# China's Revolution in Military Affairs: An Uphill Endeavour

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As part of its wider modernisation, China aims to achieve a revolution in military affairs with Chinese characteristics by mid-21st century. As a first step China is mechanising and informationising its combat forces but recognises that the Revolution in Military Affairs (RMA) will entail far reaching socio-economic reforms. China is establishing a technological-industrial base for its RMA by participating in international programs like the European Union Galileo project and leveraging civil domestic programs in information technology and space.[1]

Following the 1991 Gulf War, the Revolution in Military Affairs (RMA) has preoccupied the Chinese People's Liberation Army (PLA) in much the same way as it has preoccupied military planners in other major powers. This preoccupation has led the Chinese military to sponsor many RMA-related conferences and to the publication of many RMA related books in China.

At the same time China's military has begun modernising along RMA lines.[2] The size of China's military has been reduced twice during the 1990s, it has been reorganised into a progressively flatter structure, operational doctrine has been revised,[3] military training has been made more realistic,[4] and command and control capability has been enhanced via the introduction of much new information and electronics related equipment. Importantly, large numbers of college graduates have been recruited to improve overall competency and quality of military officers[5] and to facilitate the operation of sophisticated equipment and the implementation of RMA oriented reform.

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[1] This is an edited version of a paper prepared for the conference, The State of Art in the Global Defense Industry: Implications for Revolution in Military Affairs, sponsored by Rajaratnam School of International Studies, November 2007.

[2] For a comprehensive analysis on China's military modernisation, see David Shambaugh, *Modernizing China's Military: Progress, Problems, and Prospects* (Berkeley, CA: University of California Press, 2002).

[3] For an in-depth analysis in this regard, see James Mulvenon and David Finkelstein (eds), *China's Revolution in Doctrinal Affairs: Emerging Trends in the Operational Art of the Chinese People's Liberation Army* (Washington DC: Center for Naval Analysis, November 2005), in <http://www.cna.org/documents/DoctrineBook.pdf> [Accessed 11 October 2007].

[4] For a relevant analysis, see Arthur Ding, 'Training Leading toward Joint Operation for Future Conflict in the Taiwan Strait', read at the conference, The Rise of China: Asian and European Perspective, sponsored by Observation Research Foundation, New Delhi, 23-24 November 2006.

[5] For a sociological study over college graduates' motivations to join the Chinese military and impacts on its officer corps' composition, see Youzhong Tian, *Xuesheng guan: junying li de*

China's defence industry has also been comprehensively reformed in a process called defence industry conversion.[6]  This has allowed defence industry enterprises to diversify their productions into civilian products and to regularly release less sensitive technologies for civilian market.  This reform has included separation of suppliers and end users, and the opening up of the supply side of the defence market by allowing private enterprises to supply products to military, thereby integrating civil and military sources of supply.  China has also introduced a bidding process to facilitate competition among suppliers;[7] and has fostered collaboration programs with advanced countries.[8]

Nevertheless, some questions remain unanswered in this context: How does China conceive RMA?  How does China's conception of RMA affect the reform of its defence industry and subsequent military acquisition and procurement?  What are the strengths and weaknesses of China's defence industry and will it facilitate or impede China's implementation of RMA?  How does China address its technological deficiency?   Finally, how does globalisation affect China's RMA?  This article attempts to shed some light on these questions.

## China's Conception of RMA and China's Approach

In general, the PLA sees RMA as a technology driven phenomenon in the military field and human society.  It is driven mainly by the development of information technology (IT).   These technological developments then combine with broader human innovation to bring changes to military organisation/structure and operation doctrine, culminating in a revolution in Chinese military affairs.[9]

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*zhishi fenzi* (College Graduates Turned Military Officials: Intellectuals in Military Barrack) (Beijing: Social Science Documentation Press, 2005).

[6] For an earlier comprehensive analysis of China's defence industry conversion, see Paul Folta, *From Swords to Plowshares: Defense Industry Reform in the PRC* (Boulder, CO: Westview, 1992). For a recent comprehensive analysis, see Evan Medeiros et al., *A New Direction for China's Defense Industry* (Santa Monica, CA: Rand, 2005).

[7] For a discussion in this regard, see Arthur S. Ding, 'Market Factor and Reform of China's Armament System since late 1990s', *Zhongguo dalu yanjiu* (Mainland China Studies), vol. 48, no. 1 (March 2005), pp. 29-52 (in Chinese).

[8] For an analysis on China's effort in this regard, see Arthur S. Ding, 'Globalization and Defense Industry in East Asia: Seeking Self-Sufficiency and Teaming up for Dual-Use Technology', read at Conference on Globalization and National Security, sponsored by IDSS, Singapore, March 14-16, 2006; James Mulvenon and Thomas Bickford, 'The PLA and the Telecommunications Industry in China', in James Mulvenon and Richard H. Yang (eds), *The People's Liberation Army in the Information Age* (Santa Monica, CA: RAND, 1999), pp. 245-57.

[9] It should be noted that RMA and information warfare (IW) are deliberately blurred by this author due to the fact that RMA is heavily dependent on information technology, and has elements of IW.  Chinese views on RMA and information warfare are rather similar to that of Americans. For an analysis in this regard, see James Mulvenon, 'The PLA and Information Warfare', in Mulvenon and Yang (eds), *The People's Liberation Army in the Information Age*, pp.

To the Chinese military, the RMA also reflects a larger and deeper revolution in China's social and economic development. They fully realise that China's greatest test will be its ability to continue to reform its political, social and economic systems to a level at which Chinese society can sustain the RMA being introduced to the Chinese military. This suggests that China has grasped the essential socio-economic foundation of RMA.[10]

The PLA perceives the RMA as a new type of war of mass destruction. In the PLA view, innovative application of the new technology to military operations and military organisation will profoundly affect conduct of war, and countries with superior IT technology capabilities and innovation will easily overwhelm those without.[11]

Hence, while the Chinese military might want the RMA, they recognise that technological, economic and social constraints mean it is not yet feasible. That said, they need to respond to and be prepared for RMA. As some observers have pointed out, the Chinese military seems to have reached some consensus over how the PLA should respond to the world wide trend of RMA.[12]

Increasing tension in the Taiwan Strait could also reinforce the above socio-economic constraints on China's effort to participate in the RMA. China's need to be prepared for military conflict with the United States over the Taiwan issue distracts Chinese policy attention and diverts resources from RMA development.[13]

The above limitations and constraints have forced a compromise: 'RMA with Chinese characteristics' which emphasises 'asymmetry', by which an inferior Chinese force can prevail over a superior US adversary. The emphasis on Chinese characteristics also precludes the PLA from mechanically copying the US model of RMA development.[14]

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175-86. Toshi Yoshihara has good explanation on why Chinese analysts have been so obsessive with information warfare concept. See Yoshihara, *Chinese Information Warfare: A Phantom Menace or Emerging Threat?* (Carlisle, PA: US Army War College Strategic Studies Institute, November 2001).

[10] Ji You, 'Learning and Catching up: China's RMA Initiative', in Emily Goldman and Thomas Mahnken (eds), *Information Revolution in Military Affairs in Asia* (New York: Palgrave McMillian, 2004), p. 99.

[11] Ibid.

[12] Ibid., p. 104.

[13] Arthur Ding, 'The Lesson of the 1995-1996 Taiwan Strait Crisis: Developing a New Strategy toward the United States and Taiwan', in Laurie Burkitt, Andrew Scobell and Larry M. Wortzel (eds), *The Lesson of History: The Chinese People's Liberation Army at 75* (Carlisle, PA: US Army War College Strategic Studies Institute, July 2003), pp. 379-402.

[14] Ji You, 'Learning and Catching up: China's RMA Initiative', p. 104.

The Chinese model involves simultaneous mechanisation and informationisation. As former Central Military Commission (CMC) chairman Zemin Jiang has noted, this approach entails "using informationization to upgrade mechanization, and using mechanization to accelerate informationization".[15]

The policy of pursuing RMA with Chinese characteristics was formalised in *China's National Defense 2004* as follows:

> To adapt itself to the changes both in the international strategic situation and the national security environment and rise to the challenges presented by the RMA worldwide, China adheres to the military strategy of active defence and *works to speed up the RMA with Chinese characteristics*.[16]

The relationship between mechanisation and informationisation was further explained as follows:

> Going with the tide of the world's military development and moving along the direction of informationalization in the process of modernization, the People's Liberation Army (PLA) shall gradually achieve the transition from mechanization and semi-mechanization to informationalization. Based on China's national conditions and the PLA's own conditions, the PLA persists in taking mechanization as the foundation to promote informationalization, and informationalization as the driving force to bring forward mechanization.[17]

The current CMC chairman, Jintao Hu, reportedly also endorses this strategy by indicating a consensus at senior levels of the PLA. The combination of mechanisation and informationisation was reiterated in the *China's National Defense 2006* as follows:

> It [China] strives to ensure coordination between the revolution in military affairs with Chinese features and preparations for military struggle, *mechanization and informationization* (emphasis added), combat force building of services and arms, current and long-term development, and efforts devoted to the main and secondary strategic directions.[18]

The previous emphasis on simultaneous mechanisation and informationisation remains unchanged.

> Enhancing the performance of the armed forces with informationization as the major measuring criterion. The PLA, taking mechanization as the foundation and informationization as the driving force, promotes the composite development of informationization and mechanization to achieve

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[15] Ibid., p. 104.
[16] *China's National Defense in 2004,*
<http://english.peopledaily.com.cn/whitepaper/defense2004/defense2004(2).html> [Accessed 16 September 2007] (emphasis added).
[17] Ibid.
[18] *China's National Defense in 2006,* <http://english.pladaily.com.cn/site2/special-reports/2007-01/15/content_706615.htm> [Accessed 16 September 2007].

> overall capability improvement in the fields of firepower, assault, mobility, protection and information.[19]

China aims to achieve a fully fledge RMA program by 2050. According to *China's National Defense 2006*,

> China pursues a three-step development strategy in modernizing its national defense and armed forces, in accordance with the state's over-all plan to realise modernization. The first step is to lay a solid foundation by 2010, the second is to make major progress around 2020, and the third is to basically reach the strategic goal of building informationized armed forces and being capable of winning informationized wars by the mid-21st century.[20]

## RMA and Technologies Needed

The above approach implies that the Chinese military will respond to the world wide trend of RMA and US' potential challenge by at least selectively developing some ITs and procuring some information equipment.[21] At issue is what specific technologies in this very broad field the Chinese will develop and procure in pursuing "RMA with Chinese characteristics"?

Studies show that PLA's priority focus of RMA-related technologies is similar to that of the United States: technologies for command, control, intelligence, and cyber warfare. According to Andrew Yang, the advanced weapons and systems that China is attempting to develop cover a wide range of technologies, including those for enhanced Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) network, electronic magnetic warfare, soft-kill information warfare (or cyber warfare), and hard-kill capabilities ranging from cruise missile, anti-radiation missile, laser/particle beam, laser-guided smart bomb, to anti-satellite system.[22] Other researchers share this view.

> IT technology, including R&D [Research and Development] of IW [Information Warfare] systems, C4ISR facilities, early warning networks and electronic warfare architecture, are all top priorities for PLA in its drive to achieve informationization. One key goal is to construct an integrated systems of systems at the strategic and tactical levels. The development of space assets is regarded as the key to successfully leaping ahead … In the

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[19] Ibid.

[20] Ibid.

[21] Yunchuan Zhang, director of Commission of Science, Technology, and Industry for National Defense, said that the Chinese Communist Party has made strategic deployment for defence under the condition of informationisation although he did not elaborate it. See Zhang, 'Xinshiqi guofang keji gongyeh de fazhan yu gaige' (Development and Reform on Science, Technology and Industry for National Defense in the New Era), <http://big5.gov.cn/gate/big5/www.gov.cn/zwhd/2006-10/22/content_420113.htm> [Accessed 16 September 2007].

[22] Andrew Yang, 'China's RMA: Rattling Mao's Army', in Emily Goldman and Thomas Mahnken (eds), *Information Revolution in Military Affairs in Asia* (New York: Palgrave McMillian, 2004), pp. 125-38.

> short term, the PLA plans to network existing hardware, equipment with available information platforms that will act as force multipliers.[23]

The Chinese military does not provide any official statement on specific technologies which they regard as relevant to their version of RMA. Their *China National Defense in 2006* provides the following glimpses:

> It [PLA] is speeding up the development of integrated electronic information systems, enhancing the comprehensive integration of various types of weapon systems and support systems, and facilitating information sharing and fusion,[24]

which, related to the C4ISR system,

> promotes the composite development of informationization and mechanization to achieve overall capability improvement in the fields of firepower, assault, mobility, protection and information,[25]

and probably involves precision guidance, navigation, Information Warfare (IW) defence capabilities.

A statement by China's Commission for Science, Technology, and Industry for National Defense (COSTIND) also gives some hints. It says

> in the period of the 11th Five-year plan covering 2006-2010, science, technology, industry for national defense … has to meet demand of mechanization and informationization of the military in the field of high-tech weapons and equipment … In the space industry, focus should be placed on manned space, moon exploration, large capacity communication satellite, and new generation of rocket programs … In the field of electronics industry, emphasis should be placed on upgrading comprehensive integration capability of electronic and information system, strengthening the engineering capability of critical electronic components and information products.[26]

COSTIND was responsible for overseeing defence industry production, mapping out defence industry development policy, helping defence industry reform and working out product standard of military systems under the State Council. COSTIND has been downgraded to a bureau under the newly established Ministry of Industry and Information Technology in March 2008.

Some argue that what Chinese military is doing should not be regarded as RMA. This is because the PLA mixes RMA with asymmetry, assassin mace,

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[23] Ji You, 'Learning and Catching up: China's RMA Initiative', p. 105.

[24] *China's National Defense in 2006,* <http://english.pladaily.com.cn/site2/special-reports/2007-01/15/content_706593.htm> [Accessed 16 September 2007] (emphasis added).

[25] *China's National Defense in 2006,* http://english.pladaily.com.cn/site2/special-reports/2007-01/15/content_706615.htm> [Accessed 16 September 2007].

[26] 'Guofang kegongwei tichu shiyiwu zongti yaoqiu fendou mubiao han zhuyao renwu' (COSTIND raises comprehensive requirements, endeavour targets and main missions for the 11th five year plan period), <http://www.costind.gov.cn/n435777/n717840/n717862/49409.html> [Accessed 16 September 2007].

or 'punctuation' warfare. In addition, the PLA has procured traditional platforms such as jet fighters, submarines, warships, ship-to-ship missiles and smart bombs which fall outside the ambit of RMA.[27]

The argument continues that RMA should focus on 'network centric warfare' (NCW) capability in which sensors and shooters are separate but linked. Proponents of this view argue that the priority accorded by the Chinese military on procuring platform in the past decade means that the PLA mixes military modernisation with RMA.[28]

The above argument has some merit, particularly in light of the preponderance of platforms in Chinese military procurement. But the Chinese military, well aware of the limitations and constraints they face, has decided to take a long-term approach to achieving RMA. This is manifest in the three-step development strategy for achieving RMA around mid-21st century, as announced in the *China's National Defense in 2006*.

We should also take into account less visible procurement by the PLA in recent years. The Chinese military has made a tremendous effort to build up a nation-wide network system through optical fibres and communication satellites. It has also endeavoured to build up real-time on-line systems through deploying various kinds of satellites in the space.[29] These efforts, while consistent with building up a NCW capability, are still rudimentary compared with what the United States has achieved.

Chinese military takes a long-term approach in equipping its force. As some observers point out:

> R&D priority do not aim to equip PLA in the next few years, but rather ensuring it will be at the frontiers of high-technology breakthrough in the future … it is more important to establish the right direction for PLA's future than it is to acquire advanced hardware.[30]

## China's Technological-Industrial Base for RMA

Ever since its establishment in 1949 the PRC has sought to build up its defence industry as part of a strong and prosperous nation able to escape from 100 years of historical humiliation by foreign colonialists. Nearly six decades effort has yielded a very comprehensive defence industry, which covers space, aviation, nuclear, shipbuilding, ordnance and electronics (or more broadly, IT) industries.

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[27] Shih-yueh Yang, 'Revolution in Military Affairs' Concepts in the People's Liberation Army: A Comparative Perspective', *Zhongguo dalu yanjiu* (Mainland China Studies), vol. 48, no. 4 (December 2005), pp. 31-52.

[28] Ibid.

[29] For an excellent analysis on this regard, see Mark Stokes, *China's Strategic Modernization: Implications for the United States* (Carlisle, PA: US Army War College Strategic Studies Institute, 1999).

[30] Ji You, 'Learning and Catching up: China's RMA Initiative', p. 107.

Of the six industries, space and IT are more directly related to China's RMA requirements, although both industries need other science and technological input. RMA development is prompted by the IT industry, which can also sustain the Chinese military's 'asymmetric' advantage and capability. The space industry can provide the platforms and various sensors required for NCW.

It should be noted that China's recognition of the importance of space and IT technology and their potential military application dates from the mid-1980s, as the well known '863' program attests.[31] Nevertheless, it is safe to argue that it was only after the 1991 Gulf War that the Chinese leadership realised the RMA era was upon them and began promoting the IT and space related industries in line with the new slogan, "fighting a local war under high-tech condition", which was later further revised as "fighting a local war under informationisation condition". This shift was reinforced by the 1995/96 Taiwan Strait crisis.

Many of RMA related technologies have been included in the '863' program.[32] In IT area, for instance, they include technologies for:[33]

- intelligent computer software and hardware systems capable of high-speed parallel computation and of processing large amounts of video and picture information;

- telecommunication, which includes technologies for communication network and exchange, optical fibre communication, individual communication network, multimedia communication, and broadband digital network.

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[31] The '863' program, which was approved by China's reform architect, Xiaoping Deng in March 1986, was proposed by some China's top scientists. Aiming at boosting China's national strength and competitiveness in the future, these scientists proposed to concentrate limited resources on developing information, space, laser, automation, energy, material, and biotechnology. Later in the 1990s, oceanic survey technology, superconductor, remote sensing real time convey system, large capacity switch board exchange system, and rice gene mapping were included in the program. For an excellent analysis on the origin of the '863' program, see Evan Feigenbaum, *China's Techno-Warriors: National Security and Strategic Competition from the Nuclear to the Information Age* (Stanford, CA: Stanford University Press, 2003).

[32] For a complete introduction of the '863' program, see 'Guojia gaojishu yanjiu fazhan jihua' (The National High Technology Research and Development Program of China), in <http://www.863.org.cn/863_105/index.html> [Accessed 11October 2007]. It should be pointed out that in June 1997, China launched a '973' Guojia zhongdian jichu yanjiu fazhan jihua (National Basic Research Program) as China's on-going national keystone basic research program, which also covers IT, energy, and materials fields, along with agriculture, resource environment, population as well as health fields and synthesis and frontier science. For an English introduction of the '973' program, see <http://www.973.gov.cn/English/Index.aspx> [Accessed 11October 2007].

[33] This section draws from Chapter 2.2: IT sector of the *Guojia gaojishu yanjiu fazhan jihua*, in <http://www.863.org.cn/863_95/863briefing/863bif001_32.html> [Accessed 11 October 2007]. It seems that information security technology was added later.

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- information acquisition and processing technologies, which include those for earth survey; high resolution Synthetic Aperture Radar satellite; satellite based infrared remote sensing; high resolution large calibre optical telescope; very large scale integration Integrated Circuit (IC) chip for ultra high-speed signal processing; as well as microwave solid component and in-time signal processing;

- optical-electronics components and optic-electronics/micro-electronics system integration, which include large capacity high speed optical fibre communication and key components and systems of advanced photon switch system, optical-electronic IC and photon IC, and new optical-electronic components and processing.

With regard to space technology, two areas were prioritised in the '863' program.[34] They were "to develop advanced heavy rocket to upgrade China's commercial launch capability", and to continue to undertake space Research and Development (R&D). In fact, the space element of the '863' program aimed at paving the way for manned space via the development of large capacity rockets, launching spacecraft from the earth to space, and, eventually, establishing and operating a manned space station.[35]

The synergies between the IT and space programs should be emphasised. The '863' program includes development of various sensors in the IT program, while the space element of the '863' program is confined to developing manned spacecraft. Nevertheless, command, control and communication of manned spacecraft need IT support. Hence China's progress with manned spacecraft caused progress in the IT field.

In the past decades, China has developed several types of sensor satellites which have definite military application.[36] SAR satellites have been launched with an objective to provide high resolution all-weather information, track moving targets and satisfy military mapping requirements; four navigation satellites, which have both navigation and communication

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[34] This sector draws from the Chapter 1.2.1 of the '863' program, in
<http://www.863.org.cn/863_95/863briefing/863bif001_22.html> [Accessed 11 October 2007]. It should be pointed out that space technology was briefly touched in Chapter 1 while it is completely removed in Chapter 2 without any explanation.

[35] For a complete story of the '863' space program which leads to the '921' manned spacecraft program, see 'Zui wanzheng jiemi zhongguo hangtian' (The most detailed story of China's space program), in <http://military.china.com 2005-10-24>, cited from
<http://military.china.com/zh_cn/critical3/27/20051024/12779635.html> [Accessed 11 October 2007].

[36] Information on China's satellites draws from Sinodefence, Space-Based Systems, in
<http://www.sinodefence.com/strategic/spacecraft/default.asp> [Accessed 11 October 2007]. For a recent analysis on China's military space strategy, see Ashley J. Tellis, 'China's Military Space Strategy', *Survival*, vol. 49, no. 3 (August 2007), pp. 41-72,
<http://www.informaworld.com/smpp/section?content=a780978527&fulltext=713240928> [Accessed 16 September 2007].

functions, have been in orbit to provide all-weather and two-dimensional positioning data for both military and civilian users, and the network covers most areas of East Asia region. In addition, weather satellites (Feng Yun series), maritime surveillance satellites (Hai Yang series), and military and civilian communication satellites have been in orbit.

With these satellites in orbit, a C4ISR system, although rudimentary, has gradually been built up, and the Chinese military has been testing the system. For instance, in the Jiefang No. 1 (Liberation No. 1) or Donghai No. 6 (East Sea No. 6) military exercise, which was held in April-August 2001 to test and evaluate three-service joint operation capability for amphibious attack, space-based reconnaissance assets were mobilised. During the exercise, the Chinese military:

- reportedly mobilised for the first time a military reconnaissance satellite to monitor an area of 350 square miles centring on the Taiwan Strait;

- deployed an indigenously developed Y-12 early warning aircraft to conduct electronic and counter electronic warfare aimed at crippling the virtual enemy's command and communication systems.

Two communication satellites were also used in the exercise. China boasted of being capable of doing reconnaissance, surveillance, identification of fixed and mobile large- and medium-sized warships cruising in China's south-east waters and surveillance of a large warship (mainly aircraft carrier) in real time under all weather conditions.[37]

The system was further tested in the subsequent Jiefang No. 2 military exercise held in June-August 2004. According to a Taiwan media report, the exercise entailed deployment of a new air defence radar system, AS901, at brigade level of the 1st and 31st Group Armies. Particularly significant was the Chinese military's capacity to link all air defence radars through a data link system and to transmit all tactical information to a Tactical Intelligence Centre (TIC). The latter, which was reportedly established in 1998, could transmit all tactical intelligence to the commanders of front-line PLA troops who had access to experimental tactical data link receivers at battalion level.[38]

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[37] *Wen Wei Daily* (Hong Kong) (18 August 2001); Ding, 'Training Leading toward Joint Operation for Future Conflict in the Taiwan Strait'.

[38] This paragraph draws from Chen Donglong, 'Dongshan dajunyan gongjun pingxiang zhiguan xin jishu chulu' (The PLA's New Technology for Synchronic Command and Control Appeared in the Dongshan exercise), *ET Today, Military Affairs* (29 August 2004), in <http://www.ettoday.com/2004/08/29/11250-1678587.htm>. Recently, Chinese media pointed out that all air defence radars were all linked together, enabling the PLA Air Force radar units to protect China's all airspace. 'PLA's air defence radars able to protect all airspace, military',

A third case can be found in Chinese ground force. The 'Golden Autumn Ten' exercise,[39] which was held in October 2000 in different places simultaneously in China. During the exercise, a special force unit code named 'Hunting Leopard' was delivered by armed helicopters into a pre-planned place in the enemy's rear area. The small unit reconnoitred and kept monitoring an important target, and transmitted picture information back to the command center real time on line. The small unit destroyed the enemy's target under the cover of coordinated firepower.

'Assassin mace' types of weapons were also being developed. A typical case is cyber warfare.[40] The media has reported accusations by the US,[41] German, and British[42] governments that hackers sponsored by the Chinese government had penetrated those governments' data bases. The US Department of Defense was particularly concerned because its NIPRNet (Non-classified Internet Protocol Router Network) was penetrated by Chinese hackers.[43] The NIPRNet is crucial to the quick deployment of US forces should China attack Taiwan: by crippling a Pentagon Net used to call US forces, China gains crucial hours and minutes in a lightning attack designed to force a Taiwan surrender.

The Chinese military is reportedly supplementing the assassin mace concept with 'Network People's Warfare'. This entails organising thousands of local reserves and militia forces into reserved information warfare units to be trained in information operations. Such units have reportedly been formed in Hebei, Fujian (Xiamen city), Shanxi (Datong city), and Shanxxi (Xian city). These units are further divided into network warfare, electronics warfare, psychological warfare, intelligence warfare and technical support specialities.

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Xinhua, October 9, 2007, <http://english.pladaily.com.cn/site2/news-channels/2007-10/10/content_976883.htm> [Accessed 11 October 2007].

[39] This section draws from 'Lijian: shiji dayanbing' (Razor-Sharp Sword: A Grand Exercise of This Century), in <http://news.xinhuanet.com/mil/2005-07/06/content_3177291.htm>; and 'Junshi xunlian lingyu lide yici lishixing feiyue' (A Historical Leap in the Field of Military Training), *Liberation Army Daily* (17 October 2000), p. 6.

[40] This paragraph draws from Robert Marquand and Ben Arnoldy, 'China Emerges as Leader in Cyberwarfare', *Christian Science Monitor* (14 September 2007). For an interesting story of how US countered Chinese hackers, see Nathan Thornburgh, 'The Invasion of the Chinese Cyberspies, and the Man Who Tried to Stop Them: An Exclusive Look at How the Hackers Called Titan Rain Are Stealing US Secrets', *Times (*28 August 2005). Media had that the Chinese cyberwarfare unit, composed of three sub-units; offence, defence, and technical support, was established in 1999.

[41] Alan Sipress, 'Computer System Under Attack, Commerce Department Targeted; Hackers Traced to China', *Washington Post* (6 October 2006); and Richard B. Schmitt, 'Chinese suspected in Capitol hacking cases', *Los Angeles Times* (12 June 2008).

[42] 'MI5 warns over China spy threat', *BBC News* (2 December 2007), <http://news.bbc.co.uk/go/pr/fr/-/2/hi/business/7123970.stm; and 'Steep rise in hacking attacks from China', *Financial Times* (5 December 2007).

[43] John J. Tkacik, Jr., 'Trojan Dragons: China's International Cyber Warriors', *Web Memo*, no. 1735 (12 December 2007).

The above cases illustrate how the Chinese military have gradually adapted IT related equipment, along with space assets for information acquisition, in order to develop a capability for fighting a high-tech war under the condition of informationisation. The cases also demonstrate that, after two decades of high-tech systems development, supplemented by reverse engineering, China has succeeded in developing at least the rudiments of the technological-industrial capacity required to indigenously produce those IT equipment and space assets needed for RMA.[44]

In developing the technological-industrial basis for pursuing the RMA it desires, China's key strengths include its willingness to provide the requisite financial support (funded via long term double digit economic growth) and political determination. The Organisation for Economic Co-operation and Development's research points out that China has overtaken Japan to become the second-biggest spender on research and development after the United States. The report says China is expected to invest US$136 billion in R&D in 2006, a figure which is ahead of Japan's US$130 billion, but behind the US$330 billion the United States will invest. The report also says that China's spending on research as a percentage of its gross domestic product doubled to 1.2 percent in 2004 from 0.6 percent in 1995, and the number of researchers climbed 77 percent in the same period to 926 000, second only to the 1.3 million in the United States.[45]

Such persistent investment can attract talented college/university graduates to join the defence related R&D teams. When the defence industry conversion started in the 1980s, the whole industry suffered from a continuous brain drain. This trend, however, began to turn around from the beginning of the 21st century: the number of college/university graduates quadrupled in 2003, leading to a concomitant rise in the unemployment of college/university graduates and levelling-off of pay rates. In these circumstances, working at the defence R&D fields has become a relatively attractive. To the Chinese government, investing in defence industries could not only save them from continuing brain drain and possibly eventual collapse[46] but could also help prepare China for world wide competition.[47]

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[44] For a milestone study on China's effort in developing information dominance, see Stokes, *China's Strategic Modernization: Implications for the United States*. Chinese government publishes annual reports of the '863' program, detailing expenditure, projects approved, major advances achieved in each year. For the 1999-2002 reports, see http://www.863.org.cn/english/annual_report/index.html> [Accessed 11 October 2007].

[45] 'China overtakes Japan as No 2 in R&D spending', *Bloomberg* (5 December 2006).

[46] One Chinese rocket expert was quoted to say that the '921' manned space program has saved the whole space industry from eventual collapse. Hu-jun Li, 'Huojian xitong yanjiuyuan: 921 gongcheng wanjiule zhongguo hangtian' (A research staff at rocket system: the 921 program saved China's space industry), <http//:news.sina.com.cn/c/2005-10-20/10358062875.shtml> [Accessed 11 October 2007].

[47] Feigenbaum's research points out that when making proposal to Xiaoping Deng which became the '863' program, those top notch scientist and engineers emphasized that high-

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## Role of Importing and Globalisation

While allocation of resources and political determination are necessary, they are not sufficient for China to achieve its desired outcome. As the Chinese analysts know better than foreign observers, a rigid central command type of economic system, along with a closed political system, isolation from the outside world and active discouragement of dissent in the PRC's first thirty to forty years have impeded innovation, despite persistent investment in 'hardware'.[48] An inappropriate evaluation system introduced as a result of institutional reform in science/technology sector has created an incentive for the science/technology research community to indulge 'rent seeking' behaviour.[49] Near monopoly of resource allocation to large state own enterprises—characterised by "problems in corporate government, weak management skills, and organizational structures, power monopolies, subsidies, preferential policies",[50]—would not be conducive to innovation, either.

For all the above the reasons, China has relied on importing technology, and at the same time, leveraging globalisation to engage in RMA. One instance is China's participation in the Galileo project. The Galileo project, which is run by the European Union (EU), is composed of thirty navigation satellites intended to build up an accurate navigation system in space at an estimated total cost of €4 billion. Once fully operational, the Galileo project is to have margin error of one metre, a figure which is much more accurate than the ten metres of the US Global Positioning System (GPS).[51] Giove A satellite, which served as test function for the whole Galileo program, was launched in December 2005 by a Russian rocket, and its successor, Giove B, was launched in April 2008.[52]

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technology is related to China's long term international status and prestige. Feigenbaum, *China's Techno-Warriors: National Security and Strategic Competition from the Nuclear to the Information Age.*

[48] Shengzu Gu, Zhengyou Li et al., *Chuanxin yu gaojishu chanyehua—Xinshiji de zengzhang yuanquan* (Innovation and High-Technology Industrialization—Growth Source for the New Century) (Wuhan, Hubei: Wuhan University Press, May 2001), pp. 62-8.

[49] 'Zuai keji zizhu chuanxin de tizhi yinsu' (Institutional Factors Impeding Indigenous Innovation), *Xuexi shibao* (Study Times), in http://big5.china.com.cn/xxsb/txt/2006-05/22/content_6215892.htm> [Accessed 11 October 2007].

[50] Sylvia Schwaag Serger and Magnus Breidne, *China's Fifteen-Year Plan for Science and Technology: An Assessment*, *Asia Policy*, no. 4 (July 2007), p. 158, in <http://www.nbr.org/publications/asia_policy/AP4/AP420%Serger_Breidne20%RN.pdf> [Accessed 24 July 2007].

[51] For an analysis on the security implication of the Galileo project, see Gustav Lindstrom, *The Galileo Satellite System and Its Security Implications*, Institute for Security Studies of the European Union Occasional Paper No. 44 (April 2003).

[52] 'GALILEO on track: successful launch of the GIOVE-A satellite', 28 December 2005, in <http://europa.eu.int/rapid/pressReleasesAction.do?reference=IP/05/1712&format=HTML&aged=0&language=EN&guiLanguage=fr> [Accessed 11 October 2007].

The EU decided to develop their own GPS in the early 1990s, and the final decision to develop the project was made in February 1999.  In order to resist pressure from the US which tried to block the EU from developing the project, non-EU countries were approached to jointly develop the project and share the cost.

Accordingly, the EU approached China in June 2001.  After more than two years of discussion and negotiation, an agreement between the EU and China was reached in October 2003, and a further agreement to delineate, scope and confirm items for cooperation was signed on 9 October 2004.  Under the agreements, China, the first non-EU participant nation, agreed to invest €200 million.  Of this amount, €70 million will be used for the period of development, while the remaining will be used for the period of deployment.[53]

China set up a new enterprise as EU Galileo Industries' counterpart in China.  The new company, China Galileo Navigation Satellite Company Ltd, has four share holders from four defence related institutes, China Aerospace Science and Industry Corp., China Electronics Technology Group Corp., China SATCOM, and Chinese Academy of Space Technology of China Aerospace Science and Technology Corp.

China will definitely benefit from joining the Galileo project.  As a formal non-EU member, China is to participate in the decision making of the Galileo project, R&D and management.    This will facilitate China's R&D, manufacturing, management, commercial exploitation and military application associated with its own budding navigation satellite system.[54]

China is looking to the Galileo project to generate substantial business opportunities: as a full member of the project, China can obtain receiver specification data for end users earlier.  This will enable it to manufacture positioning related products and sell positioning related services at home and abroad, noting that the Galileo receiver will be compatible with the US GPS and Russia GLONASS systems.  It is estimated that by 2025, the navigation system can create €205 billion for selling receiver related products and in an estimated revenue of €168 billion worth of value-added opportunity.[55]

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[53] 'China-Europe GNSS Technology Training and Cooperation Center', in
<http://www.cenc.org.cn/news/news2005091701.htm> [Accessed 11 October 2007].
[54] For an analysis on the capability of China's navigation satellite system, see Geoffrey Forden, 'Beidou weixing dingwei xitong dui zhongguo heliliang de yingxiang' (Impact of China's Beidou Positioning System on China's Nuclear Force) (Chinese translation), in
<http://www.surveyor.com.cn/Article/Meander/200601/Article_168.htm> [Accessed 11 October 2007].
[55] Liu Huanran, 'Ouzhou qielilue weixing daohang jihua de yingyong ji xiaoyi fenxi' (Benefit Analysis on the Navigation Application of the EU Galileo Satellite), *Zhongguo Hangtian*

The military application of the Galileo project has concerned countries in the Asia Pacific region.  The system's navigational accuracy will give China's military platforms and munitions a precision strike capability as well as enhanced command, control and comprehensive battle management capabilities.

Participation in the Galileo project is also likely to help China develop its new generation of navigation satellites.  Although China already has had four Beidou navigation satellites in orbit, deficiencies of system reportedly limit its military application severely: it can reportedly only provide two-dimensional positioning without being able to measure altitude; the system is not able to provide positioning service to high-speed vehicles; it can only provide positioning services to those able to emit a requesting signal (rather than passively receiving positioning signal) and then only to large receivers with long antennas; its capacity is small, being limited to 150 users at one time; and the system heavily relies upon a ground control center for signal transmission between users and satellites.  China is looking to improve its second generation Beidou satellites by accessing Europe's technology via the Galileo project.[56]

In another instance, China imported technology to produce small satellites: In the late 1990s, Tsinghua University and Surrey University of Great Britain formed a collaborative micro-satellite project.  As one of the leading institutes in this field, Surrey University is well known not only for developing various micro-satellites but also for jointly manufacturing them with various institutes and universities world wide.

Tsinghua University reportedly set up a state sponsored aerospace research center in 1998, and dispatched several engineers to Surrey in October 1998 to learn relevant technology.  Beginning July 1999, the both sides started to jointly manufacture micro-satellites, the first of which weighed 50 kg and had a 40-metre resolution capability.  This jointly manufactured experimental micro-satellite was successfully launched to the space in June 2000 for communication and remote sensing tests.

This experience has enabled China to develop more advanced indigenous micro-satellites.  Having learned the whole process of developing a micro-satellite (including mission analysis, comprehensive design, manufacturing, assembly, test and evaluation, and operation), Tsinghua University

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(Aerospace China), no. 5 (2000), in <http://www.space.cetin.net.cn/docs/ht0005/ht000507.htm> [Accessed 11 October 2007].
[56] 'Beidou xitong yingshang zhiyue qi junshi yingyong' (Beidou system's limitations constrain its military application), in
<http://military.china.com/zh_cn/top01/11053250/20070429/14073720.html> [Accessed 13 June 2007].

independently developed another smaller 25 kg micro-satellite which was successfully launched into space on 18 April 2004.[57]

Tsinghua is reportedly building on the above experience with a 25-kg satellite in developing another much smaller satellite. The so called Micro-Electric Mechanic Satellite (MEMS) will be less than 5 kg with micro GPS receivers, camera, and micro-propellant. This tiny satellite is reportedly a pilot project intended to test critical MEMS technology.

A third case was in the optic-fibre and mobile phone field. Telecommunication plays a pivotal role in building up C4ISR, and optic-fibre cable is essential for building up RMA capability. The optic-fibre cable has several advantages in military applications.[58] They can carry considerably more communications traffic than older technologies that were available to the PLA in the past and they are faster. The cables are able to transmit data at a rate of 565 megabytes a second or higher. This represents an enormous increase over older copper-wire based systems and significantly improves the PLA's ability to transmit, receive and process large amount of information (including visual images) from central government and the various military regions.

Optic-fibre cables are also less prone to corrosion and electromagnetic interference, making them more reliable. Their light weight and small size make them ideal for mobile battlefield command as well as fixed military headquarter. Most important of all, it is extremely difficult for American and other intelligence services to monitor military communications conducted over optic-fibre cable, particularly landline connection between Beijing and strategic command and control centers thorough the country.

Optic-fibre can be used as sensors in sonar arrays, as well as in perimeter defence systems and even biological weapons detection. It can also be used for local area networks in warships and in precision guided munitions. Therefore, acquisition of fibre-optics means better weapons and Command, Control, Communications, Computers and Intelligence (C4I), in addition to the clear benefits to communications.

In order to exploit these advantages, the Chinese military sought to manufacture optic fibre in China. To this end they formed joint ventures with foreign companies seeking to enter China's growing market. Lucent Technologies of the United States was the first to form joint venture in China to produce fibre optics, and Lucent Technologies Shanghai Fibre Optics Co.

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[57] Ying Tianxing, 'Zhonggong zhongdian daxue jiji yanfa xiaoweixing weixing zhi yanxi' (Study on China's Top University actively develop small and micro satellites), *Zhonggog yanjiu* (Studies on Chinese Communism) (Taipei), vol. 39, no. 3 (March 2005), pp. 107-17.
[58] The discussion of advantages on optic-fibre cable and Lucent Technologies' investment in China draws from Mulvenon and Bickford, 'The PLA and the Telecommunications Industry in China', pp. 255-6.

used to be the largest fibre optics manufacturer in China before the Shanghai branch, along with Lucent Technologies Beijing Fibre Optics, was sold to Corning in July 2001. The Lucent Shanghai branch reportedly sold 680 000 kilometres of optic fibre in China's domestic market in 1997 and intended to expand its production capacity to 1.5 million kilometres of cable a year in 1998. The French maker, Alcatel, also produce optic-fibre cable in China later.

The Chinese military has also tapped mobile telecommunication technology in building up C4I capability. These technologies include Code Division Multiple Access (CDMA) which allows many users to use the same bandwidth without interfering with one another. Asynchronous Transfer Mode Switching is another cutting edge technology. All these technologies can provide more reliable communications facilities with much improved capacity, and possibly accelerate the development of C4I capabilities if China can successfully absorb them.

Chinese military enterprises have successfully formed joint ventures to facilitate transfer technology for military applications. For example, the China Electronic System and Engineering Company (CESEC), which is under the Fourth sub-Department, Radar and Counter-Electronic Warfare sub-Department, of the PLA's General Staff Department, has been an instrument for transferring technology. The CESEC formed China Telecom-Great Wall Communications with China Telecom, which was formerly under the Ministry of Post and Telecommunication. Foreign companies were invited to bid for contracts at provincial and local levels for building a nationwide cellular network based on CDMA technology, and all the well known equipment suppliers, Motorola, Northern Telecom, Ericsson, Qualcomm and Lucent, participated in the ensuing competition for supply contracts.[59]

On the other hand, China's growing technological-industrial base will enable it to export RMA-related technology and products, making China an important actor facilitating globalisation, although on a small scale to begin with. For example, in May 2007, China launched a communication satellite for Nigeria from its Xichang launching station with a Long March-3B rocket under a contract signed in December 2004 between China and Nigeria. According to media reports, this was China's first export of a satellite. It was also the first time China provided 'turn key' type of service to a customer. The service 'package' ranged from the manufacturing of the satellite, the launching of the satellite from a Chinese-manufactured rocket, building of two ground control stations for Nigeria, the provision of training and operational support, to the arrangement of bank loan of US$200 million. It is reported that China trained over fifty Nigerian experts in fifteen months, enabling them to undertake the preliminary design of a satellite. This

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[59] Mulvenon and Bickford, 'The PLA and the Telecommunications Industry in China'.

success is likely to help China win more cooperation contracts with other countries: thirty-eight countries have signed letter of intent with China.[60]

Another potential export market is Latin America. In 2006, China agreed to assist Venezuela to develop a series of satellites with a goal of making Venezuela a space club member, beginning with production of a communication satellite. The communication satellite, which will deliver Venezuela's television programs to the whole of Latin America, is to be launched from Venezuela in August 2008. The communication satellite is to be followed by geological survey satellites, in which the Venezuelan military reportedly plays an important role.[61]

The above two cases suggest that China is likely to become a major exporter of RMA related technologies and systems. This will have serious international political ramifications. If China continues to grow, and the development of its RMA related technological-industrial base keeps pace, China is very likely to provide information products including whole packages of military aid to developing countries at a reasonable price, leading to a possible re-alignment of the global balance of power.

## Conclusion

China has made enormous effort in developing and building RMA related technological-industrial bases with that the aim of producing RMA related weapons and equipment indigenously and achieving RMA sometime around mid-21st century, as stipulated in *China's National Defense in 2006*.

In fact, China has succeeded in building a limited technological-industrial base, and new products testifies to the newly developed capabilities: various satellites, along with manned spacecraft, have been launched into space for information acquisition, navigation and communication purposes; and a nationwide telecommunication has been built up through the use of optic-fibre cable and communication satellites for processing and transmitting large amounts of information.[62]

In addition, changed military doctrine also testifies to the newly developed capability. A new doctrine has been developed in which the previous

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[60] Zhu Jianling, 'Maiweixing daifashe zhonggong fuwu quanfangwei' (China's across-the-board service: selling and launching satellite), *China Times* (Taiwan) (15 May 2007). However, this satellite malfunctioned recently because of a power problem. Nigeria's Zhongguo zao weixing shiling (Nigeria's satellite made by China malfunctioned), BBC Chinese News, 13 November 2008, <http://news.bbc.co.uk/chinese/trad/hi/newsid_7720000/newsid_7726800/7726846.stm> [Accessed 24 November 2008].
[61] 'Venezuela denglu dazao shoumei weixing' (Venezuela approaches China for manufacturing the first satellite), *United Daily News* (Taiwan) (2 March 2006).
[62] For a detailed analysis on the new doctrine of fighting a local war under informationisation, see Mulvenon and Finkelstein (eds), *China's Revolution in Doctrinal Affairs: Emerging Trends in the Operational Art of the Chinese People's Liberation Army*.

emphasis on demonstrating artillery fire power has switched to emphasise *yitihua*, in which IT equipment is widely used to integrate different services and arms for jointly executing a military mission.[63] The *yitihua* concept is equivalent to western militaries' concept of joint operation, a term which is based on an assumption that a command and control system has been built. There is no doubt that what China is doing now is to develop information dominance in the direction of RMA.

It should be pointed out that this effort has involved more than continuously pouring money into the development of new technology. As reform goes deeper and deeper, the Chinese leadership has fully realised that RMA related technologies are the outcome of appropriate institutions, and technology development can only be realised if it proceeds hand-in-hand with institutional reform.[64] In other words, priority has gradually shifted to fostering a 'culture' conducive to innovation.

It seems that China is at the crossroads in developing RMA. Positive elements facilitating RMA with Chinese characteristics are abundant. Sufficient experience has been accumulated in managing complex environment from economic development in the past three decades; continuing growth has made persistent investment in defence R&D affordable; institutional reform to sustain defence industry reform in the long term is being undertaken.

On the other hand, some factors, mostly socio-political ones, may impede China's RMA effort. A closed political system is likely to suppress creativity and innovation; R&D related decision making is still dominated by bureaucrats rather than entrepreneurs in major defence industries; no real competition is practiced for major defence R&D projects, and division of labour in defence industry still prevails for fear of creating large scale unemployment to cause social and political instability. It is a daunting task to completely transform China's defence industry with an indigenous capability on which RMA is based.

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[63] Ding, 'Training Leading toward Joint Operation for Future Conflict in the Taiwan Strait'.
[64] See Ding, 'Market Factor and Reform of China's Armament System since late 1990s'.