THE *ALBUM DE COLBERT*: THE IMAGE OF SHIPBUILDING

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SUMMARY

The Album de Colbert compiled by an anonymous author in the second half of the seventeenth century is among the most important illustrated testimonies of the art of shipbuilding. Probably commissioned by Jean-Baptiste Colbert, Minister of Finance and Minister of the Navy of the kingdom of France, the Album was composed to make Louis XIV understand the complexity of shipbuilding. It was also made to support the creation of a navy with the ambition of being competitive with the Royal Navy and with the intent of modernising and expanding the French shipbuilding industry. The fifty plates that make up this illustrated treatise unravel the story of the construction of a first-rank 80-gun line vessel, from the laying of the keel to the launch. It is a unique document that has no contemporaries or precursors because it is not a didactic collection of boats, like the previous treaties that had a completely different methodological approach, more technical-descriptive than illustrative, but it wants to go beyond the scientific treatise. Its purpose was instead to measure itself with representation, showing through the strength of drawing and images the peculiar aspects of the reality of shipbuilding, using iconography as a means of transmitting knowledge related to the world of shipyards and shipbuilding in the 17th century.

1. INTRODUCTION

The *Album de Colbert* (anon, n.d.), now preserved at the Historical Navy Service in Vincennes, compiled by an anonymous author in the second half of the seventeenth century, is among the most prestigious illustrated examples of the art of shipbuilding (Vergé-Franceschi & Rieth, 2001). It was drafted probably at the time of Louis XIV of Bourbon, known as *Le Roi Soleil* (1638 - 1715), on behalf of Jean-Baptiste Colbert (1619 - 1683) (De La Roncière, 1919), Minister of Finance, Secretary of State of the Maison du Roi, and Secretary of State of the Navy of the kingdom of France. It was composed to illustrate the construction of vessels in France, and, indirectly, to testify to the desire to create a navy with the ambition of being competitive with the Royal Navy, if not even becoming the first navy in the world. This project was a consequence of the economic and colonial policy of the French sovereign, a policy suggested by his Minister Colbert: having control of the sea, of the commercial shipping lines and of military dominance, implied having a permanent war fleet, to guarantee French maritime interests, as it had already been imagined by Cardinal Richelieu (1585 - 1642). In 1624, Richelieu decided to equip the kingdom of France with a real state navy and created the first three French naval teams with bases respectively in Brouage, Brest, and Le Havre. Richelieu, designated as «grand maître, chef et surintendant de la navigation et commerce de France» («grand master, chief and superintendent of navigation and commerce of France»), also decided to make Toulon the main French military base in the south of the country (Peter, 1994, 1995; Vergé-Franceschi, 2002), because beyond the Strait of Gibraltar, ships under the English, Dutch and Hanseatic flags had a strong dominion over the seas. Richelieu had already established that warships were no longer to be owned by local captains, ship-owners, or lords, but instead were owned by the state that had built, armed, and kept them in service.

In 1637, the French fleet included about forty ships, but the shortcomings of the French royal navy were numerous: the officer corps was not very disciplined and had to be renewed with each military campaign. The recruitment of the crews was very summary: the sailors were men gathered in the ports and embarked by force, as was also the case in England. In 1640, Cardinal Jules Raymond Mazarin (1602 - 1661) was forced to considerably reduce the navy budget; from that moment, the French monarchy's commitment to the naval field was secondary, and budget priority went to military operations on land. In 1642, 65 ships and 25 galleys were moored in the port of Toulon, almost the entire French fleet in the Mediterranean. Five years later, in 1647, the first "modern" vessel, the *Reine*, was launched from the shipyards of Toulon. Nonetheless, in 1661, the royal navy was limited to about thirty poorly equipped ships with little maritime activity.

Colbert was an assistant to Mazarin, and it was Mazarin himself who recommended Colbert to King Louis XIV. In 1652, when Cardinal Mazarin was in exile, Colbert was asked to direct the affairs of the cardinal during his absence. Finally, in 1661 Mazarin died; Colbert took his place and became First Minister of State. Following this Colbert's rise to power was rapid. In 1665, Colbert became Minister of Finance, then in 1669, Minister of the Maison du Roi as well as Minister of the Navy. Arriving at the Ministry, Colbert found only 20 intact warships, of which only two or three could be used in navigation on the high seas; out of 20 galleys, only six were still in service. The naval force that Richelieu had assembled - 80 ships and 20 galleys - had been almost destroyed during the Fronde. After the siege of La

Rochelle (1627-1628), the end of the Thirty Years War (1618-1648), and of the Fronde (1648-1653), the situation of the French merchant navy was catastrophic. In 1669 Colbert persuaded Louis XIV, who was barely interested in the maritime problem and rarely visited shipyards, to address the issue of navy renewal. Colbert obtained the authorisation to create the Ministry of the Navy, of which he was the first Minister and which made him the father of the modern French Navy, a position that allowed him to take over the problem of the navy. In this capacity as Minister Colbert embarked on an ambitious modernisation programme for the French fleet (Boissonnade, 1923). To initiate this important navy renovation project and interest the King, Colbert ordered the building of a flotilla of smaller-scale ships, which he placed in the large body of water overlooking the palace of Versailles, and where the king could constantly admire the evolution of these ships. Subsequently, having obtained the interest and the approval of the King, Colbert started a shipbuilding programme, freeing France from the constraint of importing ships from abroad (Lemineur, 1996; Chaline, 2016).

The decisive change of policy, therefore, took place with Louis XIV, inspired by Colbert, who wished to equip the country with a naval force capable of opposing the United Provinces (the Dutch Navy) and England (Lutun, 2003). In 1667, the first 120-gun vessel, the *Royal Louis*, was launched in Toulon. Two years later, the Arsenal of Marseilles was completed and Colbert returned the galleys to Marseilles while he left the other vessels in Toulon (Zysberg, 2007). In 1675 the number of galleys increased from twelve to twenty-five. Their growth in numbers was linked to the fact that they were in any case an undeniable element of prestige and a powerful factor of intimidation, as well as a formidable weapon of combat, especially against Barbary pirates.

In just ten years, the number of units built increased from 30 to 120 ships: the French arsenals were no longer able to meet the number of orders for new vessels, and therefore it became necessary to buy ships from Holland. This progression by leaps and bounds was accompanied by the training of naval personnel: a corps of naval officers was created and a system of recruiting crews was established. The training of naval officers initially took place in the royal schools of hydrography and was identical for both merchant navy and navy officers. But while merchant navy officers were chosen from seafarers belonging to the private merchant navy, the officers of the navy came from the nobility, because it was thought that their nobility would be enough to guarantee their abilities. Colbert chose Dieppe and Le Havre to establish the first hydrography schools.

A royal ordinance of 1681 defined the subjects to be taught, the recruitment, and the duties assigned to officers and non-commissioned officers on board ships. Ordinary citizens went to hydrography school to get a job in the merchant navy but if necessary they could become “auxiliary officers” in wartime. Finally, Colbert favoured the emergence of important commercial companies such as the *Compagnie des Indes Orientales*, the *Compagnie des Indes Occidentales*, and the *Compagnie du Levant*, along with an expansion and renewal of the merchant navy.

In this sense, the *Album* is likely to have been meant to illustrate to the King the complexity of shipbuilding and therefore the need to modernise and expand the French shipbuilding industry, as well as starting a fleet renewal with the construction of a more modern ship in keeping with the rise of the French state. Colbert's Album anticipates the revolution in shipbuilding literature, which would see its maximum expression in France with the publication of the *Élémens de l'architecture navale ou Traité pratique de la construction des vaisseaux* by Henri Louis Duhamel du Monceau (1700 - 1782) (Duhamel, 1752). The fifty illustrations (“*planches*”), that make up this illustrated document, unravel the history of the construction of a first-rate line vessel with 80 or perhaps 84 guns, from the laying of the keel to the launch. It is a unique document that has no contemporaries or precursors because it is not a didactic collection of vessels, like previous treaties, that had a completely different methodological approach, more markedly technical-descriptive. It did not have followers even in the most famous and in some ways exhaustive *Encyclopédie ou Dictionnaire raisonné des sciences, des arts et des métiers* by Denis Diderot (1713 -1784) and Jean-Baptiste Le Rond d’Alembert (1717 -1783). It was superior in the quality of its illustrations to works more dedicated to naval architecture, such as the *Architectura navalis* (Furttenbach, 1629) by Joseph Furttenbach (1591 - 1667), the *Hydrographie* (Fournier, 1643) by Georges Fournier, the *Elemens de l’architecture navale* (Duhamel du Monceau, 1752) or *L’architecture navale* (Dassié, 1677) drawn up by François Dassié, drawing master at the school of Design of Toulon, and the work of Carel Allard (1648 - 1709), Dutch cartographer and engraver, who published in 1697 *L’art de bâtir les vaisseaux* (Allard, 1719), which takes up the encyclopaedic text by Nicolaes Witsen (1641-1717) (Witsen, 1690) and the most descriptive treatise by Cornelis van Yk (1649 - 1712) entitled *De Nederlandsche Scheeps-Bouw-Konst Open Gestelt* (Van Ik, 1697), to name just a few of the best known examples in the literature.

The *Album de Colbert* aimed to go beyond a scientific treatise and instead, it measured itself with representation, showing through the power of drawing and images, the peculiar aspects of the reality of shipbuilding. It used iconography as a means of transmitting knowledge related to the world the shipyard and the construction of the vessels in the 17th Century. The *Album* is an important work of dissemination, oriented to the transmission of technical and construction knowledge in the field of shipbuilding. The work was drawn up thanks to the foresight of Colbert, architect of a renewal of the arsenals and ports (Dunkerque, Le Havre,

Brest, Rochefort, Port-Louis), as well as the French Navy, and promoter of the birth of the Naval Engineering Schools of Rochefort, Dieppe and Saint-Malo. An avant-garde character for his time, a visionary with his feet firmly on the ground that France only met too late. With his son, Jean-Baptiste Colbert (1651 - 1690), Marquis of Seignelay, Minister Colbert invited numerous craftsmen, shipwrights, and master rope makers from the Hanseatic cities and the Netherlands to work in France to install and set up arsenals, and shipbuilding yards in the kingdom's main ports (Acerra, 1985).

2. COLBERT AND THE BIRTH OF LOUIS XIV'S NAVY

Colbert shared the opinion of the engineer Louis Nicolas de Clerville (1610 - 1677), who considered very harmful the habit of «chartering Dutch ships rather than building them ourselves» [Letter from Clerville to Colbert of 18 May 1663]. At the time of Colbert's entry to the Ministry of the Navy, France had a rather modest fleet. The investigation ordered by Colbert and conducted on 17 May 1664 in La Rochelle by the Admiralty judge Jean de Mirande (1630 - Unknown) showed the inadequacy of the merchant navy stationed in La Rochelle. Of the 32 ships in the port, only 18 had a tonnage of over 100 tons and only two of these were between 300 and 400 tons. In the rest of the country, the situation was no better; there were, in fact, in all of France only 19 ships with a tonnage between 300 and 400 tons, while the rest were of modest tonnage. The largest ships barely reached 400 tons. In addition, the ships were located in numerous ports: La Rochelle, Bordeaux, Nantes, Dieppe, Dunkerque, Abbeville, Honfleur, Calais, Le Havre, Saint-Malo, Rouen, Saint-Brieuc, Bayonne, Marseille, Toulon, and Saint-Jean-de-Luz. They were basically small boats (flûtes), flat-bottomed, large and heavy, with a round stern, the most used merchant ships at that time. All these ships were weakly armed and had no other use than for the transport of goods. They were also relatively old ships, most of them over sixteen years in service and some as long as twenty. Few were less than ten years old with the majority having been built abroad. In addition, the French Navy still had many "d'antan" ships, galleys concentrated in Marseille and Toulon to form the naval squadron of the Mediterranean.

In a note presented to the Conseil du Commerce, Colbert pointed out the tragic situation of the French fleet and ports, in particular La Rochelle, which had been severely hit by a major siege during the Thirty Years War. He remarked to the King that the fleet was in conditions of great inferiority compared to the Dutch and English ones. On August 10, 1678, France signed the peace treaty of Nijmegen, at the end of the war against the United Provinces. By winning, France took control of Franche-Comté, some Flemish cities, and the county of Hainaut, and Louis XIV was proclaimed Louis the Great. It was an important victory in a war, the so-called Dutch War (1672-1678) fought by the kingdom of France against a coalition formed by the principality of Brandenburg, the Holy Roman Empire, Spain, and the United Provinces. French Navy also fought on the sea for the first time in the history of the kingdom of France, and it achieved decisive successes during the conflict, and the appellation acquired by Louis XIV was due to the merits achieved in battle by Marshal Henri de La Tour d'Auvergne, Vicomte de Turenne (1611 - 1675), by Admiral Abraham Duquesne (1610 - 1688), winner in the Mediterranean over the Dutch Admiral Michel Adriaenszoon de Ruyter (1607 - 1676).

Even if there is not direct evidence, the successes in the naval field probably led Colbert to commission the famous iconographic album. Indeed, the album shows the construction of a vessel, which was presented as an instrument of power and hegemony on the seas, but also a symbol of the military power of the French state. Thus, he aimed to show the king the complexity of building warships, in order to arm the fleet of France and make it equal to that of the English, Spanish and Dutch powers (Acerra *et al.*, 1998); establish a state of the art knowledge in shipbuilding to initiate a navy renewal and expansion programme. Furthermore, his goal was also to educate his son Jean-Baptiste Antoine Colbert, Marquis de Seignelay (1651 - 1690), and soon to be his successor, in the burdensome duties as Secretary of State for the Navy (1683), and later Minister of France. (1689) (Dingli, 1997; Vergé-Franceschi & Rieth, 2001).

In a short time, Colbert became increasingly aware that it was necessary to provide for the construction of a fleet "on his own", as he could no longer depend on foreign shipbuilding. For this reason, he promoted the renewal, modernisation and expansion of shipyards that allowed him to create a shipbuilding industry capable of producing ships in series on the basis of a standardized project. However, in this standardisation process, each site had to be autonomous in terms of planning, management, site management, procurement of materials, etc. The Album de Colbert, which describes in detail each phase of the construction of a vessel, was, therefore, the synthesis of this ambitious programme of the French Navy Minister. The principles of construction and armament of warships had to be such that naval squadrons could thus be competitive with those of the English and Dutch navies. This massive industrial effort, truly formidable for the time, obviously had to be implemented with substantial funding from the Crown. «Vous pouvez nous détruire des navires, nous avons amplement de quoi reconstruire» («You can destroy our ships, [but] we have a lot with which to rebuild them») wrote Colbert. In 1662 Colbert obtained a sum of three million *livres* for the navy, a sum that the Minister was able to quickly double and then triple in a few years.

In 1670, funding rose to 13 million *livres*, with an average annual indemnity of about ten million (five

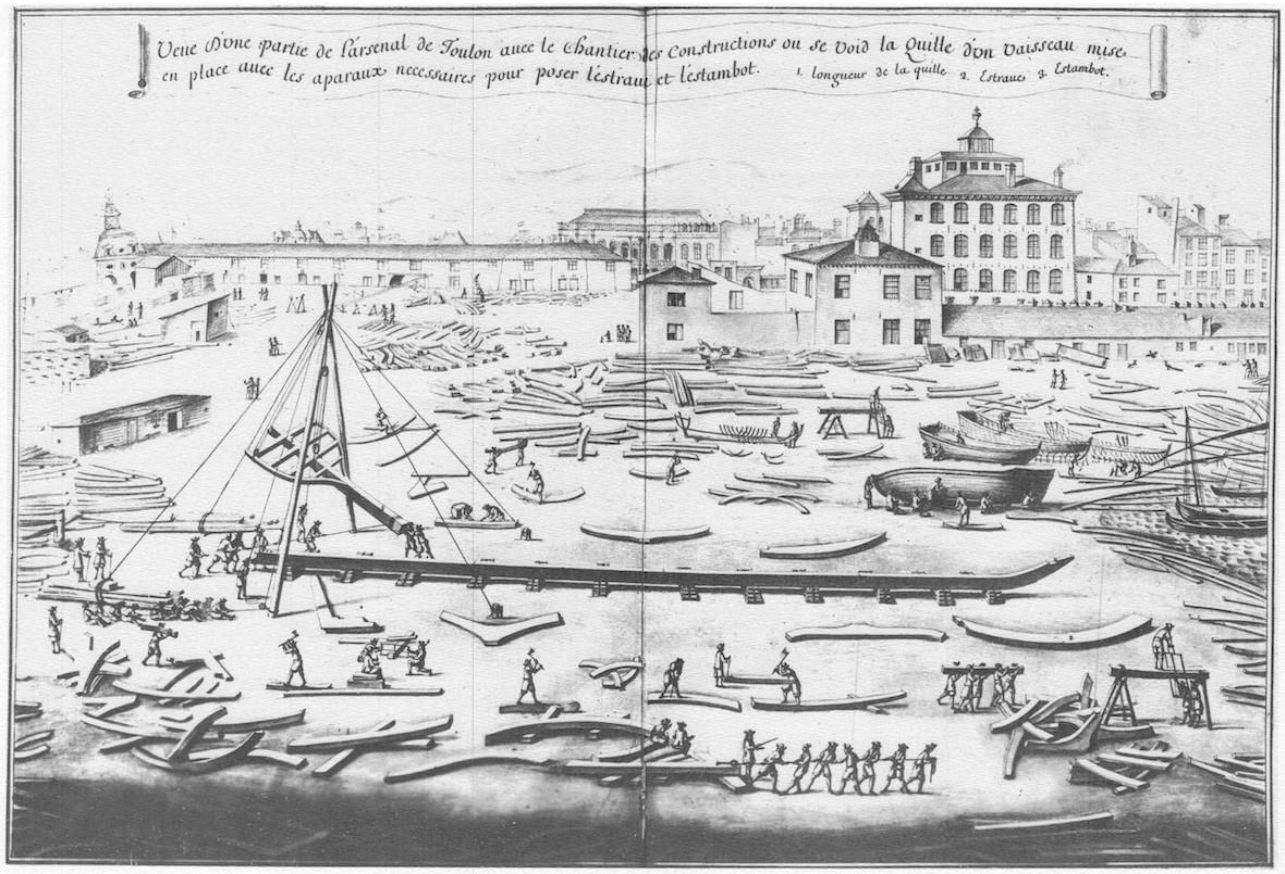

Figure 1: View of the Arsenal of Toulon, from *Album de Colbert*, Plate n. 1 (anon., n.d.).

times greater than the two million *livres* spent by Mazarin shortly before his death). The results were not long in coming to fruition, thanks to the impressive work carried out in the yards of Toulon (Figure 1), Rochefort, Brest, Le Havre, Dunkerque, Boulogne, and Calais: in 1671, the French Navy had 196 ships as well as a certain number of galleys; in 1677, it had 300 ships and galleys, with approximately 50,000 sailors in service. This soon increased to 160,000. It was certainly an exceptional undertaking because prior to the programme the yards were devoid of everything: as regards construction materials, there was a lack of wood, ropes, tar and products for caulking, bronze and iron for small parts and accessories, guns and armaments in general, etc. Colbert wrote in a memorandum of May 20, 1671: «Non seulement à l'égard du goudron, écrit-il le 20 mai 1671, mais même de toute autre marchandise propre à la marine, il faut généralement s'en fournir dans le royaume, plutôt que d'en prendre des étrangers, quand bien même ces dernières seraient à quelque chose meilleur marché; étant important, pour mettre nos manufactures en valeur, de s'en servir de préférence à celles du dehors et de convier par cet exemple les marchands à s'en servir de même» (Not only with regard to tar, he wrote on May 20, 1671, but even any other goods specific to the navy, it is generally necessary to provide it in the kingdom, rather than to take it from foreigners, even if even the latter would be something cheaper; being important, in order to showcase our factories, to use them in preference to those outside and for example to invite merchants to use them in the same way).

From 1669, the effort put in place by the Ministry of the Navy meant that the shipyards were amply supplied with everything necessary for the needs of a modern shipyard. Likewise, the ports and shipyards of Toulon, for the Mediterranean area, and Brest for the Atlantic area, became strategic. Brest also became the port par excellence where the fleet resided to counteract the British and Dutch naval hegemony. The renovation of the construction sites also went hand in hand with an urban renewal of the port cities, and to do so, Sébastien Le Prestre, Marquis de Vauban (1633 - 1707), military engineer and builder of fortifications, collaborated. Vauban participated in the expansion and to the defence of the port of Toulon, where thanks to its port plan up to one hundred ships could be moored. The shipyard was expanded and equipped with everything needed to put numerous ships into production, such that some six or seven were completed every year. In addition, the warehouses were replenished for the procurement of materials, equipment and the construction, armament, and outfitting of ships. There were thousands of cannon pieces, and minor armaments, anchors, accessories of all kinds, sails and ropes in quantity thanks to the construction of new factories in the service of the Navy. According to Colbert's intentions, the new port-shipyard of Rochefort was to emulate, for production and landing capacity, the port city of Saardam, an

impressive port in which the Dutch built their ships. The site chosen in Rochefort – "la Chatellerie de Rochefort" - was a village of about 500 inhabitants surrounded by marshes, and within a few years, thanks to the impressive works promoted by the Ministry of the Navy, it turned into a port city with a large shipyard where about 20,000 workers and technicians worked (Dupont & Fardet, 1986), so much so that due to its size and the wealth of industrial factories it took the name of "Versailles de la Mer". The architect François Blondel (1618 - 1686) drew up the town planning and development plans of the city and Louis Nicolas de Clerville directed the construction work (Blanchard, 1979). Construction began in 1663 and seven years later, the new city was defended by a system of fortifications, and the shipyards were equipped with foundries for the production of guns, and gunpowder stores, dry and repair docks, weapons depots and food, factories for the construction of the masts of ships, an imposing factory of ropes (the royal rope factory), and factories for the production of what is necessary for the construction and preparation of warships. In addition, the city housed officers and engineers who worked on the plans for the new ships. The shipyard's production capacity was substantial: in 1673, 26 large ships and six galleys were built, along with other smaller boats (Acerra, 1993; Pierre, 2003).

The centralisation of naval production in the arsenals and the standardisation of the construction of new vessels made it possible to build in series the different types of vessels, as well as frigates, minor ships and even galleys, which still found their use in the French Navy. This new production system brought considerable advantages in the management of the shipyard and in shipbuilding, with a significant reduction in construction times. The chronicles tell that in the port of Rochefort it was possible to set up a frigate in 30 hours, in Brest in 22 hours, while in Marseille a galley was set up in just 7 hours. During one of these performances, in Marseille, with Colbert's son present, the workers began to set up a galley starting at 6:30 in the morning, and the Marquis de Seignelay saw it sailing around 5 p.m. towards the Chateau d'If.

This enormous industrial effort was combined with a strong commitment in the training of shipbuilders in their various specialisations, and that of newly recruited sailors. For this reason, Colbert made sure that a naval school was established in each port to meet the needs of shipbuilding and armament. A maritime school and a hydrography school were also set up in Rochefort, as well as an artillery school; in Saint-Malo, a Collège de marine to teach hydrography to naval officers and sailors. In 1693, all these efforts, particularly those in the field of hydrography, led to the development of numerous engineers who specialised in drawing up maps and atlases. The *Neptune français* (Pène & Cassini, 1693; Frémont et al., 1700) is the first of its kind, and it covered a geographical area that went from Norway to Gibraltar. The maps were considerably improved thanks to the classification according to the reference system in geographical coordinates according to latitude and longitude (Bierre, 1992).

3. SHIPWRIGHTS AND NAVAL ENGINEERS AT THE SERVICE OF *ROI SOLEIL*

To expand the fleet, Colbert made use of numerous expert shipbuilders (Acerra, 1985): Rodolphe Gédéon (Unk - 1672) in the Toulon shipyard, Jean de Wert (17th century) in the Chantier de la Seudre, Laurent Hubac (c. 1607 - 1682) in Brest, and others (De La Roncière, 1919, p. 158; Seris, 1987, p. 69). Moreover, numerous skilled craftsmen, such as Flemish and English carpenters, were hired to increase the skilled workforce. Nonetheless, Colbert promoted a massive import of construction and finishing materials, such as wood, pitch, tar, copper, anchors, from northern Europe; Pyrenean wood, Auvergne hemp, pitch, and resin from Gascogne.

From 1689 to 1693, France put into service an average of 17 ships per year, a unique performance in its history. By 1691, the arsenals operated at full capacity, and orders for the navy reached an unprecedented level. The French Royal Navy had 154 vessels in service, including 102 first and second-rate ships, while the number of galleys peaked at 40 in the Mediterranean, while another 15 were built at Rochefort. Due to their low artillery equipment, galleys were used for escort or reconnaissance missions, as their combat effectiveness was significantly lower than ships of the line.

Such an economic and productive commitment also affected the production of wood. The French forests still had age-old oaks, a legacy of the policy adopted in previous years for the construction of warships for the royal navy. In the mid-17th century, the French Navy was reduced to a minimum, relying on a small number of warships and thus having the need, in case of conflict, to charter or buy ships from foreign powers. In order to stop buying foreign ships in case of war, Colbert decided to reorganize the entire production chain, from the cultivation of the oak, called Colbert's "treasure" (Vaslin, 2011), to the shipyard, and from that moment the kingdom's forests were preserved for military and economic interest. The construction of a large ship required, in fact, the felling of thousands of trees and this needed a prudent but above all planned forestry policy, in order not to excessively reducing the wooded areas. At that time, coppicing was practiced, consisting of young trees that grew back on the cut stumps, at least every 25-30 years, to supply the cities with wood and the salt and glass industry with fuel. Shipyards needed large items of wood, but not necessarily straight; in fact, the rounded shapes of the ships required curved trunks, sometimes with an unusual if not bizarre shape, due to particular construction elements. A first-rate vessel required nearly 3,000 oaks and a number of other species

for its construction, such as fir or spruce for the masts, ash for the capstan, guaiac imported from the colonies for the blocks. The lack of construction timber had thus forced France to turn to foreign markets: oak wood was mainly imported from Italy and Albania; the pine from the north of Europe. Therefore, in the event of war, the control of the timber routes became strategic for a great nation like France.

In the eyes of the French statesman, however, the forest was an important source of wealth that had to be preserved and properly managed (Figure 2). The ordinance issued in August 1669 - Ordonnance de 1669 of Louis XIV «sur le fait des Eaux et Forêts» (on the fact of Water and Forests) (Gallon, 1752) - sanctioned a vigorous resumption of control of French forests. According to Colbert, it was necessary to preserve a quarter of the forest area, and the age of the felling of the trees had to be reduced to twenty years. For this reason, at least 32 young trees per hectare, judged by the forestry management to be quite straight and vigorous, and which could become construction timber, had to be preserved in any case (Corvol, 1999).

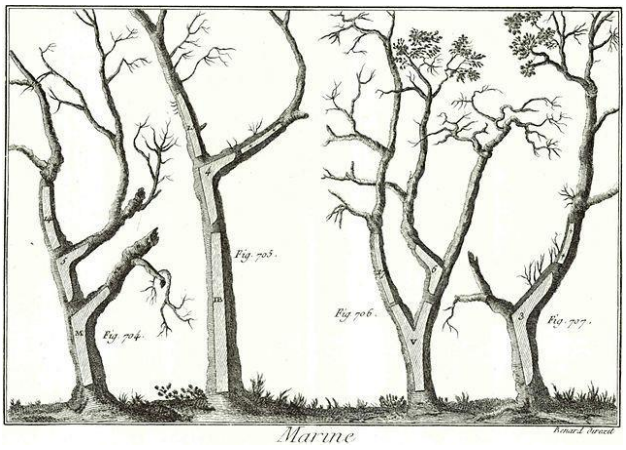

Figure 2: How to use trees "naturally" to build a ship in the 18th century, from *Encyclopédie méthodique. Marine*. Paris: Panckoucke; Liége: Plomteux, 1783-87; planche 101 (Goujon, 1803).

In this way, precise rules were also established regarding the felling of trees. The results were not long in coming: the revenues of the royal forests were increased about twenty times in twenty years. Colbert also initiated the development of forests for the production of trees in Provence, Auvergne, and the Pyrenees. In this process of verification and renewal of the fleet, Colbert started the reorganisation of the shipyards. At the same time, he also started a process of standardisation and industrialisation that foresaw the construction of models of vessels used as references in the shipyard, new professionals with good mathematical skills alongside the shipwrights, but above all improving ship geometry, to enhance the performance of the new ships. Shipyards were to be managed by a new professional body of men, who had to be trained in the naval schools. Nevertheless, in the construction sites, the employment of specialised foreign workers was not disdained, and espionage was resorted to if necessary to discover the secrets of the master builders of other countries.

This project required many skilled workers, both in the construction phase and in management and navigation. On the one hand, it started a new process of training for technicians and workers, and on the other hand, it made sure that the best builders were invited to collaborate with the French shipyards. Europeans included: the Neapolitan Biaggio Pangallo (Maître Blaise or Monsieur Blaise or Sieur Pangalo, 1650 - 1714 or 1719) (Dobrenko & Palmer, 2000) and the English Master Shipwright, Anthony Deane (1633 - 1721). The latter was accused of having transmitted military information to France; condemned and incarcerated in the Tower of London, he was finally released (9 July 1679 - 14 February 1680). Deane was one of the first to apply the scientific principles of statics to the construction of military ships between 1666 and 1675. Among others, the Dutch Heijndrick Dircksz Sluijck (1607 - 1686) also worked in France. Sluijck was been one of the largest Dutch shipbuilders and timber merchants. He was overseer of the Waterlandse Doopsgezinde Gemeente (Waterlandse Baptist Church) and guardian of Zaandam. In the years 1666-1667 six ships were built on behalf of Louis XIV: the *Neptun*, built by Jan Hendricksz Cardinael (17th century) in Zaandam, *Le Conquérant*, *L'Invencible*, *Le Courtisan*, *L'Intrépide* and *Le Normand*, the latter built by Sluijck in Sardam or Saerdam (now Zaandam). The last three vessels then changed their names to *Le Magnifique*, *Le Grand* and *Le Saint Louis* in 1671. The effort undertaken by the Ministry of the Navy was considerable. In 1673 alone, twenty-six ships and six galleys left the shipyards of Rochefort. In a very short period, the French Navy had more than 300 ships and galleys in service (1677), and within a century it became a prestigious navy comparable to the English and Dutch (Winfield & Roberts, 2017).

4. THE *ALBUM DE COLBERT*

This *Album* (Anon., n.d.), outlines in detail in fifty sheets the construction of a three-deck ship, from the laying of the keel to its complete rigging of sails. The album is anonymous and has no date (probably it was written around the years 1660-70); however, the representation of the Arsenal of Toulon in the first table allows us to establish that the text is before 1677. This is due to it showing the building to prepare tarred ropes, for the subsequent caulking of the ships, as that building disappeared in that year due to a fire. The *Album* does not refer to any specific ship built in that period, which reinforces the hypothesis that it was written with a mainly didactic-illustrative objective intended to tell through images, the different phases of the construction of an 80 or perhaps 84 guns vessel. In fact, between 1663 and 1667, eight ships of this type were built in the French shipyards, including the following four in the

Arsenal of Toulon: *Saint Philippe* (1663, 74 then 84 guns), *Paris* then *Royale-Thérèse* (second rank vessel, 1670, 70 then 80 guns), *Île de France* then *Lys* (1691, 76 then 84 guns) and *Sceptre* (1691, 80 then 84 guns) (Winfield & Roberts, 2017, p. 56-60).

The *Album de Colbert* is a unique work and differs in the quality of the images and completeness of the descriptions from contemporary works published in the 17th century in France (Figure 3). Among those in print, were the aforementioned *Hydrographie* by Fournier (1643), the Dassié's *Architecture navale* (1677), and *De la construction d'une gallaire et de son équipage* by Ithier Hobier of 1622 (Hobier, 1622). Many designers and engravers are likely to have contributed to the editing of this volume, although there are some similarities in style, drawing and shading, with a work dedicated to the merchant navy. This the *Albums de Jouve, Desseins de tous les bâtiments qui naviguent sur la Méditerranée*, par Jean Jouve, de Marseille, published in 1679 and consisting of 32 plates.

The Album is made up of 50 plates and is intended to illustrate the construction phases of a vessel. The ship represented in the plates is a first rate three-deck line vessel without a forecastle, armed with 80 guns, and probably with a tonnage of around 1,500 tons. The vessel represented complies with the Navy regulations, which defined the arrangement of artillery on three decks for those of a First Rate. The Navy Ordinance of April 1689 (Anon., 1764) is the one that set the dimensions of this category of ships for the first time: «... cent soixante-trois pieds de longueur de l'estrave à l'estabot par dehors; quarante-quatre pieds de largeur en dehors les membres, & vingt pieds quatre pouces de creux, à prendre sur la quille au-dessus des bouts du bau en droite ligne» (one hundred and sixty-three feet in length from the stern to the outside; forty-four feet wide outside the ribs, & twenty feet four inches deep, to be taken on the keel above the ends of the beam in a straight line) (Anon., 1764: 292). It was an imposing ship for the time: the length from the stern to the bow was 148 French feet (about 48.07 m / comparison with the Paris foot equal to 32.484 cm), maximum beam was equal to 40 feet (c. 12.99 m), and the draught was equal to 20 feet (c. 6.50 m). From a structural point of view, it was a complex vessel that required the best woods for its construction. It was to be built according to a model-type system called *maître-gabarit et de la tablette* (Rieth, 1996). This method made it possible to create the skeleton structure from the bow to the stern of the vessel by tracing construction lines (the water lines) starting from the main section that defined all the dimensions of the vessel, with a displacement suitable for the loads it had to support (Vial-du Clairbois, 1793, p. 520).

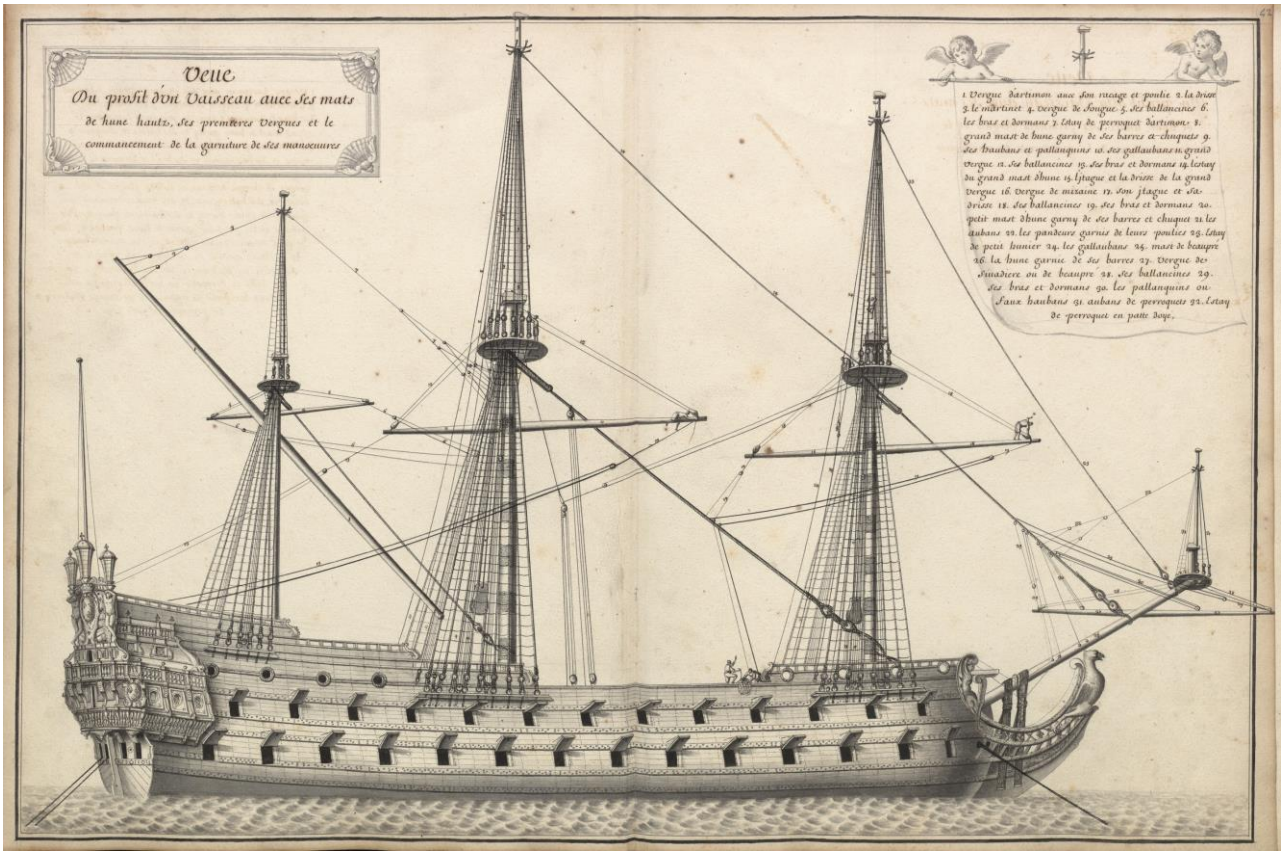

Figure 3: Plate n. 42 showing the vessel with its masts, yards, and rigging ropes (anon., n.d.).

The vessel had the number of guns divided as follows for each side: the first battery deck had 14 gun-ports, as did the second battery deck, while on the third deck there were 13 gun-ports (four forward and six aft) and 3 on the forecastle.

The set of tables that make up the album are a synthesis of the way that vessels were built in France, based on graphic representation. The tables, in sequence, allow us to understand how the construction of the vessels took place, from the laying of the keel to its completion. The drawings are very beautiful illustrated, but there are some inconsistencies or errors and the dimensions of the vessel as depicted are sometimes approximate. For example, trying to overlap the plans of different decks, the openings and passages of the masts do not always coincide. Similarly, the profile (side view) in plate no. 39, the level of the stern and the lower castle are different from that of plate no. 47, where the longitudinal section of the vessel is shown. The gun ports of the stern tower appear or disappear according to the different views. The list could be further extended, although it should be emphasised that the author could have observed the construction of several warships at different times, reporting in a single document the drawings of ships, however partially different from each other. The guns of the third battery are however quite weak and poorly protected. The first battery is very close to the waterline and would have become unusable in the event of a strong heeling of the ship.

A summary of some of the tables follows, even if the *Album de Colbert* would deserve an in-depth analysis for the richness of the iconographic and descriptive contents. Plate no. 1 is a didactic image of the Toulon's shipyard, and it shows the keel set up with what is necessary for the implementation of the fore and aft stem. On the other hand, it is important to point out how the ordered succession of plates from number 2 to number 38 represents the construction of the vessel step by step. Plate no. 39 shows the complete vessel at anchor. Plates n. 40 and n. 41 rather deal with the maintenance procedures for the hull, while plate no. 42 shows the vessel with its cage masts, flagpoles, and rigging ropes. The following plates (n. 43, 44, 45, 46, and 47) illustrate the interior fittings and the functions assigned to the individual decks, then plate number 48 showis a view of the stern of the vessel moored in the roadstead, plate no. 49 shows the same vessel seen from the bow, and finally plate no. 50, is the most iconographic of the album, illustrating the vessel in all its magnificence.

5. CONCLUSIONS

The limited scientific knowledge of the time probably led to a widespread interest in construction methods but few references to the shape of the hull and stability, due to an uncritical emphasis on drawing and construction rules. There was a lot of attention to the constructive aspects, but less knowledge and application of physical and mathematical laws. Before the mid-1600s, the slow evolution of hulls' shape was based on the observation of the sea and the skill of shipwrights. The architecture of previous designs was rather linked to traditional concepts and regional artistic tastes, where the aesthetic aspect and the magnificence of the ship were of great importance; in this external form developed, especially for the superstructures, almost independent of technical considerations or any scientific basis. The need for greater speed, greater ability to embark artillery, supplies for long voyages, and the transport of goods, as well as greater agility in manoeuvres and berthing, linked above all to war experiences, led to adaptations and modifications on an empirical basis. This slow evolution of shipbuilding was also linked to the scarcity of written documentation on reliefs of the actual shapes of sailing ships. Indeed, the invention of printing, the evolution of technical drawing and perspective contributed to the birth of modern naval architecture. However, the development of ideas in the naval field certainly anticipated the technological capacity of the time to for those ideas to become operational. This happened even if scientific and mathematical advances were slow to be applied, not only due to insufficient technological capabilities but also due to widespread distrust of the employment of mathematics in the construction technique. In fact, the most pressing construction and maintenance problems of the ship concerned the limited length, for reasons of the structural strength of the hulls, the deformation of the hull due to the stresses exerted by the wind on the sails and for those caused by the weight and the use of artillery. This involved water infiltration and deterioration of the entire structure, which was continuously subjected to reinforcement operations with various methods. There was also the continual search for wood suitable for the various components of the hull and masts, the external protection of the hull against the aggression of shipworms and the internal rotting of the wood of the hull. The resistance to advancement of a hull in the fluid medium, on the other hand, had a modest impact on the shapes of the hull, due to the low speeds involved; at such speeds the frictional resistance being more significant than the wave making resistance. More attention was given instead to the evolution of the shapes for the purpose of stability and balance of the ship, the refinement of the shapes for the decrease of the resistance to increase the speed and the reduction of the leeway angle, problems that remain the basis of modern studies to improve the performance of sailing yachts (Bettini, 2019).

Concluding, the *Album de Colbert* should be considered a significant example of the renewal of technical literature, which took place in the 17th Century, and which led to both the didactic iconography of the great Encyclopaedias and to the more technical endeavours that gave rise to specialised manuals. The work could be considered to have launched a new methodological way in naval design, starting a virtuous path that in a century

led the craftsmanship of the project and shipbuilding to a system of "industrialisation". The shipwright was no longer the only architect of the construction; he became part of a staff of technicians who involved naval architects and engineers, as well as shipyard technicians, such as carpenters, blacksmiths and caulkers, in addition to the artists (Tacchella, 2020).

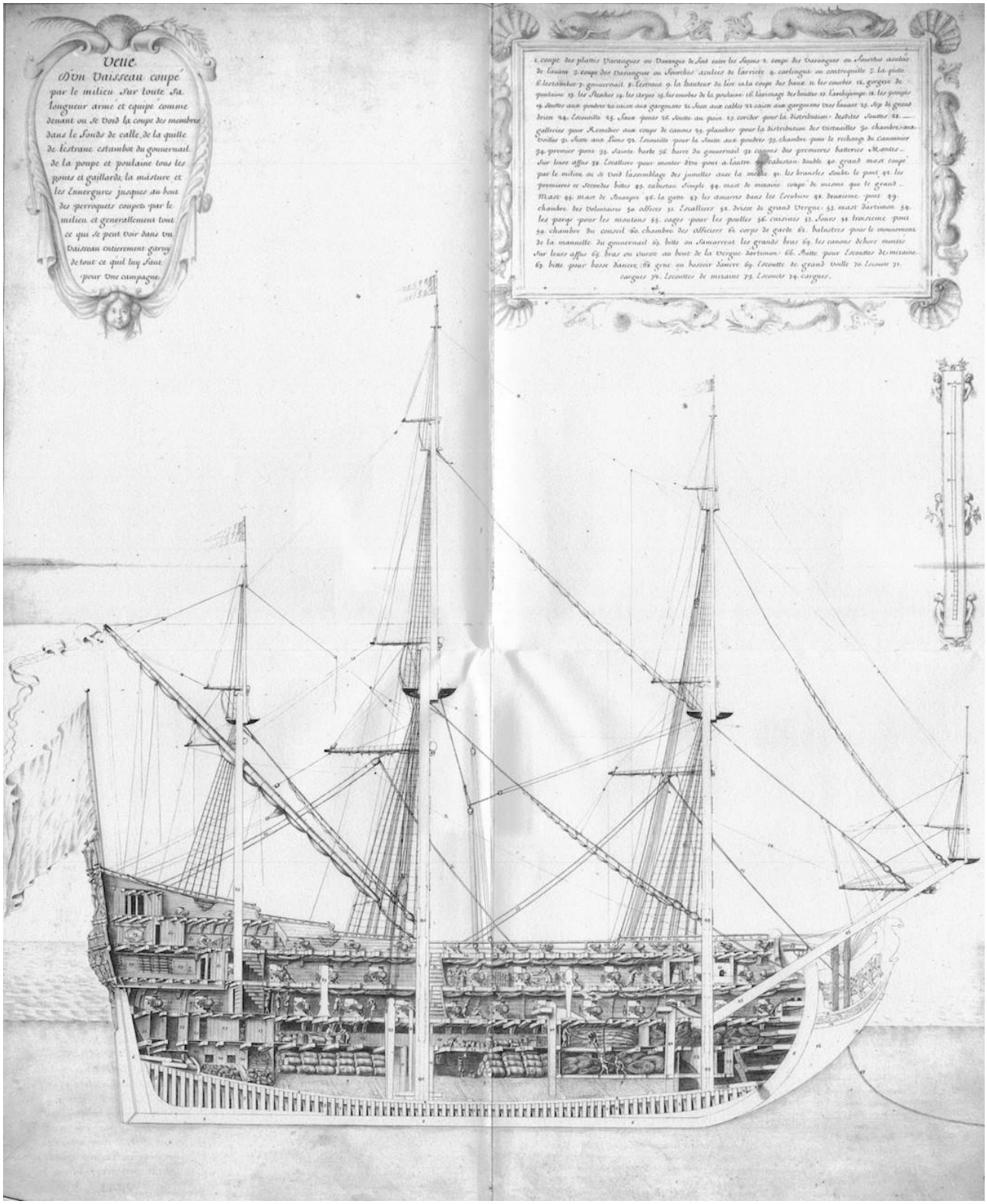

Figure 4: Plate n. 47, longitudinal section of a vessel (anon., n.d.).

Two distinct ways of narrating the construction of vessels can be seen in literature of the period. There is a more descriptive way, where the ship is "told" in written form, practically without images and with only summary didactic illustrations, and a more encyclopaedic one, where the ship is described and illustrated in terms of construction elements. Compared to them, the *Album de Colbert* is instead a manual for the construction of a vessel, step by step, almost a contemporary "instruction booklet" for assembly, an archetype of the industrialisation processes of the previous thirty years to its publication. The *Album* is the representation of a production process that will see its complete and exhaustive synthesis in the formation of the construction plans in the following centuries with the drafting of general plans, water lines, significant sections, and the development of decks, in consequence of the progress of mathematics and descriptive geometry thanks amongst others to Gaspard Monge (1746 - 1818), who was also appointed Minister of the French Navy in 1792, and of his followers including Jean-Victor Poncelet (1788 - 1867), and of the representation through the technical design.

The *Album de Colbert* could be considered a theatrical "scene" where the ship is the central character (Figure 5), a mime who tells her story, showing herself scene after scene, through the objects that compose it and through the images that describe it. Her existence is made real only by representation, and thanks to man's creative capacities of imagination, it materialises even in the absence of the object itself. In this sense, the *Album de Colbert* stands as an element of conjunction between technical-practical knowledge and technical-scientific knowledge. Illustration and representation are the distinctive tools of that junction that will see the development of Naval Architecture and Naval Science beyond the empirical knowledge of the construction tradition in the naval field. The importance of Colbert's Album lies in its content, as it is a "photograph" of shipbuilding techniques in France at the time of Louis XIV.

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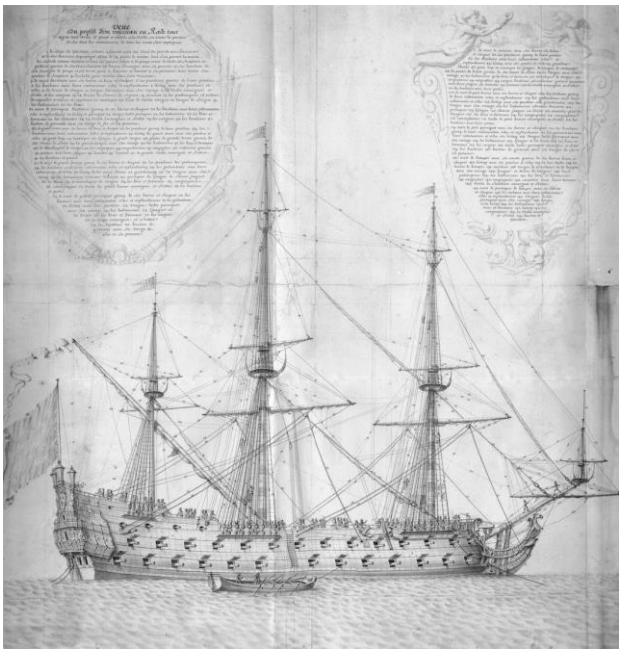

Figure 5: Plate n. 50 showing 80 guns vessel fully rigged, fully fitted out, and ready to get underway (anon., n.d.).

7. REFERENCES

1. ACERRA, M. (1985) *Les constructeurs de la marine (XVII e -XVIII e siècle)*, Revue Historique, Avril-Juin 1985, T. 273, Fasc. 2 (554) (Avril-Juin 1985), p. 283-304.
2. ACERRA, M. (1993) *Rochefort et la construction navale française*. Librairie de l'Inde éd., Paris.
3. ACERRA, M., MERINO, J., MEYER, J. and VERGÉ-FRANCESCHI, M. (1998) *Les marines de guerre européennes: XVIIe-XVIIIe siècles*. Presses de l'Université de Paris-Sorbonne, Paris.
4. ALLARD, C. (1719) *L'art de batir les vaisseaux, et d'en perfectionner la construction ; de les garnir de leurs apparaux, les mettre en funin, les manœuvrer, &c. ... outre, Les pavillons de divers etats. Le tout tiré des meilleurs Auteurs Hollandois, comme Witsen, van Eyk, Allard, &c.* David Mortier, Amsterdam.
5. ANONYMOUS (1764) *Ordonnance de Louis XIV pour les armées navales & arsenaux de marine. Du 15 avril 1689* (1764). Prault Pere, Paris. Livre treizième. "De la construction des vaisseaux. Titre II. De la construction et proportions des vaisseaux. Art. I".
6. ANONYMOUS (n.d.) *Dessins représentant toutes les phases de la construction d'un vaisseau, dit «Album Colbert»*. Paper No. SH 140, XVIIe siècle. Bibliothèque Vincennes. See also: *Dessins représentant toutes les phases de la construction d'un vaisseau, depuis sa mise en chantier jusqu'à son lancement et son arrimage. Parmi ces beaux dessins, on peut signaler des*

vues des différentes poupes de vaisseaux royaux Paper No. SH 141 ex 1514, Bibliothèque Vincennes.

7. BETTINI, C. (2019) *Come progettavano i Velieri. Alle origini dell'architettura moderna di navi e yacht*, ETS, Pisa.
8. BIERRE, C. (1992) 'Jean-Baptiste Colbert, Bâtisseur de la Nation ou La Politique du Grand Dessein', in *L'Europe, vecteur d'une reprise de l'économie mondiale*, edited by TENNENBAUM, J., LAROUCHE, L.H., BIERRE, C. Institut Schiller, Paris.
9. BLANCHARD, A. (1979) *Les Ingénieurs du roy, de Louis XIV à Louis XVI : étude du corps des fortifications*. Impr. Déhan, Montpellier.
10. BOISSONNADE, M.P. (1923) *La marine marchande, le port et les armateurs de La Rochelle à l'époque de Colbert (1662-1683). Comité des travaux historiques*. Bulletin de la section de géographie, T. XXXVII, 1922, Imprimerie nationale, Paris.
11. CHALINE O. (2016) *La Mer et la France. Quand les Bourbons voulaient dominer les océans*, Flammarion, Paris.
12. CORVOL A. (1999), *Forêt et marine*, L'Harmattan, Paris.
13. DASSIÉ, F. (1677) *L'architecture navale: contenant la maniere de construire les Navires, Galeres & Chaloupes, & la Definition de plusieurs autres especes de Vaisseaux.* Jean de la Caille, Paris.
14. DE LA RONCIÈRE, C. (1919) *Un tricentenaire: un grand ministre de la marine, Colbert*.: Plon-Nourrit et Cie, Paris.
15. DUHAMEL, H.-L du Monceau (1752). *Élémens de l'architecture navale ou Traité pratique de la construction des vaisseaux*, Charles-Antoine Jombert, Paris.
16. DINGLI, L. (1997) *Colbert, marquis de Seignelay, le fils flamboyant*, Perrin, Paris.
17. DOBRENKO, A. and PALMER, A. (2000) *The model of La Légère in the Central Naval Museum, St Petersburg: master shipbuilder Blaise Pangalo in Peter the Great's shipyards*, The Mariner's Mirror, 86, 2000 - Issue 1, p. 37-49.
18. DUHAMEL DU MONCEAU, H. L. (1752) *Elemens de l'architecture navale ou traité pratique de la construction des vaisseaux*. Charles-Antoine Jombert, Paris.
19. DUPONT, A. and FARDET, M. (1986) *L'Arsenal de Colbert Rochefort.* Centre Internationale de la Mer, Rochefort.
20. FOURNIER, G. (1643) *Hydrographie, contenant la théorie et la practique de toutes les parties de la navigation.* Michel Soly, Paris.
21. FRÉMONT D'ABLANCOURT, N., MORTIER, P. and CHAZELLES, J.-M. de (1700) *Suite du Neptune françois; ou atlas nouveau des cartes marines ... Levées par ordre exprès des roys de Portugal... et données au Public par... Monsieur d'Ablancourt, dans lequel on voit la description exacte de toutes les côtes du Monde...* Pierre Mortier, Amsterdam.
22. FURTTENBACH, J. (1629). *Architectura navalis.* Jonam Saurn, Ulm.
23. GALLON, DE (1752). *Conférence de l'Ordonnance de Louis XIV. Du mois d'Août 1669. Sur le fait des eaux et forêts, Avec les Édits, Déclarations, Coutumes; ... depuis l'an 1115 jusqu'à présent. Contenant les loix forestières de France. Nouvelle édition...* Bernard Brunet, Paris.
24. GOUJON, L.-J.-M.A. (1803) *Des Bois propres aux Constructions Navales. Manuel à l'usage des Agens Forestiers et Maritimes. Contenant les Lois, Règlemens et Instructions relatifs à la disposition et à l'usage des bois dits de Marine. Accompagné de vingt-sept figures gravées et enluminées, réduites sur celles données par l'Administration générale des Forêts, à la suite des instructions officielles du 20 Messidor XI. Suivi d'un Dictionnaire des principaux termes d'Architecture Navale.* Goujon fils, Imprimeur-Libraire, an XI, Paris.
25. HOBIER, I. (1622) *De la construction d'une gallaire et de son équipage*. Denis Langloys, Paris.
26. LEMINEUR J.-C. (1996*) Les Vaisseaux du Roi Soleil, étude historique*, Omega, Paris.
27. LUTUN B. (2003) *La Marine de Colbert. Études d'organisation,* Economica, Paris.
28. PÈNE and CASSINI, J.-D. (1693) *Le Neptune françois ou Atlas nouveau des cartes marines levées et gravées par ordre exprès du roy. Pour l'usage de ses armées de mer ... Revue & mis en ordre par les Sieurs Pene, Cassini & autres*. H. Jaillot, Paris.
29. PETER J. (1994) *Vauban et Toulon : histoire de la construction d'un port-arsenal sous Louis XIV*, Institut de stratégie comparée, Paris.
30. PETER J. (1995) *Le Port et l'arsenal de Toulon sous Louis XIV : la construction navale et les approvisionnements*, Economica, Paris.
31. PIERRE, J. (2003) *Les constructions navales à Rochefort*. Le Croît vif, Paris.
32. RIETH, E. (1996) *Le maître-gabarit, la tablette et le trébuchet : Essai sur la conception non-graphique des carènes du Moyen âge au XXe siècle*. CTHS, coll. Histoire des sciences, Paris.
33. SERIS, J.-P. (1987) *Machine et communication: du théâtre des machines à la mécanique industrielle*. J. Vrin, Paris.
34. TACCHELLA, C. (2020) *The Royal Louis (1668), A Sailing Masterpiece*, International Conference on Ships, London 2020.
35. VAN IK, C. (1697) *De Nederlandsche Scheeps-Bouw-Konst Open Gestelt: vertoonende Naar wat Regel, of Evenredenheyd, in Nederland meest alle Scheepen werden gebouwd;*

mitsgaders Masten, Zeylen, Ankers, en Touwen, enz. daar aan gepast. Andries Voorstad, Delft.

36. VASLIN, J.-M. (2011) *Les chênes français, le "trésor" de Colbert.* Le Monde, 27 avril 2011.
37. VERGÉ-FRANCESCHI, M. and RIETH, É. (2001) *France maritime au temps de Louis XIV: édition critique des deux Albums dits de Jouve et de l'Album de Colbert*. Ed. du Layeur Paris. ISBN 978-2911468742. The work reproduces three collections of engravings dedicated to the French Navy and made in the seventeenth century on the initiative of Colbert. One, known as the Album de Colbert, is dedicated to building a warship. The other two, known as the *Albums de Jouve. Desseins de tous les bâtiments qui naviguent sur la Méditerranée, par Jean Jouve, de Marseille* (1679), probably engraved in 1679 and published in 1710, describe the fishing and trading vessels.
38. VERGÉ-FRANCESCHI, M. (2002) *Toulon, port royal : 1481-1789*, Tallandier, Paris.
39. VIAL-DU CLAIRBOIS (1793) *Dictionnaire Encyclopédique de Marine.* Tome Premier. Panckoucke, Paris. Article second: Méthode pour tracer le plan de projection d'un vaisseau de 70 canons, pp. 516-533.
40. WINFIELD, R. and ROBERTS, S.S. (2017) *French Warships in the Age of Sail 1626–1786. Design, Construction, Careers and Fates*. Seaforth Publishing, Barnsley.
41. WINFIELD, R. and ROBERTS, S.S. (2017) *French Warships in the Age of Sail, 1626–1786: Design, Construction, Careers and Fates*. Seaforth Publishing, Barnsley.
42. WITSEN, N. (1690) *Architectura navalis et regimen nauticum Ofte Aaloude en Hedendaagsche Scheeps-bouw en bestier*. 2nd Ed. Pieter en Joan Blaeu, Amsterdam.
43. ZYSBERG A. (2007) *Marseille au temps du Roi-Soleil : la ville, les galères, l'arsenal : 1660 à 1715*, J. Laffitte, Marseille.

