Exploration of Research Models Oriented Towards the Main Battlefield of the National Economy (Postprint)

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Abstract

"Facing the main battlefield of the national economy" is one of the "Three Orientations" in the Chinese Academy of Sciences' new-era institutional policy. This paper analyzes the relationship between scientific and technological capabilities and national development, arguing that orienting research toward the "main battlefield of the national economy" necessitates close collaboration between academia and industry. Building upon an overview of mainstream international research collaboration models, the article articulates the practical experiences and lessons learned from the five-year exploration of research collaboration models between the Institute of Computing Technology of the Chinese Academy of Sciences and Huawei.

Full Text

Preamble

The cause of innovation calls for innovative talent, and young scientific and technological personnel constitute the main force and backbone for building a world leader in science and technology in the future. In June 2011, the Chinese Academy of Sciences (CAS) formally established the "Youth Innovation Promotion Association," an innovative initiative for the comprehensive cultivation of young scientific talent under 35 across the entire academy. Through effective organization and support, this program aims to unite and galvanize young scientific workers, broaden their academic horizons, promote mutual exchange and interdisciplinary collaboration, enhance their capacity to organize research activities, and train a new generation of academic and technical leaders. Over the past five years, the association has grown to nearly 3,000 members, becoming a core backbone force among young researchers at CAS. Many of these young scientists have not only achieved significant accomplishments in scientific research but have also developed profound insights into technological progress and national development. Under the guidance of the CAS Bureau of Personnel, the *Bulletin of Chinese Academy of Sciences* has partnered with the Youth Innovation Promotion Association to launch the "New Youth, New Thinking" column starting January 2017, showcasing the reflections and ideas of outstanding young scientific talent at our academy across multiple dimensions, including scientific frontiers, science and technology policy and systems, and talent development.

Exploring Research Models for the National Economic Main Battlefield*

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Abstract

"Facing the national economic main battlefield" represents one of the "Three Orientations" in CAS' s new-era policy guidelines. This paper analyzes the connection between scientific and technological forces and national development, arguing that orienting research toward the "national economic main battlefield" requires close collaboration between academia and industry. After introducing mainstream international research cooperation models, the article presents the practical experiences and lessons learned from the research cooperation model exploration between the Institute of Computing Technology (ICT) of CAS and Huawei Company over the past five years.

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To adapt to new reform circumstances and development requirements, CAS has established its new-era policy guidelines of "Three Orientations"and "Four Leads" : facing world science and technology frontiers, facing major national needs, facing the national economic main battlefield, and taking the lead in achieving leapfrog scientific and technological development, building a national highland of innovative talent, establishing a high-level science and technology think tank, and constructing world-class research institutions. The explicit inclusion of "facing the national economic main battlefield" in these policy guidelines reflects an accurate assessment of current national reform and development circumstances and a profound understanding of the connection between scientific and technological forces and national development.

1. The Service Object of Scientific and Technological Forces

What should a nation' s scientific and technological forces serve? Generally, three states can be identified. (1) During special periods, science and technology are dominated by national strategic needs. For example, Alan Turing, known as the "father of computer science," participated in code-breaking missions for the British government during World War II, making distinguished contributions. (2) Civilian needs rise and compete with national strategic needs for scientific and technological resources, sometimes creating conflicts. Both the United States and the Soviet Union experienced this state during the Cold War, which represents an extremely unstable condition that, if mishandled, can affect national development and social stability. (3) National strategic needs and civilian needs become basically aligned, forming complementary and mutually transformative demands that improve the efficiency of research resource allocation.

The United States, for instance, has experienced all three states. During World War II, the U.S. was in the first state, with numerous professors devoting themselves to weapons development, including those from top institutions like Harvard and Yale. Harvard professors developed new torpedoes for the U.S. Navy. According to statistics, in 1941 the U.S. government funded approximately 6,000 researchers for military research, a number that rose to 30,000 by the end of World War II in 1945. After the war, as the U.S. economy recovered and civilian needs developed rapidly, the country transitioned to the second state, which continued until the 1970s. During this period, most universities like Harvard and Yale returned to serving civilian needs, while a few institutions such as MIT and some national laboratories continued serving national strategic needs, including the Apollo Program and the Semi-Automatic Ground Environment (SAGE) system. However, this state was unstable; the 1960s in America were marked by prominent social contradictions and numerous mass movements. Nevertheless, through the influence of various social forces, the U.S. relatively smoothly transitioned from national strategic needs dominance to increasingly prosperous civilian needs. At MIT, student and faculty protests forced the university to remove military projects from campus, while IBM proactively shifted from primarily military contracts to civilian markets, pioneering computer leasing services and developing the enterprise-oriented System/360.

Since the 1970s, the U.S. has gradually entered the third state, effectively balancing the allocation of scientific and technological forces between national strategic (military) needs and national economic development needs, forming an innovation path exemplified by the "Silicon Valley model."

2. Cooperation Models Between US Academia and Industry

Serving the national economic main battlefield through scientific and technological forces requires collaboration between academia and industry. Taking information technology as an example, a 2003 report by the U.S. National Academy of Sciences, *Innovation in Information Technology*, revealed the close interaction between academia and industry in basic research and industrial promotion [Figure 1: see original paper].

This close cooperation has been achieved through continuous exploration by U.S. academia, industry, and government.

(1) Transformation of educational philosophy in American academia. Traditionally, universities focused on basic disciplines and pure academic research, remaining distant from social and civilian needs. To the general public, universities were classic and elegant institutions— "ivory towers." However, Stanford University pioneered a change in educational philosophy during World War II, arguing that universities should not be ivory towers detached from society but institutions serving the public and industrial development. Today, many world-renowned universities have transformed their philosophies. In 2011, on the occasion of Harvard' s 375th anniversary, President Drew Gilpin Faust discussed Harvard' s new governance philosophy in a media interview, stating that "lifelong learning begins at school and ends in society," emphasizing that universities should serve society rather than remain ivory towers.

(2) American academia actively exploring teaching, research, and talent cultivation systems that meet enterprise needs. Taking Stanford as an example, after adjusting its educational philosophy, the university introduced a series of new measures . These reforms laid a solid foundation for Stanford' s rise and enabled deep integration between Silicon Valley enterprises and the university. Harvard has also implemented measures to practice its service-to-society philosophy, creating a new School of Engineering and Applied Sciences to strengthen applied technology research and establishing an Innovation Lab (i-lab) in 2011 to encourage professors and students to participate in entrepreneurship.

(3) Various cooperation models developed by U.S. industry. Based on observations, several primary models exist:

1. Enterprises establish research funding programs specifically for university professors, who can submit project proposals to companies and receive funding after passing review.
2. Enterprises donate their most advanced products free of charge to university laboratories, hoping researchers will conduct studies based on these products.
3. Enterprises recruit interns from universities, allowing students to directly engage with cutting-edge corporate needs during internships and feed these insights back to academia.
4. Establish non-profit organizations similar to the National Science Foundation that collect research needs from enterprises and channel them to universities. Companies join by paying membership fees, and professors apply for funding based on their research interests.
5. Enterprise-directed funding models, typically involving several companies jointly funding a university laboratory directly, with funding reaching millions or even tens of millions of dollars.
6. Enterprise-led open-source community models that attract academic participation in improving and optimizing open-source projects, achieving

win-win outcomes.

(4) U.S. government policies encouraging intellectual property and talent mobility between academia and industry. In 1980, the U.S. government enacted the Bayh-Dole Act, allowing universities to retain patent ownership of research outputs funded by the federal government. This significantly improved the technology transfer rate of research achievements and accelerated their industrialization. Since 1985, the U.S. President has awarded the National Medal of Technology and Innovation to scientific and technical personnel making outstanding contributions to technological progress. Notably, recipients of the National Medal of Technology and Innovation, like members of the National Academy of Sciences and National Academy of Engineering, come largely from industry. For example, among the first recipients in 1985 were Apple founders Steve Jobs and Steve Wozniak. This honor-granting mechanism that makes no distinction between academia and industry has promoted talent mobility and cooperation between the two spheres.

3. Transformation Practice of ICT' s Research Cooperation Model

Through these cooperation models, U.S. academia and industry have formed a harmonious atmosphere characterized by mutual respect and reciprocity, division of labor and collaboration, jointly promoting technological development. In contrast, a noticeable gap exists between Chinese academia and industry. How to bridge this gap and form effective cooperation models between Chinese academia and industry has become an essential issue for orienting research toward the national economic main battlefield.

3.1 Progress in ICT-Huawei Cooperation

China' s economic development has entered a new normal, facing pressure for industrial restructuring and upgrading, which requires more scientific and technological forces to serve the "national economic main battlefield."In fact, Chinese industry' s demand for frontier technology is growing stronger. Take Huawei as an example: in 2016, its revenue reached 390 billion yuan with a net profit of 37 billion yuan, and its R&D investment reached 60 billion yuan, making it a world-class technology company with some technologies in globally leading positions. This creates a stronger need for Huawei to master frontier core technologies. Domestic internet companies also maintain high profit margins of around 30%, comparable to international first-class enterprises, giving them the economic capacity to explore frontier new technologies.

Against this backdrop, the Institute of Computing Technology (ICT) of the Chinese Academy of Sciences, led by Director Sun Ninghui, has once again taken the lead in transformation, actively exploring research models oriented toward the national economic main battlefield.

In September 2011, ICT signed a five-year strategic cooperation framework agreement with Huawei to establish the "ICT-Huawei Joint Laboratory," aiming to conduct long-term strategic cooperation in the ICT (information and communication technology) field and lead the development of China' s information industry. This represents the largest cooperation in ICT' s history with an enterprise and also the largest cooperation in Huawei' s history with academia. Consequently, both parties shoulder the heavy responsibility of exploring new cooperation models between Chinese academia and industry.

After five years of cooperation, the ICT-Huawei Joint Laboratory has achieved a series of results, including generating over 300 patent families, conducting patent layout around the core technologies of the third-generation data center (DC 3.0) in areas such as system architecture, software-defined architecture, message-based memory, integrated storage, networking, operating systems, and heterogeneous/parallel programming, accumulating a batch of core technologies for Huawei, some of which have already been applied in Huawei products. The Joint Laboratory has published more than 70 international papers in computer systems research and jointly released white papers to the global community twice, promoting Huawei' s integration into the international academic community. It has also delivered over 40 high-level talents to Huawei, including nearly 30 PhD graduates. These achievements have been recognized by various parties within Huawei. Therefore, after the conclusion of the first strategic cooperation phase, both sides renewed the five-year strategic cooperation framework agreement for the "ICT-Huawei Joint Laboratory" at the end of 2016.

3.2 Exploration of Academia-Industry Cooperation Models

However, cooperation between ICT and Huawei did not proceed smoothly; rather, it experienced multiple setbacks and difficulties before gradually finding mutually acceptable approaches. In the initial cooperation phase, both parties had high expectations. However, in actual implementation, significant differences in organizational methods and institutional cultures led to increasing divergences, primarily manifested in two aspects. On one hand, ICT' s positioning focuses on medium- to long-term research, a point highly recognized by Huawei' s senior leadership. Ren Zhengfei has emphasized on multiple occasions that the company should "increase research funding investment, look toward the long term, reestablish new cooperation models around innovative directions, and lock in long-term cooperation with professors." Consequently, the Joint Laboratory initially set goals oriented toward medium- to long-term research with a 5-10 year horizon. However, Huawei' s internal processes and evaluation mechanisms had not been adjusted accordingly, remaining results-oriented. Therefore, Huawei' s middle- and grassroots-level employees placed greater emphasis on short-term deliverables and hoped to see cooperative research with short-term effects. On the other hand, both sides held inconsistent value judgments regarding research outcomes. For example, in patent applications, differences in background knowledge, frontier trends, and industry needs between the two parties’ personnel often led to divergent views on the value of the same patent. ICT researchers considered some innovative ideas to be high-value patents, but Huawei personnel, approaching from enterprise needs, often disagreed, frequently resulting in stalemates during patent review processes.

These divergences forced the Joint Laboratory to suspend all research projects in April 2015 after three years of operation. Subsequently, both sides spent half a year summarizing and reflecting on the problems in the cooperation process, ultimately proposing three adjustment schemes: (1) Adjust the expected output cycle of projects, with 80% designated as evolutionary technology projects (showing results within 3 years) and 20% as disruptive projects (producing results in 5-10 years). Previously, the Joint Laboratory had focused primarily on 5-10 year disruptive technologies, creating internal review pressure for Huawei’ s counterpart departments. (2) Adjust the technology organization model. Research content would be organized according to system and product dimensions, fully utilizing Huawei’ s existing systems or products to tackle key technical points. Previously, joint research had been organized in the form of “973” projects with strong academic inertia, where each sub-project pursued disruptive innovation and interdependencies among sub-projects led to overall progress falling short of expectations. (3) Adjust resource integration methods. Huawei restructured internally to form cross-departmental project teams, expanding the resource mobilization capacity for cooperative projects within the company. Previously, apart from the department directly interfacing with ICT, other Huawei departments had insufficient understanding of cooperative projects, resulting in inadequate alignment between needs and technologies.

In October 2015, the adjusted ICT-Huawei Joint Laboratory launched a new round of seven research topics. Today, this phase of research topics has completed its first round of acceptance, and various Huawei parties have expressed strong recognition of the adjusted cooperation model and research outputs, which has facilitated the signing of a new five-year strategic cooperation framework agreement for the Joint Laboratory.

4. Conclusion

Throughout history, contradictions in the cooperation process between academia and industry may be an inevitable part of the journey. In fact, Stanford University’ s close ties with Silicon Valley enterprises only developed gradually after multiple failed explorations. In the late 1930s, Stanford experienced an unsuccessful cooperation with industry when a Stanford physics professor invented the microwave tube. The Sperry Company saw its market potential and funded joint commercialization, but during the cooperation, the company completely controlled the laboratory, crudely interfered with research directions, forcibly accelerated experimental progress, and even restricted the publication of faculty research papers, ultimately ending in an unhappy separation. Such examples offer many warnings and insights.

After these adjustments, the ICT-Huawei Joint Laboratory has regained vitality, though it has yet to reach an ideal model, and many aspects of the cooperation process still require 磨合 (磨合) and improvement. However, having gone through this summary and reflection process, both parties' management has established an effective communication channel, which should enable better handling of future cooperation challenges. Finally, it is hoped that our experiences and lessons can provide some inspiration and assistance to other organizations exploring better cooperation models between Chinese academia and industry.

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