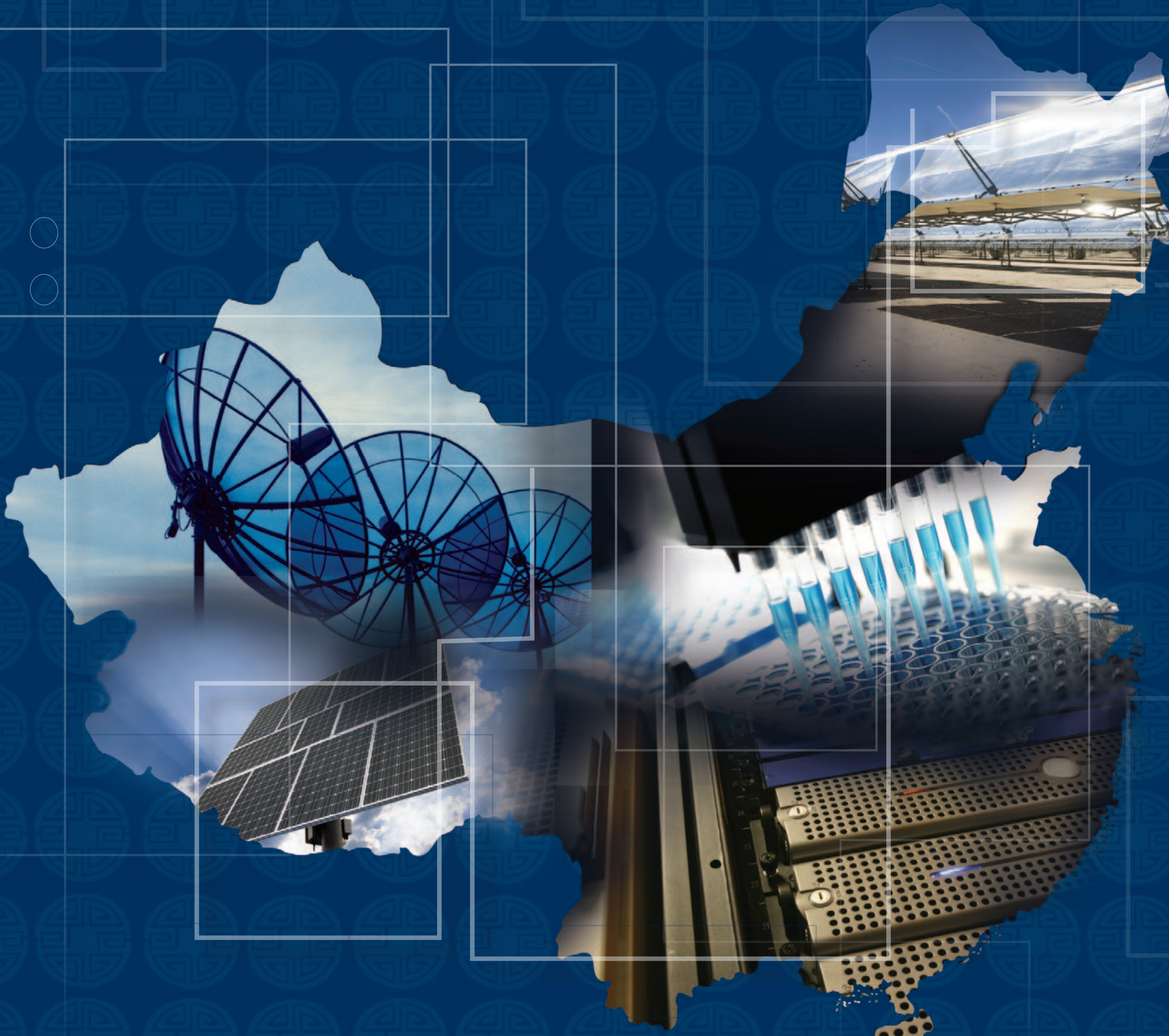
China's Drive for 'Indigenous Innovation'

A Web of Industrial Policies



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The second stage of Chinese economic reform aims to bring about "the great renaissance of the Chinese nation" through "innovation with Chinese characteristics."

OVERVIEW AND EXECUTIVE SUMMARY

To mark the October 1, 2009 sixtieth birthday of the People's Republic of China, eager crowds of Chinese citizens jostle through walkway tunnels under the moat surrounding the titanium-and-glass domed National Grand Theatre. They have come to watch "Road of Renaissance," a Broadway style show produced by the Communist Party.

In the theatre complex known as "The Egg," some 3,200 performers sing and dance their way through 170 years of Chinese history – from the mid-1800s Opium Wars, to the 1930s Japanese invasion, to the 1949 founding of the PRC and the 2008 Beijing Olympics – in an explosive spectacle of propaganda wrapped in high-tech stagecraft.

The show opens with elegant Qing Dynasty ladies enjoying a Summer Palace opera until flames erupt as Western troops burn it to the ground. Rag-clad peasants stagger under crates overflowing with gold bars destined for foreign ships. Waterfalls of blood drip down the theatre walls as hundreds of Chinese corpses stacked like timber come alive to rise up and vanquish Japanese troops.

The tragic 1950s Great Leap Forward and 1960s Cultural Revolution are swiftly dismissed. Film clips of China's first nuclear explosion and satellite launch lead the way to gleaming skyscrapers, Olympic medal records, speeding bullet trains and Chinese astronauts walking in space -- all punctuated with enormous newsreel images of top Party leaders from Mao Zedong to Hu Jintao narrating the Party's record of triumphing over adversity time and time again.

Migrant workers, engineers, bankers, cooks, taxi drivers, farmers, students and bureaucrats lock arms and sing the national anthem. On this 60th anniversary, China is marking its resurgence as a great nation that will soar to ever greater heights as long as all Chinese people stick together.

The show ends with "Long Live the Great Communist Party" flashing on the screen.

"Road of Renaissance" mixes two conflicting sentiments: victory and victimization. These clashing themes of unbridled national pride vs. distrust of foreigners are cross-stitched throughout the fabric of China's national psyche and political culture. They are also deeply entrenched in China's vast economic planning bureaucracy and fused into the DNA of the country's extensive new industrial policies that Party leaders have hung under the banner of "Indigenous Innovation."

The result is an indigenous innovation political and economic campaign that amounts to an all-hands-on-deck call to action for the Chinese nation to roll up its sleeves and complete the mission of catching up and even surpassing the West in science and technology that began 200 years ago when foreigners with modern weaponry and transportation technology came calling as the Chinese dynastic system was dissipating.

The campaign is focused on employing China's fast-growing domestic market and powerful regulatory regime to decrease reliance on foreign technology and develop indigenous technologies that will enable China to solve its massive environmental, infrastructure and social problems, and as a result enhance both its economy and national security.

The slogan and broad plans for indigenous innovation were officially unveiled in 2006. But the policy's importance and complexity are just now coming to global attention as supporting regulations pour out of bureaucracies in Beijing and across the country. In Party liturgy, "Indigenous Innovation" is China's follow-on blueprint to Deng Xiaoping's 1978 "Reform and Opening." The evidence for the historical importance of indigenous innovation includes: the turbulent preparation process, unprecedented senior level management mobilization, elaborate web of policies and implementation tools and surging government science and technology spending -- topping $130 billion this year, according to the National Bureau of Statistics -- as China races to develop its own integrated circuits, passenger airliners, global technology standards and all manner of intellectual property.

All this is reinforced through frequent and forceful statements and speeches from President Hu Jintao and Premier Wen Jiabao. As Premier Wen said in unveiling the 2006 policy outline: "We fundamentally have to rely on two main drivers, one, to persist in the promotion of opening and reform, and two, rely on the progress of science and technology and the strengths of innovation."

Indigenous innovation is a massive and complicated plan to turn the Chinese economy into a technology powerhouse by 2020 and a global leader by 2050. The landmark document that launched the campaign carries the bureaucratic title "The National Medium- and Long-Term Plan for the Development of Science and Technology (2006-2020)" (now known in the West as the MLP). Bland as the title may be, the MLP describes itself as the "grand blueprint of science and technology development" to bring about the "great renaissance of the Chinese nation."

The MLP preamble calls for the Chinese people to "seize the opportunities and meet the challenges brought by the new science and technology revolution" … because … "despite the size of our economy, our country is not an economic power, primarily because of our weak innovative capacity."

The MLP blueprint is full of grand visions, good intentions and gilded rhetoric about international cooperation and friendship. It calls for fostering open-minded scientists who take risks and work in collaboration with the best scientists across the globe. It encourages Chinese enterprises to establish overseas research and development centers. It calls for "establishing the nation's credibility and image in international cooperation" and "to perfect the nation's intellectual property rights system." It also sets goals for expanded cooperation with foreign universities, research centers and corporate R&D centers.

But it is also steeped in suspicion of outsiders. The MLP explicitly states that a key tool for China to create its own intellectual property and proprietary product lines will be through tweaking foreign technology. Indeed, the MLP defines indigenous innovation as "enhancing original innovation through co-innovation and re-innovation based on the assimilation of imported technologies." It also warns against blindly importing foreign technology without plans to transform it into Chinese technology. The report states: "One should be clearly aware that the importation of technologies without emphasizing the assimilation, absorption and re-innovation is bound to weaken the nation's indigenous research and development capacity."

As a result, the plan is considered by many international technology companies to be a blueprint for technology theft on a scale the world has never seen before.

As the MLP blueprint was pushed through the Chinese bureaucracy, the openness and international cooperation aspects seem to have been trimmed away. The major implementing rules and regulations are emerging encased in what some scholars have dubbed "techno-nationalism." The bureaucracy's thinking bears some resemblance to the architect of the magnificent National Grand Theatre's vision of his creation as a "cultural island in the middle of a moat."

Policies forming the moat include a mandate to replace foreign technology in such "core infrastructure" as banking and telecommunications systems. That means products like integrated circuits, operating software, switches and routers, database management and encryption systems.[1] Patent rules now make it easier for domestic retaliation by Chinese companies which face overseas Intellectual Property Rights (IPR) lawsuits from foreign competitors.[2] Product testing and approval regimes are geared to delay the introduction of foreign imports into China, and to study foreign designs and production processes before the products cross the border.[3] A refocus on state-industry monopolies and controlled competition privileges accompanied the enactment of an anti-monopoly law that seems fixated on foreign transactions.[4] Government procurement policies block products not designed and produced in China.[5] Chinese industrial and technology standards serve as market barriers to foreign technology.[6]

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[1] In 2003, a high-level Chinese leadership body created what is known as China's 5-year National Cyber Security Strategy to address threats to information systems and networks through an indigenous national assurance system under firm domestic control. This is a comprehensive and confidential strategy, with its priorities reaching just about every aspect of information security technology. As part of China's national cyber security system, the Ministry of Public Security (MPS), the State Council Informatization Office (SCITO) and the State Secrets Bureau issued a technical policy in 2007 known as the Multi-Level Protection Scheme (MLPS). Under the MLPS and its Implementing Measures, the core intellectual property of all products, systems and information security management technologies used in "critical infrastructure" such as banks, ports, and utilities must be Chinese.

[2] Under China's Patent Law, applicants can obtain utility model patents that are issued quickly and are harder to invalidate based on prior art because they do not undergo a substantive examination.

[3] See the discussion later in the paper on the certification system established by the Certification and Accreditation Administration of China.

[4] In 2004, while the AML was being drafted, the State Administration for Industry and Commerce commissioned a survey to identify abuses of intellectual property by MNCs so that appropriate regulations could be drafted and remedies imposed. The list of abuses included common unilateral refusals to deal, and the example used in the survey to illustrate that practice involved the largest network equipment manufacturer (i.e., Cisco) allegedly refusing to license its IP to Chinese companies which wanted to connect to its equipment. *See* "Multinationals' Anti-Competition Behavior in China and Counter-Measures Therefore," *Industry and Commerce Administration*, Section (1)D, Issued by the Anti-Monopoly Division, Fair Trade Bureau, State Administration for Industry and Commerce (March 1, 2004).

[5] In 2002, China enacted the Government Procurement Law, which provided (with a few exceptions) that procurement purchases by government organizations should be limited to domestically-made goods. Since that time, a variety of implementing measures on government procurement have been issued under the 2000 law which are discussed later in this paper.

[6] China is revamping its standards system to (i) lessen the "control of foreign advanced countries over the PRC," especially "in the area of high and new technology"; and (ii) increase the effectiveness of Chinese technical standards as important protective measures or barriers to "relieve the adverse

With these indigenous innovation industrial policies, it is very clear that China has switched from defense to offense.

The financial meltdown in the West, and China's deep-pocketed ability to maintain high growth, have convinced China's leaders that the time has come to step forward and make global rules and employ China's market to build global companies. Some Chinese scholars contend that Party leaders last year even edited Deng Xiaoping's authoritative 1989 foreign affairs directive, updating the wording to instruct Party officials to be less humble and more assertive. The holy grail of science and technology is considered the key to China finally breaking free from its embattled past. Premier Wen expressed this "never again" view in November 2009 when key indigenous innovation regulations were unveiled: "Only by using the power of science and technology will China, this massive ark, be able to produce the immeasurable ability to allow nobody to stop our advance forward."

China so far seems to be oblivious to the impossibility of having it both ways, hunkering behind the "techno-nationalism" moat at home while reaching into the global network of science collaboration and research. What is worrisome for the business community is that these indigenous innovation industrial policies are headed toward triggering contentious trade disputes and inflamed political rhetoric on both sides. For the academic and scientific research community, the results could be devastating. Ethnic Chinese scientists in the US, who are involved in research projects and advisory bodies in both countries, could become tragic collateral damage if politicians decide to question their loyalties. And while China's scientists, prodded by the state, are making gains, significant discoveries and inventions are still few and far between given the enormous sums of money spent and China's impressive and fast growing talent pool.

It would be difficult to find anybody in the international business community or among China's trading partners who oppose the Chinese leadership's 2003 goal of upgrading the country's economy through "scientific development." China's remarkable rise in the past 30 years is an unprecedented global achievement that has brought the country great respect, admiration and many friends around the world. This extraordinary progress came from Chinese political leaders who displayed courage and confidence in making radical and painful changes in the country's system, and hungry and tireless citizens who gathered knowledge and know-how from around the world and worked 24-hours-a-day to succeed.

While indigenous innovation is considered by China to be a bold second act of Deng's reform and opening, in the West the campaign is increasingly perceived as anti-foreign and regressive. Indigenous innovation seems to be a policy borne as much of China's fear of foreign domination as China's pride in its great accomplishments and desire to be a leader in the rules-based international system.

For many multinationals – especially tech companies -- the policies appear to signal that the pretense of goodwill is gone. The belief by foreign companies that large financial investments, the sharing of expertise and significant technology transfers would lead to an ever opening China market is being replaced by boardroom banter that win-win in China means China wins twice.

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impact of foreign products on the China market." See Preface and Part I, Section IV, "Study on the Construction of National Technology Standards System," Standards Administration of China (September 2004). Discriminatory Chinese standards are critical, according to the Standards Administration of China, because most other trade barriers (e.g., tariffs, import quotas and licensing requirements) have been removed as a result of WTO commitments. *See id.*

When it comes to technology transfers, Chinese officials believe foreign companies have been duplicitous and stingy. In their view, the bargain was market access in exchange for know-how and technology, and foreign companies held back their best to contain China's rise. Multinationals, on the other hand, consider open markets to be the normal state of business. Their reluctance to bring their technological crown jewels to China comes from living through many years of rampant disregard for IP protection and joint-venture partners who reopened as competitors down the road once they got what they needed.

These separate points of view, and China's persistent IP theft problem, are now compounded by the indigenous innovation industrial policies which compel technology transfers in order to have access to the China market. But the problem now goes far beyond the China market as multinationals expect to see their own technology coming back at them globally in the hands of Chinese competitors.

At the same time, many multinationals are increasingly dependent on their China profits. As one conglomerate strategist said: "We can't afford to antagonize China." Behind the smiling faces they display in Beijing, many foreign tech executives are rethinking their China plans as they try to figure out whether they should, or how they can, adjust to the new Chinese system. Some figure that they may be better off entering into technology partnerships with Chinese government companies to have their products qualify as indigenous innovation and reap the profits for a few years before unloading those divisions as it becomes apparent their global prospects are likely doomed by the China deal. Others are looking to tap into Chinese indigenous innovation funds and partner with Chinese companies to enter into adjacent businesses where they aren't real players. Aerospace, telecoms and transportation are seen as the ripest opportunities under this scenario. But many single industry and single product companies could be destroyed in the process. Global markets are likely to become increasingly distorted, and the end result could be a chilling effect on innovation globally.

As political tensions rise over indigenous innovation, the Obama administration and Congress should understand this is not just another run-of-the-mill China policy dispute that can be addressed through new rounds of bilateral diplomatic discussions and bombastic legislative initiatives. In the aftermath of the global financial crisis and in light of the Chinese government funding much of the American budget deficit, there is a power shift underway—at least China firmly believes that.

No matter whether or not the US agrees with that view, the indigenous innovation campaign and surrounding web of industrial policies represent the beginning of a new era in not only the US-China economic and political relationship but in China's relationship with international business and the developed world.

What follows is an attempt to explain the details of China's still unfolding indigenous innovation industrial policies while placing them in historical, political, social and economic context. Only through understanding this "intricate web" and clearly analyzing the emerging and likely global repercussions can business leaders and policymakers in the US, China and across the globe seek solutions that avoid China becoming enmeshed in political confrontation and protracted trade disputes with those countries and companies that lead the world in innovation and invention.

PLAYING SCIENCE AND TECHNOLOGY CATCH-UP

When a rapidly modernizing West came knocking on the Qing Dynasty's door in the late 1700s, China was still hopelessly feudal and focused on literature and the arts. Since then, China has been playing science and technology catch-up with the West. The "Self Strengthening Movement" of the 1860s was aimed at mastering weapons and transportation technology to fend off the foreigners. The early 1900s saw the first wave of Chinese students heading overseas. Chinese students at Cornell University in 1914 founded the Science Society of China. Modern universities with strong science curriculum were established by Western missionaries in cities across China. The KMT government under Chiang Kai-shek in 1928 formed Academia Sinica to coordinate basic scientific research.

After the 1949 Chinese revolution, the remnants of Academia Sinica were renamed the Chinese Academy of Science (CAS) and reorganized as a carbon copy of the Soviet Academy of Science. The Soviet Union sent some 11,000 scientists and technicians to China, while China sent nearly 40,000 students to the Soviet Union. While the Soviets provided a massive technology transfer, Chinese Communist Party (CCP) bureaucrats took charge of all science and research facilities and focused them on mammoth projects to create an industrialized economy as fast as possible. Even today, the Party considers its first national science and technology plan, authored by CAS in 1956 with Soviet oversight, as one of its seminal achievements. The 12-year plan listed 582 research projects. But it is now remembered as the "two bombs and a satellite" plan that laid the groundwork for China's 1964 atomic bomb, 1967 hydrogen bomb and 1970 "East is Red" satellite, all projects to which US-educated Chinese scientists were key contributors.

China's science establishment was decimated by the 1957 Anti-Rightist Campaign and the Cultural Revolution, which lasted from 1966 to 1976. Chinese scientists who had returned after 1949 to build the new China, or escape McCarthyism in the US, were key players in China's science and technology accomplishments. But these political campaigns singled them out as spies and enemies. China's universities were closed, its research institutes shuttered and the country's scientists were sent to the countryside as it became more important to be "red" than "expert."

When Deng Xiaoping launched reform and opening in 1978, he focused immediately on science and technology as key to China's modernization. The State Science Commission summoned some 20,000 experts to draft a new blueprint for science to serve as a driver for restarting China's economy. Some 6,000 delegates participated in a March 1978 National Science Conference at which Deng Xiaoping called for fast action. "Without the high-speed development of science and technology," Deng said, "it is impossible to develop the national economy at a high speed."

That meeting produced a plan that focused on 27 sectors of research and 108 key research projects. Eight large projects were planned in the fields of agriculture, energy, materials, electronic computers, lasers, space science, high-energy physics and genetic engineering. Since the day Deng Xiaoping unveiled science and technology as one of China's "Four Modernizations," science policy has been in the direct hands of the country's top leaders, far beyond anywhere else in the world.

Formal responsibility was placed in the premier's hands in 1983 with the creation of a "leading group" for science and technology, a structure the Party employs for its most crucial initiatives. Throughout the 1980s and early 1990s, science and technology system reforms and new programs went into fast-forward. At the same time, Chinese diplomats scrambled around the world signing S&T cooperation agreements with nearly 100 countries. Thousands of Chinese scientists took up posts in nearly every major international science organization.

THE ELIXIR OF "SCIENTIFIC DEVELOPMENT"

Progress in science and technology was top of mind for President Hu and Premier Wen as they came into office in March 2003. They were handed an economy advanced far beyond even Deng Xiaoping's impatient expectations. China boasted a treasure trove of city-center skyscrapers, gleaming airports, hyper-efficient cargo ports, suburban villa complexes, amusement parks, tourist retreats and renovated universities. These economic jewels were tied together with superhighways, satellites, fiber optics and the fastest and largest telecom build out in history. After decades of discussions, China had entered the World Trade Organization. Beijing was getting ready to host the 2008 Olympics.

But the wide wealth gap between the cities and countryside, epidemic pollution, endemic corruption, several hundred protest demonstrations on any given day and an uncomfortable dependency on imported raw materials were just a few of the things that could keep the leaders awake at night.

They heralded "scientific development" as the elixir for China's structural problems and the main theme of their administration. Programs to improve social services and education in the countryside, reduce pollution, reinvigorate Party discipline and upgrade foreign investment to high tech manufacturing from low-wage assembly were put in place. They also gave marching orders for the state to purchase oil, ore and other key resource deposits overseas.

There were a few bright spots on the science and technology front. In October 2003, China launched the Shenzhou V, its first manned spacecraft. The country's 12 academic institutes working on the Genome Project were closing in on disease-causing genes. Chinese nanotechnology research was spawning advances in coatings and materials.

The most notable celebrated breakthrough in Chinese innovation occurred at Shanghai Jiaotong University in 2003. Chen Jin, a 35-year-old Fujian native with a University of Texas PhD and experience as a Motorola scientist, had invented a home grown Chinese microprocessor. Appearing on national TV surrounded by dozens of high-level government officials, Chen unveiled the "Hanxin," or "China Chip," with the capacity to process 200 million instructions per second, proudly fulfilling a nearly two decade-long national goal.

Aside from these successes, the state of science and technology was bleak, if not a bit embarrassing. Despite the expenditure of billions of RMB through thousands of government programs and projects, China was still struggling to innovate and invent. Refurbished government research labs with world class instruments and well-educated scientists dotted the country. But their mission of helping Chinese industry was stillborn as Chinese private companies scrambled for quick profits and state-owned enterprise (SOE) managers were unfocused and distracted by their politics and perks.

In their absence, the Chinese research institutes worked closely with multinationals which were accustomed to partnerships with universities and research labs. The best and brightest science graduates of Chinese universities continued to head overseas for advanced study and science posts. The US alone was home to 62,500 China-born science and engineering PhDs. Mainland China natives were heading many American research labs and university departments. More than a few of them had been among the 60,000 Chinese students granted US residence permits by President George Bush in 1990 in the aftermath of Tiananmen.

Strong science leadership was sparse due to the 45-55 year old "lost generation" that was the result of school closures during the Cultural Revolution. Overseas recruiting had brought mixed results. The "100 Talents Program" of Chinese Academy of Science brought back 778 foreign scientists between 1998 and 2004, but fewer than half had doctorates and almost none had tenured appointments abroad. Some top level scientists were lured back, but most of them kept positions in both places, maintaining foreign university tenure while taking advantage of Chinese government funding and facilities for research projects. China was simply unable to bring back top talent due to uncertainty about academic freedom, the ability to conduct quality research, and weak IPR protection.

"INNOVATION WITH CHINESE CHARACTERISTICS"

China was once the center of global innovation with such inventions as the compass, gunpowder, paper and printing. So why is the country struggling to become innovative now?

Scientist and historian Joseph Needham – whose "Science and Civilization in China" in the 1950s traced this subject in voluminous detail – believed that China lost the plot on innovation due to "bureaucratic feudalism." Needham and a swarm of scholars who followed him contend that Chinese civilization lost its ability to innovate in the 14th Century when central government control was imposed in order to build canals, irrigation systems and other infrastructure that crossed boundaries of local fiefdoms.

In the late 1990s, on the heels of a massive infrastructure building spree, Chinese scientists and their patrons in the government began to push for a "national innovation system." CAS in 1997 issued a report entitled "The Coming of the Knowledge Based Economy" that was distributed to top Party leaders. Then Chinese President Jiang Zemin got personally involved in reform efforts and arranged new funding for CAS on the advice of his son Jiang Mianheng, a Drexel University PhD, who was a vice-president at CAS and also head of a venture capital firm in Shanghai.

Lu Yongxiang, a hydrologist and former president of Zhejiang University, in 1997 was appointed as the new president of CAS with instructions to reform what was still somewhat of a Soviet-style dinosaur. Lu became an active evangelist for Chinese innovation as he retired inactive scientists and reorganized CAS. Within a year, he launched a "Knowledge Innovation Program" and consolidated the academy's 120 research institutes, investing in people and infrastructure with the goal of creating 30 globally recognized research centers.

The CAS report and program caught the leadership's attention and made "innovation" an increasingly fashionable buzzword. President Jiang weighed in publicly in August 1999 with a keynote speech at a science conference. "In today's world, the core of each country's competitive strength is intellectual innovation, technological innovation and high-tech innovation," he declared.

As President Hu and Premier Wen worked through their scientific development agenda they realized that to realign the economy they needed to create drama and take drastic actions. So after conferring with their colleagues on the ruling 9-member politburo standing committee – 8 engineers and one hydrologist – they decided to take a page from Deng's 1978 playbook.

With the rallying cry of "innovation," Premier Wen in mid-2003 used his position as head of the Leading Group on Science, Technology, and Education to bring together the two heavyweights of science and technology in China – CAS and the Ministry of Science and Technology (MOST) – to coordinate an old fashioned Soviet "big push" style campaign. So with Premier Wen as the official leader, the Leading Group for the Development of a National Mid- to Long-term Science and Technology Development Plan was launched.

As the home of China's most elite scientists and best-equipped research centers outside of the military, CAS used its global network to summon ethnic Chinese scientists from top US universities and research centers to advise the effort. Before long some 2,000 scientists, bureaucrats and business managers were organized into 20 working groups to conduct specific studies and hammer out objectives and detailed plans.

Prominent Chinese scientists, both domestic and overseas, were eager to be involved. There was much talk about radically revamping the government's S&T bureaucracy, taking decisions on projects and funding away from government officials and expanding the use of peer reviews for project approvals. The hope was to create an ecosystem of innovation in which communities of scholars would collaborate and criticize each other's work. Some argued for learning from the American innovation system since it had created the bulk of the globe's science breakthroughs for a few decades.

As the discussions evolved, the working groups seemed to copy pieces of the current American S&T system and the old American S&T system. In the post-World War II era of the 1950s and 1960s, large American corporations often enjoyed monopolies or limited competition not unlike the large Chinese state-owned-enterprises of today. These American behemoths had the money and time to hire platoons of scientists and engineers and put them to work on radical innovations that didn't have immediate commercial applications. The research labs for AT&T and Xerox alone created many of the breakthrough technologies upon which much of today's communications equipment is based.

This dramatically changed as the 1970s brought more foreign competition and computerization increased the ability to acquire and process information. The US government dismantled monopolies and broke down competitive barriers. Financial markets forced companies to focus on short-term results. US multinationals now use in-house R&D for product improvements and outsource more research oriented activities to domestic or foreign laboratories and universities. Many rely on acquiring young companies with innovative products to maintain a pipeline of inventions.

At first, discussions were quite open and vigorous, with representatives of the various agencies understandably taking positions that furthered their own interests. The National Natural Science Foundation of China (NSFC), modeled on the US National Science Foundation, was a champion of focusing on peer-reviewed basic and applied research. The National Development and Reform Commission (NDRC), the country's macro policy planning powerhouse, wanted to keep the planners in charge.

The Ministry of Industry and Information Technology (MIIT) wanted to protect its role in crafting China's industrial policies and its oversight of telecom, Internet, software and electronic goods manufacturing. The Ministry of Finance (MOF) and China Development Bank (CDB) sorted out the enormous funding responsibilities. The Ministry of Education (MOE) worked to guarantee projects and money for university labs and recruit Chinese scientists to come home.

THE BUREAUCRATS BEAT THE SCIENTISTS

Responsibility for coordinating and drafting the plan was assigned to MOST Minister Xu Guanghua, a forestry specialist who had spent much of his career at CAS. Following his 2001 appointment, Xu had devoted himself to boosting Chinese innovation with his ministry in control of the process. MOST bureaucrats pushed hard during the internal debate to have the plan focus on "megaprojects."

The 20 reports prepared by the 2,000 participants were reviewed by MOST, CAS and many others, and then MOST spent 12 months drafting the plan in consultation with MOF, CAS and the Chinese Academy of Engineering. Megaprojects moved higher and higher up the priority list. Once the veteran bureaucratic operators from MOST rolled up their sleeves, it became their show.

When brainstorming came to a close, the scientists were pushed aside. They had argued for research grants allocated through peer review panels that included eminent scientists from around the world. Many staunchly opposed the idea focusing on megaprojects, saying that innovation could only come from individuals or small teams working on projects that they were passionate about and had undergone rigorous examination. They argued that central planning and megaprojects would be wasteful exercises as thousands of people would have to come to consensus to move anything forward.

Overseas Chinese scientists appealed to senior leaders to avoid heading down the megaproject path. In the summer of 2004, a group of 11 ethnic Chinese scientists who were members of the Society of Chinese Bio-scientists in America wrote an open letter to Premier Wen saying that the big biology projects in the plan would stifle competition among scientists and hamper the prospects of genuine innovation. *Nature* magazine followed with a special Fall 2004 issue containing a collection of essays from prominent Chinese scientists, from inside and outside of China, which criticized the draft plan for giving bureaucrats too much power over scientists. Published in Chinese and English, the essays argued that the power to distribute research money should be taken away from MOST and funneled through peer-review organizations.

They argued that if megaprojects remained the central focus, money would be allocated to mediocre projects based on personal connections instead of pursuing real science. In one article, two US-based ethnic Chinese neuroscientists joined China's senior life scientist from CAS to suggest that the power of MOST over research funding should be reduced, and perhaps the ministry should be disbanded altogether.

When Chinese newspapers and magazines jumped into the debate, MOST and its supporters convinced the government's General Administration of Press and Publications to ban distribution of the *Nature* supplement, and the Party propaganda department warned editors to drop the topic and avoid playing into the hands of "foreign forces".

As the debate was squelched, scientists complained that China seemed unable to break out of Needham's "bureaucratic feudalism." The favorite ditty in Chinese scientific circles became: "Small grants, big review; medium grants, small review; big grants, no review."

Party leaders in December 2004 gathered their wider leadership circle for a briefing on indigenous innovation and the planning process. The 204 members of the CPC Central Committee were summoned to listen to lectures on the draft S&T development plan. One of the most prominent speakers was Wan Gang, then president of Tongji University in Shanghai and a leader of China's R&D efforts on battery powered automobiles. While the German-educated Wan was already quite prominent, his confidence and the clarity of his briefing got the top Party leadership talking about placing him in a key national role.

As MOST bureaucrats drafted the MLP, eight members of the Party politburo standing committee visited CAS between November 2004 and 2005 to learn about the academy's

Knowledge Innovation Program. In the 1980s and 1990s, CAS had been moving away from basic research and had adopted a strong commercial orientation. CAS leaders now told the Party bosses that their hope was to move CAS back toward basic research and fostering breakthrough innovations. CAS unveiled to the Party leaders its own Medium- to Long-Term Plan that set the ambitious goal of making CAS one of the top three research institutions in the world by 2020.

"INDIGENOUS INNOVATION" BECOMES ACT II OF "REFORM AND OPENING"

In October 2005, the CPC Central Committee met and elevated indigenous innovation to a strategic level equal to Deng Xiaoping's "reform and opening" policy. The Party consensus was now formed. The indigenous innovation campaign was enshrined as a national strategy that would put science and technology development at the center of rebalancing China's industrial structure and development pattern. In a January 2006 speech, President Hu said: 'In the face of international scientific development and increasing international competition, by seeing the development of science and technology as a central thread in the development strategy and actively committing to its progress, China can seize the opportunity for development."

Following President Hu's speech, the State Council in February 2006 released the official announcement confirming the Party's decision and unveiled the MLP blueprint. The MLP contained a comprehensive litany of hundreds of China's most serious problems and development shortcomings alongside an exhaustive list of goals and objectives for solving them through science and technology. The MLP called for using the guiding principle of *zizhu chuangxin,* or "indigenous innovation," to leapfrog China into a leadership role in science-based industry by the year 2020. But it also referred to a longer term goal of "laying the foundation for China to become a science and technology power by the middle of the 21st Century."

It was originally slated to be published in 2005. But battles between the scientists and the bureaucrats, and disputes among government entities for control of projects and funding, delayed it by a year. In the end, Premier Wen personally intervened to referee and make the plan more detailed and action oriented. As it was unveiled, President Hu said that China would follow a new path of "innovation with Chinese characteristics."

The need for China to have a focused S&T strategy and practical policies aligned with fiscal discipline was made abundantly clear by a national embarrassment that surfaced right after the indigenous innovation policy was announced. Chen Jin -- the Shanghai professor who had become China's science rock star and a magnet for buckets of government money after unveiling his invention of the "China Chip" in 2003 -- turned out to be a fraud.

His downfall was doubly worrisome because the "China Chip" was the product of earlier government efforts to spur innovation. The development of a home-grown digital signaling processing chip (DSP) had long been a top domestic priority. The government had showered Chinese scientists, particularly those returning from the West, with handsome salaries and generous benefits. These scientists faced the twin problems of sky-high expectations in an already image-conscious society and enormous pressures to produce concrete results.

It was this pressure cooker that produced Chen and his bogus chip. MOST and MOE had financed Chen's founding of a microelectronics school and research center with more than 100 employees. Chen had created a family of private companies and developed the Hanxin II, III and IV. All this began to unravel in December 2005 when several disgruntled employees claimed that migrant workers in Chen's lab had simply scratched off the

“Motorola” trademark from the original prototype and replaced it with “Hanxin.” In May 2006, after a 5-month investigation, the Chinese government confirmed the accuracy of the allegations and stripped Chen of his post and titles.

A RAMBLING PLAN OF BREATHLESS AMBITION

The vigorous and divisive debate in drafting the MLP blueprint, and the lack of clarity in how to implement it, are evident in the final document. It weaves back and forth in a dizzying fashion that packages programs and goals in multiple ways in various sections.

- The plan targets 11 key sectors for employing technology development and innovation to solve China’s problems. They include energy, water and mineral resources, environment, agriculture, manufacturing, transportation, information and services, population and health, urbanization, public security and national defense. Within these sectors, there are 68 priority areas that have clearly defined missions and expectations of technology breakthroughs.

- It also earmarks eight fields of technology in which 27 breakthrough technologies are to be pursued. These include biotech, information technology, advanced materials, advanced manufacturing, advanced energy technology, marine technology, laser technology and aerospace technology.

- There are four basic research programs highlighted: protein science, nanotechnology, quantum physics and developmental and reproductive science. These research programs are aimed at exploring 18 basic scientific issues and hundreds of listed subsets ranging from the “dialogue between the human brain and computers” to “supersonic propulsion systems and super high-speed collisions” to the “evolution of black holes and diverse celestial bodies” to “biological processes within the earth’s system” and “the role of the central nervous system, immune system and endocrine system in health and major disease”.

- The MLP aims to solve China’s energy natural resource shortage through coal liquefaction and gasification, renewable energy development, exploration and extraction technology and power grid efficiency.

- Water shortages are to be fixed through desalination and efficient distribution systems. Dozens of pollution control objectives are aimed at cleaning up China’s horrific pollution through environmentally friendly fertilizers, herbicides and pesticides and waste recycling.

- Building a modern dairy industry and creating genetically modified crops are two leading aims for solving the country’s food safety and limited arable land problems.

- High speed rail and electric automobile technology are priorities as are next generation internet and supercomputers, stem cell based tissue engineering, energy efficient buildings, disease prevention, manufacturing robotics, deep sea exploration expertise, fast neutron nuclear technology and drugs and reproductive health products “to ensure that the country’s population is below 1.5 billion and the birth defect rate is below 3 percent”.

- The goal is to increase China’s gross expenditure on R&D to 2.5 percent of GDP by 2020 from 1.3 percent in 2006, with a target of basic research reaching 15 percent of R&D spending by 2020.

- The plan called for China's overall reliance on foreign technology to "decline below 30 percent" from an estimated 60 percent in 2006.

- The MLP also directed that the number of patents and leading academic papers from Chinese nationals will rank among the top five in the world by 2020.

MEGAPROJECTS FOR "ASSIMILATING AND ABSORBING"

The most ambitious components of the plan are 16 megaprojects. They are vehicles for an import substitution action plan aimed at creating Chinese indigenous innovations through "co-innovation" and "re-innovation" of foreign technologies supplied by companies seeking to profit from the massive government outlays on the megaprojects..

According to the MLP, as the "major carriers of uplifting indigenous innovation capacity," the megaprojects are aimed at "assimilating and absorbing" advanced technologies imported from outside China so the country can "develop a range of major equipment and key products that possess proprietary intellectual property rights." The government procurement market is assigned to be a key driver for these projects. The plan calls for creating a buy-China policy for government procurement and expanding the creation of China's own technology standards to get out from under the burden of paying license fees and royalties to foreign companies.

While the MLP identified the goals and specific sectors in which the government deemed innovation is of strategic importance, the 11th Five-Year Plan for High-Technology Industries (2006 -2010) issued in December 2007 formally detailed the 16 megaprojects.

Based on official MOST definitions, the priorities emphasized in the 13 of the 16 Special Projects are detailed below. Three projects are currently deemed classified. (See Appendix 1 for a description of each megaproject.)

- Core electronic components, high-end general use chips and basic software products

- Large-scale integrated circuit manufacturing equipment and techniques

- New generation broadband wireless mobile communication networks

- Advanced numeric-controlled machinery and basic manufacturing technology

- Large-scale oil and gas exploration

- Large advanced nuclear reactors

- Water pollution control and treatment

- Breeding new varieties of genetically modified organisms

- Pharmaceutical innovation and development

- Control and treatment of AIDS, hepatitis, and other major diseases

- Large aircraft

- High-definition earth observation system

- Manned spaceflight and lunar probe programs
- Undisclosed, believed to be classified military projects

"ACTING AS THE BONES TO SUPPORT THE RISE OF A NATION"

Implementing this massive plan was the subject of much debate and political maneuvering. Even before the detailed megaprojects were unveiled, the State Council in June 2006 issued what amounted to a "playbook" of agency responsibilities and policy directives.

To ensure that the megaproject plans didn't get lost in the Chinese bureaucracy, Party leaders assigned responsibility for the 99 supporting policies to ministers, vice-ministers and other senior officials by name and with deadlines attached. The NDRC was assigned the largest burden, with 29 policies to implement. The MOF and its tax administration got 25 between them. MOST got 17. The Ministry of Education got nine.

- NDRC's main assignment was to strengthen the ability of small and medium enterprises to innovate, including such tasks as developing guidelines for increasing the recognition of Chinese brands and developing guidelines for building national engineering labs.
- MOF was assigned to produce the financial policy push and pull: tax breaks and other incentives for enterprises to invest in innovation, and policies for driving innovation through government procurement incentives.
- MOST got the piggy bank, with the responsibility for assigning funds for science parks, research labs and the megaprojects. The China Development Bank was directed to open the spigot wide for soft loans to enterprises which pursue indigenous innovation projects. The Export-Import Bank of China was assigned to create special accounts for innovative enterprises.

A year after indigenous innovation became China's new economic development mantra, Party leaders were still impatient for real action. Their answer was to reorganize and further modernize MOST to better manage the sprawling plan and its 16 megaprojects. In April 2007, Party leaders tapped the star of their earlier leadership briefing, Tongji University president and former 10-year Audi engineer Wan Gang, to become minister of MOST and the first non-communist of minister rank in 35 years.

Wan Gang in June 2007 added muscle to MOST by establishing a "Special Projects Office," the equivalent of an economic war room to make the megaprojects happen. In conjunction with MOF, the megaprojects office evaluates applications, approves funding, monitors the projects and acts as a troubleshooter when problems arise. The budget for each project is very specific and identifies both central and local government contributions. Other ministries and agencies are supposed to lead implementation for each plan. The MOST megaprojects office organizes high-level, bi-monthly meetings at which ministers and vice-ministers gather with other senior officials to assess and push forward the megaprojects.

This unprecedented high-level hands-on micromanagement demonstrates that the indigenous innovation program is the government's highest strategic economic priority. But it also should remind international government leaders and foreign technology company executives that the same ministers they meet in Beijing for friendly trade talks are also directing plans for creating Chinese technologies and companies to replace them.

The bureaucracy steadily moved ahead with laws to support the MLP. In July 2008, a new "Science and Technology Progress Law" placed into statutes that China was "boosting indigenous innovation capacity and constructing an innovation-oriented country." This law cleared the way for the mechanisms to examine, assimilate and re-innovate the key technologies and equipment imported using government or state-owned-industry money.

As State Councilor Liu Yandong, the leading official responsible for technology policy, in 2007 had told a small group of ministers and techno-policy elite: "The majority of the market is controlled by foreign companies, most core technology relies on imports, the situation is extremely grave as we are further pressured by developed countries who use blockades and technology controls – if we are not able to solve these problems we will forever be under the control of others."

Premier Wen himself in December 2007 urged faster progress on the indigenous innovation program, saying that "in today's world, science and technology is the ultimate deciding factor of a nation's overall competitiveness, with indigenous innovation acting as the bones to support the rise of a nation."

The money spigots opened in November 2008 when China responded to the Global Financial Crisis with the quick rollout of a 4 trillion RMB stimulus program which included 160 billion RMB for indigenous innovation. Within days, the government allocated 27 billion RMB for the first phase of work on three megaprojects: core electronic devices, semiconductors and wireless broadband. An additional five megaprojects were launched with stimulus money in the following months.

NO SHORTAGE OF MONEY

The total amount that China spends on science and technology is not easy to determine. Funding is scattered across the central, provincial and local governments in addition to thousands of universities, government research labs and SOEs.

According to figures from the National Bureau of Statistics that likely catch some but not all of these funding sources, in 2008 China's spending on science and technology reached 1.54 percent of GDP for a total of RMB 912 billion, or US $133 billion at current exchange rates. The bureau reported that of this total, 21 percent was government money (split about 50-50 local and central); 70 percent was Chinese "enterprise" money; some 4 percent was loans from financial institutions, and the rest scattered among other entities (see Appendix 2 for S&T and R&D data from 2000 to 2008).

Academics who track these numbers say that they do not come close to reflecting reality. They suggest that much of the money attributed to "enterprise" is most likely government money supplied to research institutes that have been registered as companies. Clear and detailed statistics aren't available. But it is clear that Chinese enterprises aren't major players in science and technology, and those that are involved usually depend on government funding, often through soft loans. Many SOEs are flush with cash, especially several dozen largest SOEs that have been chosen to become national champions and currently enjoy monopolies or controlled competition. When the plan was unveiled in 2006, the Party mouthpiece *People's Daily* complained that SOEs "are not taking research and development seriously" and noted that some 75 percent of SOEs didn't even employ a single R&D staffer.

The State-Owned Assets Supervision and Administration Commission, or SASAC, which holds the government shares and manages China's national level SOE behemoths, responded by ordering state industry throughout China to come up with indigenous innovation strategies. The order apparently fell on deaf ears. Former MOST Vice Minister Liu Yanhua in May this year told a Sichuan newspaper that 80 percent of large Chinese enterprises still don't have an R&D team.

Despite the goals of enterprise funding, the majority of the indigenous innovation money will be allocated by MOST and NDRC from government coffers and soft loans from China's State Development Bank and Export Import Bank.

There are a handful of programs dating back to the 1980s that have been the backbone of China's science funding system through which these funds will flow:

- The 1982 **Key Technologies Program** is aimed at focusing scientists on addressing core scientific issues related to China's social and economic development. It has been China's largest ever scientific effort, involving scientists in some 1,000 research institutes. Every five years it produces an updated "Key Science & Technologies Projects Plan." Today the program handles some 20 percent of central government S&T spending and is under the supervision of MOST.

- The 1986 **National High Technology Research and Development Program** (known as **"863"** for its March 1986 founding date) was launched to promote China's high-tech development in such key areas such as information technology, biology, aeronautics, automation, energy, materials and oceanography. Government institutes, university research labs and state-owned company R&D departments all participate in 863 initiatives. CAS is the biggest recipient of 863 money.

- The 1988 **Torch** program has been responsible for building more than 50 national level high-tech zones across China. Managed by MOST, Torch will likely be tapped for funding infrastructure to support indigenous innovation projects related to materials, biotechnology, electronic information, integrated mechanical-electrical and energy-saving technology.

- The 1994 **National Key Laboratories** program was designated to increase S&T capacity by building research facilities with world-class equipment for basic and applied research. Within a decade, RMB 1.3 billion was spent building 153 key labs. The goal is for these labs to work with Chinese enterprise for innovation.

- The 1997 **National Basic Research Program** (known as the **973** program) was created to conduct basic research aligned with such national strategic targets as agriculture, energy, information technology, healthcare and materials. Today it is the main central government program for basic research and it receives about 10 percent of central government S&T money.

FILLING UP THE TOOLBOX

The goals of China's indigenous innovation campaign and the megaprojects are implicit and clear – capture the market space for domestic Chinese firms with SOEs having the favored position. For example, the official goal of China's "Next Generation Wireless Broadband" megaproject is called the "1225 strategy," the goal of which is to capture 10 percent of global patents, 25 percent of the telecom semiconductor market, 20 percent of the global broadband hardware market and 50 percent of the domestic market.

The indigenous innovation campaign took on more shape as implementing policies rolled out:

- The February 2006 "National Outline for Medium- and Long-Term Science and Technology Development Planning" detailed preferences for domestic goods and service providers.

- A September 2006 tax bureau "Circular on Preferential Tax Policies for Innovation Enterprises" offered two year exemption of enterprise income tax.

- The December 2006 "Administrative Measures on the Accreditation of National Indigenous Innovation Products" outlined the plans for creating national indigenous innovation product catalogues.

- The May 2007 "Measures for Administration of Government Procurement Budgets for Indigenous Innovation Products" warned government at all levels to develop specific indigenous innovation procurement plans or they would lose procurement funds.

- Also in May 2007, "Measures for Assessment of Government Procurement of Indigenous Innovation Products" lowered government procurement supplier qualification standards for companies doing indigenous innovation.

- In December 2007, MOF issued "Measures for the Administration of Government Procurement of Imported Products" which directed that approval by a board of experts is necessary for government entities to purchase imported goods. It called for favoring foreign suppliers that provide the domestic industry with technology transfers and training services.

- A January 2008 "Enterprise Income Tax Law" offered a preferential rate of 15 percent to high-tech enterprises designated by the government as indigenous innovation companies because they developed and owned their intellectual property.[7]

THE BUY-CHINA PLAN

China's plan to use its domestic market to drive its indigenous innovation campaign gained traction on November 15, 2009 with the release of the public draft of the "Circular on Carrying Out the Work on Accreditation of National Indigenous Innovation Products," known as Circular 618. MOST, the NDRC and MOF issued the joint circular announcing the creation of a new national-level catalogue of products that will receive preferential treatment in government procurement. Many provinces and municipalities had already prepared their own product catalogues most of which essentially cut foreign products out of local government procurement. The Shanghai catalogue, for example, listed 258 products, only two of which were from manufacturers with foreign investment.

The unveiling of Circular 618 created a stir. It focused on six high- and new-technology fields: computers and application equipment; communications products; modern office equipment; software; new energy and new energy devices; and high-efficiency and energy-

[7] Circular 172 (April 14, 2008) provides that High and New Technology Enterprises (HNTE) requires "independent ownership of core intellectual property (IP)," which is now defined to include the "exclusive licensing for more than five years of the IP rights associated with an enterprise's major business." Despite this looser definition of IP ownership, an entity can qualify for the 15 percent rate only if it "conducts continuous R&D activities" that are meaningful both in substance and in quantity.

saving products. It defined an indigenous innovation product as one which has IPR owned by a Chinese company and a commercial trademark initially registered within China. Foreign companies complained that their products, even if developed and made in China, would not meet these requirements. The foreign multinationals considered this to be thinly disguised protectionism as no global foreign company has initially filed its trademarks in China. Additionally, multinational R&D facilities in China are connected to global operations, so the products they create are often the result of global collaboration and not work only done in China.

With Circular 618, the foreign business community and foreign governments began to connect the dots on the emerging "China model" and the array of industrial policies and market access barriers that were part and parcel of the indigenous innovation campaign. Headlines in the international business press such as "Business Sours on China" and "Foreign Firms Feel Shut Out in China" led Premier Wen at his annual March press conference to promise to meet with foreign business executives, something he had seldom done since coming into office. The Ministry of Commerce (MOFCOM) huddled with MOST, NDRC and other agencies to assess the situation.

Meanwhile, in December 2009, MOST, MOF, MIIT and SASAC forged ahead with a catalogue of 240 types of industrial equipment in 18 categories that the government is encouraging domestic companies to produce to upgrade China's manufacturing base. Chinese companies that participate in the effort were promised a mix of tax incentives and government S&T subsidies as well as priority status on national indigenous innovation product catalogues. A month later, the State Council released the draft of implementing regulations for its Government Procurement Law. The draft defined a "domestic product" as made within China's borders with "domestic manufacturing costs exceeding a certain percentage of the final price." MOF in 1999 had said that products with less than 50 percent of their value produced in China were considered imports.

The government backtracked slightly on April 10, 2010, with draft revisions to Circular 618 that would soften some of the most controversial requirements. The draft removed references to "indigenous brands" and the requirements that the trademarks and brands must first be registered in China and the IP owned by the local entity. Foreign business associations, however, continue to push for elimination of the indigenous innovation product catalogues altogether.

"ACTIVELY" GET SOMETHING ACCOMPLISHED

So when did China shift from defense to offense?

Some analysts trace China's more assertive commercial and diplomatic attitude to the Party's 11th Ambassadorial Conference in Beijing in July 2009. The meeting was called to communicate the Party leadership's latest diplomatic strategy and policy directions led by the indigenous innovation campaign. China's ambassadors were summoned home for the event. They were joined by officials responsible for foreign affairs from the ministries, provinces and regions, as well as key SOE executives who carried minister or vice-minister ranking. The defining event was a speech by President Hu, presented with the eight other members of the politburo standing committee on stage with him.

According to a report by Bonnie Glaser of the Center for Strategic and International Studies, President Hu urged the assembled officials to be more assertive in their diplomatic duties and "actively advocate multilateralism" now that America's reputation had been damaged by the global financial crisis. President Hu also announced a key new formulation to project

China's "soft power." He instructed the assembled Party leaders to be more influential in global politics, more competitive in global economics, more attentive to the country's international image, and serve as a more appealing moral force in the world. The Chinese media quickly labeled the instructions "The Four Strengths."

But the real game-changing message at the conference may have been an extra dose of assertiveness and activism added to Deng Xiaoping's foreign policy guidelines that the Party has lived under since Deng issued them in 1989 after the collapse of the communist Eastern Bloc. Deng's original 24-character message had been boiled down and enshrined in Party liturgy as an eight-character slogan: *Taoguang Yanghui, Yousuo Zuowei* (Keep a low profile and bide our time, while getting something accomplished).

The Chinese leadership is extremely sensitive about this slogan because it has been interpreted by some in the West as demonstrating that China is quietly amassing wealth and power while hiding its true intentions to dominate the world. Chinese scholars told Glaser that two additional characters were added to the slogan at the conference, though the expanded slogan hasn't shown up in open publications. Chinese scholars said that following heated debate, and upon the decision of President Hu himself, the word *jiji,* or "actively" was added to the final phrase to make it "while **actively** getting something accomplished."

THE "CHINA MODEL"

This Party attitude adjustment came just six months after the government gave more clarity to the "China model" of economic development led by SOE "global national champions." As China opened its economy wider to meet WTO commitments, the government found that foreign companies were quickly building dominant positions in sectors where WTO gave them enough running room. To protect what the government considered to be "economic lifeline" sectors, SASAC in December 2008 called a press conference to announce new regulations to clarify the role of SOEs in China's economy.

SASAC divided state industries it wanted to protect through continued government ownership as being either "key" industries that would remain "state dominated," meaning majority owned and controlled by the government, and "underpinning" industries that would remain "largely in state hands."

The key industries named by SASAC are: armaments, power generation and distribution, oil and petrochemicals, telecommunications, coal, aerospace and air freight industries. The exact meaning of "state dominated" was not clearly spelled out. It is likely to mean different things for these seven industries and their subsectors. It was made clear that for arms, oil, natural gas and telecommunications infrastructure that the government will have sole ownership or absolute control of all the central enterprises and all the "major" subsidiaries associated with these industries. SASAC's circular also includes an "etcetera" at the end of the list of sectors, thereby leaving room for expansion in the future.

For aerospace and air freight, the circular said that the state retains sole ownership and absolute control of the central enterprises but not the subsidiaries. For the "downstream products of petrochemicals" and the "telecommunications value-added service industry" the government would continue to encourage foreign investment and promote "diversity in property rights," according to the circular.

The circular said that the state would play a large supervisory role in the "underpinning" industries of equipment manufacturing, automobiles, electronic communications, architecture, steel, nonferrous metals, chemicals, surveying and design, and science and technology. This term also means different things depending on the industry. For equipment manufacturing, automobiles, electronic communication, architecture, steel and nonferrous metals, the state will retain absolute control or conditional corporate control of the central enterprises associated with these industries, according to the circular. For science and technology and surveys and design, the state will have a “majority stake” in directing central enterprises to undertake these tasks.

SASAC also announced a plan to make the SOEs more competitive through mergers and acquisitions to create some 20 or 30 powerhouse companies that would become “internationally competitive.”

THE “NATIONAL CHAMPION” ECOSYSTEM

To build Chinese national champion SOEs and implement the indigenous innovation plan, China has been crafting an elaborate and extensive ecosystem of industrial policies. It is built atop the solid base of foreign investment and ownership restrictions created in the 1990s, such as 50 percent maximum ownership of car plants and minority ownership limits in sectors ranging from telecom to genetically modified organisms to new energy equipment.[8] This industrial policy ecosystem includes:

- a domestic patent regime allowing the use of “junk patents” that can be employed to retaliate against foreign companies inside China which have filed IPR violation lawsuits against Chinese companies outside of China;

- compulsory certification and standards requirements that slow or block the entry of foreign products into the China market;

- requirements for the disclosure of technology secrets and other proprietary information that serve to exclude foreign products from major Chinese markets; and

- uneven and lax enforcement of IPR protection.

Chinese government officials and many Chinese business people view technology and industrial standards as trade weapons used to discriminate against them. As a result, mandates to create and legitimize Chinese product standards through pushing products into the fast-growing Chinese domestic market are woven throughout indigenous innovation initiatives.

Most international product and technology standards, and the associated testing and certification for conformance, are the result of inventions that capture a market and the combined efforts of industry coalitions and non-government standards bodies. In China, this process is turned around. Standards are established by government bodies which manage the certification process then push them into the marketplace. The backdrop for this is that private industry has just been re-established in China, and there have been many cases where private companies steal IP and produce shoddy products as they cut corners to beat others to market. As a result, Chinese citizens by and large trust the government to be more reliable to create and police product standards.

[8] For a comprehensive analysis of how the Chinese government is using a multitude of policies to build up a strong domestic renewable energy industry through national champion SOEs, see “China’s Promotion of the Renewable Electric Power Equipment Industry – Hydro, Wind, Solar, Biomass,” Dewey & LeBoeuf, LLP (March 2010).

With the government controlling standards, certification and testing regimes can be formidable tools for protectionism. Under the indigenous innovation campaign many restrictions, requirements and constantly changing standards have been coming out of China's national and local regulators. A key piece of this is the Chinese Compulsory Certification system which issues the "CCC Mark" of safety approval for China's tech and industrial products.

The CCC system is estimated to affect some 20 percent of US exports to China. In almost all cases, the products are already approved by qualified international organizations. But China requires redundant testing by Chinese government-owned labs and recertification, which often starts with the foreign manufacturers paying international travel expenses for Chinese inspectors to visit their factories. Incredibly detailed requirements often delay foreign products as Chinese competitors capture the market. For example, cosmetics companies must submit each new shade of lipstick or nail polish for months of separate testing and certification.

China in August 2008 enacted an "Anti-Monopoly Law" (AML) that incorporates key elements of antitrust laws from Europe, the US, South Korea and Japan. The law can be a useful tool for industrial policies because it lacks many details and legal clarity. It also essentially exempts state-sanctioned monopolies and SOE-dominated sectors, thereby giving enforcement agencies and courts wide discretion to use the AML to protect domestic companies and boost the fortunes of national champions.

The AML focuses on three types of monopolistic conduct: "monopolistic agreements" that involve such actions as price-fixing and the divvying up of markets; the "abuse of a dominant market position" that is defined as the ability to "control prices, quantities and other transaction terms" or "affect or prevent market entry;" and "mergers and acquisitions" that lead to concentrations that "exclude or restrict competition." The AML presumes market dominance if any single company has a market share in excess of 50 percent, any two firms have a market share exceeding 66 percent or any three firms have market share exceeding 75 percent.

Multinationals are greatly concerned about the AML and its presumption of market share limits as well as its apparent exemption for SOEs that are built up by the central government.[9] In light of the indigenous innovation policy of replacing foreign technology in critical infrastructure and the mandate to reduce the use of foreign technology to less than 30 percent in the entire Chinese economy, multinationals with dominant market shares globally and in China may find the AML knocking at their door.

In fact, some PRC officials have tried to use the AML to force technology transfers. The State Administration for Industry and Commerce (SAIC), which helps enforce the AML, has

[9] When the AML was drafted, there was a major debate and division among PRC policymakers on whether to subject SOEs to restraints on anti-competitive conduct. A compromise was achieved: The chapter on abuse of administrative powers remained in the final law, but the AML apparently excludes operational activities of SOEs with a controlling position in industries vital to the Chinese economy as long as they are supervised to protect consumer interests and advance technological progress and they act in accordance with applicable law. *Compare* AML Article 7 *with* AML Chapter V (Articles 32-27). This is like the fox guarding the chicken coop, as it could be interpreted to mean that SOEs which dominate their industry as a result of government policy preferences and legislative support are exempt from the AML. We have no other official guidance on the applicability of the AML to SOEs.

[9] *Action Urged on Antitrust Law*, China Daily (Sept 1, 1998).

drafted a regulation that would allow compulsory licensing of intellectual property owned by a dominant company that unilaterally refuses to license its IP if access to such IP is "essential" for others to effectively compete and innovate. [10] The refusal to license in such cases would be considered by SAIC to be an "abuse of IP." A similar provision was included in a 2005 draft of the AML itself, but extensive foreign criticism persuaded China to remove it. [11] The concept has quietly resurfaced in SAIC's draft regulation, which could be used to force compulsory licensing of MNC technology to a budding Chinese competitor that alleges foreign IP is impeding its innovation capabilities.

INTELLECTUAL PROPERTY RIGHTS AND WRONGS

China has created a decent IPR legal regime on paper, but enforcement all too often appears to be deliberately weak. Since joining the World Intellectual Property Organization (WIPO) in 1980, China has created the laws and tools necessary to have respectable IPR protection. But the political will doesn't exist to pursue serious enforcement.

As in many developing countries, much of Chinese industry got started by copying the products of others. Chinese law makes it difficult to find smoking guns if proprietary technology is stolen or leaked. As a result, some companies have become masterful in using pilfered blueprints and designs and sophisticated reverse engineering techniques to copy foreign products and jumpstart their companies. The patent system also enabled Chinese parties to "hijack" patents of others – by claiming a patent on an invention that was not published anywhere in the world or sold in China, such as for a product invented by another and revealed at a foreign trade show.

Taiwan, South Korea, Hong Kong and other Asian export bases were masters of piracy in the 1980s and 1990s. As Apple computer came out with new models, Taiwanese "Pineapple" copycats were on sale in Taipei markets within weeks. While these actions led to many years of trade disputes, global distribution of the copycats was limited. The Asian Tiger economies were small. To build real scale, the products had to be exported, thereby giving customs inspectors the chance to mitigate damage to global supply chains.

Then along came China, a continental-sized, fast-growth economy almost starting from scratch in terms of modern manufacturing and consumer goods. Copycat products could scale without crossing national borders. As IP theft in China created huge supply chain and distribution networks, more and more pirated goods have flooded into export markets.

After joining WIPO in 1980, China step by step signed on to other international IPR agreements and conventions. China adopted its Trademark Law in 1982, and its Patent Law in 1984. Industrial IPR protections were promised in 1985 by joining the "Paris Convention." In June 1989, China acceded to the "Madrid Agreement for the International Registration of Trademarks." The Copyright Law was adopted in 1990. These have all been amended and improved many times in subsequent years, and supplemented by a host of other protections such as the 1991 Computer Software Protection Rules.

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[10] *See* Article 18, Guidelines for Anti-Monopoly Law Enforcement in the Area of Intellectual Property Rights (Fourth Draft Revision).

[11] The AML as enacted condemns "abuse of IP" by a dominant company but does not define the concept or the remedy for the conduct. *See* Article 55, Anti-Monopoly Law of the People's Republic of China (adopted at the 29th Meeting of the Standing Committee of the National People's Congress on August 30, 2007). Article 55 states that an entity can be charged with abusing its IP under the AML only if its exercise of IP is not in accordance with China's IP laws and regulations.

Two key organizations under the State Council are responsible for IPR administration: SAIC and the State Intellectual Property Office (SIPO). The China Trademark Office and the Trademark Appeal Board are under SAIC. SIPO oversees the Patent Office. The Copyright Office falls under the General Administration for Press and Publications.

Special intellectual property courts have been established in large cities and many provinces. They represent a relatively highly skilled sector of the judiciary and a significant investment by the state in a relatively small area of total civil litigation. In 1992, the Supreme People's Court established an intellectual property division. While China now has one of the most active civil dockets in the world for IP cases, there is little active police or administrative enforcement of IP protection. Enforcement action in the courts often raises the question whether the judge is willing to overlook the political pressure to favor local companies and "indigenous innovation" even where it violates multinational IP rights. Doing so is especially difficult when the technology relates to one of the Chinese government's targeted industries.

The recent guidelines of China's Supreme People's Court regarding the implementation of China's IP strategy contain much favorable language about the need to protect IP rights. But they also include several troublesome paragraphs indicating the judiciary's propensity to advance China's national innovation agenda. For instance, they note:

> *We should intensify the protection of core technologies which may become a breakthrough in boosting the economic growth and which have independent intellectual property rights so as to promote the development of the high and new technology industries and newly rising industries, improve the independent innovation capabilities of our country and enhance the national core competitiveness.*[12]

In 1995, Customs was given authority to stop counterfeited goods from coming into or going out of China. Administrative enforcement is delegated to local IPR offices and police who often are most interested in protecting local businesses. Fines and punishment for administrative IPR cases remain too low to serve as adequate deterrents. Full access to civil and criminal channels is difficult due to very high value and volume thresholds for bringing criminal cases.

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[12] Guidelines of the Supreme People's Court on Several Issues Regarding the Implementation of the National Intellectual Property Strategy, Par. 9 (No. 16 [2009] of the Supreme People's Court March 29, 2009). The Guidelines also note that judges should:

- "fully appreciate that the implementation of the intellectual property strategy is an urgent need to build an innovative country, . . . and a crucial move to enhance the national core competitiveness by taking into account such aspects as helping to enhance the independent innovative capabilities of our country, improve the system of social market economy of our country, enhance the market competitiveness of the enterprises of our country, enhance the national core competitiveness and open wider to the outside world." (Par.1).

- "ensure the correct political direction . . . also improve the enterprises' independent innovation capabilities." (Par. 8).

- "properly deal with the relationship between the competition policies and industrial policies. . . ." (Par. 16).

- ". . . create intellectual property out of the independent innovation fruits, and to have them commercialized, industrialized and marketized." (Par. 17).

Attorneys who specialize in Chinese IP cases say that since the launch of the indigenous innovation campaign they have observed backtracking in China's progress toward an unbiased legal system that protects IPR. Chinese government officials and academics complain that China gave away too much in joining the WTO. They say it is unfair that at similar stages in their development Japan and the Asian Tigers had much weaker IPR protection systems than China when it agreed to join the WTO.

"Under the rules of the WTO, intellectual property rights, technical barriers to trade and anti-dumping have become a major barrier for most of China's companies to compete in the international arena," former MOST Minister Xu Guanghua said in 2009.

LOCK AND LOAD YOUR PATENTS

China's patent regime has been tailored to help accomplish two major indigenous innovation goals. One is to incentivize Chinese companies to file patents that contain little substance so that they can learn the patent process for later filing of real invention patents. The other is for Chinese companies to be able to use domestic patents to retaliate against foreign companies which file intellectual property infringement lawsuits offshore that stymie the international expansion plans of Chinese companies.

The key tool for accomplishing this is China's use of the German "Gebrauchsmuster", or "utility model" patent. Such patents don't exist in the US. Filings of these patents are not reviewed, and require only vague information. They can be used to obtain patents that are merely descriptions of products owned by others with a few small changes added in. China's patent law also follows the European "first to file" and not the American "first to invent" principle. As a result, Chinese companies are able to obtain patents for products they didn't invent but for which they filed the patent first. The definition of "invention" in Chinese patent law is also quite relaxed: "any new technical solution relating to a product, process or improvement…"

China's original March 1984 patent law was amended several times to bring it into closer alignment with international standards. A group of 1992 amendments added food, pharmaceutical and chemical products as eligible items for patents. They also extended "invention" patent rights to 20 from 15 years, and "utility" patent rights to 10 years from five years. In 1994, China joined the International Patent Cooperation Treaty (PCT), and the Chinese patent office was qualified to receive and process international patent applications. In 2000, China's patent law was amended to try to bring it into compliance with the WTO agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).

Recent developments have not been so positive. In March 2009, the Supreme Court encouraged local courts to "dramatically" raise compensation awards against patent infringers. But most of these cases have been brought against foreign companies by Chinese holders of the "utility model" patents _ or "design patents" which are even less rigorous than the utility patents.

Both of these patent categories are considered to be "junk patents" by most patent attorneys and regulators. Hundreds of thousands of these patents are filed every year in China as part of the indigenous innovation drive. Patent filing is part of SASAC's performance evaluation for SOEs. Local governments provide instant profits for companies by giving subsidies to pay for patent filing costs that often exceed budgeted costs.

The turning point for China's patent regime came in October 2009 with the third amendment to the patent law. It added 12 new articles and revised about half of the original 69 articles.

SIPO said the revision was aimed at promoting indigenous innovation and reducing China's dependence on foreign-owned patents.

This third amendment required that patents for products "completed" in China must be filed in China, and the patent holder must obtain SIPO approval for subsequent overseas filing. The patent also must undergo a security examination, a rule the US also has, but in China the failure to follow this rule could subject the patent holder to criminal charges for divulging "state secrets" an elastic term with no clear legal definition.

A "compulsory licensing" provision was also expanded to include circumstances in which the patent holder has not "sufficiently exploited the patent without any justified reason" within 3 years of approval, or when a court or administrative organization has determined that the patent is not being used in order to eliminate or restrict competition. These provisions give China wide leeway to force foreign companies to license technology in China.

Chinese nationals accounted for 877,611, or nearly 90 percent, of 976,686 patent applications in China in 2009. Some 230,000 of these were "invention" patents which require detailed information and undergo detailed review. Utility patents numbered 308,861. Design patents totaled 339,654. So nearly three-quarters of Chinese patent filings were in the "junk" category.

FRENCH LESSONS AND HOME COURT ADVANTAGE

These "junk patents" are proving to be a potent weapon against foreign companies. This became clear in September 2007, just three months before the list of 16 indigenous innovation megaprojects was unveiled. IP attorneys globally sent alert memos to their clients after the Intermediate People's Court in the coastal city of Wenzhou ordered the French electronics giant Schneider Electric to pay the Chint Group of Wenzhou RMB 334.8 million (about US $50 million) in damages for infringement of Chint's China "utility model" patent.

This unprecedented penalty, 17 times higher than any previous IPR award in China, was undoubtedly approved at high Party levels as the Chint-Schneider dispute had been elevated to bilateral discussions as high as French President Nicolas Sarkozy and President Hu. But it was also the perfect case for China to use as a warning to multinationals who believe they will be able to sue Chinese companies for IPR infringement outside of China while continuing to operate unimpeded in the Chinese market.

Founded in 1984 as a small workshop with a RMB 50,000 investment, Chint was the China market leader in low-voltage electronic apparatus in the mid-1990s when it expanded into Europe where Schneider dominated the marketplace. Starting in 1995, Schneider filed 19 patent actions in Europe and 6 patent cases in China against Chint for infringements on various electric switches, relays and circuit breakers. Schneider won lawsuits in Germany and Italy but some others were dismissed by the courts. Various injunctions against Chint selling products during the lawsuits slowed Chint's European expansion, however.

As the lawsuits simmered, Schneider's attempts to engage Chint in merger discussions were rejected. In August 2006, as the indigenous innovation implementation policies were rolling out in Beijing, Chint counterattacked with the Wenzhou lawsuit accusing Schneider of using circuit breaker technology for which Chint had been granted a "utility patent" in March 1999. The lawsuit claimed that five models of Schneider products fell within the patent's scope, and calculated that the global sales of these models had totaled RMB 883.6 million, with profits of RMB 334.8 million, from August 2004 to July 2006.

Schneider claimed that Chint's China utility patent was invalid as Schneider invented the products and had obtained French patents for the technology in the early 1990s. China's Patent Review Board in April 2007 rejected Schneider's plea to invalidate Chint's utility patent. In September 2007, the Wenzhou court ruled in favor of Chint and ordered Schneider to pay the company RMB 330 million in damages. A month later, MOFCOM approved Schneider forming a 50-50 joint venture with Delixi Electric Co., which is Chint's largest domestic competitor founded by two Chint founders who had left the company early in its existence.

On April 15, 2009, Schneider and Chint agreed to a global settlement with Schneider paying Chint RMB 157.5 million (US $23 million). After the ruling, Chint board chairman Nan Cunhui told Xinhua that other Chinese companies should follow his example of using Chinese patent laws to protect themselves from competition. "Suing business rivals for patent infringement is a common resort that some transnational companies use to elbow out competitors and dominate the market," Nan said. Two weeks later, Chint announced that its solar subsidiary, Chint Solar, had raised $50 million in its first round of venture funding.[13]

RAW POWER MAKES THE RULES

China's aversion to foreign product standards goes hand in hand with feelings of victimization by foreign patents. As China built out its telecom system and became an electronics manufacturing center in the 1990s, Chinese industry complained that they were doing all the work but their profits were going to foreigners for royalties and license payments. Newspaper headlines screamed about license fees paid to owners of the European GSM and American CDMA telecom standards patents. The Chinese government estimated that the percentage of fees to foreign companies on wholesale prices constituted 20 percent of handsets, 30 percent of computers and 20-40 percent of machine tools. Chinese DVD player makers claimed they paid $10 in royalties for each product they sold for about $30. Wu Xiahua, the director of National Special Display Engineering Research Center, estimates that China currently pays US $45 billion in licensing fees to various foreign IP holders every year.

Shortly after the Hu-Wen administration came into office, China pushed back. In November 2003, a coalition of eight Chinese ministries announced that by June 1, 2004 all wireless devices sold in China must include support for a new Chinese home-grown standard for wireless local area networking (or WLAN). This new standard was to be used in computers and other networking equipment in China for communicating with wireless hotspots, printers and other accessories.

The Chinese standard, dubbed "WAPI" for Wireless Authentication and Privacy Infrastructure, was billed as being able to resolve security loopholes in a protocol known as 802.11, or Wi-Fi, the global standard for wireless networking. In reality, however, it suffered from a number of technical limitations. Foreign computer and chip makers who wanted continued access to the Chinese market were told to partner with one of 11 Chinese politically connected companies to which the WAPI standard had been disclosed.

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[13] A more recent example involves the *Aigo vs. HP* and *Aigo v. Toshiba* cases, also asserting patent infringement. *See* Mark Lee & Debra Mao, "China's Aigo Sues Hewlett-Packard, Toshiba for Patent Violation" (April 27, 2010); available: www.bloomberg.com. Notably, as in the Schneider case, the IP here also involved utility model patents that are harder to invalidate based on prior art than invention patents because they are not subject to substantive examination.

This action immediately escalated into a major trade dispute. Foreign chip, computer and communications equipment makers worried that complying with WAPI would require sharing confidential designs and encryption technology with the Chinese companies and government. They also feared that WAPI would force them to produce separate products for China and the global market.

The American Wi-Fi Alliance in January 2004 announced it would support suspending the sale of Wi-Fi chips to China if a compromise wasn't reached. By April the issue had become so controversial at high political levels that Vice-Premier Wu Yi announced that China would "indefinitely delay" WAPI enforcement.

Nonetheless, China forged ahead, submitting WAPI for recognition by the Geneva-based International Organization for Standardization, a standards setting body with representatives from 163 countries that promulgates worldwide proprietary industrial and commercial standards – of which only a few are free of charge. In March 2006, the ISO rejected the WAPI standard and the Xinhua news agency huffed that the rejection was the result of an "organized conspiracy against China." Others pointed out that China had refused to reveal the core algorithms, and approved standards are required to be transparent.

In March 2006, just one month after the official launch of indigenous innovation, the government formed a WAPI Industry Alliance of 22 top domestic IT and telecom enterprises. WAPI was established as the standard for products eligible for government procurement, and WAPI technology was installed in stadiums for the 2008 Beijing Olympics. MIIT announced that previous ISO decisions applied only to computers, and required that all mobile phones sold in China starting in 2009 support WAPI. But they were also allowed to simultaneously have Wi-Fi. So Nokia, Motorola, Samsung and all the others complied.

Chinese customers continue to use Wi-Fi, but the WAPI alliance members have gained a steady revenue stream, five years after their battle for royalties began.

NEW TELECOM STANDARD GETS OFF HOLD

As China looked ahead to upgrading its mobile phone system to 3rd Generation, or "3G", the government was determined to end the bleeding of royalty money to foreigners. The technology could be a gold mine as it would allow mobile phone web surfing and video through faster connections and the simultaneous use of speech and data. But officials had also learned through their WAPI experience that bureaucratic intimidation alone would likely not be the best route to promote TD-SCDMA.

Chinese telecom scientists and equipment vendors teamed up with Siemens to develop a Chinese standard known as TD-SCDMA. Mobile telecommunications networks require an air interface that links a mobile station and a base station. The standard air interface found in 3G networks is called W-CDMA, a technology both developed and patented in Japan. W-CDMA's use as a market standard meant that, by the mid-2000s, the Chinese government and Chinese companies had already paid out millions of dollars in licensing fees to non-Chinese patent holders.

So in January 2006, as President Hu gave a speech launching indigenous innovation as "the core of national competitiveness," MIIT formally announced TD-SCDMA as the country's standard for 3G mobile telecommunications. But the Chinese technology had significant technical problems and consumers were impatient for quality 3G deployment. The government planned to run a series of trials from March through October 2006 before introducing TD-SCDMA to the market. But the trials concluded two years behind schedule.

China's three mobile companies also balked at adopting an air interface incompatible with global mobile telecommunications devices. Finally, MIIT and SASAC ordered the three carriers—China Mobile, China Telecom and China Unicom—to build commercial trial networks in eight Chinese cities. The trials were costly and complicated, and the technology less than reliable.

In January 2009, responding to vocal consumer complaints about the delay in 3G and worries that China would be stuck with an inferior system, MIIT granted international 3G standard licenses to China Unicom (WCDMA) and China Telecom (CDMA-2000). But the Chinese TD-SCDMA standard was assigned to China Mobile, the dominant carrier and world's biggest in number of subscribers, to ensure the system had sufficient financial and technical backing to be successful. The licenses were projected to spark more than US $40 billion in equipment spending.

By the time TD-SCDMA was deployed, however, the telecom world was already moving into 4G technology.

BARRIERS AND BLUNDERS

For some foreign tech companies, the indigenous innovation campaign may present them with life-and-death decisions in the China market. For those with encryption as their core IP, such decisions are imminent.

Foreign smart card producers – the cards with embedded chips that are used for mobile phones, public transportation, national and school IDs and similar functions -- have already been hammered by Chinese encryption regulations issued in August 2007 as part of the indigenous innovation policy rollout.

The draft regulations required compulsory testing and certification of 13 security product categories. This includes smart cards, firewalls, routers, database systems, anti-spam software and various other network and web security systems. Companies with such products are required to obtain China Compulsory Certification (CCC) approval before they can be produced and marketed in China. Going through the process for obtaining CCC certification would require the disclosure of source code and other trade secrets. To comply, for example, such companies as Cisco Systems, Lucent, Norton and many others would have to reveal their encryption secrets and thereby potentially make their global systems vulnerable to Chinese government and industry snooping.

For the smart card industry, the rules meant revealing their Chip Operating System, or COS, the instructions permanently embedded in the card memory that constitute the core commercial secrets of the technology. An accompanying regulation added an additional hurdle. To apply for CCC certification, products with commercial encryption technology must first obtain certification from China's Office of Security Commercial Code Administration (OSCCA).

Japan and the European Union, home to the world's major smart card producers, in alliance with the US government and tech industry, threatened trade actions. China in April 2009 watered down the policy. The inspection and certification requirements were limited to products eligible for government procurement, and implementation was delayed to May 1, 2010. But Chinese banks, and transportation companies which oversee subway and taxi cards, switched over to indigenous smart cards after the initial 2007 rules came out. CCC certification is a prerequisite to smart cards being included in the various indigenous innovation product catalogues.

The leading global telecom and IT equipment makers and software vendors let the May 1 deadline pass without complying.

This certification requirement for products with encryption runs parallel to a June 2007 indigenous innovation government mandate that establishes guidelines to categorize information systems by the potential of a breach in the system to damage China's social order, public interest or national security. The measure specifies five categories of security, with Level 1 being normal and Level 5 being related to top national security.

Dubbed the Multi-Level Protection Scheme (MLPS), the measure lays out detailed technical standards for products used at each level, and specifies that security products used for Level 3 and above must have independent Chinese IPR, core technology and ownership. The information systems of China's banks, telecom companies and other key industries are classified as Level 3 and thereby appear to exclude foreign vendors.

This security scheme helped lay the foundation for the most public and embarrassing outgrowth of the indigenous innovation campaign so far: the infamous "Green Dam" fiasco. In early 2009, seven Chinese ministries announced a "Special Campaign to Restore the Internet from a State of Vulgarity" and launched a multi-million dollar effort to purge the Internet of content unsuitable for China's youth. In keeping with seeking indigenous solutions, contracts for the filtration software had been handed to two Chinese companies. One was headed by a Beijing businessman who was in business with a prominent member of the National People's Congress. The other was a company from Zhengzhou with close relations to top local Party officials.

Their product hit the market in May 2009 when MIIT announced that all computers produced or sold in China after July 1 must be pre-installed with "Green Dam – Escort of the Youth" software manufactured by these two companies. All schools were ordered to install it immediately. By the end of May, the Green Dam project website claimed more than 52 million installations.

The software was supposed to block pornography and other banned content. But it turned out to be a buggy mishmash of pirated code that didn't work. Garfield cartoons were blocked but much pornography went unfiltered. The software crashed personal computers and destroyed user files and data. Chinese netizens and bloggers went ballistic, and newspapers dug into the company backgrounds and the software code. It turned out that the RMB 40 million paid by MIIT for one-year usage rights, and previous government funding to the companies, had been spent to "re-innovate" software code from a US firm called Solid Oak.

Less than a month after Green Dam was unveiled, MIIT officials informed Chinese netizens that while vendors would still be required to "provide" the software, use of the software would no longer be mandatory. Both companies were later sued in US court for copyright infringement.

DAMNED IF YOU DO, DAMNED IF YOU DON'T

The indigenous innovation drive is forcing foreign technology companies to anguish over balancing today's profits with tomorrow's survival. With its extraordinary infrastructure plans and a continental-sized consumer market that has just begun to really develop, China is a market no multinational can ignore. But the price of admission is getting more expensive by the day as China opens its policy toolbox to ensure that foreign technology allowed into China is accessible for "co-innovation" and "re-innovation" by Chinese companies.

However, foreign firms are not excluded from participating in China's R&D initiatives. They are encouraged to offer their expertise, provide funding and establish their own R&D centers in China. The Chinese government wants foreign companies to participate in key S&T programs (such as 863 and 973) through cooperation with Chinese research institutions. Additionally, the government provides incentives for foreign-invested R&D centers, including exemptions of customs duties on imported equipment, as well as business and income tax deductions. Many multinationals have established R&D centers in China, but they are often tagged with the nickname "PR&D" as many are labs focused on product improvements or redesign rather than real research as multinationals have little faith in China's IPR protection regime.

Nonetheless, China seems headed toward being the driver of global growth for the next few decades. Trillions of dollars will be spent building more and more airports, ocean ports, highways, office towers, residential complexes, hospitals, shopping malls, sports facilities, consumer product factories, power plants and all the electronic communications systems, energy distribution networks and transportation and storage facilities that tie them together.

China is expected to continue spending US $60 billion to $80 billion annually just on electricity transmission and distribution equipment. This comes on the heels of China building the equivalent of the United Kingdom's entire installed electricity production base each year for the past five years. Government projections say that China will spend nearly US $150 billion on subway systems in the next five years. The Ministry of Railways' most recent plan calls for adding another 34,000 kilometers to China's rail network by 2020 at a cost of some US $730 billion.

So what could the future look like for foreign tech companies in China?

ON THE FAST TRACKS

It is no surprise that the world's train makers are transfixed by China, especially those who make high speed rail equipment. Dragonomics Research estimates that half of that US $730 billion will go toward building 16,000 kilometers of high speed rail lines—four north-south, four east-west and 19 inter-city lines. With 30,000 employees, 90 operating companies and 61 regional offices in China, Siemens tracks these trends very carefully.

The German conglomerate jumped at the opportunity in 2005 when the China National Railway Corporation (CNR) invited Siemens to join together on a contract to bid for supplying passenger trains for the Beijing-Tianjin high-speed railway. They were awarded the contract to build 60 passenger trains for the 115 kilometer railway that would reduce travel time between the two cities from several hours in clogged traffic to a fast 30 minute train ride. The contract, estimated to be worth US $919 million, was for the provision of 60 units of its wide-body passenger trains capable of carrying 600 passengers and travelling at 300 kilometers an hour. The first three trains were built in Siemens' German plant. The remaining 57 trains were made in China at CNR's plant in Tangshan. Siemens also brought 1,000 CNR technicians to Germany for training.

The project opened with great fanfare prior to the 2008 Olympics. President Hu took an 'inspection tour' ride in June 2008 and pronounced the project a "milestone in the history of China's railway development." In March 2009, Siemens announced a follow-on project to provide 100 trains for the Beijing-Shanghai high-speed railway. The Ministry of Railways denied the deal's existence, saying that the project would use Chinese technology.

In the end, CNR was awarded a US $5.7 billion contract and Siemens was contracted to supply US $1 billion in components. No matter what the details, this squabble clearly demonstrates the Chinese government's appetite to select "indigenous" technology for projects, even if it has to disguise that the technology originated from foreign sources. It appears that the Siemens technology transfer helped China become a global competitor for Siemens. Siemens and other foreign train makers now face a future of both competing against and cooperating with Chinese companies around the world.

BLOWING IN THE WIND

Technology transfer has always been the key priority in China's wind energy sector. In the 1980s, China established a series of research projects for the development of grid-connecting wind turbines with rated power ranging from 18 KW to 200 KW. But these early prototypes were not commercialized as China's R&D cycle was too slow to keep up as the market rapidly advanced into larger turbines. So China refocused its effort on foreign technology transfers. Two forms were used: license agreements and direct joint-venture partnerships.

China's domestic wind energy industry took off with the help of a set of major policy developments. In 2005, the NDRC required that all wind turbines in China must have at least 70 percent domestic content. The 2006 Renewable Energy Law dramatically increased government money for wind energy projects and dozens of companies sprang up. The 2007 Foreign Investment Industry Guidance Catalogue listed wind turbine manufacturing as an encouraged industry for foreign participation. But to upgrade domestic wind turbine capabilities, foreign involvement in the manufacturing of wind turbines over 1.5 MW was restricted to joint ventures or partnership.

Some leading foreign wind turbine manufacturers such as Vestas, Gamesa and Suzlon decided to operate independently despite these regulatory barriers. GE and a few others chose to follow the policy path. Technology transfers together with government financial subsidies, preferential tax policies and preferential treatment in project tendering and bidding have fueled rapid growth of domestic companies. In 2004, foreign wind turbines had a 75 percent market share in China. By 2009, the three largest domestic players, Sinovel, Goldwind and Dongfang alone had 60 percent of the market -- and the foreign share was down to 14 percent.

The Chinese government in late 2009 removed the 70 percent local content requirement for wind turbines after complaints from foreign governments. But it was only a symbolic move. Domestic players now can independently manufacture and they own the market for 1.5 MW wind turbines, the mainstream size installed on today's wind farms.

To promote continued indigenous innovation in the wind industry, China is regularly coming out with new requirements. The latest ones involve domestic restrictions in offshore wind turbine development and on 2.5 MW turbines manufactured in China. One foreign manufacturer said that their attorneys had counted 36 separate regulations affecting the wind sector and that the foreign industry continuously plays "whack-a-mole" as new restrictions pop up. [14]

[14] For a comprehensive analysis of how the Chinese government is using a multitude of policies to build up a strong domestic renewable energy industry through national champion SOEs, see "China's Promotion of the Renewable Electric Power Equipment Industry – Hydro, Wind, Solar, Biomass," Dewey & LeBoeuf, LLP (March 2010).

COME FLY WITH ME

In no other project or sector can the Chinese government's indigenous innovation campaign be seen more clearly than aerospace which is fueled by the country's aspiration to design and manufacture a large commercial aircraft that can compete with Boeing and Airbus. And this endeavor is well underway. China has set the year 2014 as the target for the first test flight of its home-grown 150-seat airliner, known as the C919. Commercial flights are planned to begin in 2016.

Creating a top quality indigenously developed passenger aircraft has long been a goal of the Chinese government. The first attempt came when a Pakistan Airlines Boeing 707 crashed in Western China in 1971 and Chinese engineers reverse engineered the remains to create a plane called the Yun-10. But it turned out to be as shoddy as the Russian planes they had been assembling for decades as China lacked necessary expertise and technology.

In recent years, however, China finally has accumulated the technological and financial wherewithal to have a chance to be successful. The State Council first initiated a feasibility study into the possibility of developing a mid-sized indigenous passenger aircraft in 2003. The goal was enshrined in the 2006 MLP blueprint and the airliner became one of the top priority megaprojects. In March 2008, the China Commercial Aircraft Company (COMAC) was formed to drive the plane's development, manufacture and commercialization.

The Chinese government believes that its domestic aviation market can easily make the plane a success. China air passenger numbers are growing 20 percent annually, reaching 486 million in 2009 as compared to 769 million in the US. Boeing estimates that more than 2,100 aircraft in the 150-seat segment will be added to China's existing 1,400 commercial aircraft by 2030. Some other analysts, however, believe that once bullet trains are crisscrossing China the market for airliners of this size won't be as robust as currently projected. The Chinese government also envisions the C919 as a global product with a price that will substantially undercut the Boeing 737 and Airbus A320.

The Chinese government's core strategy for assembling the C919 is to trade market access for technology. Foreign players have been lining up to integrate their technology into the C919 design via technology transfers and joint development. Parker Aerospace, General Electric, Honeywell and Goodrich have all partnered with various Chinese entities or the main aviation SOE, the Aviation Industry Corporation of China (AVIC).

No doubt the involved foreign suppliers are hoping for long-term China market access through these partnerships and technology transfers. The concern is that when COMAC is able to take care of itself "indigenously," the foreign aerospace firm may find themselves sidelined and competing globally against the Chinese companies they are now creating. The 2008 SASAC circular said that the state would retain sole ownership and absolute control of central enterprises in the aerospace sector.

OPEN MINDS, CLOSED SYSTEM

In unveiling the outlines of indigenous innovation plans in the 2006 MLP, China was quite critical of its science and technology system. The plan admitted that the capacity for innovation in government-led research is "especially weak," that the country's research establishment is "terribly uncoordinated" and that Chinese enterprises "are yet to become a principal player in technological innovation." The plan said that allocation of research resources and the evaluation of projects "falls short of accommodating the (country's) needs" while China lacks “mechanisms for rewarding outstanding personnel and encouraging innovation and pioneering activities.”

But that doesn’t mean that science is dead in China. Indeed, Chinese scientists in the past decade have become part of global science collaboration efforts, especially with their ethnic Chinese counterparts who head up major university science departments and research institutes in the US. China’s progress in global collaboration can be seen in the current number of leading Chinese science journals, some 130, up from only 27 ten years ago, as ranked by Thompson Reuters Science Citation Index (CSI) which collects papers published in some 10,000 top-quality science journals published in 44 countries. Thomson Reuters said that last year 122,998 Chinese scientific papers were included in the database, placing China third after the US and UK. Also last year, China became the number one contributor to papers catalogued by the Engineering Index. In genomics and nanotechnology, China is also creeping toward the top ranks.

A key quality indicator in these databases is the number of citations a given paper receives in papers published by others. The world average of citations per paper listed in CSI is five. Papers submitted by Chinese scientists average fewer than three. Thomson Reuters analysts who track these numbers expect China to catch up to world average citations within 10 to 15 years. Looking back at the last decade, of the 92,000 most highly cited papers in the CSI database, some 4,000 were from China.

China’s participation in global science cooperation could be severely damaged by political fallout from the view that indigenous innovation is a “techno-nationalistic” industrial policy that aims to force and finagle foreign technology transfers for “co-innovation” and “re-innovation.” Add to this the explicit quotas for reducing national dependence on foreign technology and the outright mandate to replace foreign software, chips, communications equipment and other key products in Chinese “critical infrastructure,” and you have a policy that is increasingly viewed by American, European, Japanese and other developed country governments and companies as a protectionist plan that will encourage massive global science and technology theft by China.

While a few prominent Chinese scientists have returned to China to live fulltime and work in Chinese universities and research institutes, most have been reluctant to give up their university tenure or research positions in the US and Europe. Even when Chinese entities offer significant compensation, the scientists and academics usually keep one foot in each place. Chinese scientists with many years overseas are sometimes viewed as a threat by less-experienced but influential government scientists as well as by the MOST and NDRC bureaucrats who want full control of the scientific projects that they fund.

As a result, there are dozens of top-notch ethnic Chinese scientists with senior roles and even department head positions at US universities and research institutes who simultaneously have formal and informal advisory roles at Chinese universities and government research institutes. In this day of instant communications, convenient global air travel and constant international science conferences, global science research chains are as normal as global manufacturing supply chains. Just a few clicks through the Thomson Reuters CSI database will show that it is a normal practice for scientific studies to involve very close collaboration between researchers in Europe, America, China, Russia and other parts of the world.

But as US politicians focus on the threat that China’s indigenous innovation policies could pose to America’s knowledge-based economy, these well-meaning ethnic Chinese scientists—the best and brightest who left China seeking academic freedom and scientific accomplishment—could end up caught in the middle of US-China politics and security paranoia.

LESSONS FROM THE AMERICAN EVOLUTION

China could learn some lessons from the US, where innovation has evolved from being a big company endeavor to a collaborative exercise involving universities, research institutes, startup companies and multiple pots of government money.

A 2008 study by the Information Technology & Innovation Foundation shows how the US S&T system evolved. The foundation analyzed American innovations from the past 40 years that were recognized by R&D Magazine as being among the top 100 innovations of the year. Some 80 percent of top innovations in the 1970s came from corporations working on their own. In the 1980s and 1990s, approximately two-thirds came from companies working in collaboration with universities and government-funded research labs or programs. The study's authors say that this dramatic shift is due to shrinking technology cycles from global competition and because the complexity of new technologies are often beyond the internal R&D capabilities of even very large companies.

R&D spending in the United States has undergone a similar shift. In the first three decades after World War II, the federal government was responsible for two-thirds of funding. In the past three decades, this has been reduced to just over one-quarter. Industry spending on R&D in the US now averages about $145 billion a year, approximately 72 percent of total R&D spending, according to the US Chamber of Commerce.

R&D in the United States is now an extensive and flexible industry-university-government combination. The study, for example, cites a 2006 award given to the government's Oak Ridge Lab for metal infusion surface treatment that had 14 companies, large and small, involved, as well as scientists from the University of Tennessee. In the 1970s, the Fortune 500 firms that frequently received R&D 100 awards had been given substantial direct federal funding.

Many recent awards have gone to small companies that receive money from the Small Business Innovation Research program (SBIR), which is essentially the US government's quasi venture capital arm. The program mandates that all federal government agencies that finance R&D must set aside 2.5 percent of their budget for projects with small businesses. In 2004, for example, SIBR distributed $2 billion for some 6,300 separate research projects. Firms funded through this program now consistently account for one-quarter of the annual R&D 100 awards.

Despite the reduction in its overall percentage of R&D spending, federal funding is still very important in American innovation. The study found that the number of federally funded innovations rose to 77 in 2006 from 41 in 1975. While US technology policies were monopolized by the military and space programs in the 1970s and earlier, the agencies today that support R&D initiatives include the Department of Commerce, Department of Energy, National Institutes of Health, Department of Agriculture, National Science Foundation and Department of Homeland Security, among others.

THE PAST IS NOT THE WAY FORWARD

China is a country in a race against time. China's leaders wake up every morning with the burden of lifting an additional billion people to a comfortable middle class lifestyle. Even if China continues to sprint ahead, the country can't get rich before it gets old. More than 100 million people are over age 60 today. Population projections put that number at 334 million in 2050, including 100 million aged 80 and older. So the pursuit of a high tech economy and genuine home-grown science and technology breakthroughs is understandable and laudable. This appears to be the real goal President Hu and Premier Wen were pursuing in 2003 when they mobilized government, business and academia to come up with the plan that now hangs under the banner of indigenous innovation.

Between that day and today, China has deeply analyzed its difficult economic problems and vexing structural challenges, and it has established ambitious national goals. But it appears that many of the leadership's true policy directions have been hijacked by the bureaucrats. If Joseph Needham were alive today, he certainly would be decrying the return of "bureaucratic feudalism" to science in China. Like the scientists whose voices were squelched during indigenous innovation planning, Needham would be warning that, as happened in the 14th century, a science system that is by and for the bureaucrats is certain to obstruct real advancement.

Simply put: Soviet planning cannot replicate the Silicon Valley. Ming Dynasty mindsets can't create microchips. Megaprojects that uncap gushers of government money for civil servants to spray across a landscape of state companies more familiar with R&R than R&D are likely to end in a trail of tears.

As more details of indigenous innovation plans emerge, American and European politicians are seeing an assault on their core national economic strengths. Studies by the US Chamber of Commerce's Global Intellectual Property Center detail the reasons for US distress. The number of American IP-intensive production workers in industries involved in foreign trade averaged 9.5 million between 2000 and 2007. This equals about 65 percent of US workers in tradable industries. These workers receive salaries about 60 percent higher than workers at similar levels in non-IP intensive industries. IP-intensive industries accounted for approximately 60 percent of total US exports from 2000-07. In those years, American firms exported an annual average $405.5 billion of IP-intensive products versus $278.1 billion of non-IP-intensive products.

So how do the United States and China move away from mutual mistrust and toward win-win economic interaction? Rebalancing the two countries' political and economic relationship perhaps could start with psychological repositioning.

China's worldview reflected in the official media and public pronouncements is that the US and other developed countries have a concerted agenda to contain the country's rise. It harks back to Western traders and opium merchants kicking open China's door after a Qing dynasty emperor sent their first envoys packing with a message that China needed none of their wares or ways. The Cold War trade and investment embargo is also not a distant memory. Continued US and European technology and munitions export controls imposed after the 1989 Tiananmen tragedy underpin Beijing's containment mindset, even though US export controls only affect a fraction of technology exports.

Reinforcing this "containment complex" in the official media may be a handy short-term propaganda tool. But it impedes China's ability to emerge as a true global economic and political leader. The resentful nationalism built up during the boom years as China blamed its ills on "foreign forces" has created a younger generation that is as xenophobic as it is economically insatiable.

At the same time, US politicians need to move beyond their American "exceptionalism" worldview that the country's founding ideals and system of government should be adopted globally. It is time for the US to admit that China will never be "just like us." China will continue to choose its own path. Let's not forget that the country already adopted one system from the West – Communism – and that didn't work out too well.

Since indigenous innovation hit the headlines, there have been a few small signs of progress. China has said it will provide equal treatment for local and foreign companies operating in China to qualify for indigenous innovation government procurement product catalogues (the question of whether these catalogues should even exist was not addressed). China has said it will reopen negotiations on signing the voluntary WTO Government Procurement Agreement. But China also had promised to sign this agreement "as soon as possible" after its 2001 WTO accession. Given China's focus on government procurement to drive indigenous innovation, negotiations are expected to drag on for many more years. The Obama administration has announced that it wants to revamp US export controls so that some advanced US technologies will be available for sale to China if they can be purchased elsewhere.

The best opportunity for real progress is for the US and China to focus on IPR protection. If US politicians would invest the same amount of time and effort into seeking significant Chinese IPR improvements as they have invested in prodding Chinese currency appreciation, they may have actually accomplish something. The currency debate gets lost in a cloud of economic theory. But IPR protection is governed by very clear international conventions and legal regimes that are enforceable in courts.

Not everybody in China is scheming about IP theft and coerced technology transfers. China in 2005 formed a "leading group" for national intellectual property strategy with a mandate for 33 ministries to figure out ways to protect and administer intellectual property, improve the country's capacity for indigenous innovation and address the concerns of foreign investors. A 2008 "Action Plan on IPR Protection" called for enacting 280 specific measures to improve existing IPR legislation, strengthen enforcement and improve legislative oversight. Despite the accompanying florid rhetoric, IP attorneys contend that China has backtracked on IP protection while publicizing these initiatives.

A good place for a US-China indigenous innovation dialogue to begin would be an examination of these initiatives with a focus on demonstrable improvements. Seeking a clear understanding of China's legal definition of "co-innovation" and "re-innovation" and how to address the issue through the WTO and other deliberative organizations would be constructive. But the US and China need to move beyond dialogues and set metrics for demonstrable progress. Unless China market access and IP protection significantly improves, the Obama administration will be unable to achieve its goal of doubling exports of goods and services in five years.

It is clear that the past is not the way forward for either country. China could benefit from a look back at America's ruinous response to becoming a global financial power nearly a century ago -- and consider whether the indigenous innovation industrial policies could lead China down a similar path.

There are striking similarities between today's US-China situation and the shift of influence and financial power between the US and Europe after World War I. As detailed in John Steele Gordon's "An Empire of Wealth," going into the war the US owed Europe some US $3.7 billion. But coming out of the war in 1918 America was the world's leading creditor nation, with Europe owing America US $12.6 billion. American exports had captured markets traditionally served by Europe. US manufacturing increased by 25 percent as the allies purchased US $3 billion in American products and the US government loaned US $9.6 billion to the allies.

Uncomfortable with its new position, the US turned isolationist. Congress rejected joining The League of Nations despite President Woodrow Wilson being its most ardent supporter. American politicians focused on economic self-sufficiency to prevent future enemies from being able to manipulate the US economy. Starting with a “scientific tariff” shortly after the war, the US pursued increasingly protectionist policies until the economy collapsed in the 1929 Great Depression.

Appendices

APPENDIX 1: DESCRIPTION OF 16 MEGAPROJECTS

1. **Core electronic components, high-end general use chips and basic software products**
   - This project focuses on the development of microwave and millimeter-wave devices, high-end general chips, and basic software products, including operating systems, database management systems and middleware.
   - It also emphasizes securing more patents and increasing indigenous innovation for computers and computer systems and basic software products with networking and national security applications.

2. **Large-scale integrated circuit manufacturing equipment and techniques**
   - China will focus on achieving the mass application of 90nm manufacturing equipment and attempt to localize a number of key technologies and components. It also plans to develop a wide array of equipment for manufacturing 65nm circuits, while making breakthroughs in R&D of key technologies for 45nm and below.
   - A key aim is to develop many core technologies for the manufacture of very large scale integrated (VLSI) circuits, and building an innovation system for China's integrated circuit (IC) manufacturing industry.

3. **New generation broadband wireless mobile communication networks**
   - China hopes to develop a new generation of broadband wireless mobile communication networks with large-scale communication capacities, as well as low cost and wide coverage broadband wireless communication access systems. Short-distance wireless communication systems and sensor networks also fall under the scope of this project.
   - China seeks to increase the number of Chinese patents in international technology standards and widen the application for these technologies while achieving an industry output of more than RMB 100 billion.

4. **Advanced numeric-controlled machinery and basic manufacturing technology**
   - This project calls for the study of two-to-three types of large high-precision computerized numerically controlled machine tools, and the development of key high-precision CNC (computer numerically controlled) machine tools and other basic equipment required by the aerospace, space shipbuilding, automotive and energy production equipment sectors.
   - China also seeks to make advancements in the R&D of CNC machine tools, and build research centers and training facilities to promote the development of medium and high-grade CNC machine tools.

5. **Large-scale oil and gas exploration**
   - This project emphasizes the study of high-precision seismic exploration and exploitation technologies for oil, gas and coal-bed gas in western China.
   - Also of critical importance are technologies suited for exploration and exploitation of deep sea oil and gas resources, as well as resources with access complicated by difficult geological conditions.
   - China hopes to improve design and manufacturing capabilities for a broad range of related technology with the aim of raising oil and natural gas discovery rates by 10 to 20 percent, respectively, and achieving an oil recovery ratio of 40 to 50 percent.

6. **Large advanced nuclear reactors**
    - With this project China's goal is to combine imported technology and indigenous innovation to achieve advancements in a third generation of pressurized-water nuclear reactor power plants.
    - China also wants to complete standard designs and develop key technologies to build the first series of pilot high-temperature gas-cooled nuclear reactor power plants. This includes 200 MW high-temperature gas-cooled nuclear reactor power plant construction pilot projects.

7. **Water pollution control and treatment**
    - China will select various types of river basins for zoning based on the ecological function of the water source, and study key technologies to control and prevent water pollution, and treat lake contaminants for the remediation of water resources.
    - China also aims to makes advancements in technologies to protect, process and distribute drinking water, and create a system to monitor water pollution and water quality improvement.

8. **Breeding new varieties of genetically modified organisms**

    - The main goals of this special project are to obtain indigenous intellectual property rights for a series of valuable new genetically modified organisms (GMOs), and to breed new classifications of disease resistant, high-yield, high-quality GMOs to improve research and scientific capabilities in support of agricultural industrialization and sustainable development.

    - The implementation of the gene modification special project has significant strategic importance for increasing indigenous innovation in China's agricultural science and technology capabilities, improving agricultural efficiency and crop yield, and in increasing China's global agricultural competitiveness.

9. **Pharmaceutical innovation and development**
    - China is placing a significant emphasis on domestic drug innovation. The goals of the project include advancing technologies for the identification, verification and manufacture of 30 to 40 new chemical and bio pharmaceuticals.
    - China seeks to increase capabilities to test the efficacy and safety of new drugs.
    - China also aims to develop new Traditional Chinese medicines with verified quality and reliability.

10. **Control and treatment of AIDS, hepatitis, and other major diseases**
    - The aim of this project is to achieve breakthroughs in the R&D of key technologies for new vaccines and pharmaceuticals. In doing so, China hopes to independently develop 40 types of unique diagnostic reagents, and 15 vaccines.
    - China also will attempt to design standards for Chinese and western medicine-based prevention and cure plans.

11. **Large aircraft**
    - China will institute feasibility studies for developing the key technologies required for the domestic production of large aircraft.
    - Key focuses will include the design, R&D and manufacture of power systems and testing systems for large aircraft.

12. **High-definition earth observation system**

- China hopes to develop an all-weather and full-time earth observation system with advanced high-definition observation systems at satellite, aircraft and stratospheric levels.
- An additional focus of this project is to establish an Earth observation data center and to improve the quality of space-related data produced in China.

13. Manned spaceflight and lunar probe programs

- China seeks to make advancements in key technologies required for extra-vehicular activities for astronauts, and for the Rendezvous and Docking (RVD) for spacecraft.

- A central focus of this project will be to establish a man-operated, orbiting space laboratory.

- Laying the foundation for a lunar probe program is also a focus of this project. The plan includes developing satellites for moon exploration, the creation of an orbital-moon exploration program, as well as general advancements in technologies for lunar exploration.

14-16. Undisclosed, believed to be classified military projects

APPENDIX 2: TOTAL SPENDING ON S&T AND R&D (2000-2008)

Spending on S&T (in billions of RMB)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	Δ2000/8
Total	234.67	258.94	293.80	345.91	432.83	525.08	619.67	769.52	912.38	677.1
• growth from previous year %	NA	10.34%	13.46%	17.74%	25.13%	21.31%	18.01%	24.18%	18.56%	**288.79%**
Government Funds	59.34	65.64	77.62	83.93	98.55	121.31	136.78	170.36	190.20	+130.38
• as % of total	25.28%	25.35%	26.42%	24.26%	22.79%	23.1%	22.07%	22.14%	20.85%	**-4.43%**
• growth from previous year *	NA	.07%	1.07%	**-2.16%**	-1.47%	0.31%	-1.03%	0.07%	-1.29%	
Self-raised Funds by Enterprises	129.64	145.84	167.67	205.35	277.12	344.03	410.69	518.95	637.05	+507.41
• as % of total	55.24%	56.32%	57.07%	59.36%	64.03%	65.52%	66.28%	67.44%	69.82%	**14.58%**
• growth from previous year*	NA	1.08%	0.75%	2.29%	4.67%	1.49%	0.76%	1.16%	2.38%	
Loans from Finance Institutions	19.62	19.08	20.19	25.93	26.50	27.68	37.43	38.43	40.52	+20.9
• as % of total	8.36%	7.39%	6.87%	7.50%	6.12%	5.27%	6.04%	5.00%	4.44%	**-3.92%**
• growth from previous year *	NA	-0.97%	-0.52%	0.63%	1.38%	-0.87%	0.77%	1.04%	-0.56%	
Undefined	26.07	28.38	28.35	30.70	30.66	35.06	34.77	41.78	44.61	+18.54
• as % of total	11.11%	10.96%	9.64%	8.86%	7.08%	6.68%	5.61%	5.43%	4.89%	**-6.22%**
• growth from previous year*	NA	0.15%	-1.32%	-0.78%	1.78%	-0.4%	1.07%	0.18%	-0.54%	

*statistic refers to growth of previous year as share of total spending
Source: National Bureau of Statistics

Spending on R&D (in billions of RMB)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	Δ2000/8
Total	89.57	104.25	128.76	153.96	196.63	245.00	300.31	371.02	461.6	372.03
• growth from previous year %	NA	16.38%	24.51%	19.57%	27.71%	24.60%	22.58%	23.54%	24.4%	**315.35%**
Government Funds	NA	NA	NA	46.06	52.36	64.54	74.21	91.35	101.88	+55.52
• as % of total				29.92%	26.62%	26.75%	24.71%	24.62%	22.07%	-7.85%
• growth from previous year *				NA	-3.3%	0.13%	-2.04%	-0.09%	-2.55%	('03-'08)
Self-raised Funds by Enterprises	NA	NA	NA	92.54	129.13	164.25	207.37	261.10	331.5	+238.96
• as % of total				60.11%	65.67%	67.04%	69.05%	70.37%	71.35%	11.24%
• growth from previous year *				NA	5.56%	1.37%	2.01%	1.32%	0.98%	('03-'08)
Undefined	NA	NA	NA	15.36	15.14	16.21	18.73	18.57	28.22	+12.86
• as % of total				9.98%	7.70%	6.62%	6.37%	5.01%	6.11%	-3.87%
• growth from previous year *				NA	-2.28%	-1.08%	-0.25%	-1.36%	1.10%	('03-'08)
Proportion of Expenditure on R&D to GDP	1.00%	1.07%	NA	1.13%	1.23%	1.34%	1.42%	1.49%	1.54%	+0.54%

*statistic refers to growth of previous year as share of total spending
Source: National Bureau of Statistics

APPENDIX 3: ACRONYMS USED IN THE REPORT

AQSIQ	General Administration of Quality Supervision, Inspection and Quarantine
AVIC	Aviation Industry Corporation of China
AML	Anti-Monopoly Law
CAS	Chinese Academy of Sciences
CCC	Chinese Compulsory Certification
CDB	China Development Bank
COMAC	China Commercial Aircraft Company
CNC	Computer Numerically Controlled
CPC	Communist Party of China
CSI	Science Citation Index
DSP	Digital Processing Chip
GMO	Genetically Modified Organism
IC	Integrated Circuit
IPR	Intellectual Property Rights
ISO	International Organization for Standardization
MIIT	Ministry of Industry and Information Technology
MLP	The National Medium- and Long-Term Plan for the Development of Science and Technology
MLPS	Multi-Level Protection Scheme
MOFCOM	Ministry of Commerce
MOE	Ministry of Education
MOF	Ministry of Finance
MOST	Ministry of Science and Technology
NDRC	National Development and Reform Commission
NSFC	National Science Foundation of China
OSCCA	Office of Security Commercial Code Administration
PCT	Patent Cooperation Treaty
R&D	Research and Development
RVD	Rendezvous and Docking
S&T	Science and Technology
SAIC	State Administration for Industry and Commerce
SASAC	State-Owned Assets and Supervision Management Commission
SBIR	Small Business Innovation Research
SIPO	State Intellectual Property Office
SOE	State-owned enterprise
TRIPS	Trade-Related Aspects of Intellectual Property Rights
VLSI	Very Large Scale Integrated circuits
WAPI	Wireless Authentication and Privacy Infrastructure
WIPO	World Intellectual Property Organization
WLAN	Wireless Local Area Networking