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Manufacturing in the Eye of the Storm: Shen Hong and the Nine Great Installations Project During China's Cultural Revolution

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The construction of nine high-end technical installations (hereafter Project NGI, for Nine Great Installations or 九大设备) in the 1960s and 1970s was an indispensable part of the development of China's defense and heavy industries. The project put more than 1400 machines into operation or trial operation during the Culture Revolution (1966–1976), and they served essential technical functions in sectors such as aviation, aerospace, machinery, metallurgy, and electronics, and directly advancing the development of these fields. It took more than a decade for Project NGI to go from planning to completion—a surprisingly uninterrupted and steady development while China fell into unprecedented turmoil. One important reason for Project NGI's success was the vital leadership of Shen Hong (沈鸿, 1906–1998), the technical director of the project and a high-ranking official. Supported by state leaders such as Zhou Enlai and Nie Rongzhen, Shen and his colleagues adopted a suitable roadmap for technological development, coordinated the best-performing manufacturing forces in the country, and successfully manufactured the NGI machines. Project NGI is significant for the history of Chinese science, technology, and medicine during the Cultural Revolution not because it was technologically original, but because it represents an extraordinary case, in which the project's technological development seemed to be largely exempted from the interference of the turbulent Cultural Revolution. The project's national defense orientation, its pragmatism, and the contemporary dogma of self-reliance (自力更生), in addition to Shen Hong's political maneuvering, all contributed to the creation of a relatively calm and favorable environment around Project NGI. Despite the widespread turmoil in the country, Shen managed to assemble a stable and continuously productive team, which executed experiments, absorbed previously introduced Soviet technologies, stayed informed about advanced European and American technologies, and ultimately accomplished the construction of the NGI machines.

Introduction

During the Cold War, especially through the 1960s and 1970s, China acquired the capability to manufacture jet fighters, satellites, intercontinental ballistic missiles (ICBM), and nuclear weapons. Most of these military products have since been upgraded many times, but the machinery that originally manufactured them is still in operation as of 2017. One group of such machines was produced under a program to develop nine high-end technical installations, commonly called the "Nine Great Installations" or "九大设备" (hereafter Project NGI) in China. Each of the project's installations was a large assembly of specialized machinery. Together, they represent one of most important achievements in twentieth-century Chinese industrial technology. The development of NGI machinery during the Cultural Revolution, however, has hitherto not been adequately studied, a situation we hope this paper may help improve.

The NGI included the machines listed in Table 1. Later, an aluminum alloy foundry workshop was also added to the project. Therefore, Project NGI eventually contained ten high-end technical installations, comprising a total 1406 individual machines of more than 839 different types.[1] Only one single instance was eventually manufactured for each type of installation because they were expensive to build and one set was enough to meet the contemporary national demand. As Table 1 shows, all except one of the nine installations were completed during the decade of the Cultural Revolution; seven of these nine installations were

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[1] Jian Li 李健 and Kailiang Huang 黄开亮, *中国机械工业技术发展史* [*The History of the Chinese Machinery Industrial Technology*] (Beijing: Jixie gongye chubanshe, 2001), 1280.

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Table 1. The Nine Great Installations.[a]

Name	Year of project initiation	Year in official operation	Present location of the installations	Representative product
The 10 MN (meganewton) oil press	1961	1966[b]	Beijing Composite Materials Co., Beijing	Missile nose cones and rocket shells
The 2800 mm hot rolling mill	1961	1969	The Southwest Aluminum Co., Chongqing	Aluminum alloy thick plates of rockets or spacecrafts
The 2800 mm cold rolling mill	1961	1970	The Southwest Aluminum Co., Chongqing	Skins of aircrafts, aluminum alloy plates of spacecrafts
The 125 MN horizontal hydraulic press	1961	1971	The Southwest Aluminum Co., Chongqing	Billets of structure parts for aerospace devices
The 2–80 mm steel tube mill	1961	1971	Chengdu Seamless Steel Tube Plant, Chengdu	Tubes of aerospace devices
The 2300 mm alloy sheet rolling mill	1961	1971	Taiyuan Iron & Steel (Group) Co., Taiyuan	3 mm cold-roll steel sheets
The 300 MN hydraulic press	1961	1973	The Southwest Aluminum Co., Chongqing	Longerons of aircrafts, large forged rings for rockets
The 80–200 mm steel tube mill	1961	1975	Chengdu Seamless Steel Tube Plant, Chengdu	Undercarriages of aircrafts, tubes of weapons
The 700 mm, 20-roller tandem cold rolling mill	1961	1984	Chongqing Iron & Steel (Group) Co., Chongqing	0.03 mm metal strips

[a]Data in this table are drawn from the Statistical Information Bureau & Coordination and Planning Bureau, the Ministry of Machinery Industry ed. 机械工业部统计信息司, 综合计划司编. *机械工业历史统计资料* 1949–1984 [*Historical Statistical Information of Machinery Industry (1949–1984)*] (1985), 147. Editorial Board of the Machinery Industry in Contemporary China 《当代中国的机械工业》编辑委员会, *当代中国的机械工业* [*The Machinery Industry in Contemporary China*] (Beijing & Hong Kong: Contemporary China Publishing House & Hong Kong Motherland Press, 2009), 169–74. Jian Li 李健 and Kailiang Huang 黄开亮, *中国机械工业技术发展史* [*The History of the Chinese Machinery Industrial Technology*] (Beijing: Jixie gongye chubanshe, 2001), 1280–86, 1290–92. ''技术装备 [Technical Equipment],'' SWA website, accessed June 25, 2017, http://www.swa.com.cn/Equipment.asp. ''产品服务 [Product Service],'' SWA website, accessed June 25, 2017, http://www.swa.com.cn/ProductServe.asp.
[b]This installation was put in trial operation in 1965, a year that some researchers took for its official operation.

set up at plants in Chongqing and Chengdu of Sichuan Province, deep in southwest China and far away from China's northern border and coastal line, demonstrating the contemporary Chinese authority's concern and preparation for possible foreign invasions from either the north (the Soviet Union) or the sea (the United States).

It has never been easy for any country to produce such large and sophisticated technical installations at any time. In the United States and the Soviet Union, most similar installations appeared between the 1940s and the 1950s. Such development met the demand of World War II and the US-Soviet space race. The Chinese realized the importance of similar installations not only from their own experience in industrial development, but also from the international spillover of scientific and technological knowledge from industrialized countries, especially the transfer of Soviet technology to China in the 1950s and the 1960s. Otherwise, it would be impossible for the Chinese to know which types of machines would be suitable for certain functions.

Most installations developed under Project NGI was put into operation or trial operation during the Cultural Revolution and quickly became indispensable to China's aviation, aerospace, machinery, metallurgical, and defense industries, which it has advanced since the late 1960s. For instance, the 10 MN oil press, the first product of NGI put into operation, has been used to shape missile nose cones since 1969. Moreover, this installation has manufactured many essential parts for high-tech projects such as China's first artificial satellite, the Beijing Electron-Positron Collider, extrudate and die forgings for airplanes,[2] the East Wind and Long March rockets, the Tiangong-1 space lab, the Shenzhou spacecraft, and the Chang'e lunar orbiters and surface vessels in the late twentieth and early twenty-first centuries.[3] The products of Project NGI have long been recognized internationally. Southwest Aluminum (Group) Co., Ltd. (SWA, 西南铝业集团公司), for example, relying on its five high-end technical installations, won a production license from the Boeing Company as early as 1987 to manufacture precision castings and forgings for the company.[4]

The Chinese considered the NGI machines "national treasures" because, for a long time, only four countries in the world—the United States, the Soviet Union (subsequently Russia), France, and China—could boast similar installations.[5] Five of the nine installations received national prizes, such as the National Science Conference Award (国家科学大会奖) and the China Quality Award (中国质量奖). Yet, the story of Project NGI's development has largely been forgotten.

So far, historians have focused on the history of finished industrial products in China, such as the nuclear weapons, artificial satellites, missiles, and airplanes, but overlooked programs like Project NGI, which made the manufacture of the aforementioned products possible. So far, no focused case studies had addressed Project NGI; more comprehensive works have only superficially covered issues concerning industrial technology.[6] The manufacture of these highly sophisticated industrial products reflects China's high manufacturing level. How China acquired such

[2] Planning and Development Department, State Bureau of Non-Ferrous Metal Industry 国家有色金属工业局规划发展司, *中国有色金属工业大型企业事业单位要* [*Overview of Large Enterprises and Public Institutions in the Chinese Metallurgical Industry*], 内部发行 [internal distribution] ed. 1999, 121.

[3] "发展中的西南铝 [The Developing SWA]," SWA website, accessed June 25, 2017, http://www.swa.com.cn/Aboutswa.asp?flag=0.

[4] "国际合作 [The International Cooperation]," SWA website, accessed June 25, 2017, http://www.swa.com.cn/Aboutswa.asp?flag=9.

[5] Weici Cai 蔡惟慈, Xinmin Zhao 赵新敏, and Zhiju Yao 姚之驹, *中国机械工业回顾与展望(第一版)* [*Review and Outlook of the Chinese Machinery Industry*, 1st ed.] (Beijing: Jixie gongye chubanseh, 2013), 66–67.

[6] Evan Feigenbaum, *China's Techno-Warriors: National Security and Strategic Competition from the Nuclear to the Information Age* (Stanford, Calif: Stanford University Press, 2003), 13–68.