

Shaping Vernacular Industrial Architecture in the Sericulture Revitalization*

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Abstract:

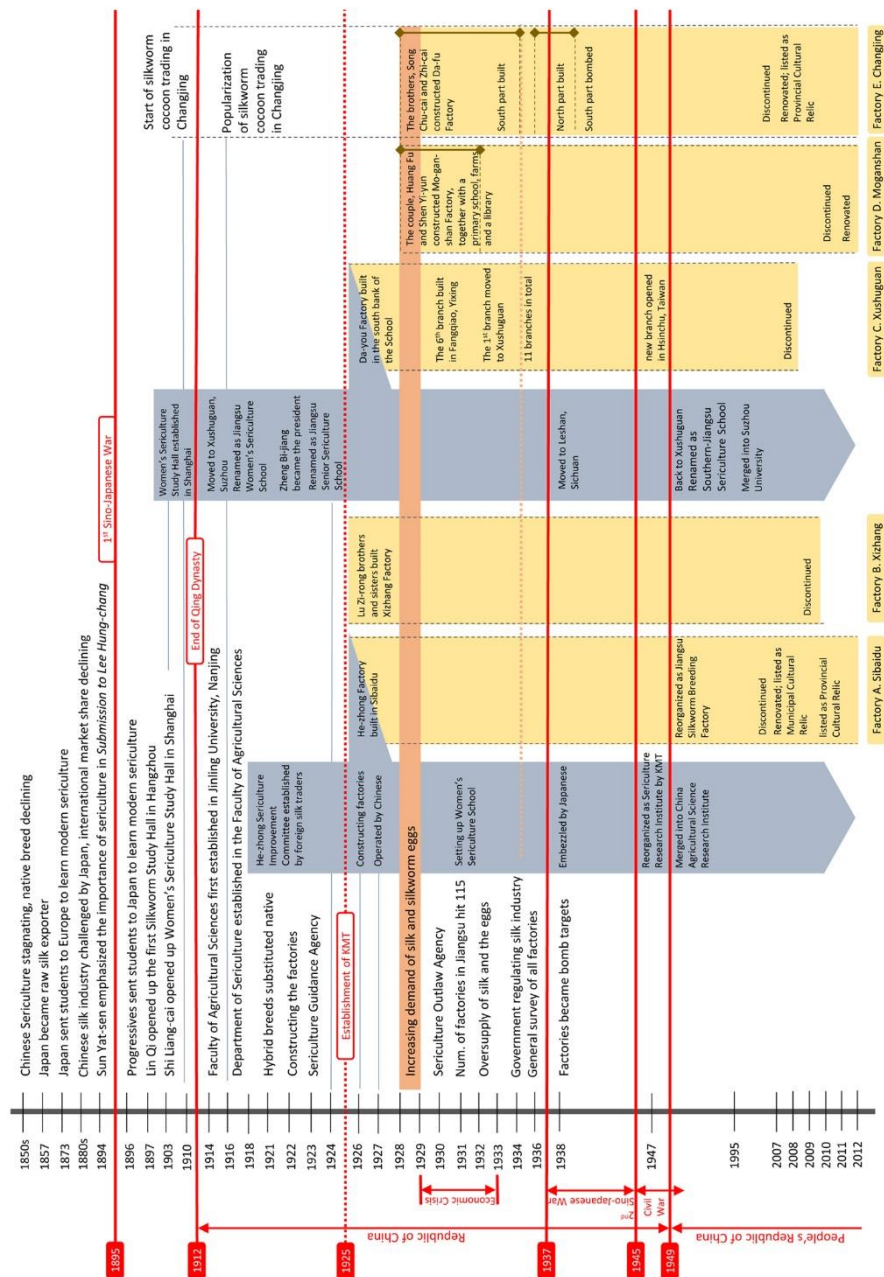
This paper conducts a retrospective study of how a particular architectural type of Silkworm Breeding Factory emerged in parallel with the course of Chinese sericulture history. By dividing the decline and revitalization process into four periods, the study elaborates the key roles of educational institutions and governmental agencies in shaping this vernacular industrial architecture at different stages. It investigates how external references and local technical tradition wrestled and fused into architectural tectonics that inherits modern rationality.

Keywords: Silkworm Breeding Factory, Sericulture, Vernacular industry, Environmental and hygienic criteria, Modernism architecture

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1. INTRODUCTION

In the second half of the 19th century, fueled by the Self-Strengthening Movement (1861-1894), China had a nationwide industrialization campaign keeping up with the modern Europe. This involves importing scientific and technological achievements of the Industrial Revolution afterwards, bringing in modern entrepreneurial system to construct a number of manufactories and chemical factories. In this process of modernization, China was indeed forced into the international rules of the game to transplant western industrialization achievements without its own development and accumulation. Grand industrial projects during this period were constructed imitating the western precedents, for example, the Jinling Machine Manufacturing Bureau founded by Lee Hung-chang in 1965 was designed by English engineers. Although the Self-Strengthening Movement failed in the end, it provoked the far-sighted personage to assimilate modernism and advance technology in a more profound way. Directly importing foreign technology gave way to gradually revitalizing vernacular industry, which was believed to be a more indigenous and legitimate path to a stronger China. The revitalization of Sericulture in the regions south of the Yangze River and the emergence of industrial architecture for silkworm breeding, unfolded in this background.



2. DECLINE OF EMPIRICISM IN SERICULTURE (1850S-1894)

China was first in the whole world to breed silkworms and reel silk. Sericulture in China was leading in ancient world and constantly spreading to surrounding countries. Japan, for instance, introduced Chinese sericulture via Korean peninsula in the mid of the 3rd Century.

Sericulture played an important role in the regions south of the Yangze River. These regions enjoy a mild climate with ample rainfall. The resource of sunlight, heat and water here come in a good accordance. The deep and nutritious topsoil provides a nice ground for mulberry trees, the leaves of which are the only food for silkworms. All together this is a favorable natural environment for silkworm raising. Sericulture became the top subsidiary business among the agricultural population in these regions. Take the city of Wuxi as an example, in the 1920s, 99.91% out of all agricultural population breed silkworms. This contributed remarkably to the regional economic prosperity [1:31].

However, due to the longtime empiricism in agriculture, the development of sericulture stagnated. Without improvement, the quality of native breeds slowly deteriorated and by the mid-19th Century, silkworm diseases spread rapidly and production declined. In the meanwhile, sericulture in European countries, for example, Italy and France, developed significantly following technological advancement. In early Meiji Era (1867-1876), Japan proposed a plan to increase silk exportation, which started with sending youths to Europe to learn modern sericulture, establishing sericulture schools and test sites. Soon after, Japan boosted its domestic industry and took the international lead in silk market [1:46-47]. The global silk market kept growing, yet the Chinese silk industry was both corrupted from inside and challenged by the Japanese from outside. The proportion of Chinese share in the international silk market was shrinking. Worse still, the First Sino-Japanese War (1894-95) inflicted a huge blow to the Chinese economy as a whole.

3. MODERN SERICULTURE AND EMERGING SILKWORM BREEDING FACTORIES (1894-1927)

In the same year when the First Sino-Japanese War began, Sun Yat-sen submitted a written statement to Lee Hung-chang to emphasize the importance of sericulture for people's livelihood, and suggested to send students to France to learn modern sericulture in order to resolve the massive silkworm diseases[1: 47]. Shortly after the First Sino-Japanese War concluded, progressive intellectuals Luo Zhen-yu, Lin Qi and others also proposed to send students overseas to learn modern sericulture and improve silkworm breeds.

Japan became the actual medium for China to modernize sericulture. Mainly three actions were taken: the first was to send students to Japan to learn modern agricultural technology; the second was to invite Japanese experts over to lecture around and demonstrate modern breeding process,

and to set up curriculum accordingly; the third was to translate sericultural writings from Japanese. In 1908, the number of Chinese students learning agriculture in Japan reached 300[1: 48].

In 1897, Lin Qi opened up the first Chinese institution for sericulture education in Hangzhou – Sericulture Study Hall. The Study Hall inherited the curriculum from Tokyo Institute of Sericulture, and copied a cocoonery to showcase how to raise superior silkworms and produce silkworm eggs in a modern process. This early-stage cocoonery no long exist, but we could trace the archives of the Japanese predecessor.

At the turn of the 20th Century, modern Japanese Silkworm Breeding Factories, such as Fukushima Branch, Kumamoto Branch of the central Silkworm Breeding Testing Field, are of complete timber structure that are common among small to medium buildings in Japan [2]. These factories have evenly distributed large windows, some with shadings. There are often clearstories along the ridge. These characteristics are in favor of abundant ventilation and lighting without over-heating.

Following the establishment of Hangzhou Sericulture Study Hall, educational institutions kept emerging in other places. Hangzhou Hall was taken as a model and its graduates were invited to take positions in new halls. In the meanwhile, progressive people endeavored to build Silkworm Breeding Factories to supply superior silkworm eggs and spread scientific breeding methods to local farmers. On the official side, Jinling University set up Faculty of Agriculture in 1914 and Department of Sericulture in 1918.

In the 1920s, educational institutions and silk traders became the initiative in improving silkworm breeds and disseminating scientific raising methods. Local farmers were gradually aware of the benefit. Before the reform, farmers in the regions south of the Yangze River could only raise one cycle of silkworms in spring, subject to the climatic conditions and the type of breed. Benefited from the new Summer Breed, Autumn Breed, and Early Autumn Breed, together with the professional Breeding Workshops that provide a stable internal environment, local farmers could raise up to four cycles of silkworms each year [1:87]. This obviously resulted in a massive growth in raw silk production. Chinese sericulture revitalized and prospered once again.

Silkworm Breeding Factories emerged in this period from 1894 to 1927, are the first batch of factories of this kind in China. They were all affiliated to sericulture educational institutions. This is the historical period when traditional empiricism in agriculture approaches and adapts to modern scientific agriculture. In the perspective of Architecture, this is the period to admit and translate a particular industrial building type from foreign countries, especially Japan. Representative examples are the He-zhong Factory in Sibaidu, Zhenjiang and Da-you Factory in Xushuguan, Suzhou --

He-zhong Factory (Sibaidu, Zhenjiang): Sponsored by He-zhong Sericulture Improvement Committee and a local squire, the construction of He-zhong Factory started in the autumn of 1926 next to the Zhenjiang Railway Station [3]. It then became a massive factory complex with

a total of 21 buildings, including a cocoonery, laboratories, storages, cold storages, a water tower and office buildings. The whole complex is well preserved and now a precious evidence of sericulture development. The cocoonery is a three-storey timber-brick structure of an H-shaped plan [4]. The connecting corridor is essential for protective circulation between the two main areas of production. Windows on the south and west façade are fitted with flexible shading system, which is a combination of timber frame and bamboo roller shutters [5]. The windows themselves are normal except that underneath some of the windows, there are foot windows. According to the traces on the wall fabric, these foot windows were built after the major construction was finished [5]. They don't appear in any regular pattern.

Da-you Factory (Xushuguan, Suzhou): In 1926, the president of Suzhou Women's Sericulture School raised funding from alumni and built Da-you Factory on the wasteland to the south of the School, to give impetus to local industry and economy [6]. This factory had been in production until around 2010. For the purpose of optimizing cross ventilation, the fenestration of the cocoonery is intricate and methodical – for each bay, there is a huge casement window with four columns and three rows of panels, each can be outswing opened separately [5]. Besides the four corners of this window, there are four air vents fitted with slidable wooden panels on the interior wall. In virtue of these individually controllable window panels and vents, workers could maintain a relatively stable internal environment by adjusting ventilation and humidity in response to external conditions.

4. INDIGENIZING SILKWORM BREEDING FACTORIES AND FLOURISHING OF SERICULTURE (1927-1931)

In 1918, silk traders from France, England and America residing in Shanghai invited local traders in Jiangsu, Zhejiang and Anhui to co-found He-zhong Sericulture Improvement Committee of China. The foreign traders took charge of the Committee until 1927 when they realized that they couldn't fully comprehend and involve in local production process, and the hybrid silkworm breeds they provided were not acceptable among the farmers. Then the Chinese members in the Committee took over control, and soon afterwards set up six affiliated Silkworm Breeding Factories to supply eugenic silkworm eggs in demand.

In the same year of 1927, the Sericulture Improvement Committee initiated Sericulture Guidance Agency in Wuxi. The Guidance Agency disseminated scientific knowledge for mulberry cultivation and silkworm raising, popularized the eugenic breeds and accelerated the improvement progress. As a result, the production of mulberry leaves, cocoons and raw silk saw a substantial increase. In 1929, the number of such Guidance Agencies reached 38.

The booming silk industry in turn led to higher demands on silkworm eggs. Stimulated by the economic opportunity and assisted by local Guidance Agencies, there was a trend that many squires and silk traders invested in building new Silkworm Breeding Factories [1]. The improved hybrid breeds require more attentive caring environment and skills, which could not be fulfilled in the traditional household breeding manner. Even if the silkworms could survive and spin, their

eugenic genre could not fully perform. Therefore, professional Silkworm Breeding Factories became even important and necessary. The demands on silkworm eggs kept rising until peaked in the autumn of 1928. According to statistics in 1931, there were 115 factories in Jiangsu Province alone, mainly in the city of Wuxi, Suzhou and Zhenjiang [7].

The period between 1927 and 1931 is when private Silkworm Breeding Factories flourished around the regions south of the Yangze River, benefited both from technology offered by Sericulture Guidance Agencies and capital invested by local squires. In the perspective of Architecture, this is the period of indigenizing this particular industrial building type. Under specific climatic and economic conditions, anonymous efforts were endeavored to integrate the external reference into the local manufacturing convention and building technology. Representative examples are the Mo-gan-shan Factory in Deqing and Da-fu Factory in Changjing, Jiangyin —

Mo-gan-shan Factory, Deqing: During 1928 to 1932, a senior officer of Kuo Ming Tang, Huang Fu and his wife Shen Yi-yun lived in seclusion in Mo-gan-shan, where they raised funds to set up a primary school, a library, farms, irrigation works and a Silkworm Breeding Factory. The main cocoonery are fitted with canopies on both the north and south facades. The canopies are consisted of brick columns, concrete beams and tiled roofs. They are of the same height as the roof of the main structure, leaving a 30-40cm gap in between for uninterrupted ventilation in parallel with shading. There is also an underfloor heating system for dehumidification, formed by a series of coal stoves and built-in tunnels [5].

Da-fu Factory (Changjing, Jiangyin): Local industrialist and tradesman Song Chu-cai invested to construct Da-fu Factory. The factory had two parts, the southern part was built in 1928-34, destroyed later in the war; the northern part was built in 1936-38, in service until very recently. The main cocoonery in the northern part is of the highest achievement of its kind among all that have been surveyed, with a complete and complex system designed for both cross ventilation and thermal pressure ventilation [5]. The construction details were refined to balance functional requirement and material capacity, and presented in a form of rational aesthetics.

5. THE SECOND DECLINE OF SERICULTURE AND ESTABLISHMENT OF ENVIRONMENTAL AND HYGIENIC CRITERIA (1931-1938)

As mentioned earlier, the demand on silkworm eggs peaked in 1928. The reason is that in the meanwhile when private Silkworm Breeding Factories emerged here and there in China, an economic crisis (1929-1933) engulfed the entire capitalist world. Consequently, the price tag of raw silk in global market dropped off dramatically, many silk companies went bankrupt, so that outlets for silkworm eggs were blocked. In order to stabilize the domestic market, Kuo Ming Tang government started to control augments of new factories and supervise the process of production at the state level.

Soon a series of decrees were launched. Kuo Ming Tang government first promulgated a decree that standardized the specifications of eugenic silkworm eggs and the process of breeding, then issued qualifications to manufacturers to further regulate the market. In 1930, Sericulture Outlaw Agency was established, through which the government could suspend a factory for rectification and even ban it from operation completely. According to the archive, out of the total of 111 factories investigated in 1934, 7 were compelled 'to renovate before re-open', 8 were compelled 'to renovate within one year' and 16 were asked to 'improve' [8]. Most of these unqualified factories were not purposely built for silkworm breeding, but altered from earlier functions. Because of the strict quality control, purposely-built professional Silkworm Breeding Factories became ever more necessary. In 1934, 105 new factories appeared, out of which only 24 were converted from existing buildings.

Sericulture Outlaw Agency gave qualitative evaluation and suggestions on the criteria, covering the aspects of temperature control, humidity control, air quality, luminous level and disinfection level [7]. Not only that the process of silkworm breeding demands precise temperature and humidity level, but different stages of a silkworm's lifecycle have slightly different requirements. Therefore the workers had to mediate between the external weather conditions and the internal microclimate constantly by means of operating the building fabric.

The major purpose of natural ventilation here is not to cool the space down, but to exchange air and exhaust extra moist. The most desirable status of ventilation is not to keep the rate high, but to keep frequent (to maintain certain air current at all times), even (to let air current go through each and every corner) and gentle (to keep the air velocity in between 0.2-0.3m/s) [9].

Inside a cocoonery, bamboo trays are stacked densely on the shelves, usually 8 trays on each shelf. So horizontal air current is desirable as it can run through the interspace between the trays. Sufficient yet not excessive amount of air inlets and outlets are necessary. Excessive openings would lower down the thermal insulation of the walls. The area of air inlets should be in the range of 1/6 to 1/4 of the floor area. The openings on the south and north walls should align in order to achieve satisfactory cross ventilation. The openings should be high and wide enough (minimum 2.1m x 1.0m) and the position should correspond with the bamboo tray shelves to optimize the performance [9].

In summer time, the external temperature is much higher than the requirement, so excessive ventilation could only lead to over-heating. Between 10 in the morning to 7 in the evening, all south-facing windows should be closed. In this case, air circulation is relied on thermal pressure between the upper and lower air vents. The degree of thermal pressure is related to the height difference between the vents. Larger difference creates higher pressure. To further guarantee the frequency and reliability of ventilation, clearstories or dormant windows are desirable. It is important to build air ducts for the clearstories or dormant windows to prevent hot air in the attic draw back down into the working space. Wind cowls with rotatable caps commonly found in industrial buildings are optional to prevent air flow backward.

The establishment of environmental and hygienic criteria, together with the governmental supervision and control, made the architectural type of cocoonery more scientifically rational. However, the Second Sino-Japanese War (1937-45) broke out in 1937, followed by the Civil War between Kuo Ming Tang and the Communist Party of China (1946-50). Production and living across China were heavily affected. Silkworm Breeding Factories were among the Japanese bombing targets and many were severely damaged.

6. DISCUSSION AND CONCLUSION

Different from the situation during Self-Strengthening Movement when scientific and technological achievements were directly imported, the process of rationalizing and modernizing sericulture is a gradual adaptation and transformation. In this process, the scientific knowledge of environmental and hygienic requirements for breeding silkworms was translated into requirements for architectural design. Although external references were evident, the rationality of design was fulfilled by settling climatic conditions and constructional capacity different from Japanese and European counterparts. It is a phenomenon that the already deep-seated and widespread vernacular industry absorbed the essence of modernity, and subsequently approached, adapted and transformed to reach its culmination in re-creation and re-indigenization.

The overall layout of a Silkworm Breeding Factory needs to take transport circulation and technical process into consideration, which is principal in all industrial building design. Yet there is no need for large-span or high-ceiling as most industrial buildings. What makes Silkworm Breeding Factory even more distinct from other industrial buildings is that the products are living organisms. To some extent, it is the closest to civil architecture among all industrial ones. The characteristics of cocoonery are mainly in the aspects of internal environment and hygiene, that is to say, the mediation of light and air. It is merely a matter of difference in the specific range of temperature, humidity and air quality, yet the principles and methods of how the building fabric responds to inner environment is the same for both silkworm factory and civil architecture. It is only in this particular historical period, earlier than the prevalence of building service and mechanical control, that requirements on interior environment would solely rely on architectural tectonics.

The precise and variational demands on interior environment throughout the whole lifecycle of the creature, led to the perfection of architectural tectonics. The microclimate for a single silkworm is considered in the scale of a building, in other words, the microclimate for each creature won't be guaranteed unless the environment in the building scale is appropriate. In this sense, the scientific issue of modernizing sericulture is transformed into an architectural problem, which involves scientific analysis and technological targets on issues such as shapes, size and positions of openings. When the worldwide economic crisis struck Chinese silk industry, the environmental and hygienic criteria became the scientific guidance for governmental regulation and remediation. By quantifying the invisible light, wind and air as technological targets, the

competitive power in silk market is extended and translated into the precision of environmental and hygienic control in architecture.

The spatial characteristics of western modern architecture derives from the utter pursuit of spatial hygiene, to a large extent due to the phobia of overcrowding and darkness of the late 19th century cities. For a long time, China was believed to be the recipient of western modernism. The discussion on modernism architecture has always centered on the western paradigm. A particular self-expectation was formed so that judgment is about to what extent the overall presentation of a piece of work meets the principles and characteristics of the western precedent. This mental state of orienting oneself to the paradigm and subsequently falling into the discourse of either inclusion or exclusion, is so-called psychological 'belatedness' in the process of modernization and post-colonial period[10]. Affected by this 'belatedness', judgment of indigenous practices was concentrated on formal consistence of modernism architecture, not taking into consideration the complicated and contradicted social historical factors and the fragmented evidence of modern rationality. From this historical study of Silkworm Breeding Factory as a particular architectural type, we can see the wrestling and fusion between foreign scientific attitudes, and local production culture and technical tradition, and the emergence of architectural tectonics that inherits modern rationality.

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GLOSSARY

Silkworm Breeding Factory 蚕种场

cocoonery 蚕室

Sericulture Study Hall 蚕学馆

He-zhong Factory in Sibaidu, Zhenjiang 镇江四摆渡合众蚕种场

Da-you Factory in Xushuguan, Suzhou 苏州浒（xu）墅关大有蚕种场

Mo-gan-shan Factory in Deqing 德清莫干山蚕种场

Da-fu Factory in Changjing, Jiangyin 江阴长泾大福蚕种场

He-zhong Sericulture Improvement Committee 合众蚕桑改良会

Sericulture Guidance Agency 蚕业指导所

Sericulture Outlaw Agency 蚕业取缔所