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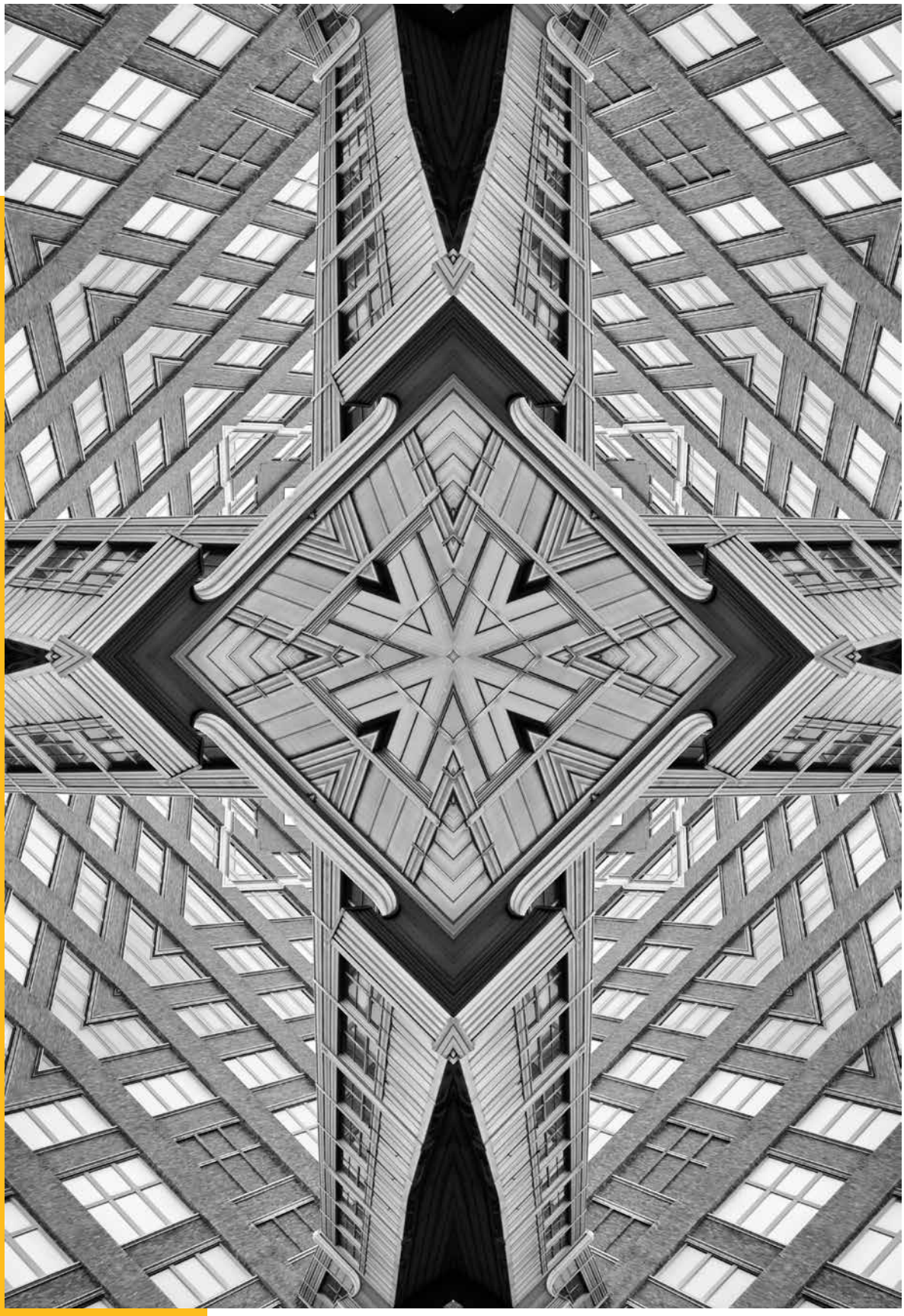

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China's Military-Civil Fusion Strategy, the US Response, and Implications for India

Manoj Joshi

Abstract

Military modernisation was the fourth and last of Deng Xiaoping's 'Four Modernisations'. Even before the third modernisation got underway—that of science and technology—China began using commercial technologies to advance its military capabilities. This strategy has gained salience since Xi Jinping came to power in 2012 and made it the state's key goal to transform the PLA into a "world-class military". Military-Civil Fusion (MCF) became a focus of this effort and was designated as a national strategy in 2014. This has provoked concerns across the world, especially in the United States which has unrolled a series of policies to contain MCF. This paper analyses China's strategy of leveraging its flourishing commercial technology sector and rising capabilities in innovation, to drive military modernisation. It explores the potential implications for Sino-Indian military balance and the overall relations between the two countries.

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Introduction

For a while now it has been clear that China is a rising power in science and technology, and this development is raising concerns around the world because of China's assertiveness and the opaqueness of its goals. In recent years, fears have centred on a Chinese strategy called 'Military-Civil Fusion' (MCF) which is aimed at spurring innovation in key sectors and leveraging dual-use technologies for military end-uses. China, which has long practiced what is called Civil-Military Integration (CMI) sees MCF as a master strategy that needs to be amalgamated with other national strategies for economic development and transformation, "to achieve an organic, powerful, and comprehensive national system of strategies."[1] Where CMI was aimed at the civil sector supporting the military on a range of issues including logistics and technology development, MCF's target is the leveraging of emerging and high technologies, developed for civilian use, to boost military capability. According to the US-China Economic and Security Review Commission, China has adopted a "whole of society" effort to achieve leadership in Artificial Intelligence (AI), new and advanced materials, and new energy technologies because they can trigger advances in other technologies with consequent economic and military gains.[2]

To be sure, there has always been a symbiotic link between civilian and military technologies in most countries. Indeed, academics and analysts such as Lewis Mumford,[3] Seymour Melman,[4] and David F Noble[5] have written extensively about the centrality of the military in American industrial development. Historically, the US has leveraged the close relationships between its defence sector, the academia, and the private sector. There is no dearth in literature about the US military's role, for example, in triggering the development of the civilian nuclear programme, or commercial aviation. Lesser known are Noble's examples of how in the 1950s and 1960s, the US Air Force promoted Computer Numerical Controlled (CNC) machines, or that the US Navy triggered the growth of containerisation in cargo handling.[6] A generation later, as the Advanced Research Projects Agency (ARPA) changed its name to Defense Advanced Research Projects Agency (DARPA), US military research gave birth to the Internet and Global Positioning System (GPS) technology.

Introduction

In a larger sense, CMI and MCF are not just about dual-use technology, but the effective military use of civilian facilities, technology, and talent. This could mean using highways as emergency airstrips, civilian transport for military logistics, or emerging and high technologies to create new weapons systems or enhance the capabilities of the older ones, or attracting civilian talent and venture capital to aid military programmes.

Today the US's fear is that China's efforts are aimed at leapfrogging over them in terms of military power. The US is concerned that the Chinese-style command development—especially in critical, cutting-edge emerging technologies (ETs) such as Artificial Intelligence (AI), new and advanced materials, new energy, biotechnology and quantum technology—could help China enhance its existing military weapons and create a new generation of lethal autonomous systems, hypersonic weapons, and directed energy weapons. These could threaten the United States.

There are five levels of American concerns. First, of China stealing foreign technology, demanding technology transfer from companies as a price for their entry into the country, or making strategic acquisitions of foreign companies to access their technology. Second, of using technologies acquired for civilian use for military purposes. Third, of Chinese students in US universities and academic collaborations aiding entities whose goal is to enhance China's military development. Fourth, of Chinese investments in western technology companies and startups enabling them to access and control new and emerging technologies. Fifth, the activities of Chinese research laboratories such as those established by Baidu, Huawei, Tencent in third countries like US, Australia, India being used to enhance Chinese technology which, in turn, can be used for military purposes back home. The US now recognises that technology has become the core of US-China competition. While the US is ahead in most areas, there is no clear winner yet in certain technologies such as AI and quantum computing.

Introduction

Adopting its 14th Five-Year plan for 2021-25 in November 2021, China explored, for the first time, the development of "disruptive" technologies to close the gap with the United States. The plan seeks to "accelerate the modernization of weapons and equipment, focus on indigenous innovation in national defence science, accelerate the development of strategic forward looking *disruptive technologies*, and accelerate the upgrading of weapons and equipment (Emphasis added)."[7]

There are two aspects to military-civil fusion developments. First is the creation of the so-called new and "disruptive technologies" that could range from sixth-generation fighters, quantum radar and communications systems, hypersonic weapons, and unmanned equipment platforms—ships, aircraft, ground systems—driven by AI.[8] The second is the enhancement of existing platforms by a new generation of sensors and weapons, high-energy systems like laser and rail guns, which could provide them a military edge.

China has not hesitated to demonstrate how technology, originally developed for civilian use, is enhancing their military capability. In December 2017, they conducted a display of swarming through the performance of 1,108 quadcopters at an air show. In May 2018, they demonstrated a similar swarm of 56 unmanned boats. More recently, in January 2021, they advertised exoskeleton suits for use in the Himalayan border with India. They also revealed other military technology, including High Power Microwaves (HPM), laser weapons, rail guns, Electromagnetic Aircraft Launch Systems (EMALS) systems, Hypersonic vehicles, and stealth ships. Most important may yet be the earlier launch of the Micus satellite to achieve quantum communications. In 2017, scientists from the University of Science & Technology, CAS-Alibaba Quantum Computing Lab, Chinese Academy of Science Institute of Physics and Zhejiang University entangled 10 super conducting qubits. The building of a National Laboratory for Quantum Information Science in Anhui province was also revealed. [9]

Introduction

Ideally, all countries seek to promote an integrated development of their civilian and military sectors. China's technological advances are well-known, though they have been marred by allegations of technology theft, forced transfer, or diversion of technology and civilian know-how. Given the rapid buildup of the Chinese military, these innovations have generated alarm in the US. In India, however, the implications of MCF have yet to be clearly understood. It is only recently, in 2020, that Indian military leaders began discussing civil-military integration.[10] India's technology sector is not too well-developed and cannot easily replicate the Chinese strategy.

> "There are two aspects of military-civil fusion developments: the creation of new and 'disruptive technologies', and the enhancement of existing platforms."

From Civil-Military Integration to Military-Civil Fusion

The relationship between military and civilian technology is as old as Western civilisation. Early human beings may have learnt to make the wheel to ease the problem of transporting heavy loads, but it also enabled the invention of the war chariot—the cutting-edge military platform of its day. The steam and internal combustion engines have spawned a vast range of military machines. Military compulsions demanded the highest levels of technology, to begin with—whether in metallurgy, machines, or means of propulsion. Wars by themselves were destructive and devastating, yet the demands of the military led to technological innovation and aided economic advancement during times of peace.

New and emerging technologies can either be the outcome of scientific-technical evolution, or else driven by doctrinal imperatives. Clearly, it is the latter in the case of China, with the compulsion to improve its defence capabilities vis-à-vis the United States. Existing weapons platforms and systems have seen evolutionary improvement via the incorporation of components and elements of new technologies—e.g., delivery systems, sensors, C4SIR systems (Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance), and space systems. In some instances, the improvement was so substantial—such as the development of the GPS technology—that it led to the creation of an entirely new class of weapons and capabilities. In other instances like nuclear energy, rocket propulsion, or the internet, they have had nothing short of a revolutionary impact.

In recent years, the concept of MCF has come to focus on account of China's activities in harnessing its civilian technology to boost its military capabilities, closely following the American model. China analyst Elsa Kania writes, "China's initiatives in military-civil fusion are informed by a close study of, and learning from, the U.S. defense industry and American defense innovation ecosystem." [11] In certain ways, the MCF "can be described as China's attempt to imitate and replicate certain strengths from a US model."[12] China has closely

studied the US experience in the contemporary period, especially the functioning of institutions like the DARPA and the more recent Defence Innovation Unit (DIU), and their relationship to research institutes and private sector companies.[13]

The DIU, set up in 2015, is headquartered in Silicon Valley and has offices in Washington, Boston, and Austin. It began as the Defence Innovation Unit Experimental (DIUx), mandated to lead the Pentagon's outreach to speed up the adoption of commercial innovation with a view of transforming military capacity. Separately, in 2017, the US Air Force created the AFWERX which stands for "connecting innovators, accelerating results" as a programme to encourage commercial innovation that could be rapidly fielded to advance military capability through linkages between the academia, industry, investors, and international partners.

Historically, Chinese defence research has been dominated by its 11 State Owned Enterprises (SOEs). China, however, is aware that in the Information Technology area, many of the emerging technologies are the product of research being conducted by the private sector. A good example is AI, which is shaped by research in the laboratories of global technology giants such as Amazon, Google, Microsoft, IBM, Facebook, Baidu, Tencent, Alibaba, and Bytedance. Whether it is in drones or cyber tools, private companies and startups have led the way.

Observers have noted a marked difference in the attitudes of Chinese companies and those of their Western counterparts, to enabling technologies like AI. According to one report, "In China, there appears to be a greater sense of urgency about adapting to the changing technology."[14] Many of these Chinese companies have not simply pursued military applications of advanced technologies, but are seeking to use them to boost the country's industry and manufacturing which must cope with a slowdown, as well as a shrinking population.

From Civil-Military Integration to Military-Civil Fusion

There is an important difference in the way the US and China are undertaking civil-military integration. In the US, the linkages have evolved over decades and "there is a partnership for spin-off and spin-on technologies, with the goal of assisting commercial companies and the military."[15] In the case of China, at this stage, it is seen as a one-way process in which the civilian companies assist the military; any commercial benefit is just a corollary, and not by design. It is for this reason that it is referred to as 'military-civil fusion' rather than "civil-military fusion."[16]

According to Greg Levesque, the biggest difference between the approaches of China and the US is that for the former, the processes are state-directed. For the US, meanwhile, the Department of Defense "does not tell companies that they need to participate in certain initiatives or which dual use technologies to develop, though…it does send market signals."[17] While civil-military integration has an older history in China, its effort to create a military-civil "partnership" network in the area of technology comparable to that of the US, is a new one. They hope to get results more quickly through command methods with a huge investment of funds and central direction. US State Department officials are convinced that the PRC is seeking to use ETs and advanced technologies "to develop the most advanced military in the world."[18]

> "In the US, civil-military linkages have evolved over decades and 'there is a partnership for spin-off and spin-on technologies, with the goal of assisting commercial companies and the military.' For China, it is seen as a one-way process in which the civilian companies assist the military."

From Civil-Military Integration to Military-Civil Fusion

Given the nature of the Chinese system, there have long been programmes that mandate the "civil" part of the state to support the People's Liberation Army (PLA). It has had different names—most recently, 'military-civil integration' and 'military civil fused development'. Its present name is military-civil fusion.[19] As the names have changed, China's understanding of the concept also has. In the 1980s, when Deng launched the Four Modernisations, the concept was "defence conversion": to release overcapacity in the defence setup for civilian and commercial purposes and seek technological spin-offs. In the 1990s, China began to think of civil-military integration with expectations of spin-off and spin-on from the relationship.

However, in one form or another, China's plans to overcome deficits in the critical areas related to its national security have always been present. At one level they date to the National High Technology Program of March 1986 (the third month of 1986, and hence, 'Program 863').[20] Earlier, in the Mao Zedong era, China had the "two bombs and one satellite" program of 1956-57, which referred to the development of the atomic and hydrogen bomb, and a space satellite.[21]

Eventually, China's Manned Space programme, 'Project 921', was approved in September 1992. It functioned under the Central Military Commission (CMC) Equipment Development Department and was headed by a military officer. Another important, albeit less well-known plan was '995' (named for the year and month of the US bombing of the Chinese embassy in Belgrade). It sought to develop and deploy strategic weapons and research the so-called "assassin's mace" technologies that would target an enemy's vulnerabilities.[22]

As its economy and technological abilities took a leap in the 2000s, China realised that certain technologies had dual uses and, in certain sectors like AI and robotics, the distinctions could be blurred. The notion of using civilian personnel and technology to boost military capability began to take root, with the additional attraction of aiding the country in avoiding excessive defence expenditure. This has been an important imperative because China is acutely aware that military overreach contributed to the collapse of the Soviet Union.

From Civil-Military Integration to Military-Civil Fusion

In the 2000s, the notion of CMI began to make way for 'Military Civil Fusion (MCF)' which was seen as beyond a mere mechanical merger of the "civil" and "military" elements. "Fusion" was seen as something that would, like a chemical reaction, yield a product greater and more significant than its components.[23] On the ground, however, success has been more elusive. The private sector was viewed with suspicion in the state-dominated sector where the 11 SOEs that constitute China's defence industrial base walled themselves off in an enclave that had no relationship with the rest of the economy. In 2010, less than 1 percent of its civilian high-tech enterprises were involved in defence-related activity. China envied the US system where resources were being efficiently managed through partnerships between the government and private-sector companies.[24]

The Chinese leadership saw the first two decades of the 21st century as one of strategic opportunity. CMI/MCF plans were embedded in the 2006 National Medium- and Long-Term Plan for the Development of Science and Technology (2006-2020), also known as MLP. Along with plans in the area of electronics, semiconductors, telecommunications, aerospace, pharmaceuticals, and clean energy, were military programmes on high-powered lasers, the Beidou navigation system, and hypersonic craft.[25]

While the evolution of Western technology has, in a sense, been *sui generis* in the modern era, the primary Chinese thrust was in absorbing Western technology through an IDAR process (Introduction, Digestion, Assimilation, and Re-innovation). This moved up the scale from Introduction of foreign technology through acquisition by various means; Digestion by encouraging the dissemination of the information of the technology acquired; Assimilating it by incentivising the use of its products; and finally, Re-innovating by improving it to make the products internationally competitive.[26] Behind this was an enormous national effort that involved planning, investment, acquisition of technology through covert and overt means, and dissemination to various competing laboratories.

From Civil-Military Integration to Military-Civil Fusion

Taking advantage of the openness of the West, especially the US, China has also focused on training generations of students in American and western universities. More recently, many countries have hosted laboratories owned by Chinese companies where their specialists have worked with their Chinese counterparts. China also reached out to foreign scientists and engineers through the Thousand Talents Program, luring these professionals with signing bonuses, high salaries, and well-funded labs—to work in China. Begun initially to attract overseas Chinese, the program has targeted top-flight foreign talent to aid China's technology development in a focused range of domains.

> "As its economy and technological abilities took a leap in the 2000s, China realised that certain technologies had dual uses and, in certain sectors like AI and robotics, the distinctions could be blurred."

Leadership

In a January 2021 paper for the Center for New American Security, Elsa Kania and Lorand Laskai have pointed out that MCF is not something new. Rather, China had been pursuing civil-military integration in some form or the other since the 1980s, and MCF merely "builds upon a long history of prior policies and initiatives."[27] With the ascent of Xi as supreme leader in 2012, the notion of civil-military integration began hardening to one of MCF.

Xi pushed a range of deep reforms in the PLA and its management by the CMC. At the same time, he announced the implementation of specific policies to encourage closer collaboration between the private sector and the state. When he took over as president in 2013, Xi raised the issue of military-civilian integration and called it a national strategy. Speaking to a PLA delegation at the National People's Congress in 2013, he spoke of the importance of coordinating economic and national defence construction. A year later, speaking at a Politburo meeting in August 2014, Xi said that China needed to "incorporate the military innovation system into the national innovation system" and align the civilian and military efforts to attain synergy.[28]

Among the early reforms of Xi was to get the PLA to innovate in producing military goods and instead of providing services like medical care to civilian sectors, using the latter to enhance the capabilities of the former. In July 2016, a CMC directive on integrating the economic and defense sectors was issued, calling for qualitative change in the collaboration of the civilian and military sectors. This emphasised the loosening of the barriers between military technologies, services, and the civilian sector, the use of dual-use technologies, and the direct participation of civilian services to the PLA. [29]

Xi and the Communist Party of China (CPC) have been building on the leadership role played by PLA strategists. These included Jiang Luming, who since the mid-2000s had seen the significance

of MCF and began to articulate it as a strategy for rapidly building up China as a powerful nation with a military capable of emerging victorious in a confrontation of systems.[30] Within the PLA, three key institutions have shaped the MCF after the reorganisation of the PLA academic institutes in 2017: the National Defense University and the Academy of Military Sciences, both located in Beijing, and the National University of Defence Technology in Changsha, the capital of Hunan province. They have created research centres to work on MCF where PLA personnel interact with private-sector consultants. Parallel to this effort is a research system set up by the big defence SOEs like China Aerospace Science and Technology Corporation (CASIC), China Aviation Industry Corporation (AVIC), Norinco, and the China Electronic Technology Corporation (CETC).[31]

At all times, Xi has played the role of cheerleader as well. Speaking to the PLA delegates at the annual session of the National People's Congress in 2017, Xi referred to the ongoing military reform and efforts to provide science and technology support to the PLA. In his view, MCF was all about civilian technology serving military purposes, and defense technologies being adapted for civilian use. One aspect of his message was on the importance of military-civilian cooperation in training PLA personnel, especially in the area of science and technology.[32] Later, in June 2017, at the first plenary meeting of the Central Commission for Integrated Military and Civilian Development (CCIMCD), an apex body created in January that year, Xi identified the areas of focus for the new MCF strategy.

They covered infrastructure, defence-related S&T industry, weapons and equipment procurement, talent cultivation, socialisation of the support system for the military, and national defence mobilisation. He also called for joint military and civilian development in the area of maritime affairs, outer space, cyberspace, biology, and new energy. In his remarks, he said the strategy "must combine state guidance with the market's role and comprehensively employ institutional innovation."[33]

Plans

China's military White Paper issued in 2015 had a section on "In-depth development of Civil-Military Integration" that called for accelerating CMI in key sectors. At this stage, clearly the issues were fairly basic as the white paper called for uniform military and civilian standards for infrastructure, key technology areas, and major industries, and exploring ways to train military personnel in civilian educational institutions, developing weaponry and equipment by civilian industry, and outsourcing logistics. It called for joint development of infrastructure, space, and maritime exploration, and making military and civilian resources more compatible and mutually accessible.[34]

Yet, things were already changing at that point. In the same year, China came up with a three-stage 10-year action plan to make the country the world's foremost power by 2049. Under the 'Made in China 2025' (MIC2025) Plan, ten priority industries were identified: information technology; high-end CNC machines and robots; aerospace equipment; ocean engineering and high-end vessels; rail transportation; energy saving and new energy cars; electrical equipment; farming machines; new materials; and biomedicine and high-end medical equipment.[35] A key part of the strategy was to open up the Chinese market to foreign investments and encourage foreign companies and institutions to set up R&D centres in China.

A lot of this came together with the 13th National Five-Year Plan (2016-2020) also known as the 'Internet Plus' Plan, because of its focus on promoting the production of semi-conductors in China, along with aviation equipment and satellites.[36] The Ministry of Science and Technology outlined its own plan within the rubric of the national plan and titled it '13th Five-Year Special Plan for S&T Military-Civil Fusion Development.' This called for a focus on AI, biotechnology, and quantum technology.[37] Linked to this was the Artificial Intelligence Development Plan announced in July 2017. The Plan named MCF as one of the "six main duties" for AI development: to

strengthen military-civilian integration in the AI domain. A focus was to smoothen the process of communication and coordination among scientific institutes, universities, enterprises, and military industry units. The directive emphasised the importance of military-civil two-way traffic in relation to AI and its uses.[38]

Many of these trends were later reflected in the July 2019 Chinese military White Paper, 'National Defense in the New Era' that saw China's effort as one to counter "risks from technology surprise and growing technological generation gap."[39] If the 2015 white paper spoke of winning "informationised local wars"; the 2019 one discussed a situation where AI, quantum information, Big Data, cloud computing, and the Internet of Things (IoT) would enhance this to "intelligent[tised]" wars.[40] The notion of "intelligentised" wars was one where China would seek information dominance, including information denial to adversaries. The document also spoke of the importance of the responsibilities of the new PLA Strategic Support Force (SSF) in "integrating existing systems and aligning civil and military endeavours."[41]

By the time the 14th Five-Year Plan (2021-2025) was adopted, the external environment for China had changed. The US had abandoned its policy of engagement for one of confrontation and competition. For this reason, China became less forthcoming about plans such as Made in China 2025 and the AI Development Plan, as well as projects including the Thousand Talents Programme. Following the fifth plenum of the CPC in October 2020, it was revealed that China was intensifying its pursuit of self-sufficiency in technology in the next Five-Year Plan. The 14th Plan did talk of deepening military-civilian S&T collaboration and innovation and coordination in planning "for maritime aerospace, cyberspace, biotech, new energy, AI, quantum technology and other fields, promote resource sharing between military and civilian S&T facilities." The plan also spoke of the need to strengthen "co-construction" of military-civil facilities and the common use of infrastructure as well as to "improve military and civilian talent exchange and use."[42]

The outline of the plan, translated by the Center for Security and Emerging Technology (CSET), had few quantitative details. A few months later, however, the Central Comprehensively Deepening Reforms Commission, which is another apex body chaired by President Xi Jinping adopted a three year (2021-2023) blueprint of a plan to revamp the science and technology system. The plan aimed at dealing with western technology restrictions, seeking to promote "self-sufficiency and self-empowerment."[43]

Just a few days earlier, at a Politburo meeting, Xi had asked for the country to double-down on "technology security" measures. The meeting dealt with the country's five-year plan for national security, although details of the measures were not publicised. What was only revealed was that the meeting discussed improving China's ability to govern the areas of biosecurity, internet, data, and AI security. The meeting once again emphasised the need for China to maintain control over advanced technology needed for national security.[44]

Institutions

China has long had a robust system of planning for national defence, given its single-minded concerns of this subject. This was incorporated in the Ministry of Industry where there was a Commission for Science Technology, Industry for National Defense (COSTIND). In 2008, this was superseded by the State Administration for Science, Technology and Industry for National Defense (SASTIND). The charter of SASTIND gives it responsibility for the implementation of the Five-Year Science and Technology MCF Development Plans and for MCF efforts in government agencies, private companies, universities, and local governments. The outfit, which is under the Ministry of Industry and formation Technology, is also responsible for the regulations and standards of China's defence industry.[45]

Among the sectors that have had greatest potential for collaboration were those relating to cyber and information technologies. In both areas, civilian industry had assumed a dominant position and both had a huge relevance for the military in areas like cyber security and information warfare. Indeed, a great deal of collaboration was already going on in this area. The next step was the creation in January 2017 of the Central Commission for Integrated Military and Civilian Development (CCIMCD), with Xi as Chair. This is essentially a high-powered coordinating body whose membership comprises of the top leaders of the CPC, CMC, and the government. The purpose of this Commission is to provide apex-level deliberations and decision-making on issues related to MCF. The deputy heads are Wang Huning and Han Zheng, both members of the Politburo Standing Committee—the apex body of the CPC.

Another institutional layer came through the deep reform and reorganisation of the PLA and the CMC in 2016-17. This was occasioned by the understanding that these measures were needed to cope with global trends in military technology and operations, and principally the fear of falling behind the US. In the reorganised CMC, the Science and Technology Commission came directly under it, and was made responsible for the strategic management of national defence, organising and guiding cutting-edge technological innovation in S&T, and promoting civil-military integration of S&T. In addition, in July 2017, the creation of a new Military Science Research Steering Committee (MRSC) was announced. The committee, patterned on the DARPA, would report directly to the CMC and engage with the private sector to build on innovations and focus on cutting-edge technology.[46]

It is important to note the manner in which the four lead MCF organisations work. The CPC-led CCIMCD is responsible for providing national-level coordination at the highest political level; the SASTIND, meanwhile, works at the level of the PRC government; the CMC S&T Commission oversees the high-level CMF coordination

at the PLA level; and the MRSC focuses on strategic technology guidance "designating key military technologies, identifying new technology innovators in the commercial sector and linking them to the PLA's network."[47]

At a meeting of the CCIMCD in October 2018, Xi called for the creation of a rule-based system which would encourage private-sector participation in military industrial efforts. According to a news report, the discussion was on the need to build up a fairer market environment "to push forward competitive procurement, to guide state owned military industrial enterprises to open up in an orderly manner, and to increase the ratio of civilian and private enterprises that take part in such competition."[48] Clearly there were concerns relating to the role of SOEs which tend to smother private-sector efforts. There were also calls to devise effective means to promote scientific-technical innovation and "for making breakthroughs in key and core technologies."[49]

Xi's hand is also visible in yet another area that plays a key role in MCF: cyber security and information technology. This is yet another key institution—the Central Cyberspace Affairs Commission (CCAC) that is chaired by Xi himself, with Premier Li Keqiang as his deputy.[50]

Another important step has been the formation of MCF industrial parks and zones around the country to promote dual-use innovation. The zones focus on MIC2025 industries and act as hubs to promote the kind of linkages that are envisaged between commercial firms, universities, the PLA, and SOEs. For example, the Zhongguancun Science and Technology Zone in Beijing has an MCF committee that oversees an MCF industrial park within the zone and is responsible for linking the civilian industry with military customers.[51]

At the heart of the Chinese MCF approach are universities, many of which have already achieved world standards especially in the fields of STEM (science, technology, engineering, mathematics). According to Christopher A Ford who was the US Assistant Secretary of State for International Security and Nonproliferation till January

2021, some 80 Chinese universities have been certified to undertake classified research and developments related to military projects. SOEs also fund the education of certain students in turn for service commitments.[52]

As an "enabling" technology that can transform many other technologies, AI is a significant focus of Chinese efforts. China's private-sector giants like Huawei, Baidu, Tencent, and Alibaba, have been making huge investments in AI and finance is flowing to scores of startups; some have set up facilities abroad.[53] In November 2017, these three companies along with the voice-recognition firm iFlytek were formed into a National Team to develop AI applications. Baidu was to focus on autonomous driving, Alibaba on cloud computing and smart cities, Tencent on medical diagnosis, and iFlytek on voice intelligence. Later, SenseTime, a Hong Kong facial-recognition company was included for intelligent vision. [54]

> "At the heart of the Chinese MCF approach are universities, many of which have already achieved world standards especially in the fields of STEM."

The MCF Rollout

As a result of leadership and institutional efforts, the PLA has begun "actively pursuing AI enabled systems and autonomous capabilities in its military modernization."[55] This is already visible in the robotics and unmanned systems and Precision Guided Munitions (PGM) already deployed which may have a degree of autonomy. In 2018, the CETC and Baidu created a "joint lab for intelligent command and control technology."[56] As MCF has evolved, however, it is clear that it is not just about technology, but a larger effort to strengthen military capability by deploying civilian talent and using commercial logistics "as a guiding concept for China's approach to national defense mobilization."[57]

In an article in 2018, You Zheng, vice president of China's prestigious Tsinghua University highlighted the role of the institution in promoting MCF in AI. Tsinghua, he said, was being entrusted by the CMC's Science and Technology Commission to set up a high-end laboratory for Military Intelligence as part of the country's "AI super power" strategy. The lab would be built upon Tsinghua's existing strengths on basic research as well is its experience in applied technology with companies like Tencent and Sogou.[58] No doubt this pattern would have been replicated elsewhere as well.

The PLA's SSF and its Joint Logistics Force are reaching out to companies and research institutions. The SSF has signed cooperation agreements with many universities and the funds being made available for the CMF are encouraging municipalities and provinces to promote industrial clusters that would push cooperation between SOEs, research institutes, and private companies.[59]

In 2017, the PLA Air Force signed up with five huge e-commerce and logistics companies to upgrade civil-military logistics integration: China Railway Express, China Postal Express & Logistics, JD Logistics, SF Express, and Deppon Logistics.[60] In the CMC, the pivotal role is played by the Equipment Development Department which has opened up more than 2,000 projects to private companies; it has announced that it would declassify 3,000 defence patents for

use by the private sector. Further, the SSF signed talent and search agreements with nine research institutions and laboratories.[61] As Kania has noted, the PLA's advances "are taking shape through the efforts of Chinese military research institutes, the Chinese defense industry, and the emerging ecosystem of commercial enterprises supporting military-civil fusion."[62]

China has set up ambitious targets for themselves and have been working hard systematically, mustering large sums of money for the purpose. However, despite the dominance of the Communist Party rule, the process of "fusion" has not been easy. One reason is that the 11 SOEs that form China's defence industrial base, continue to operate largely in their own enclaves and have not been helpful to the process.

Addressing a press conference in December 2017, Chief Engineer Long Hongshang of the SASTIND said that CMF suffered from poor top-level planning, inadequate liberalisation of the military industrial base, insufficient sharing of military resources and information, and poor "spin off" of defence technology.[63] For this reason, perhaps, a special effort is being undertaken to "upgrade" policy to get the SOE giants into the innovation game. This is one of the targets of the current Five-Year Plan that ends in 2025. According to a Chinese report, specific targets have been set for the growth of R&D investment intensity" of SOEs.[64] As Li Hongjuan of the National Development and Reform Commission (NDRC) put it, while private enterprises have high market sensitivity and flexible mechanisms towards technology innovation, SOEs had the advantage of resources and capital.[65]

There are other issues as well that slow down the process. One is that of intellectual property rights (IPRs). The poor protection offered to IPRs in China is a disincentive for researchers and innovators. In a regime used to copying or acquiring technology through transfer or theft, privileging original research is not easy.[66] The second challenge is managerial. The dominance of SOEs and the top-down command system in the country, makes it difficult for the evolution

of a managerial culture in which innovation can thrive. What MCF demands is an entirely new way of working and managing scientific and technical output.

As US rhetoric and actions intensified, China girded itself to take on the US. In September 2020, a *Global Times* report highlighted the visits of Chinese leaders like Vice Premiers Liu He and Han Zheng to key national defence and high-tech hubs in the US, to push for homegrown innovation. It cited Bai Chunli, president of the Chinese Academy of Sciences who urged the Chinese scientific community to turn "technologies mentioned in US' technological containment list into China's mission for future scientific and technological development."[67]

> "China has set up ambitious targets for themselves and have been working hard systematically, mustering large sums of money for the purpose."

US Response

The country most concerned about China's MCF is the United States which, in a sense, is a target of Chinese efforts; as of now, however, the US is way ahead of any other country when it comes to MCF. However, China's swift rise, its manufacturing prowess, and its increasing emphasis on R&D has rattled the US.[68] The worry in the US is not that it will be overtaken by China any time soon, but that in Beijing's systematic command-style functioning, it can make breakthroughs in key "enabling" emerging technologies like AI or quantum computing that could dramatically enhance China's military capabilities. While this is about technologies whose military potential is yet to be fleshed out in any significant way, it is the fear of the unknown that drives the US to often exaggerate Chinese activities.

This has segued into a complicated narrative, one where, through the process of commercial acquisition, forced technology transfer and theft, China had become a technology power. Simultaneously, it has created a vast R&D machine by harnessing foreign-educated Chinese students, foreign scholars, and research institutions to become a world leader in emerging technologies. It is now seeking to leverage this into supplanting the US to become the world's foremost military power.

To mitigate the risk, the US launched in 2014 what it called its "3rd offset strategy". In the past, these "offset strategies" have been launched at key moments when the US feels that the technology table is tilting against it. It was, for example, the 2nd offset strategy, following the Vietnam war in the 1970s that focused on standoff weapons, precision targeting, stealth capabilities, space-based communications and navigation. It is these capabilities which matured in the 1990s and gave the US its formidable military edge in the two Gulf Wars.[69] According to Robert O Work, the Deputy Secretary of Defense (2014-2017) closely associated with the programme, the third offset "posits that advanced computing, big data, machine learning and artificial intelligence (AI)—and vastly improved autonomous systems and operations they will enable—are pointing towards new and more powerful battle networks involving human-machine collaboration and combat teaming."[70]

US Response

Beginning in 2018, the US began to overhaul its regulations to check Chinese use of western technologies for military use. Its first target was Huawei, the world leader in 5G technology which was placed under sanctions in mid-2019. Earlier policy had focused on separating civilian and military use of products, but the very notion of MCF is to promote the use of civilian technology for military uses. As part of the US response, the Foreign Investment Risk Modernisation Act (FIRRMA) of 2018 expanded the authority and scope of the Committee on Foreign Investment in the US (CFIUS)—an apex inter-agency committee that reviews foreign investments with national security implications to the US. As of 2018, the Export Control Act imposed greater restrictions on exports on emerging and foundational technologies to China and shifted the power of regulating ET and foundational technology export from the CFIUS to the Bureau of Industry and Security (BIS). In October 2020, after a lengthy process, the BIS, in common arrangement with the other members of the Wassenaar Arrangement,[71] issued new controls on six recently developed or developing technologies. These included hybrid additive manufacturing, CNC tools, computational lithography software, technology for finishing wafers for 5 nm production, digital forensics tools, software for monitoring communications, and metadata from telecom providers and sub-orbital craft.[72]

On 29 May 2020, declaring that the PLA was using certain Chinese students "to steal American technological secrets and innovation," then US President Donald Trump issued a proclamation to block certain graduate-level-and-above Chinese nationals who were linked to entities that "implement or support China's Military-Civil Fusion (MCF) strategy" from using special visas to enter the US. According to the proclamation, the action was necessary as MCF was "an attempt to develop the most technologically advanced military in the world by any means necessary, including by co-option and coercion."[73]

At the same time, the Chinese developments also pushed the US to redouble its own efforts in military innovation and enhance the Pentagon's ability to leverage commercial technologies.[74] As part of this, the US has been making special efforts in the area of AI. In

February 2019, Trump issued an executive order on maintaining American leadership in AI. Noting that it was the policy of the US to sustain its economic, S&T leadership in AI, the government wanted a coordinated strategy where all federal agencies will treat AI funding as a priority; it laid out an all-of-government timeline for action.[75]

Another strand of the effort came through the DIU's success in developing links with Silicon Valley. By 2016, 450 companies from 39 states had competed for DIU projects and it had awarded USD 100 million in contracts for 45 pilot projects in autonomous systems, AI, IT, and space.[76] By 2020, contracts worth USD 882.6 million had been awarded to 189 companies in the US, nearly half in California. Some contracts had also gone to foreign companies in Canada, France, Israel, New Zealand, Spain, and the UK. Many of these companies were first-time vendors of the Department of Defence. The technology focus areas were AI, autonomous systems, cyber, space, and human systems.[77]

Additionally, under the 2019 National Defense Authorisation Act, a National Security Innovation Capital programme was initiated with funding of USD 15 million to accelerate efforts of startups at developing dual-use technology. The NSIC works under the DIU.[78] Another programme under the DIU is the National Security Innovation Network (NSIN) that reaches out to new communities of innovators who may have never considered working on national security issues. These include schemes for paid summer internships and other fellowships to undergraduate and graduate students to study solutions for national security issues. Another of its initiatives is to attract top-level STEM talent for the Pentagon.

While US programme funding appears small, the challenge is to leverage both talent and money that may not have had any prior interest in defence work and to overcome the hesitation of some companies to work with government programmes, for ethical concerns. The US, however, has just about begun this and there is no saying where the effort will lead, given the enormous pool of talent that is already available.

US Response

By all accounts, the Trump Administration was the turning point of US attitudes towards China, particularly in the area of technology. While the rhetorical focus was the issue of tariffs, policy moves in the technology area have been the most consequential. The most visible manifestation of this was the case of Huawei, which has suffered a steep decline in revenues because of fears raised by the US relating to its 5G technology.

So far, the Biden Administration has not made any significant changes to the regime of technology restriction and restrictions on visas to certain categories of Chinese students. This is evident from the November 24, 2021 BIS notice adding eight more Chinese entities to its Entities List that require compulsory licence for export. The aim was to prevent US ETs "from being used for the PRC's quantum computing efforts" that could in turn help the PLA to develop a range of applications, from counter-stealth and counter-submarine technology, to the ability to break encryption or develop unbreakable codes.[79]

> "Developments in China have pushed the US to redouble its own efforts in military innovation and enhance the Pentagon's ability to leverage commercial technologies."

Implications for India

If China is developing capabilities to take on the United States, then it can hugely enhance Indian vulnerability. In essence, there will be a growing asymmetry between the military capacity of China and India—one that cannot be easily addressed given the size of the economies of the two countries and their level of industrialisation.

This paper has demonstrated that China's efforts in MCF have yet to generate significant outcomes. This is not unexpected, given that it has not been long since 2015 when the MCF strategy was launched. The reality, however, is that efforts are underway that could yield significant results and have implications for the military balance. At the least, therefore, countries like the US and India ought to have a strategy of de-risking themselves from the eventuality of Chinese successes.

India's military has been aware of the developments in the field of emerging technologies and have been undertaking studies in the area of swarms, robotics, AI, Big Data analytics, and algorithmic warfare. Indeed, the Integrated Defence Staff's 2013 Technology Perspective and Capability Roadmap (TPCR) mentions AI, robotics, EMP weapons, and unmanned underwater vessels (UUVs).[80] In 2018, the Department of Defence Production task force report on the use of AI in defence led to the creation of a high-level Defence AI Council (DAIC). Meanwhile, the Niti Aayog and the Ministry of Electronics and Information Technology has set up, with some private institutions, a Model International Centre for Transformative AI (ICTAI) in Bangalore.[81] As of 2020, India has also boosted the budget for quantum technology applications such as communications, computing, and cryptography.[82]

However, while the institutional framework has been created, there is yet to be action on the ground. This is evident from the recent anodyne remarks of Defence Minister Rajnath Singh, who said that there was need "to develop dual-use technologies so that both military and civilian sides benefit."[83]

Implications for India

To be sure, there are important differences between India and China. Because of its efforts and technology acquisition strategy, China has become a major centre of technology which is already influencing the world in cutting-edge domains such as 5G, AI, and quantum communications. As part of these efforts, it has developed a huge technology ecosystem of universities, institutes, high-tech zones, and industrial parks that are aiding its efforts to emerge as a technology power.

Meanwhile, India is a key player in certain areas including IT services, design, and product engineering, even as it does not have the overall depth that China has. Like China, India has adopted strategies of technology acquisition from the West; unlike Beijing, New Delhi has avoided using underhand means. Instead it has sought to license technology and even develop it *de novo*. But its results have been meagre.

India is not without experience in the area of civil-military integration. The best example of this is the manner in which India's nuclear weapons programme was embedded in its nuclear power industry. An even more successful model has been in outer-space—the SLV-3 formed the core of the Agni missile programme and a variety of satellites developed for civilian use have provided the country its military imaging and communications satellites. The advantage here has been that both the nuclear and the space programmes are run by the government, with the prime minister himself at the helm. The bigger challenge is to find the synergy between the private sector technology areas and those of the military. In more practical terms, the current stage of CMF is more about using civilian assets like satellites, roads, logistics systems, and airfields for military use. For some time, India has been working on the idea of using civilian companies to repair vehicles, tanks and weapons in their base workshops, but the project has met with little success.[84] In the past year, the Indian Air Force has taken up an idea—quite common elsewhere—to use highways as emergency air bases.[85]

The challenges before India

It is clear from the Chinese experience that the leadership required to set in motion the goal of MCF must be at the very apex—i.e., for India, by the prime minister himself. While prime ministers are not expected to be experts on the subject, institutionally, they bring the enormous clout of their office to cut bureaucratic red-tape, untangle or join wires, and drive the entire process. This has also been validated by India's own experience in its nuclear and space programmes.

1. This is about Military-Civil or Civil-Military Fusion—in other words, using civilian and dual-use technologies and facilities to sharpen the spear of national defence. Given the constrained resources of the country, a wider recourse to MCF is needed, where civilian facilities, personnel and training are tapped, along with existing and dual-use technologies. This requires sensitising both the civilian and defence sectors to the possibilities that exist for synergy.

2. The state of India's larger manufacturing and innovation capacities will be a vital cog in the MCF process. These are areas where efforts are ongoing. The government, for one, has articulated the *Aatmanirbhar Bharat* (Self-Sufficient India) policy of promoting domestic manufacturing. This stops at the "IDA" part of the IDAR solution, however. The last and equally important aspect is a systematic "re-innovation" strategy where products of imported technology are improved upon, to start with, setting the stage for the emergence of domestic innovation. India is constrained by the IPR restrictions that come with technology acquired from foreign countries and there is an understandable reluctance to follow the Chinese path of obtaining them through illegal means. Even so, there is enough room for generating synergies despite the obvious handicaps.

3. The most notable handicap is perhaps the lack of apex-level leadership. Perhaps the existing Cabinet Committee on Security can undertake regular meetings where MCF is the sole agenda.

Implications for India

Bureaucrats, military leaders, and experts from both the government and private sectors may be invited to participate.

4. A second-tier leadership must be provided by a small group of the Union Council of Ministers responsible for science and technology, commerce, defence, railways, space, roads, transportation, and shipping. They can be made responsible for the execution of policies decided on by the apex committee.

5. A third tier should comprise of a reformed and restructured Ministry of Defence to make it more open to innovation and partnerships with the private sector. The SOE problem that afflicts China also plagues India. For example, Defence Public Sector Units and dockyards come under the authority of the Ministry of Defence, which is also the sole customer for their products. There is a built-in bureaucratic bias in favour of the DPSUs that discourages the private sector. There are other issues, too, such as the vetting of non-government personnel to work in sensitive sectors and paying consultants and specialists market salaries.

6. The Ministry of Defence (DRDO), as well as the three services of the armed forces need to identify institutes and academic facilities that work in their ecosystem which can be given specific areas of specialisation, and who can then engage specialists and consultants from the civilian world and develop collaboration lines with universities in India and other countries.

7. The Scientific Adviser to the Defence Minister, who used to be the DRDO chief as well, should be made head of a small but reasonably well-funded grant-giving agency like the US DARPA or China's Military Research Steering Committee. Its leadership should have considerable autonomy and be freed of the usual governmental procedures or links with the DRDO. They should strictly confine themselves to the grant-awarding and monitoring process and not be involved in the every-day work of the entities they fund.

Implications for India

The funding should target non-governmental institutions like universities and research institutes, startups, and companies with the aim of promoting cutting-edge science, as well as its technological applications for the military.

8. A fourth level is often ignored: the realm of states and state governments. All of them have policies of promoting industry and commerce, infrastructure development, and related sectors. All of them run universities as well. They should be encouraged to adopt MCF policies wherever feasible.

9. Finally, it is important to discuss the state of higher education in India. Merely relying on technology institutes, even if they are as good as the IITs, is not sufficient. A vibrant civil-military integration strategy would require an equally vibrant university system. Unfortunately, many of India's universities are imparting only token education. This is something that the apex committee may like to ponder. No CMF or MCF strategy can work, if the university system is dysfunctional.

Conclusion

A Congressional Research Service Report in October 2021 provided an assessment of the state of play in the area of ETs. It argued that the implications for emerging technologies in warfighting and strategic stability "are difficult—if not impossible—to predict."[86] Besides their actual development, it remains to be seen as to "the manner in which emerging technologies are integrated into existing military forces and concepts of operations." There are many broad trends which could affect the future character of war but you could also see one set of technologies being able to cancel another.

This paper agrees with analyst Elsa Kania, whose April 2020 special report on Chinese AI developments concluded: "The PLA's trajectory in the development and potential employment of AI/ML enabled and autonomous weapons systems remains uncertain."[87] In her view, it is difficult to assess when these technologies will mature and be deployed. However, because of the manner in which these systems could affect the military balance, it was important for the US to monitor the developments and "pursue measures to mitigate such risks."

Kania and Laskai acknowledge that China is making a huge effort through large-scale investments to promote MCF and there are some advantages in the command model. Since 2015, there have been 35 funds established to promoting MCF worth some USD 68.5 billion to be spent in the coming years. These funds make strategic investments often combining state and commercial investment. But it is "far too early to evaluate with much confidence the returns on these Chinese MCF investment vehicles."[88] They have pointed out that Chinese rhetoric on CMF is often "aspirational". On the ground, the top-down process has been difficult to execute. While Chinese leaders often wish to define a clear-cut architecture for the CMF structure, but that "it belies the much messier reality of how MCF has taken shape through a range of local policies." [89]

Conclusion

Perhaps the last word on the current situation of Chinese MCF comes from the University of California, San Diego scholar Tai Ming Cheung. In May 2021, assessing the status of the MCF development strategy, Tai noted that there has been insufficient research and analysis on the subject both in China and the US. His view was that "the official MCF development strategy is still in its early stages of evolution."[90]

There are issues as well for the US's efforts to slow down Chinese MCF. An October 2021 report of the CSET noted that AI-related systems are still a fraction of the overall purchasing activity of the PLA. Their assessment is that this activity is focused on intelligence analysis, predictive maintenance, information warfare and navigation, and target recognition in autonomous vehicles.

What is alarming, however, is that American technology continues to slip through the efforts to block transfers since a lot of it is Civilian Off-the Shelf (COTS) technology and most of the suppliers do not appear to be on US export control and sanctions regimes. The bottomline assessment is that as of now, PLA investment is roughly equivalent to that of the US and "it remains to be seen how exactly AI might alter the balance of military power in the Indo-Pacific."[91]

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