

The Nano-tech Impact on the Future Military Affairs

奈米科技對未來軍事之衝擊

作者 備役少將曾祥穎

Abstract 提要

1. The main stream of PLA's military modernization is the asymmetric warfare, and the emerging nano-technology is one of the main targets, which should be concerned.

不對稱作戰係共軍現代化之主流，新興的奈米科技之發展應列為關切的主要目標之一。

2. Nano-technology may improve information technology and its characteristics may change the nature of materials. That may bring a renewed arena in the military development beyond current knowledge in the near future.

奈米科技將使資訊科技益發精進，其特性可改變物質之本質，近期在軍事領域發展中將可能超出現有知識之外。

3. There are three approaches that can be used in the military development: to integrate the current technology; to partially upgrade existing systems and to develop new weaponry. It should follow the way of from “small to big, little to many, point to whole, slow to fast, and simple to complex” in progress. It is a sequence “from quantity change to quality change” and this is an un-reversed course, according to history. No matter whichever approach we take, it will be connected with the changes or adaptation of the doctrine, operational concept, tactics, organizations, etc.

奈米在軍事上發展的途徑有三：結合現有技術、局部提升現有系統以及研發全新戰具。就歷史而言，其進程為「由小而大，由少而多，由點而面，由慢而快，由簡而繁」，是一個「由量變到質變」的不可逆的過程。無論採取任何途徑，必將牽動思想準則、作戰概念、戰術戰法與組織編裝之改變或調整。

4. Nano-weaponry has its own limitations. One of them is that the size is too small. Its build-in functions and operational range are limited, too. Mother Nature is its biggest enemy.

奈米武器本身有其限制，其中之一為體積太小，內建之功能與作業的距離有

限，其最大敵人為大自然。

5. Currently, there have been three nano-tech regions established by the PRC government already, and it planned to build a base in the Tianjing area to coordinate the efforts of the industry, governmental, academic and defense circles for developing and researching their nano-technology.

目前，中共已成立3個奈米科技區域，並結合產業、官僚、學術與國防圈子發展他們的奈米科技。

6. Nano-technology has emerged, no matter we like it or not, and this is the truth. There have been some changes now and will be new and significant. To face such kind of impact comes with the question: are we ready to respond to the challenge ahead yet?

奈米科技業已浮現。不管我們喜歡與否，這是事實。目前已有某些改變，也許即將有重大變化。面對這樣的衝擊，問題是：我們是否已準備好因應當前的挑戰了？

Foreword

After the military action of the Operation Iraqi Freedom (OIF) accomplished on April 14, 2003, the effectiveness of the Revolution in Military Affairs (RMA) triggered by information technology (IT) in the late 1970s was proven on the battlefield again. There is no doubt that the combination of artificial intelligence (AI) and information technology into the military operation will be the mainstream in the next decades. But another phenomenon that the media and multi-based sensors providing real or near real time battlefield pictures to not only the military decision makers but the whole world also remind the military planners that the term “Surprise” needs to be reconsidered about its nature. We may find that the weight of emerging technology will be increased in terms of “Knowledge Surprise” especially. That is why the People’s Liberation Army (PLA) wants “to take the road of composite and leapfrog style development” for her military modernization.^①

前言

2003年4月14日，美伊戰爭軍事行動結束後，於1970年代末期，由資訊科技引發的軍事事務革命所產生的效益，再度在戰場上獲得明證。無疑的，人工智慧與資訊科技結合於軍事作戰必將為未來數十年的建軍主流。然而，媒體與多重情

① “China’s National Defense in 2004” by Information Office of the State Council of the PRC, Dec. 2004, Beijing, pp.12~13.

蒐體系所提供戰場即時或近乎即時圖像的現象，不但提醒軍事決策人員，也告訴了世人，必須重新思考「奇襲」的本質。我們已見到新興科技的份量增加，尤以「知識奇襲」為然。此亦為共軍現代化所以要採取「複合式與跨越式發展途徑」之原因。

There is a consensus in the Asian-Pacific regional security issue that the PLA is the main threat to the Republic of China (ROC) on Taiwan both currently and in the near future. However, before 2020, the PLA has her own subjective limitations, which should be overcome, especially about the lack of the high quality human resources. That is to say, we should be carefully watching the modernization of the PLA not only in the feasible future but also the decades beyond. If the asymmetric warfare thought is the main stream in PLA's military modernization, the development of Nano-technology will be one of the main objectives, which should be put into consideration on military planner's minds. Because the potential of the nano-technology may greatly enhance the effectiveness of the AT & IT capabilities, which will be housed in new weapon systems in the future.

中共為我國當前與近期的主要威脅，已係亞太區域安全議題之共識。不過，在2020年前，共軍有其主觀條件之制約，尤其是在優質人力資源方面，有待克服。換言之，我們不但必須密切關注共軍當前現代化發展，更應注意其未來之展望。若中共軍事思想係以不對稱戰爭為其軍隊現代化之主流，奈米科技發展即應列為主要標的之一，因為其具備有極大的潛力，足以大幅增進內建於未來新武器系統內的資訊科技與人工智慧的能力。

The impact of nano-technology's characteristics on the military affairs

奈米科技特性對軍事之衝擊

The nanometer (10^{-9} meter) is the description of the scale of length. The distance between one and one hundred nanometers is called the nano scale^②. A nano material doesn't belong to the macroscopic fields in traditional classical physics and the microscopic behavior of quantum physics. It is between those and presents the Meso-scopic phenomenon. Because the electron, photo, quantum interact itself and each other, there interactions will induce apparent material, element and system changes, which exceed the

② The width of ten shoulder-to-shoulder hydrogen atoms is about one nanometer. See Lue, She-Yuan, Nanometer New World, Science Development, National Science Council, Taipei, Vol. 359, Nov. 2002. p. 6.

current physical, chemical, and biological phenomena that we know. They can no longer be reasonably interpreted by traditional or current scientific theories and technological models. The main theme of nano-technology is to explore those characteristics by means of manipulating structure of atoms, molecules, macromolecules, and effectively manufacturing or utilizing these apparatus to improve the livelihood of human beings.

奈米（ 10^{-9} 公尺）為一長度之描述。物質介於1~100奈米之間者，謂之奈米尺度，其特性既不屬於傳統古典物理的巨觀（macroscopic）領域，也不屬於量子物理下的微觀（microscopic）行為。而是位於兩者之間呈現出介觀（Mesoscopic）的現象。在這種尺度下，由於電子、光子、量子本身與彼此之交互作用，引發材料、元件及系統產生顯著超出目前所認知的變化或全然不同的物理、化學與生物特性與現象。無法以傳統的科學或當今的科學理論或技術模式獲得合理的詮釋。奈米科技主要即是利用掌握原子、分子或巨分子尺度的結構，來探索這些特性，並有效製造或使用這些裝置，以改善人類的生活。

When the material shrinks to the nanometer scale, because of the surface and volume effects, which induce changes in its nature, it is called a nanometer micro-particle, and has four characteristics and effects: quantum scale effect, miniature scale effect, surface and critical effect and macro-quantum tunnel effect which constitute the basic characteristics of nanometer-particles and solid nanometer objects. Under their interactions, materials produce the following physical and chemical characteristics: low melting point, high specific heat capacity, high extensibility; high catalytic, high diffusivity; high hardness, high tenacity, high elasticity; strange magnetism; hyper-wave-absorbing ability. Therefore, they are multi-phased composites materials; can combine materials structure and functions, and are intelligent, low-pollution, recyclable, energy-saving, and durable materials. Currently, the most advanced fields in this area are the electronic components and integrated circuits. Many papers indicate that the future nano-electronic components will be “smaller, faster, and cooler”. In other words, the extent of “digitization” will be magnified by less component volume and power consumption, but have more capable server and databank functions. According to our experience, whenever artificial intelligence capabilities become more powerful, innovation and development will be greater as well.

當任何物質縮小至奈米的尺度，將因其表面效應與體積效應導致產生性質的改變，謂之奈米微粒，其有4種特性與效應：量子尺寸效應、小尺寸效應、表面和臨界效應，以及巨觀量子隧道效應。這4種效應構成奈米顆粒與奈米固體的基本特性，在它們的交互作用下，物質產生以下的物理與化學特性：低熔點、高比熱容、高延展性；高催化性、高擴散率；高硬度、高韌性、高塑性；奇特磁性；

超強吸波性。因此，奈米材料將是具備結構與功能相結合之智慧型、低污染、可再生、節約能源、耐用的多相複合材質。目前在此方面進展最快的為電子元件與積體電路。故而有許多研究報告指出，可以預見的是未來所有的奈米電子元件必將「更小、更快、更冷」。亦即是「數位化」的程度，將因元件的體積與耗能變小，伺服器與資料庫功能變大，由經驗得知當人工智慧更強時，創新與研發的能力亦愈強。

Since we thought the application of nanotechnology will change the manufacturing processes and methods of future materials and components fundamentally, it will be inevitably applied to the military field and will generate profound impacts on weapons, equipments, operational concepts, and doctrines etc., as a decisive factor in “Knowledge Warfare” in the future.

既然我們認為奈米科技之運用將從根本上改變未來材料與元件的製程與生產方式，就必將運用到軍事領域，對武器、裝備、作戰思想與準則產生深遠的影響，而成為未來「知識戰爭」中的決定性因素。

In contemporary thinking, nano-technology has a great potential in the military area. For example,

就目前的思想認為，其在軍事上的潛能甚大，例如：

- For the electronic technology, they may improve the acquisition and detection capabilities of intelligence information, have better data transmission advantage, greatly enhance the capacities of C4/I/SR system, and reduce the damage of the electromagnetic pulse (EMP) effect on the electronic subsystem of the equipments and weapon systems.

在電子技術方面：可增進情報資訊獲得與偵測能力，較佳的傳輸優勢，大幅強化自動化指、管、通、資、情、監、偵系統之能量，同時減低電磁脈衝對武器裝備電子次系統之危害。

- For the construction material, they may strengthen weapon systems performance to enhance the quality, reduce the weight, increase the range and payloads of the platforms, and prolong the shelf life of equipments and systems.

在材料結構方面：可強化武器裝備性能，提高質量，減輕重量，以增加載臺之作戰距離與酬載，延長裝備使用壽限。

- For the micro-weaponry, it is reported that experimental types such as nanometer unmanned aerial vehicle, and miniature smart weapon system, such as spy grass and spy ant, have been available. It may increase the flexibilities of strategy, tactics and deployment, and gain more activeness on the battlefield than before^⑧.

在武器微型化方面：已有實驗型之微型奈米無人載具以及類似間諜草之類的
註⑧：於下頁。

智慧型武器之報導，將可增加戰略、戰術及部署彈性，較以往更有利於爭取戰場之主動。

-For the mold simulation, it will make current methods for mold simulation more effective^③.

在模式模擬方面：可使已廣為目前新武器研發所運用的模式模擬法則更為有效。

Comparing with the traditional weapon systems, the future nano weapons will be extremely small in size and be highly intelligent. The fighting capacity and functions of such weapons will far exceed our current understanding for a single soldier platform. Meanwhile, because they are cheap, small, portable, and can be easily deployed, the inferior side could likely use these weapons as an asymmetric means massively against the enemies with superior equipments and armaments.

儘管目前所知之實驗型奈米武器距離實用化尚遠。但與傳統的武器系統相比，未來的奈米武器系統均將呈現微型化與高度人工智慧化，使得單兵或單一武器載臺的戰力與功能超乎我們所知，同時，因其體小輕便，攜行與部署相對容易，再加上價格相對低廉，弱勢的一方可以藉此不對稱之手段，大量的使用於戰場，以對抗優勢的敵人。

Because it can greatly absorb and scatter electromagnetic wave, the nano coating can be a protection means used on the traditional armored vehicles. Such painting can reduce the echo signal to a minimal level, and achieve the purpose of invisibility in the electronic environment. It can also be used to receive electronic pulse, to adjust the armored vehicles camouflage with the battlefield terrain and plants, by changing colors quickly, or following the instructions to change the coating pixels. By reducing detection of infrared and optic reconnaissance and surveillance devices, it can help the combat units to avoid the enemy's long distance smart weapon attack, and can develop its strength when needed. For the inferior, who should survive first before engaging enemy, this coating provides vital factors to win the war.

由於奈米塗料強大的吸收與散射電磁波的能力，若運用到傳統的戰車上，可使回波訊號降到最低，從而產生電子環境下隱形之目的。亦可藉智慧塗漆接收電

③ Zhao-dong (ed.), "Nano-tech and Weaponry", (Beijing: Jun Shi I Wen, Sep. 2001), pp. 161~168. (Chinese version)

④ Huang Der-huan, "Nano-tech changing the world" Published by Ying-zhou Publication, Taipei, July 2002, pp.133~134. (Chinese version)

子脈衝的方式，使戰鬥車輛之偽裝隨地形與植物而快速變化，或依據指令改變塗料之像素，使其與地形、地貌一致。使得敵方之光學與紅外線偵測器材之偵獲率降低，可避免敵方精靈武器遠距精準之攻擊，亦可依戰況之需要發揮其戰力。對必須於戰前保持戰力的弱勢一方而言，此為獲得戰爭勝利之重要因素。

When the term of nanometer semiconductor was known to the public, it means the deployment of nanometer-weapons is not far away. The efforts of improving current systems or developing new systems will break the boundaries of current fluid mechanics. These can cause current early warning, information reconnaissance and target selection functions and operation plans by various radars, optic devices, and radios useless. In order to respond to the new “emerging threat”, we had better think earlier how to deal with it, in order to prevent surprise or defeat by nanometer weapons of the enemy in the battlefield.

當奈米半導體的術語為大眾所熟悉時，即意味奈米武器部署之時日已然不遠。不論係改良現有系統或研製新的系統，均將突破現有流體力學對載臺或系統之限制。使得現有之以雷達與光電系統為主的早期預警、情報偵蒐與目標獲得功能與作戰概念失效。為因應此種新「浮現中的威脅」，我們必須及早籌謀，以防止敵人部署奈米武器系統於戰場時遭致奇襲或敗績。

Because of the character of nanotechnology, to acquire the target information will be more difficult in the future and we need more time and knowledge to analyze the information that we gathered to make right judgments. It is a time-consuming work indeed and it will reduce our reaction time dramatically. In terms of force planning, if it is possible that the enemy will take adventurous actions into crises or conflicts against our national security, it will, without doubt, use surprise attacks. If this assumption is accepted, we should accordingly change our means and responses of fighting.

由於奈米之特性，未來目標情報之獲得更將困難，我們必須以更多的時間與知識分析所獲致的情資，並做出正確的判斷。此為耗時耗力之作為，使我可用於因應之時間急劇壓縮。對建軍而言：敵國有盲動冒進引發危機或衝突以危害我國家安全之可能。亦即是敵人奇襲的可能性增加。如果所設前提合理，作戰與因應方式當然應該改變。

The main problems of current nano-technology

奈米科技之主要問題

Although we expect that nanotechnology has a great advantage of making the new weaponry micro-sized, smarter and intelligent, there are still some limitations. Because of the nanometer material is hard to compose, and is small in size, the performance will

depend on the weather situation, in other words, the biggest “enemy” is perhaps Mother Nature. Furthermore, because of the small size, no matter the power of micro turbojet engine is from fuel or solar battery, its capacity could not sustain system operational and communication for a long period. That is why right now the operation range of experimental micro unmanned aerial vehicle can only fly 2-3 kilometers away from the operator, and in the air for about an hour.

雖然我們認為奈米科技有使新的武器微型化、精靈化並能大幅提升現有武器性能的優點。但也有一些先天上的限制。因為奈米材料合成不易，體積甚小，其性能及表現常受天候左右，其最大的「敵人」亦非大自然莫屬。此外無論微機電的渦輪發動機之動力來源為油料或太陽能電池，受限於其體積小，無法長時間支援系統運作與通信之需求。此亦為目前實驗型超小型無人載具僅能距離作業人員2~3公里飛行，留空時間約1小時的原因。

People can foresee that emerging nanotechnology will have a brilliant prospect in the future life and have great influences on the human society, global economy and national security, but there are still too problems from theories to realities. However, the spending on the basic research is too big and the risk of development is too high for any individual or a corporation. Nanotechnology should depend on national support to carry on the research projects after all.

人們已預見新興的奈米科技對未來的生活、人類社會、全球經濟與國家安全有重大的影響。但是在理論與現實之間仍有許多問題有待克服。不過，其基礎研究之花費太大，發展的風險太高，實非個人或公司所能負擔，必須有賴國家的支持，才得以有成。

Taiwan, United States, Japan, Western Europe, and the People's Republic of China, all have their own national projects to support research and development in this area. Each nation has her center of gravity of course. The PRC began with the “eighth 5-year project”, which started to research nanometer material composites and manufacture devices. Taiwan has her own 6-year project, too. Along with the accumulation of knowledge and technologies, the upcoming 10 to 15 years is the most important period to every country and the military^⑤.

我國、美國、日本、西歐與中共，都有國家級的計畫支持此一領域之研發。各國亦各有其重點。中共從「八五計畫」起就開始奈米合成材料與製造設備之工

⑤ Gong Jian-hua, “The Nano-tech You Should Know” Published by Shi-Mao Publication, Taipei, July 2002, pp.209~210. (Chinese version)

作。我國國科會亦有「六年計畫」。隨著知識與技術之累積，對各國以及軍事而言，未來的10~15年將是最重要的時刻。

The approaches of nanotechnology in the military development 奈米在軍事上發展之途徑

The approaches that nanotechnology can be used in the military development are: to integrate the current technology; partially to upgrade existing systems and to develop new weaponry. There should follow the way of “from small to big, little to many, point to whole, slow to fast, simple to complex” in progress. It is a sequence “from quantity change to quality change” and this is an un-reversed course, according to history. No matter whichever approach we take, it will be connected with the change or adaptation of the doctrine, operational concept, tactics, organizations, etc.

奈米在軍事上發展的途徑有：結合現有技術、局部提升現有系統以及研發全新戰具。就歷史而言，其進程為「由小而大，由少而多，由點而面，由慢而快，由簡而繁」，是一個「由量變到質變」的不可逆過程。無論採取任何途徑，必將牽動思想準則、作戰概念、戰術戰法與組織編裝之改變或調整。

1.To integrate the current technologies

一、結合現有技術

Currently, the main trend of the nanotechnology research and development is to melt nanometer powder into conventional materials, and to perform so called “nanometer amendment.” The purpose is to let the materials have partial nanometer characteristics and functions but without adjusting current production lines drastically. This is the fastest way and most economical measure to upgrade the combat strength we have now. To the conventional services platform and weaponry, coating with nanometer powder or pellets over the surface on the traditional materials, may reduce friction coefficient and drag forces, and in traditional fluid mechanics increase speed and mobility. Especially, it has superior electromagnetic wave absorbing and scattering ability, which can reduce the echo signals greatly, and achieve the purpose of invisibility in the electronic environment. For the coating on the sizeable weapon systems, it can blend the weapon into the terrain, and feature as natural plants, for example, making those equipments invisible from infrared and optic detection, and getting the advantage of preserving before it engages the enemy.

目前奈米科技研發的主流是將奈米粉末與傳統材料摻和，以達到所謂的「奈米改性」。其目的是使其具備部分奈米性能，卻無須大幅調整現有之生產線。這是目前所知最快速、最節約提升戰力的方式。對傳統的三軍載臺與武器而言，塗

裝奈米粉末或顆粒於傳統的材質表面，應可大幅降低傳統流體力學上的磨擦，減少阻力，增加速度與機動性。尤其是其優異的電磁波吸收與散射的能力，可大大的減低回波信號，達到電子隱形的效應。將塗裝用於大型武器系統，可使其類似天然植物而融入地形、地貌，而不被紅外線觀測與光學器材偵知，獲得在與敵人接戰前「保存戰力」之利。

The nanometer coating technology has other excellent merits, such as prolonging systems duration time in corrosives, and lasting heat resistance, all benefit to prolonging the shelf life. If this idea is correct, it is worthwhile to upgrade parts to improve the weaponry and equipments, which have been deployed. It is very important to the country whose financial resources are limited or unable to develop new weapon systems. At least this approach may lighten the defense expenses quite a lot.

奈米塗裝技術還有其他的優點，如延長系統之腐蝕時間，增強其抗磨與耐熱等，均有助於裝備之抗老化，延長使用壽限。如果此一概念為真，亦即是已部署之武器裝備才值得以套件實施改良。對財力不足或無力開發新武器系統的國家，至關緊要。至少此一方式可減輕其國防財力之負擔。

2.To partially upgrade existing systems

二、局部提升現有系統

The automated C4ISR has a significant influence on the modern armed forces. The critical points are whether the volume of database and the transmission methods of information could well serve the need of creating precise Common Operational Environment (COE) in order to make commanders of different levels have identical situation awareness, share the same combat plans with other friendly force, and achieve the missions by the most effective force assignment.

自動化C⁴ISR能力之強弱，對現代軍隊戰力之發揮影響甚大。關鍵點在於資料庫的容量與數據傳輸的方式，是否能夠達到建立精確的共同作戰環境圖像之要求，以使各級相關之指揮官有一致之狀況覺知，並得以與友軍共享相同之作戰圖像，以確保指揮官得以最有效的運用其兵力，完成其任務。

If we review the development of information technology, we may assume that within 5 years, nanotechnology shall have a significant breakthrough. Hard disks will be size smaller and smaller in size, with capacity higher and higher, and the speed faster and faster. Based on those developments, products can extend the current standard of miniaturization and artificial intelligence. If the volume of database becomes smaller, and its decision-making supporting functions becomes more effective, these products can replace old or outdated parts and constitute powerful sub-systems or parts according to the demand of war-fighting.

Besides, the additional compatible subsystems can be integrated into original systems with “applique method”, to make a digital upgrading for better performance.

如果回顧資訊科技發展的過程，未來5年之內，奈米科技在此領域應會有重大進展。因為硬碟的尺寸日減，存取的能力日高，處理的速度愈快，在此成果上再向微型化與人工智慧化延伸，資料庫的體積一旦愈來愈小，決策支援能力愈來愈強，屆時便可以依據作戰需求做出功能強大的次系統或組件，以汰換老舊或不符作戰所需的組件。此外還可以運用「貼花方式」將額外的可相容的次系統結合至原有系統，使其得以做數位化之提升，而增進其功能。

3.To develop new weaponry

三、研製全新戰具

Since nanotechnology makes artificial intelligence weaponry “micro-sized”, there have been a lot of reports about “spy grass,” “machinery bug,” “ant soldier,” “sparrow satellite”. Those system functions are very limited, and they are easy to be massively produced. Besides, it has self-destruction device embedded, and the damage control is better than currently deployed mines. Another advantage is that the cost is relatively low and hard to be detected by the adversary. Those new weaponry may become the trend of future. However, if there is no strong command and control capability to support those devices, they may be cheated by the opponent forces or be jammed by excessive and confusing data or information, letting the user hard to make decisions or ever make a wrong one. Moreover, because the size is so small and they are easily influenced by the weather, these new weapons could at most be used as a supporting role to assist the surveillance and reconnaissance. Currently, we should not expect these weapons too much in view of that.

由於奈米科技使人工智慧的武器得以「微型化」，各式如「間諜草」、「機器蟲」、「螞蟻兵」、「麻雀衛星」之報導已屢見不鮮。因為這類系統功能極其有限，便於大量製造與使用，並內建有自毀裝置，在損害管制上較地雷為佳。另有成本相對低廉，不易為敵發現之優點。此類新型武器確實為未來之趨勢，不過若無強大的指管能力加以支援，反而容易受敵方之欺騙或因所傳送情資過於分歧，致使使用者難以下達決心，做出錯誤的決策。再加上因其體積過小，易受天候之左右，目前為止僅將其用於輔助或支援角色，補監偵之不足，而不寄予過高期望應為合理之選擇。

For the research and development on the main battle platforms and weapon systems, because of improvement of materials, the thrust, accuracy, and lethality, thermal efficiency will all increase. The trend is moving toward to reducing the size, and various missile

systems and unmanned aerial vehicles are the highly possible options, as the material needed in these new weapons will be much less than the fighters, tanks, and ships. Besides, missiles have no problems about the survivability of pilots in high speed, high altitude, high G-force environment, and therefore, they can achieve the objectives we desired.

對於主戰載臺與武器研發，因材質的改良，推力、精度、殺傷力與熱效應之提高，趨勢是朝向縮裝方向發展，最有可能的品項將是各式飛彈與無人載具系統。因其所需材料較戰機、戰車與戰艦為少，而且飛彈亦無飛行員於高速、高空、大G力的環境下存活的問題，卻可達到所望之目的。

Nano-tech development policy of the PRC 中共之奈米政策

The PRC is enthusiastic about improving and innovating her weapon systems, including basic and strategic high-tech researches. The goal is to form a defense scientific research system to enhance the independent capability of defense-related sciences, technologies and industries^⑥. The Chinese recognized that the info-tech and bio-tech are supported by nano-tech, and the opportunities will be lost if they still follow the old way.^⑦

中共正全力的改進其創新系統之科學研發事宜，包括基礎與戰略的高科技研究。其目標為組建一個國防科學研究體系以強化其有關國防科學、技術與工業體系的獨立研發能力。他們認為奈米科技是支持資訊與生物科技的，如果仍依循以往方式的話，機會就會喪失了。

Currently three nano-tech regions had been established in Beijing (north), Shanghai (east), and Shenzhen (south) already, and the PRC planed to build a base in the Tianjing area to coordinate the efforts of the industry, governmental, academic and defense circles to develop and research its nano-technology. The short-term goals are focusing on semiconductor, biological, and medical researches, coating and rocket booster^⑧. Although the progresses are not as good as they desired but the their published paper indicated the basic research efforts are very promising.

⑥ "China's National Defense in 2004", p. 76.

⑦ Lee Feng-sheng (editor) "Building Nano Economics" Published by Shu-chung Publication Taipei, Dec. 2002, pp. 264~265. (Chinese version)

⑧ Ibid, pp. 269~274.

目前，中共已以北京（華北）、上海（華東）與深圳（華南）為中心，成立3個奈米科技區域，並預定以天津地區為基地，結合產業、官僚、學術與國防圈子發展他們的奈米科技。近期是以半導體、生物、醫療、塗料與火箭馬達為重點。雖然其進度並不如預期，但就中共所發表的論文，顯示其基礎研究極為豐碩。

Conclusion 結 論

War is the field that the two adversaries fulfill their will freely. It is a relationship of functions, in a mathematics term, which changes as the situation changes. When the tactics and equipments used by one side are significantly changed but unknown to the other side, the former would very likely take the surprise strategy. In retrospect, we could make a conclusion that all faults are nothing but from misunderstanding, misconception, and misjudgment, or even worse- ignorance- to detect the trend of changes and prepare earlier. In the era of "Knowledge Warfare", the worst approach is to meet the challenge and resist the change arrogantly.

戰場是敵對雙方自由意志發揮之場所，呈現函數的關係，隨狀況之改變而變。當任何一方所用的戰術、戰具產生重大變化而不為敵所知悉時，即容易獲得戰略的奇襲。檢討戰史上失敗的案例，我們可以得到以下結論：所有的錯誤都不外乎誤解、誤知、誤判甚至——無知，未能洞察潮流之改變而及早因應。在「知識戰爭」的時代，最壞的狀況就是刻意對現況的自大與愚昧，抗拒變革。

The war instruments and methods evolve as knowledge progresses, and such evolution waits for no man. We learn and know that if we want to survive under adversary's attack, we better use new approaches to think about the future, especially in a time of knowledge, which almost decides every thing. Nanotechnology is emerged, no matter we like or not, and this is the truth. There have been some changes now and will be new and significant ones in the future. To face such kind of impact, the question is: are we ready to respond to the challenge yet?

戰爭工具與手段隨著科技與知識的進步而與時俱進，不曾停下等待落伍的人。我們從戰史上學習並知道，如果要在敵人攻擊下獲得生存，必須以新的思維去思索未來。尤其是在這個知識決定一切的時代。奈米科技業已浮現。不管我們喜歡與否，這是事實。目前已有某些改變，也許即將有重大變化。面對這樣的衝擊，問題是：我們是否已準備好因應當前的挑戰了？

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