China's Move Into Synthetic Biology: Will It Pay Off?

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China's role as the world's factory – a role it has played for the last three decades – is undergoing a major transition: from 'made in China' to 'designed and created in China,' from imitator to innovator. Like the "newly industrializing economies" of East Asia a generation ago, China's meteoric economic growth has been fueled by export-oriented industrialization. The extraordinary amount of Foreign Direct Investment China receives was originally driven by its plentiful supply of cheap labor. In recent years, however, as its economy has grown at historically unprecedented rates, its investments in science and technology have started to pay off. As labor costs have risen, foreign firms are increasingly drawn to China for two other reasons: the ability to partner with China's growing (and relatively inexpensive) science and engineering talent pool, and access to what is becoming the world's largest consumer market. China has grown to become the world's second-largest economy, its GDP surpassing Japan's in 2010. Corrected for purchasing power parity, PPP, the IMF estimates that China's economy will surpass that of the U.S. in 2016[1] – assuming, of course, that current trends continue.

Despite its frequent assertions to the contrary, China clearly sees itself as an emerging world power, bent on becoming globally competitive both economically and technologically, and thereby resuming what the Chinese increasingly feel is their rightful place in history. Shortly after his appointment as the general secretary of the Chinese Communist Party, during a visit to the National Museum off Tiananmen Square, President Xi Jinping stood in front of an exhibit called 'The Road to Rejuvenation,' and reminded the assembled dignitaries and reporters that

> After the 170 or more years of constant struggle since the Opium Wars, the great revival of the Chinese nation enjoys glorious prospects…. Now everyone is discussing the Chinese dream, and I believe that realizing the great revival of the Chinese nation is the greatest dream of the Chinese nation in modern times.[2]

Since its adoption of the 15 year Medium and Long Term Plan for Science and Technology (hereafter MLP) in 2005, China's leaders have been investing increasingly in 'indigenous innovation' in advanced technologies, as a means to realizing the "Chinese dream." The MLP calls on China to invest heavily in advanced technologies, with nanotechnology identified as one of four 'science megaprojects' for special attention.[3] The MLP, reinforced by China's 11th and 12th Five Year Plans, and buttressed by similar plans and spending at the provincial and local levels, can be seen as state-led industrial policy. This investment in science and technology has

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[1] The IMF forecast sees the U.S. economy reaching $18.3 trillion in 2016; China reaches $18.7 trillion. Figures calculated from IMF *World Economic Outlook* database, available at http://www.imf.org/external/pubs/ft/weo/2011/02/weodata/index.aspx (accessed May 15, 2013).

[2] Wong, Edward (2012) "Signals of a more open economy in China," *The New York Times* (December 9) (http://www.nytimes.com/2012/12/10/world/asia/chinese-leaders-visit-to-shenzhen-hints-at-reform.html?pagewanted=all&_r=0)

[3] The others are reproductive biology, protein science, and quantum research. The MLP also identifies thirteen 'engineering megaprojects,' eight 'frontier technologies,' and eleven 'key areas' for targeted investment.

yet to pay big dividends, but the trend lines are promising. China's universities and science parks are impressive to look at, with labs and facilities that rival those of the U.S. and Europe. Sparkling facilities, however, do not automatically translate into innovative breakthroughs.

In our past research at CNS-UCSB, my group has utilized a mixed-method approach to studying China's success in promoting nanotechnology. We have conducted numerous field trips to universities in Beijing, Tianjin, and the Shanghai area and interviewed leading scientists, engineers, and architects of China's nanotechnology programs. Our initial research focused primarily on basic research; more recently, we have looked at the commercial results of this research, including a case study of Suzhou Industrial Park. We have also analyzed publications and patents, using bibliometric data-mining techniques. In both cases our central questions have been twofold: (1) How effective is Chinese state policy in fostering innovations in nanotechnology – particularly innovations that result in products that could result in sustainable economic growth? (2) What is the role of international collaboration in fostering S&T development in China?

These questions, and methods, could be readily adapted to the study of synthetic biology in China. Despite the absence of an agreed-upon definition of synthetic biology, it is high among China's future investment priorities,[4] seen as having the potential to create breakthroughs in both basic science and practical applications. Research in areas related to synthetic biology began as early as the 1960s, when Chinese scientists made synthetic insulin; China is active in the Human Genome Project, contributing to its database; and China has been investing in emerging technologies such as genomics, bioinformatics, stem cell research, and, of course, nanotechnology. All of these are fields related to synthetic biology, providing a strong foundation on which to build (Pei, Schmidt, and Wei, 2011). Five British universities have recently received grants from Britain's Synthetic Biology China Partnering Award program; in the words Douglas Kell, head of Britain's Biotechnology and Biological Sciences Research Council (BBSRC), "co-funded initiatives such as this scheme will see British and Chinese scientists learning from each other's expertise and benefiting from the globalization of excellent science."[5] And the third annual Cold Spring Harbor Asia conference on synthetic biology will be held in Suzhou, is scheduled for December 1-4, 2014.[6]

A future societal initiative on synthetic biology would be remiss in overlooking the global role that China will play in basic research, development, and commercialization, the result of both aggressive state polcies and international collaborations.

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[4] It is included in the Chinese Academy of Science Roadmap for Innovation 2050; CAS roadmap Innovation 2050 (http://www.edu.cn/html/rd/z/cxlx.shtml)s

[5] BBC News, "Universities get Synthetic Biology China Partnering Award grants" (October 14, 2013) (http://www.bbc.com/news/uk-england-24524634)

[6]The 3rd Cold Spring Harbor-Asia meeting on Synthetic Biology will cover recent exciting developments in synthetic biology research around the world covering novel genome engineering tools and strategies for both prokaryotes and eukaryotes. One of the core synthetic biology themes, designing cellular circuits, will also be covered. This meeting will also cover recent advances in metabolic engineering, which upon integration with synthetic biology, is playing increasingly important roles in moving towards bio-based economy through the establishment of bioprocesses for the sustainable production of chemicals, fuels and materials from renewable non-food biomass. More exciting emerging tools and techniques of synthetic biology will also be covered (http://www.csh-asia.org/2014meetings/synthesi.html)