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Global Technology Revolution China

Foresight Brief No. 165

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Type: Technology foresight within the local and regional context
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Duration: 2007-2008 **Budget:** N.A. **Time Horizon:** 2020 **Date of Brief:** Dec 2009

Purpose

The purpose of this study was to identify emerging technology opportunities that the Tianjin Binhai New Area (TBNA) *and the* Tianjin Economic-Technological Development Area (TEDA) *in Tianjin, China could incorporate into their strategic vision and plan for economic development through technological innovation, to analyze the drivers and barriers that they would face, and to provide action plans for implementation.*

China's Next Regional Engine for Economic Growth

The Tianjin Binhai New Area (TBNA) consists of 2,200 square kilometres along 150 kilometres of coastline in the municipality of Tianjin in northeast China. Tianjin municipal authorities first established this locality in 1994. At that time an arid, undeveloped area, TBNA was given the ambitious task of spurring industrial growth in Tianjin. In little more than a decade, it has become home to 1.4 million people, northern China's largest container port, and a broad base of industry and manufacturing.

In 2006, China's State Council named TBNA a "special pilot zone" with a mandate to become the country's next regional engine for economic growth. Now reporting directly to the State Council, TBNA is expected to invigorate the economy of the northeastern Bohai Rim region in the same manner as Shanghai and Suzhou did in the Yangtze River delta area and Guangzhou and Shenzhen in the Pearl River delta area.

The Tianjin Economic-Technological Development Area (TEDA) is one of three administrative zones in TBNA. It is also TBNA's industrial and manufacturing base and the centre of TBNA's financial and commercial activities. TEDA is to play a key part in the economic growth envisioned for TBNA. Established in 1984, TEDA is today a bustling industrial-park complex. It possesses a robust manufacturing base, with pillar industries in electronics, automobiles and parts, food processing and biopharmaceuticals. Many of the world's Fortune 500 companies, top Chinese firms, and other leading multinationals have strong presences in TEDA.

A Vision of the Future for TBNA and TEDA

The State Council envisions TBNA becoming a centre in north China for leading-edge research and development (R&D) and technology incubation, first-class modern manufacturing, and international shipping and logistics. At the same time, the State Council intends for TBNA to lead efforts to address many of China's most urgent national problems, such as rising energy demands, a growing scarcity of usable water supplies and gravely escalating urban pollution. Thus, TBNA is to pre-

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sent an alternative to the traditional industrial economy, shaping a model of sustainable development and eco-friendly industry.

Innovation in science and technology (S&T) stands at the core of this vision of economic and environmental development, particularly of cutting-edge R&D. TBNA will need to take definitive steps to pursue this goal, and TEDA will be at the forefront of this effort. Building on its existing manufacturing base, TEDA aims to transition from a successful industrial-park complex into a state-of-the-art science and engineering (S&E) centre for high-impact emerging technologies. Other enterprises with relevant capacity located elsewhere in TBNA will follow suit. The desired end result is innovative R&D that meets international standards and positions TBNA as a global technology leader.

The Role of this RAND Study

Early in the process of developing a strategic plan for this ambitious transformation, senior managers from TBNA and TEDA found a 2006 report by the RAND Corporation, *The Global Technology Revolution 2020*: *Bio/ Nano/ Materials/ Information Trends, Drivers, Barriers, and Social Implications.* (Referred to hereafter as GTR 2020. See EFMN Foresight Brief No. 90). This report presents a comprehensive foresight analysis that identifies *technology applications* (TAs) most plausible by 2020, those countries capable of acquiring them and their likely effects on society.

Having reviewed GTR 2020, TBNA and TEDA managers approached RAND to conduct a foresight study designed specifically for their purposes. They commissioned RAND to do the following:

- Identify promising emerging TAs for TEDA and other high-tech centres in TBNA to implement as a pivotal part of TBNA's overall strategic plan for economic growth.
- Identify the capacity needs to implement these TAs as well as the critical drivers and barriers that might facilitate or hinder implementation.
- Develop a strategy and action plan for each TA.
- Provide guidance on how these TAs might fit into an overarching strategic plan for TBNA's economic development.

Incorporating Local Context and Current Realities

The analysis leading to the selection of TAs and, eventually, the strategies and action plans for them took into account four principal factors:

- TBNA and TEDA's missions as mandated by China's State Council,
- China's pressing national needs,
- drivers and barriers to technological innovation in China as a whole and for TBNA more specifically and
- relevant capacity currently available to TBNA and TEDA both locally and more broadly in R&D, manufacturing and S&T commercialization.

The starting point was the 12 TAs identified in GTR 2020 as those that China could acquire by 2020. This was combined with a rigorous study of the realities, circumstances and issues in TBNA and in China more broadly, drawing on a diverse array of Chinese- and English-language sources:

- Chinese- and English-language documents describing the mission, history and current status of TBNA and TEDA,
- Chinese- and English-language literature on China's social, environmental and economic needs, and measures that the Chinese government has taken to date to address them,
- on-site interviews in TBNA, TEDA, the Tianjin Port, the municipality of Tianjin more broadly and the city of Beijing,
- visits to S&T institutions that could provide capacity outside TBNA and TEDA, such as Tsinghua University and the Chinese Academy of Sciences and
- a two-day workshop in TEDA with key figures from TEDA scientific institutions, firms and management.

Emerging Technology Opportunities for TBNA and TEDA

Based on analysis of the above sources, the authors narrowed the 12 TAs identified in GTR 2020 down to a final selection of seven. These either come directly from GTR 2020 or are hybrids combining one or more of the original 12.

1. ***Cheap solar energy :*** Solar-energy systems inexpensive enough to be widely available to developing and undeveloped countries as well as disadvantaged populations.
2. ***Advanced mobile communications and radio-frequency identification (RFID):*** Multifunctional platforms for sensing, processing, storing and communicating multiple types of data. RFID involves technologies that can store and wirelessly transmit information over short distances.
3. ***Rapid bioassays:*** Tests to quickly detect the presence or absence of specific biological substances with simultaneous multiple tests possible.
4. ***Membranes, fabrics and catalysts for water purification:*** Novel materials to desalinate, disinfect, decontaminate and help ensure the quality of water with high reliability.
5. ***Molecular-scale drug design, development and delivery:*** The abilities to design, develop and deliver drug therapies at the nanoscale to attack specific tumours or pathogens without harming healthy tissues and cells and to enhance diagnostics.

6. ***Electric and hybrid vehicles:*** Automobiles available to the mass market with power systems that combine internal combustion and other power sources.
7. ***Green manufacturing:*** The development and use of manufacturing processes that minimize waste and environmental pollution and optimize the use and reuse of resources.

Drivers and Barriers to Implementation

Widespread, sustainable implementation of any TA depends on the balance between the drivers that facilitate implementation and the barriers that hinder it. The factors considered that will most influence China's ability to successfully pursue cutting-edge R&D and technology innovation were:

- the country's needs,
- its national R&D policies,
- other national policies that could generate demand (or, as appropriate, reduce demand) for certain TAs,
- intellectual property rights (IPR) protection,
- finance and banking laws and regulations,
- local policies, laws and regulations that could directly affect the ability of individuals and organizations to conduct cutting-edge R&D and commercialize innovative technologies,
- human capital and
- culture of R&D and innovation.

These same eight factors will most affect TBNA's ability to develop and implement the selected TAs. Some of these are clearly either a driver or a barrier throughout most of China. But occasionally, local circumstances make them stronger or weaker drivers or barriers in a particular organization or region (or for a specific TA) than they are elsewhere in the country.

Several of these factors are unmistakable barriers in TBNA and hold for all seven TAs. IPR protection, for example, remains a barrier in TBNA, as in China as a whole, to both homegrown innovation and the involvement of foreign capital and talent in new R&D and technology ventures. Finance and banking laws and regulations are also a barrier in TBNA, as they are in China generally, because they discourage investment of venture capital. But, for certain of the seven TAs, sources of venture capital available to TBNA for specific technologies mitigate this barrier to some degree. Lack of a culture of R&D and innovation is a third barrier in TBNA, as it is in China as a whole. It discourages the risk-taking in new ventures that is essential to pursuing and commercializing groundbreaking R&D.

TBNA has one driver that all seven TAs share: human capital. This stems from the strength of TBNA's current manufacturing base, the corresponding workforce and the concentration of academic institutions in the municipality of Tianjin. However, young Chinese people are tending to shy away from technical and vocational training, and domestic competition for S&E talent is heated. Both of these could be mitigating factors.

Capacity Currently Available to TBNA and TEDA

To fulfil the State Council's mandate, TBNA and TEDA will need capacity in three areas: (1) R&D, (2) manufacturing and (3) S&T commercialization. Both local capacity—in TBNA, TEDA, and the municipality of Tianjin more broadly—and that from elsewhere in China and internationally will play a part.

In terms of R&D capacity, TBNA and TEDA have a growing number of institutions that provide cutting-edge research facilities and a professional cadre of highly trained scientists and engineers. But they face intense competition, both within China and abroad, for human capital of this calibre.

With regard to manufacturing capacity, TBNA and TEDA have a substantial industrial base that has been growing for the nearly 25 years since TEDA's inception. Investment by an array of Fortune 500 companies, a track record of increasing industrial output and a rising gross domestic product (GDP) indicate the strength of this base. TBNA is also steadily improving the physical infrastructure—utilities, cargo facilities and waste-management processes—that are vital to manufacturing capacity. But a potential shortage of the skilled labourers and technicians needed to work in manufacturing and, again, heightened competition for those on the job market are real challenges.

As for S&T commercialization, TBNA and TEDA operate a well-established network of research parks and technology incubators aimed at supporting emerging high-tech enterprises. Ample financial incentives help spur development and attract human capital. Yet, these enterprises face considerable challenges due to China's need to better protect IPR and reform finance and banking laws and policies. They also lack strong linkages between R&D institutions and commercial industry to facilitate the transfer of high-tech products to the market.

Strategy for Building TBNA's Future

Implementation Strategies for the Selected TAs

China already has a well-developed first-generation solar-electricity industry. Consequently, the best opportunity for TBNA and TEDA in ***cheap solar energy*** lies not in entering the first-generation market but rather in becoming an R&D and manufacturing centre for second- and third-generation systems, initially for the global export market.

TBNA should aim to become an R&D and manufacturing centre for ***mobile communication devices and RFID systems***. It should focus initially on the domestic Chinese market and then broaden to the global market. In addition, it should build state-of-the-art R&D programs in two component technologies: displays and power sources.

The long-term strategy is for TBNA to become a leading player in the global marketplace for state-of-the-art ***rapid bio-assays***. But its initial focus should be on using licensing and partnership agreements to attract leading companies to TBNA and TEDA.

Long-term goals for TBNA are: (1) to become a centre for R&D in nanoscale ***membranes, filters and catalysts*** and (2) to become a leader in manufacturing state-of-the-art membranes for purifying water. It is vital for TBNA to foster close relationships between research labs and private companies to facilitate commercialization.

TBNA should aim to become a centre for R&D and manufacturing of ***drugs developed through bio-nanotechnology***. It should focus initially on attracting investment from foreign enterprises and, in tandem, on aggressively building homegrown R&D capacity. Eventually, it should direct R&D activities toward commercializing novel medical treatments and techniques.

Given the strong market potential of ***electric- and hybrid-vehicle*** components, TBNA should develop and expand collaborative R&D on subsystems and component technologies. At the same time, it should develop the capacity to manufacture hybrid vehicles and components for hybrid and electric vehicles. It should target the growing global market first and the Chinese market later.

TEDA should become a centre for ***green manufacturing*** in China. The initial focus should be on attracting to TBNA those companies at the leading edge of green chemistry and engineering. Over time, TBNA itself should start conducting R&D on new green manufacturing processes and, eventually, implement them in TBNA and TEDA.

An Overarching Strategic Plan

The seven TAs should form a pivotal part of TBNA's strategic plan for economic growth through technological innovation. All of the TAs are in line with promising global trends; they are well suited to current capacities in TBNA, TEDA and the municipality of Tianjin and build on existing pillar industries; and they support Chinese government priorities.

Part of the overarching strategic plan should be geared toward addressing broad general challenges that currently stand as barriers to all seven TAs. The plan should include measures to help TBNA and TEDA enforce existing laws in the IPR domain. TBNA and TEDA should incorporate into the plan ample opportunities for cross-fertilization between research facilities and industry. Finally, it is vital that TBNA build a culture of R&D and innovation. The plan should contain elements that promote flexibility and risk-taking in TBNA and TEDA's funded ventures. TBNA could use a three-pronged framework to integrate the specific action plans for the seven TAs into an umbrella strategic plan:

- Develop state-of-the-art R&D capacity in relevant areas.
- Update and expand the existing manufacturing base.
- Build capacity for S&T commercialization.

These three activities would need to be carried out in parallel. Each requires using and expanding existing local capacity and introducing new capacity. Novel advances should stem from and extend the existing capacity base while fresh R&D programs are started and new companies with state-of-the-art capabilities come in to bring overall capacity up to world-class standards. Each will also support the others.

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