Towards a technological hegemony of China

by
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Introduction

The present growth without precedent of the Chinese economy has modified its relative world position in various fields. This is particularly true of its scientific development, so much so that in the mass media, China is often presented as the "red dragon" that will one day gobble up the rest of the world.

This brief paper tries to evaluate the strength of the scientific sector and its potential to consolidate into what I have described elsewhere (1) as an "industrial network", that is to say, towards a structure that is characterized in the capitalist countries by its strong bonds and synergies between the economic actors of the nation, its military, its agents (such as domestic multinational), and the academic and research world (e.g. universities, institutes of research, etc…).

High-tech sweatshops or indigenous scientific development?

It is well know that China is the factory of the world. Indeed, it is currently the world's biggest OEM (original equipment manufacturer). Exports of Chinese high-tech goods have grown from 0.9% of the world production in 1980 to 5.5% in 1999 and 8.7% in 2001. In 2004, China overtook the United States as the world's largest exporter of a broad range of electronic goods, including computers, mobile phones and digital cameras. Chinese exports of information and communications technology goods rose by 46% y/o/y to 180 billions (+12%). Outstripping U.S exports of 149 billion. Since then, its leadership has even increased and has remained unchallenged (2).

The progression in the electronic sector of the Chinese enterprises has been simply spectacular. Nowadays the factories of the delta region of Guangzhou, whether Chinese or Taiwanese, or foreign held supply the lion share of the 310 million PC to be shipped in 2008. But is it that the foreign ventures assembling their products in China have a large share of the trade upon which they can exercise a tight control thru their own industrial proprietary rights (3) or is China eating up their shares with its own proprietary technology? China often complains that the factories retains no more than a penny for their efforts but is it really the case (4)?

A good example of the forces at play is the case of the Lenovo Group (a Chinese company whose main shareholder is the Chinese Academy of Sciences). Lenovo, from humble beginning as a retailer of foreign technology, went on to buy out in 2006 the notebook division of International Business Machines Corporation or IBM (EUA) for US$ 1.75bl. Since then, Lenovo has moved on to take the third rank in the world with a 6.9% market share, developing its own products to compete head-on with HP and Dell (respectively nº1 and nº2). Its success emphasizes the competitiveness and innovation Chinese companies have been able to create in recent time in a field that was thought to be out of reach of their competence (5) just few years ago. In the process, it must be noted that the famous Japanese companies on the 1980s have floundered badly, with for example Sony and Fujistu pulling the plug on their high-tech manufacturing activities while the Chinese were taking up the challenge.

Nevertheless, we should note that the strength of a company in the high-tech sector does not necessarily means that there is a depth and breadth in the scientific domain. It could be a sign of sweatshops rather than brain shops. This is obvious when one considers that much of the researches going on at the local level have often been a direct result of the intense penetration of foreign actors, mainly from the US and the European union (EU), taking advantages of the low wages environment provided by China. This is particularly true when looking at electronic, biotechnology and nanotechnology. The available statistics show that 80% of the sales generated on those fields have been coming from the 700 High-Tech parks controlled by foreign investors (6).

However, such a process is not one-dimensional for it inevitably creates an accumulation of know-how and knowledge of western technologies in the sector that the Chinese scientific establishment is surely and prompting digesting. Furthermore the continuous economic growth of the country provides a further stimulus that makes inevitable a consolidation and the emergence of a rising national “industrial network”.

In actual fact, there are many signs that the process is already at an advanced stage and it might become sooner rather than later of international relevance (even though many developments were primarily crude copies combined later on with improvement and/or adaptation of a foreign technology, when it was not actually purely reversed engineering processes).

Thus, Chinese participation in the Human Project Genome and its success at deciphering the genome of the rice did not come as a surprise. China is also involved in experimental nuclear fusion with its own EAST reactor (7) whose design is said to be more advanced than in other Tomawak reactors.

Furthermore China is one of seven countries participating in the multinational project to build the €10 billion (US$15.5 billion) experimental ITER nuclear plant in Cadarache in Southern France. Construction of the plant began in 2007 (8).

Nanotechnology is also a field where China has embarked keenly. And lastly we should mention its well-known space program, which is closely linked to a development of its aerospace capability both in the civil and military sectors (9).

As regards the space program, its linkage to an industry is already in place. Hence, only a few weeks after the successful launch of the manned spaceship Shenzhou VI, in October 2005, China announced that COSTIND (Commission of Science, Technology and Industry for National Defense), a state organization, would develop new military technology and would launch the development of a midrange aircraft to compete with Boeing, Airbus and other aircraft manufacturers on the world market (10).

Significantly, China is also investing in Galileo, the European GPS project, signing an agreement with the EU in order to accede to the services offered by the European geo-positioning system when in use (11). According to Li Jiahong, an official of the National Remote Sensing Chinese Center (a department of the Ministry of Science and Technology of China) "the cooperation between China and Europe in the project will provide useful information for China to develop its own independent positioning satellite system at a later stage".

In the short to medium term, China will consolidate its current ST reach around domestic actors that are likely to emerge as significant global actors. "China should not be the factory of the world any longer" says Yang Fan, a professor of commerce at the China Politics and Law University. Economic liberals have been shouting for more innovation for years, even decades, says Yang. The difference is that "this time, I think the government is taking our suggestions".

As part of his call to create an "innovative economy" within 15 years, President Hu Jintao has urged the Chinese to invent proprietary technologies and vowed to boost state R&D spending, which was just 1.23 percent of GDP in 2004. (Japan and the United States spend 3.3 percent and 2.7 percent of GDP, respectively, according to the OECD.) There is indeed a controversy as to the real size of the R&D spending of China, as the OECD has estimated that it is now larger than what Japan spends in the sector, when calculated at purchasing power parity (12).

In any case, the size of the science and technology sector of China is certainly understated. It is far from negligible and growing very rapidly. It was 89 billion Yuan (US$11.2 billion) in 2000. It jumped to 196 billion Yuan in 2004 (US$24.5 billion) with 66% originating from the private sector. But more interesting is the size of the human resources put into it. In 2003, R&D employed directly or indirectly 3.2 million people out of which 820,000 were pure scientists with post-graduate qualifications.

More importantly for the future, the latest statistics show that now China is churning out of universities three times more engineers than the United States (whose numbers are decreasing since the end of the past century). If current trends continue, says Richard B. Freeman, economics professor at Harvard University and director of labor studies at the National Bureau of Economic Research, "by 2010, China will produce more science and engineering PhDs than the U.S.".

Another benchmark is in the world of scientific publication. The number of scientific papers from Chinese researchers has more than doubled since 1998. China's publications of scientific papers amount to 5.1% of the worldwide total, and in the field of professional publications, China produces 4.38% of the worldwide total. In some specialized fields, such as nanotechnology literature, the percentage is even higher, at 6.3%.

China's international agreements of cooperation in the field of science and technology are also expanding widely. By 2004, China has already signed up 96 intergovernmental pacts.

As regard to patents, the State Intellectual Property Office of the PRC had received about two million applications in 2004, 1,8 million of them being domestic applications. By May 2008, the number of domestic applications had reached 3,552, 982, a near doubling in less than 4 years. At the global level, Chinese companies or state actors have also applied for Chinese patents to be recognized and in that respect the European Patent Office has signed a cooperation agreement with its Chinese counterpart and the number of patents covered under the scheme have increased at a rate of 25% per year, every year for the past decade (13).

The grand strategy

The above developments are the product of a planned policy that was initiated in the late 1970s and which translated into a program known as “The Key Technologies and Research Development Program” (KTRDP) adopted in 1982. The strategic aim was to improve China’s competitiveness in science and technology. The program was first oriented towards national construction and it covered agriculture, electronic information, energy transport, materials, resources exploration, environmental protection, medical care and other fields.

Hiring ten of thousands of researchers in over 1,000 research institutes, the KTRDP had a great impact on the national economy. Then in 1983 the so-called National High-tech Research and Development Program known as “Program 863” complemented it. It had the specific stated objective “to foster the Chinese development from high technology in the medium and long term”. The program covered twenty fields, among them biology, spaceflight, information, laser, automation, energy, new materials and oceanography.

A distinctive feature of the program was the declared intention to benefit the industrial sector, as the aim was that the results would be whenever possible “quickly industrialized”.

A third program was launched twelve years later, in 1995, to foster fundamental indigenous scientific research. It was known as the 973 Program. Were involved the Ministry of Science and Technology, the Chinese Academy of Sciences (CAS), the National Academy of Sciences and the National Ministry of the Defense of China. All established a myriad of institutes and research centers as well as companies in strategic sectors.

Thru such State actors, the government developed, in addition to the multiple clusters and work groups involved in the high-tech sector, a series of infrastructure projects, such as regional or national high-tech industrial parks to attract foreign capital, and create polls of engineers who, when working in affiliated research institutes, acquired a status close to that of a civil servant.

The Chinese government has also been working hard to lure foreign-educated Chinese scientists back to the mainland to beef up its local human resources. An example of this policy was the hiring of Han Jie, 48, a graduate from the University of Utah (USA) where he got a PhD in materials science and engineering. Han worked for IBM and for NASA's Ames Center for Nanotechnology before being offered the position of director of the National Engineering Research Center for Nanotechnology in Shanghai, in spring 2005. In 2006, Han and his team moved into a new US$15 million complex equipped with top-of-the line facilities.

Among other projects, the center is working on energy-efficient streetlights made from nanomaterials. "In the U.S., we try to build up technology for the future, but in China, I try to build technology that can be used today", Han said (14). Such laboratories have been in the past the "incubators of new High-Tech start-ups" provided with tax incentives and soft loans given by one of the main Chinese banks. (Lenovo, too, was an offshoot of a similar incubator of the Chinese Academy of Sciences.)

In addition to the policy of providing the industrial companies with a direct linkage to dedicated research centers, the government established a network among the universities whose main purpose was to consolidate the transfer of applied technology between the academic and the industrial world (15). In that respect, the China Machine Tool and Tool Builders' Association has pledged in January 2006 to enhance the country's independent innovation capability, to develop core technologies and to give top priority to innovation in the 11th Five-Year Plan period (2006-10) (16).

Association President Wu Bailin disclosed that the Ministry of Science and Technology and the National Development and Reform Commission are jointly drafting a plan to boost the development of the country's computer numerical controlled (CNC) machine tools in the coming five years. "You can introduce advanced technology, but you cannot purchase the core technologies nor innovation capabilities," Wu quoted a senior official of the Ministry of Science and Technology as saying.

Espionage and competition in high technology

The rise of China and its ongoing development has been perceived in the West with ambivalence. On the one hand, China is a huge potential market expanding quickly, on the other, it is becoming a fierce competitor. Thus it is not surprising that in some quarters its unrelenting progress is met with worries.

In the field of high technology, it has led to wild speculations that a systematic program of technological espionage with substantial finances provided by the central government is in place and executed by front companies, students or other agents. The head of operations of counterintelligence of the Federal Bureau of Investigation (FBI) of the United States, David Szady, assures that, "espionage has helped Beijing to acquire in only a couple of years technologies that normally take a decade to develop".

Furthermore, according to Larry Wortzel, who was attaché at the American Embassy in China in 1995 (later on the Asian Studies Director at the Heritage Foundation in 1999), the American Deputy Undersecretary of Defense for Technology Security and Counter proliferation, testified that "there are between 2,000 and 3,000 Chinese companies operating in the States to gather secret or proprietary information, much of which is national security technology or information. The FBI recently put the number of Chinese front companies in the U.S. at over 3,200. Many of these front companies are the spawn of the military proprietary companies" (17).

Those statements seem to find their justification in the fact that there are currently a dozen cases under investigation in the United States that involve individuals accused of acquiring goods with the specific purpose of smuggling their technologies to China. The technologies mentioned are in the field of night vision, or codes for the projection of seismic image and even submarine propulsion (18).

Larry Wortzel asserts, "The tendency to rob intellectual property and secrets of high technologies made all the more worse that the Chinese laws on intellectual property rights are not enforced forcefully. The problem is all the more exacerbated that centralized programs such as Program 863 are specifically designed (sic) to acquire foreign technology with a military application. This creates a climate where the robbery of secrets become a source of money".

Yet, one should not forget the case of Wen Ho Lee, the former Chinese-American nuclear weapons scientist once suspected of being a spy, who received US$1.6 million from the American government and five news organizations in a case that turned into a fight over reporters' confidential sources. Wen Ho Lee was never charged but agreed to plead guilty of improperly downloading classified information (19).

Among the much talked about cases, was the case of the company Huawei Technologies involved in telecommunications. The company is said to have started by doing reverse engineering on switches. By 2001, a tip-off from government agencies in the US had alerted Indian authorities about the suspected activities of the Bangalore-based subsidiary software firm Huawei Technologies.

The suspicions about Huawei Technologies stem on the supposed ties of Huawei Technologies co-founder Ren Zhengfei with the PLA. Reng Zhengfei was an officer with the rank of major decommissioned in 1984 (20). Huawei also made headlines in 2003 when it was sued by Cisco (USA) (21). The case was settled out of court and today the observers think that Cisco tried to sap the strength of a company it saw rightly as a dangerous competitor (22). Since then, Huawei Technologies jointly with Bain Capital has acquired 3 Com Corp in a 2.2 billion deal sealed on September 2007. Ironically, when looking at the Cisco claim, Huawei announced in May 2007 the formation a joint-venture company with the US based Symantec to develop security and storage appliances to market to telecommunications carriers. Huawei will own 51% of the new company, to be named Huawei-Symantec Inc. Symantec will own the rest. The joint venture will be based in China.

Whatever the merits of such accusations, the sole fact that Huawei and other Chinese companies are now confronting head-on high-tech companies is significant. Furthermore, China with the full support of companies such as Huawei is now trying to turn the table by developing new high-tech standards, a development that is strongly resisted by the established Western companies. New standards with Chinese patents would reverse the situation from one requiring Chinese manufacturers from paying high patent royalties to companies like Intel to one where Western vendors would find themselves in the opposite position.

The first experiment in that respect was in the sector of wireless connectivity. It involves a security protocol (called WAPI) that China says provides superior security protection than does Wifi (or WLAN as the protocol is known). First, China announced in 2004 that only WAPI-enabled equipment could be sold in the country. Intel and other chip vendors announced immediately that they would refuse to sell microprocessors in China if the requirement was imposed. Privately, the American companies asked the American government to help, since of course they had no desire to lose access to so vast a market. The dispute worked its way up through diplomatic channels. Eventually, China postponed the effectiveness of the homegrown standards requirement, but it was only a truce and not a final resolution to the dispute (23).

Notwithstanding its failure so far to get the WAPI protocol adopted by ISO, the Chinese learnt a valuable lesson and they remain determined to eventually fight the IEEE organization, and to turn up the heat as well on the American based IEEE. It should be noted that the Wifi/WAPI tussle was not occurring in an economic vacuum.

Simultaneously there are multiple other standards competitions on going in China that could also break into more open conflicts. These include a DV standard, a RFID standard, and most significantly, a 3G-telephone standard. China represents the largest market for mobile cell phones in the world, and thus if it were to choose to license its own home-grown TDSCMA standard over the American and European rivals the economic consequences could be extreme (24). But China is also using such leverage to get concession from manufacturers, looking into the future for the next generation of protocol. There is no doubt as China is the producer of 90% of the cell phones of the world, that such new protocol will be loaded with some Chinese characteristics.

Those examples highlight the fact that, nowadays, foreign companies in the telephony and audio-visual sectors are now facing strong Chinese competitions, not only on the manufacturing field but in the technological one as well. Not surprisingly the WTO has been hard pressed by the Western companies to corner China on the question of intellectual property rights and standards with the aim of hampering the development of homegrown Chinese standards but it is probably the wrong approach as China has its own claim to make when it comes to standards which are heavily biased in favor of established Western companies. Strangely, once again the Japanese, who have been caught more than once in a tussle about standards in the media sector (in particular Sony against Philips) seem to trail behind China in this new assertive approach about standards.

What is clear, whatever the view one may have on espionage activities (and China would not have the monopoly of such an activity, the Western countries doing the same), is that Chinese companies can compete by buying out foreign companies, or by developing their own technologies, with their western competitors. A neat example is in the nuclear energy sector where China has since 1986 been able to train its Chinese engineers assigned to the construction of the Daya Bay nuclear plant (developed by EDF France), so much so that today it has full control over its own nuclear industry.

The likelihood of China becoming a major competitor on the world market of science and technology, both with civil and military components, is sending shivers to the Western countries. This explains many alarmist commentaries of the type "China may supplant the United States in a not so distant future as the world leader in science and technology. If so, it might become a threat to the Asian friends of Washington"(25).

Although such a scenario is not impossible in the long term, to become true China has still a long way to go. Nevertheless, alarmist commentaries have the benefit for the Western countries to size up what needs to be done to keep their leadership in place and what policies to adopt to contain China's emergence. For those countries such as the United States to do nothing would inevitably bring about a redistribution of the global wealth in favor of China, which would vastly increase its political and economic clouts on the world scene. This is for the current administration in Washington an unacceptable outcome (26).

Therefore it is not surprising to see that the USA is reacting strongly –in words if not in facts, to anything that outlines Chinese's capability, hence, the endless criticism of the military capability of China and the modernization of its army (as if the United States were the only country to have the right to spend US$400 billion a year on weaponry and other military equipments).

Thus the USA keeps criticizing the "massive" increase of the Chinese military budget and particularly the spending on high-tech weaponry or research. Yet, the fact is that the total military expenditures of China is at least 2.5 times smaller than the official expenditures of the USA military on research alone, whatever the formula used to work out the military budget of China (27). But what is at stake actually is not so much military capability but the research into new technologies that have always been the flip side of massive budgets in the army, in particular in the aviation and satellite systems.

Conclusion

From all data available, China is unlikely in the short term to become the next hegemonic power, nor is it possible for the country to become overnight the new leader in science and technology. Yet, China has reached a turning point and so has the world order. With economic growth continuing at the current pace, even though the Chinese government would have to direct at some point more energy to its domestic economy (if only because its trade balance might become politically unmanageable), China is bound to be a global major player. And that is new, or was forgotten in the past century.

It is all the more obvious that China is already planning for the future with confidence, as it has already sized up its present limitations in the scientific research sector. The requirements to consolidate it within an industrial network have been clearly identified by the government.

As Dr Fang Xin, member of the Standing Committee of the National People's Congress, professor of the Chinese Academy of Sciences admits readily "(currently) most of the resources needed to progress in science and technology return overseas while the domestic capacity does not provide yet an effective support".

She adds that poor coordination between the departments of the government and weak market mechanisms are hampering greatly the capacity for technical innovation. Furthermore the research institutions have limited resources, are poorly integrated while universities have few researchers and the intermediary agencies lack maturity. Notwithstanding and precisely for reasons mentioned by Dr Xin, China has been formulating and implementing a series of measures (briefly mentioned in this paper) to address its shortcomings and to establish a series of mechanisms similar to those adopted in the West (28).

It may be necessary here to outline that, with few exceptions (such as Cuba's biotechnology sector and generic medicine, or the aerospace sector in Brazil), developing countries have remained unable to establish indigenous research in science and technology developments. This situation is clearly a left-over of colonialism as their national interest remains often subordinated to that of the West while their own capitalist elite class that could at best be qualified of "mediocre" is all too pleased to play the role of intermediary in the production chain.

In addition, the global financial system, established by the West to serve its own interest, provides no incentive to depart from the current pattern. The loans oiling the economy of the developing economies that organizations such as the World Bank provide are always highly conditional while the policies of structural adjustment like those pursued by the International Monetary Fund never provide the leeway necessary for the nurturing of a homegrown strategy in science and technology.

The paper has been translated from Spanish and edited by Serge Berthier

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<u>Gian Carlo Delgado Ramos' endnote</u>

1 In "La Amenaza Biológica: mitos y falsas promesas de la biotecnologia" Plaza y Janes – Mexico 2002.

2 Science & Engineering indicators 2004. National Science Board (USA) 6-10.

3 US Microprocessor maker AMD disclosed in January 2006 that Tsinghua Tongfang, the third largest domestic computer maker, would adopt AMD chips in nine of its computer models. Beijing-based Tsinghua Tongfang is the latest computer maker to partner with AMD, which competes fiercely against the dominant player Intel. Some computer makers, including HP, leading Chinese-maker Lenovo and Founder, began to work with AMD for low prices, good technologies, and as an alternative to Intel (China Daily 01/05/2006 page 11).

4 See Lau Nai-keung in the China Daily 2006/6/6. "Not only it is unfair, he wrote, but it is unsustainable. This is not efficient and we do not enjoy limitless supplies of capital or labor. We have to add more value to our products and services by migrating from OEM to ODM (original design manufacturer) and OBM (original brand manufacturer). Indigenous innovation is the logical way.

5 Lenovo is controlled by Legend, a company started in 1984 by Liu Chuanzhi, and ten other researchers of the Chinese Academy of Sciences. The original brief was to study the IT sector, then totally controlled by foreign entities such as IBM, HP, Compaq, AST and Acer (Taiwan). Legend became the sales agent of AST (United States), and then started to produce AST motherboards. Soon Legend started to make improvement to the motherboards. ASD folded few years later. Legend expanded under its own name and with its own innovations.

6 For example, the Zhangjiang High-Tech Park nearby Shanghai is home to eight government-run labs and thirty-four local and multinational drug makers, including Roche's own research and development center.

7 China's reactor, known as the acronym EAST for Experimental Advanced Superconducting Tokamak was built at the Institute of Plasma Physics, a research department of the Chinese Academy of Sciences, in Hefei. It is a smaller version of the International Thermonuclear Experimental Reactor (ITER) to be built in Southern France, which is not expected to be fully operational for a decade.

Unlike conventional fission reactors, nuclear fusion produces no greenhouse gas emissions and only low levels of radioactive waste. Researchers hope it may