Using large-scale programs to help develop technological capabilities: Cases in China

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Agenda

- The phenomenon
  - How to develop technological capability
- Research question
- Literature
- Research methodology
- Key findings
- Discussion
- Revising the chapter

The phenomenon

- Impressive achievements
  - Becoming leaders in technological innovation

- Examples

Impressive achievements

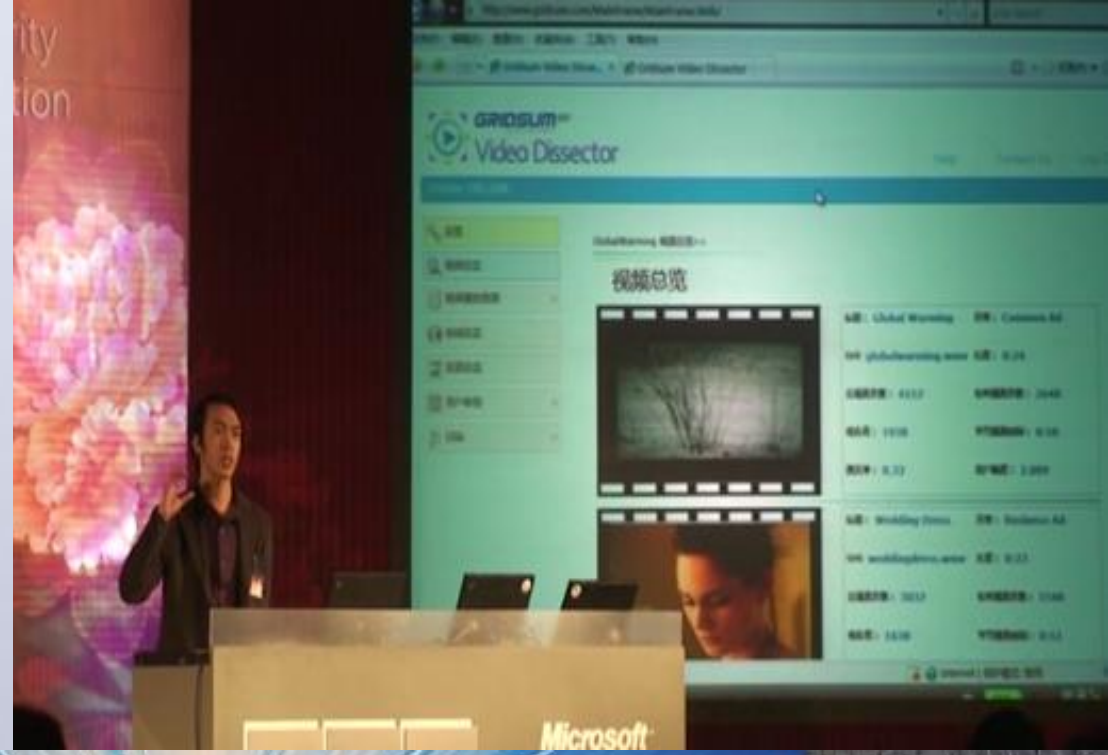
- 4G/5G/Telecom equipment/network
  - # of Base station
- ICT/Internet firms (AI, BIG DATA, CLOUD)
  - BATJ; IFLY: NLP
- UHV transmission system: State grid
- High speed rail
- HPC
- Hong Kong-Zhuhai-Macao Bridge
- Aerospace & Aeronautics ?
- New generation entrepreneurs

Telecom equipment


中国商用飞机有限责任公司
C919
B-001A
C919

ZPMC

- Shanghai Zhenhua Port Machinery Co., Ltd. (ZPMC), was established in 1992 by Mr. Guan, Tongxian at the age of 59 with $1 million.
- The largest large-size port container crane maker in the world, and captures more than 70% of the world market.
- One of the leaders making spiral bevel gears, making it well positioned in the ocean engineering equipment industry


GRIDSUM
Video Dissector
视频总览
Microsoft


国家信息中心
State Information Center
GRIDSUM 国双
国家信息中心与国双科技
战略合作签约仪式
2012年
16日
GRIDSUM

BROAD

- Established in 1988
- One of leading Central Air Conditioning systems makers in China
  - Price 30% higher than competitors
- Sustainable building

Our flying and camera stabilization systems redefine camera placement and motion.

DJI products are redefining industries. Professionals in filmmaking, agriculture, conservation, search and rescue, energy infrastructure, and more trust DJI to bring new perspectives to their work and help them accomplish feats safer, faster, and with greater efficiency than ever before.

Largest genome sequencing organization

Why impressive achievements?

- Firm level
  - Huawei: R&D, RMB 100B; Hire 600 from Tsinghua u.
- Large technical system/Sector level
  - 8 Large programs
  - Before: behind the frontier
  - After: leading position

Programs	Brief description
Yun 10	Initiated in 1972 and ended in 1986. First try for China to develop large civil aircraft. A lot of debates about the success and failure of program.
The three Gorges program and power generating equipment	The program created the opportunity for local power generating equipment makers to improve technological capabilities and gradually provide advanced products such as 1000MW class ultra-super critical turbine.
Subway equipment	Initiated in the late 1990s by Shenzhen Metro and has proved to very successful in helping local firms developing advanced subway equipment.
3G/TD-SCDMA	Initiated mainly by Datang, key technology developer for TD-SCDMA and TD-LTE/TD-LTE Advanced (3G and 4G international standards).
High speed rail	Initiated by the former MOR. Started by transfer technology from MNEs but are able to develop leading technology and products internally by local firms.
C919	Initiated in 2008 by the central government. New try for China to develop large civil aircraft.
UHV Transmission	Initiated by State Grid, the largest power transmission company in China.
Xiqidongshu/CNPC	Initiated in 2000 to transport natural gas from the western part of China to the eastern part, because most of China's natural gas resources are in the western part of the country, but the consumption is mainly in the economically more developed eastern part.

High speed rail

- In 2004 the Ministry of Railway (MOR) decided to massively transfer technology from multinational enterprises (MNEs) to help with China's high-speed rail development.
- On 26 October 2010, CRH380A, a highly localized high-speed train went into operation.
  - On 3 December 2010, CRH380A reached an operation speed of 486.1 km/h, the highest in the world.
- **Locally developed and manufactured new generation high-speed trains went into operation on 26 June 2017, indicating that local firms had developed strong technological capabilities in not only manufacturing but also designing and engineering.**

- By the end of 2017, China has more than 25,000 km high-speed rail under operation, accounting for about 60% of high-speed rail in the world.
- In 2017, more than 7 billion people travelled through high-speed trains in China.

Research question

- (1) How the 8 large scale programs were initiated
- (2) What strategies did the key stakeholders use to implement these programs
- (3) What theoretical and practical insights can we draw from these programs.

Literature

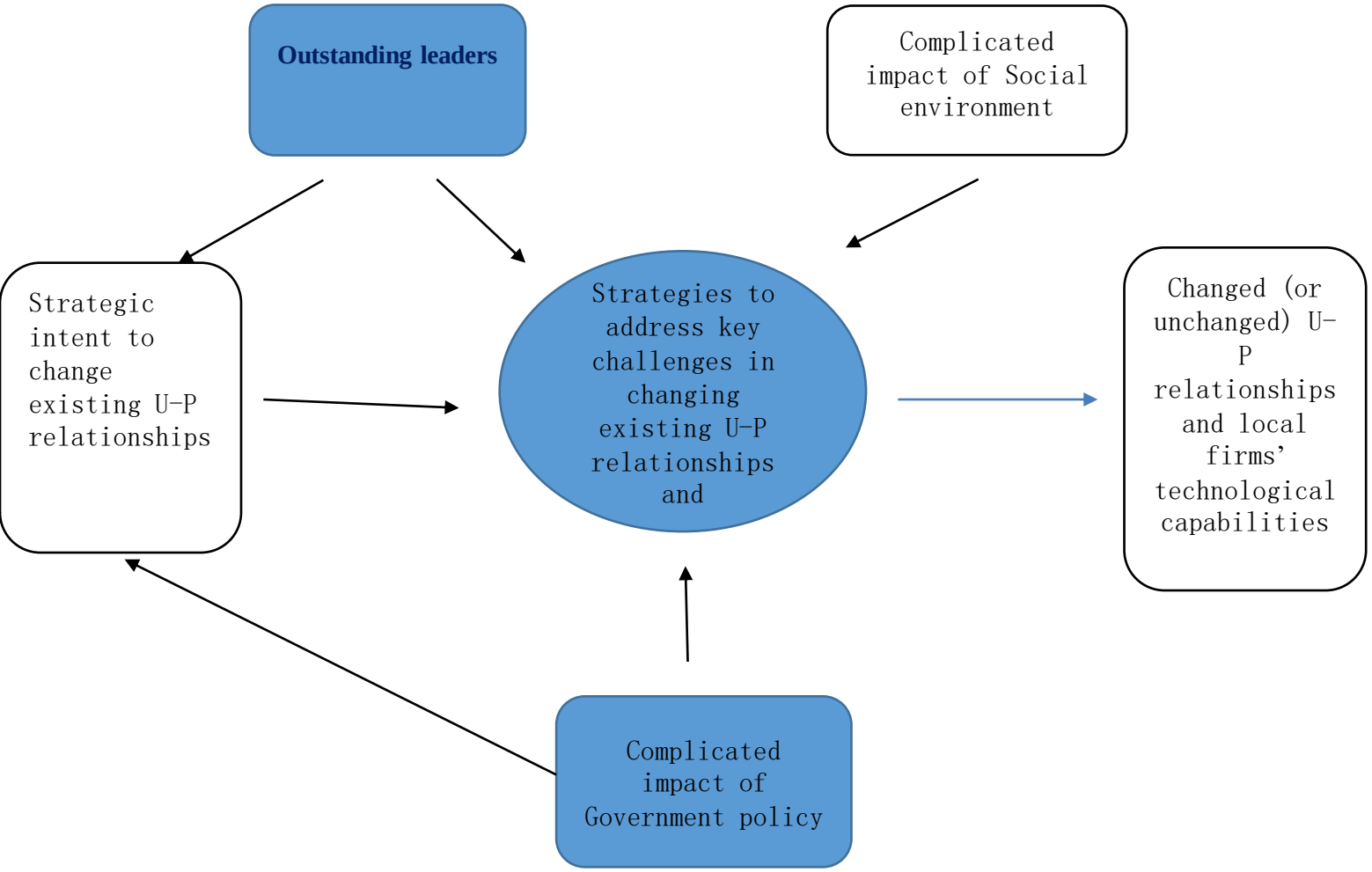
- The first is about CoPS (Davies and Hobday, 2005; Hobday, 1998; Prencipe, 2000).
  - Different from consumer goods
- The second is about large technical systems (Carlson, 1991; Hansen and Rush, 1998; Hughes, 1987; Walker, 2008).
  - A lot of risks and high commitment is needed
- The third is about strategies and challenges in developing countries' development of large technology systems and adoption of CoPS.
  - MNEs dominate; why change?

Research methodology

- A case study method (Eisenhardt, 1989; Glaser, 1978; Glaser and Strauss, 1967; Yin, 1989).
  - More precisely, this chapter is based on three case studies, supported by gov. agencies or firms.
    - 3G
    - SOE
    - User-driven innovation
- Interviewed more than 140 people

4 Key findings

- *Initiation of large scale programs based on strategic intent*
  - *Changing the existing U-P relationships*
    - *Rely less on MNEs, more on local firms*
- *Different strategies to build new U-P relationships*
- *Complicated impact of government policies and the social environment*
- *The crucial role of outstanding leaders*


Outstanding leaders
Complicated impact of Social environment
Strategic intent to change existing U-P relationships
Strategies to address key challenges in changing existing U-P relationships and
Changed (or unchanged) U-P relationships and local firms' technological capabilities
Complicated impact of Government policy

Initiation of large scale programs based on strategic intent

- Three types of initiators
- For users, why not buy from MNEs?
  - Too expensive
    - Bad service
  - Do not want to develop new product
  - Addressing challenges or seizing opportunities
- For producers, they also want to be leaders
  - Change their industrial/competitive position
  - 3G/TD-SCDMA
- For government, help users and producers, to achieve better development

Key strategies to build new U-P relationships

- When the central government is the key initiator, technology transfer from MNEs was more likely to be the key challenge, so **leveraging the huge domestic market to transfer technology** is an important strategy.
- When the key initiator is a producer, the key challenge is more likely to be the so-called **"latecomer disadvantage"**, because people believe that MNEs' technologies and products must be more advanced (Gao, 2007; Liberman and Montgomery, 1988, 1998), so the key strategy is to overcome this disadvantage.
- When the key initiator is a user, **"latecomer disadvantage"**, also has negative impact, but the impact is smaller, because it could provide resources to support the initiative; the key challenge becomes complex coordination.

- The most difficult: producer initiated program

Impact of government policies and the social environment

- Highly complicated

- Government: supportive? Yes, no
  - 3G/TD-SCDMA
- Society: supportive? Yes, no
  - 3G/TD-SCDMA
- Open door policy: positive impact, negative impact?
  - Minority, understand the negative side; but, very influential

The crucial role of outstanding leaders

- CoPS, large technical systems
  - High investment, highly risky, uncertainty, long time, so high commitment needed
  - Who want to take all the responsibilities? Burden?
    - Who are able to?
- Some people, unique people
  - High ambition, high strategic intent, high capability
- Two examples
  - 3G/TD-SCDMA
  - Shenzhen Subway

3G/TD-SCDMA

- Huge latecomer disadvantage
- Mr. Tang Ruan, Mr. Zhou Huan, and Mr. Li Shihe
- They could stay on their positions from 1997 until 2009, when the technology was officially commercialized

People and organizations	Perceptions and views
Government officials	
Song, Zhiyuan, Vice Minister of the former MII	January 1998: when the majority of the participants of the Fragrant Hill Meeting did not support the idea of proposing TD-SCDMA to ITU, Song, Zhiyuan said: "I suggest we agree. Even if it failed, it could be regarded as a success, because it could help us accumulate experience".[a]
Minister level government official of the former MII	December 2002: When visiting Datang, the government official asked: "Why Datang insists that we develop TD-SCDMA when MNEs have developed WCDMA and CDMA2000?"[b]
Minister level government official of the former Informationization Office of the State Council	October 2005: "Why we do not give clear support to TD-SCDMA? No support is the biggest support. We are waiting to see if TD-SCDMA would become mature".[c]
People from firms	
Zhou, Huan, Former COE of Datang	March 2002: "I am not expecting that the government would make TD-SCDMA the only 3G national standard. What I am expecting is that the government could say that TD would be used even with 10 preconditions: TD is mature, is reliable, is low cost, is of high quality, …now the government is not giving enough support to TD".[d]
Yang, Zhiqiang, Former Vice Director, Technology Department, China Mobile	August 2003: "WCDMA is the best choice for China Mobile to move to 3G, and TD-SCDMA could be a complement".[e]
Wang, Xiaochu, former Chairman of China Telecom	March 2006: "The customers are the underlying forces for choosing which 3G standard", indicating that China Telecom favor WCDMA.[f]
Li, Shihe, Datang Mobile, Father of TD-SCDMA	April 2008: "TD-SCDMA will die soon, because government agencies have not developed a clear plan. No one has made it clear whether TD-SCDMA will be used in China. No one knows which service provider will use TD-SCDMA".[g]
Former VP of Strategic Planning, Huawei	July 2011: "Why Huawei was not active in investing in TD-SCDMA for a long time? The government policy was not clear. It was not clear whether or not TD-SCDMA would be used in China. Huawei is a company, so we have to listen to the market".[h]
Other people	
Liu, Chunhui, Telecom Reporter	February 2005: "Professor Hu, Angang from the TsinghuaUniversity made unfair comments on TD-SCDMA in his 3G report. He did not mention problems occurred in testing other 3G technologies but highly exaggerated that in TD-SCDMA".[i]
Li, Jinliang, Former Chief engineer, 7th Research Institute of the China Electronics	February 2010: In commenting on the argument that TD-SCDMA is a failed patriotic experimentation, Li, Jinliang said: "In the future when we reflect on TD, we'll realize that it's not a dead 3G standard but a classic textbook on indigenous innovation from 3G to 4G".[j]

[a] Yang and Lu (2010).
[b] Interview at Datang (January 7, 2011).
[c] Interview at former Informationization Office of the State Council (June 8, 2007).
[d] Interview with Zhou, Huan (2002, March 25). Retrieved from http://www.yesky.com/NetCom/218424581927469056/20020325/1603507.shtml.
[e] Yang, Zhiqiang's speech at TD-SCDMA Summit. Retrieved from http://tech.sina.com.cn/it/t/2003-08-28/1632226667.shtml.
[f] Wang, Xiaochu: China Telecom has developed a complete 3G plan. Retrieved from http://www.21cbh.com/HTML/2006-3-27/29065.html.
[g] Li, Shihe, Father of TD: TD is suffering an euthanasia. Retrieved from http://tech.sina.com.cn/t/2008-04-21/11532151035.shtml.
[h] Interview with former VP of Strategic Planning, Huawei (July 8, 2011).
[i] Liu, Chunhui: Hu, Angang's comments on TD-SCDMA are unfair. Retrieved from http://biz.163.com/05/0224/10/1DBM3PTF00020QED.html.
[j] Li, Jinliang refute the claim that TD-SCDMA is a failure. Retrieved from http://www.dvbcn.com/2010-02/03-44888_3.html.

Shenzhen Subway

- Strategic intent: 1998, Become a leading subway firm in the world supported by digital technology
  - MNEs: expensive; do not have equipment required
- Mr. Jian Lian, VP in charge of procurement and operation, retired this year
- Localization process almost 20 years
  - Gradual process, balance multi-stakeholders interests
  - Risk management, in charge of both procurement and operation
    - Test and improve locally developed products/Systems

Discussion

- Research questions
  - (1) How the 8 large scale programs were initiated
  - (2) What strategies did the key stakeholders use to implement these programs
  - (3) What theoretical and practical insights can we draw from these programs.
- Insights
  - Theoretically, evolution of large technical system in developing country different from developed countries
    - The process of invention, development, innovation, transfer, growth, competition, and consolidation (Hughes, 1987)
    - Not inventor-entrepreneurs, or financier- entrepreneurs and consulting engineers, but manager-entrepreneurs make crucial decisions
    - Many “reverse salients” come from MNEs
  - Practically,
    - MNEs
    - Local initiators

Revising the chapter after the conference

- Long cycle technologies
- Design capabilities
- Non-tech capabilities
- Comments

- Thanks you!
- Q&A