中国简报 China Brief
a journal of analysis and information
The JAMESTOWN FOUNDATION

VOLUME 19 • ISSUE 2 • JANUARY 18, 2019

IN THIS ISSUE:

Successful Lunar Landing Demonstrates Continuing PRC Advancements in Space

By John Dotson

China's Lunar Probe Explores New Territory on the Moon's Surface

On January 3rd, PRC officials announced a successful landing by the *Chang'E-4* probe (嫦娥四号探测器) in the Van Karman Crater near the lunar south pole. **[1]** The mission was noteworthy for being the first time that any lunar probe had successfully landed on the far side (or "dark side") of the moon's surface. **[2]** Chinese state media hailed the landing as both a scientific milestone and a "great achievement for the motherland" (Xinhua, January 4). NASA Administrator Jim Bridenstine joined other international voices in praising this latest achievement for the PRC space program, stating: "Congratulations to China's Chang'e-4 team for what appears to be a successful landing on the far side of the Moon. This is a first for humanity and an impressive accomplishment!" (Twitter, January 2)

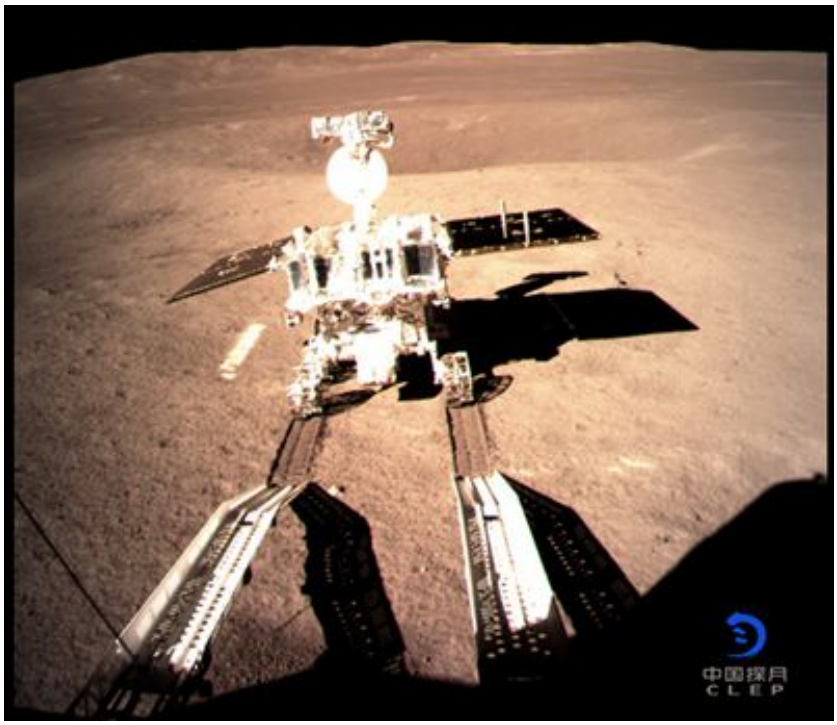


Image: The rover Yutu-2 *deploying on the moon's surface after a successful landing by the Chang'E-4 lunar probe (January 3).* (China National Space Administration)

The *Chang'E-4* probe and its associated *Yutu-2* rover vehicle (玉兔二号巡视器) contain instruments for analyzing lunar geology, to include "a panoramic camera, infrared imaging spectrometer, and radar measurement devices, to obtain images of the moon's surface and detect lunar soil and structure" (Xinhua, January 4). The probe also reportedly holds an experimental package of plant seeds and silkworm eggs, intended to monitor the ability of these organisms to survive and grow in the lunar environment. It further contains at least two sensor packages managed jointly with European partners: a particle detector from German researchers, and an ion detector from scientists in Sweden (National Geographic, January 2).

The History of China's Lunar Exploration Program

The PRC's *Chang'E* lunar exploration program, named for a goddess of the moon from Chinese mythology, dates back to the launch of the initial *Chang'E* probe in 2007. This first platform orbited approximately 200 kilometers from the moon over a period of 16 months, mapping the lunar surface and taking remote measurements of lunar soil, before ending in a controlled crash on the moon's surface in March 2009. The second *Chang'E* mission, launched in October 2010, conducted similar surveys in lunar orbit before proceeding into deeper space, where it conducted a close fly-by of the asteroid "4179 Toutatis" in December 2012. *Chang'E-3* was the first of China's probes to actually touch down on the moon's surface, landing in December 2013 in the Sinus Iridum Crater. *Chang'E-3* and its associated *Yutu-1* rover conducted geological surveys and astronomical observations until the two platforms experienced a series of technical difficulties,

which resulted in a final loss of contact in July 2016 (Spaceflight Now, August 4 2016; Xinhua Backgrounder, December 8 2018).

Even as the *Chang'E-3* mission was ongoing, PRC officials had indicated as early as May 2015 that the next planned mission, *Chang'E-4*, would be directed towards a landing on the far side of the lunar surface (Chinese Academy of Sciences, May 21 2015). It is likely that Chinese scientists were interested in the prospects for making genuinely new scientific discoveries amid the geological formations and astronomical vantage points of the moon's unexplored far side; it is also likely that the opportunity to achieve a space exploration milestone held great patriotic appeal for PRC scientists and government officials alike. The successful deployment on January 3rd of both the lunar landing vehicle and its lunar rover provided a dramatic vindication of the aspirations announced nearly four years earlier.

The Planned Future of Chinese Lunar Exploration

Chinese exploration of the moon is unlikely to end with the current mission, and ambitious plans have already been announced for the future of the *Chang'E* program. A planned launch of the *Chang'E-5* platform was originally scheduled for November 2017, but was scrubbed due to problems with the *Long March 5* heavy launch rocket. Plans have since been announced for a *Chang'E-5* launch sometime in 2019 (GB Times, April 25 2018).

Chang'E-5 is intended to be a lunar sample return mission, consisting of four modules: two will land in the Oceanus Procellarum (a lunar mare in the western region of the moon's visible side), with one platform collecting geologic samples, and the second returning them to orbit; a third module will act as a docking station in orbit; and a fourth module in orbit will then return the samples to Earth (NASA Goddard Space Flight Center, December 7 2018). This multi-stage effort would be the most complicated yet attempted in the Chinese lunar program, and reflects a growing willingness by PRC space engineers to attempt increasingly challenging and complex operations.

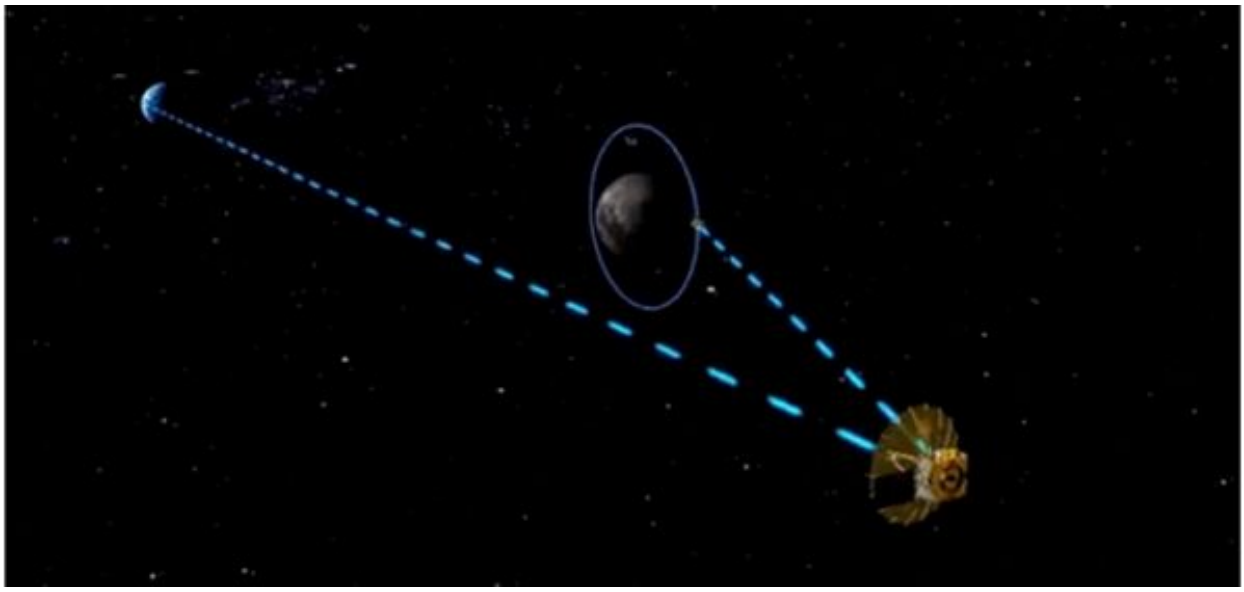
In the wake of the successful *Chang'E-4* landing, officials from the China National Space Administration made further announcements regarding future moon missions: a *Chang'E-6* mission intended to bring back geologic samples from the lunar south pole; a *Chang'E-7* mission to perform terrain and environment surveys in the same region; and a *Chang'E-8* mission to test technologies associated with a possible lunar research base (Xinhua, January 14). No projected dates have yet been announced for these missions.

The possibilities for such missions beyond *Chang'E-5* point to ambitious plans on the table for the coming decades. In a promotional video jointly produced by the National Defense Technology Industry Agency (国家国防科技工业局) and the National Aerospace Agency (国家航天局)for the PRC's "National Space Day" in April 2018, plans were announced to work towards a future manned outpost near the lunar south pole (China News, April 24 2018). Senior scientists involved with China's lunar exploration program have suggested that such a lunar base might follow from manned missions to the moon, projected for the 2030s (GB Times,

March 12 2018). These future Chinese efforts could involve Russian cooperation: Russian media announced in June 2018 that the two countries had agreed to establish a joint information center to support future lunar and deep space explorations (Moscow Times, June 8 2018).

The *Queqiao* Satellite and a Banner Year for China's Satellite Industry

To support the *Chang'E-4* mission, the *Queqiao* ("Magpie Bridge") satellite (鹊桥卫星) was launched on May 21 2018, and entered its orbital position on June 14, 2018 (Xinhua, June 14 2018). The satellite now reportedly holds a halo-shaped orbital pattern in space around Lagrange Point 2, at a distance of approximately 455,000km from Earth (Xinhua, December 8 2018). **[3]** From this position, *Queqiao* acts as a signal relay for transmissions between the *Chang'E-4* craft (and its rover) and mission control personnel on Earth *(see image below).* In addition, *Queqiao* is also equipped with another joint Sino-European project: the Netherlands-China Low-Frequency Explorer (NCLE), an experimental low-frequency radio astronomy device (Netherlands Institute for Radio Astronomy, undated).



A still image from a video produced by the China Academy of Space Technology that illustrates how the Queqiao satellite (lower right), orbiting around Lagrange Point 2 beyond the moon, acts as a signal relay for another platform in lunar orbit. (GB Times, Dec 19 2018).

The successful deployment of the *Queqiao* satellite received far less media attention than the *Chang'E-4* lunar landing, but it demonstrates a development with potentially greater implications for China's technological, commercial, and military future: namely, the PRC's continuing successes in deploying an ever-more advanced array of orbital satellite systems. 2018 was a banner year for PRC space launches, with a combined 36 launches from the PRC's two major launch centers in Jiuquan, Inner Mongolia and Xichang, Sichuan Province (MIT Technology Review, December 19 2018; NASA Spaceflight, December 21 2018).

Aside from the *Queqiao* operation, other successful satellite launches in 2018 included:

- Eight pairs of satellites (sixteen total) for the Mark 3 Beidou (北斗) Satellite Navigation System were successfully sent into orbit in 2018, with official statements predicting the successful completion of the Beidou-3 constellation in 2020 (GB Times, November 19 2018; China Satellite Navigation Office, December 27 2018).
- In early June, China launched what was reportedly the last of its *Fengyun-2* (风云二号) series of meteorology satellites, which was hailed in state media as a means for China to assist countries participating in the Belt and Road Initiative with information regarding storms and other natural disasters (Xinhua, June 5 2018).
- On December 21, the PRC sent into orbit the first in its series of *Hongyun* (虹云) satellites. When complete, the *Hongyun* constellation is intended to be a "network of 156 communications satellites into low Earth orbit… capable of covering every corner on the Earth, including the Arctic and Antarctica" (NASA Spaceflight, December 21 2018).

Implications for the Future

The landing of *Chang'E-4* and its rover on the moon's far side, and the successful deployment of the *Queqiao* satellite as a signal relay platform, both represent capstone achievements for China's evolving space program. The PRC's aspirations for space exploration are bold—particularly its declared goals of sending manned missions to the moon, and even constructing a habitable lunar base—and it remains to be seen whether practical engineering will successfully match soaring ambition. There is every indication, however, that the PRC is seriously applying attention and resources towards the achievement of these goals, which are bound together with national pride and the government's intent to project an image of China emerging as a successful great power under the leadership of the CCP.

Beyond matters of national prestige, the PRC's lunar exploration program—and in particular, the *Queqiao* satellite—also demonstrate how the continuing advancements of China's space industry carry implications much closer to home. *Queqiao* demonstrates not only the advancing capabilities of the PRC space industry to support more challenging space exploration missions; it also displays the increasingly robust capacity of the PRC to place into orbit an ever-expanding array of satellites with broad commercial and military applications. *Queqiao* was perhaps the most dramatic Chinese satellite project of 2018, but it was accompanied by the successful deployment of dozens of other satellites that are steadily increasing the PRC's capabilities (and potentially, competitive positions) in navigation, telecommunications, meteorology, and other fields. Even as inspiring images return from the far side of the moon, government, commercial, and scientific leaders should remain cognizant of the potential implications that PRC aerospace advancements may hold for the nearer-term terrestrial future.

John Dotson is the new editor of China Brief. Contact him at cbeditor@jamestown.org.

Notes

[1] The Van Karman Crater (VKC) is a large impact crater (approx. 180km in diameter) located in the southern hemisphere of the far side of the moon. The VKC is located within an even larger impact crater known as the South Pole – Aitken Basin (Universities Space Research Association – Houston, undated).
[2] The far side (or "dark side") of the moon is normally obscured from terrestrial-based sensors and transmitters due to the fact that Earth's gravity holds the moon in a synchronous rotational orbit – with one hemisphere permanently facing Earth, and the other (the far side) facing deeper space (Space.com, November 14 2017).
[3] A Lagrange point is a location in space where the combined gravitational forces of two celestial bodies create a region of equilibrium, in which a smaller object may maintain a stationary (or semi-stationary) position relative to the larger two bodies. Lagrange Point #2 is located beyond the moon's orbit around Earth (NASA, March 27 2018; and NASA, June 23 2010).

***

Emerging EU Policies Take a Harder Look at Chinese Investments

By Ashley Feng and Sagatom Saha

Like the Belt and Road Initiative (BRI), foreign direct investment (FDI) from the People's Republic of China (PRC) now has a much broader reach than Beijing's own backyard. It is well-known that Washington is actively working toward mitigating U.S. vulnerabilities to PRC investments in strategic sectors, and those that contain critical technologies and infrastructure. However, Europe, a region that also offers access to high technology desired by the PRC, is also taking a harder look at its own potential investment vulnerabilities. This process is leading to increasing debates and increasing regulation, both of which could impact the future course of Chinese investment in Europe.

While overall PRC foreign investment fell in 2017, investments in Europe were more resilient, increasing to 25 percent of the PRC's global investment as compared to 20 percent in the previous year. PRC investment in Europe doubled in 2016 to $40 billion as compared to the previous year (Economist, October 4 2018). This figure dipped in 2017, but still remained robust at an estimated $33.7 billion (Merics and Rhodium Group, May 2018). Of the PRC's top twenty foreign investment destinations in 2017, five were EU member states (PRC Ministry of Commerce, October 2018).

In order to defend its strategic interests, the European Union passed an investment screening mechanism in November 2018 targeted at the PRC. However, the voluntary nature of the mechanism, as well as concerns that the investment screening process may not be strict enough, has caused individual member states to rely on their own national laws and regulations. While there is a definite need to be more vigilant as individual member states decide how to defend their critical technologies and economic infrastructure from the transfer of intellectual property to the PRC, individual EU states should band together against the PRC's vast economic weight and its tendency to press for bilateral, rather than multilateral, deals. Converging around France's regime of investment regulation is a place to start.

France: "Long-Term Investments, Not Looting"

France has a longer history than its neighbors of scrutinizing foreign direct investment (FDI). The French Parliament first passed legislation in 2003 that enabled the government to screen and cancel foreign investments in national security sectors like defense (Légifrance, March 9 2003). The parliament later expanded the government's jurisdiction in 2014 to cover sectors traditionally considered "critical"—such as energy, transportation, health and communications (Légifrance, May 15 2014). However, it is important to note that it was a proposal from a U.S. firm, General Electric, that served as the primary trigger for this expansion of French investment screening (Politico, June 26 2014).

It did not take long for PRC investment to become a central concern for French lawmakers. In the first month of Emmanuel Macron's presidency, the newly-elected French president temporarily nationalized French shipbuilder STX, which owns the only shipyard in France large enough to construct naval vessels and warships (Defense News, September 27 2017). Macron made the move to halt the purchase of STX by Fincantieri, an Italian firm in a joint venture with a Chinese state-owned firm (Le Figaro, April 20 2017). The deal only went through after the French government received an unusual guarantee: namely, that it could renationalize STX if Fincantieri failed to safeguard dual-use technology from transfer to Beijing (Le Monde, September 27 2017).

Later, at the beginning of 2018, the French Ministry of Economy and Finance announced that it would strengthen its 2014 decree by expanding the definition of critical technology to include artificial intelligence, cybersecurity, robotics, big data, and semiconductors, thereby tightening rules against forced technology transfers (French Ministry of Economy and Finance, February 19 2018).

Most importantly, France is pushing a new approach to investment screening that could translate well to its neighbors, based on the concept of "golden shares" (Reuters, July 19 2018). Under this concept, the French government would grant itself golden shares that bestow special voting rights, such as the ability to block potential acquisitions in companies operating in critical sectors. Unlike other investment screening mechanisms, the European Commission has made it clear that EU law permits golden shares as long as countries can justify their use on the grounds of national security, or consumer and environmental protection. Experts have praised the concept on the grounds that it allows France to sell off ailing state assets while maintaining state influence in strategic industries (Reuters, July 19 2018).

Because of its relatively high debt-to-GDP levels, France cannot easily close itself off to increasing PRC investment (Eurostat, June 6 2018). In fact, President Macron's first state visit in 2018 was to China, where he welcomed long-term PRC investment while pushing for better access to the Chinese market for French companies, and stronger protection for French intellectual property. President Macron's finance minister, Bruno Le Maire, added a strong warning: "If investors come to France or Europe only to gain access to the best technology without benefiting France or any other European country then they are not welcome. There are looters in every country, and all of them need to understand that Europe has the means to protect itself" (Bloomberg, January 9 2018).

United Kingdom: A Two-Track System

Despite the negative economic implications of Brexit, the United Kingdom has paralleled France in tightening the regulation of FDI. Between 2000 and 2016, the United Kingdom was the largest destination country for

new Chinese investment in Europe, with the country accounting for 23 percent of Chinese FDI during the same period. Like elsewhere in Europe, PRC investment in the United Kingdom has been concentrated in a handful of sectors: real estate and hospitality, information communication and technology, agriculture and food, and energy (Institut Français des Relations Internationales, December 2017).

Extensive PRC investment in sensitive areas of the UK economy during the tenure of former Prime Minister David Cameron—such as the Hinkley Point C nuclear power plant—resulted in calls for stricter investment rules under Prime Minister Theresa May. The decision to allow investment in Hinckley Point by China General Nuclear Power Group, a state-owned enterprise that has been accused of trying to obtain US nuclear technology for Beijing, resulted in the proposal of a new legal framework for foreign investments in Britain (The Guardian, December 21 2017). The new proposal, first aired for public consideration in September 2016, would allow the British government to intervene in investment projects where the government identifies national security concerns (Latham & Watkins, September 16 2016).

The UK proposal came along two tracks: a short-term proposal intended to change the Enterprise Act of 2002; and a longer term, far-reaching reform that culminated in an official white paper in July 2018. The Enterprise Act is the current legal framework that allow the Competition and Markets Authority to screen investments into the United Kingdom. In certain instances, the Secretary of State may intervene on matters relating to national security, media plurality, and financial stability (Herbert, Smith, Freehills, October 18 2017). The short-term proposal declared that deals involving companies with revenues of 1 million pounds (decreased from 70 million pounds) would be subject to review, and removed the requirements for a 25 percent control of supply threshold for review in the sectors of dual-use technologies, computing hardware, and quantum technology (Department for Business, Energy, and Industrial Strategy, June 2018).

As a component of longer-term reforms, under the proposed national security investment rules business owners are encouraged to notify the government of transactions that could have an impact on national security. After this notification, a Senior Minister is given fifteen days to screen the notification, during which time they can choose either to call for a national security assessment, or to decline to pursue further action. After the national security assessment is completed, the Senior Minister will then decide whether or not to intervene. While the submission of a notification is voluntary, Senior Ministers can still call for a national security assessment on any transaction, and companies that fail to comply can face criminal charges (Secretary of State for Business, Energy, and Industrial Strategy, July 2018). Initial estimates by the UK government indicate that there would be around 200 notifications a year.

The United Kingdom is clearly wary of PRC investments in certain sectors, as well as the extent of those potential investments. In its July 2018 announcement on tightening investment restrictions, the UK made it clear that it is looking toward its neighbors, such as Germany and other developed economies, to gather lessons on how to respond to Chinese FDI (Department for Business, Energy, and Industrial Strategy, July 24 2018).

Germany: "Keeping a Watchful Eye"

Recent high-profile PRC takeovers have also compelled German lawmakers to tighten their country's investment restrictions. In 2016, Midea, a Guangdong-based company and one of the world's largest manufacturers of commercial appliances, moved to takeover Kuka, Germany's largest industrial robotics firm (New York Times, July 4 2016). The deal, which represented the biggest-ever takeover of a German

company by a PRC buyer, raised suspicions because Midea offered a 60-percent premium on shares for the purchase. It also seemed to represent an unusual purchase for Midea, which primarily sells basic household appliances like air conditioners and washing machines (New York Times, July 4 2016; DW, August 17 2017).

Although Chancellor Angela Merkel did not attempt to block the Midea-Kuka deal, her then-minister for economic affairs and energy, Sigmar Gabriel, criticized PRC acquisitions on the grounds of national security risks. Midea's acquisition only went through after it made legally binding assurances that it would protect Kuka's intellectual property and customer data (New York Times, July 4 2016). The same year, another PRC firm with opaque ties to the Chinese Communist Party, Fujian Grand Chip Investment Fund, attempted to purchase German semiconductor firm Aixtron. The United States blocked the deal on national security grounds, as U.S. weapons systems use Aixtron's technology; however, the German government had already withdrawn approval for the bid earlier that year (Reuters, December 8 2016).

Spooked by both incidents, Germany became the first among several EU countries to tighten its foreign investment policies in 2017, rewriting its laws to allow Berlin to block foreign acquisitions that involve critical technologies (Reuters, July 19 2018). These changes allowed the German government to block Yantai Taihai Group (a PRC firm that produces components for nuclear reactors) from buying the German machine-tool firm Leifeld in August 2016 (South China Morning Post, August 26 2018). Leifeld produces equipment for the nuclear and aerospace industries, creating concerns for technology transfer in these sensitive areas. In the same month, the German government also prevented the State Grid Corporation of China [国家电网有限公司], the largest utility in the world, from acquiring a 20-percent stake in a German transmission systems operator, citing a "major interest in protecting critical energy infrastructure" (Wall Street Journal, July 27 2018).

Despite such prominent examples of scuttled deals, there still remain concerns regarding PRC investment in Germany. In early 2018, Li Shufu, the chairman of Geely, one of China's largest automotive manufacturers, acquired a $9 billion stake in Daimler, making him the firm's largest shareholder (New York Times, March 15 2018). Li surreptitiously purchased his stake a year after Daimler had denied a proposal by Li to take a stake in the company, thereby raising questions about the effectiveness of the new German foreign investment law. The German government did not intervene in the transaction, but then-Minister for Economics and Energy Brigitte Zypries said the government must "keep an watchful especially watchful eye" on PRC investments (BBC, February 26 2018).

More importantly, Geely's prospective partnership with Daimler aligns neatly with the PRC's "Made in China 2025" [中国制造2025] national industrial policy. This initiative plans to transform China's economy into a leading high-value economy, and has identified new energy vehicles as a key sector. Germany is the second largest destination for PRC investment in Europe, and the country's advanced manufacturing and utilities sectors have accounted for more than two-thirds of recent Chinese investments in the country (Institut Français des Relations Internationales, December 20 2017). As a result of such lingering concerns, Berlin has already moved to tighten the investment restrictions issued in 2017, raising from 25 percent to 10 percent the threshold for investment scrutiny for a non-European firm in the defense, technology, or media sectors (Wall Street Journal, December 16 2018).

European Union: One Union, Many Mechanisms

The Daimler case puts front and center the notion that individual European countries are ill-equipped to tackle predatory PRC investments. Before the case, in February 2017 the French, Italian, and German governments called for the European Commission to deal with the issue at a multilateral level (German Federal Ministry for Economic Affairs and Energy, February 2017). As individual member states started reforming their foreign investment laws, they also began pushing the EU to implement a unified mechanism, worried that PRC investment could weaken the EU as a whole. In addition, the PRC's individual outreach to eastern European Union countries—both bilaterally and through the "16+1" mechanism—has caused concerns that China could undermine the collective security of the European Union (European Commission, September 13 2017). **[1]**

These dynamics, along with growing concerns that Europe was losing technological advantages to China, caused the Finance Ministers of France, Germany, and the United Kingdom to write a joint letter to EU Commissioner Cecilia Malmstrom in February 2017 (Federal Ministry for Economic Affairs and Energy, February 2017). Since then, the European Commission has adopted an EU-wide screening mechanism for foreign direct investments (European Commission, November 20 2018).Of the twenty-eight member states in the European Union, there are only fourteen EU member states that currently have investment screening mechanisms in place. The mechanisms diverge between countries, varying between scope, investments covered, critical sectors, grounds for screening, and the design of the screening procedures. Prior to recent legislation, the EU only had a merger control regime that, in some cases, allowed for a review of FDI; however, this was based solely on the effects that the merger would have on competition in the EU.

To remedy some of these problems, the European Parliament approved a new mechanism in November 2018 that would allow EU member states to restrict inbound investment on national security grounds, and to protect critical infrastructure in the same fashion as some of its member-states like France and Germany. Additionally, member states will also have the option to comment on investments in other countries—regardless of whether the investment has been completed, whether the member state has a screening mechanism, or whether the investment is being screened. This information will then be passed onto the European Commission. However, the Commission will also have the ability to provide an opinion on investments if the Commission decides that it will affect the security or public order of the EU as a whole (European Parliament, June 12 2018).

Forging a European Consensus

The PRC, unlike Russia, does not seek to destabilize the European project, despite its preference for dealing with its member-states bilaterally (or within multilateral frameworks that China leads, such as the "16+1" Initiative). However, the PRC's industrial strategy is a legitimate concern for both the European economy and Europe's collective national security. While the European Union's initial moves towards further investment restrictions are a welcome first step, the proposals are still voluntary and in the very early stages of implementation. Only time will tell whether European collective security is effectively protected through these new mechanisms.

France's cautious yet open approach to FDI could serve as a model for improving upon the broader EU framework. The current EU framework agreed upon in November is an important first step, but the lack of standardization among EU countries and voluntary nature of the framework could lead to uneven implementation. By following the French model, and attentively vetting investments on a case-by-case

basis—as well as presenting a united set of policies to guide all of its member states—the EU can protect its critical technologies and national security while remaining open to mutually beneficial business opportunities.

Ashley Feng is a research assistant in the energy, economics, and security program at the Center for a New American Security. She can be found on Twitter @afeng79.

Sagatom Saha is an independent energy policy analyst based in Washington, D.C. His writing has appeared in Foreign Affairs, Defense One, Fortune, Scientific American and other publications. He is on Twitter @sagatomsaha.

Notes

[1] The "16+1" is a name applied to an ongoing initiative by the PRC aimed at expanding economic and cultural linkages with states in Central and Eastern Europe. The 16 states involved in the initiative are: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Macedonia, Montenegro, Poland, Romania, Serbia, Slovakia, Slovenia. (Investment and Development Agency of Latvia, June 2017).

***

China's "New" Academy of Military Science: A Revolution in Theoretical Affairs?

By Joel Wuthnow

Background

One of the overlooked but consequential features of China's current period of military reform has been an overhaul of the research and doctrinal development system within the People's Liberation Army (PLA). One key change has been a realignment of research institutes within the Academy of Military Science (AMS), which has emphasized blending AMS's traditional focus on doctrine writing with new capabilities being developed by the science and technology (S&T) community. Whether or not a new generation of PLA doctrine will be able to leverage advances in artificial intelligence, robotics, and other high-tech fields will be a key test of the success of the new system.

The overarching operational focus of the current round of reforms has been on improving the PLA's ability to wage "informationized local war" (信息化局部战争), which is defined by the incorporation of advanced technology into joint operations—such as amphibious landings, blockades, or precision firepower strikes—that would be used in a conflict against Taiwan or another regional adversary. The first round of reforms, carried out in late 2015 and 2016, aided this goal by creating a new joint command structure and establishing the Strategic Support Force and the Joint Logistics Support Force, which will supply critical capabilities to joint commanders **[1]**. The second round, completed in 2017, pushed this agenda a step further through "below-the-neck" force structure changes, and by revising the professional military education (PME) system to provide more instruction on joint operations— including changes to the National Defense University (NDU) and the National University of Defense Technology (NUDT).

A New Focus on Reform at the Academy of Military Science

An important area of focus in this second phase of the reforms was a reorganization of AMS. Established in 1958, AMS originally focused on developing military "science" based on Marxist theory. More recently, AMS scholars have tried to derive lessons from foreign militaries to aid PLA modernization and development. AMS publishes academic publications such as the *Science of Military Strategy* (another version of which has also been published by NDU) and the journal *China Military Science*, as well as drafting China's defense white papers. AMS also has a graduate student department but is not a PME institution per se, since those students receive degrees elsewhere **[2]**. Despite these other roles, the organization's fundamental purpose is writing the internal guidelines for the employment of military forces at the tactical, operational, and strategic levels of warfare—known in western jargon as "doctrine." AMS reports directly to the Central Military Commission (CMC), from which it receives taskings and to which it submits reports.

While AMS underwent a series of organizational transformations over its 60-year history, Xi Jinping and other reformers nevertheless decided that it would need to be updated to better fulfill its mission. To set principles for reforming the "military science research" system, a high-level CMC commission was established sometime in 2017 (Cankao Xiaoxi, July 25 2017). While this commission looked across the entire PLA, the focal point was on AMS as the military's premier center for research and doctrinal development. During a July 2017 ceremony in which he conferred new flags on the leaders of AMS, NDU, and NUDT, Xi urged AMS to adapt to the "new requirements of military scientific work" and to build a "world-class military scientific research institution" (Xinhua, July 19 2017). The bureaucratic grade of AMS has technically been reduced a level (from Theater Command leader grade to Theater Command deputy leader grade, a change that also affected NDU); however, AMS continues to report to the CMC.

The "New" AMS – A Stronger S&T Focus

Following Xi's remarks, AMS quickly reconfigured its internal organization. The most significant change was the merging into AMS of six research institutes previously subordinate to the PLA's former general departments. These six institutes, including the Military Medicine Institute (军事医学研究院), System Engineering Institute (系统工程研究院), and National Defense S&T Innovation Institute (国防科技创新研究院), primarily focused on technical research **[3]**. Symbolizing this new focus, the CMC appointed Lieutenant General Yang Xuejun (杨学军), an engineering Ph.D. and former president of the NUDT, as AMS president (Caixin, July 20 2017). Existing departments with more of a theoretical focus were retained, but consolidated in new institutes: the War Institute (战争研究院) and the Military Political Work Institute (军队政治工作研究院) (Pengpai, September 9 2017).

These changes were accompanied by other reforms designed to improve AMS's contributions in the S&T arena. One set of improvements involved new partnerships with civilian universities and research academies, such as a new cooperative research center co-sponsored by the AMS System Engineering Institute and the China Aerospace Academy of Systems Science and Engineering (Pengpai, April 20 2018); and a research

collaboration between AMS and Guangzhou University focused on robotics, "intelligent manufacturing," and other high-tech areas (Sohu, September 2 2018). AMS has also established a hiring program for younger civilian technical experts from S&T degree programs, which resulted in the hire of 120 new researchers in 2017, and a second hiring phase that commenced in mid-2018 (Tencent, April 13 2018).

A theme of these initiatives was supporting what the PLA refers to as "military-civilian fusion" (军民融合), which is sometimes also translated into English as "civil-military integration." A key obstacle to military modernization long understood but only partially addressed by PLA planners was the bureaucratic stove-piping of the military and civilian sectors. **[4]** This meant that key advances in the S&T realm often did not translate into the effective production of dual-use technology or military weapons and equipment. New personnel exchanges, funding schemes, and joint research projects organized by AMS are all ways to help reduce this dilemma and accelerate PLA modernization.

Official PRC media has indicated that such mechanisms have been helpful in achieving a raft of quick breakthroughs in the wake of the reforms. *PLA Daily* claimed that AMS had more than 3,300 "scientific research tasks" underway; that it had recruited 20 "academicians" [院士]; and had submitted "more than 100 high-end research reports" to higher authorities (PLA Daily, May 11 2018). Another report lauded the innovation by AMS researchers of a "coal-based diesel" fuel source that would improve PLA "ground equipment" while also increasing China's energy security (Keji Ribao, June 6 2018). Even the more traditional War Institute was praised for creating a new Joint Operations Lab Center (联合作战实验中心) which within a few months had developed new models of simulating joint campaigns in computer-assisted wargames (People's Daily, January 14 2018).

All of these changes reflected a rebranding of AMS as a powerhouse of technological innovation for the PLA. During his May 2018 inspection tour, Xi lauded AMS's achievements but encouraged it to deepen its new mission by paying "proper attention to the transformation and applications of the results of S&T innovation, so as to let innovation better serve combat power building" (Xinhua, May 16 2018). As Elsa Kania rightly suggests, given its new responsibilities, AMS could therefore emerge as a key technological "incubator" just as the PLA is "seeking an advantage in future military competition." **[5]**

Blending Theory and Technology

The more consequential aspect of the AMS reforms, however, does not lay solely in supporting technological innovation: innovative projects were already being conducted in the predecessor organizations of the new AMS institutes, and these efforts would have continued regardless of the consolidation. Acquiring new civilian expertise will certainly contribute to the success of the PLA's research enterprise, but employment pathways for these scholars could have (and have been) created for personnel across the PLA, including in the NDU and other institutes.

Instead, the key factor is the closer alignment of S&T progress with doctrinal development. Chinese military analysts have long regarded the incorporation of technological innovations into doctrine as a prerequisite for building a strong military. For instance, in a December 2014 essay, AMS scholar Zhao Xiaozhuo praised 19th century Prussian military thinker Carl von Clausewitz for applying Newtonian physics into the military doctrine of the "center of gravity" (China Online, December 5 2014). Zhao also lauded the U.S. military for blending technology into doctrine (a role performed most notably by the U.S. Army Training and Doctrine Command), which has in turn guided successful U.S. combat operations over the past few decades. AMS publications have reflected on the relationship between technology and doctrine, often drawing from foreign wars—a key example being U.S. use of precision-guided munitions in joint campaigns. **[6]**

It is no surprise, then, that a primary goal of these reforms was to develop stronger coordination between the PLA's technological and doctrinal communities. In July 2017, Xi Jinping called on AMS to "adhere to the close integration of military theory and military S&T" and to "promote collaborative innovation" (Xinhua, July 19 2017), while in May 2018 he again highlighted the need to "properly carry out the integration of theory and S&T" (Xinhua, May 16 2018). A July 2018 article in the Chinese Communist Party's flagship theoretical journal *Qiushi,* written by an AMS scholar, similarly argued that the PLA needed to achieve the "deep integration" of theoretical and technical research, including making better use of quantitative analysis as part of more theoretical expositions (Qiushi, July 31 2018). Another source saw AMS becoming a kind of "R&D aircraft carrier" that would combine the PLA's expertise in social science, natural science, and engineering (Pengpai, September 9 2017).

This vision revealed an existing weakness for PLA modernization: namely, how to adapt cutting-edge advances in areas such as artificial intelligence, quantum computing and communications, big data analysis, nanotechnology, and robotics into the development of doctrinal regulations and teaching materials. The 2013 *Science of Military Strategy* had almost nothing to say about the role of any of these technologies in military strategic thinking. **[7]** Part of the problem was that some of these technologies were new, and their military applications as yet undetermined. However, this also reflected the organizational constraints of the PLA's doctrinal development system: those responsible for devising the regulations had little if any contact with the PLA's S&T community, much less civilian experts.

Merging disparate technical research institutes into AMS is only a first step in overcoming this weakness. AMS interlocutors have suggested that scholars continue to work largely in their own communities, in a variety of locations in and outside of Beijing, and have not made much progress to date in adopting a more genuinely "collaborative" organizational culture. Moreover, while PLA media has praised the productivity and innovations of AMS scholars, examples of cooperation between different institutes remain scarce. There are, however, signs that observers can look for—such as geographic consolidation of institutes, praiseworthy examples in the media, and publications co-authored by teams of experts drawn from the different institutes— to assess whether progress is being made. **[8]**

Conclusions

Whether or not the restructured AMS is successful in its goals will be an important factor in the PLA's drive to deepen its ability to think through the obstacles and opportunities of waging "informationized local wars." Doctrine being developed by AMS scholars and taught to future field commanders and staff officers could revolutionize the ways in which the PLA would plan and prosecute a future conflict, taking advantage of technological leaps that in some areas might have surpassed even the U.S. military. This would support ongoing improvements in other areas of the reforms—to include joint command and control, training and evaluation, and joint PME. A failure to achieve more effective collaboration between the PLA's intellectual communities could mean that business continues as usual, and that technological progress remains confined to ivory towers.

Dr. Joel Wuthnow is a research fellow in the Center for the Study of Chinese Military Affairs at the National Defense University. His research areas include Chinese foreign and security policy, Chinese military affairs, U.S.-China relations, and strategic developments in East Asia. The views in this article reflect only his views and not those of NDU, the Department of Defense, or the U.S. government.

Notes

[1] For an overview, see Joel Wuthnow and Phillip C. Saunders, *Chinese Military Reform in the Age of Xi Jinping,* China Strategic Perspectives 10, NDU Press, 2017.
[2] The author is indebted to Ken Allen for this observation.
[3] The other additions included the Military Legal Systems Institute (军事法制研究院), the Chemical Defense Institute (防化研究院), and National Defense Engineering Institute (国防工程研究院). In addition to the eight institutes, the new AMS structure also included a Graduate Student Department (研究生院) and two research centers: the Evaluation and Demonstration Center (评估论证中心) and the Military Science Information Center (军事科学信息中心).
[4] See the chapters by Tai Ming Cheung and Brian Lafferty in the forthcoming volume Phillip C. Saunders et al. (eds.), *Chairman Xi Remakes the PLA: Assessing Chinese Military Reforms* (Washington, DC: NDU Press, 2019).
[5] Elsa Kania, "Incubating Innovation? – New Directions for the PLA Academy of Military Science," *Battlefield Singularity*, May 29, 2018, https://www.battlefieldsingularity.com/musings-1/incubating-innovation-new-directions-for-the-pla-academy-of-military-science.
[6] See, e.g., AMS Strategic Research Department (ed.), *Science of Military Strategy* (Beijing: AMS, 2013), 95-6.
[7] The volume did briefly mention quantum computing as a part of the global revolution in military affairs, but did not consider how it could be used in PLA operations. Ibid, 73.
[8] Evidence could also show up in the PLA's "6th generation" of doctrinal regulations, though this will most

likely be classified. For a discussion, see: Elsa Kania, "When Will the PLA Finally Update Its Doctrine?" *The Diplomat*, June 6, 2017, https://thediplomat.com/2017/06/when-will-the-pla-finally-update-its-doctrine/.

***

Examining Belt and Road "Debt Trap" Controversies in the Philippines

By Alvin Camba

Controversies Surrounding Chinese Investment in the Philippines

The prospect of "debt traps" occurring in developing nations has been a popular recent topic in media and policy circles—and in particular, discussions of debt traps that might accompany infrastructure projects associated with China's Belt and Road Initiative, or BRI (China Brief, January 5; Washington Post, August 27 2018). Chinese investment and financing deals in the Indo-Pacific region have in some cases involved high interest rates and unsustainable payment schemes that serve to elicit debt-for-equity swaps when the debtor government is unable to effectively pay back the loans (China Brief, January 5).

Such controversies have also been prominent in the Philippines—where, since President Rodrigo Duterte's rapprochement with the PRC in October 2016 and an accompanying increase in Chinese lending and infrastructure projects, there has been no shortage of critics claiming that Chinese loans will plunge the Philippines into a PRC-controlled debt trap. These commentaries range from a negative comparison of China's interest rates to that of Japan (Philippine Daily Inquirer, August 4 2018); to alarming projections of future debt burdens (Philippine Daily Inquirer, November 23 2018); to descriptions of Chinese investment as an economic "invasion" that threatens the sovereignty of the country (The Philippine Star, March 27 2018). These arguments have been further fueled by President Rodrigo Duterte's ambitious "Build Build Build" (BBB) program, which is set to use 7.3% of the country's annual GDP to fund an evolving list of 75 major infrastructures worth $183 billion over the next five years (Philippine Government Infrastructure Portal, September 2018).

However, in considering the danger of a debt trap, it is important to analyze the particular factors at play within the host state. In the case of the Philippines, a debt trap remains unlikely in comparison to states such projects are subject to contestation from multiple elite groups with varying interests, as well as organized civil society organizations. As will be seen in the discussion below, political factors have limited the composition of Chinese aid projects in the Philippines, and have thus far delayed their implementation.

Project Composition and the Philippine Economy

A debt-trap occurs when debt obligations reach an unsustainable threshold of a country's gross domestic product (GDP)—thereby creating a high debt-to-GDP ratio, and leading to low growth that effectively uses most economic output to cover debt payments. However, if a country's GDP growth increases faster than its debt levels, then high levels of absolute debt will not lead to a debt trap. In the case of the Philippines, the country possesses economic fundamentals that mitigate against the danger of excessive indebtedness. Between 1999 and 2014, Philippine debt increased from $51 to $77 billion (Central Bank of the Philippines, 2019). However, at the same time, the country's external debt to GDP ratio (in percentage) decreased from

61.6% to 27.3% (Business World, August 4 2018). The total amount of the country's annual debt service during those years ranged from $6.5 to $7.5 billion, but the percentage of debt service decreased from 14.6 to 6.2%, indicating that less of the country's GDP has been used for servicing debt (Central Bank of the Philippines, 2018).

Many reports that predict a debt trap for the Philippines ignore the varying conditions of Chinese financial aid and loans—assuming high interest rates for all loans and progression on all Chinese commitments in order to estimate a ballooning total debt obligation (Forbes, May 13 2018). Moreover, they also ignore the likelihood that projects that generate internal demand could successfully contribute to economic growth. Indeed, a crucial issue in the Sri Lankan case is that the Mambantota Port has seen very low levels of shipping traffic, which made the project unnecessary and extremely costly (Daily Mirror, August 17 2018). Whereas Sri Lankan ports target the international market, however, the Philippine economy relies on domestic consumption, and there is a huge internal demand in the Philippines for transportation services.

Deficiencies in transportation infrastructure have long constrained economic growth and quality of life in the Philippines. Two major Chinese-funded rail projects offer the prospect of improving this situation by reducing reliance on vehicles, and making possible the more rapid shipment of goods. The Subic Clark Railway Project, a 70-kilometer cargo rail, seeks to increase the movement of goods between the Subic and Clark Freeports, which have been major areas of growth and employment in Northern Luzon. (SunStar, October 7 2018). Further south in Luzon, the Chinese-funded PNR South Rail involves a proposed 639-kilometer high-speed rail extending from Manila to Matnog, which could significantly improve transportation connectivity in the region (Manila Standard, November 4 2018).

Construction crews at work on the Chinese-funded Binondo-Intramuros Bridge (commonly called the "Chinese Friendship Bridge") in Manila (ABS-CBN News, December 04 2018).

Furthermore, the diversity of development lenders makes a debt trap unlikely. On a roster of approved and planned development projects issued by the Philippines government in autumn 2018, 16 Chinese-affiliated projects are listed—to include the two rail projects listed above, interprovincial road and bridge projects, and support for two major dam projects. However, the PRC is not the sole lender for such initiatives: according to the same official list, more than half of developmental infrastructure projects in the country are funded by the Japanese International Corporation Agency and the Asian Development Bank (National Economic and Development Authority, September 28 2018). This broader diversity of lending sources, as compared to the circumstances of nations like the Maldives and Sri Lanka, makes the Philippines far less subject to domination by a single lender.

The Intersection of Philippine Politics and Chinese Infrastructure Projects

Some of the planned PRC-funded initiatives may not even come to fruition. Unlike states with strongly centralized executive power, other actors matter in the Philippines—to include regional and local governments, economic elites, and civil society. This means that even with the support of the Duterte administration, foreign capital projects may be subject to opposition. In the current list of projects, host state actors have already delayed or modified key Chinese-supported initiatives. In the case of the PNR South Rail mentioned above, the project has been delayed by mayors in the regions of Quezon and Bicol, whose towns would be affected by the rail construction. These mayors have competed for the location of train stations in order to concentrate economic revenue, political capital, and trade routes in their own jurisdictions. These squabbles continued until the second quarter of 2018, when a series of compromises paved the way for the project to proceed. **[1]**

Another illustrative example of such local conflicts may be seen in the controversies surrounding the proposed Binondo-Intramuros Bridge in Manila (also called the "China Friendship Bridge"). The Binondo Building Association in Manila, as well as the Yulo family (an influential family in the Philippines Chamber of Commerce), complained to the National Economic Development Authority that the bridge was unnecessary, and that it would negatively affect several of their buildings (Manila Times, September 4 2018; South China Morning Post, November 24 2018). These actors, as well as local civil society groups, invoked multiple issues to delay bridge construction: they questioned the project's effects on traffic and local residents, and argued that the project would impact several churches, including a UNESCO Heritage Site. This group was supported by the National Historical Commission of the Philippines, a government institution that aims to preserve and research historical sites in the Philippines (Manila Bulletin, September 5 2018).

The Philippine bureaucracy has also played a role in slowing down the pace of Chinese-sponsored construction. Philippine government functionaries have often blamed the Chinese side for such delays (Philippines Inquirer, November 19 2018). However, delays have occurred due to the disagreements between the Chinese and Philippine bureaucracies regarding *renminbi* usage, co-financing, and the employment of Chinese labor (GMA Network, August 28 2018). Philippine bureaucrats, fearing a policy shift in the event of a change to a more China-skeptic administration, have wanted to ensure that the projects fulfill every possible financial and technical standard (Philippine Star, November 19 2018). Additionally, delays in issuing preferred lists of contractors for some projects have followed from feasibility studies required by the Philippine government—which have in turn impacted the incentives for Chinese contractors (Bilyonaro, 2018).

Conclusions

The combination of domestic economic demand, diversity in aid funding, and a contentious political culture and civil society in the Philippines make a Chinese-dominated dept trap unlikely. The success of President Duterte's ongoing infrastructure drive depends on a number of factors, to include project implementation, the projected internal demand of Philippine provincial economies, and the vetting processes of Philippine bureaucrats. However, as long as the Philippines maintains public scrutiny and multi-sectoral vetting of such infrastructure projects throughout their entire life-cycle, the country faces strong prospects for maintaining its financial solvency and national sovereignty.

Alvin A. Camba is a PhD Candidate in the Department of Sociology at Johns Hopkins University, and a non-resident fellow at the Alberto Del Rosario Institute (ADRi). He has written for various policy platforms or media organizations, to include The New Mandala, East Asia Forum, and South China Morning Post.

Notes

[1] This reflects the author's own field research conducted in the Philippines in 2018. (See also East by Southeast, August 22 2018.)

***

Assessing the Future of Chinese Sea Power: Insights from the "Marine Science and Technology Award"

By Ryan D. Martinson

In late December, the Chinese press announced the 2018 winners of the "Marine Science and Technology Award" (MSTA), an annual prize recognizing China's best work in oceanic research (China Ocean News, December 26 2018). For outside observers, the list of winners helps to identify pockets of excellence in Chinese marine science and technology. It also sheds light on Beijing's current maritime intentions and future maritime capabilities—namely, where China is investing its resources, and which of its investments are panning out. Since 2016, award organizers have released limited information on winning "classified projects" (涉密项目), which are of special interest to those seeking to gauge China's maritime ambitions. This article aggregates these data to identify the organizations and individuals at the forefront of strategically-important ocean research and development in China. It also explores how this information creates opportunities for more targeted analysis of individual Chinese maritime research projects.

Background on the MSTA

The Marine Science and Technology Award (海洋科学技术奖) recognizes Chinese "scientific and technological achievements that make breakthrough contributions" in the field of ocean research (Chinese Society for Oceanography, March 29 2013). Established in 2012, the award is organized by three scholarly associations: the Chinese Society for Oceanography, the Pacific Ocean Society of China, and the Chinese Society of Oceanology and Limnology. The MSTA is overseen by an award committee. The committee in turn

selects an award jury, which is responsible for judging nominations. The jury comprises dozens of China's top experts in marine science and technology (Chinese Society for Oceanography, December 16 2018). Office staff located within the Chinese Society for Oceanography serve to facilitate the six-month-long selection process.

The award recognizes outstanding work in both scientific research and the development of new products, equipment, materials, and techniques. It accepts nominations from a wide range of fields, ranging from environmental science to ocean resource exploration. The committee considers projects related to "support for maritime security" (海洋安全保障) and "defense of maritime rights and interests" (权益维护)—euphemisms for actions to assert China's territorial claims in the East China Sea and South China Sea (Chinese Society for Oceanography, March 29 2013). Most, if not all, classified projects likely fall within these categories.

The award jury selects "first prize" (一等奖) and "second prize" (二等奖) winners. In some years, they also choose a single "grand prize" (特等奖). Aside from honor and recognition, winners receive modest cash awards. Table 1 shows total numbers of grand prizes, first prizes, and second prizes awarded since 2012, as well as the numbers of winning "classified" projects.

Table 1: Numbers of Winning Projects for Each Award Category (2012-2018)

	Grand Prize		First Prize		Second Prize	
Year	Total	Classified	Total	Classified	Total	Classified
2012	1	0	9	0	49	3
2013	0	0	7	0	26	4
2014	0	0	6	0	22	1
2015	0	0	6	0	18	1
2016	1	0	9	1	26	4
2017	1	0	9	3	25	6
2018	0	0	10	1	30	5

Winning Classified Projects (2016-2018)

After award decisions are vetted by the award committee, the results are released to the public. Lists of award winners contain the name of the project, the nominating organization, the organization(s) involved in the project, and the chief scientists and engineers that completed the work. From 2012-2015, award announcements excluded any information about winning classified projects: instead, the phrases "secret project" (保密项) or "omitted" (略) were inserted as placeholders. This changed in 2016, when the award committee started providing the name of the nominating organization, the lead research organization, and the

chief investigator for winning classified projects. Award announcements continued to omit the title of classified projects, using the character "secret" (密) as a placeholder. Table 2 aggregates the available information about winning classified projects since 2016.

Table 2: Awardees for Classified Projects (2016-2018)

Year	Prize	Lead Research Organization(s)	Chief Investigator(s)
2016	First	State Oceanic Administration (SOA), Second Institute of Oceanography (国家海洋局第二海洋研究) and four others	Hao Zengzhou (郝增周) and twelve others
	Second	SOA, National Marine Data & Information Service (国家海洋信息中心) and two others	Wu Xinrong (吴新荣) and 9 others
	Second	China State Shipbuilding Corporation (CSSC), Systems Engineering Research Institute (中国船舶工业系统工程研究院)	Cai Bin (蔡斌) and nine others
	Second	CSSC, Systems Engineering Research Institute	Guo Yongjin (郭永金) and nine others
	Second	CSSC, Systems Engineering Research Institute	Zhang Chunyan (张春燕) and nine others
2017	First	SOA, South China Sea Environmental Monitoring Center (国家海洋局南海环境监测中心) and three others	Fang Hongda (方宏达) and Shi Xiaojun (时小军) and thirteen others
	First	SOA, Second Institute of Oceanography and three others	Wang Difeng (王迪峰) and nine others
	First	CSSC, 708 Research Institute (中国船舶工业集团公司第七〇八研究所) and four others	Zhang Gengyuan (张根源) and nine others
	Second	SOA, National Marine Data & Information Service	Fu Hongli (付红丽) and nine others
	Second	PLA Navy Dalian Ship Academy (中国人民解放军海军大连舰艇学院)	Su Shipeng (苏轼鹏) and nine others
	Second	China National Petroleum Corporation Dagang Oilfield Exploration and Development Research Institute (中国石油大港油田勘探开发研究院)	Yuan Shugin (袁淑琴) and nine others
	Second	CSSC, Systems Engineering Research Institute	Deng Yongjun (邓拥军) and nine others
	Second	CSSC, Systems Engineering Research Institute	Wang Jianhua (王建华) and nine others
	Second	CSSC, Systems Engineering Research Institute	Wang Yuan (王媛) and nine others
2018	First	SOA, Third Institute of Oceanography (国家海洋局第三海洋研究所)	Yang Yanming (杨燕明) and fourteen others
	Second	SOA, National Marine Data & Information Service and two others	Zhang Xiaoshuang (张晓爽) and nine others
	Second	PLA University of National Defense Science and Technology (中国人民解放军国防科技大学) and three others	Fei Jianfang (费建芳) and nine others
	Second	SOA, South China Sea Planning and Environmental Research Institute (国家海洋局南海规划与环境研究院) and four others	Chen Lei (陈蕾) and nine others
	Second	CSSC, Systems Engineering Research Institute	Yang Yuntao (杨运涛) and nine others
	Second	Harbin Engineering University (哈尔滨工程大学) and two others	Zhao Lin (赵琳) and nine others

Observations from the MSTA Data

Although limited, these data points do allow for some useful observations. Two organizations dominate the top tier of classified marine research and development work in the PRC: the State Oceanic Administration (SOA) and China State Shipbuilding Corporation (CSSC). Of the twenty award-winning classified projects since 2016, sixteen were led by research units or organizations affiliated with one of these two institutions. In the case of CSSC, the Systems Engineering Research Institute has been the leading awardee, winning seven of the eight awards granted to CSSC since 2016. SOA entities have also won eight total awards since 2016, with three going to the National Marine Data and Information Service; and the Second Institute of Oceanography earning two awards, both first-place. Of the five first-place awards given to classified projects since 2016, four went to SOA-led projects.

That CSSC is well-represented should come as no surprise: it is one of China's two largest state-owned shipbuilding conglomerates, and it constructs the bulk of China's warships and a range of other equipment for the People's Liberation Army Navy (PLAN). CSSC's Systems Engineering Research Institute oversees several key research groups—including the Ocean Smart Technology Innovation Center, which researches unmanned platforms (Xinhua, December 5 2017); and the Key Laboratory of Acoustic Warfare Technology (CSSC Systems Engineering Research Institute, undated).

For its part, SOA has long played an important role in strategically-important marine science. For example, the SOA Third Institute in Fujian publicly acknowledges that it conducts "military oceanography" and "projects for national defense construction" (China Ocean Online, October 3 2007). It and other parts of SOA have helped the PLAN strengthen its awareness of the ocean battlespace environment, both in the East Asian littorals and further afield. In January 2009, the institute signed a cooperative agreement with the PLAN that included pledges of support in marine science and technology; this relationship was further bolstered with a second agreement in April 2017 (China Maritime Studies Institute, November 2018).

One surprise takeaway from the data is that the Chinese Academy of Science (CAS) did not lead a single winning classified project in the 2016-2018 period. CAS ocean research institutes are among the country's best. However, CAS appears to focus on building foundational knowledge, which others can then apply to the development of new military capabilities. In 2012, for example, several CAS research institutes completed a large unclassified study of the physical oceanography and acoustic properties of waters within the First Island China (i.e., the "near seas"). Directed by Hou Yiyun (侯一筠), a researcher at the CAS Institute of Oceanography, the project ultimately led to improvements in systems used by the Chinese military: the PLAN South Sea Fleet Center of Meteorology and Oceanography, for instance, applied the new knowledge to increase its ocean data assimilation capabilities and improve forecasting of oceanic conditions (e.g., waves, currents, temperature, salinity, etc.) (Shandong Province Department of Science and Technology, undated).

Other Insights from the MSTA

The information in Table 2 presents opportunities for further investigation into individual winning projects. For example, Yang Yanming (杨燕明), a researcher at SOA's Third Institute of Oceanography, led a classified project that won a first-place prize in 2018. Yan is the Director of the Institute's Laboratory of Ocean Acoustics and Remote Sensing (Harbin Engineering University, April 25 2016). His ties with the Chinese military are readily documented: a media profile shows that in 2009 he received an award from the PLA for undisclosed research (Optics Journal Online, undated). Recently, Yang's acoustics research has focused on waters beyond the near seas: from July-September 2017 he participated in China's 8th Arctic Marine Scientific Expedition, one of eleven researchers to do so from the Third Institute. Yang and two colleagues conducted experiments on underwater sound propagation in the Arctic Ocean (Third Institute of Oceanography, October 12 2017). Yang has also done work on "convergence zones"—ocean areas amenable to long-range submarine detection—in deep-sea areas east of the Luzon Strait (between Taiwan and the Philippines), the very waters that U.S. submarines must navigate when entering the South China Sea (Acta Oceanologica Sinica, July 2015).

Lists of award winners also provide a useful reference for U.S. researchers and research institutions considering engagement with Chinese counterparts. A review of past interactions suggests that U.S. interlocutors may not have been fully aware of the relationships between civilian oceanic research institutions and the PLA. The U.S. Naval Postgraduate School (NPS) is a case in point: its Department of Oceanography has sponsored visiting fellows from Chinese research institutes, such as the Second Institute of Oceanography (Second Institute, undated)—which the above data show to be a key center of classified marine science and technology research. NPS scholars have also travelled to China to share their expertise with Chinese researchers, some of whom work on classified projects. For instance, in November 2013 the director of the NPS Naval Ocean Analysis and Prediction Laboratory participated in a SOA-sponsored conference on ocean monitoring technologies, held in Zhejiang Province (China Argo, November 30 2013). Others present at the conference included researchers from the PLA Institute of Technology, PLA Unit 61741, the Second Institute of Oceanography, and the directors of three award-winning classified projects led by the National Marine Data & Information Service: Wu Xinrong, Fu Hongli, and Zhang Xiaoshuang (China Argo, November 29 2013).

Caveats and Conclusions

Although MSTA announcements provide some hints regarding state priorities for oceanic research, they may not identify all the leading persons and institutions in this field: for instance, some projects may be so highly classified that risks of exposure outweigh the benefits of public recognition. There is also the possibility that favoritism and bureaucratic patronage could skew the award results, and this very real possibility argues against attaching too much importance to rankings within and across each award class. Foreign analysts of Chinese maritime strategy should not simply dismiss the potential significance of projects that have not received the validation of a Marine Science and Technology Award. However, referring to lists of MSTA

winners can serve to identify some of the more prominent Chinese institutions performing oceanic research, and may provide further avenues of research for scholars and others focused on the PRC's naval and commercial maritime development.

Ryan D. Martinson is an Assistant Professor at the U.S. Naval War College (NWC), and a member of NWC's China Maritime Studies Institute. The views in this article reflect only his views and not those of NWC, the Department of Defense, or the U.S. government.