

INDUSTRIAL ARCHITECTURE IN BRAZIL

A ARQUITETURA INDUSTRIAL NO BRASIL

ARQUITECTURA INDUSTRIAL EN BRASIL

 <https://doi.org/10.56238/sevened2025.036-036>

Marcelo Cachioni¹

ABSTRACT

To understand the development of industrial architecture in Brazil, it is necessary to know the historical process of industrial implementation, from the first and limited initiatives during the colonial regime to the expansion into diverse regions starting in the 19th century. After a long period of adaptation in rudimentary constructions, brought by foreign professionals and companies, Brazilian industrial architecture reflects, despite the chronological lag compared to European countries like England and France, the models and typologies established after the Industrial Revolution, in the functional designs and in the choice of construction systems and materials used in the works, as well as in the implementation of the factory layout within the territory. The text will address how the first manufacturing initiatives took place in Brazilian territory until the opening of the first factories, in different phases, from the period of prohibition, through the government incentives that benefited investors, to industrial development in the 20th century. Regarding the establishment of factories, the configuration of the factory space and the consolidation of the industrial typology as a new architectural typology in Brazil will be analyzed. Subsequently, the analysis will focus on the implementation of industrial establishments and the architectural styles employed in Brazilian industrial architecture, as well as an analysis of common construction techniques and systems, in addition to influential projects of national industrial architecture, whose authors stood out for the innovative solutions used in the buildings that properly characterize the modality of industrial architecture in Brazil.

Keywords: Industrial Architecture. Brazilian Industrialization. Industrial Typologies. Construction Techniques and Systems. Projects and Architects.

RESUMO

Para compreender o desenvolvimento da arquitetura industrial no Brasil, é necessário conhecer o processo histórico da implantação industrial, desde as primeiras e restritas iniciativas no regime colonial, até a expansão nas mais diversas regiões a partir do século XIX. Após um longo período de adaptação em construções rudimentares, trazida por profissionais e por empresas estrangeiros, a arquitetura industrial brasileira reflete, apesar da defasagem cronológica em relação a países europeus como Inglaterra e França, os modelos e tipologias estabelecidos a partir da Revolução Industrial, nos projetos funcionais e na escolha dos sistemas construtivos e dos materiais empregados nas obras, como também na implantação da planta fabril no território. No texto será abordado como se deram as primeiras iniciativas de manufatura em território brasileiro até a abertura das primeiras

¹ Post-Doctorate in Architecture and Urbanism. Faculdade de Arquitetura e Urbanismo da Universidade de São Paulo (FAU-USP). E-mail: mcachioni@gmail.com
Orcid: <https://orcid.org/0009-0005-7801-3674> Lattes: <https://lattes.cnpq.br/8844622388189119>

fábricas, em diferentes fases, desde o período de proibição, passando pelos incentivos governamentais que beneficiaram os investidores, até o desenvolvimento fabril no século XX. Com relação ao estabelecimento das fábricas, será analisada a configuração do espaço fabril e a consolidação da tipologia industrial como nova tipologia arquitetônica no Brasil. Na sequência, a análise sobre a implantação do estabelecimento industrial e os estilos arquitetônicos empregados na arquitetura industrial brasileira, como também a análise sobre as técnicas e sistemas construtivos comuns, além de projetos influentes da arquitetura industrial nacional, cujos autores se destacaram pelas soluções inovadoras utilizadas nas edificações que caracterizam propriamente a modalidade da arquitetura industrial no Brasil.

Palavras-chave: Arquitetura Industrial. Industrialização Brasileira. Tipologias Industriais. Técnicas e Sistemas Construtivos. Projetos e Arquitetos.

RESUMEN

Para comprender el desarrollo de la arquitectura industrial en Brasil, es necesario conocer el proceso histórico de establecimiento industrial, desde las primeras y limitadas iniciativas durante el periodo colonial hasta la expansión a diversas regiones a partir del siglo XIX. Tras un largo periodo de adaptación en construcciones rudimentarias, introducidas por profesionales y empresas extranjeras, la arquitectura industrial brasileña refleja, a pesar del desfase cronológico con respecto a países europeos como Inglaterra y Francia, los modelos y tipologías establecidos desde la Revolución Industrial, tanto en los diseños funcionales como en la elección de sistemas y materiales constructivos empleados, así como en la implantación de la planta fabril en el territorio. Este texto abordará cómo se produjeron las primeras iniciativas manufactureras en territorio brasileño, hasta la apertura de las primeras fábricas, en diferentes fases: desde el periodo de la prohibición, pasando por los incentivos gubernamentales que beneficiaron a los inversores, hasta el desarrollo de las fábricas en el siglo XX. En cuanto al establecimiento de las fábricas, se analizará la configuración del espacio fabril y la consolidación de la tipología industrial como una nueva tipología arquitectónica en Brasil. La siguiente sección analiza la implementación de establecimientos industriales y los estilos arquitectónicos empleados en la arquitectura industrial brasileña, así como las técnicas y sistemas constructivos comunes. Además, se presentan proyectos influyentes en la arquitectura industrial nacional, cuyos autores se destacaron por las soluciones innovadoras utilizadas en los edificios que caracterizan la modalidad de la arquitectura industrial en Brasil.

Palabras clave: Arquitectura Industrial. Industrialización Brasileña. Tipologías Industriales. Técnicas y Sistemas Constructivos. Proyectos y Arquitectos.

1 INTRODUCTION

The study entitled "Industrial Architecture in Brazil" is part of the final report of the Post-Doctorate in Architecture and Urbanism with the Graduate Commission of the Faculty of Architecture and Urbanism of the University of São Paulo (CPG FAUUSP) entitled: "The architecture and industrial archaeology of the Central Mills and Power Plants in France and Brazil: recovery of the architectural memory of the Central Mill of Piracicaba", under the supervision of Prof. Dr. Beatriz Mugayar Kühl. The purpose of this research is to analyze the formation, development and consolidation of Brazilian industrial architecture, understanding it as a concrete expression of the economic, technical and social transformations that accompanied the process of national industrialization. It is based on the understanding that industrial architecture goes beyond the functional and technological dimension of factories: it constitutes a historical and cultural document, capable of revealing the relationships between territory, work, modernization and identity.

The proposed approach seeks to situate industrial architecture in the broader context of the country's modernization dynamics, showing that factory buildings are direct products of production processes and, simultaneously, agents of transformation of urban space. Factories and industrial complexes have contributed to shaping new landscapes and ways of life, establishing physical and symbolic landmarks in cities. In this sense, industrial architecture is understood as a specific form of expression of technical advancement and social organization, but also as an instrument for reading the urban and territorial history of modern Brazil.

Throughout the work, the historical path of Brazilian industrialization is described, from the colonial period, when manufacturing activities were prohibited, to the consolidation of the large manufacturing complexes of the twentieth century. Each stage of this path is linked to different economic and political contexts, such as the coffee cycle, European immigration, the advent of railroads and the industrial incentive policies of the governments of Getúlio Vargas and Juscelino Kubitschek. The main objective is to identify and understand the architectural typologies, construction systems, forms of implementation and technical agents that contributed to the constitution of industrial architecture in the country.

It seeks to demonstrate that, although marked by technological and financial dependence on European countries, Brazilian industrialization was able to generate its own architectural solutions, the result of a process of appropriation and creative adaptation of external models to local conditions of climate, materials and labor. Thus, national industrial

architecture is interpreted not as a mere reproduction of foreign paradigms, but as the result of a dialogue between tradition and modernity, between imported technique and regional constructive knowledge.

The research is justified by the conviction that industrial architecture constitutes a cultural heritage of high relevance, still little recognized in the field of preservation. Such buildings represent material testimonies of a period of profound transformations in the Brazilian territory, when manufacturing production began to order new forms of urban occupation and to redefine the role of medium-sized and inland cities. The factories, warehouses and workers' villages configure complex cultural landscapes, in which memory, technology and social life are intertwined.

Understanding this architectural heritage is essential for reading the process of national modernization and also for valuing the material expressions of work and production. In this sense, the study seeks to contribute to the expansion of the recognition and preservation of the Brazilian industrial heritage, affirming it as an important integral part of the collective memory and as a fundamental component of the urban, economic and cultural history of the country.

2 METHODOLOGY

The research was conducted through a historical-analytical approach, which combines bibliographic survey, documentary study and typological analysis. It is based on fundamental authors, such as: Santos (2006), Azevedo (2009; 2010), Maffei (1982), Padin (2009) and Rufinoni (2004), to reconstitute the context of industrialization and the architectural models that served as a reference for Brazilian factory constructions. At the same time, comparative readings of buildings and industrial complexes were carried out, considering the implantation, materials, techniques and formal language. This methodology allowed the correlation of the technical and spatial aspects to the territorial and social dynamics of each period.

With this approach, we sought to articulate history, technique and territory, treating industrial architecture not only as a product of engineering and economics, but as a symbolic expression of the country's modernization. Thus, the study proposes a critical reflection on the cultural value of the Brazilian industrial heritage and reinforces the need to integrate it, in a more systematic way, to the preservation policies and the construction of the national collective memory.

3 RESULTS

3.1 HISTORY OF BRAZILIAN INDUSTRIALIZATION

Since the beginning of the colonization process of the Brazilian territory by the Portuguese in the sixteenth century, Portugal's economic interests were related to the extraction of minerals and vegetable raw materials, such as brazilwood, and later to the acclimatization of sugarcane for export production. Thus, after a long period of prohibition on factory production, Brazilian industrialization officially began a century later than the Industrial Revolution, however, in the same period of implementation as Portugal, also backward compared to England and France.

Santos (2006) observes that the implementation of industries in Brazil has always involved political control, since the Portuguese colonial system dominated by British mercantilism, which did not accept initiatives that represented some competition in the market. Thus, the Brazilian economic subjugation meant the occurrence of an industrial architecture that was technically and chronologically outdated, in comparison with the development of the industrial system in England and the United States.

Authors dedicated to the study of industrialization establish periods or time frames to characterize different technical and sociocultural conjunctures, with each period representing a proposal for understanding the ruptures in the social and economic structure, as well as the type of energy and technical innovations used (SANTOS, 2006).

Azevedo (2010) understands the Brazilian industrialization process in four main periods, which make it possible to perceive the advances and setbacks in production, and also in industrial architecture. The first period, between 1785 and 1808, is known as the 'Prohibition' phase; the second period, from 1808 to 1930, is called the 'Implantation' period; the third period, between 1930 and 1956, is called the phase of the 'Brazilian Industrial Revolution'; while the fourth period, after 1956, is called the stage of the 'internationalization of the Brazilian economy'. The author also considers that, from the 1980s onwards, a process of deindustrialization began in Brazil.

The initial period, between 1500 and 1808, is known as the "Prohibition", because there was a restriction on the development of industrial activities in Brazil, with only small factories of spinning, footwear and containers for internal consumption being allowed, justified by the distance between Portugal and the colony. In this sense, Azevedo (2010) states that soon after the Portuguese discovered the Brazilian territory, an extremely open economy developed, oriented to the production and export of sugar to Europe, where a new

and respectable surge of urbanization was occurring, demanding greater demand for this product. For the author, the rupture related to the dominant functioning of the economy at that time is important, initiating the transformation of the subsistence economy and food assistance to the Kingdom, to an economy aimed at mercantile profit; and consequently integrating Brazil as a new production space (AZEVEDO, 2010).

On the other hand

the structuring of this sugar economy is already associated with the emergence and increase of conflicts of interest - namely, the trend towards monoculture, on the one hand, and the needs of diversified agriculture, on the other; the regulation of the export trade by the king and, with a tendency to oppose it, the liberal desire of the big merchants - which configures the capitalist dynamics that are beginning to emerge in other parts of Europe (AZEVEDO, 2010, p. 20).

The first isolated experiences occurred in the Northeast, however only with the implementation of the Captaincy of São Vicente, by its donee Martim Afonso de Souza, favorable conditions were created for the installations and proper functioning of the first mills on the south coast of the country. from 1532².

One of the first three sugar mills in Brazil - Engenho do Governador - was built in 1533, on the initiative of Martim Afonso de Souza, together with Jan Van Hielst, Francisco Lobo and Vicente Gonçalves, constituting the Sociedade Armadores do Trato³. It was strategically located at the foot of Morro Nova Cintra, to be supplied with water from the north slope by a channel that disappeared in a landslide. Later, in 1557 it belonged to Erasmo Schetz and Sons, from Antwerp in Belgium, when it was renamed São Jorge dos Erasmos (figure 267) and had its period of greatest sugar production in the place, until at least 1580. From the beginning of the seventeenth century, the mill suffered the effects of the decline of the sugar culture in Brazil, being under the administration of Schetz's heirs until 1603. However, around 1615, the mill would have been destroyed by a fire caused by the Dutch pirate Joris Spilbergen, reduced to ruins since then⁴.

² VOICES OF THE MILL. Available at: <<http://www.engenho.prceu.usp.br/vozes-do-engenho/>>. Accessed on 21 Jan. 2021.

³ Contrary to what is commonly thought, the Engenho dos Erasmos is the third built where the city of Santos is currently located. The first was the Engenho de Madre de Deus (1532), by Pero de Góes; and the second was the Engenho de São João (1533) by José Adorno, near Morro de São Bento (ENGENHO DOS ERASMOS (1). Available at: <<http://www.pimentel.jor.br/santos/fotos114.htm>>. Accessed on 21 Jan. 2021).

⁴ The ruins of the old mill were donated Octávio Ribeiro de Araújo in 1958 to the University of São Paulo, which restored the best preserved unit (LICHTI, Fernando Martins. **One of the first mills**. Available at: <<https://www.novomilenio.inf.br/santos/h0133g.htm>>. Accessed on 21 Jan. 2021 and ENGENHO DOS ERASMOS (1). Available at: <<http://www.pimentel.jor.br/santos/fotos114.htm>>. Accessed on 21 Jan. 2021).

Figure 1

Ruins of the Erasmos Mill



Source: <http://condephaat.sp.gov.br/benstombados/ruinas-do-engenho-dos-erasmos/>

In addition to the Erasmos Mill, Melo (2009, p. 9) points out that in 1534, six mills operated on the coast of São Paulo, rising to 11 units in 1557. However, in the first two centuries of Portuguese colonization, production and export farming did not prosper in São Paulo.

The development of sugar production in the North of the Colony led to the decline of Vincentian production, as its mills were reduced to four in 1585, and were deactivated at the beginning of the seventeenth century.⁵

The first mills implanted in the Northeast region were initially concentrated in two locations: in Pernambuco, from Olinda, developing to the south, to Penedo and to the north, to Goiana, going to Paraíba and Rio Grande do Norte; and in Bahia, from Salvador to the entire Recôncavo Baiano (Andrade, 2007, p. 15). The result of the sugarcane expansion is known as the "sugar civilization", as it determined the forms of implantation and development of the settlement of rural and urban centers in this region.

During the seventeenth century, the Captaincy of Pernambuco had a considerable production, in about 150 mills, representing most of the sugar production of the entire colony, enough to fill between 80 and 90 large vessels per year, from the port of Recife to Europe (Menezes, Muniz and Silva, 2012). Thus, since the sixteenth century, a production considered pre-industrial was configured in Brazil, in which the productive scale no longer refers to the small dimensions imposed by its previous artisanal character (AZEVEDO, 2010).

According to Hardman and Leonardi (1982),

[...] during the first three centuries of our history, industrial activities (here understood

⁵ QUEIROZ, Suely Robles Reis de. Some notes on the sugar plantation in São Paulo in the colonial period. *Annals of the Paulista Museum*, Volume XXI. São Paulo, 1967, pp. 112-117.

in the generic sense of the term) were practically reduced to the manufacture of sugar in the mills and to mining. The techniques used in both cases were quite rudimentary, with little difference between the process of making sugar and brandy in the sixteenth century and the beginning of the nineteenth century [...]. During the long colonial period, a series of other artisanal and manufacturing industrial activities were developed here, but all of them with an accessory activity, occupying a secondary role in the economy as a whole (HARDMAN and LEONARDI, 1982, p. 24).

In summary, the few primitive manufacturing enterprises were dedicated to extractive activities, with the function in the production chain, of supplying the raw material, that is, various ores and vegetables such as Pau-Brasil, as well as semi-processed agricultural products, especially sugarcane (SANTOS, 2006).

In the second half of the eighteenth century, some iron and fabric industries developed, and began to compete with the court trade, threatening to make the colony financially and politically independent, leading D. Maria I to extinguish in 1785, all textile manufactures in the colony, except for that of thick cloths, which were used by slaves and workers (AZEVEDO, 2010).

The second period, between 1808 and 1930, is called "Implantation", when the Portuguese royal family moved to Brazil, and Brazilian ports were opened to foreign trade, with a rate of 24% for imported products and 16% for the Portuguese. With the establishment of 15% for English products in 1810, local industrial development became minimal as a result of competition from imports from England, which predominated in the Brazilian consumer market. At that time, Azevedo (2010) recalls, slavery was still in force and there were few free and salaried workers to consolidate a consumer market. Furthermore, the investing elite of the coffee market was not yet willing to invest in industrial activity.

Considered the first factory installed in Brazil, the Real Fábrica de Ferro Ipanema (figure 268), was created by Royal Charter in 1810, starting to operate in 1811, located in the dense forest of Morro de Araçoyaba (current Ipanema National Forest), in Iperó, region of Sorocaba. "Europeans, especially Spaniards and Portuguese, at the head of indigenous people and mamluks, removed from ovens a pasty and incandescent mass that was taken to the mallet and transformed into bars" (TOMAZELA, 2007, A 29 apud PADIN, 2009, p. 48).

Figure 2

Real Ipanema Iron Factory in Iperó, SP



Source: <http://www.ipatrimonio.org/ipero-real-fabrica-de-ferro-de-sao-joao-de-ipanema/#!/map=38329&loc=-23.425597000000014,-47.59790254,17>

In addition to the Royal Iron Factory of São João de Ipanema, in the Province of São Paulo, the Prata Iron Factory (1812), the Morro do Pilar Factory (1812) and the São Miguel de Piracicaba Factory (1827) were also created, these in Minas Gerais (CORREIA et al, 2006).

Coffee growing became the main Brazilian economic activity from 1840 onwards, constituting a source of accumulation of the capital necessary to promote industrial activities (SANTOS, 2006), including those related to the export of coffee such as the production of cloth bags for the storage of beans.

In this sense, the textile industry received tax incentives in 1846 and, in the following year, raw materials in general also received it. However, the local industry was not yet able to develop in a country with a slave regime, with scarce availability of free and salaried workers, also representing a timid consumer market (PADIN, 2009).

Brazilian industry, dependent on the import of capital goods, mainly machinery, still had unqualified labor. In 1850, the Eusébio de Queirós Law prohibited the slave trade, causing important consequences for industrial development, especially the availability of capital, previously used in the purchase of slaves, in the industrial sector (AZEVEDO, 2010).

According to Padin (2009), Brazil's entry into the industrial market, with development of significant proportions, occurred only from the 1850s onwards, remembering that, in addition to Great Britain, even in 1880, the Industrial Revolution had not yet reached many countries, such as Germany and Portugal, which entered the industrial stage in 1870, and the United States during the years following 1860, achieving a firm structure only at the end

of the century⁶.

Santos (2006) considers that in São Paulo, the inaugural moment of its modern industrialization occurred in 1866, from the inauguration of the São Paulo Railway - SPR, the future Santos-Jundiaí Railroad, also a milestone in São Paulo's urbanization. Until then, coffee exports were carried out via the port of Rio de Janeiro, the capital of the Empire, from where coffee extended from the end of the eighteenth century to the Paraíba Valley of São Paulo in the nineteenth century. from where the product was sent to the main importer, the USA. However, the political and economic frameworks changed, elevating the capital of São Paulo to the center of capital, infrastructure and labor force and, later, the most dynamic Brazilian industrial center (SILVA, 1986; SANTOS, 2006).

Reis Filho (1990, p.6) describes the period between the 1860s and 1890s as the time of the establishment of the first large factories in the State of São Paulo, therefore before the occurrence of the great migratory currents. In that period, the textile sector was the one with the highest growth, partially favored by the growth of cotton cultivation, due to the lack of the American product in the market, while the Civil War occurred in the United States between 1861 and 1865. Thus, the North American conflict stimulated cotton production in the province of São Paulo since the 1860s and, in turn, the abundance of this raw material instigated its industrialization, and by the end of that decade, the first textile industries were already installed in the interior of the province and, in the capital of São Paulo, in the following years (PADIN, 2009; AZEVEDO, 2010).

Along these lines, Santos (2006) considers that the factories installed in Brazil reached the technical level defined from the First Industrial Revolution in Europe, only since the last three decades of the nineteenth century, still in the Imperial period. After the development of an economy basically supported by agriculture, mainly for the production of sugar and coffee, the industrialization of São Paulo was made possible by the profits obtained from the commercialization of coffee in the foreign market (AZEVEDO, 2010).

Dean (1971, p.10) points out that coffee production initiated the monetary economy, the first prerequisite of an industrial system. With the surplus money added to the export of coffee, fundamental improvements for industrialization were funded, such as railways, trams and electricity and gas networks, in addition to promoting social transformation.

⁶ FORBES, Robert James. Energy until 1850. In *The Invention of the Steam Engine*. São Paulo, 1972, p.73.

The coffee agroindustry, in full development⁷, needed labor, stimulating considerable European immigration, which brought new techniques of manufacturing production, being the first salaried (organized) labor force in Brazil. Immigrants established an effective consumer market essential to industrial development, in addition to a specialized workforce (AZEVEDO, 2010).

The immigration policy instituted by the government also boosted the coffee culture in the first republican period, with the demographic growth and productive capacity of São Paulo, in rural and urban areas, conquering a significant domestic market. São Paulo also asserted itself as a commercial and financial center of great influence, when a considerable part of the coffee elite began to reside in the capital, diversifying its business, investing in commercial and manufacturing activities, through Corporations, mainly in the textile and food sectors, also linked to the coffee complex (SINGER, 1977; SANTOS, 2006).

Maffei (1982, p.13-14), in turn, points out that 1870 was the year of the beginning of the implantation of industry in the State of São Paulo and divided the phases of Industrial expansion of São Paulo into five periods, comprising, respectively, up to the decade in which his research is inserted: first period, from 1870 to 1920; second period, 1920 to 1940; third period, from 1940 to 1955; fourth period, from 1955 to 1965; and fifth period, from 1965 to 1980. According to the author, the initial period consisted of the textile, leather and skin, wood, metallurgy, ceramics, chemical products, food, clothing and furniture industries.

In this context, the textile industry is considered by Arantes Santos (2011) to be responsible for the pioneering spirit of modern industry in Brazil. The first weaving company in São Paulo was the Companhia Industrial, founded in 1874 by Major Diogo de Barros. The factory employed 400 workers and had about 150 looms and a generator that produced electric lighting inside from 1880 onwards, allowing night work - a solution later adopted by the large factories in São Paulo (REIS FILHO, 1990, p.6).

Azevedo (2010) points out that the first industrial boom in Brazil occurred in the 1880s, when the number of establishments went from 200 factories in 1881 to 600 units in 1889, inaugurating the process of import substitution. Reis Filho (1990, p.6) also observes that:

[...] It was after 1889, with the establishment of the Republic, that it became simpler to create companies and multiplied the workshops and industrial facilities. From that moment on, small businesses, founded by immigrants, gained importance (apud

⁷ Funded by coffee, the School of Law (1830) was founded and, before the First World War, the schools of Engineering, Commerce, Medicine and Biology (Dean, 1971 in Padin, 2009).

PADIN, 2009, p. 50).
For Padin (2009) this idea

it comes from the fact that between 1890 and 1900 the city of São Paulo had its population composed of 50% immigrants and in some factories 90% of the workers were Europeans. In the first decades, however, the factories were created by the richest families, linked to mercantile activities and coffee production. Among the most important names are: Silva Prado, Aguiar de Barros, Penteado or Lacerda Franco, Rodovalho or Pacheco Jordão, Souza Queiroz and Souza Aranha. The first immigrants of equivalent weight then appeared at the end of the century: Matarazzo, Crespi, Scarpa and Siciliano (PADIN, 2009, p. 50).

However, at the end of the nineteenth century, while the Second Industrial Revolution was developing in Europe, as a result of the inclusion of scientific knowledge in industrial techniques, creating new technologies, Brazil was still a century behind, compared to industrially developed countries, due to the absence of significant foreign investments in industrial production, with exceptions in the sugar industry. until the end of the nineteenth century (SANTOS, 2006, p. 26; PADIN, 2009).

In the period between 1880 and 1930, the installation of light industries of non-durable consumer goods predominated, giving rise to Brazilian industrial capital, from national mercantile capital, directly linked to the agro-export sector. Santos (2006) considers industrialization as typical of the republican period, especially after the 1930s, when the agro-export economic model based on coffee cultivation went into decline with the crisis of the New York Stock Exchange, installed in 1929. This condition was accentuated due to the difficulties in importing industrialized products during the two World Wars, stimulating factory production to supply the domestic market, especially in Rio de Janeiro and São Paulo, and for export (SINGER, 1977; CANO, 1995; SANTOS, 2006).

Between 1920 and 1940, the second period highlighted by Maffei (1982) developed in different ways in the two decades. In the first decade, growth was slow due to the lack of a tendency towards the concentration and organization of associations controlling prices and production; while in the second decade, exports expanded and growth accelerated. It was in 1939, in this period, according to the author, that the value of industrial production exceeded that of agriculture by 30%.

The sectors that grew the most were cotton, cement and iron fabrics, among the sectors of execution of

mineral products, vegetable products, metallurgical, mechanical, transformation of non-metallic ores, wood and related products, paper and cardboard, rubber, vegetable oils and greases, hides and skins, pharmaceutical chemicals, hair and feathers, textiles, clothing and footwear, food products, beverages and stimulants, civil construction, electricity products, publishing and printing (MAFFEI, 1982, p. 14).

The Third Period, from 1940 to 1955, according to Maffei (1982) was marked by the Second World War, which hindered imports, directing the material possibilities to domestic production, with the objective of meeting the expanding domestic market.

For Azevedo (2009), the phase known as the Brazilian Industrial Revolution comprises the years from 1930 to 1956, marked by the Revolution of 1932 and by the internal policies of the Vargas government that operated changes in order to remove from the power of the State, the traditional oligarchies that represented agrarian-commercial interests. The federal government adopted an industrializing policy, promoting the replacement of immigrant labor by national labor, formed in states in the Southeast, such as Rio de Janeiro and São Paulo, Minas Gerais, and also in Rio Grande do Sul, due to the rural exodus resulting from the decadence of coffee, in addition to migratory movements from the Northeast. The author reinforces that Vargas made investments in industrial infrastructure by implementing basic industry and increasing energy generation; even creating the National Petroleum Council - CNP, the National Steel Company - CSN, the Vale do Rio Doce Company and the São Francisco Hydroelectric Company.

Azevedo (2010, p. 16) points out that it was characteristic of many of the industries created after the First World War, to only assemble parts produced and imported from abroad, being subsidiaries of foreign headquarters. Later, at the beginning of World War II, growth slowed as a result of the impossibility of importing equipment and machinery, highlighting the importance of the Capital Goods Industry. "Despite this, our exports continued to be maintained, leading to an accumulation of foreign exchange. The national raw material replaced the imported one. By the end of the war, there were already industries with national capital and technology, such as auto parts."

While in the first decades of the twentieth century there was a predominance of the consumer goods industry, other types of industrial activity that required technological apparatus began to develop in the 1940s, such as minerals, metallurgy and steelmaking, including the production of steel by CSN from 1946 onwards, which expanded the industrial development of the country, as steel is the basis for several industrial branches (AZEVEDO, 2010).

Serious problems hindered Brazilian industrial development from 1950 onwards, such as the lack of energy⁸, low oil production and deficiencies in the transport and communication system. However, Azevedo (2010) points out that in the second Vargas government (1951-1954), developmental projects based on state capitalism, through public investments in the extinct Brazilian Coffee Institute - IBC, in 1951, in addition to the BNDES, among other agencies, left important subsidies for Juscelino Kubitschek's Plan of Goals, with the high cost of internationalization of the Brazilian economy (AZEVEDO, 2010).

Santos (2006) considers that one of the characteristics that best defines this historical moment is the use of Technology, that is, the incorporation of scientific knowledge into industrial techniques and processes, as well as the administration and organization of work. The invention of the combustion engine and the use of electric energy in machines made it possible to expand production capacity, in addition to the application of knowledge of modern Physics and Chemistry to the transformation process (SANTOS, 2006).

As a result, new productive sectors were asserted, such as petrochemicals and automobiles. According to Santos (2006) also

The Economy of Scale was set up, which, in the face of the phenomenon of accelerated urbanization, consolidated mass consumption and planetary coverage. Associated with mass consumption, the Cultural and Entertainment Industry emerged, applications of mechanisms and inventions related to the mechanical production of images and sound records (SANTOS, 2006).

The fourth period, from 1955 to 1965, according to Maffei (1982) is characterized by the manufacture of production goods: machinery, equipment, motor vehicles and heavy raw materials. New sectors of activities were created: automotive, plastics, heavy chemicals, petroleum products, petrochemicals, machinery and tools, heavy boilermaking, electronic equipment and household appliances.

In this sense, the fourth period, according to Azevedo (2010) is recognized as a phase of internationalization of the Brazilian economy, due to the policies of the Kubitschek government's Plan of Goals, which from 1956 onwards began to dedicate two thirds of the resources to stimulate the energy and transportation sectors. It was at this time that the road sector developed intensely and the production goods industry also grew, from 37% to 63% in relation to the consumer goods area, with reflection, mainly in the steel, metallurgy

⁸ According to Azevedo (2010), in order to correct these problems, the São Francisco Hydroelectric Company was founded, among others.

(automobiles), chemical, pharmaceutical, and shipbuilding sectors (implemented in Rio de Janeiro in 1958).

Azevedo (2010) points out that in this phase the internationalization of the Brazilian economy grew, based on the actions of multinationals, whose foreign capital was attracted by exchange, tariff and tax incentives offered by the government. However, the political crisis in the early 1960s, after the resignation of Jânio Quadros (1961), was prolonged by the political pressures faced by his successor, João Goulart (1961-1964), in the face of the economic reforms provided for in the Triennial Plan. In addition, political unrest and inflation, combined with a favorable international political circumstance, led the country to the coup d'état in 1964⁹ (SANTOS, 2006; AZEVEDO, 2010).

The fifth period, from 1965 to 1980, for Maffei (1982) was characterized by enormous industrial expansion with the doubling and diversification of production, with total opening of the economy to foreign capital, combined with the enormous investment of multinationals from Japan, the United States, Germany, Italy, France, Great Britain, Holland and Sweden.

In the military government, as for the economic model, there was not a break with developmentalism, but a peculiar stage of the process of industrial updating, which had been initiated by Vargas and remained in the Dutra and JK governments. The military continued to implement heavy industry and infrastructure, such as the production of electricity, steel, petrochemicals; necessary for the formation of sectors producing intermediate goods, consumer goods and capital, in addition to the opening of highways, in order to ensure the conditions for the expansion or growth of its business to the private sector (CANO, 1995; SANTOS, 2006; AZEVEDO, 2010).

After the initial recessionary period (1964-1967), the military government was strengthened related to the Latin American geopolitical context in the international circumstances of the Cold War, which guaranteed to associate national and international capital, sponsored by the public power with various actions that created public and state-owned companies and also encouraged the installation of transnational corporations with investments in infrastructure (transport, telecommunications and energy). Such actions¹⁰ were translated into the 'Brazilian Miracle' or 'Economic Miracle' (1968-1974), as a product of

⁹ The coup triggered a military dictatorship in 1968, with Institutional Act No. 5 (AI 5), which closed the National Congress, ending legislative activities. The military regime only ended 20 years later, economically and politically exhausted, like the developmentalism that sustained it (Santos, 2006).

¹⁰ The 'Brazilian Miracle' is related to two plans drawn up during the military governments with the objective of guiding economic development and correcting imbalances in the adopted model: the first and second National Economic Development Plan (PND I and PND II), implemented from 1972 to 1979 (SANTOS, 2006).

economic restructuring (CALDEIRA, 1997 in SANTOS, 2006, p. 30).

Maffei (1982, p. 22) informs that in the 1970s

There was a great expansion of some sectors that until then were implanted in the Greater São Paulo region, and with the need for expansion created new factories outside the Rio-São Paulo hub, São José dos Campos, Pindamonhangaba, Taubaté and other municipalities in the Paraíba Valley. They also expanded to the coast, along the Anchieta-Imigrantes complex and occupying the remaining areas of the municipalities of São Bernardo, Santo André, São Caetano, Diadema and Rio Grande da Serra up to the dams at the beginning of the Serra do Mar.

In that period, the durable and non-durable consumer goods industry expanded, with the production of sophisticated products such as airplanes, computers, calculators, microprocessors, as well as steel, iron, cement and oil. The export of manufactured products was also stimulated through government incentives. In 1979, exports of industrialized and semi-industrialized products surpassed exports of primary goods, such as agricultural products, minerals, and raw materials (MAFFEI, 1982; AZEVEDO, 2010).

Direct and indirect investments by foreign capital grew in Brazil, but this growth was proportional to the progressive indebtedness, causing a slowdown in the initial growth, added to the exhaustion of the authoritarian regime, with an inflationary process and external indebtedness (SANDRONI, 1999 in SANTOS, 2006, p. 31).

After a period of rising inflation, with the military already out of command of the State, the Cruzado Plan, which although it had implicit electoral objectives, was launched on February 28, 1986, by the Sarney government, and was characterized as an attempt to promote the growth of Brazilian economic production without going through the painful fiscal and monetary austerity that would be the trademark of the Real Plan. in 1994. However, the customs protection that existed at the time, restricting imports, led to shortages, especially of basic necessities, promoted by oligopolized sectors of the economy, which condemned the economic plan to failure, despite their policy of keeping the exchange rate frozen and, with the real interest rate low, the GDP had experienced an unprecedented bubble of internal consumption in its history (AZEVEDO, 2010).

According to Azevedo (2010), the adjustment of public accounts after the Real Plan and the adoption of political and legal measures to support micro and small industry, as well as the entry of foreign capital attracted by the privatization programs of state-owned companies, made venture capital investment in the industrial sector attractive. The author

considers that the desired stability in the rules of the economy during the mandates of Fernando Henrique Cardoso and the decision of his successor, Luís Inácio Lula da Silva, to maintain the same rules of the economy also contributed to this (AZEVEDO, 2010).

3.2 INDUSTRIAL TYPOLOGIES IN BRAZIL:

From the industrialization process initiated since the Industrial Revolution in Europe, new architectural typologies were developed with the aim of meeting the needs of the new factories. In Brazil, the first initiatives followed the traditional patterns arising from the old manufacturing facilities, until there was a need to import large machinery, which brought with it the requirement for adequate projects for the construction of manufacturing buildings according to the various production chains.

With regard to the typological analysis of Brazilian industries, there is a great variety of factory types that distinguish them in time and space. Arantes Santos (2011) recognizes as conditioning factors for the development of industrial buildings, the political, economic and technological moments, in terms of the priorities of a given time and the conditions that the country offered for technological innovation (Arantes Santos, 2011).

As for the typological aspects, according to Hardman and Leonardi (1982), it is possible to recognize two precursor typologies of industrial architecture in Brazil, which served as a model for the construction of several manufacturing centers in the territory of São Paulo. The first typology developed was called 'Brazilian colonial', in which the façade is configured in a similar way to that of a large farmhouse for the production of sugar or coffee, characteristic of the first mills.

According to Azevedo (2009), the configuration of the primitive sugar factories in Brazil was basically the result of technological factors of production, which did not show much variation throughout the colonial period. As an example, the Engenho São Jorge dos Erasmos, one of the first three built in Brazil in 1533 which, according to Luís Saia's report to the DPHAN in 1966, had an architectural design of the Azorean model, of the real type (powered by water), with successive platforms to overcome differences in level, with porch access, and all facilities arranged below the same roof, in an agglutinated party¹¹. Saiah's hypothesis (1966) is confirmed in a document dated 1548, belonging to the 'Archives

¹¹ It was donated in 1958 to the University of São Paulo (CONDEPHAAT. *Ruins of the Engenho dos Erasmos*. Available at: <<http://condephaat.sp.gov.br/benstombados/ruinas-do-engenho-dos-erasmos/>>. Accessed on 21 Jan. 2021).

Généraux du Royaume de Bruxelles'¹² and, translated by prof. Eddy Stols, about this device:

[...] a very large house of 6 flights and a slave quarters with a blacksmith shop, all provided with bastions, and also two houses covered with tiles, very good and strong [...] all these houses rise at one height and all together and close together in such a way that no farm is so strong for the opposites¹³.

About the operation of the primitive São Paulo mills, archaeological records found at the site of the Engenho dos Erasmos, such as the stone millstone and the shapes of sugar loaf are the main remaining evidence, according to archaeologist Margarida Andreatta, responsible for the excavations¹⁴.

The millstone is a wheel about one meter in diameter that made the axles rotate with which the sugarcane was crushed to obtain the juice. It was driven by animals or slaves.

Another important piece for the historical reconstruction of the mill are fragments of the sugarloaf molds, which the researchers are trying to reconstruct. These molds - cones with a hole at the end - received the boiled sugarcane juice and stored it for 45 days, after which the 'bread' (block of hardened sugar) was removed. The 'bread' was cut by the slaves so that the 'noble' parts of the sugar - intended for export - were separated from the part that mixed the sugarcane bagasse and impurities - intended for the slaves' food. The noble part of the 'bread' was lighter and was deposited in the top layer of the sugar block. At the bottom, darker brown sugar was deposited¹⁵.

As for the installations, a niche embedded in one of the walls indicates the probable location of the chapel of the mill; five stone thresholds, one of which has marks in the shape of a half semicircle, indicating the movement of the doors of one of the rooms of the probable house of the lord of the mill. Also, in the remaining walls, there are vertical rectangular holes - the 'arrows' that served so that the occupants of the room could observe occasional external threats and shoot enemies without being hit by those who were outside¹⁶.

The Engenho dos Erasmos is considered the only remnant in the world of the Azorean-style mills, coming from the Azores Archipelago, where the Portuguese developed their sugar

¹² LICHTI, Fernando Martins. *One of the first mills*. Available at: <<https://www.novomilenio.inf.br/santos/h0133g.htm>>. Accessed on 21 Jan. 2021.

¹³ SIQUEIRA, Fausto. *The first factory in Brazil*. (1996). Available at: <<http://www.pimentel.jor.br/santos/h0133f.htm>>. Accessed on 21 Jan. 2021.

¹⁴ FOLHA AGENCY. *Dutch pirate destroyed mill*. (1996). Available at: <<http://www.pimentel.jor.br/santos/h0133f.htm>>. Accessed on 21 Jan. 2021.

¹⁵ FOLHA AGENCY. *Research finds sugarloaf pan*. (1996). Available at: <<http://www.pimentel.jor.br/santos/h0133f.htm>>. Accessed on 21 Jan. 2021.

¹⁶ Ibid..

industry. In comparison, the northeastern mills, after that of the Erasmos, built their buildings separately for each function, in a typology specific to the Brazilian mills¹⁷.

The architecture of the buildings did not undergo major changes until the imperial period, when, from the incorporation of new construction techniques, the introduction of the steam engine and new purging processes, the area and the floor shape of the manufacturing spaces underwent some changes, with the adaptation to the new productive capacity of the mills, although the architecture of the traditional mill was not essentially altered (AZEVEDO, 2009).

Azevedo (2009) cites as an example the Bahian mills of the first half of the nineteenth century, whose main architectural characteristic is the factory in the shape of a shed, with a rectangular plan configured by three or more naves, covered by only one hipped or four-pitched roof, which is supported by masonry supports or pillars. The central nave was generally supported by wooden scissors with a span of up to 12m, while the lateral ones were supported by beams or half-scissors, overcoming spans of up to 6m. In addition

Many factories had balconies on one or two sides of the shed. It is worth mentioning that these constructions appeared in the Recôncavo as early as the eighteenth century, but only became widespread in the following century. The scissors in the central span were generally of the pig yoke type, formed by two legs connected at mid-height by a tie rod. The thrust produced by these imperfect scissors was absorbed by the side ships (AZEVEDO, 2009, p. 117).

Also in Bahia, most of the mills located in the Jaguaripe River basin have an integrated party, with the big house and the factory in the same construction. However, in other cases, all the factory functions are brought together in a single space and the mill house remains isolated, in many cases, also fulfilling other functions (AZEVEDO, 2009).

The sugar production facilities were divided into two or even three independent buildings where milling, cooking and purging were carried out, since the sixteenth century. Azevedo (2009) understands that apparently the solution with the milling house and boiler together and the separate purge house predominated, whose scheme prevailed in the nineteenth century, in the traditional sugar production area of the Recôncavo Baiano, and generally, the two constructions were arranged parallel to each other or forming an 'L', when combined.

¹⁷ FOLHA AGENCY. *Dutch pirate destroyed mill.* (1996). Available at: <<http://www.pimentel.jor.br/santos/h0133f.htm>>. Accessed on 21 Jan. 2021.

Azevedo (2009) highlights the introduction of the in-line furnace, ending in a chimney, known as the Jamaican train¹⁸, among the modernization elements that influenced the reformulation of the factory space in the nineteenth century:

This new type of furnace, in addition to the advantages it brought in the broth cooking stage, contributed to the reduction of the area of the old milling house and boilers, enabling better working conditions and compatibility with the purging activity, since it did not emit as much smoke and heat. Due to the ease of location, compared to previous furnaces, the equipment also allowed greater flexibility of the internal space (AZEVEDO, 2009, p. 120).

Steam¹⁹, which replaced the water wheel and animals as a driving force in the first half of the nineteenth century, is considered another important element introduced in traditional mills, serving mainly to drive the mills and as a heat transfer vehicle for the cooking of the juice. Its installation initially occurred in the milling houses, not requiring the reformulation of the factory space (AZEVEDO, 2009).

The spatial configuration of the mills was linked to the sugar manufacturing process, which basically consisted of three main stages: sugarcane grinding, juice cooking and purging, and each stage of sugar production was reflected in the architecture of the factories, specifically aimed at making sugar production viable; while the main house fulfilled the function of housing and the church, of a space of religious worship (MENEZES, MUNIZ and SILVA, 2012).

In addition to the traditional built complex, the mills had very complex structures, involving various functions related or not to sugar production. In this sense, sugar began to be produced in the mill - the building that housed the mill - responsible for extracting all the juice from the sugar cane and in the boiler house, where the juice was cooked (Menezes, Muniz and Silva, 2012).

Apart from the mill itself, several other buildings participated in the manufacturing process, such as the purge house, where the molasses resulting from the cooking of the broth rested for several days, until it was transformed into sugar. For the operation of the mill (figure

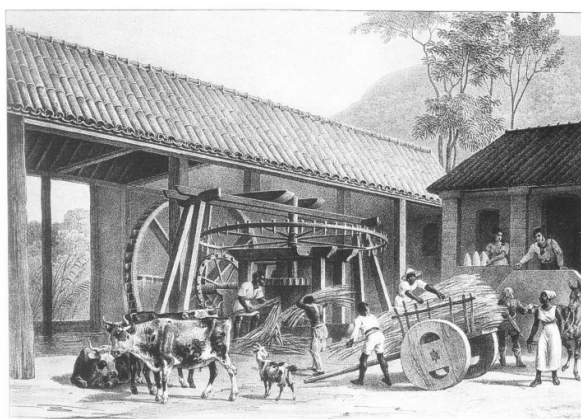
¹⁸ At the beginning of the nineteenth century, the Cuban sugar manufacture expanded the Jamaican train by adding two or three clarifiers, consisting of large cast iron vessels (1.75 m to 2 m in diameter), where the sugarcane juice was heated, without boiling, and lime was added for clarification. In the system, the solid elements of the juice were separated from the liquid by decantation (FRAGINALS, Manuel Moreno. *O Engenho. Cuban Sugar Social Economic Complex*. v.3. p. 215).

¹⁹ To obtain a vacuum in the closed cooking pans and in the equipment for drying the sugar, the pneumatic device patented by John Hagnes (FRAGINALS, Manuel Moreno. *O Engenho. Cuban Social Economic Complex of Sugar*. v.3. p. 215.).

272), it was necessary to have the support of pottery, carpentry, carpentry, among others, in appropriate places. As well as warehouses, to preserve equipment and the sugar produced, as well as sugarcane bagasse, used to feed the furnaces (MENEZES, MUNIZ and SILVA, 2012).

Figure 3

Sugar mill



Source: Rugendas (1835).

The banguê-type mills were moved by human or animal traction (trapiche mill) or by water wheels (royal mill). They produced brown sugar (demerara), which was then subjected to a bleaching process using clay, being destined for export. On the other hand, the mills that produced rapadura for the domestic market were called contraptions²⁰. According to Coelho de Souza (1970, p. 37; 38):

In the Banguês, at harvest time, the activity is intense. The reeds, brought by the carreiros in their oxcarts or by the money changers in their donkeys, go to the wooden mills. The juice, collected in large tanks, is taken to the boilers to be cooked over a raw fire. It goes, after cleaning, to the copper pots where it is thickened and beaten. Taken to the purging house, the molasses is placed in clay, wood or iron molds that, placed on perforated boards, let the honey drain that can be used for the manufacture of sugar de retame, or for the distillation of brandy in copper or clay stills.

In this way,

This produces an inferior type, raw sugar, which can be dried or molasses, purged, brown or retam. They are the same processes, the same routine and backward

²⁰ MUSEUM OF THE UMA. **Engenhos**. Available at: <<http://www.museudouna.com.br/engenho.htm>>. Accessed on: 21 jan. 2021.

methods that, through centuries, still persist in the primitive sugar industry of the Banguês. The decadence of these mills was not long in coming, overcome by the ever-increasing technique and industrialization (COELHO DE SOUZA, 1970, p. 37).

Beyond the Banguês

Others work, moved by water, with the three variants: "cupbearer", "covilhete" or "half cupbearer" and "rasteiro", depending on the place where the liquid falls on the wheel of the mill. Finally, the steam engines. In general, in the humid Northeast the colonial "banguês" and the large modern mills coexist (COELHO DE SOUZA, 1970, p. 37).

As for the housing segment, the owner of the mill and his family lived in the main house (or used it in seasons), which fulfilled the political and administrative function of the factory complex, in addition to being a symbol of the power and authority of the plantation owner (figure 274). Azevedo (2009) believes that it is possible that the older mill houses were very simple, since most of the investments were intended for the manufacture of sugar (AZEVEDO, 2009).

The enslaved labor lived in slave quarters and there were also houses for salaried employees. According to Simonsen (2005, p. 118), depending on the size, the mill could be similar to a small village, with the displacement of a large number of people to a given region, favoring the population increase in Brazilian lands based on its growth.

The mill represented a true village, requiring the use not only of many hands, but also the necessary lands of sugarcane fields, bush, pasture and supplies. In fact, from the mill house, the house of housing, slave quarters and infirmaries, it was necessary to have about a hundred settlers or slaves, to work in about twelve hundred massapê tasks (of nine hundred square fathoms), in addition to pastures, fences, vessels, utensils, iron, copper, oxen and other animals.

Figure 4

Megaípe de Baixo Mill



Author: José Wasth Rodrigues. Source: <https://www.behance.net/gallery/94554113/ENGENHO-MEGAÍPE>

In São Paulo, in the first phase of installation classified by Maffei (1982) between 1870 and 1920, the manufacturing facilities were still small and rudimentary, configured as small workshops.

As the space requirement due to the equipment was small, and they did not have problems of pollution or excessive noise, they worked in mansions, which were 2-story buildings with the same solution used for commercial houses, that is, at street level the workshops worked and on the upper floor, the office and sometimes, the owner's house, as is the case of the National Hat Factory on the street where Ladeira do Ouvidor is today, in the historic center of São Paulo, and the Schritzmeyer and Co. Hat Factory, on Quirino de Andrade Street, which began its activity in 1853 (MAFFEI, 1982, p. 28).

Following the European model of the first modern industries, recurrent to the already established, of a residential nature, simplified and adapted to its scale and the operation of the machinery, generally for factories founded in the Empire, the textile factory installed in buildings similar to rural manor houses (SANTOS, 2006). It had cotton cultivation on its own land, and manufacturing was configured as a kind of extension of agricultural activity with industrial capital originating from farmers, such as: the São Luiz Factory (figure 276) in Itu²¹ (1869) and the São Bento Factory in Jundiaí²² (in the period between 1874 and 1908, prior

²¹ The São Luiz Fabric Factory in Itu was the first steam factory in São Paulo and the second installed in the country, with machinery from the USA and England. Built in three distinct moments, the first part has colonial characteristics on the façade. The second, in greater proportion, added classicist elements such as the full arches; while the third part was built following the Manchesterian model (ESPAÇO FÁBRICA. Available at: <<https://espacofabrica.com.br/>>. Accessed on 26 Jan. 2021).

²² Companhia Fiação e Tecidos São Bento S/A was the first weaving company in Jundiaí, founded by Antônio de Queirós Teles as Companhia Jundiahyana de Tecidos e Cultura S/A, in 1874, being the first industry in the city, which became the national center of the fabric industry in the first half of the twentieth century. and name

to the reforms and expansion that correspond to the control of the company by French bankers) and the Votorantim Factory (Cachioni, 2013).

Figure 5

São Luiz Fabric Factory in Itu, SP



Source: <https://biblioteca.ibge.gov.br/biblioteca-catalogo.html?id=447266&view=detalhes>

Another industrial typology found in the Brazilian territory, according to Hardman and Leonardi (1982), is the one known as 'British Manchesterian' (factories created at the beginning of the twentieth century): in this pattern, the typical façade of exposed masonry, sober and heavy structure and symmetry of planes was common, presenting a modern system of factories fully implemented and manifesting the separation of agrarian capital and subordination to international capital (FAUSTO, 1977).

In this way, the 'Manchester factory system', characterized by the concentration of a productive mode in a single place, became the most expressive organizational model, as it provided the conditions for technology to become the priority element of capitalist accumulation, responding more adequately to the needs of the market (DECCA, 2004, p.70).

Miranda (2003) observes that varied typological solutions were built in the Brazilian industrialization in formation, in the early decades of the twentieth century: horizontal buildings for spinning and weaving; or vertical parts, for mills and grain processing plants. The implementation of these factories varies between peripheral to the lot or in line, with a program organized in only one building or in parts, and can be structured in iron, brick or concrete, whose lighting was usually provided by side openings with the help of *sheds*, skylights and lanterns (MIRANDA, 2003).

changes (S/A Industrial Jundiaense, São Bento, and Têxtil L'Affit S/A, ended its activities in 1989 (TECELAGEM SÃO BENTO. Available at: < https://pt.wikipedia.org/wiki/Tecelagem_S%C3%A3o_Bento>. Accessed on 26 Jan. 2021).

According to Miranda (2003), most of the factories built until the First World War were stripped, with modular markings on the structures, or a few frames with o'its and platbands. For the author, in the case of spinning and weaving, mainly, there are clear English and North American influences, disseminated through industrial catalogs of the early twentieth century, which suggested standardization of façade treatment solutions and spatial arrangements for floor plans, where the machinery would be installed. "In this picture, 'Manchesterian' influences are observed, where the brick was the seal and also the finishing of the building" (MIRANDA, 2003, p. 27).

In this line, according to Maffei (1982) the projects executed followed calculation standards and American projects, and the assemblers of metal structures copied American or English drawings, repeating without any alteration, structures made in England more than 50 years ago. Still, Miranda (2003, p. 30) states that

The organization of the volumes took place according to production: in line, in the alignments of the land with the central courtyard or even another structure of occupation of the lot, but characteristics such as free plan, modulation, high ceilings and standardization of the openings were almost constant. The vast majority of buildings of this period were defined in pavilions in sheds, with one or two floors structured in iron and perimeter walls of masonry.

Examples of this type of influence are the Nossa Senhora da Ponte de Sorocaba Factory (1881), the Votorantim Factory (1893), the Mariângela Factory of São Paulo (1907), the Società Per l'Expostazione e Per l'Industria Ítalo-Americana de Salto - Brasital²³ (from the expansion and transfer of the corporate name to this firm in 1904); the São Bento Factory after association with international financial capital in 1908; and the Francisco Matarazzo Industries in Água Branca in São Paulo (1920)²⁴, Santa Rosália Spinning and Fabric Factory (figure 281) in Sorocaba (1890), Santa Adélia Factory (figure 282) in Tatuí (1908), and Crespi Cotonifício (1897), among others (MIRANDA, 2003; CACHIONI, 2013).

²³ Brasital was formed by the merger of the old textile mills Jupiter (1895-97) and Fortuna (1898), and the paper mill (on the left bank of the Tietê River) purchased by the Italian company 'Società Ítalo-Americana per Importazione e Esportazione' in 1904. Its mills also boosted the industrial profile in the city. The Italian-American Factory was renamed Brasital, by combining the names Brazil and Italy, in 1919 (Valderrama and Oliveira, 2008).

²⁴ Indústrias Reunidas Francisco Matarazzo in Água Branca in São Paulo. In the early 1920s, they diversified the group's production, until then concentrated basically in flour and fabrics, in Brás. The railway branch integrated into the industry project improved the production transport system. Little remains of the old factory, as many buildings were demolished or abandoned, leaving practically the Boiler House (<http://www.ipatrimonio.org/?p=137#!/map=38329&loc=-23.525214999999996,-46.678043,17>).

Figure 6

Santa Rosália Spinning and Fabric Factory in Sorocaba. Built in 1890



Photo: Philip Gunn, 2001. Source: <https://www.scielo.br/img/revistas/anaismp/v19n1/html/a02fig16a> 20.htm

Figure 7

Santa Adélia Factory in Tatuí. Founded in 1908



Photo: Philip Gunn (2001). Source: <https://www.scielo.br/img/revistas/anaismp/v19n1/html/a02fig16a> 20.htm

Miranda (2003) informs that mills and silos, industrial types very common in Brazil, were built in smaller proportions than their North American counterparts, since the flour was still mostly imported. Between the end of the nineteenth century and the beginning of the twentieth century, based on foreign machinery, the activity of the mills often determined that their project was also carried out by foreign technicians, as well as in the central sugar mills. For this reason, the author points out that European standards used in the construction of mills adapted to Brazil were common, such as the 'Manchesterian' pattern, which is common in English factories, with facades in exposed brick masonry, a sober and heavy structure, with symmetry of planes (MIRANDA, 2003, p. 30, 31).

The acquisition of machinery from European companies was often accompanied by the assembly project of the factory, which also included the design of the building carried out

by production engineers who designed the plan of the building, in a functional character, following the established typology, and the facades according to models of treatises by authors such as Blondel.

Generally, according to Miranda (2003, p. 31) the mills and grain processing mills were built in a multi-plant system, with an external structure in brick masonry that is reduced as the efforts decrease with the elevation of the pavements.

The internal grate was made of iron pillars and beams with wooden interfloors, since this material was at the time more efficient in drying grains. Facades often had a modulated marking of the masonry reinforcement and the standardized openings in iron. The internal organization was basically divided into three zones: pre-cleaning and cleaning (where the silos and grain elevators were) and the milling sector, always imposing vertical conceptions of party.

As examples of this industrial typology, the author cites the Antonina Mill in Antonina - PR, the Rio-Grandense Mill in Porto Alegre - RS and the Rio-Grandense Mill in Rio Grande - RS (MIRANDA, 2003).

Thus, from the final decades of the nineteenth century, through the architecture produced by the factories, the constitution of a cultural landscape typical of the industrial environment is identified in the Brazilian territory. Correia (2010) points out that in this period, the manufacturing centers became important expressions of Brazil's transformation into an industrial society:

not only because of their origins, uses, functions and social conflicts, but also because of the formal characteristics that many of these places have assumed when referring to values, materials and symbols of the manufacturing world. In the architecture of some of these villages and manufacturing centers, a typically industrial aesthetic emerged, based on notions of economy, efficiency, utility and functionality (CORREIA, 2010 apud CACHIONI, 2013, p.464).

According to Santos (2006, p. 26), as a result of the creation of the assembly line by Henry Ford in 1912 and the incorporation of scientific knowledge into factory production and management, profound transformations occurred in industrial production, which required greater performance of the industrial space. In this sense:

Horizontality was necessary to house machines and assembly lines, extensive and sequential due to rationalization, which implies the economy of displacements. It also needed vast constructions for storage (raw materials and products), control and

administration. Mechanization and the use of electricity have increased the production systems and the internal conditioning of the buildings, making it possible to break with the traditional typology, the factory of warehouses with shed roof. [...] The factory of rationalist design, ground floor or floor, with a flat roof, transparent or even totally closed with artificially controlled lighting, humidity and temperature is established.

In addition

The administrative sector was expanded, which, like the new 'utilities' (synthetic raw materials and packaging equipment), required specific facilities, as well as social services (the 'facilities'), such as medical care, housing, health and leisure for employees (SOBRINO, 1996 in SANTOS, 2006, p. 26).

The factories of the Second Industrial Revolution required more space as a result of the increase in technical production capacity and the international proportions adopted by the markets. With the use of metal structures and reinforced concrete, large spans became generalized with continuous and versatile spaces in open plan, allowing varied arrangements (SANTOS, 2006). However, the incorporation of the technical standards typical of this phase in Europe and the USA only occurred again with a delay in Brazil, more than 50 years later and

[...] we began it between 1933-1955 in a restricted and incipient way and in a more decisive way in the periods 1956-1962 and 1968-1980, when we completed the installation of the sectors producing durable consumer goods, intermediate goods and capital (CANO, 1995, p. 23 apud SANTOS, 2006).

Moreira (2007) points out that these models were initially disseminated at the national level, through the importation of the machinery necessary to install the first factories in the country. However, the author considers that difficulties in carrying out the construction of the first factory buildings, related to the scarce guidelines and specifications for the installation of those enterprises, combined with the lack of specialized labor and the lack of the necessary means of transportation, often made the installation of factories in Brazil unfeasible (MOREIRA, 2007).

According to Maffei (1982), in the 1920s, based on the construction of large-scale industries and the diversification of the type of product, industrial buildings in São Paulo began to be settled in remote neighborhoods, such as Brás, Belenzinho, Água Branca and Mooca, which were transformed into areas with characteristics of industrial use accompanied

by low-income labor, especially Italian, Spanish and Portuguese immigrants. The first buildings built with the objective of housing equipment and machines were characterized as large sheds where more than 200 workers worked, and due to industrial requirements, they had spans of more than 15 meters and a ceiling height of more than 6 meters. The author points out that most were exposed masonry walls, with small side windows for lighting and roofing with wooden scissors and imported French tiles.

At the end of the 1920s and during the 1930s, with the importation of equipment for the electrical, metallurgical and weaving industries, in addition to the injection of English capital, imported metal structures were installed, constituting the main part of the industrial sheds, usually in type I laminated profile or two-inch iron profile lattice pillars, welded or screwed. Maffei (1982, p. 30) points out that

The roof structure was made of metal tresouros, in welded or screwed iron profile, shed type, with a roof of imported slate tiles. Some roofs, as in the case of metallurgical industries, a type of ventilation was used with a lag in the roof, forming a lantern. The side closure was made with a brick wall up to the roof, following the design of the roof.

The sheds then formed a set very similar to the English industrial complexes of the mid-nineteenth century, with large brick chimneys (MAFFEI, 1982).

Only in the 1940s, after the installation of large steel mills, such as CSN, did metal structures begin to be produced in Brazil. In the 1950s, with the implementation of auto parts industries and vehicle assembly plants in the USA and Germany, the projects of Brazilian buildings were copies of those built in the USA in the 1930s and 1940s, transferring the machinery, equipment and design of the buildings to São Paulo. Thus, according to Maffei (1982, p. 30),

[...] in the landscape of the Presidente Dutra Highway or Via Anchieta, the large metal sheds, with lateral closure and roof in ficrocement tiles or corrugated metal sheets, and the façade facing the highway, in red ceramic brick masonry up to the top to hide the roof and give it a rectilinear, horizontal shape. This type of architecture is limited by industrial companies with national capital, aiming to have the same status as the industries of multinational groups.

According to Maffei (1982), the only project of that period that escaped the standards of imported warehouses was the Duchen Factory, at the beginning of Via Dutra, designed by Oscar Niemeyer, using concrete arches and slabs.

In the 1960s, Maffei (1982) informs that the possibility of using new materials, in addition to the competitive price of concrete, allowed new proposals for structures for industrial warehouses in aluminum, concrete shears, precast concrete, among others. In the 1970s, new materials, solutions and construction techniques were consolidated, when sophisticated industries of electromechanical and electronic equipment were built that needed pressurized or air-conditioned sectors, as well as pharmaceutical or chemical industries, which introduced in the country the "sealed factories", which did not need natural ventilation, adopting a flat roof with electromechanical ventilation.

3.3 THE IMPLEMENTATION OF THE BRAZILIAN INDUSTRIAL ESTABLISHMENT:

Like the European factories, Brazilian industrial establishments were implemented in various ways in the most varied territories, according to the manufacturing requirements, mainly in relation to watercourses and the supply of raw materials and, later, in proximity to the railways.

Regarding the implementation of the productive space, Santos (2006, p. 18) proposes morphological categorization distinguishing three architectural configurations of industries: isolated works, industrial complexes and factory complexes. The author identifies as an "isolated work" the monospatial manufacturing unit where all the equipment, stages and transformation activities are in a single environment in the building - isolated works typical of the eighteenth century. The "industrial set" is characterized by the grouping of buildings, according to the need to dismember activities into specific buildings, determining the grouped organization according to a product or the planning adopted for its production, involving constructions for concierge, warehouses, offices, workers' village, among others. Finally, more recently, the "factory complex" corresponds to the gathering of manufacturing groups for reasons of a corporate or technical nature (equal or complementary raw material), often formed by different companies, manufacturing processes and products, recurrent in modern manufacturing units (SANTOS, 2006).

The geographical space particularly offers support to the history of Brazilian factories with information referring to the most prosperous places, such as the capitals and more developed cities. In this sense, initially the factories were located in areas far from urban centers, mainly due to the generation of energy, which required the construction of buildings in the vicinity of water resources, whose situation has been maintained since the invention of the steam engine in 1776, but allowing the proximity of industrial activities to the cities

(ARANTES SANTOS, 2011).

In the first industrial experiments carried out in colonial Brazil, there is an archaeological record proving that the Engenho de São Jorge dos Erasmos in Santos was formed following the Azorean model, with all its facilities arranged in a building, in an agglutinated part, configuring a morphology characterized as an isolated work. Still as isolated works, the first experiences of installing sugar mills in the Brazilian pre-industrial period were practiced. According to Gomes (1996, p. 118) the proximity to water resources represented an important conditioning factor for the location of the mills.

From a more organic implantation, the buildings of the mills were arranged on the ground in a more rational way, probably following French models. As all arrangements and buildings were always independent of each other, the construction systems were not necessarily the same for all units of the same mill. Of the set of buildings that made up the mill, four stand out for their permanence: the *mill* itself, also called *the factory* or *bush*, the *main house*, the *slave quarters* and the *chapel*. The latter was always built with the most durable materials - stone or brick masonry - indicating its symbolic value to overcome the vicissitudes of the plantation owners. All other buildings could be temporary and this was shown even in the materials with which they were built.

For Gomes (1996, p. 118) "The image, therefore, of fortresses that was sought to spread in analogy with the big houses of the Pernambuco mills applies only to a few and exceptional cases".

For the industrial complexes, the proximity to the water resources remained a condition when the central steam-powered mills were installed, whose mills depended on the channeling of water from tributary streams of the rivers that also served as a means of transport to transport the production. In the same way, for the pioneer weaving mills, it was also important to implant them in the vicinity of river waterfalls, where hydroelectric plants could be installed to supply energy for the electric looms.

With respect to the implementation of the industry, it was common to have a close link with the railroads, with facilities subordinated to the need for railroad branches for loading and unloading. According to Rufinoni (2004, p. 52) "[...] the whole set, finally, shows the formation of a complex productive network, where the existing urban structure was developed in response to the needs of the industrial complexes installed there, in full activity in the first decades of the twentieth century" (RUFINONI, 2004, p. 52).

In the city of São Paulo, railroads were installed on the banks of the rivers, with the objective of minimizing difficulties caused by the relief of the plateau where the urban fabric

is established. Padin (2009, p. 53) considers that, for this reason, many plots of land where industrial buildings were installed are in areas with humid soil.

In many cases, such as in the warehouses of Indústrias Matarazzo, located in the Jaguaré neighborhood, in São Paulo, the foundations were executed with pine piles. Constantly moistened wood does not rot or lose its mechanical resistance properties (PADIN, 2009).

These areas in the strip of floodplains and river terraces, which are bordered by the railroad roads, were much sought after by commercial establishments, which intended to maintain their headquarters in the capital of São Paulo. At first, the industries were attracted by the proximity to the railway stations and, later, they began to occupy the intermediate stretches intensively, where large warehouses or warehouses were also installed in large lots (BARDESE, 2011, p. 33).

Rufinoni (2004) points out that many of the large lots determined by the occupation of industrial complexes still remain, in areas where the development of other activities caused the division of lots and the dismemberment of industrial complexes, whose original characteristics are still perceived. "The 'block-lots' formed by the large industrial complexes, even if officially dismembered among several owners, still mark the landscape as continuous blocks - often compact - of built mass" (RUFINONI, 2004, p. 43).

On the other hand, workers' villages were implanted next to the industrial complexes, in small lots, usually single-family, distinct from the occupation of the industries. Housing was granted to workers by paternalistic industrialists, as a way of obtaining the worker's loyalty to the factory. Generally, the villas were built in a row or semi-detached, aligned with the sidewalk, and may have small backyards or common patios inside (CACHIONI, 2013).

Factory complexes were built close to water resources, also having their own railway line, which connected to the branches of the main railways. In the sugarcane sector, close to the sugar and alcohol mills, other factories were installed that also processed sugarcane derivatives, such as the production of paper. Next to the production complex, in addition to the workers' villages, schools, a library, a Catholic church, a community center, an outpatient clinic, a cinema, a ballroom and a dry goods warehouse were built by paternalistic entrepreneurs, constituting new neighborhoods far from urban centers.

3.4 CONSTRUCTION TECHNIQUES AND SYSTEMS OF INDUSTRIAL ARCHITECTURE IN BRAZIL

The repertoire of techniques, systems and stylistic and constructive elements used in pioneering industrial buildings in Brazil, is similar to that used in European countries such as France, England and Italy, as well as in the USA, justified by the fact that many of the constructive elements were imported from Europe, including the metallic structural system and the tiles, which were allied to mud bricks, which were already produced in Brazil.

In addition to the preponderant choice of exposed masonry highlighted by authors such as Rufinoni (2004) and Padin (2009), whose device can vary between English, Flemish or traditional, depending on the need for greater or lesser thickness to support roof structures, full and depressed arches composed of ceramic elements specially produced for this purpose are identified, constituting models of classicist and Romanesque inspiration. According to Padin (2009, p.52) the choice of brick masonry probably induced the option for solutions for door and window openings in depressed arches, high and with narrow lintels, as well as ornaments made from the careful rigging of bricks.

Bardese (2011) points out that until the installation of railroads and the foreign repercussion on the employment of salaried labor and also on imported taste and techniques, brick masonry was still little used in São Paulo constructions. According to Toledo (1983, p. 13) "[...] Until the advent of the railroad, São Paulo was a city of clay." ²⁵ In fact, according to Silva Bruno (1954), at the end of the 1850s, there were only nine small tile and brick factories in the city, which were mainly used for paving, and the first large brick factory was only inaugurated in 1859, in Bom Retiro²⁶.

From the installation of the railroads, the architecture of São Paulo underwent significant changes, with the presence of English technicians and the importation of machinery accompanied by the construction techniques used in the process of expansion of the railroad lines. According to Bardese (2011), associated with the phenomenon of immigration, the railway stations and factories promoted the dissemination of the use of brick masonry in constructions, albeit slowly, introducing a construction system little used in São Paulo until that moment, which allowed the realization of wider spaces, meeting the new programs of activities of this historical period. The author points out that the factories and railway stations built in exposed brick masonry and metal structures demonstrate the great

²⁵ TOLEDO, Benedito Lima de. **São Paulo: three cities in a century**. São Paulo: Duas Cidades, 1983, p.13.

²⁶ Silva Bruno (1954, p.470) in Bardese (2011, p. 64).

influence of English industrial architecture (BARDESE, 2011, p. 64), called by Hardman and Leonardi (1982) as British Manchesterian.

From then on,

The walls were usually built of brick and lime masonry. This modification, so simple, implied a significant increase in precision: the measurement errors, which with the use of traditional techniques could almost always be evaluated in decimeters, were now reduced to centimeters. The walls, with a uniform width, allowed the mechanized production of doors and windows (REIS FILHO, 1995, p. 159).

And

[...] The adoption of industrially produced construction elements and formal standards capable of assimilating them, within traditional solutions, meant, under these conditions, at the same time an advance in technology and the reinforcement of colonial-type ties (REIS FILHO, 1995, p. 183).

Mainly through the immigrant European labor, the bricks that were initially used in a special way in railway stations, industries and warehouses, became popular and enabled the accelerated growth of the city of São Paulo, as the main construction material. Bardese (2011, p. 64) attributes the success of bricks to the fact that "[...] Its low cost and ease of transportation by railroads provided faster and safer construction, especially in relation to the frequent rains, in addition to meeting the growing demand for the new programs". In addition, from the 1870s onwards, the City Council began to demand the replacement of rammed earth as a construction technique in 1873²⁷, which was highlighted by the provisions of the Code of Postures of 1875.

Bardese (2011) exposes that

The municipal and ecclesiastical government itself was gradually eliminating from the city its provincial and traditional aspects and customs, hiding or replacing any non-European trace of its streets, houses and customs, just as these new residents, influential in political and economic life, began to aspire to a city at their height, eliminating the vestiges of their provincial past (BARDESE, 2011, p. 64).

Brick masonry was the construction system used for the construction of chimneys, and there are also examples made up of various materials, such as stone masonry and metallic

²⁷ MORSE, 1970, p.255.

material. However, exposed brick masonry was more widespread due to its lower cost, ease of maintenance and resistance to heat, and can be erected with circular, rectangular or prismatic section. In addition to their functional origin, chimneys also served as an aesthetic component in the formation of the industrial landscape, considered by Arantes Santos (2011, p. 37) as an "element that configures a distinct meaning in industrial construction". For the author,

More than that, the chimney was a strong support for the memory of the place, the company, the community and those who in some way are or were part of the daily life of the industry. Sometimes, they even received ornaments that could not even be seen in the body of the building itself, so that their presence in the factory scenario could be remarkable.

In this sense, Bach (2009, p. 17) considers that:

The image of the chimney, an icon of the industrial city, also appears in the rural scenario, and is presented as a major vestige of this industrial activity that moved the region in the period analyzed and, at the time in which this production occurred, it was also a distinctive element of economic progress for the company it represented (apud ARANTES SANTOS, 2011, p. 37).

Regarding the factory buildings, Rufinoni (2004, p.43) points out that the technique used, as well as the architecture adopted, did not present significant variations in the construction of the first factories in São Paulo.

The large buildings - which could occupy an entire block - were usually built with exposed brick masonry and cast iron or steel structure. Metal or wooden roofs were the most common solution; in sheds or in two successively repeated gables side by side.

According to Padin (2009, p. 53), from the constructive point of view, all industrial buildings in São Paulo from this period have the same characteristics.

All are simple casings in brick, wood and iron. Internal productions develop as a function of their better rationality and productivity, however, at this time they still define the building little. In fact, the construction system used was based on the construction knowledge of the time and the availability of materials. The difference in relation to the profusion of decorative elements in the eclectic buildings of the same period lies in the fact that they had many of their components and construction materials imported, which made construction more expensive, and was not interesting in the case of

industrial architecture.

In several industrial buildings, the main structure was made of brick masonry, while the cast iron pillars had only the function of supporting the internal part of the roof structure. In turn, the use of iron in constructions also enabled constructive innovations not allowed by wood, such as the São João Market (1890), the Chá (1892) and Santa Ifigênia (1913) viaducts (PADIN, 2009; BARDESE, 2011).

Furthermore, Rufinoni (2004, p. 158) identifies in the industrial complex built in the Mooca neighborhood in São Paulo,

use of advanced architectural techniques, such as iron and steel structures, which were quite versatile for the construction of the free spaces and high ceilings that the factory facilities so badly needed. It is, therefore, the search for design solutions appropriate to specific functions, a fact that corroborates its importance for the history of architecture and contributes to the formal coherence generally achieved.

In this sense, Rufinoni (2004, p.52) concludes that

The vast majority of the buildings analyzed have the same construction system: bones made with a metallic structure, cast iron or steel, and solid brick masonry sealing. Sometimes the use of load-bearing masonry is noticeable and the metallic elements are restricted to the support of the roof structure, also metallic or wooden. The frames generally adopted are made of iron, in a few exceptions, made of wood. The ornaments of the pots - exquisite details of bricks arranged sometimes longitudinally, sometimes transversely - repeat the theme in curious and peculiar variations.

Padin (2009) informs that most of these buildings were built on the ground floor, but there are examples of vertical construction, such as the Cotonificio Crespi (1897), designed by Giovanni Batista Bianchi. The metal structures of many sheds were imported, among them, *sheds* sealed by glass to allow zenith lighting, which can open to allow ventilation (PADIN, 2009).

The need for natural lighting and ventilation forced the creation of openings and the movement of the lateral and roof fence planes, creating open windows, lanterns, mansards and finally the *shed* - openings in the roofs with the objective of offering lighting, before the use of electric light -, which made it possible to create "a basic module for the multiplication of the factory space", according to Santos (2006, p. 21). Anyway

It made it possible to open the side or air to ventilate and illuminate the internal space, as well as its expansion through the addition of other modules and in all directions. Complementary architectural solutions, such as the gutter system and devices for the control of light and undesirable winds, allowed for the improvement of this typology (SANTOS, 2006).

The use of *sheds* conditioned the design of the factory building and configured a top line known as "sawtooth roofs", which is striking for the formal understanding of the units. The development of this model, according to Moreira (2007, p. 125), "made it possible, in the first decades of the twentieth century, to apply the concept of the production line that revolutionized industrial production" (apud Arantes Santos, 2011, p. 38; 39). And, according to Santos (2006), the sequence of the shed roof combined with the chimneys of the steam boilers, composed the image of the modern factory, the typical factory architecture of the First Industrial Revolution (SANTOS, 2006).

Also imported from European countries were metal structures such as trusses and purlins, which were generally equipped with rafters and wooden slats and; ceramic tiles usually brought from France, known in Brazil as Marseille type tiles (PADIN, 2009).

In addition to the metal structures,

The development of European industry made it possible to supply, under advantageous conditions, tinplate and copper, for the assembly of flashings, rails, conductors and finishing pieces in general. Cast iron conductors and gutter clamps with decorative designs were common (Reis Filho, p. 1995, p. 162).

It is worth remembering that

Intended for all sectors of construction, they ranged from structural parts such as beams and columns, to secondary finishing resources such as garden ornaments, fountains and railings, not to mention stairs, window and door fittings. pipes, bathroom pieces and stoves (Reis Filho, p. 1995, p. 164).

Bruna (2002, p. 35) adds that

In Brazil, these elements are strongly present in all nineteenth-century architecture. Not only were hollow columns and beams in cast or wrought iron (as it was also called) imported, but also finishing pieces and ornaments for gardens, such as fountains, benches and railings imitating tree trunks.

For Maffei (1982, p. 33) there has always been a great interrelationship between the

type of building in terms of space, construction system and materials, with the type of product manufactured, as well as the manufacturing process, depending on the type of equipment and machinery. That is:

The evolution of industrial architecture has not only followed the evolution of construction technique, materials and aesthetic concepts (plastic-formal) that are inherent to architecture itself, but also of the type of industry as a function of the industrial production process (with all the inherent needs) and the type of product manufactured (with all the implications of transport, handling, areas, etc).

3.4 PROJECTS AND ARCHITECTS OF BRAZILIAN INDUSTRIAL ARCHITECTURE

The projects of industrial buildings built in Brazil from the 'Implementation' phase have varied origins, justified by several factors. As verified in the previous chapters, depending on the productive branch, the project was contracted together with the machinery, and was often developed by the mechanical engineers responsible for assembling the imported equipment. The catalogs of the machinery industries, which instructed the assembly of the equipment, provided general guidelines for the construction of buildings, according to production needs. There are also several records of constructions carried out by engineers and contractors, based on treaties and construction manuals, which allowed the application of their rules and practical examples in industrial buildings. However, despite the numerous factories designed by civil and mechanical engineers, based on manuals and catalogs, relevant architects in Brazil were also hired for the development of factory projects.

According to Maffei (1982), Brazilian industry, due to its technological dependence and the origin of capital, obeys imported parameters, always prevailing from the beginning, the design coming from abroad. In the evolution of the history of industrial buildings, the fundamental element to understand the solutions adopted is the origin of the capital, considering that the national capital was partial and, in some industrial sectors, came from some family groups that passed the capital that had been invested in the agricultural or import sector to the industrial sector.

The so-called "Captains of Industry" were mostly people with European training, and the little "know-how" they had was imported, acquired along with the machinery and equipment. Thus, our industry, due to its technological dependence and the origin of capital, obeyed imported parameters and always followed the design that came from abroad (MAFFEI, 1982, p. 33).

Maffei (1982) states that the evolution of the architecture of industrial buildings not only followed the evolution of aesthetic concepts, materials and construction techniques, inherent to architecture itself, but also developed as a function of the industrial production process and the manufactured product. The author considers that the physical characteristics of industrial buildings built with foreign capital are similar to those found in their country of origin, including the project, which was imported along with the equipment and the production system. "In some cases, even the metal structure was imported, and a model of architecture from the time of the European industrial revolution was reproduced in Brazil", and from the mid-nineteenth century, "with the buildings closed with exposed mud brick masonry walls, with the shape of the upper part following the design of the roof shed" (MAFFEI, 1982, p. 159).

Along these lines, Santos (2006) also notes that many of the factory projects were the responsibility of those responsible for the installation of machinery imported from Europe and North America, who represented the companies in Brazilian branches and, with the importation of machinery, the architectural project was often imported along with the equipment (SANTOS, 2006).

Among the main manufacturers of machinery for sugar production, the 'Société Anonyme des Anciens Établissements Cail' had in Rio de Janeiro, the Belgian civil engineer Francisco de Lumay as the company's representative and attorney. In addition to business representation, it maintained an office specializing in mechanical construction for industries; supply of material and complete facilities for central sugar and distillation mills; carrying out public works; metal bridges and iron buildings. At the Monte Alegre Central Mill in Piracicaba, Lumay, in addition to conducting the assembly of the machinery, was also the author of the construction project of the factory building, according to the contract signed with the owner²⁸.

In the same way, 'Brissonneau, Frères & C.' kept in the Brazilian subsidiary the industrial engineer André Paturau and the engineer Fernando Dumoulin, French, as representatives of the company and responsible for the assembly of central sugar mills, among them: the mills of Porto Feliz, Rafard and Piracicaba, being probably the authors of the projects of the buildings that housed the machinery.

However, not all contracts provided for the supply of exclusive or specific projects for the buildings. Moreira (2007) highlights the importance of the catalogs produced by British

²⁸ Information extracted from the Deed of purchase and sale made by Francisco Lumay to Doctor Pedro Augusto da Costa Silveira, of a central mill and assembly for the sum of one hundred and fifty-one thousand eight hundred and sixty francs, 30/12/1886II, inserted in the Inventory of Pedro Augusto da Costa Silveira, 1887. Piracicaba, 1st Office, box 21 A.

and American machinery industries, such as Platt Brothers & Co, Howard & Bullough Limited, Brooks & Doxey Limited and Dodson & Balow. In addition to detailed information about the machinery sold, these catalogs also contain proposals for industrial typologies and architectural and constructive solutions, which aimed to facilitate the assembly of factories.

Saia (1988) considers that the architectural solutions exhibited in these catalogs suggested a trend towards the standardization of façade treatment solutions and made it possible to understand some elements that distinguished textile manufacturing buildings, in addition to the dimensions, such as

the dust exhaust towers of the preparation areas, the stairwells, the engine room and areas corresponding to the situation of the sectors of the transmission systems that were externally evidenced, highlighted or deserving differentiated treatment on the homogeneous facades (SAIA, 1988).

During this period, just as it became frequent in Europe to consult treatises such as Blondel's 'Cours d'Architecture' (1750), it was also common to consult treatises and construction manuals by other European authors such as Louis Cloquet²⁹, João dos Santos Segurado³⁰ and Pasquale Carbonara³¹, as well as the Brazilian Alexandre Albuquerque³², which described and taught good ways to use the new techniques and common materials, for industrial constructions, as well as for institutional or residential buildings (BARDESE, 2011).

Cloquet's Treatise on Architecture (1922), divided into five volumes, brings in Volume IV, descriptions and examples illustrated with plans and facades, of buildings that are part of the repertoire of industrial architecture, such as markets and slaughterhouses, railway stations and collective housing for the working class.

The Insured (undated), 'Masonry and Stonework', 'Buildings' and 'Construction Materials' manuals provide information on the application of construction materials and systems, with several illustrations. The first volume was especially consulted by the builders, regarding the good use of rules for the execution of masonry, according to the devices most appropriate to the needs of the factories, mainly because they are, in the vast majority, buildings in exposed masonry in greater or lesser size.

²⁹ CLOQUET, Louis. *Traite d'architecture*. Paris: Librairie Polytechnique, 1898.

³⁰ SEGURADO, João Emílio dos Santos. *Masonry and Stonework* (4th edition). Lisbon: Bertrand, s.d..

³¹ CARBONARA, Pasquale. *Architettura Pratica*. Torino: Unione Tipografica - Editrice Torinese, 1980.

³² ALBUQUERQUE, Alexandre. *Civil Constructions*. São Paulo: Empresa gráfica da "Revista dos Tribunais" LTDA, 1952.

Carbonara's Treatise on Practical Architecture (1954) follows Clocquet's line, divided into eight parts distributed in five volumes, where he also presents descriptions and examples illustrated with plans and facades, by categories. The volumes of part 3 refer to 'buildings for the organization of work', bringing references applicable to factory buildings.

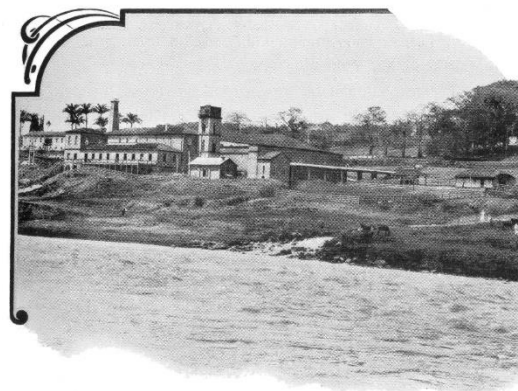
The manual of Civil Constructions of Albuquerque (1938; p. 52) brings in Chapter IX - referring to roofs - especially in the item 'Iron structures', examples of fabrication and assembly of trusses 'indicated in the roof of large spans', complemented with the item 'Roofing Materials', with several examples of metal shears for application in factory buildings.

Used by engineers and contractors, the manuals and treatises contributed to the consolidation of an architectural typology with common elements, currently considered as a determinant to be qualified as a typology of industrial architecture.

According to Moreira (2011), there was a greater occurrence of contractors with some experience in factory construction, in the last decades of the nineteenth century, among which the following stand out: Bernardo Mascarenhas, who provided services in the installation of the Companhia Industrial São Joannense, in São João del-Rei - MG; and the 'engineer' Carlos Hargreaves, in charge of the construction of the Santa Rita, Corcovado, América Fabril Factories and the expansion of the Cruzeiro Factory, in Rio de Janeiro. Still in the textile industry, in São Paulo, the English engineer Arthur Dryden Sterry built the pioneering São Luiz de Itu Factory and went to Piracicaba, where he installed and managed the Santa Francisca Fabric Factory (figure 285).

Figure 8

The Santa Francisca Fabric Factory at the beginning of the twentieth century



Fabrica de Tecidos « Arethusina ».

Source: FERRAZ, Mario de Sampaio. Piracicaba and its Agricultural School. Brussels: Imprimerie V. Verteneuil & L. Desmet, 1911, p. 27.

From this period on, it became quite common for foreign engineers from the railroad companies to work in the design and construction and assembly of factories, such as engineer William Ellison, from the D. Pedro II Railroad, responsible for the project of the Brasil Industrial Factory, in Rio de Janeiro (BALLEIRAS, 2003 in MOREIRA, 2007).

According to Bardi (1985):

At that time, São Paulo was adorned with the architecture of representation, but industrial parks were already being built and, if any engineer highlighted the façade, it was at the request of the principal, because the industrial establishments presented simplicity of construction, a harbinger of changes in architecture (Bardi, 1985, p.66 apud MIRANDA, 2003, p. 27).

Thus, in addition to the role of civil engineers in the development of projects for factory buildings, Rufinoni (2004, p. 54) shows that some of the most relevant architects of the period also designed industrial buildings in São Paulo, such as: Julio Michele, for the São Paulo Alpargatas Shed (1907); Giovanni Batista Bianchi, with the building of the Crespi Cotton Swirl (1897); Ramos Azevedo and Ricardo Severo, for the Ernesto de Castro Warehouses; and Victor Dubugras, in the Piratininga General Warehouses project.

Subsequently, Santos (2006) evaluates that in the Vargas government (1930-1945), industrial architecture began a new phase in Brazil, in qualitative and quantitative terms, because in addition to the growth in demand for this type of building (induced by the State), the pioneering relationship was also changed, characterized by imported projects ('packages'), in a typical situation of technological and political dependence.

Thus, from the 1930s onwards, the participation of Brazilian architects and engineers in large-scale manufacturing projects occurred gradually. According to Santos (2006), it was not by chance that, in the Vargas government, the greater participation of Brazilian professionals in manufacturing projects coincided with the modernization of industry, at a time when the concepts of the Modern Movement, which had been experimenting in Europe and the USA since the 1920s, were disseminated. Deemed

A diffuse ideology, but through the few schools, incipient patronage and especially public works, it guided Architecture and Engineering in the country in the following decades. Significant examples of Industrial Architecture were designed and built. Some are references to the creative capacity of Brazilian architects (SANTOS, 2006, p. 28).

However, in this period, Santos (2006) considers the participation of foreign architects and engineers who migrated to Brazil as a result of the world wars and in search of the new professional opportunities provided by Brazilian industrialization to be remarkable.

The author also highlights the training of these professionals through the ascending publication of industrial projects in articles in specialized journals of Engineering and Architecture, which were created in large numbers during this period, and the specialization of products, companies and professionals who began to dedicate themselves especially to manufacturing projects in these sources is noticeable (MAFFEI, 1982 and SEGAWA, 1997 apud SANTOS, 2006, p. 28).

The engineers who developed projects for the manufacturing buildings of the Engenho Central had academic training in the best educational institutions in France, such as Ecole Polytechnique, Ecole Centrale des Arts et Manufactures, Ecole Supérieure d'Electricité, Ecole des Arts et Métiers, Ecole Nationale des Industries Agricoles, Institut Industriel du Nord, among others (MIALHE, 2012), which justifies the quality of the projects, as well as its execution.

4 DISCUSSION

In this study, we sought to understand the formation and consolidation of industrial architecture in Brazil as a material expression of the economic, technical and cultural transformations that marked the process of national industrialization. Starting from a long historical path, from the factory restrictions imposed by the colonial system to the expansion of the large industries of the twentieth century, it was sought to demonstrate that, although late and dependent on foreign models, Brazilian industrialization developed its own architectural solutions, appropriate to local conditions and deeply linked to the territory.

The analysis showed that each stage of industrialization: prohibition, implementation, Brazilian industrial revolution, internationalization and expansion; corresponded to specific economic and political contexts, influenced by factors such as the coffee cycle, European immigration, the advance of railroads and state incentive policies, especially in the governments of Getúlio Vargas and Juscelino Kubitschek. These elements were decisive for industrial growth and for the consolidation of manufacturing centers, especially the State of São Paulo.

From the typological point of view, two main matrices were identified: the colonial, inherited from the sugar mills, and the Manchesterian, inspired by the British factories of the

nineteenth century. of lighting and large chimneys, which became symbols of progress and industrial modernity.

The forms of implantation of factories also revealed a significant evolution: from isolated mills to factory complexes and complexes articulated with railroads, new cultural landscapes emerged, in which workers' villages, schools, warehouses and churches express the intertwining between work, urbanization and daily life.

Finally, Brazilian industrial architecture cannot be understood as a simple imitation of European paradigms, but as a process of critical and creative appropriation, in which engineers and architects, such as Giovanni Batista Bianchi, Ramos de Azevedo, Ricardo Severo and Oscar Niemeyer, adapted concepts and techniques to the material, climatic and social realities of the country. Thus, industrial architecture constitutes an essential cultural heritage for the reading of Brazilian modernization, representing the living memory of the relationship between technology, territory and work.

5 CONCLUSION

The analysis of industrial architecture in Brazil allows us to understand that the development of this typology was profoundly conditioned by the economic, political and technological transformations that shaped the national industrialization process. From the colonial mills to the large factories of the twentieth century, it is observed that architectural evolution has always been associated with productive dynamics and forms of work organization, revealing the constant dialogue between tradition and modernity.

Although the country entered the industrial process late, under a strong dependence on foreign capital, techniques and models, Brazilian industrial architecture consolidated its own identity. This identity results from the creative adaptation of European models, especially the British and French, to the local conditions of climate, materials and labor, producing original architectural solutions that combined functionality, economy and aesthetics. The striking presence of exposed brick masonry, metal structures, shed roofs and chimneys became a symbol of industrial modernization and the emerging urban landscape.

The implementation of the factories, initially along watercourses and, later, railways and highways, profoundly transformed the territory, giving rise to industrial complexes and complexes accompanied by workers' villages and social equipment. These industrial centers not only boosted urban growth, but also configured new cultural landscapes and ways of life, expressing the interdependence between production, housing and social coexistence.

From a professional point of view, the study shows the passage from an initial phase, dominated by foreign engineers and imported projects, to a stage of technical and creative autonomy, marked by the work of Brazilian architects and engineers such as Giovanni Batista Bianchi, Ramos de Azevedo, Ricardo Severo and Oscar Niemeyer. This transition symbolizes the maturity of the national industrial architecture, capable of integrating technique, function and form in line with the demands of a country in modernization.

In summary, the historical path of industrial architecture in Brazil reveals more than the evolution of a constructive type: it mirrors the very trajectory of the formation of the modern nation. The factories, warehouses and workers' villages are material testimonies of a period of intense transformations, representing a cultural heritage of high historical, aesthetic and social relevance, whose preservation is essential for understanding the relations between technology, territory and collective memory in contemporary Brazil.

ACKNOWLEDGMENTS

Prof. Dr. Beatriz Mugayar Khül, Graduate Committee FAU USP.

REFERENCES

- Andrade, M. C. de. (2007). A civilização açucareira. In F. Quintas (Org.), A civilização do açúcar. SEBRAE / Fundação Gilberto Freyre.
- Arantes Santos, R. M. (2011). Análise tipológica e o patrimônio industrial: Estudo de fábricas doceiras na zona rural de Pelotas, RS [Dissertação de mestrado, Universidade Federal de Pelotas].
- Azevedo, E. B. de. (2009). Engenhos do Recôncavo Baiano. Iphan/Programa Monumenta.
- Azevedo, E. B. de. (2010). Patrimônio industrial no Brasil. Revista Eletrônica Arq.Urb, (3).
- Bach, A. N. (2009). Patrimônio industrial rural: As fábricas de compotas de pêssego em Pelotas- 1950 a 1970 [Dissertação de mestrado, Universidade Federal de Pelotas].
- Balleiras, M. H. M. (2003). Usina Monte Alegre - um breve histórico do lugar [Manuscrito].
- Bardese, C. I. (2011). Arquitetura industrial. Patrimônio edificado, preservação e requalificação: O caso do Moinho Matarazzo e Tecelagem Mariângela [Dissertação de mestrado, Faculdade de Arquitetura e Urbanismo, Universidade de São Paulo]. (Original work published 2018)
- Bardi, P. M. (1981). Miguel Dutra. O poliédrico artista paulista. MASP.
- Bruna, P. J. V. (2002). Arquitetura, industrialização e desenvolvimento. Perspectiva.

- Cachioni, M. (2013). Londres, Lisboa e São Paulo: Vigilância, ordem, disciplina e higiene nos espaços de sobrevivência operária [Tese de doutorado, FAU USP].
- Cano, W. (1995). Reflexões sobre o Brasil e a nova (des)ordem internacional (4ª ed.). Ed. Unicamp; Fapesp.
- Coelho de Souza. (1970). Tipos e aspectos do Brasil (pp. 36–37). CIBEP; INEP; MEC.
- Correia, T. de B. (2010). Patrimônio industrial e agroindustrial no Brasil: A forma e a arquitetura dos conjuntos residenciais. In Segundo Seminário de Patrimônio Agroindustrial, São Carlos.
- De Decca, E. S. (2004). O nascimento das fábricas. Brasiliense.
- Gomes, G. (1996). Engenho e arquitetura: Morfologia dos edifícios dos antigos engenhos de açúcar de Pernambuco. Resgate: Revista Interdisciplinar de Cultura, 5(1), 117–119.
- Hardman, F. F., & Leonardi, V. (1982). História da indústria e do trabalho no Brasil: Das origens até os anos 20. Global.
- Maffei, W. R. A. (1982). A concepção arquitetônica dos edifícios industriais [Dissertação de mestrado, Faculdade de Arquitetura e Urbanismo, Universidade de São Paulo].
- Menezes, C. A., Muniz, B. M., & Silva, M. A. da. (2012). Os engenhos de açúcar e a construção do patrimônio cultural alagoano. In Anais do VI Colóquio Latino-Americano sobre Recuperação e Preservação do Patrimônio Industrial. TICCIH. <http://portal.iphan.gov.br/pagina/detalhes/1207/>
- Mialhe, J. L. (2012). Cidadãos de dois mundos. O Engenho Central e a imigração francesa na região de Piracicaba. Biscalchin Editor.
- Miranda, A. E. (2003). A evolução do edifício industrial em Porto Alegre 1870 a 1950 [Dissertação de mestrado, Universidade Federal do Rio Grande do Sul].
- Moreira, D. C. (2007). Arquitetura ferroviária e industrial: O caso das cidades de São João del-Rei e Juiz de Fora [1875-1930] [Dissertação de mestrado, Escola de Engenharia de São Carlos, Universidade de São Paulo].
- Padin, P. A. (2009). Arquitetura da indústria. Estudo da abrangência do trabalho do arquiteto no projeto de edificação industrial [Dissertação de mestrado, Faculdade de Arquitetura e Urbanismo, Universidade de São Paulo].
- Reis Filho, N. G. (1995). Quadro da arquitetura no Brasil. Perspectiva.
- Rufinoni, M. R. (2004). Preservação do patrimônio industrial na cidade de São Paulo: O bairro da Mooca [Dissertação de mestrado, Faculdade de Arquitetura e Urbanismo, Universidade de São Paulo].
- Saia, H. (1988). Arquitetura e indústria: Fábricas de tecido de algodão em São Paulo, 1869/1930 [Dissertação de mestrado, Faculdade de Arquitetura e Urbanismo, Universidade de São Paulo].
- Sandroni, P. (1999). Novíssimo dicionário de economia. Best Seller; Círculo do Livro.
- Santos, A. P. dos. (2006). Arquitetura industrial: São José dos Campos. Fundação Cultural Cassiano Ricardo.

- Silva, S. (1986). *Expansão cafeeira e origens da indústria no Brasil* (7ª ed.). Alfa-Ômega.
- Silva Bruno, E. (1991). *História e tradições da cidade de São Paulo* (Vols. 1–3). Hucitec. (Original work published 1954)
- Simonsen, R. C. (2005). *História econômica do Brasil: 1500-1820* (4ª ed.). Senado Federal, Conselho Editorial. (Edições do Senado Federal; v. 34)
- Singer, P. (1977). *Economia política da urbanização* (4ª ed.). Brasiliense.
- Sobrino, J. S. (1996). *Arquitectura industrial em Espanha, 1830-1990*. Cátedra.
- Souza, J. S. de. (1974). *Porto Feliz: O Engenho Central*. Subsídios para o estudo dos Engenhos Centrais do Brasil no século XIX. *Anais do Museu Paulista*, 25, 1971–1974.
- Tomazela, J. M. (2007, fevereiro). Chuvas causam rombo na barragem da Represa de Hedberg, em Iperó (SP). *O Estado de S. Paulo*, p. A29.
- Toledo, B. L. de. (1983). *São Paulo: Três cidades em um século* (p. 13). *Duas Cidades*.