The modernization of the naval military industry in Spain in the nineteenth century: the example of Cartagena's arsenal

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ABSTRACT. This article analyses the revitalization of XIX century Spanish military shipbuilding, which went through a period of significant transformation.
In the case of the Arsenal of Cartagena, it became the leader of the international hydraulic technology.
The strong cooperation between the Spanish industry and technology and those of other countries, would reactivate Spanish industrial structure. All this encouraged economic and technical comparative research.

THE NINETEENTH-CENTURY SPANISH naval industry was at the forefront of international hydraulic technology of the time. This article deals with the importance of the economic and technical changes that made this possible. The historical context is the Industrial Revolution and the naval sector in Spain in the nineteenth century, within the context of Spain's mid-century attempt at modernization.

Spanish naval history has been written mainly by the naval officers themselves, who shaped it according to their own viewpoints. It is therefore an area which Spanish historiography has, for the most part, disregarded and which presents many gaps. The gap concerning aspects of industry and naval engineering is even larger; furthermore, the complexity of dealing with some technical aspects from a historical point of view must be taken into account[1].

1. The importance of naval research in Spain was fully acknowledged when the University of Murcia and the Polytechnic University of Cartagena jointly created the 'Mare Nostrum' Campus of International Excellence.

The eighteenth century has been the century most thoroughly researched from the point of view of the naval industry, because of the economic, political and social importance of the creation of three Maritime Departments and their arsenals. The nineteenth century, however, has been explored a lot less thoroughly, although it is crucial for the innovations in hydraulic engineering within the context of Spain's general economic development, and after the major economic crisis which coincided with the crisis of the *Ancien Regime* itself.

Nowadays the need for detailed and carefully researched studies on naval history cannot be questioned[2]. All methodological approaches may be used in exploring the wide range of subjects which this area of study offers: economic, social, labour, political, military and technological. The analysis of the Spanish naval industry in the nineteenth century is particularly interesting since this was a century that witnessed a very important transformation, with improvements in the arsenals after the years of neglect and decline in the infrastructures necessary for ship-building, which was particularly acute during the reign of King Ferdinand VII (1784-1833). During Ferdinand's more than twenty years on the throne, the Army, like all other national bodies, was subjected to measures of suppression and to purges, resulting in oblivion and the decline in its facilities, materials and staff.

In the second half of the nineteenth century, Spain struggled to become industrialized, but lacked the appropriate technology and a skilled labour force. As part of the economic effort to modernize the country, the re-building of ship-yards was given special consideration. The ambitious foreign policy during the reign of Isabella II (1830-1904), and the need to keep the country's overseas possessions, required a major naval squadron, which was lacking at that time. This accounts for the great economic and technical effort to make the Spanish naval industry, and specifically the Arsenal at Cartagena on which this paper focuses, a landmark within the hydraulic engineering works of the time.

2. In December 2010, the first Chair of Naval History was created in Spain, set up jointly by the University of Murcia and the Spanish Navy, of which I am myself a member.

During the second half of century XIX Spain fought to become industrialized, and a significant revamping effort in many aspects of its economy was carried out, that would be evident in the military naval industry. After long years of abandonment due to the economic shortages and the political situation, the liberal Spain of XIX century had to restructure its shipyards to adapt them to the changes imposed by new technology.

The adjustment that had to be done for the abandoned and obsolete military installations of the arsenals in order to prepare and revamp them deserves special attention. The Spanish military naval industry, and in particular the Arsenal of Cartagena, would become a point of reference for hydraulic engineer works through the building of a modern dock plane on a level, whose construction was possible thanks to the collaboration with the British industry.

The search for prestige in foreign policy that was carried out in the reign of Isabel II, and the need to preserve the still important overseas territories, required resources which were lacking. For that reason a great economic and technical effort would be carried out.

The Spanish military naval industry in century XIX would live a revamping period through important improvements carried out in collaboration with the international industry. This would produce a reactivation of the industrial network of the sector and would allow comparative studies on other European countries with more advanced technology.

1. The background: the rise and decline of the Spanish naval industry in the seventeenth century

IN THE EIGHTEENTH CENTURY due to the tensions and conflict in Europe, Spain needed large military port facilities which would put her on a par with her European rivals – England, France and The Netherlands – all of which were very advanced, both in naval planning and in the support from their arsenals.

In accordance with the plans of the Navy Quartermaster-General, Patiño, approved by Philip V in 1726, it was decided to create three large Maritime Departments: North, South and East. Their key element was the construction of an arsenal in each of their three capital cities: Ferrol, Cadiz, and Cartagena.

At first an arsenal did not have an exclusively 'naval' meaning, but was a 'factory, a mill, or a supplies and stores depot'. The definition of this word varied according to the development and the eminently maritime specialization of this type of facility. In the eighteenth century, there was a change in the concept of arsenal, and facilities were geared towards a faster and more efficient production of ships devised only for war purposes.

Thus it was not the lack of ships, but rather the need for specific ones that shaped the policy regarding arsenals (Demangeon and Fortiter, 1978, p. 23). Strategic objectives influenced their creation and, together with technical reasons, partly defined their location, which was often in sparsely populated areas, thus giving rise to military cities. Such was the case of Rochefort, Brest, Cherbourg, Portsmouth, Cartagena, Ferrol and Cadiz (Merino, 1980, p. 175). The construction work continued from Philip V's second mandate, through the reigns of Ferdinand VI and Charles III, and ended with the reign of Charles IV; in other words, it continued practically throughout the eighteenth century.

The Spanish Navy's first arsenal was La Carraca, near San Fernando, Cadiz (Quintero, 2005). The location was chosen because of the marshy terrain of its environs, which made it almost unassailable. The construction of the main buildings and facilities reached its peak about the middle of the eighteenth century, when the three dry docks, the San Carlos, the San Luis, and the San Antonio were built (Llabres, 1952, pp.175-178). They were the key element to the naval facilities of the time and, after being enlarged and altered in the nineteenth and twentieth centuries, are still in use today.

When the Northern Arsenal was built at Ferrol, the hydraulic facilities

of its naval outbuildings were determined by the considerable tides of the Bay of Biscay's rough waters. As in Cadiz, we can identify two different periods in the construction of this naval base. Firstly, a plan for a grand arsenal with dry-careening docks was carried out; this was followed by the urban projects for the city and the coastal defences (Rodríguez Villasante, 1988, p.16).

Cartagena had been the base for the Spanish Galley Squadron from the sixteenth century, and, as at Cadiz and Ferrol, the building of the Arsenal was part of a more extensive building plan, aimed at creating the eastern naval base. The facilities and fortifications, built in accordance with the city's standing as the headquarters of the Maritime Department, would leave their indelible mark on the city's urban space (Andrés Sarasa, 1989, p.58). In the course of the building, the original plans were altered repeatedly and several technical experts were involved in the project, both military engineers (Rubio y Piñera 1988) and famous naval officers, who contributed with their international experience in the sector.

A naval base, such as the one built in Cartagena at that time, consisted of the "creation of huge industrial facilities with thousands of skilled workers, concentrating all activities in one single area: commercial activities, activities connected with health, manufacturing and storage, administration and financial activities" (Merino, 1981, p.44). It was more than just a naval base and became the centre of Cartagena's urban economy and, to a certain extent, a sizeable part of the regional and extra-regional economy (Pérez Picazo, 1987, p. 1295). From its construction in the eighteenth century, Cartagena's Arsenal was therefore a major industrial complex, which became the main industrial site on the Spanish East Coast and promoted the development of many other economic activities. In the short term, this signified a period of obvious expansion for the city of Cartagena in an area that was totally dependent on state investments and was extremely fragile in the event of an economic crisis.

During the third and final construction period of Cartagena's Arsenal, the military engineer Sebastián Feringán and his main collaborator and successor Mateo Vodopich were responsible for building dry docks, intended for dry-careening the ships. These were the first dry docks to be built in the Mediterranean, and are considered among the major hydraulic works of the first seventy years of the eighteenth century. Their regular use meant that arsenals were able to overcome many difficulties experienced previously in naval construction. In this project, Feringán showed the extent of his technical training and his thorough knowledge of the subject, in that, as well as the construction difficulties, he also dealt with the problems caused by the lack of tides in the Mediterranean (Piñera, 1889).

The water was drained away by means of manual pumps, known as chain or rosary pumps. This involved pulling the pumps manually to drain the water that had accumulated because of rain or terrain leakages. This heavy work was even harder in Cartagena because of the lack of tides, and was therefore not at all comparable to the other ordinary tasks at the Arsenal; this was why the men doing this job were the convicts with the longest terms of imprisonment[3] which they served in the so-called "pumps pool", located between the two docks, and they were never let out. After the definitive suppression of the galleys in 1803, the "draining pumps" became the only task specifically reserved for those convicted for violent crimes (Lasala Navarro, 1961).

The problem was solved by the use of a steam engine for pumping, and Cadiz Arsenal was probably the first in Spain and perhaps in continental Europe to use this technology. The plans of the machine, referred to as the "fire pump", were implemented by the Spanish naval officer Jorge Juan, and after his death his work was continued by Captain Julián Sánchez Bort[4].

3. AMNM (Naval Museum's Archive of Madrid). Ms. 2489. Doc. 49. Destination of convicts in the service of ships.
4. AMNM. Ms. 1240. Doc. 2, fols. 4-6. Setting-up of steam draining-pumps at the careening docks by Julián Sánchez Bort.

The dry docks were in use until the end of the eighteenth century. Those years saw intense repair, replacement and careening work. The dry docks provided the Navy with important tools for ship repairs and for the preservation of naval rigging. When work at the Arsenal ceased, the dry docks ceased to be of use too, and thus their abandonment, which inevitably led to constant leakage. They stopped working, never to work again[5].

After building these three naval bases and putting their respective dockyards into operation, the Spanish Navy enjoyed a primacy in naval status globally throughout the eighteenth century. However, the nineteenth century as a whole was its most disastrous and dullest period. It began with the unsuccessful and much debated sacrifice at Trafalgar, continued with the arsenals' modernization and the resumption of naval construction around the 1860s, and ended with the disaster of Cuba and the Philippines.

The Spanish Navy maintained its prestige during the reign of Charles IV, when it was regarded as the second-best navy in the world. On 7 March 1793, war was declared on the Convention, and Spain and England allied against France. Because of its character and its significance, the campaign soon became a precedent in the Peninsular War. Three military forces were formed, and their maintenance bled public funds dry. This difficult situation was felt in the Navy and in the Maritime Departments of Cadiz, Ferrol and Cartagena (Roda, 1992, pp. 165-179).

In the case of Cartagena, the consequences were very important, since the lack of funds in the Arsenal's treasury had the socially-important effect of the non-payment of salaries to the naval dockyard's employees, which had dramatic consequences for the town's population, whose main source of employment was the Arsenal[6].

On 22 July, 1795, the armistice was signed in Basel and the Treaty of

5. In the 1920s they became docking bays for the submarine base of Cartagena's Arsenal.
6. AAC (Archive of Cartagena's Arsenal) Agreements of the Department's Economic Board, 1794.

San Ildefonso was signed with the government of the Directory on 18 August, 1796. Thus friendly relations between France and Spain – which were characteristic of the eighteenth century – were re-established. And so, as a continuation of the family pacts, the Treaty of San Ildefonso was, above all, a maritime agreement, whereby the Spanish and French naval forces were committed to act jointly against the British. The Spanish Navy thus became a major sacrificial victim, since the Treaty forced it to go beyond its available means.

The terms of the new treaty, and Great Britain's frequent attacks on the Spanish dominions in America, led to overseas confrontation between both powers from 1796 to 1801. As a result of this war, the Spanish Treasury collapsed, mainly because of the decline of the Spanish colonial system which had previously enabled the Treasury to stay afloat.

Trade with the Indies came to an almost complete halt, and colonial independence had to be organized. Once more the Spanish Navy was an accurate reflection of the crisis of the state, with its arsenals suffering enforced budget cuts, which led to the expected economic and social conflict. In Cartagena the situation became so serious that a fortnight's workload allotment system was adopted for workers at the Arsenal, and in 1800 the workers who refused to go to work went on strike. It comes then as no surprise that some years later at the forefront of labour conflict in the Region of Murcia (which included Cartagena) was the 'Naval Mastership', as the Arsenal workers were known (Roda, 2007).

Soon afterwards, Spain signed the second Treaty of San Ildefonso with France and declared war on Great Britain (1804). Napoleon's grand chimerical dream of invading Great Britain faded with the Franco-Spanish squadron's defeat in the waters of the Cadiz Bay area, off Cape Trafalgar in 1805[7]. Although it has been said that the Bourbon Spanish Navy met its death at Trafalgar, despite that great disaster, the Spanish Navy did not die; what did begin was the decline of the corporate spirit, and the erosion of

7. It is an iconic subject for naval historians, and many different books on the subject have appeared on the occasion of the recent bicentenary.

its prestige in the eyes of the whole country. For Spain, Trafalgar signified the end of all its efforts in the eighteenth century, the end of power and the end of the Empire (Laso de la Vega, 1863, p.405-440). The morale and the material situation of the Navy after Trafalgar is easily imaginable. The whole country was distraught and the Navy's forces humiliated and demoralized. The material losses were substantial, although the Navy could handle them. But the public purse, dependent for the most part on the contributions of America's viceroyalties, was already in a state of collapse.

Although, theoretically, Trafalgar should have meant an increase in careening, overhauling and ship-building activities, in practice quite the opposite occurred. The dockyards were practically idle. The Treasury's difficult situation directly influenced the economy of the Maritime Departments, and the shortage of all kinds of labour materials made the completion of pending works impossible (Roda, 1990, pp. 501-512). The fact is that it was not only the disaster of Trafalgar, but also the Peninsular War which aggravated the Treasury's shortages[8]. Although it was put aside for a while, since the fighting moved to the centre of the Peninsula, the events of the conflict did not spare the Navy. Fighting on land resulted in a great deal of pillaging in the arsenals, depots, and even in the ships' supply stores. The fact is that the Navy was in a very difficult situation and, a far cry from their intense activity and strength of the past, its Maritime Departments and Arsenals went through their worst years:

> Cadiz, Ferrol and Cartagena, places admired in the past for their magnificent and sumptuous Arsenals, by means of which Spain symbolized the very idea of its power and wealth, are nowadays places where one can certainly affirm that cruel desolation and grinding poverty have taken up lugubrious residence[9].

8. This situation was condemned by the authorities, AMNM. (Archive of the Naval Museum of Madrid) Ms. 883. Report addressed to the King by the Spanish Secretary, Madrid, 2nd February 1816.
9. AMNM. Report on the state of the navy, reported by the minister Vázquez Figueroa, Madrid, 20 October, 1812.

Cartagena's Arsenal supplied all kinds of materials by sea, not only to the troops but also to the besieged cities. This constant outflow generated very difficult economic situations, because of the lack of funds in all sectors and the lack of all kinds of goods. It may be said that this situation extended to the city of Cartagena as a whole, since a sizeable part of its citizens were directly or indirectly dependent on the Arsenal. This is confirmed by the constant complaints the Economic Board of the Department addressed to the Local Committee and to the Regency Council, often in very dramatic terms, describing how the Arsenal's workers, also known as the 'Naval Mastership', had to resort to begging to survive[10].

After the Peninsular War, those six years left a terrible legacy. The demographic losses due to fighting, epidemics and emigration were very serious (Torres Sánchez, 1990), as were the commercial crisis and the big decrease in port activity. With the country shattered, Ferdinand VII returned to the Peninsula and countermanded whatever the Assembly of Cadiz had legislated. The situation was so extreme at the end of the reign that it could be said that the Navy "had ceased to exist" (Fernández Duro, 1895-1903, p.65). A Royal order of 31 August, 1825 laid down that only one Maritime Department was feasible, the one in Cadiz with a single Chief of Naval Operations, whereas those in Ferrol and Cartagena were downgraded to the status of Naval Stations. Thus, the lack of resources was officially acknowledged.

There were almost no vessels, and even fewer fit for sailing; thirty-three months' salary was due to the staff, and almost nothing was left, except for the buildings, since the supply and store warehouses were completely empty. Since the Navy's participation in the war had not been at all intense, this devastation could only be attributed to the absolute state of neglect which it had to endure.

The only two Naval Ministers of Ferdinand VII were the officers in command, Luis María de Salazar and José Vázquez Figueroa. Both of them made many attempts to revive the Navy, but none were successful;

10. AAC. Agreements of the Department's Economic Board (1808-1812).

these were very hard times, described by Merino Navarro (1981, pp.22-23) as the hardest years in Spanish history. During those years, Spain's collapse as a primary world power came about at a pace which sends a shiver to any historian who attempts to research it; furthermore, available descriptions of the Arsenal at that time present a very different picture from that which was typical of such a facility:

> there are nothing but the contractors' assets, because if they contain anything, it belongs to them almost entirely; apart from that, it can be limited to some goods that time has not managed to erode, such as the old cannons and the anchors, since, with regard to the supply of either seasoned or unseasoned timber, there is nothing we can say, the former being so necessary for building and careening; with the addition perhaps of only the remains of a dismantled ship that decayed because it could not be careened.[11]

The situation of Cartagena's Arsenal in the first decades of the nineteenth century was hopeless. The city's constrictions as a port and military city made it especially sensitive to the crisis, which had been growing since the end of the eighteenth century. As long as the Arsenal stayed active, the possibilities of growth were guaranteed, but the situation completely changed when, at the turn of the century, military usage came to a halt, and the Arsenal was no longer of interest, nor the Department's strategic position (Roda, 2001, pp.309-316). The Royal Treasury collapsed and budget allocations for the Navy were to be progressively reduced (Cousillas, 1907, pp. 697-716).

Cartagena experienced the economic crisis more intensely than the rest of the Region of Murcia because it was an industrial settlement, and it suffered particularly from the fiscal pressure caused by the difficult economic circumstances at the beginning of the nineteenth century. Poverty, hunger and desperation seized the Maritime Department, the

11. AMNM. Report on the state of the arsenals, written by Brigadier Alonso de la Riva in 1834.

Arsenal and the city itself, affecting all their production and consumption sectors: most of their inhabitants were employed in the naval dockyard's workshops, and the shops depended on the purchasing power of the so-called 'Naval Mastership'.

The reason for all this lay in the general conditions of the country, exhausted after the Peninsular War and the loss of the American colonies. There was no demand for warships because the state went bankrupt and foreign policy did not need them. The chaotic situation of the Spanish Navy in the first forty years of the century mirrored that of the Ancien Regime's state as a whole. As Professor Fontana (1987) has shown, increasing tax revenues without altering the status of the most privileged sectors was an impossible dream.

2. Spanish economic recovery in the nineteenth century

THERE APPEARS TO BE some agreement among Spanish historians regarding Spanish underdevelopment in the first thirty years of the nineteenth century[12]. This time-lag in Spain's Industrial Revolution compared to the more advanced European countries was, according to various theories proposed by historians, dictated by several controversial events. Nevertheless, throughout the nineteenth century, Spain experienced a complex transition from its status as a traditional-type, colonial empire to a modern nation (Prados de la Escosura, 1993, p. 23).

During the reign of Elizabeth II in Spain (1833-1868), there was a very vigorous phase of economic expansion worldwide. An unquestionable economic take-off in Spain took place about 1844; although this take-off showed an almost irreversible delay of 40 years (Vilar, 1983, p. 116), Spain set out to shorten the internal, making a great effort to modernize and industrialize itself in the mid-nineteenth century (Vilar, 1990).

Since the publication of the seminal works by Vicens Vives (1953, p.

12. Many authors agree with this idea; c.f. the recent updated work by Bernecker, W. (1999).

13), the nineteenth-century Spanish economy has been the subject of an enormous amount of research that has revised contemporary economic historiography. The words of the Catalan historian – "Impoverished because of the domestic wars, the selfishness of those in power and the backwardness of the productive classes, the country achieved a degree of underdeveloped capitalism only in the last century" – are aimed at discovering the causes of Spanish economic underdevelopment, a task that has been continued by a large number of studies published in recent years (Tortella, 2009).

The historiography of the 1970s formulated the radical theory of failure, which was later revised in less harsh terms. This theory of failure was based on exogenous and endogenous factors. The exogenous factors include the dependence on foreign trade and foreign capital and the loss of the colonies. The endogenous factors include national and geographical determinants as well as social factors, such as government instability and ill-advised economic policies. Two fundamental books by Tortella and Fontana were published in 1973; these were followed two years later by Nadal's work (1975), which can be considered the first to present a global interpretation. Nadal identifies a dualism in the process of industrialization/deindustrialization, adopting an appropriate methodological approach and further develops the idea of failure.

Historians argue that nineteenth-century Spain tried to adjust the country's pace of development to that of countries which, with the United Kingdom in the lead, were inaugurating a new, radically different phase, but that, nevertheless, the real industrialization of the country is an indigenous phenomenon. Along these lines we find the theory of Sánchez Albornoz (1968), who defended the duality of nineteenth-century Spanish economy because of its ambiguous nature.

For his part, Prados (1993, p.65) preferred to use the term "backwardness" rather than "stagnation" or "failure" to describe the Spanish economy, since he considered that this concept was compatible with growth, and thus was the most appropriate for a quantitative description of the Spanish

economy at that time. Aided by the use of statistical sources, he rejected the exogenous theories and argued that the reason for backwardness in the foreign sector lay in the Spanish economy's low level of openness, due to a short-sighted and selfish protectionism (Prados, 1993, p.14).

Nineteenth-century historians have traditionally tended to emphasize the role foreign powers played in Spain's economic backwardness. The loss of the colonial empire was seen to be largely responsible for the economic situation (Prados, 1993, p.93). Emancipation had certainly some negative effects in the short term, but the key factors in the delicate situation of the post-imperial economy are found in the difficulties inherent in the manufacturing industry and in the deficiencies of a treasury with a weak fiscal basis.

As far as agriculture is concerned, Nadal, Vicens, Tortella and Sánchez Albornoz discuss its role in the country's economic backwardness, referring to the theory of the resistance to change, and point out the lack of appropriate resources. The agrarian sector has been generally criticised for its low productivity and for using funding allocated to industry. Thus, its stagnation partly explains the delay in the modernization of Spain's economy (Tortella, 1983, p. 29).

From his quantitative evidence and revisionist position, Prados (1993) defends Spanish agriculture, claiming that it was more responsive than was previously believed. He also pointed to the protectionist policy and the inability of the urban sectors to attract the rural population as being responsible for the Spanish economy's slow, though far from negligible, progress. After the studies carried out by the Group of Studies in Rural History and the publication of the *Agrarian History of Contemporary Spain*, it seems very difficult to support the theory of backwardness, and, for revisionists, agriculture even appears a dynamic sector (García Sanz, Garrabou and Sanz Fernández, 1985).

Spanish agriculture underwent two processes that changed the agrarian sector in the nineteenth century: the liberal agricultural revolution and agrarian expansion. One of the main objectives was the aboli-

tion of forms of enclosed property, and the most significant measures were the large-scale processes of property confiscation by the state, one of the most studied issues and the subject of numerous publications[13]. There were four stages in property confiscation in nineteenth-century Spain, the most important being those decreed by Mendizabal in 1836 and by Madoz in 1855. Real-estate confiscation caused the replacement of an aristocratic and feudal social and economic system by a capitalist one, albeit lacking in any entrepreneurial spirit. This is, of course, a very complex subject and gives rise to highly controversial opinions.

As far as the development of mining in the Iberian Peninsula is concerned, the Industrial Revolution valorized Spanish mining resources, although they were not exploited intensely until the end of the nineteenth century, when they became the Spanish economy's most dynamic factor[14]. For their part, the iron, steel and textile industries emerged as leading sectors at the dawn of factory manufacturing in nineteenth-century Spain, thanks to the introduction of the steam engine (1833) and of modern machinery[15].

The current debate among historians focuses on the limitations of Spanish industrialization and its backwardness in relation to that of other countries; overall, economic historians have been very pessimistic (Lande, 1979). Yet according to recent comparative analyses, Spanish industrial development in the nineteenth century cannot be described as a failure: it shows growth rates that are by no means negligible, although within a general dynamic of moderate growth (Prados, 1993, and Carreras, 1990).

The growth of foreign investment in the Spanish economy coincides

13. This issue has been the subject of continuous debate; the seminal works by Fontana, Tomás and Valiente, Simón Segura and Rueda are all important.
14. Many authors have researched different aspects of mining, although there is quite a small number of published works, and they stress the similarity of conditions rather dealing with mining itself.
15. There is no lack of publications on Spanish industry in the Isabelline era, which cannot be dwelled upon at length here; cf., for example, the book by Nadal and Carreras (1990).

with the Isabelline period, since investments began in the decade between1850 and1860, and ended during the First World War. As far as the banking system is concerned, modernization did not feature fully until the second decade of the twentieth century. In the nineteenth century, the Spanish banking system was generally characterized by the co-existence of old and modern institutions (Campillo, 1963, p.44).

The most serious reform in the Treasury during the Isabelline period was that carried out by Mon-Santillán: it laid the foundations of the modern treasury, and allowed for an increase in state revenue and made economic growth possible in the 1850s and 1860s. In fact, it was only the tax system that underwent minor changes in the following hundred years (Comín, 1988). As regards Spanish trade policy, there were two opposing doctrines, protectionism and free trade, which contended for leadership in Spain between 1833 and 1868.

The transport system is another key aspect in the modernizing process of any country, and geography was an exceptional hindrance in the case of Spain. After the attempts made by the Bourbons to improve roads in the eighteenth century, the Peninsular and Carlist wars had disastrous effects. The nineteenth century brought new needs (Ringrose, 1972) which included the building of paved roads, railways and canals. The plan for restructuring overland communications was entrusted to the Civil Engineers Society, founded in 1799 (Sáenz Ridruejo, 1990, p. 2). Beginning in 1840, a major road-building programme was carried out, but the most important issue was the construction of the railway network, which took place when the Railway Law, passed in 1855, was enacted (Tedde de Lorca, 1978). Sea transport also underwent a profound transformation process, based on the improvement of ports and of their signalling systems (Frax Rosales, 1981, p. 90).

In the mid-nineteenth century, ship-building was given a boost with the law passed on 1 November, 1837, which banned the importation of ships of any kind. This resulted in the development of the Catalan and Basque dockyards. However, in 1853 the purchase of steamboats abroad

was authorized, since state dockyards in Spain were not able to meet national demand.

With regard to the military fleet, the need to build a modern squadron, in line with the advances in naval construction so that the Liberal Union's government could carry out the objectives of its foreign policy, has already been discussed. This involved a modernization of the abandoned arsenals, which were unable to engage in ambitious ship-building. The use of steam propulsion in the Spanish Navy did not begin until 1830[16]. The first military steamship built in Spain was the *Jorge Juan*, although it had a foreign engine. The first Spanish-made steam engine for the Navy was assigned in 1856 to the *Liniers*, which had been launched in Cartagena the previous year (Lledó,1997, p. 45).

The first half of the nineteenth century was the era of steam, but the second half was the era of iron ships. The battleship evolved thanks to progress in metallurgy, even though it took longer for them to be accepted (García Parreño, 1982, p.107). Sailing and wooden ships coexisted with iron ships and steam engines until the Crimean War revealed the inefficiency of wooden ships facing coastal batteries and the battleship came into being. When this revolutionary invention appeared, Spain was carrying out a programme of building screw-driven frigates and had to change its plans: now the frigates had to be armour-plated. After several commissions to foreign dockyards, mainly British ones[17], several ships under construction were adapted; but the first Spanish Navy battleships to be armour-plated at source were the great frigates *Victoria* and *Numancia* (Robert, 1984, pp.5-32 and Vega Blasco, 1989, p. 41).

The policy of intervention abroad, as well as the maintenance of the remains of the old colonial Spanish empire, required an appropriate fleet; hence the importance of starting a programme of reactivating the

16. AMNM. Ms.453. Docs. 62, 63, 64 y 65. Dossier about the construction of steamboats in Spain.
17. AGMAB (Navy's General Archive "Alvaro de Bazán"). Arsenals. Leg. 5308-118. Navy's Commission in Great Britain. Dossier about the construction of the frigate "Victoria" (1863).

naval facilities. The Liberal Union's foreign policy, with its characteristic expeditions, contained a small technical contradiction: it demanded a squadron to carry out this policy and at the same time it requested the essential modernization of the dockyards and arsenals where the squadron could be built (Roda, 2003).

From 1859, during the Liberal Union government's period of political stability and economic growth, the sorry state of the Navy began to be finally overcome. This required the action of two naval ministers: MacCrohon and Zavala. The core of the plan for a new, respected and prosperous Spain was, according to Raymond Carr (1970 pp. 258-259), the supplementary budget of 1859. However, the government was accused of financing the country's prestige and the armed forces instead of making a productive investment.

The budget amounted to 2,000 million *reales*[18], and, within it, top priority was given to the plan to build a naval squadron. This was proof of the determination of the Liberal Union's leader, General O'Donnell, to make Spain appear as a major power, coupled with the desire to favour the new engineering industries as much as possible, without offending the progressive defenders of free trade. The funding this budget gave to the Navy was the second-highest in the budget, following that given to the Ministry of Public Works: 450 million *reales*, of which 350 million were for ship-building, adding war materials and Navy equipment, and reforming the arsenals.

Spain lacked the new facilities in the dockyards which the major changes in the material resources of the naval industry in the first thirty years of the nineteenth century made necessary. There was the need to build new ships, which were essential for interventions in foreign affairs and for defending what was left of the colonial empire. But first the necessary infrastructure work at the state dockyards had to be carried

18. The *real* was the silver coin that formed the basis of the Spanish monetary system until the mid-nineteenth century. In 1868 it was replaced by the *peseta*, which was divided into 100 cents. In modern times, a *real* equalled 25 cents of a *peseta*.

out. The text of the supplementary budget echoed the dramatic situation the Navy had faced some years earlier, and the improvements required to provide Spain with a modern fleet:

> With the Navy reduced to an almost empty shell by the actions of the Treasury arsenals should be aided first. We need dredgers, hoppers, docks, slipways, factory buildings, stores, cranes, dry docks, warehouses, etc ...[19].

3. The transformation of the arsenals in the nineteenth century: Cartagena at the forefront of the naval industry

IT WAS CLEAR THAT there was a need to build new naval infrastructures to transform and modernize Spanish arsenals. Cartagena was a pioneer in that it hosted the construction of what was at the time a major advancement in hydraulic naval engineering: a dry dock on a horizontal plane together with a floating iron dock. But the other two arsenals in Spain also underwent a modernization of their facilities about the middle of the nineteenth century, as can be inferred from a brief survey of their development.

At the beginning of the nineteenth century, the Arsenal at Cadiz still had the same ship-building slips, facilities and wooden pits as it had in the eighteenth century; it also had the three dry-careening docks, which since 1789 had been drained by steam pumps, and rigging, blacksmithing facilities and general dockyard workshops. Work had never stopped, and most ships had been built there during the Spanish Navy's difficult period. It had been the only Department which had kept its rank, and because of the good condition of its facilities, the existing docks merely needed improving and preparing for the new technical requirements arising from the advances in shipbuilding[20].

19. AAC. "Report on the Navy's budget for the financial year 1859". Included in the bill for the *Supplementary Budget of 1859* (Madrid, National Press, 1959), pp.105-106.
20. AMNM. Ms. 1222. Docs. 4,6,7,8 and 18. Relating to the inspection visit to the Arsenal of La Carraca by Tomás Halladle, San Fernando, 21 May, 1835.

In 1857 the preparatory work began to solve the problem of widening the entrance to the second careening dock (Sierra Orantes, 1865, pp.35-38), in order to adapt it to the new size of steamships. Furthermore, a gate-vessel was assembled to close the dock: this gate-vessel had been built in Great Britain with the same technology that would be used to build the one at Cartagena. The names of the docks, "San Carlos", "San Luis" and "San Antonio" were also changed to "Number 1", "Number 2", and "Number 3", a fourth dock parallel to the other three being added in 1899. This was where the Spanish Navy's training ship, "Juan Seastián Elcano", was usually moored, and thus this fourth dock was named after the ship.

The naval base of Ferrol, on the other hand, had been completed in the first decade of the nineteenth century, and its grand port layout, meticulous engineering and rational design were considered remarkable at the time. It had twelve slips and two careening docks (Rodríguez Villasante, 1986). Throughout the eighteenth century, the shipyard at Ferrol, like the other two in the Spain, had seen intense activity, but in the last few years of the century its decadence was already apparent. Thus, from 1798, when the last ship of the line was launched, until 1820, there was almost no activity at its slips. It was not until the middle of the century that the recovery of the dockyard at Ferrol was apparent, as was also the case with the rest of the Navy.

Between 1825 and 1850 there was not much building work done at Galician arsenal, and what was done was not very important. The most significant work was the construction of a new dry dock that was able to careen ships weighing up to 700 tons. In Elisabeth's reign, after the Parliament had approved the supplementary budgets of 1859 and 1861, there were already plans to build new docks appropriate for the new size of the ships.

The building work on the first dock was inaugurated by Minister MacCrohon on 22 September, 1859. Although at the beginning it was thought that building a large double dock would be useful, it was later decided to build a simple one (anonymous, 1879, pp.515-516). Similarly, there was a plan to build and assemble a floating iron dock, similar

to the one to be built in Cartagena[21], which required a 'tidal dock' to function, as was stated in the corresponding budget of 1863. Here, as with payment for the planned hydraulic works at the northern Arsenal, reference is made to "a floating iron dock, ordered in Great Britain, transport to Spain and assembly expenses included, for a total of 17 million *reales*"[22]. The machinery's external description and size matches quite well to the one to be built in Cartagena, which also arrived at the Arsenal in sections, but this one was never assembled nor refloated.

The project as a whole consisted of the building of a large tidal dock, which in turn involved building a dry dock, 'San Julián', also named "La Campana" after its location. It was necessary to take land from the city's gardens for its construction, and also to remove the Arsenal's defensive ditch and modify the city wall (Rodríguez Villasante, 1984, p.141). The tidal dock was closed with a gate, and the building works were directed by the naval engineer Modesto Domínguez. It was at the time another outstanding example of civil (and not military) hydraulic engineering, as was also the case with the Santa Rosalía dock in Cartagena. In the end, this project was limited to the masonry dock, inaugurated in 1879 (Chacón Pery, 1878, pp. 263-275 and 496-502), and put into service later than the Cartagena Arsenal's facilities (Lozano Courtier, 1997).

The Spanish government aimed to refurbish the three state docks at the same time. This is inferred from several permits issued for the authorized companies to carry out the appropriate studies and preparations for the building of floating docks in the future[23]. Moreover, a

21. Both docks were built in Great Britain by the same specialized factory, and transported to Spain in blocks for subsequent assembly.
22. AAC. *Budget of the Ministry of the Navy for the financial year 1863-64* (Madrid, National Press., 1863), p. 100.
23. AAC. M -I -h. Leg. 1. Exps. 30 and 31. Content R.O. of Feb 18 and May 15, 1861, relating to the authorization for the companies, Forges et Chantiers de la Mediterranèe, and for the individuals, Gladstone, Peto, Balley and Betts to carry out exploratory and studies at the three arsenals, in order to draw up projects for building floating docks in the future.

publication of that period envisaged specialized roles in shipbuilding for the three existing arsenals, as well as the appropriate improvements that should be made to their facilities.

> At La Carraca, notwithstanding those improvements already made, as at Ferrol, there are still no large docks for the largest vessels, with corresponding slips and a good crane; since Ferrol had to build, Cadiz had to preserve and Cartagena had to replenish and deal with setbacks. At a time when ships are of a considerable size, it is advisable for Cadiz and Ferrol to meet not only the building requirements, but also those for maintenance. (Ramírez Gabarrús, 1980, p. 43)

Those were prophetic words, since nowadays the biggest docks are in fact in Cadiz and Ferrol. In the mid-nineteenth century, Spain had a respectable naval force once again, and the Navy recovered a ranking that placed it fourth among the naval powers of that time, similar to the position it held at the beginning of the century. At the end of the reign of Isabella II, the Navy was a significant power which inevitably followed the Army's path of political initiatives. This explains why the Navy played an active part in the 1868 Revolution and in the cantonal events.

From the beginning of the reign of Elizabeth II, the official reports[24] showed the bad condition of the outbuildings used for the construction and maintenance of ships in the Arsenal at Cartagena. The infrastructures required radical renovation work, and so it was essential to build a new dry dock adapted to the new technological advances in naval engineering in the mid-nineteenth century.

Several different technical solutions were examined, and it was decided to build a large naval centre with a dock on a level plane above sea level, in front of which there would be another dock or receptacle

24. AAC. Report – Cartagena's Health Council – on the pitiful condition of this Naval Station, 11-13 August, 1834. Reports on the inspection visits to the three arsenals by Brigadier Casimiro Vigodet, Cartagena, 28 February 1835.

where a third floating iron dock would be placed. This was built for the most part between 1858 and 1866 and was named the Santa Rosalía dock. With a high cost and enormous technical significance, it was a very complex piece of hydraulic engineering, whose advanced technology placed Cartagena at the forefront of international naval engineering, both in the civil and the military sectors (Roda, 2008).

With the building of this dock on a level plane and the assembly of the floating iron dock, the city enjoyed a period of splendour similar to that experienced during the construction and the early years of the Arsenal in the eighteenth century, and all kinds of economic activity were revived. The fact that Spain had lagged behind in the industrialization process was ascribed to the shortage of technological advances and qualified staff; hence the need for prestigious international technicians, and so the labour force consisted of both Spanish and foreign workers. The presence of foreign workers caused many problems, especially because of the need to share work-areas and the need for them to adapt as they came from totally different labour situations.

The work was directed by civil engineers who specialized in roads, ports and canals, since they had a better technical training at the time, because the Association of Navy Engineers had been dissolved for many years. However, since the work was for the Spanish Navy, official management was always the responsibility of a military engineer; and so power disputes between civil and military engineers were a constant feature throughout the construction work.

As for the budget of the Santa Rosalía dock, a budget of 22,921,583.50 *reales* was drawn up originally, but the actual investment in 1865 was 34,298,179.66 *reales*. Progress on the work was reported monthly and in detail throughout the construction process. These reports showed the amount spent on technicians' bonuses and salaries, as well as on labourers' wages.

The cost control of building materials was also carried out monthly and in a very precise manner. There is a record of the expenditure for

wood, iron, stone, concrete, sand, lime, plaster, coal, bricks, tiles, masonry, paint and rigging, as well as for the different types of tools, machinery and office supplies[25]. Table 1 shows an increase in total expenditure between 1861 and 1863, when work on the construction of these important naval facilities at Cartagena was at its peak.

The key element in the Santa Rosalia dock was the floating dock[26]. Quality in dock-building was essential in this case and the Spanish industry was at the time unable to build to such a high standard. The commission to construct the dock was given to the British company George Rennie & Sons in Greenwich, which at that time was reputed to be the most expert company. The dock was built in sections, and then sent to international ports, where the sections were assembled, riveted and finished by skilled British workers. A number of ships then transported the sections to Cartagena. Here everything was assembled, under the supervision of the British engineer John Fenwich, using British workers and the local workers of the 'Naval Mastership' as labourers.

The dock manufacturer himself referred to it as the first practical example of a known iron floating dock: "The dock at Cartagena was the first practical example of constructing an iron floating dock" (Rennie, 1870), which confirms the high regard in which the work was held in the field of international engineering at the time. The building work at the Arsenal in Cartagena became cited in the technical publications of the time (Enciclopedie, 1893; R.O.P., 1853; R.O.P., 1862), which considered it, together with Gdansk, as the first example where the floating dock and the dock were inseparable.

The Virgen del Pilar, as the iron floating dock was named, was launched on 4 June 1866[27], as if it were a ship, and started to render valuable service. The total cost of its construction had amounted to

25. AAC. M -I h. Leg. 1. Work progress reports concerning the Santa Rosalia dock (1858-1865).

26. It was a forerunner of *Syncrolift*, which nowadays works in Cartagena with an American patent.

27. AAC. General States of Navy, 1867, p. 304.

11,594,327.76 million *reales*, as shown in Table 2, with some additional expenses for building materials and wages during its reconstruction, bringing the total final cost to 19,542,698.71 *reales*.

From the moment of its inauguration, Cartagena's dock became a showcase of hydraulic technology in Isabelline Spain; it went beyond strictly military usage and many commercial ships from all over the world went there to be repaired. It ceased to function on 26 February 1982, and was decommissioned on 8 April of the same year.

In the twentieth century, a dry-careening dock started to function in 1906, thus completing the Santa Rosalia dock set. This set, in turn, was to become part, as one of its factories, of the "Spanish Society of Shipbuilding", a company that monopolised shipbuilding in Spain until the Civil War. In 1947 a new company was founded, the Nacional Bazán de Construcciones Navales Militares S.A., within the administrative framework of the Board of Industry, after ending the contract with the "Spanish Society of Shipbuilding" and undergoing a transitional period in which a Council responsible for military shipbuilding took on the management of the three factories, while a new trading company took over the dockyards.

The three horizontal slips of the Santa Rosalia Dock have, for some decades, borne the name of Empresa Nacional Bazán. In January 2001, Bazán and Astilleros Españoles merged, resulting in the short-lived company IZAR. In 2005 Navantia was created as the state company for military shipbuilding. This was the result of IZAR's devolution into two companies. Today the same reception dock and the same horizontal slips continue to guarantee the life of ships with the most advanced technology. The now-dismantled Virgen del Pilar floating dock has been replaced by more modern ones, but in spite of the years that have elapsed, these modern docks still perform basically the same functions.

Conclusions

Historical research on the modernizing process which the Spanish Military Naval Industry underwent in the nineteenth century has been eclipsed until now by the construction of the three peninsular Arsenals in the eighteenth century. That is why it is essential to bring to light the economic and technical significance of the renovation work undertaken in this period, especially that at the Arsenal in Cartagena, which can be described as a major demonstration of hydraulic technology in Spain in the second third of the nineteenth century.

Spain's collapse as a naval power in the first years of the century reached its height with the final demise of the Spanish Navy during the reign of Ferdinand VII. Its immediate consequence was that the Arsenal in Cartagena practically came to a total halt, since the activity in its slips, warehouses and workshops ceased almost completely. The decline of the dockyard was parallel to that of the city; Cartagena had a close economic dependence on this naval centre because of its marked character as a military city.

The situation started to improve about the middle of the century, when an interventionist and prestige-seeking policy in foreign affairs urgently required a squadron in good condition. The supplementary budgets of 1859 and 1861 allocated significant sums to shipbuilding and the renovation of the arsenals' infrastructures. The dockyards needed to be adapted to major changes that had taken place in naval material resources worldwide from the first third of the nineteenth century. Slowly, space was made for the steam engine, the propeller, the iron hull and the battleship.

Cartagena was the place where a horizontal dockyard was built, comprising three slips, a receiving dock and a floating dock; this was an ambitious hydraulic project which involved a complete overhaul of the naval facilities at the Arsenal in Cartagena. All the warehouses and workshops hummed with activity, many Spanish and foreign labourers lived together behind the dockyard's walls, and renowned professionals came to contribute their knowledge and experience.

The Spanish naval industry thus underwent an important transformation, as a result of the country's economic growth and the active policy in foreign affairs. Both circumstances raised people's awareness of the need to renew the dockyards, to adapt them to the new technological needs and enable Spain to build the new ships, which by then had already become a reality.

The industrialization of Spain in general was involved in the reactivation of shipbuilding industry, stimulating many other related sectors. Cooperation with international industry was also important and suggests the oppurtunity to conduct more in-depth comparative studies.

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APPENDIX

The modernization of the naval military industry in Spain in the nineteenth century: the example of Cartagena's arsenal

Table 1. Total expenditure in reales for the Santa Rosalia dock (1859-1865)

MONTHS	1859	1860	1861	1862	1863	1864	1865
	Reales	Reales	Reales	Reales	Reales	Reales	Reales
January	222,650	168,593.38	594,221.22	530,486.59	1,106,541.22	393,511	293,411.39
February	248,079	131,858.96	599,151.71	530,717.73	324,684.84	281,447.30	185,067.21
March	454,865.74	252,081.46	658,602.47	442,242.51	464,925.76	391,756.66	257,091.88
April	163,994.88	167,926.56	910,423.44	481,977.04	391,941.69	309,773.12	141,759.92
May	179,334.46	263,692.55	962,288.81	615,685.64	515,632	399,559.54	165,949.08
June	132,610.39	420,784.16	521,178.42	430,144.37	613,297.60	319,586.35	152,817.13
July	249,145.80	274,026.52	631,611.90	509,353.35	604,798.40	395,274.58	264,530.90
August	119,605.36	282,977.37	539,314.42	640,147.11	634,756.18	394,333.77	172,485.40
September	165,181.78	505,556.94	789,542.33	466,267.80	601,630.34	341,444.08	194,242.80
October	157,909.47	363,942.78	754,181.57	472,981.59	499,151.76	292,206.30	163,780.60
November	251,857.79	555,997.72	553,646.68	307,097.40	421,940.49	286,258.51	166,426
December	237,235	497,633.01	568,611.01	390,570.54	508,434.16	203,425.42	166,770
TOTAL	3,488,019.22	3,890,071.41	8,082,773.98	5,817,671.67	6,687,734.44	4,007,576.63	2,324,332.31

Source: Own calculations from AAC. M-I-h work progress reports (1859-1865).

Table 2. Breakdown of the total cost of Cartagena's floating dock

Item	Reales
Construction in Great Britain	666,666.64
Cargo and shipping costs	717,939.12
Customs duty	207,327.76
TOTAL	11,594,327.76

Source: Own drawing from AGMAB. Arsenals. Leg. 3939. Report of the Ministry of the Navy, Madrid, 1st August, 1864.