technology adoption.




Acronyms: Chinese Communist Party (CCP), National Development and Reform Commission (NDRC), Ministry of Industry and Information Technology (MIIT), Ministry of Science and Technology (MOST), Ministry of Finance (MOF), State Internet Information Office (SIIO), Ministry of Education (MOE), Chinese Academy of Sciences (CAS), Chinese Academy of Engineering (CAE), National Natrual Science Foundation of China (NSFC), State Administration of Science, Technology and Industry for National Defense (SASTIND)

## IMPLEMENTING HIGH-LEVEL POLICY: AGENCY-LEVEL STRATEGIES

Until March 2017, two development plans with focus on AI have been released by the central agencies responsible for policy planning. The *Robotics Industry Development Plan (2016-2020)*, jointly released by NDRC, MIIT, and MOF in April 2016, set concrete technology targets and government strategies for developing the robotics industry in China in the next five years. The *Implementation Plan for "Internet Plus" Artificial Intelligence 3-Year Initiative*, jointly released by NDRC, MIIT, MOST and SIIO in May

2016, outlined nine key engineering areas in AI technology development between 2016 and 2018. Building upon the State Council Guiding Opinions on Actively Rolling out the *"Internet Plus" Initiative*, this plan also identified specific strategies the government would take to promote the development of technology and industry.These plans echo numerous high-level policy strategies to facilitate AI R&D. They emphasize key strategies including funding for research and development, government support for workforce development and higher education curriculum development, and support for international collaboration and market expansion.

## Funding for Research and Development

In tandem with the private sector, government funding can provide sufficient incentive to invest in high-risk and long-term projects in a developing field such as AI. While direct funding is difficult to quantify now and for previous years, the government provides public records of financial and tax incentives that support AI R&D.[5] These include:

- The **Fund for Industrial Restructuring and Upgrading**, a new central budgetary scheme started in 2016 and managed by MIIT and MOF with the goal of supporting industrial restructuring and technology upgrades in line with the *Made in China 2025* roadmap for manufacturing. While the full scale of this support is unknown, in 2016, this budgetary scheme allocated 2.783 billion RMB ($404.3 million) to projects in "smart manufacturing standardization and new model applications" alone.[6] This fund did not exist prior to 2016.
- The 2017 **Central Basic Infrastructure Budget**, a regular central budgetary scheme managed by MOF to fund infrastructure development projects, shows that the government will allocate 1.05 billion RMB ($152 million) to infrastructure for "Internet Plus" and 4.23 billion RMB ($614 million) to infrastructure for "key projects in emerging industries" in 2017.[7]
- The **Central Financing for Science and Technology** is a regular central budgetary scheme for science and technology projects managed by MOST and MOF in collaboration with other agencies. As both "smart manufacturing and robotics" and "artificial intelligence 2.0" were identified as priorities in the *13th Five-Year Plan for National Science and Technology Innovation*, AI research, development and commercialization is likely to receive prioritized support in one or more of these funding categories.
- The **Multiplied Pre-Tax Deduction of Research and Development Expenses for Enterprises** is a tax scheme managed by MOF, the State Administration of

Taxation and MOST that allows companies to deduct 150% (increased to 175% for medium and small-sized science and technology companies in 2017) of research and development expenses, or 250% of such expenses if they lead to an intangible knowledge product (patent, software, etc.), within the tax year in the calculation of taxable revenue.

- The **Insurance Compensation for First Key Technology Equipment** is a central grant managed by MOF, in collaboration with MIIT and China Insurance Regulatory Commission, to subsidize the insurance premium paid by producers of the first batch of key technology equipment to insure against quality or safety issues.

Call for proposals (CFPs) for national labs are also already underway.[8] In March 2017, the first national lab of deep learning technology and application was inaugurated at Baidu, China's Internet giant company in Beijing. Besides central government funding, local governments across the country also provide various kinds of local-level incentives, such as grants, tax deduction, and subsidy for rents and equipment costs to complement or extend the central programs.

## Education and Workforce Development

Like the U.S., China faces a huge discrepancy between the supply of talented workers and the demand. According to the Ministry of Education, China faces a talent gap of more than 200,000 workers in industrial robotics applications, which is projected to increase 20-30% annually.[9]

The Chinese government recognizes curriculum development and workforce training as an urgent R&D need. In 2015 the Ministry of Education (MOE) updated the *Catalog of Student Majors in Vocational and Technical Education for Regular Institutes of Higher-Education*, which serves as a basic guideline[10] for institutes to offer vocational degree programs, to designate majors including "Industrial Robots Technologies," "Industrial Internet of Things Applications Technologies," "Industrial Internet of Things Engineering Technologies," "Smart Product Development," and "Unmanned Aerial Vehicles Applications Technologies." This formalized the choices for Chinese institutes to start programs and enroll students in these majors, and streamlined the management of such programs. By August 2016, over 300 higher education vocational institutes in China already founded programs for students majoring in industrial robotics technologies alone.

The government has also spearheaded collaboration with the private sector in workforce training. In 2016 MOE signed *Implementation Plan of Collaboration Projects in Vocational Education Concerning Industrial Robotics* with three robotics companies, ABB Engineering (Shanghai), Shanghai Step Electric Corp., and CHL Rob. (Beijing Huahang Weishi Robotics), to co-develop ten public vocational training hubs and 90 vocational

## GLOBAL TALENT ACQUISITION IN PRACTICE: LEARNING FROM BAIDU

Chinese companies have already embarked on international expansion through talent recruiting and start-up acquisition. For instance, the Chinese Internet giant Baidu, often dubbed the Google of China, has developed a powerful voice recognition engine Deep Speech 2 with the help of scientists recruited globally. Deep Speech 2 can learn languages and transcribe speeches faster and more accurately than humans. Baidu hired Andrew Ng from Google in 2014 to oversee and expand its research in AI based in the Silicon Valley (Ng departed Baidu in March 2017). Baidu's Beijing-based Institute of Deep Learning is led by Lin Yuanqing, the former head of the Media Analytics Department at NEC Labs America, and its chief scientist is Xu Wei, who previously worked in the U.S. at companies including NEC Labs America and Facebook.

In September 2016 Baidu created a $200 million venture capital unit, Baidu Venture, to focus on investing in early-stage artificial intelligence, virtual reality, and augmented reality. In January 2017 Baidu hired Lu Qi, a former Microsoft executive and AI expert, as Group President and COO as part of its plan to become a global leader in AI. Baidu has now made a string of investments in foreign AI-related start-ups, including U.S.-based ones like the VR company 8i, the computer vision company xPerception, and sensor producer Velodyne.

training centers in Chinese vocational schools in the next three years. MOE would provide five million RMB ($726,427) funding to each training hub, three million RMB ($435,856) to each training center, and additional resources for teacher training and equipment.

### International Collaboration and Expansion

China is the world's largest manufacturer and consumer, with significant demand for products including industrial robots, and one of the world's largest Internet markets, with around 800 million connected users who are potential customers of AI-powered products. Benefitting from global knowledge production and meeting consumption needs both require international cooperation. Development plans state that the Chinese government will undertake the following international strategies: (1) incentivize overseas

Chinese and global talents to conduct research and found start-up companies in China through such national programs as the "Recruitment Program of Global Experts"; (2) promote international exchange and collaboration in research, technology, standards development, intellectual property rights, and testing certifications; (3) encourage Chinese companies to expand abroad; and, (4) encourage industry associations to set up platforms for international exchange and collaboration.

With increased government support, such models of global cooperation are likely to continue; yet regulatory changes in the U.S. and Europe could potentially derail Chinese companies' investments in politically sensitive foreign start-ups. A whitepaper commissioned by the U.S. Department of Defense concludes that Chinese investment in American start-ups working on critical technologies such as AI could help increase Chinese capability in military technologies.[11] The perceived security implications of Chinese investment might prompt more stringent U.S. government review of foreign investment, and thus lead to the creation of roadblocks for Chinese companies hoping to investment in American AI start-ups. On the other side of the Atlantic, the rush of Chinese investment in European high-tech companies, particularly the high-profile acquisition of the top German robot manufacturer Kuka by Chinese manufacturer Midea Group in January 2017, caused a similar outcry for tighter investment screening and control. In February 2017, Germany, France and Italy asked the European Commission to review the possibility of E.U. member states blocking foreign investment based on security and economic criteria, which could serve to scrutinize and potentially exclude Chinese investment in European high-tech companies.

## China's Growing AI Innovation Ecosystem

A nascent AI innovation ecosystem is developing in China as the nation's major technology hubs support AI researchers, entrepreneurs, and investors. Three cities dominated the Chinese AI sector in 2016: Beijing, home to 242 AI companies; Shanghai, home to 112 AI companies; and, Shenzhen, home to 93 AI companies.[12] The big industry players are three Chinese Internet giants, Baidu, Alibaba, and Tencent, known as "BAT." As discussed earlier, Beijing-based Baidu, and more recently Shenzhen-based Tencent, have established AI research labs and invested in AI start-ups at home and abroad. Hangzhou-based Alibaba, China's largest e-commerce company, focuses on services to "democratize AI": it has introduced AI-powered solutions ET, a suite of all-encompassing services from video recognition to financial risk analysis and traffic forecasting, to Aliyun, its pubic cloud service for industry and government clients.

The start-up scene is particularly vibrant in Shenzhen, a city close to Hong Kong in South China's Guangdong Province. Shenzhen has two of the top 50 global AI startups[13]: iCarbonX, an AI-biotech start-up that uses algorithms to analyze genomic, physiological

and behavioral data and provide customized health advice; and UBTECH Robotics, the first company in China to commercialize humanoid robots that can interact with human tools and environments. Shenzhen is also a major manufacturing region for industrial robots, producing more than 78.7 billion RMB ($11.4 billion) worth of robots in 2016.[14]

A close look at Shenzhen's innovation ecosystem reveals the advantages that government policies, in coordination with favorable market conditions, have in fueling the growth of AI. As the first Special Economic Zone (SEZ) established in China and the first National Innovation City, Shenzhen has benefited from government policies supporting market openness, entrepreneurship, and R&D collaboration between universities and firms. Firstly, as a financial center with one of the only two stock exchanges in Chinese mainland, Shenzhen's financial industry provides ample private funding for local startups. This complements government programs, such as the 500 million RMB ($72.5 million) annual budget to develop robotics, wearable devices and smart manufacturing,[15] Government-backed Venture Capital (VC) funding is also growing. Secondly, known as the "hardware capital of the world," Shenzhen and the surrounding Pearl River Delta region have formed a complete industry supply chain for AI-enabled applications. A dense web of manufacturing businesses, ranging from component suppliers to module providers to solution partners, cut the cost of turning an idea into a product. As Karina Chang, the director of Shenzhen-based hardware incubator Hax quipped, "You can buy a $9 computer chip here and turn a chair or desk into a smart device."[16] Thirdly, while Shenzhen does not have national universities known for basic research, it supports applied R&D, university spin-offs, and tech transfer to local firms through collaboration with leading universities, research institutes and firms. Finally, the Shenzhen government offers grants and all kinds of privileges (housing subsidies, tax reduction, healthcare, jobs for spouses, school enrollment for children) to attract top overseas talents to settle down in Shenzhen, on top of national talent programs. One such initiative is the Peacock Plan, which provides awards of up to 1.5 million RMB ($217,495) to each selected individual. Since 2011, the Peacock Plan has supported more than 1,200 individuals; among them are AI entrepreneurs such as the founders of Intelli-Fusion, the creator of the visual intelligence system "DeepEye" which can recognize a suspect from a million people in just one second.

## PRIORITIZING AND BENCHMARKING SUCCESS

In the words of Andrew Ng, AI will transform industries "just as electricity transformed almost everything 100 years ago." China has identified the following nine major technology areas to focus its government planning and support on by 2018, per the *Implementation Plan for "Internet Plus" Artificial Intelligence 3-Year Initiative*:

- **Core AI technologies**, including basic research in fields such as deep learning, neuromorphic computing, and neuromorphic system for information processing; the development of basic software and hardware such as chips, sensors and operating systems; and, applied research in areas such as computer vision, biometrics, complex environment recognition, human-computer interaction, natural language processing, machine translation, smart controls, and cybersecurity.
- **Public information service platforms** for computing, such as clusters for large-scale deep learning; industry information services; cloud-based information processing; open source algorithms and technologies; neuromorphic information services; and, comprehensive cybersecurity services. Priorities extend to support programs for testing and certification, standardization, intellectual property, and startup consulting.
- **Smart homes**, including appliances and consumer products in healthcare, entertainment, security, environmental monitoring and energy efficiency, and AI-related designs in homes, offices, shopping malls, and communities.
- **Smart vehicles** such as driverless cars, and supporting technologies including smart performance chips, smart operating systems, high-precision maps, smart sensors, and smart control.
- **Smart unmanned transportation applications**, such as unmanned aerial vehicles (UAVs) and unmanned ships, as well as applications in shipping and logistics, agriculture, disaster relief, surveying and mapping, power line inspection, and security patrol.
- **Smart security** achieved through image and video precision recognition, biometric recognition and coded recognition, and adoption in public security.
- **AI-enabled end user applications**, such as smart translation, smart human-computer interaction, programming and software systems for smart product enhancement, and product customization and specialization to increase consumer adoption.
- **Smart wearable devices**, including core technologies for smart wearable devices and their applications in healthcare, sports, security, manufacturing, and commerce.
- **Smart robots**, including the development of AI-enabled technologies to enhance the quality of robots; the demonstration of smart industrial products in labor-intensive, high-risk, and environment-sensitive industries; and the development of specialized robots for counter-terrorism, disaster relief, healthcare, educational entertainment, and home services.

While the forthcoming AI-specific national development plan will likely list concrete

figures to measure China's success, the current Robotics Industry Development Plan (2016-2020) can shed light on potential metrics and targets the government may use in quantifying and assessing broader AI development. The following targets are set for robotics in the year 2020:

- **Annual volume of industrial robot production by Chinese indigenous brands** will reach 100,000; for robots with six or more axes,[17] the annual volume of production by Chinese indigenous brands will reach 50,000.
- **Annual sales of service robots in China** will exceed 30 billion RMB ($4.36 billion).
- There will be at least **3 globally competitive enterprises** in robotics and at least 5 **AI-related industry clusters** in China.
- **The MTBF (Mean Time Between Failure)** for industrial robots produced by Chinese companies will reach 80,000 hours.
- **The quality of Chinese service robots** in a variety of areas including healthcare, disaster relief, counter-terrorism, and basic research will reach comparable quality levels with their counterparts in the global market.
- **The quality of the core components of robots** produced by Chinese companies will reach comparable quality levels with their counterparts in the global market, and Chinese-made robot components will reach at least 50% of the market share for robots with six or more degrees of motion.
- **Robot density for industries that are prioritized for automation** will reach 150 per 10,000 employees.

## SHORTCOMINGS FOR CENTRAL PLANNING

Even in centralized governments, planning does not automatically yield the desired result. According to the Mercator Institute for China Studies, a European think tank, while a few international champions might emerge from Chinese technology firms under the Made in China 2025 roadmap, China will likely fail to "catalyze a comprehensive, broad-scale technology upgrading across the Chinese economy."[18] In the short term, China faces challenges such as a deficit in top AI research talents and an education system unprepared for an automation-driven economy. China still has very few AI scientists capable of producing world-leading research: according to Yu Kai, the founding director of Baidu's Institute of Deep Learning, the number of experts is "between 5 and 10." In terms of the workforce, China's education system is not yet able to fulfill the rapidly rising need for skilled labor in smart manufacturing, as evidenced by the talent gap discussed earlier. The acceleration of automation could also lead to further job

displacement, and possible instances of social unrest that the Communist Party seeks to avoid; thus there is a greater urgency to fill the gap in adult continuing education and workforce training.

In the long term, systemic issues, such as inefficient funding management and campaign-style overspending, could also pose challenges. Research in China has long suffered from its inefficient bureaucracy that both distributes government research funds and supervises their use. This has made it necessary for researchers to maintain favorable personal relationships with government officials and administrators, and creates issues such as academic corruption and embezzlement. Nevertheless, the ongoing reform of the central financing for science and technology may bring positive changes. In financing technology commercialization and industrial projects, China's campaign-style policy can be compounded by the local governments' tendency to overspend their budget and eagerness to create local champions. This has led to the waste of funds on projects featuring similar technologies and the over capacity of production, in sectors such as the solar photovoltaic sector. The same inefficiency could occur in AI-enabled sectors, such as industrial robots. By 2016 more than 40 industrial parks devoted to robotics have been built or are being built in China, and 28 provinces have made industrial robots a target sector for development. This government-fueled investment boom shows worrying signs of becoming a market bubble.

## KEEPING AMERICA GREAT: RECOMMENDATIONS FOR U.S. POLICYMAKERS

China's AI policies will accelerate AI research and development, with positive and negative impacts for the U.S.[19] At a time when the U.S. share of global R&D expenditures (in all areas) is declining,[20] Chinese investment is good news for the international research community. China's large population, which creates huge amounts of data, rising adoption of automation, and penchant of an increasingly affluent and aging population to purchase smart products, all make the nation a top market for AI-enabled applications. On the other hand, the U.S. faces a rapidly rising competitor that may challenge its research leadership and innovation edge. Many of the steps taken to encourage Chinese AI R&D can also be used to boost U.S. competitiveness. Concrete recommendations include:

- **Engage with the Chinese government to ensure market access for American companies, through negotiation of technology standards in line with international best practices, and discussions of issues such as data privacy, data ownership, cybersecurity, and ethics.**[21] China is still at an early stage in formulating standards for AI-enabled technologies, and its domestic market for AI-enabled products may exceed 40.6 billion RMB ($5.9 billion) in 2018.[22]

The U.S. federal government needs to continue its dialogue with China in negotiating and enforcing relevant technology standards, so that U.S. companies can have undisrupted access to this foreign market. The federal government may encourage information sharing between U.S. and Chinese companies and industry associations, through existing platforms such as the United States Information Technology Office (USITO) in Beijing, to create leverage and influence on Chinese decision making. Accelerating the negotiations on a U.S.-China Bilateral Investment Treaty (BIT), which includes equal treatment for each country's investors and clear guidance on excluded sectors, would be in the interests of both sides and help address potential Chinese investment barriers. The federal government also needs to continue dialogue with China on issues such as data localization, cybersecurity and ethics, and closely monitor the development of Chinese laws and regulations that may create regulatory burdens for U.S. firms.

- **Ensure free and fair competition for American firms on the global market, through protecting intellectual property (IP) right, negotiating and enforcing international trade rules, and adopting sensible policies in export and investment control.** As U.S. firms compete on the global market, the federal government needs to continue dialogues with trading partners including China to strengthen their IPR regimes, and to protect U.S. firms from IPR abuse, such as forced technology transfer in exchange for market access. The federal government needs to also investigate and monitor potential competition strategies from other countries including China, such as production and export subsidies, import barriers, and local content requirement (e.g. requiring a minimum share of domestic products in local projects or procurement), and if applicable, use international trade rules to ensure a level playing field for U.S. firms. As AI-powered technologies can attract massive cross-border investment and may have potential military applications, the federal government needs to continue sensible export control mechanisms as well as impartial screenings of foreign investment through CFIUS (the Committee on Foreign Investment in the United States), protecting U.S. national security without missing out the economic benefit of export and foreign investment.
- **Incentivize talented, high-skilled people from other countries to study, work, teach and found start-up companies in America.** Cutting-edge AI technologies can often be applied and deployed faster in China than in the U.S., due to high customer loyalty to major product platforms and a competitive ecosystem that rewards rapid integration of AI into existing products. For instance, Baidu's online translation system already used neural network one year before Google's neural machine translation caught industry attention. Exchanges between engineers, researchers, students, and entrepreneurs between the U.S. and other countries

including China is therefore necessary to allow the U.S. to closely monitor the latest technology development. In addition, the U.S. innovation system has traditionally excelled in creating start-ups, many of which are founded by highly skilled immigrants attracted to its world-class education. In the global competition for highly-skilled workers, the U.S. needs to continue to secure this advantage.

- **Enhance public-private collaboration in identifying current and future needs for skilled labor and meeting such needs through workforce training and retraining.** Research suggests that 47% of all American jobs are at risk of automation.[23] While China bolsters its labor market by targeting higher education vocational institutions, the U.S. federal government needs to help equip American workers with the skills in demand in a changing economy. One way to do so is to enhance support for vocational training in local community colleges, apprenticeship programs and on-the-job training in collaboration with the private sector. As workers work with newer machines, the federal government also needs to continue enforcing regulations to ensure workplace health and safety.
- **Maintain and increase federal support for K-12 STEM education.** High-quality STEM education engages students' intellectual curiosity, leading to long-term advantage in the growth of talents in emerging fields such as AI. According to the OECD Program for International Student Assessment (PISA), U.S. student performance ranked 35th in mathematics and 25th in science in ranking in 2015, while Chinese student performance ranked 6th in mathematics and 10th in science during the same year.[24] The U.S. federal government needs to continue developing programs to help students learn as effectively as their future competitors from abroad. As AI poses a challenge, it also suggests a solution: "smart" educational games have the potential to customize learning experiences to meet diverse student aptitudes and interests.
- **Maintain and increase federal support for public universities, particularly for technology transfer capabilities.** Public universities provide world-class education to future American workers at affordable prices. They rely on government funding to do so. In addition, to keep the ecosystem of innovation that underpins American's leadership in AI functional, the federal government must incentivize research universities to turn faculty research into commercial success. Technology transfer programs, such as the Small Business Technology Transfer program, can designate funds specifically for university start-ups. The federal government can also encourage additional roles that universities can play in the innovation ecosystem. The University of Michigan, for example, will take a leadership role as a testbed for autonomous vehicles.

As policymakers around the world anticipate the full Chinese national development plan

slated to be released later this year, science and technology innovation policy released between 2006 and 2017 suggests that China will continue to prioritize developments in industries including manufacturing and transportation, and support a myriad of applications areas such as education, healthcare, home services, and public security. The U.S. should expand upon earlier guidance offered by the Obama Administration to develop a complete and comprehensive national strategy for AI R&D that accounts for and compliments Chinese priorities, ideally covering many of the points described above. Maintaining global leadership in artificial intelligence requires a mix of policy levers and funding strategies to ensure the safe, equitable, and profitable development of new technologies and applications.

## Endnotes:

1. Richard Bellman, An introduction to artificial intelligence: can computers think?. San Francisco, CA: Boyd & Fraser Pub. Co. 1978. This brief follows Bellman's definition that emphasizes artificial intelligence not as a single technology field, but as a general term for a group of research fields that concern the automation of activities associated with human intelligent behavior with minimal human intervention. Robotics, for instance, falls under the general umbrella of AI.

2. National Science and Technology Council Networking and Information Technology Research and Development Subcommittee, "The National Artificial Intelligence Research and Development Strategic Plan," October 2016, https://www.nitrd.gov/PUBS/national_ai_rd_strategic_plan.pdf.

3. China's five-year plans are a series of successive economic and social development initiatives devised by the Communist Party of China through the plenary sessions of the Central Party Committee and the National People's Congress. In addition, industry-specific five-year plans are usually released by the ministry/ministries regulating the target industry and serve as guideline documents for industry development for the upcoming five years.

4. They include: the National Development and Reform Commission (NDRC), the Ministry of Industry and Information Technology (MIIT), the Ministry of Science and Technology (MOST), the Ministry of Finance (MOF), and the State Internet Information Office (SIIO), a functional office within the Information Office of the State Council that supervises online content management and handles the approval of businesses related to online news reporting.

5. All Chinese Renminbi (RMB) to US Dollars (USD) conversion was done using the exchange rate on April 14, 2017

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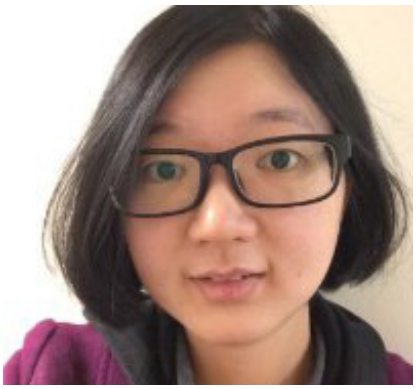

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