Inheritance Value of the Machinery of the Factory "Azucarera del Pilar" in Motril and the Sugar Industry in Eastern Andalusia

José Antonio Saez-Calvo[1,2](✉)

[1] Polytechnic University of Valencia, Valencia, Spain
jose.saez@intec.edu.do
[2] INTEC- Technical Institute of Santo Domingo, Santo Domingo, Dominican Republic

Abstract. The Pilar factory is an example of the survival of steam engines in the 20th Century. It is currently the most extensive mill train preserved, not only in Spain but also in Europe. In terms of dimensions, it is only comparable to a steam steel rolling mill. Up to 11 steam engines are preserved for different uses, from the movement for grinding to the elevators and cane drivers. The mill train is the heart and the essential part of the symbolic sugar factory in Motril, which should be transformed into an industrial sugar museum. The machinery has the declaration of Asset of Cultural Interest. At the same time, the chimney and the rest of the enclosure that is conserved are protected because they are part of its context. Steam engines, manufactured in foundry and representing the last period of the sugar industry, are the only reference of this type in Europe as a set of parts representing an assembly. In this paper, there will be a technical and historical review, with figures, of the five mill trains that remain in Spain, curiously in the provinces of Granada and Malaga. Emblematic places where a robust sugar industry developed at the end of the 19th Century, based on steam engines, presented different configurations, and grinding sugar cane and beets.

Keywords: Mill train · Sugar cane industry · Industrial heritage · Steam machines · Granada development

1 Introduction

Historical aspects of the development of the province of Granada and some of the regions of Eastern Andalusia cannot be understood if it is not mentioning its almost thousand-year-old sugar tradition. Although in the "Calendar of Cordoba" in 961, the existence of sugar cane is cited on the coast of Salobrena and Almunecar, the botanical studies where the cultivation in the area stated dates from the end of the 11th Century with Ibn Wafid or the first decade from 12th Century with the Granada botanist Al Tignari in his work "Treaty of Agriculture."

Sugar in Granada was a lever in developing the urban nucleus and of infrastructures, especially from the end of the 19th Century when the overseas provinces of Cuba, Puerto Rico, and the Philippines were lost from the Spanish Crown.

M. Ceccarelli and R. López-García (Eds.): HMM 2022, HMMS 40, pp. 470–486, 2022.
https://doi.org/10.1007/978-3-030-98499-1_38

Fig. 1. Aerial overview. Azucarera del Pilar [5]

It was significant potential in the tram or railway network in the characterization of the landscapes of the buildings—currently, one of the top-ranked in the cataloging of cultural assets [12].

These transformations necessarily introduce social and ecological conditioning since the hydraulic and landscape organization of the environment is affected by the socio-economic and environmental structure. Agricultural technical issues reflect that the crop requires abundant irrigation in summer and unique climate and location conditions.

The basis of the current paper focuses on "Nuestra Senora del Pilar", Fig. 1, in Motril. It shows the sugar production and storage system from an industrial point of view, and the result of the technological development that sugar is industrialization entailed focused on steam engines.

During the 19th Century, the sugar industry became the recipient of technological transformations such as the application of steam engines in different applications, such as moving to mills or internal transportation for the raw materials and final products Fig. 2.

Starting in 1882, an essential beet-sugar industry was created in Spain. Therefore, it must bear in mind the phenomenon of the development of technology applied to beet, becoming an apparent competition to the sugar cane.

2 The Sugar Cane Industry in the South

2.1 The Crop as an Industrial Origin and Development

Sugarcane is a grass of the genus "Saccharum" that grows optimally in tropical and subtropical territories, ranging in height between two and five meters. The stem, three to five centimeters in diameter, is made up of cylinder joints separated by knots, in variable

Fig. 2. Cane square and overhead cable laying [7]

numbers depending on the height of the stalk (from 40 to 60), covered with long leaves with serrated edges alternately arranged. The stem is covered with hard tissue. Its interior is composed of fibrous material or spongy pith, in whose interstices microscopic cells containing sucrose are housed; This, separated from other impurities, constitutes sugar.

These characteristics are reflected in the layout design of the industrial plant. A transport line is necessary where the trunk of the cane enters a sequence of mills, where the grinding takes place and the start of obtaining the so-called juice.

Botanists have described more than 20 species of the genus Saccharum, among which the Creole cane (called in Andalusia "Cana de la Tierra," Doradilla, or Algarrobena) and the yellow cane of Tahiti (called American cane in Andalusia) stand out. Its genetic instability makes it susceptible to degeneration. Still, at the same time, it allows producing crosses, new varieties destined to increase its saccharin richness or improve its resistance to more extreme climatic situations [16].

The optimal climatic and water conditions for its development range between 20 and 25 degrees Celsius in average temperature and 1,200–2,000 mm. of precipitation. The coastal plains of the Andalusian Mediterranean had a moderate temperature, and a thermal amplitude at the limit of these requirements, and the insufficient rainfall could be compensated by artificial irrigation.

2.2 Location of the Industry, Near the Crop Development

Due to the microclimate configured on the coast from Adra to Velez Malaga, known in its longest distance as Costa Tropical, it meets the climatic, orographic, and latitude conditions for the sugar crops to acclimatize and be productive.

In addition, isolated to the north by the mountain ranges and bathed in the south by the Mediterranean Sea, a microclimate is created that protects from the rigors of the continental climate.

Sugarcane was the alternative that was followed in the 19th Century. There is now a commitment to other tropical crops, such as kiwi, mango, custard apple, kakis, avocados, papayas, guavas.

It was established to consider being an exotic crop in Europe and a specific luxury item, which led to industrial plants associated with farmland, creating activity, developing technology, and productive techniques. Irrigation works business initiatives had to be faced, together with the workforce's learning, soil conditioning, and the worst part, the destruction of mountains, to obtain wood for the energy supply of the boilers.

Specifically, the "Vega del Rio Guadalfeo" is a large coastal plain that is climate protected and meets the requirements for developing sugar cultivation. It results from the silting process of an old bay and with the sedimentary contributions of the river and other channels such as the Ramblas de Molvizar, Puntalon, Alamos, and Las Brujas.

And it is here where the first sugar factory with steam engines was in Almunecar and the Pilar factory.

3 The Industrial Process

Since each building is handled individually, it may be designed to conform with any given set of requirements, made necessary by conditions existing at the factory site.

The width of the building is determined by the space occupied by the tandem, gearing, power machinery, hydraulic accumulator, and the conveyor for transportation.

To obtain the sugarcane juice and industrially design the extraction, within a continuous process to increase the performance faster, the industry substituted both the animal and water traction for the force generated in a steam engine associated with the milling machine Fig. 3.

A series of operations were performed, including selecting and preparing the sugar cane, cutting, milling to obtain the bagasse, cooking, and crystallization. In particular, the technology applied to Pilar's factory focuses on milling the sugar cane using a gear train driven by a steam engine, whose movement is communicated to cylinders that produce the milling (pressing) of the sugar cane.

3.1 Industrial Design is Based on the Type of Crop and Technology Available

When the cane is cut (mature) to be driven to the mills, these must be of such capacity and in such good condition that they allow the total tonnage to be continuously ground in the shortest period possible.

By grouping several mills into a train with their units, a profitable extraction of the cane juice is ensured in one plant. As a result of this high extraction, a minimal percentage of sucrose remains in the bagasse after the last mill. And bagasse contains so little moisture that it is ideally suited as fuel.

The possibility to join the new technologies coming from the Industrial Revolution, together with the option of wood to feed the boilers, made the incorporation of steam

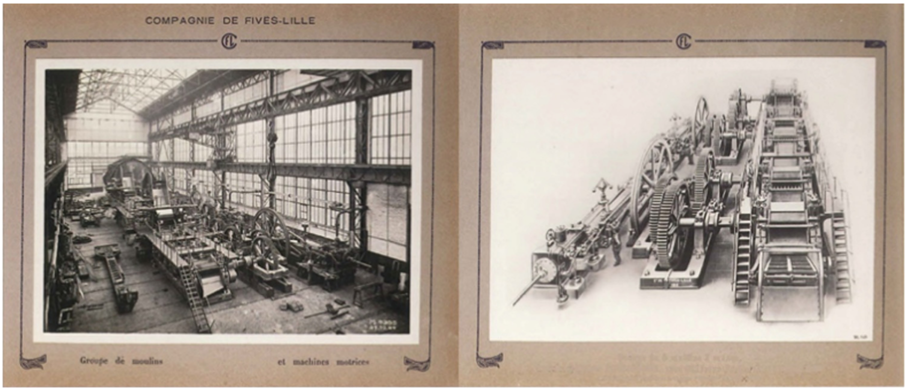


Fig. 3. Left: Test bench at the Fives-Lille factory for a mill train with shredder and drive machines. 1924. Right: Steam-powered cane mill train, built by the Fives-Lille company. 1921. Miguel Gimenez Yanguas Collection [4]

engines, associated with the mill, that can propel the mill, along with hydraulic pumps, powered by steam boilers through a connection of pipes.

3.2 Machinery Description

All the mechanical components are fixed in bases made of cast iron due to the stress to which the machinery is subjected.

The side covers are made of semi-steel and are made so that they hug the side heads and are also provided with a spring for adjusting screws that allow an easy and fast adjustment of the cane and bagasse hubs while they are grinding.

The top caps are cast steel and are provided with hydraulic pistons to regulate the pressure in the hubs. All thrust bearings are phosphor bronze. The crowns are tough to cast steel, turned cast, and well-tempered. The axes of the hubs are provided with double crowns, adjusting perfectly.

Iron plate guards cover the crowns for protection, preventing bagasse from clogging them and collecting excess oil that escapes from the bearings.

A steam engine moved the conveyor belt, and from the cane square, where there is a well from which the conveyor belt starts, it fed the cane mill train from the top.

First, it entered the defibrillator to make fiber from the cane, and then it entered the three mills, whereby mechanical pressure, the cane was squeezed, and the juice obtained Fig. 4.

There is a transfer of the reeds, where steam engines operate the shafts that the mill moves the mass, and the stakes have trunnions, which can weigh 1000 kilos.

The mills have hubs or fluted cylinders, which go in an equilateral triangle, and with gears that join them to rotate in unison.

The tops of the mills have hydraulic hubs, which, if any stone or unwanted element penetrates, hydraulic pressure accumulators such as oil presses, and a machine or steam cylinder for a pressure meter. The closures must be caught next to the gears, and it carries large bronze windings that correspond to the defibrillator Fig. 5.

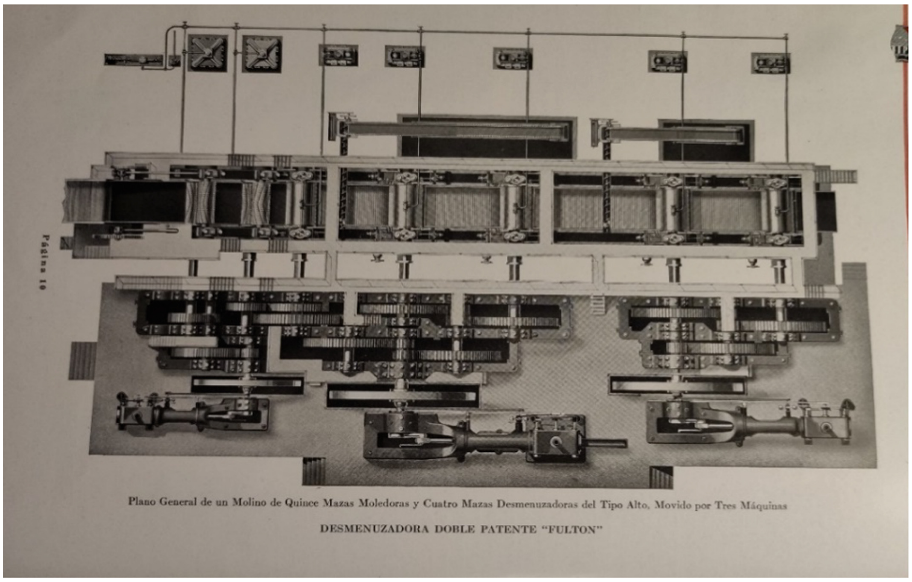
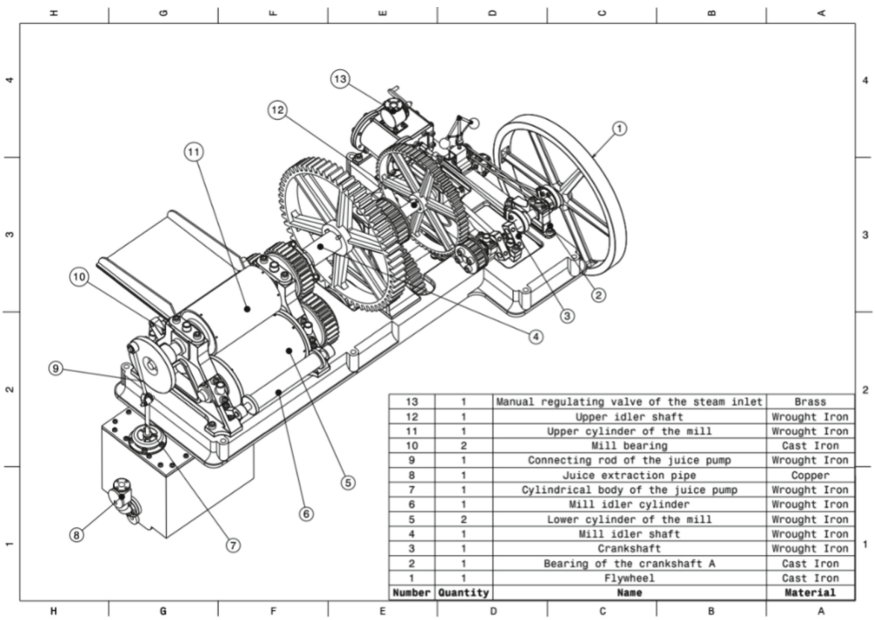


Fig. 4. Drawing. Layout triple mill train. Fives- Lille [4]

The oil enters through the upper part and is injected by the pump. There are conveyor belts, which go up to the upper floor from the bottom of a mill.



Number	Quantity	Name	Material
13	1	Manual regulating valve of the steam inlet	Brass
12	1	Upper idler shaft	Wrought Iron
11	1	Upper cylinder of the mill	Wrought Iron
10	2	Mill bearing	Cast Iron
9	1	Connecting rod of the juice pump	Wrought Iron
8	1	Juice extraction pipe	Copper
7	1	Cylindrical body of the juice pump	Wrought Iron
6	1	Mill idler cylinder	Wrought Iron
5	2	Lower cylinder of the mill	Wrought Iron
4	1	Mill idler shaft	Wrought Iron
3	1	Crankshaft	Wrought Iron
2	1	Bearing of the crankshaft A	Cast Iron
1	1	Flywheel	Cast Iron

Fig. 5. Mill and steam machine assembly plan [14]

The milling or pressing of the sugar cane requires considerable compression force. However, the steam engine generated very high speeds that were unsuitable for milling, and it was, therefore, necessary to transform speed into power employing a compound gear train Fig. 6.

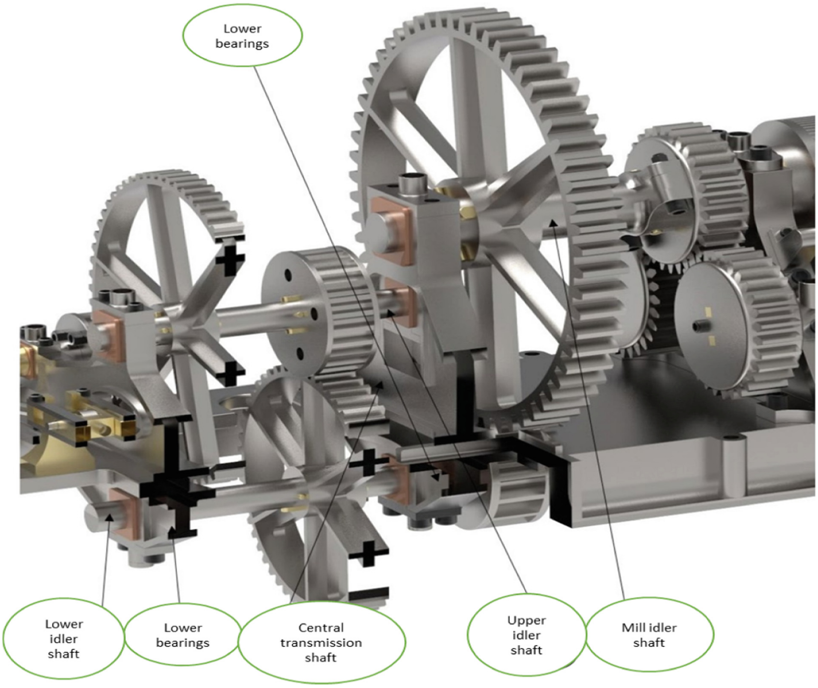


Fig. 6. Detailed gear train [14]

Once the cane had already been shredded, it had passed through the defibrillator and the three mills, the woody part of the cane, the resulting residue, which is bagasse, was going to feed as fuel the special burners that the steam boilers had.

It can be noted that this type of factory was ecological and already used biofuel, and cogeneration was established [6].

The steam engines operate at a speed of 70 to 80 rpm, and the speed-torque reducer, made up of the gears, reduces that speed to that suitable for the hubs or cylinders, which is of the order of 8–10 rpm Fig. 7.

Steam engines have a dead point in which you cannot move no matter how much steam entered, and with the ratchet, you had to get it out of that point.

Once the juice came out, it was mixed with lime from a nearby lime kiln installed in Granada in the Duque de San Pedro Sugar Factory, from 1890, in Lachar. And in 1929, they dismantled it from Lachar and brought it to Pilar. Oxide of lime was obtained, it was like a small blast furnace, it had limestone (calcium carbonate) and coke coal in alternate layers, it was made to burn, that is, it burned, and the heat made the calcium carbonate decompose into oxide of lime and carbon dioxide. The lime oxide came out from the

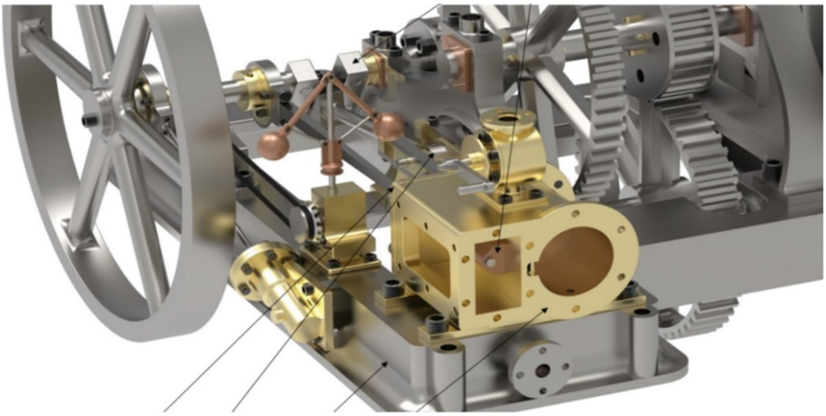


Fig. 7. Steam engine without steam-chamber side cover [14]

lower part and went to a trommel that quenched the lime oxide with water, and calcium hydroxide was obtained. The calcium hydroxide was mixed with the juice from the mill train. Then it made a series of chemical products precipitate, mainly monocalcium phosphate, which is soluble, and tricalcium phosphate was formed. As lime was added in excess to carbonate the juice, in the manufacturing hall, making the carbon dioxide that was extracted from the upper part of the lime bubble, it was sucked up with pumps, moved by steam engines, bubbled through the juice with each paid and the excess passed to calcium carbonate.

In other words, we have tricalcium phosphate, which precipitates, calcium carbonate that we have precipitated in excess, with carbonic anhydride. In the press filters, through some cloth, the juice was passed with the pressure in horsepower because of the pumps, and the solid phase remained in the fabrics, which, when the filter press was opened, fell into the collection hopper.

As soon as the juice was purified, it had to be concentrated under a vacuum, and for this, we have an evaporation set. The fluid enters the first boiler with indirect steam from the steam engines. Evaporation of the juice takes place, these vapors are conducted to a second boiler to feed the exchanger of the double boiler, the fluid continued to evaporate, and thus it was passed to the third, and from the third to the fourth. From the fourth, the steam went to the vacuum column, 10 m high, were at the top was a water shower. Then the moisture condenses and produces a vacuum.

Of course, heating the juice has reactions, not only physical, if not chemical, of decomposition of the liquid, where methane, carbon dioxide, and carbon monoxide were obtained. If it is not removed, the vacuum that is created is ruined. There were two auxiliary steam engines, one from 1900 and the other from 1884, which moved vacuum pumps that removed the non-condensing gases from evaporation. All this in a quadruple effect. The gases were released into the atmosphere, with a very typical smell Fig. 8.

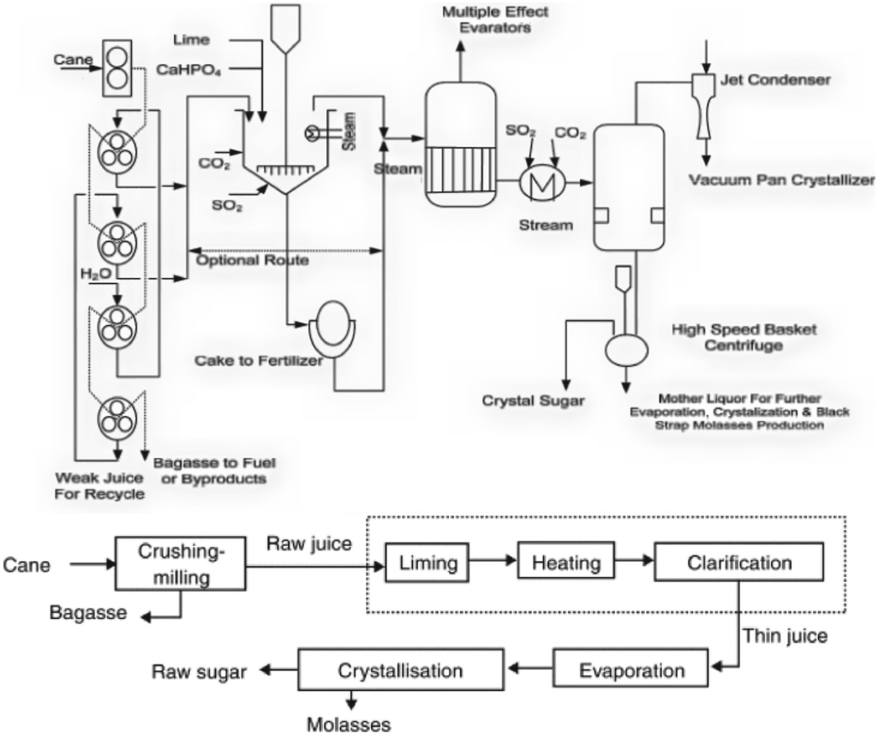


Fig. 8. Simplified flow diagram. Sugar physical-chemical process. Author

3.3 Why Do Steam Engines Survive in the Sugar Industry Compared to Electric Motors?

The system works in cogeneration. The industry needs steam for its operation and with a heat exchanger. Not over direct heat as at the beginning but steamed.

Producing steam is expensive, but in the sugar industry, it is necessary to assure of the processes [13].

The circuit was fed at a pressure of 10 kg./cm^2 of motive force for the cane milling. The water of about ten ° C must be raised to 100 degrees; the specific heat of the water is high. Once 100 ºC is reached, we have the latent heat of vaporization, but when we have steam and reheat it, the specific heat is small as the pressure increases. We put it in the steam engine, and instead of letting it escape, we send it at 2 kg. of pressure to the rest of the manufacturing process Fig. 9.

The production of the factories in Motril was concentrated in El Pilar. In 1929 it was reformed to move about 1,000 tons of cane per day. In the reform, they removed the centrifuges, where the sugar is separated from the honey. They made cane syrup concentrate here and sent it to the Atarfe distillery, directed by the engineer Zubiela. It was then sent to a small distillery in Salobrena at the San Francisco factory.

When Sociedad General Azucarera dedicated itself to making alcoholic beverages and created the Bermudez Rum Winery thus, in the last year of operation of El Pilar, they devoted themselves to manufacturing sugarcane syrup concentrate to feed the alcohol factories [7].

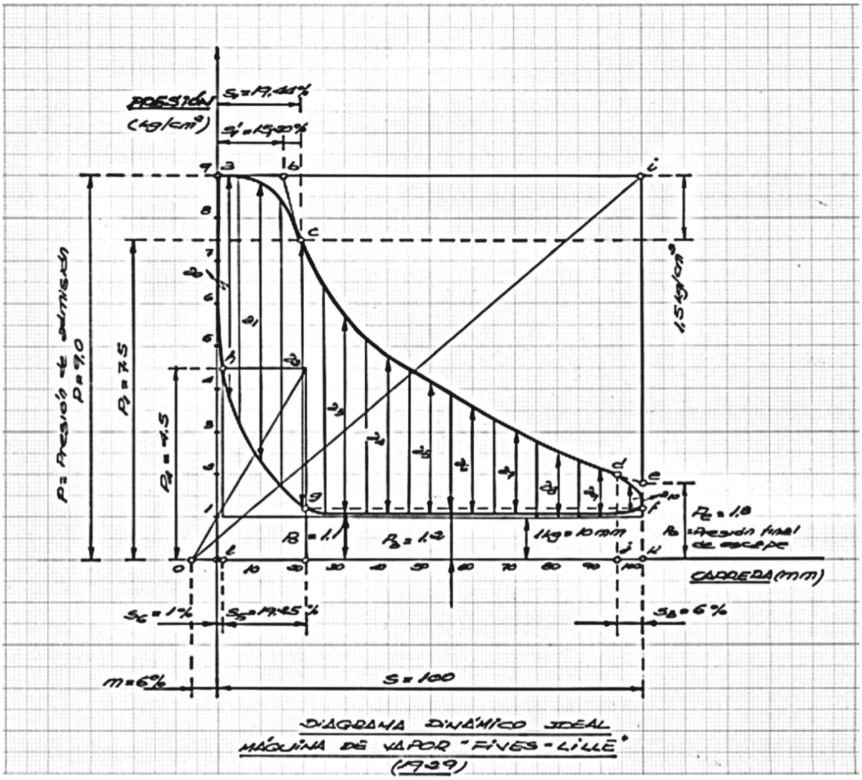


Fig. 9. Dynamic diagram Fives- Lille [4]

4 Local Deployment and Development

4.1 Crop Expansion

During the six months that a mill worked per year, it needed to have the ovens constantly lit, consuming large amounts of firewood annually. With the Royal Provision of Carlos II, it has come to prohibit the entry of cattle in the sugar lands because firewood was necessary for the milling of the cane.

According to "Simon de Rojas," the cultivated area of the "Vega de Motril" could reach 800 Ha in the middle of the 16th century; according to other sources, in 1561, it could be around 1,200 Ha. In the middle of the s. XVIII is when there are more precise files, with the Ensenada cadaster, which included between registered and no man's land around 970 Ha in 1752. Later, in 1785, 1,600 Ha of cultivation area were recorded;

and they are no more because the flooding of rivers and floodplains are not controlled. Already in 1830, 40% of the surface of the Vega continued being unproductive [15].

It is with the impulse to cultivate sugar cane when in 1860 the unproductive land was reduced to 19%, reaching 1930 with only 4.2% of the Vega de Motril and 6% of that of Salobrena.

The conclusion is that with the expansive cycle of sugarcane cultivation, the surface of the productive agricultural soil improved. Regarding property, the impact of a monoculture on the land led to the transfer of properties to sugar companies and local land-owning families. At the end of the 19th century, 65% of the holders owned less than 1 Ha. In 1930, it was 74%, participating in 16% of the total cultivated area.

4.2 Industry Deployment

The deployment of the Andalusian sugarcane industry from 1845 was based on the conjunction of two phenomena: a spectacular increase in agricultural and industrial yields, promoted by the modernization of techniques, cultivation, and manufacturing, and circumstances of fiscal policy and very favorable tariffs, which gave it the necessary protection against colonial sugars. Protected by such support, the sugarcane sector grew to the limit imposed by geography itself [2].

Despite this, peninsular sugar yields never came close to colonial ones, even though the differences in outcomes were shortened until arriving in 1881, to be only 20% compared to Cuba. The lowest productivity is always the Achilles heel. Hence, industrial and cultivator entrepreneurs always considered the protective tariff the foundation of their existence, systematically opposing any change in the metropolis-colony relations that altered this fragile status since the national market was a way out each time. More irrelevant for a Cuban production in continuous growth and, instead, the tariff allowed the survival and consolidation of a peninsular industry incapable of representing a danger [3].

This scenario became complicated around 1880; The tense relations between the colonies' interests and the Hispanic metropolis were joined by the birth and rapid development of the Spanish beet industry from 1882. From the Vega de Granada, the cultivation of beet would spread very quickly throughout the lands of the Ebro Valley and Castile, achieving at the end of the century to produce almost all the sugar consumed by Spain; Without geographic limitation and with the support of industrial productivity based on its greater saccharin wealth, the production of beet sugar tripled that of cane in a short time [9].

The national market was organized as a protected market. An oversized sector would have to supply and be composed of diverse production capacity, technological modernization, and production costs (whether sugarcane or beet); This made it necessary to carry out a drastic reconversion of the sector, resulting in the constitution of the "Sociedad General Azucarera of Spain" and the closure of the least profitable factories. In these circumstances, the worst part was taken by the sugarcane facilities. The attempt at a sugar business monopoly, in any case, did not manage to stably order the sector, having to resort to the prohibition of setting up new factories [11].

Thus, after reaching a historical record in 1900 - with the milling of 357,000 tons of cane and obtaining almost 34,000 tons of sugar - the sugarcane sector faced a drastic decline throughout the first quarter of a century, minimizing its presence in the total production of national sugar - from 35.7% in 1900 to 4.2% in 1925- and radically limiting its entire show, which in 1925 did not exceed 25% of that obtained in 1900 [10].

The fall in agricultural and sugar production constitutes the most obvious example of the industrial dismantling carried out in the first years of the century and the progressive loss of profitability in the farms, accelerated by the fall in prices and sugar cane yields. In 1900, 29 sugarcane factories were in operation. Ten were in the province of Granada, 17 in Malaga, and 2 in Adra; During that campaign, nine factories were grinding in the Vega del Guadalfeo, of which we mention Nuestra Senora del Pilar [1].

5 "Nuestra Senora del Pilar" Factory

5.1 Description

Designed by the Granada-born architect Francisco Jimenez Arevalo, the construction of the factory and warehouses began in 1882. The building complex-built brings us to the factory and colony characteristics of the sugar world. The typology of its industrial buildings results from extensions, modifications, and destruction carried out over a century.

The current factory is located to the east of the city of Motril, in the foothills of a hill included in Rambla de las Brujas; Originally, the factory was located on the outskirts of the town, although today it has been practically integrated into the urban complex.

At a lower level, the old canal is located, which serves as a dividing boundary between the old plain and the upper lands not traditionally subject to irrigation; This site has an approximate area of 7 hectares, forming a kind of theater open to the Southeast and at the base of which the facilities themselves are located.

In 1984, after 102 years of almost uninterrupted operation, the Nuestra Senora del Pilar factory permanently shut down its boilers and was waiting to be dismantled.

The factory plant consists of:

- Four industrial buildings with a three-story elevation.
- The distillery is separated from the body of the factory. It consists of a height of three floors.
- Warehouse for tools and appliances, formerly it was the chapel and stables.
- It has a central plan and an octagonal shape to which another building with a rectangular plan is attached.
- Sugar warehouse, rectangular. Inside there is a second floor.
- All these units have gabled roofs.
- The industrial area of the triple mill train consists of a plant of significant proportions to implement the vast layout Fig. 10.
- Manor and Management House has a rectangular plan with a three-story elevation attached to the four original buildings.

Fig. 10. Mill train- industrial building N.S. El Pilar. Current situation. Photo: Author

5.2 Machinery

Regarding the most valuable set of machinery that is preserved in Spain, from "Ntra. Sra. Del Pilar", it has the following eleven steam engines, Fig. 11, which are worth mentioning [8]:

- 1 Aktien- Machienenfabrik machine, which acts as the driving force of the electric generator, with a flywheel and simple slide valves.
- 1 Fives-Lille engine from 1889 gave the sugarcane cutting machinery motion power, with two twin flywheels and single slide valves.
- 2 Fives-Lille machines from 1929 provide the driving force for the mill train. The machine's shaft is coupled to a speed reduction gear train, which, in turn, connects with the mill cylinders. It has a centrifugal speed regulation system with hydraulic damping. It represents the technological cutting edge of the time, with a power of 200 CV.
- 1 B.M.A. machine. (Braunschweigische Maschinenbrau Anstalt) From 1893, which provides a driving force to a carbon dioxide compressor that, coming from the continuous lime kiln, is installed to feed the factory carbonation. It has inlet and expansion valves through a simple slide system and a Porter-type centrifugal speed regulator.

- 1 Etabs machine. Carson- Delmotte from 1898 provides the driving force to a carbon dioxide compressor coupled to its shaft, with intake and expansion valves using a simple slide system and a Watt-type centrifugal speed regulator, with four spheres.
- One machine from "Talleres Castanos" of Granada in 1900 supports an air compressor for the sulfidation process, vertical counter pressure, and admission and expansion valves by simple slide, lacking a speed regulator.
- 1 Fives-Lille machine from 1889 gives motive power to the cloth washing machine, with two twin flywheels, speed regulation by Watt system, and single slide valves.
- 1 Fives-Lille device from 1889 gives motive power to a vacuum evaporation pump through a simple slide system, Watt type centrifugal speed regulator Fig. 12.
- 1 Fives-Lille machine from 1900 provides the driving force for an evaporation vacuum pump using a simple slide system, a Watt-type centrifugal speed regulator, and an inertia flywheel.
- 1 S.A. machine from "Constructions Electriques" de France, from around 1930, gives motive power to turbines and malaxers. It has an inertia flywheel, hydraulic-type speed regulator, and Sulzer-type intake and expansion valves.

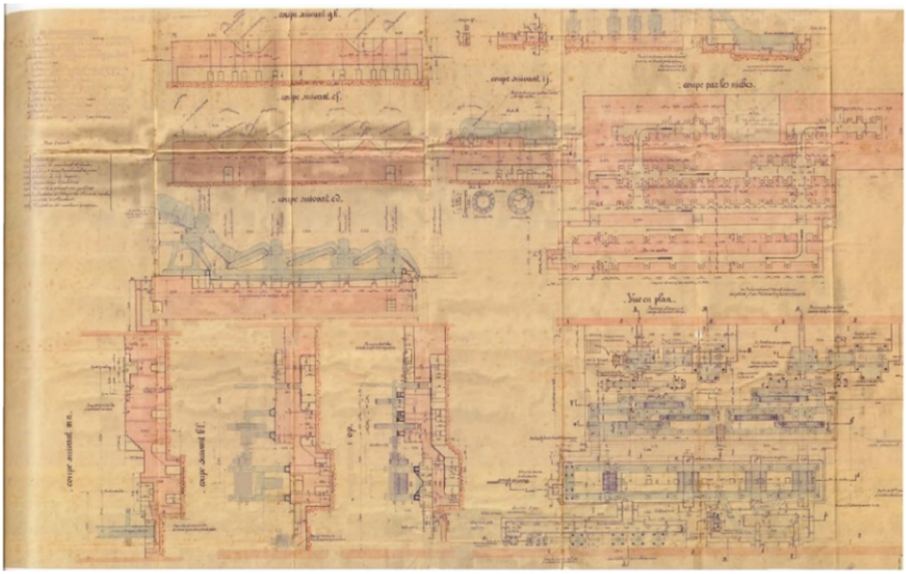


Fig. 11. Installation drawing of the mill train of the «Nª Sª del Pilar» sugar factory. 1929 ca. Miguel Gimenez Yanguas Collection [deposit]

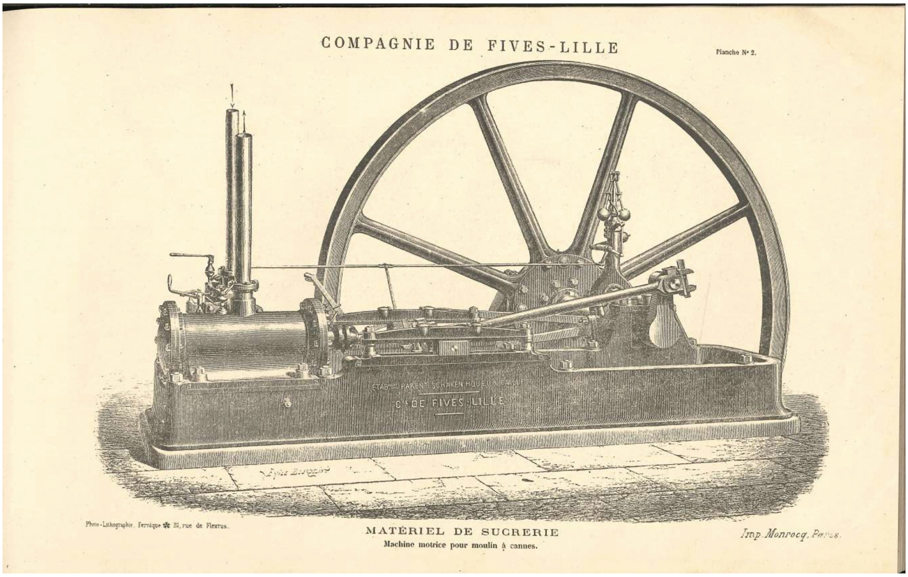


Fig. 12. Steam machine. N. S. El Pilar. Fives- Lille catalogue [4]

6 Conclusions

An industrial remnant must be valued for its technological exceptionality, not only for its outdated and antiquity, nor vintage but also for its survival character coming from a disappeared industrial activity. And bearing in mind, adding value has impacted society and development.

The Pilar sugar factory is the most complete and has the oldest triple mill train in Spain. Its construction dates from 1882. In 1984 it carried out its last milling works, being definitively closed out. It is the most valuable vestige of the industrial relics that are preserved linked to sugar production. The architectural integrity of the complex is combined with the inside machinery built between 1880 and 1929.

Therefore, the main protagonist of this article is mentioned as the sugar factory of “Nuestra Senora del Pilar” and the remains of the other four mills that remain in the provinces of Malaga and Granada, which refuse for disappearing. It is a believe this architectural and industrial complex matches with the same considerations that UNESCO used to declare the “Voelklingen” steel plant in the Saarland, considered a unique testimony of the steel industry during s. XIX and principles of the s. XX. Such mention that “Nuestra Senora del Pilar” would also deserve, in addition to the museum project.

Unlike architectural structures, which are much more resistant to the passage of time, the historical machinery linked to sugar production has undergone a considerable decline in recent decades. A certain number of pieces have been rescued and restored, but the destruction of many others is now irreversible. Despite this, there is still a rich movable heritage with a very uncertain future unless steps are taken to acquire and preserve it.

The value of an operation of this type is none other than trying to put together pieces that, regardless of their intrinsic value, can jointly give a detailed overview of how sugar was produced at the end of the last century and how the sector evolved technologically. Therefore, it is not about the conservation and exhibition of isolated machinery but constructing complete industrial sets Fig. 13.

The comprehensive rehabilitation of this factory is the best service that can be done to safeguard the historical and technical heritage that we have inherited from the sugar industry that allowed the social and urban development of the province of Granada.

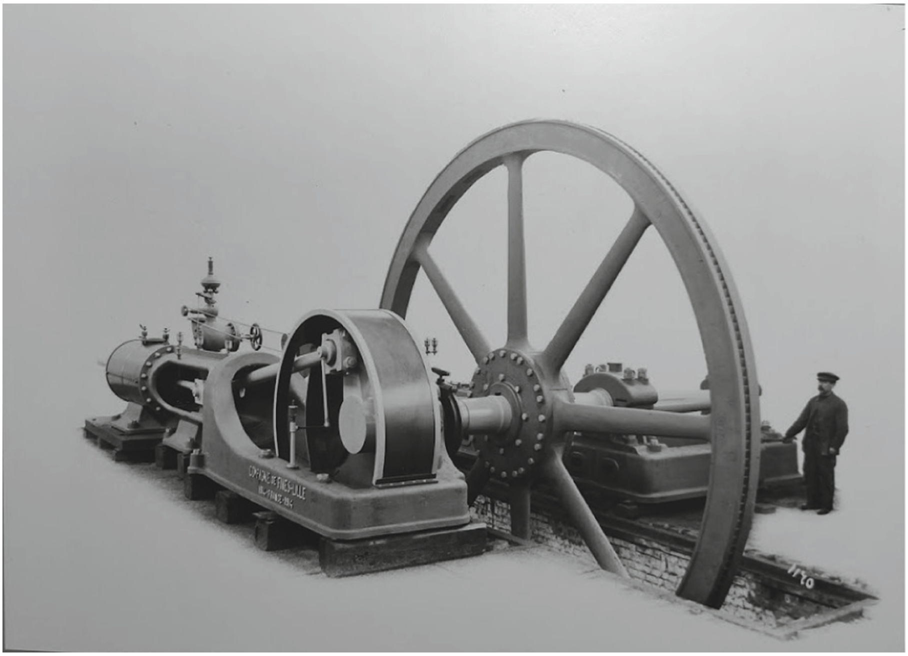


Fig. 13. Steam engine machine [4]

Acknowledgments. I want to acknowledge the support received from Industrial Engineer and UGR professor Miguel Jimenez Yanguas, for his large machine and documentation collection, as a mentor, advisor, restorer, and entirely devoted to the conservation of the industrial heritage, especially the steam machines and the Granada's sugar industry. Also, to Professor Miguel Angel Sebastian from the UNED Industrial Engineering School.

References

1. Rozua, J.M.B.: Reforma urbana y destruccion del patrimonio historico en Granada. (Urban reform and destruction of the historical heritage of Granada) University of Granada (1998)
2. Perez, J.C.: Factores de la estructura socioeconomica de Andalucia Oriental. (Factors of the socioeconomic structure of Eastern Andalusia) Archivum. Universidad de Granada (1993)

3. Evangelista, L.: Tratado de fabricacion del azucar de cana y remolacha. (Treatise on the manufacture of cane sugar and beets) Madrid (1895)
4. Fives-Lille Catalogue for Sugar Mills (1925)
5. Yanguas, M.G., Santos, S.P.: Motril y el azucar. Paisaje, historia, patrimonio. (Motril and sugar. landscape, history, heritage) Brochure Expo Millennium Granada' Kingdom. pp. 75–91 (2013)
6. Yanguas, M.G.: Importancia Tecnologica de la Industria del azucar de cana. Motril y el azúcar. Tradicion y modernidad. (Technological importance of the cane sugar industry. Motril and sugar. Tradition and modernity) Granada (1989)
7. Yanguas, M.G.: El patrimonio industrial azucarero en la Costa Granadina: origen, situación y perspectivas. (The sugar industrial heritage on the Granada Coast: origin, situation and perspectives) Jornadas Ibericas de Patrimonio Industrial y la Obra Publica. Sevilla (1994)
8. Samos, J.P.: Yanguas, M.G.: La fabrica azucarera Nuestra Senora del Pilar. (The sugar factory Nuestra Senora del Pilar) Motril (Granada). Valoracion y propuestas de actuación. VIII Congreso Internacional para la conservación del patrimonio industrial. Actas. Madrid (1995)
9. Rodríguez, M.M.: Azucar y descolonizacion. Origen y desenlace de una crisis agraria en la Vega de Granada. (Sugar and decolonization. Origin and outcome of an agrarian crisis in the Vega of Granada) University of Granada (1982)
10. Martinez, A.P., Rosado, A.: El fracaso del cartel la Sociedad General Azucarera de Espana: Un análisis desde la legislacion sobre este sector industrial (1899–1931). (The failure of the cartel the Sociedad General Azucarera of Spain: An analysis from the legislation on this industrial sector) XII International AEHE Congress. Salamanca. (2017)
11. Pascual, A., Rosado, A.: Creación, quiebra y remodelacion del trust azucarero español: la Sociedad General Azucarera Espanola (1903–1916) (Creation, bankruptcy and remodeling of the Spanish sugar trust: the "Sociedad General Azucarera Española"). Investigaciones de Historia Económica. AEHE (2019)
12. Samos, J.P., Yanguas, M.G.: Motril y el azucar. Del paisaje industrial al patrimonio. (Motril and sugar. From industrial landscape to heritage) Asukaria Mediterranea (1996)
13. Sola, J.I.R., Marin, J.R.U.: The steam engines in sugarcane production in Spain. DYNA Review #171 (2012)
14. Sola, J.I.R., et al.: An approach to the study of a 19th-century sugarcane mill and steam engine through CAD techniques and mechanical engineering. Machines throughout History for Technological Development: Analysis from Engineering Graphics. Jaen (2021)
15. Gandia, M.A.R., Yanguas, M.G., Mesa, J.M.R.: Patrimonio Industrial en Granada. (Industrial Heritage in Granada) Obra Social Caja Granada, pp. 171–187 (2003)
16. Sagra, R.: de la. Informe sobre el cultivo y la fabricacion de azucar en las costas de Andalucia (Report on the cultivation and manufacture of sugar on the coast of Andalusia) Azucarera Peninsular Company. Madrid (1845)