Testimony before the Senate Committee on Energy and Natural Resources on "recent advances in artificial intelligence and the Department of Energy's role in ensuring U.S. competitiveness and security in emerging technologies"

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Chairman Manchin, Ranking Member Barrasso, distinguished members of the Committee and staff, thank you for the opportunity to participate in today's hearing. It is an honor to be here alongside the esteemed experts on this panel. I am currently a Senior Fellow at the Center for Security and Emerging Technology (CSET) at Georgetown University where I research S&T policy development and global technology competition. I previously served as the National Counterintelligence Officer for East Asia and for most of my career I have studied China's science and technology (S&T) development and innovation ecosystem, including its efforts to acquire technology and technological know-how, how these efforts have changed over time and the policies and programs China uses to meet its strategic goals.

My testimony today will first address why the DOE labs are targeted by China and the implications of these policies for the U.S.-China strategic competition. I will provide a brief overview of China's S&T system and finally discuss research security and potential mitigation strategies. In particular, I will discuss how our systems differ, and how the role of the state impacts and influences all aspects of China's S&T ecosystem, from universities to its state key labs and its associated industries and provide potential mitigation strategies to protect the national innovation base, specifically the DOE complex. Lastly, I'll offer lessons learned, which include:

- This is not a DOE problem, but a U.S. wide problem because China's system is not the same as ours. It takes a holistic approach to developing technology—blurring the lines between public, private, civilian and military.

- China says it will use any knowledge or technology it acquires for its military. This is not conjecture, profiling, or analysis, but China's stated position for decades. Our policies and mitigation strategies need to reflect this reality.

- Scientists–and innovation–thrive with funding, lab space and freedom to pursue their craft—this is what makes the DOE labs such a tremendous resource. Giving scientists a problem to solve is not the same as giving them a solution. Political control is not the same as scientific control. We assume China cannot meet its strategic technical goals because it is not a democracy at our own peril.

- Beijing has made talent development and the exploitation of overseas students, universities, and government labs a central part of its technology acquisition strategy since the country's "opening" around 1978.[i] This is why the DOE complex is a target.

- Regardless of their personal views, Chinese scientists, businesspeople and officials interacting with the DOE complex have to respond to the PRC's government or security services if they are asked for information or data. China intimidates and harshly silences its critics—this has only grown more so in the past few years. This increasingly includes its citizens abroad.

- Beijing in many ways understands our societal tensions, which include race relations, and its statecraft is directed at them, exploiting identity politics by promoting any changes in U.S. policy as ethnic profiling, offering a narrative about being merely a proponent of "development" and science, in order to divert attention from its own questionable behavior. This is a well-funded effort.[ii]

It is because of this last point that I want to acknowledge how difficult and challenging discussing these issues can be. My own grandparents were immigrants who came to this country with little formal education, worked menial jobs and made a new life for themselves. My presence here today is a testament to the American Dream. There is no room for xenophobia or ethnic profiling in the United States -- it goes against everything we stand for as a nation.

And precisely because of these values, the issues we are discussing today will make us uncomfortable as we move forward to find principled ways to mitigate the policies of a nation-state that is ever more authoritarian, does not share our values and seeks to undermine the global norms of science and commerce and exploit our national innovation base—especially the DOE labs. These challenges are not about the concerns of one administration or the policies of one political party, but the actions of a nation-state with a different system, different regard for human rights and different view of competition, and one that has put in place policies and programs that undermine the very values we hold dear: a fair and level playing field, transparency, reciprocity and market-driven competition.[iii]

Threats to the DOE Complex: The Importance of S&T

Emerging technologies are increasingly at the center of global competition, providing the foundational research and developments that underpin future industries and drive economic growth. These emerging technologies will alter economic, political and security dynamics and directly affect national security and competitiveness. However, knowledge-based industries rely on collaborations and sharing of data, research and human capital across national borders. While this has always been a U.S. strength, it creates vulnerabilities in our innovation base as some countries use these collaborations and exchanges to support the expropriation of existing know-how and talent. This often includes the acquisition of technology and technological know-how through legal, illegal and extralegal means.

Losing our technological edge and the influence it entails will have far-reaching implications beyond scientific disciplines. Increasingly this is also not about military technologies, but dual-use technologies and commercial applications. Future strength will be built on 5G, AI, biotechnology, new materials and areas currently researched in our national labs. While DOE may still be best known for stewarding our nuclear deterrent, it also is described as catalyzing the transformative growth of basic and applied scientific research and the discovery and development of new clean energy technologies. It prioritizes scientific innovation as a

cornerstone of U.S. economic prosperity—and in my opinion is an under-appreciated resource that incorporates the lifecycle of tech development.[1] Through its labs and plants, the government builds a technically capable workforce that will support future discovery and industry.

Additionally—and importantly—DOE's work is also a window into the priorities of the U.S. government.

The Threat from China:

While China is not the only country that targets U.S. technology and the DOE complex, according to the ODNI's 2023 Annual Threat Assessment[2] "China is the top threat to U.S. technological competitiveness, as it targets key sectors and proprietary commercial and military technology from the U.S. and allied companies and institutions." This puts the DOE complex directly in China's crosshairs given the depth, breadth and importance of its mission.

Beijing views technology—and the robust S&T infrastructure needed to develop it—as a national asset. The way it has structured its system to reach this goal is inherently at odds with key assumptions of the global norms of science which are built on transparency, reciprocity and sharing. Beijing, especially Xi, looks at development as a zero sum game and that government support for key industries—the emerging technologies[1] such as AI, next generation communications and biotechnology—gives China an advantage. Xi's statements include the following:

- "We must regard science and technology as our primary productive force, talent as our primary resource, and innovation as our primary driver of growth," (November 2022)
- "We should seize the commanding heights of technological innovation." (May 2018)
- "Artificial Intelligence is a vital driving force for a new round of technological revolution and industrial transformation. China must control artificial intelligence and ensure it is securely keep in our own hands" (October 2018). [2]
- In a May 30, 2016 speech at the National S&T Innovation Conference to CAS, CAE, and CAST, Xi Jinping stated that "science and technology is a national weapon" and that "if China wants to be strong… it must have powerful science and technology." [3]
- "In today's world, S&T innovation has become a critical support for increasing comprehensive national strength…whoever holds the key to S&T innovation makes an offensive move in the chess game of S&T innovation and will be able to preempt the rivals and win the advantages." (June 2014)

Drivers of Technology Acquisition: Central Government S&T PLANS

[1] https://www.energy.gov/science-innovation
[2] https://www.dni.gov/files/ODNI/documents/assessments/ATA-2023-Unclassified-Report.pdf

China recognizes that future strength will be built on 5G, AI, biotechnology and advanced manufacturing. Its S&T development plans focus its efforts on acquiring technology that will help build these future industries, as well as the supporting industries that enable them. These are not always the "cutting edge" technology, but they either fill a strategic gap or help China control key supply chains for materials or goods.[iv] China's priorities are laid out in major policies like the Medium- and Long-Term Development Plan (MLP), Strategic Emerging Industries Strategy, and Made in China 2025.[1][2][3][4] In pursuing these technologies, China's lack of transparency with collaborators and aggressive technology acquisition practices pose increasing national security concerns. The policies focus not only on specific technology areas but seek to create the environment to foster innovation and development, and most importantly build a national innovation base that will be the foundation for future economic growth and military modernization that Beijing controls. Below is a selection of these plans and policies: [i]

The Medium and Long Term Plan for S&T Development, 2006-2020(中长期科技发展规划, 2006-2020) lays out a development strategy that is reliant on returnees, foreign collaboration, and adds a new dynamic of using the R&D laboratories of international companies that have flocked to China as another medium through which it can acquire the skills needed for China to move forward. [v] The MLP, has 16 "mega-projects" that include:

- Core electronic components;
- High-end generic chips, and basic software;
- Extra large-scale integrated circuit manufacturing and technique;
- New-generation broadband wireless mobile telecommunications;
- Advanced numeric-controlled machinery and basic manufacturing technology;
- Large-scale oil and gas exploration;
- Large advanced nuclear reactors;
- Water pollution control and treatment;
- Genetically modified new-organism variety breeding;
- Drug innovation and development;
- Control and treatment of AIDS, hepatitis, and other major diseases;
- Large aircraft;
- High-definition Earth observation systems; and
- Manned aerospace and Moon exploration.

There are three "mega-projects" that have not been publicly disclosed but are most likely:

- the Beidou satellite project;
- the high-energy laser project; and
- hypersonic vehicle.

China's plans for Strategic Emerging Industries[vi] also lays a blueprint for its future goals of dominating key sectors. It articulates how its goals are securing the China market first on the way to building global champions, creating a model for how China breaks into and controls key sectors. China considers the following its strategic emerging industries:

- energy efficient and environmental technologies;
- next generation information technology;
- biotechnology;
- high-end equipment manufacturing;
- new energy (such as solar or wind);
- new materials; and
- new energy vehicles.

Two studies produced by Georgetown University's Center for Security and Emerging Technology (CSET) provide additional details about the type of technologies China is seeking. The first uncovers how China uses S&T diplomats in embassies around the world to find and broker deals for a wide range of technology from AI and biotechnology, to items needed in factories such as vacuum seals and materials. China's "S&T Diplomats" (科技外交 官), broker transfer deals and coordinate with overseas experts to fulfill technology wish lists for Chinese entities. More than half of the 642 projects examined were biotechnology or AI projects.[vii] The second study looks at what China describes as "strangle-hold" technologies[viii]—or things where China has a gap. This list includes items such as different kinds of metrology, heavy duty gas turbines and materials for aircraft development, as well as the importance of quality in these areas. This relates to technological know-how which is equally important and why talent and training is targeted and sought after.

The "13th Five-year Plan for Military and Civil Fusion"[i] was established in 2017 and focused on emerging technologies. The plan specifically calls for a "cross-pollination of military and civilian technology in areas not traditionally seen as 'national security issues,' such as quantum telecommunication and computing, neuroscience and brain-inspired research," and states that such projects will be supported by foreign outreach initiatives. In addition to these overarching projects, there are programs to develop specific high-tech areas such as biotechnology,[ii] integrated circuits,[iii] and "next-generation" artificial intelligence.[iv] Each such program highlights the role foreign "talent" is expected to play.

China's legal system also complicates collaborations and the DOE complex's interactions with scientists and students from China. Many of China's laws compel its citizens to support its strategic goals-meaning visitors from China have to share information and data with Chinese entities if asked regardless of the restrictions placed on that data.[ix] These are China's central government laws and include:

1. National Security Law (2015).[x]
    - Article 77: Citizens and organizations shall perform the following obligations for safeguarding the national security: Provide national security authorities, public security authorities and military authorities with needed support and assistance.
2. Counterterrorism Law (2015).
    - Article 9: All work units and individuals are obligated to aid and assist the relevant departments in carrying out of counterterrorism work. If suspected terrorist activities or suspected terrorists are discovered

3. Cyber Security Law (2016). [xi]
    - Article 28: Network operators shall provide technical support and assistance to public security organs and national security organs that are safeguarding national security and investigating criminal activities in accordance with the law.
4. National Intelligence Law (2017).
    - Article 7: All organizations and citizens shall support, assist, and cooperate with national intelligence efforts in accordance with the law, and shall protect national work secrets they are aware of.

Human Cost of China's Behavior: The Role of Non-Traditional Collectors

One of the biggest challenges to understanding the scale and scope of China's actions, and designing mitigation strategies is China's use of what are called "non-traditional collectors." These are the experts—scientists, students and business people—who work on particular research projects in different industries and target technology and technological information. This is a different methodology and is documented in Chinese language policy documents over the last several decades.[xii] Our system—and I would add our institutions and the authorities we have granted them—is not designed to counter this kind of threat. Traditionally, counterintelligence has focused on intelligence officers, military end-use and illegal activities. I tell you today, if we only focus on trying to mitigate China's illegal actions, those undertaken by intelligence officers or those only related to military technology, we will fail.

The Chinese government's explicit efforts to exploit its diaspora—and our innovation base—must be addressed and countered. China's exploitation of its diaspora is also a threat to the great majority of persons of Chinese ethnicity who play no part in this, but are tarnished and may be subject to unjustified criticism because of China's actions. This makes for a difficult balance. Our response must be two-handed—protect the rights of the people targeted by the Chinese Communist Party (CCP) while dealing with transgressions. Notable here is the fact that increasingly, the CCP targets non-ethnic Chinese[3] scholars and scientists too, showing how this issue is not, in essence, one of ethnicity. Thus, the United States must continue to encourage academic exchange and an influx of scientific talent while at the same time find nuanced policy solutions, not only to stop the hemorrhaging of critical military and industrial technologies, but also, crucially, to play offense and continue to grow our national innovation base. This is also true for U.S. allies and like-minded countries worldwide.

The human cost of China's policies accrues in both directions, as Beijing disadvantages and tarnishes its own scientists who are trying honestly to work within global norms, because its domestic laws compel the disclosure of data/information. In this sense, the U.S. and other western countries are also culpable. By treating China as a neutral actor, and pretending that we operate within the same kind of system, we undercut those scientists and institutions in China trying to follow international norms. By not holding the Chinese government accountable, we give credence to a system that deprives China's educated elite from the dignity they aspire to and deserve. The Chinese people deserve better.

Talent Programs[xiii]

The CCP and Chinese government continue to view Western education—and the DOE complex—as an entry point into the U.S. innovation base because it is an easier target. Xi has called human capital the "first resource"[xiv] and China's policies reflect this.

[3] While most of China's talent programs are focused on individuals that are ethnically Chinese regardless of citizenship, China increasingly targets others as well.

- Chinese government's National Medium and Long-term Talent Development Plan (2010–2020), stated that talent was core to the country's social and economic development and set detailed national talent targets. [xv]
- 2017: "Plan to Build a National Technology Transfer System." A comprehensive articulation of China's tech transfer system. The acquisition of "high-level overseas talent"—both ethnic Chinese scientists from abroad and other foreign scientists—is emphasized throughout.
- 2016: "Planning Guide for Manufacturing Talent Development." Joint plan to import (another) "1000" foreign experts able to make "breakthrough" improvements, via talent programs and other venues. Emphasizes recruiting from "famous overseas companies."
- CAST's "HOME Program" (or Haizhi Plan, 海智计划)," instituted in 2004 by the Chinese Association for Science and Technology to "Help Our Motherland through Elite Intellectual Resources from Overseas," and supported by China's central and local governments. Its 2019 slate includes 29 projects.[xvi]

In addition to these overarching projects, as mentioned previously there are programs to develop specific high-tech areas such as biotechnology, integrated circuits, and "next-generation" artificial intelligence. Each such program highlights the role foreign "talent" is expected to play. [xvii]

China's strategy to target the DOE lab complex, and U.S. technology in general is coordinated, massive, and comprehensive. It has a multifaceted effort to acquire technology and technological know-how using legal, illegal and extralegal approaches to fill its strategic gaps. [xviii] Below is a more complete list of methodologies China uses to target technology and are seen throughout the DOE complex:

"Legal Transfers"[4]

- China-based subsidiaries of foreign companies
- Competitions (companies, universities)
- Conferences and colloquia
- Direct technology purchases
- Enrollments at foreign universities with ties to DOE
- Investments / acquisition of companies

Illegal Transfers

- Breach of contract
- Computer network exploitation
- Copyright infringement
- Reverse engineering with technological knowledge gained from the DOE complex

Extralegal Transfers

- China-based overseas returnee facilities
- Chinese professional associations
- Technology transfer forums

[4] China often uses legitimate forums and collaborations as an entrée point to work in the "grey" area and target technology and technological know-how.

- Chinese student and scholar associations
- University-linked "innovation" parks
- Technology consulting companies

China has an extensive bureaucracy—both in China and throughout the world—set up to support its technology acquisition activities. Many of these organizations seem benign at first, but they are arms of the state and represent a very different system than the U.S. and other collaborators. Below is an overview of some of this bureaucracy:

Central Government Offices

China's technology acquisition efforts are supported by government offices, with central government management replicated at the local level. They include: The State Administration of Foreign Experts Affairs (SAFEA, 国家外国专家局),[xix] the Overseas Chinese Affairs Office (OCAO, 国务院侨务办公室), the Ministry of Human Resources and Social Security (MHRSS, 人力资源和社会保障部),[xx] Ministry of Science and Technology (MOST, 科学技术部), Ministry of Education (MOE, 教育部), the Chinese Academy of Sciences (CAS, 中国科学院),[xxi] and China's clandestine services.[xxii]

"Unofficial Bureaucracy"

China uses NGOs and front organizations that parallel official bureaucracy to support programs while offering plausible deniability to foreign participants. The China Association for Science and Technology (中国科学技术协会)[xxiii] runs a "Help Our Motherland through Elite Intellectual Resources from Overseas."[xxiv] China's United Front Work Department (统一战线工作部) and Western Returned Scholars Association (欧美同学会) support transfers in multiple ways.[xxv] Other NGOs share staff and offices with their government counterparts, such as the China Overseas Exchange Association (中国海外交流学会), which fronts for OCAO, and SAFEA's "China International Talent Exchange Association" (中国国际人才交流协会)[xxvi] with multiple branches overseas.

Open source exploitation

China has operated a science and technology intelligence (STI) program since 1958 to identify useful technologies and facilitate their transfer, and seeks DOE information and data to support its strategic programs. Insiders put the number of workers at 100,000,[xxvii] up from 60,000 in 1985.[xxviii] Its budget can exceed state expenditure on R&D.[xxix] These figures are matched by a level of professionalization among "STI workers" (科技情报工作人员) unrivaled elsewhere.[xxx] Its accomplishments, heralded in book-length accounts, include support for nuclear weapons, missile, and satellite programs.[xxxi]

Overseas Advocacy Groups

Some 200 ethnic Chinese professional associations abroad accumulate the science, engineering, and enabling skills sought by China.[xxxii] Many of these groups were created independently by expatriates while others were launched at the PRC's behest. Some 61 percent "exchange

technical information, bring scientists to China, or contribute to specific Chinese talent plans."[xxxiii] Half advertise their support for China on the Chinese language versions of their websites only,[xxxiv] and many acknowledge their raison d'être as "serving China" (为国服务).

Technology Parks

Ranging from modest offices to multi-acre, multi-story mega-centers, China has put in place Technology Transfer Centers, or Overseas Chinese Scholar Pioneering Parks, National Innovation Centers for New and High Technology, etc.,[xxxv] that are subsidized clearinghouses for to transfer foreign IP to China. Studies done in 2010,[xxxvi] 2016,[xxxvii] and 2019[xxxviii] traced their growth from fewer than 300 to its present number of some 2,000 facilities.

Additionally, exploitation of Chinese language sources uncovered two-dozen major "notifications" by the State Council, Communist Party Central Committee, and national ministries between 1994 and 2020 to facilitate access to foreign technology "by various means" (**以多种方式**).[xxxix] Included are subsidies for "short term" returnees and "dual base" operations, where research abroad is mirrored in China; indigenization enclaves; "talent" programs; and incentives to transfer "patents, scientific research results, or proprietary technology."[xl] The directives are backed by measures from local authorities and these groups actively reach out to scientists currently in the DOE complex.

Figure 1: Above is a graphic representation of China's S&T development and technology transfer efforts. China takes a holistic approach to developing its S&T infrastructure and employs all facets of its government and society to acquire technology.

Conclusions

China's holistic approach to development, blurring what is civilian, what is military, what is private and what is public—has deep implications for the DOE complex. It impacts the basis for entry of Chinese students and post-docs into U.S. labs because of China's ability to compel citizens to share information. It also challenges existing export and visa policies that build their restrictions around affiliations with a military end-users but make exceptions for civilian uses. To the Chinese leadership, every civilian use is also a potential military use.

China's policies to target the DOE complex are the expression of a deliberate, state-sponsored strategy to save time and money, and "leap-frog" to the international forefront by leveraging the advances of other nations. While military and intelligence related technology are still targeted, China's efforts increasingly focus on technologies of the future such as AI, biotechnology and precision medicine and advanced manufacturing and materials. [xli]

There is no magic bullet to solving these complex challenges but, mitigation strategies should include investments in our own future, as well as concrete steps in the short-term that focus on protecting our innovation base. These steps should include stemming China's influence in our academic and research institutions through enhanced reporting requirements for resources from the Chinese government and talent programs or dual appointments, and tying collaborations and access to U.S. facilities and data to meeting the agreed upon criteria of any S&T agreement. Finally, the U.S. needs a long-term strategy to deal with a nation state with a very different system. To date, our attempts at exquisite rules-based, laws-based mitigation efforts that try to carve out collaborations with "civilian and private" entities fall flat. Below are additional suggestions for what a mitigation strategy should include:

Improve ourselves: The United States and other liberal democracies must invest in their respective futures. Not all discovery has immediate commercial applications—it took 30 years from discovery to development of the Lithium-ion battery. We must accept that everything should not be only about the lowest cost, but instead focus on the highest value for the nation. We must build research security into future funding programs. What has been laid out here demonstrates the depth and breadth of China's efforts to target our technology, and the lengths it will go to acquire it. The United States must encourage STEM education and create support networks for under-represented populations in the STEM fields. Many students leave STEM fields in the first year. If students are working their way through college, they may not have time for lab work or research experiences. Funding should be provided for this, as we are leaving whole segments of our population behind.

Face the facts: Beijing doesn't play by free-market rules, it does not respect intellectual property, it is willing to act directly or indirectly to ensure its favored companies win in the market, and it doesn't share the same views on political openness the United States, Europe and other "like-minded" countries have long shared. Engagement with China has not made it more open, and it has not acquiesced to existing norms and rules. Acknowledging this reality complicates mitigations, because we are not negotiating on individual policies but against a different system. Moreover, the people who come here, however well-meaning they are personally, are to a greater or lesser extent beholden to China's system.

Increase Transparency*:* Existing policies and laws are insufficient to address the level of influence the Chinese Communist Party exerts in our society—especially in academia. The CCP exploits identity politics through United Front influence campaigns and other state efforts. This must be addressed and made public. The recent revelations about influence in Facebook are a start. By the same token, we must increase reporting requirements for foreign money at our academic and research institutes, as well as state and local governments to better identify these avenues of influence. Talent programs set up by the Chinese government, because of the restrictions and rules they place on the participants, present a conflict of commitment where

participants are often serving two different organizations, which at best introduces conflicts of interest and in some cases fraud, and other illegal activity. Universities, government labs and research institutions should have clear reporting requirements and rules on participation. Recent actions by DOE and some academic institutions are a good first step but still don't address the entirety of the problem.

Ensure True Reciprocity: Too often S&T agreements between U.S. and China's entities do not result in true reciprocity including sharing of data from the China, access to China's most advanced institutions, and interactions with China's scientists without government interference. Connecting China's reciprocity and sharing of scientific data to its access to U.S. institutions and big science facilities is a leverage point. For too long we have looked the other way when China has not followed through on the details of the agreements that it has entered into. American taxpayers should receive benefit from the research they are supporting.

Bolster Cooperation and Alliances: Greater cooperation and integration with Allies and like-minded countries will not only foster the development of emerging tech industries, but also create alternative innovation hubs that mitigate China's unfair practices and continue to foster the global norms of science.

In moving forward, I leave the committee with the following thoughts:

- Extreme propositions, such as closing our eyes (laissez faire) or closing our doors, only benefit China—the latter by discrediting en masse all efforts to address the problem and by depriving ourselves of the contributions of foreign-born scientists.

- China's policies and plans form a complementary web of development and industrial policies for emerging technologies—and talent growth—and most importantly build a national innovation base that will be the foundation for future economic growth and military modernization that Beijing controls. ***It is not where they are today in certain fields, but the rate of change that we should focus on.***

- China's policies are increasingly challenging for the United States and its allies to counter with policy measures because ***most policy measures are tactical and not designed to counter an entire system that is structurally different***.

What will also make this difficult is that the reality that China is presenting is inconvenient to those benefiting in the short-term. This includes companies looking for short-term profits, not long-term sustainability of a particular industry, academics that benefit personally from funding or cheap labor in their labs, and former government officials who cash in as lobbyists for China's state-owned and state-supported companies. China is masterful at divide-and-conquer, identity politics, controlling the narrative and falsely presenting engagements as "win-win." In reality, China wins twice—both by gaining technology and controlling the narrative in such a way that its behavior, over time, gains legitimacy.

By not talking about the structural differences in our systems and instead focusing on individual instances of bad behavior—what is happening can seem anecdotal. In order to secure the DOE complex and protect U.S. competitiveness we have to move beyond the current tactical approach—and instead build research security into our investments, policies and programs from the beginning.

I want to thank the committee again for continuing to discuss this issue. These are hard conversations that we as a nation must have if we are to protect and promote U.S. competitiveness, future developments, and our values. If we do not highlight and address China's policies that violate global norms and our values, we give credence to a system that undermines fairness, openness and human rights, and deprives China's educated elite of the dignity they aspire to and deserve. The Chinese people deserve better. The U.S. people deserve better. Our future depends on it.

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[i] IBID

[ii] William C. Hannas and Didi Kirsten Tatlow, *Beyond Espionage: China's Quest for Foreign Technology* (Routledge 1st edition, September 2020); Alex Joske, "Hunting the Phoenix," Australian Strategic Policy Institute, 2020, https://www.aspi.org.au/report/hunting-phoenix ; Receipts of local UFWD paying overseas scientists available at: "The distribution list of provincial-level projects for the introduction of foreign intelligence special funds at the provincial level in 2018" [2018 年省级引进国外智利专项经费直项目分配明细表], https://web.archive.org/web/20201112190122/http://webcache.googleusercontent.com/search?q=cache%3AKAaZ3LpEe4oJ%3Arst.hunan.gov.cn%2Frst%2Fxxgk%2Ftzgg%2F201802%2F9516964%2Ffiles%2Fe1c7ddd51dda49f6b70a6ad5ae9b0490.xls+&cd=3&hl=en&ct=clnk&gl=us

[iii] E.g., "The IP Commission Report." The Commission on the Theft of American Intellectual Property (May 2013). Hannas, Mulvenon and Puglisi, *Chinese Industrial Espionage*. (Routledge, 2013) hereafter "*CIE*." Michael Brown and Pavneet Singh, "China's Technology Transfer Strategy" (DIUX, February 2017). Section 301 *Report into China's Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation*. Office of the United States Trade Representative (27 March 2018). U.S.-China Economic and Security Review Commission, "2019 Annual Report to Congress" (November 2019).

[iv] 十三五" 科技军民融合发展专项规划. MOST, CMC, 2017; 国务院关于印发"十三五"国家战略性新兴产业发展规划的通知. State Council, 2016; 国家科技创新基地优化整合方案. MOST, MOF, National Development and Reform Commission, 2017; 十三五" 科技军民融合发展专项规划. MOST, CMC, 2017; Simon and CAO, "China's Emerging Technological Edge: Assessing the Role of High-End Talent". Cambridge University Press, 2009.

[v] Cao et al., *China's 15-year science and technology plan*, Physics Today, December 2006.; McGregor, James, China' s Drive for "indigenous Innovation" A Web of Industrial Policies, Global Regulatory Cooperation Project, US Chamber of Commerce.

[vi] XU, Yingying, "The Strategic Emerging Industries: A new stage for Manufacturing in China" The Economist, 13 March 12; www.most.gov.cn/eng/programmes1/200610/t20061009_36225.htm]www.863.gov.cn/; Osnos, Even, Green Giant: Beijing's Crash program for clean Energy, The New Yorker, 21 December 2009; www.gov.cn/english/2006-02/09/content_184156.htm; Du Minghua, "863" Hi-Tech Program Blueprinting China's Future, 1 January, 200, from China Education and Research network website www.edu.cn/achievement_1509/20060323/t20060323_4403.shtml; Chinese government policy documents at : www.china.org.cn/english/scitech/34496.htm, www.most.cn/eng/ and Cao et al., *China's 15-year science and technology plan*, Physics Today, December 2006; "New Policies to be Issued to Lure Overseas Students Home," *People's Daily*, 29 July 2000, "China Allotted 200 Million Yuan for Students Returned from Overseas," *People's Daily*, 22 January 2002; McGregor, James, China' s Drive for "indigenous Innovation" A Web of Industrial Policies, Global Regulatory Cooperation Project, US Chamber of Commerce.

[vii] Ryan Fedasiuk, Emily Weinstein, and Anna Puglisi, "China's Foreign Technology Wish List," Georgetown University, Center for Security and Emerging Technology, May 2021.

[viii] PRC Ministry of Education (教育部) website, September 24, 2020. This article is a summary of a series of 35 separate articles that Science and Technology Daily (科技日报)—a weekday newspaper published under the auspices of (代管) the PRC Ministry of Science and Technology (MOST; 科技部) —published in 2018.

[ix] Findings of the Investigations into China's Acts, Policies and Practices related to Technology Transfer, Intellectual Property and Innovation under Section 301 of the Trade Act of 1974", March 22, 2018, USTR.

[x] China's National Security Law (2015), Counterterrorism Law (2015), Cybersecurity Law (2016) and National Intelligence Law (2017).

[xi] China's National Security Law (2015), Counterterrorism Law (2015), Cybersecurity Law (2016) and National Intelligence Law (2017).

[xii] These policies include "two bases formula", "short-term visits" and "serve in place. See Hannas et al., Routledge 2013 more a more in depth treatment of these policies.

[xiii] Original CSET Data Visualization, "Chinese Talent Program Tracker," Center for Security and Emerging Technology, November 2020. https://doi.org/10.51593/20200066

[xiv] "十三五" 生物技术创新专项规划 (*13th Five-year Plan for Biotechnology Innovation*). MOST, 2017; 国家集成电路产业发展推进纲要 (National Integrated Circuit Industry Development Plan). State Council, 2014; 新一代人工智能发展规划. (Next-Generation Artificial Intelligence Development Plan). State Council, 2017; "Why is Xi Jinping's 'First Resource' so important?" ["习近平眼里的"第一资源"为何如此重要"], *People* [人民网], July 18, 2018, http://politics.people.com.cn/n1/2018/0718/c1001-30155931.html.; 国家技术转移体系建设方案. State Council, 2017; 制造业人才发展规划指南. MOE, MHRSS, MIIT, 2016.

[xv] "十三五" 科技军民融合发展专项规划. MOST, CMC, 2017.

[xvi] Hannas and Tatlow, "China's Quest for Foreign Technology: Beyond Espionage" Routledge, 2020.

[xvii] "十三五" 科技军民融合发展专项规划. MOST, CMC, 2017; "十三五" 生物技术创新专项规划 (*13th Five-year Plan for Biotechnology Innovation*). MOST, 2017; 国家集成电路产业发展推进纲要 (National Integrated Circuit Industry Development Plan). State Council, 2014; 新一代人工智能发展规划. (Next-Generation Artificial Intelligence Development Plan). State Council, 2017.

[xviii] Cory Bennett and Bryan Bender, How China Acquires "The Crown Jewels" of US technology, POLITICO, May 22, 2018; http://www.politico.com/story/2018/05/22/china-us-tech-companies-cfius-572413; Jackie Northam, China Makes Big Play in Silicon Valley, NPR, Oct. 7, 2018.

[xix] Formerly independent but now part of MOST.

[xx] Formerly China's Ministry of Personnel.

[xxi] CAS's status as an appendage of the PRC government was confirmed by a senior staff member in a letter to the editor of *Nature* magazine on October 20, 2019, www.nature.com/articles/d41586-019-03205-z.

[xxii] Matthew Brazil and Peter Mattis, *Chinese Communist Espionage: and Intelligence Primer*, Naval Institute Press, 2019.

[xxiii] CAST's formal affiliation with the PRC government is demonstrated in Hannas, Mulvenon, Puglisi, 2013, p. 97.

[xxiv] Hannas and Chang, "Chinese Technology Transfer—Introduction," in Hannas and Tatlow, eds., 2021, pp. 11-12.

[xxv] Alex Joske and Jeffrey Stoff, "The United Front and Technology Transfer," in Ibid., pp. 258-274. Ryan Fedasiuk, "Putting Money in the Party's Mouth: How China Mobilizes Funding for United Front Work," *The Jamestown Foundation*, September 16, 2020.

[xxvi] Formerly the "China Association for the International Exchange of Personnel" (CAIEP).

[xxvii] Zeng Jianxun (曾建勋), "基于国家科技管理平台的科技情报事业发展思考 (Reflections on the Development of the Scientific and Technical Information Industry Based on the National Science and Technology Management Platform)," 情报学报 (*Journal of the China Society for Scientific and Technical Information*), 2019: 38 (3), pp. 227-238.

[xxviii] Miao Qihao, "Technological and Industrial Intelligence in China: Development, Transition and Perspectives," Prescott and Gibbons, eds., *Global Perspectives on Competitive Intelligence*, Alexandria, VA: Society of Competitive Intelligence Professionals, 1993, pp. 49-53.

[xxix] Chen Jiugeng, "Actual Strength of S&T Information Service System in China," *China Information Review*, 2006: 10, pp. 17-22.

[xxx] Hannas and Chang, January 2021.

[xxxi] Huo Zhongwen (**霍忠文**) and Wang Zongxiao (**王宗孝**), **国防科技情**报**源及获取技**术 (*Sources and Methods of Obtaining National Defense Science and Technology Intelligence*), Beijing: Kexue Jishu Wenxuan Publishing Company, 1991, and 中国科学技术信息研究所 (ISTIC), 甲子辉煌—中国科学技术信息研究所成立60周年纪念 (*60 Years of Glory—The 60th Anniversary of the Founding of the Institute of Science and Technical Information of China*), Beijing, 2016.

[xxxii] Hannas, Mulvenon and Puglisi, 2013. Ryan Fedasiuk and Emily Weinstein, July 2020.

[xxxiii] Fedasiuk and Weinstein, July 2020.

[xxxiv] Ibid.

[xxxv] Hannas, Mulvenon, Puglisi, 2013, p. 176.

[xxxvi] Ibid.

[xxxviii] Ryan Fedasiuk, Georgetown University, unpublished CSET research.

[xxxix] Hannas and Tatlow, eds., 2021, especially pp. 9-11.

[xl] Ibid., p. 10.

[xli] Hannas, Mulvenon and Puglisi, *Chinese Industrial Espionage*. (Routledge, 2013) hereafter "*CIE*." E.g., "The IP Commission Report." The Commission on the Theft of American Intellectual Property (May 2013). Michael Brown and Pavneet Singh, "China's Technology Transfer Strategy" (DIUX, February 2017). Section 301 *Report into China's Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation*. Office of the United States Trade Representative (27 March 2018). U.S.-China Economic and Security Review Commission, "2019 Annual Report to Congress" (November 2019).