Dutch Nautical Sciences in the Golden Age: the Portuguese Influence

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Abstract

It was a revolt against the king of Spain who was later also king of Portugal that created the Dutch Republic. Success at sea through the application of various aspects of nautical science, including shipbuilding and navigation, generated prosperity in the small state and ensured its survival. Dutch mariners and shipwrights owed a great debt to their Iberian counterparts. Even though the late sixteenth and seventeenth centuries were marked by decline in the peninsula features of knowledge, approaches and practices in nautical science borrowed from Spain and, even more, Portugal formed a basis for the prosperity in the United Netherlands.

Keywords

Oliveira, shipbuilding, cartography, Mercator, navigation

Resumo

A república Holandesa é fruto de uma revolta contra o rei de Espanha que, mais tarde, foi também rei de Portugal. Os diversos êxitos alcançados por mar através da aplicação de vários aspectos da ciência náutica, v.g. construção naval e navegação, deram lugar à sua prosperidade e asseguraram a sua sobrevivência. Os marinheiros e os construtores de navios Holandeses estavam, assim, em dívida com os seus parceiros Ibéricos. Apesar de ser conhecido que, entre os séculos XVI e XVII os avanços no conhecimento científico na Península Ibérica não acompanharam o ritmo que antes alcançaram, é certo que as bases da ciência náutica holandesa – ponto de partida para o progresso dos Países Baixos - têm as suas raízes em Espanha e, sobretudo em Portugal.

Palavras-chave

Oliveira, construção naval, cartografia, Mercator, navegação

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In the seventeenth century the Dutch Republic for a short period was the leading maritime state in Europe. The "Golden Century" saw a prodigious expansion in all phases of the economy. Though agriculture enjoyed considerable improvement the growth in output and employment was based heavily on commerce. It was trade, goods carried on Dutch ships, which was the source of the prominence of the northern Netherlands on the economic stage of Europe. It was the trade or more precisely the taxable income generated by that trade which made the rickety, complex and clumsy government a major player on the political stage of Europe. Indeed, Dutch economic success was based firmly on shipping, both in nearby waters and increasingly further afield in other parts of Europe and then around the world.[2] Dutch achievements were the envy of Europe. Many states, most notably France and England, embarked on a whole range of policy initiatives which did not even stop at war to outdo the Dutch and try to supplant them from their position of leadership. While the sources of the sudden expansion of the Dutch economy has long be a subject absorbing first contemporary policy makers and then historians a recurrent theme among them is technical advance and especially in nautical sciences.

The Republic was the product of a revolt against the duly constituted sovereign of the lands. Philip II of Spain had received the seven northern provinces of the Netherlands from his father when the latter retired to a monastery in 1556. Phillip's efforts at reform of the episcopal system and more generally to rationalize and simplify the existing hodgepodge of jurisdiction, created by more than a century of marriage alliances, purchases and warfare, led to a strong reaction among the nobles. In addition his efforts to revitalize Roman Catholicism and to eliminate the Protestant danger led to a strong reaction among those people Phillip perceived as religious deviants. The reaction was as great or greater among the many merchants of what was the most urbanized region in northern Europe who relied for their livelihood on contacts and exchange with Protestant merchants in Britain and Germany. Religious and political reforms displeased different groups in Netherlands society but Phillip's efforts to raise taxes led to a strong reaction from virtually everyone. The revolt which began already in 1567 took a number of twists and turns with the result that by the 1580s there was an uneasy division of Phillip's lands more or less along the line of the great rivers, the various mouths of the Rhine. Though that de facto split between the northern and southern Netherlands would not be acknowledged until the

[2] De Vries, Jan, and A. M. van der Woude. *The first modern economy : success, failure, and perseverance of the Dutch economy, 1500-1815*. Cambridge: Cambridge University Press, 1997; Israel, Jonathan I. *Dutch primacy in world trade, 1585-1740*. Oxford: Oxford University Press, 1989; Bavel, Bas J. P. van, and Jan Luiten van Zanden. "The jump-start of the Holland economy during the late-medieval crisis, c.1350–c.1500," *The Economic History Review*, 57, 3 (2004): 503–32.

Peace of Westphalia in 1648 the northern provinces had in the closing years of the sixteenth century formed a republic which would survive until 1795 and one which prospered in the otherwise economically depressed seventeenth century.

During the course of the Revolt Phillip II inherited another kingdom: Portugal. Technically and very often in fact the Dutch Republic was at war with both of the Iberian kingdoms until Portugal itself revolted successfully against rule from Madrid after 1640. The continuing conflict led at times to prohibitions of trade with Dutch ships banned from Iberian harbours, though such restrictions were short-lived. Despite the common state of war prevailing between Iberia and the Netherlands interchange, commercial and intellectual, continued. In fact the ties that began to develop between Portugal and the Low Countries in the first half of the sixteenth century strengthened through the years of war. Before 1580 there was no direct political or dynastic tie between the Netherlands and Portugal but in maritime affairs and more specifically in nautical sciences influence in various forms from the South on practices in the Low Countries was considerable.

The economic success of the Dutch Republic, which also had roots in the sixteenth century, was accompanied by great accomplishments in science and even more in technology in its "Golden Century."[3] Advances in shipping, shipbuilding and navigation were hallmarks of the scientific achievements. Even before the revolt of the Low Countries, map makers had acquired the skills which would carry them to be the leading producers, both in terms of quality and quantity, of maps in seventeenth century Europe. The rapid improvement in cartography in the Netherlands, both northern and southern, depended on borrowing from practices in Iberia and more specifically from Portugal. The very rapid advances of Portuguese map makers in the years around 1500 offered more than simply a model for cartographers in the Low Countries. Portugal had seen rapid progress in map making. There was apparently little or no map production in Portugal before the 1450s but by the first half of the sixteenth century cartographers there were producing some of the best and most influential maps in the world. Portugal proved that with a proper scientific base and an interest on the part of seaman as well as governments in compiling representations of the seas, a great deal could be accomplished in a short time. The Dutch imitated the Portuguese not just in moving rapidly from little in the way of map making to European leadership. The methods introduced and the thinking about mapping and navigation in the northern Low Countries also had roots in Portuguese practice. The same can be said at least to some degree of shipbuilding although with that aspect of

[3] Davids Carolus Augustinus. *The rise and decline of Dutch technological leadership: technology, economy and culture in the Netherlands, 1350-1800*, Leiden: Brill, 2008.

nautical science the pattern was somewhat different and more complex.

The condemnation of Catholic Portugal and Spain as backward, even "medieval" in the sixteenth and seventeenth centuries translated into a view that Iberian science and technology were also inferior. The mechanical arts and the understanding of nature were just other parts of society that suffered from the shackles imposed by popery that kept the people and governments of the peninsula from becoming part of the emerging modern world. Even if later historians may not have noticed, in fact contemporaries in the Protestant Dutch Republic recognized the superiority of Portuguese practices and borrowed them. Though many aspects of nautical sciences found their way from Iberia to the Low Countries, four seem obvious, noteworthy and of considerable importance in the long run. Three came from navigation and the fourth had to do with building vessels to sail the oceans of the world. First, the Dutch first took over the Portuguese practice of integrating theoretical speculation with practical information generated from observation. Second, Dutch cartographers looked to Portugal for theory about how to make maps. Third, Dutch maps took up the forms of illustration and decoration pioneered by Portuguese cartography. Fourth in both the practices of shipbuilding but more so in the discussion and description of how to build ships there were clear signs of Portuguese influence on Dutch nautical science. The learned as well as the practical tradition showed signs of exposure to what was being done and said in Iberia. Dutch cartographers may offer the most obvious and most graphic case of reliance on Portuguese precedent for their own scientific advances but that pattern should be taken as an indication of something considerably broader and deeper.

A revival of interest in Iberian science and technology has marked the twenty-first century. It turns out that Catholics and even Jesuits were not simply prejudiced, letting their faith get in the way of learning about nature, but in fact they were capable of significant accomplishments in a wide variety of scientific fields. Often their work was connected with European expansion and with the discovery of new plants and animals, so the attention of historians has turned to developments in the empires of the Iberian states, making the work of those Roman Catholic scientists and their networks another facet of global history. That is, however, the tip of a large iceberg. Even before the new attention devoted to scientific work in Iberia historians of Portugal had typically understood contributions to science there as being contributions to nautical science.[4] Recent

[4] Fontes da Costa, Palmira, and Henrique Leitão. "Science During the Portuguese Maritime Discoveries A Telling Case of Interaction Between Experimenters and Theoreticians," in: Daniela Bleichmar, Paula De Vos,

historiographical developments have not changed and if anything have underlined that view.

Onésimo Almeida, a scholar of history and philosophy and keen student of Lusitanian culture, has argued that the Portuguese were especially good at integrating practical and theoretical work and so generated highly productive interaction between experimenters and theoreticians. A group of men in the sixteenth century, most notably Duarte Pacheco Pereira (?–c. 1430), D. Joao de Castro (1500–48), Pedro Nunes, (1502–78), Garcia de Orta (1501/2–68) and Fernando Oliveira (c. 1507–c.1585), valued and promoted empirical knowledge, experience, as superior to received knowledge from the surviving texts by ancient authors. While they did not reject entirely the value of classical learning, something supremely valued among Renaissance humanists, they did believe that data collected by seamen for example should be transferred to land and that such experience was more reliable for knowledge of nature than any other source.[5] The principal features of their work Almeida identifies as rejection of the authority of the Ancients per se, the acceptance of experience as the key criterion of truth, the development of a scientific outlook and methodology, the interface of theory and practice and of scholars and artisans, and lastly an overall awareness of the importance of new knowledge acquired by Portuguese navigation in the opening of new frontiers.[6] It is not surprising that his most telling example comes from the world of navigation and the exchanges between the mathematician Pedro Nunes and the sailor and author of sailing instructions Joao de Castro. The latter travelled extensively in the Indian Ocean and gathered data while Nunes stayed home in Portugal examining the collected information and proposing theories to give coherence to what de Castro reported. "These interactions are emblematic of the relationships maintained by the leaders and masterminds, thinkers and entrepreneurs involved in the overseas voyages of discovery." At the end of the set of sailing instruction for the Lisbon-Goa route de Castro said that if he had a problem he could not solve he would ask his teacher, that is, Nunes. Nunes' writings included responses to the problems of sailors. Sometimes he reacted to a specific question. He also made new instruments and

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Kristin Huffine, and Kevin Sheehan, eds., *Science in the Spanish and Portuguese empires, 1500-1800*, Stanford, CA: Stanford University Press, 2009: 37–43.

[5] Almeida, Onésimo T. "Science During the Portuguese Maritime Discoveries A Telling Case of Interaction Between Experimenters and Theorecticians," in: Daniela Bleichmar, Paula De Vos, Kristin Huffine, and Kevin Sheehan, eds., *Science in the Spanish and Portuguese empires, 1500–1800*, Stanford, CA: Stanford University Press, 2009: 79.

[6] Almeida, Onésimo T. "Portugal and the Dawn of Modern Science," in *Portugal, the Pathfinder: Journeys from the Medieval toward the Modern World, 1300-ca. 1500*, George D. Winius, ed., Madison, WI: Hispanic Seminary of Medieval Studies, 1995: 343–44.

suggested new navigational methods, which were then tried out by sailors. In some cases the innovations even worked.[7]

In the Netherlands exactly the same process, pioneered by that group of talented Portuguese practitioners, became the norm. On the vexing question of measuring longitude, something which bothered seamen and theoreticians alike through to the eighteenth century, the government of the Republic enlisted scientists to examine the problem and to use the information which sailors had started to gather in voyages to Southeast Asia. The polymath Petrus Plancius (1552–1622) was not alone among men consulted at the end of the sixteenth century on how to integrate theory and practical knowledge.[8] Well before that though, even before the revolt, men from the northern Netherlands were taking information gathered at sea to improve their charts. The remarkable Amsterdam artist and cartographer Cornelis Anthoniszoon (c. 1505–53) produced a marine guide to the routes, tides, and so on of the Baltic complete with coastal elevations, the first time that had been done. A set of marine instructions like his came to be called a rutter in English, the word borrowed from the Portuguese *roteiro* or French *routier*. A third edition of Cornelis Anthoniszoon's book published in 1558 included instructions on celestial navigation which he presumably got from a Spanish or Portuguese handbook.[9] He also produced a portolan chart with the title *Caerte van Oostlant* in 1543. In the 1540s and 1550s Cornelis Anthoniszoon travelled to Algiers, in that case in the service of his monarch Charles V, but more critical for his work on navigation were his travels to the Baltic. The second edition of the map of 1548 and the third of 1553 show significant improvement, the voyages to the Baltic presumably having helped in generating a higher degree of cartographic accuracy. The map was certainly closely tied to the book of sailing instructions he did. The goal was to show sea routes and so the concentration in the rutter is on coastlines and ports.[10] That goal is obvious in the map as well. The *Caerte van Oostlant*

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[7] Almeida, "Science During the Portuguese Maritime Discoveries": 84–90; quotation at 84.

[8] Davids, Carolus Augustinus. *Zeewezen en Wetenschap De wetenschap en de ontwikkeling van de navigatietechniek in Nederland bussen 1585 en 1815*, Amsterdam: De Bataafsche Leeuw, 1986: 69–78.

[9] Burger, C. P. Jr. "Oude Hollandsche zeevaart-uitgaven", *Tijdschrift voor boek- en bibliotheekwezen*, VII, 1–16; Dubiez, F. J. *Cornelis Anthoniszoon van Amsterdam; 1507-1553*, Amsterdam: H.D. Pfann, 1969, 22-4; Lang, Arend W. *Die 'Caerte van oostlant' des Cornelis Anthonisz. 1543 : arte Nordeuropas und ihre Segelanweisung*, *Schriften des Deutschen Schiffahrtsmuseums Bd. 8*, Hamburg: Kabel, 1986: 60–87.

[10] Smith, Catherine Delano. "Cartographic Signs on European Maps and their Explanation before 1700", *Imago Mundi*, vol. 37 (1985): 18–19; Dubiez, *Cornelis Anthoniszoon*, 9–15; Haase, Yorck Alexander. *Alte Karten und Globen in der Herzog August Bibliothek Wolfenbüttel*, Wolfenbüttel: Druck: Heckners Verlag, 1972: 42–44; Keuning, Johannes. "XVIth Century Cartography in the Netherlands", *Imago Mundi*, vol. 9 (1952): 37; Lang, *Die 'Caerte van oostlant'*, 19-56; Mörzer Bruyns, W. F. J. "Leeskaarten en paskaarten uit de Nederlanden Een beknopt overzicht van gedrukte navigatiemddelen uit de zestiende eeuw", in: *Lucas Jansz. Waghenaer van Enckhuysen: de maritieme cartografie in de Nederlanden in de zestiende en het begin van de zeventiende eeuw*, Enkhuizen:

marked the arrival of the portolan chart in northern Europe. The method of production was perhaps more sophisticated than with its Mediterranean predecessors because of the cartographer's use of triangulation in a way that was improved by Gemma Frisius (1508-55), a prominent scientist who worked for Emperor Charles V and taught at the University of Leuven in the southern Netherlands. Though the technique of triangulation dated from the 1450s it was not until the early sixteenth century that it came into use and not until the mid sixteenth century that information about how to make the best of the method became widely available.[11] The *Caerte van Oostlant* was significantly better in the depiction of the Baltic coast than any predecessor, another case where the knowledge of seamen was joined with theory of the day to generate more useful maps for navigation. Cornelis Anthoniszoon, like his Portuguese counterparts, transferred sailing instructions to a portolan chart, giving visual expression to collected data.[12]

The second way in which Portuguese nautical science influenced that in the Dutch Republic was in the theory of map making. The cross-fertilization and interaction of empiricists and theoreticians in Portugal generated the best maps produced in sixteenth century Europe and by any measure. They were superior in transmitting information, in promoting certain visions of the world, in political advocacy and as works of art. There was, thanks to exploration and to government support, a great interest in how best to make maps and translate findings at sea to representations on parchment. Divisions of territory, both terrestrial and oceanic, by Iberian monarchs, as in the Treaties of of Alcaçovas-Toledo (1479) and Tordesillas (1494) promoted an interest in and respect for cartography.[13] It was only logical that map makers in the Low Countries should rely on Iberian precedents. The extreme example and the one with the longest lasting effect was Gerard Kramer's (1512–1594) development of a projection which created loxodromes, lines which intersect all meridians at the same angle and so show the true course of a ship. Under his Latinized name of Mercator his projection, first used by him in 1541, became standard. He produced that pioneering attempt just four years after Pedro Nunes had discussed in his

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Vereniging Vrienden van het Zuiederzeemuseum, 1984: 11–20; Schilder, Günter. *The Netherland nautical cartography from 1550 to 1650,* Lisbon: Instituto de Investigação Científica Tropical, 1984, 4–5.

[11] Lang, *Die 'Caerte van oostlant'*, 41–54; Niël, Maikel. "De perspectivische ruimteweergave van het Gezicht in vogelvlucht op Amsterdam van Cornelis Anthonisz." *Caert-Thresoor*, 19 (2000): 110.

[12] Crone, G. R. *Maps and their makers: an introduction to the history of cartography*, London, New York,: Hutchinson's University Library, 1953*:* 105; Lang, *Die 'Caerte van oostlant'*, 15; Lang, Arend W. "Traces of lost North European seacharts of the 15th century", *Imago Mundi*, XII (1955): 31–32; Spekke, Arnolds. *The Baltic Sea in ancient maps*, tr. A. J. Grinbergs and others, Stockholm: M. Goppers, 1961: 72.

[13] Sandman, Alison. "Mirroring the World Sea Charts, Navigation, and Territorial claims in Sixteenth-Century Spain.", in: *Merchants & marvels: commerce, science, and art in early modern Europe*, Pamela H. Smith and Paula Findlen, eds., New York: Routledge, 2002: 83–108.

Tratado da Sphera the mathematics of how to do just what Mercator did. Nunes knew about the problem from reports of sailors returning from voyages to India and the Rio de la Plata so his findings were another case of the intermixing of the theoretical and the practical.[14] It was with the support of the scientist Gemma Frisius that Mercator pursued the application of ideas emanating from Portugal. He followed up on the implications of those findings in the large number of maps he produced over the following decades. Nunes wrote in Portuguese so sought something more than only a learned audience but he did write in such a way to make his work of direct use to practical men such as captains or pilots. Though he may have just refined and put into use what Nunes had only speculated about it was Mercator who incorporated those ideas in widely disseminated representations of the physical world. The man born in Flanders and who spent much of his career in Duisberg in Westphalia not far from the border with the Netherlands saw himself not just as scientist or map maker but also as a merchant. He chose the Latin translation of that job description for his professional name. He was deeply interested in selling the products of his press and was able to make a handsome profit for himself. In the process he won an enduring reputation for innovation, one based squarely on theory generated in Portugal.[15]

The third and most obvious way, at least to the eye, in which the Dutch imitated Portuguese practice was in forms of illustration and decoration of maps. While the earliest surviving products of Portuguese cartography show no sign of decoration by the early years of the sixteenth century the use of various forms of illumination at sea as well as on land had come to be the norm. The practice may have been pioneered by Catalan cartographers as early as the fourteenth century, borrowing from what was done on large *mappaemundi* which were known in northern Europe. Portuguese makers of atlases and large maps adopted wholeheartedly the idea of using decoration both for artistic and didactic purposes and impressed the value of such practices on the rest of Europe. The most obvious case was that of the Dieppe school of cartography in Normandy which relied directly on skilled personnel imported from Portugal in the mid sixteenth century.[16]

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[14] Cortesão, Armando. *Contribution of the Portuguese to scientific navigation and cartography*. Coimbra: Junta de Investigações Científicas do Ultramar, 1974, 28; Cortesão, Armando. *History of Portuguese Cartography*, Coimbra: Junta de Investigações do Ultramar- Lisboa, 1969: 108.

[15] Kyewski, Bruno. "Über die Mercatorprojektion," *Duisburger Forschungen Schriftreihe für Geschichte und Heimatkunde Duisburgs*, Stadtarchive Duisburg in Verbindung mit der Mercator-Gesellschft, vol. 6, Duisburg-Ruhrort: Verlag für Kultur Werner Renckhoff KG., 1962: 116–17; Albuquerque, Luís de. *Portuguese Books on Nautical Science from Pedro Nunes to 1650*, Lisbon: Instituto de Investigação Científica Tropical, 1984: 5–6.

[16] La Roncière, Monique de, and Michel Mollat. *Sea charts of the early explorers: 13th to 17th century*, New York: Thames and Hudson, 1984: 30; Putman, Robert. *Early sea charts*, New York: Abbeville Press, 1983: 30–31, 84–85, 108-9; Pelletier, Monique. *Cartographie de la France et du monde de la renaissance au siècle des lumières*, *Conférences Leopold Delisle*, Paris: Bibliothèque nationale de France, 2001: 16–17.; Harrisse, Henry. *The Dieppe world maps, 1541-1553*, Göttingen: University Printing Press, 1899: 1–2.

The most impressive early example of the Portuguese practice of illuminating maps is the Miller Atlas of about 1519. The work is in fact one of the finest example of Renaissance map making and certainly an outstanding case of sumptuous as well as pertinent illustration. It may be that in fact it was a man from Holland who painted the multiple and varied illustrations. Many artists in early sixteenth century Portugal were from the Low Countries and so the presence of a Dutchman in the making of the Atlas is not surprising. The historian Alfredo Pinheiro Marques has recently argued, and persuasively, that it was in fact one António de Holanda who was responsible for the illumination which makes the Atlas so unique. While the argument is not without flaws it still seems likely that in fact already in the early sixteenth century there was exchange between the Netherlands and Portugal in matters of what to put on maps.[17] The transfer of Portuguese practice to Normandy came through the direct import of cartographers. Local map makers, though, quickly developed the skills of their Portuguese teachers and the style and appearance of their maps was exactly like that of Lusitanian products.

The ways maps were made and the ways they were illuminated transferred from Portugal to Normandy and then to the Low Countries as well but in the latter case it was without the migration of Portugese cartographers. Dutch maps, like that of Cornelis Anthoniszoon, already had ships sailing the seas in imitation of Portuguese practice. That was only the start. Lucas Jansz. Waghenaer (1533/4–1606) was an experienced pilot who took up work on shore and turned his hand to town views and to charts. His *Spieghel der Zeevaerdt*, produced at the new Christoffel Plantijn press in Leiden in 1584–1585, had an overview chart and 45 detailed charts to a uniform scale of the coasts of western Europe from the Straits of Gibralter to Norway and Finland.[18] With each chart there were sailing instructions. It was a major improvement over previous works. It included coastal profiles across the top of the double-page charts, both charts and profiles covering the same coasts. The *Spieghel der Zeevaerdt* was the precedent for sea atlases of the seventeenth and eighteenth centuries, so much so that "waggoner" became a common noun in English by 1700 meaning a book of charts for nautical use. Waghenaer brought out a modified version of

[17] Marques, Alfredo Pinheiro, "The outstanding artistic value of the *Atlas Miller*, a masterpiece by Lopo Homem, Pedro Reinel, Jorge Reinel and António de Holanda", in: *Atlas Miller,*Barcelona: M Moleiro Editor S. A., 2006: 141–45.

[18] Waghenaer, Lucas Janszoon, *Spieghel der Zeevaerdt Leyden 1584–1585*, Amsterdam: Meridian Publishing, 1964; Bos-Rietdijk, E., "Het werk van Lucas Jansz. Waghenaer", in: *Lucas Jansz. Waghenaer van Enckhuysen : de maritieme cartografie in de Nederlanden in de zestiende en het begin van de zeventiende eeuw*, Enkhuizen: Vereniging Vrienden van het Zuiderzeemuseum, 1984: 21–46; Koeman, Cornelis, "Lucas Janszoon Waghenaer: A Sixteenth Century Marine Cartographer", in: *Miscellanea Cartographica*, Günther Schilder and Peter van der Krogt, eds., Utrecht: HES Publishers, 1988: 49–66.

the *Spieghel* called the *Thresoor der zeevaert* in 1592.[19] He too included illustrations of animals and ships on his charts. They were not necessary but still he followed the fashion created by Portuguese pioneers. By the end of the century such illustration had become standard with skilled engravers in Amsterdam being called on to embellish their maps with illumination. Jan Doetecum in the 1590s proved among the most talented but was by no means alone. He and others set the standard for the following one hundred years. Certainly by the early seventeenth century Dutch mapmakers had advanced beyond the work of their Portuguese forebears but the foundation of that aspect of nautical science in the Republic had roots in the Iberian kingdom.

A fourth category of nautical science in which there was influence from Portugal on the northern Low Countries was in shipbuilding. That trade always finds a place among the list of fields in which Dutch practitioners excelled. Dutch ship design and construction were the envy of seventeenth-century Europe, a target of industrial espionage for the French and a target for violence for the English and a source of capital goods for the Venetians who simply bought Dutch ships outright. Jean-Baptiste Colbert, the minister of finance to Louis XIV, sent spies to Dutch shipyards to find out how builders produced superior vessels.[20] He also offered jobs to tradesmen from those yards so they could bring Dutch technology to France, literally embodied. Oliver Cromwell in England once in power after the deposition and execution of King Charles I, in 1651 took his country into the first of three wars against the Dutch Republic. The goal was to undermine Dutch commerce and to capture Dutch ships so that those prizes could be incorporated into the English merchant marine. As far as seventeenth century Europeans were concerned superior ship design was obviously a critical factor in the success of Dutch shipping.[21] The variety of vessel designs that came from Dutch yards as well as the scale of production have served, however, to obscure the accomplishments of other European states of the seventeenth century and before.

Contemporaries as well as historians have minimized Iberian accomplishments in shipbuilding. There was and is still a tendency to project back in time into the Middle Ages what happened in the years after 1600 and so largely ignore what went on in the fourteenth, the fifteenth and even much of the sixteenth century when ships from Portugal and Spain were conquering the oceans of the world. It is hard to sustain a claim of Iberian

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[19] Waghenaer, Lucas Janszoon, *Thresoor der zeevaert, Leyden, 1592*, Amsterdam: Theatrum Orbis Terrarum, 1965.

[20] Ferreiro, Larrie D., *Ships and Science The Birth of Naval Architecture in the Scientific Revolution, 1600–1800,* Cambridge, MA: The MIT Press, 2007: 64–65.

[21] Richard W. Unger, *Dutch Shipbuilding Before 1800: Ships and Guilds*, Assen: Van Gorcum, 1978.

technical inferiority in light of the voyages of discovery and the establishment of regular lines of communication across thousands of miles of ocean, all done before there was a Dutch Republic. It is also hard to sustain such claims given the degree to which other Europeans spent much of the early modern period trying to emulate the practices and accomplishments of late medieval Iberians. Spain and Portugal were magnets for Italian technology, talent and investment and were also sources of skilled people as well as ideas for France, England and the Low Countries.

Shipbuilding in Spain and Portugal is one aspect of science and technology which has served to revive the reputation of those Iberian kingdoms. Among others Carla Rahn Phillips has contributed to that revival through her book on the construction of galleons at the end of the sixteenth century. Both Carla and William Phillips have forced a closer look at Iberian shipping through their study of the export of Spanish wool, especially export by sea to northern Europe from the Middle Ages to the nineteenth century. Their work along with that of a number of others, including Pablo Emilio Pérez-Mallaína Bueno and Regina Grafe, has served to rectify the negative view of Iberian seafaring.[22] While recent research may have favored reviving the reputation of Spanish seafaring the implication is that Portuguese shipping, shipbuilding and nautical science need to be understood in a more positive way as well. The close ties economically and culturally between the two kingdoms both before and after the political union in 1580 suggests the two moved closely together and especially in matters maritime.

Portuguese and for that matter all Iberian and Mediterranean shipbuilding practices differed considerably from those of the northern Netherlands at the close of the Middle Ages. A number of those differences persisted through to the end of the age of sail. Many distinctions were obvious to the naked eye. In the Dutch "Golden Century" the ships of the two looked very different. The approach to building hulls in the Republic involved starting with fitting a few planks close to the keel in place before setting up the frames.[23] That remnant of shell-first construction, the standard method in the North before 1500 where the outer planks of the hull were put in place first and the internal framing added later, was nowhere to be found in Iberia. There it was keel first, then frames and finally hull

[22] Phillips, Carla Rahn. *Six galleons for the king of Spain Imperial defense in the early seventeenth century,* Baltimore: Johns Hopkins University Press, 1986; Phillips, Carla Rahn, and William D. Phillips, *Spain's golden fleece: wool production and the wool trade from the Middle Ages to the nineteenth century,* Baltimore : Johns Hopkins University Press, 1997; Pérez-Mallaína Bueno, Pablo Emilio. *Spain's men of the sea : daily life on the Indies fleets in the sixteenth century,* Baltimore: Johns Hopkins University Press, 1998; Grafe, Regina. "The Strange Tale of the Decline of Spanish Shipping," in: *Shipping and Economic Growth 1350–1850*, Richard W. Unger, ed., Leiden: Brill, 2011: 81–115.

[23] A. Rålamb, *Skepps Byggerij eller Adelig Öfnings,* 1691.

planks. In features of rig much earlier than the Iberians the Dutch moved away from a triangular sail at the stern, gave up on ships with deep waists and increased the number of sails while making each individual one smaller and so easier to handle. The Dutch tended toward a large number of independent builders and were much slower about establishing big state or company-owned shipbuilding wharves than the Iberians. So the two parts of Europe deviated one from the other in shipbuilding in the sixteenth and seventeenth centuries and deviated in accomplishments with the late sixteenth and even mroe the seventeenth century being a period of unmitigated decline in Iberia and unprecedented expansion in the Dutch Republic.

The differences had their roots in long established traditions of construction, different in the two parts of Europe but the differences even more can be traced to the kinds of trades that dominated in the Netherlands and in Portugal. The kinds of commerce placed specific constraints on local shipbuilding. The Dutch handled heavy bulky goods in largely peaceful and often protected waters using shallow harbours and in cold climates where the freezing of harbours made shipping in winter impossible. The Portuguese carried high value goods over long distances in areas prone to violence visiting deep harbours accessible all year round but subject to severe weather conditions like the hurricanes of the Caribbean. They operated in warm waters where shipworm thrived and so they had to sheath the hulls of their ships.[24] The maritime and the economic environments were dissimilar as was the political one with greater regulation in the Iberian kingdoms. The fact that shipbuilders chose different paths in the two parts of Europe is no great surprise. On the face of it Dutch shipbuilding and navigation were not like Iberian. When the Dutch found it possible to outdo Iberians even in their own Empires in the seventeenth century it suggested a distinctive and superior approach to maritime practices among the Netherlanders. The differences between the two may be more apparent, and apparent especially to Protestant historians, than real.

The Dutch relied heavily on Iberian techniques and had for centuries. Trading relations and then subsequent political ties made easier the transfer of advanced methods in shipbuilding from the South to the Low Countries in the late Middle Ages and beyond. It was from the Portuguese that Low Countries shipwrights learned the method of building their ships frame first. In 1439 the Duke of Burgundy, Philip the Good, imported Portuguese craftsmen to build a ship for him, probably on the Zenne near Brussels. They produced an example of the carvel-building method, new to the North, where builders first

[24] Phillips, *Six galleons for the King of Spain*, 24.

sett up the keel and then the frames and tacking on the hull planks to those frames last. The approach had the advantage of producing a lighter ship with less skill required by the carpenters in the shipyard. The form of hull construction meant that if there was damage to the outer planks there was no threat to the integrity of the ship, only to its watertightness. Holes in the hull could of course present extremely serious problems to a ship at but such damage was relatively easily repaired compared to vessels made with the older hull-first or clinker-building method. Incidentally the vessel those Portuguese shipwrights built for Philip the Good was lost to Catalan pirates on a voyage to the Mediterranean in 1446.[25] In 1457 two Flemish towns rented an Iberian ship for convoy duty. It had the new full rig which combined square and triangular or lateen sails, something that was novel in the Low Countries and an example soon to be followed not just in the Netherlands but by all European shipbuilders.[26]

The greatest Dutch success was with flat-bottomed bulk carriers, best suited for trade to the Baltic. Those fluyts had a relatively high ratio of length-to-breadth which was a feature of Iberian ships, but the Dutch type did not reach the lentgh limits explored by Iberian builders. The greatest Spanish success was with galleons, best suited for the open seas and for dangerous waters. Though possibly derived from a Venetian model and probably based on features of Mediterranean galleys, the Spanish galleon was a sleek defensible vessel for trans Atlantic commerce.[27] Spanish and for that matter Portuguese captains were not above making variations and employing different rigs on their ships. Dutch captains would, as they travelled to other parts of the world, consider varied options as well. For the late Middle Ages and through the sixteenth century typically Dutch building techniques lagged behind those of Iberia. In time though the Dutch did follow the Iberian or Mediterranean model of having the shipbuilder create designs and supervise workers on the wharf rather than have him as a participant in the shaping of wood.[28] It was another transfer of technology from Portugal to the Dutch Republic.

At the end of the sixteenth century the biggest difference between the Netherlands and Iberia then was not technical leadership but the type of shipping services which the merchant marines supplied. The Dutch concentrated on Baltic trades using slow cheap bulk carriers and the Spanish concentrated on trans Atlantic and the Portuguese on trans Indian Ocean trades. When the Dutch traded in the Mediterranean, though, they did so

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[25] Beylen, Jan van. *Schepen van de Nederlanden*, Amsterdam: P. N. Van Kampen & Zoon N. V., 1970: 7–8.

[26] Unger, *Dutch Shipbuilding:* 32.

[27] Phillips, *Six galleons for the King of Spain:* 40-2.

[28] Unger, Richard W. *The Art of Medieval Technology: Images of Noah the Shipbuilder,* New Brunswick and London: Rutgers University Press, 1991: 58-60.

with ships built much like Portuguese ones. The Portuguese had gigantic carracks which they used in the India trade where carrying capacity was the most important consideration. The Portuguese also had smaller and more lightly built ships for trades to northern Europe and to the Atlantic Islands which supplied both wine and sugar. There is no denying that the Dutch proved capable of producing purpose-built ships which lowered shipping costs. That ability, however, did not necessarily indicate technical leadership but could also show more effective ways of meeting demand for shipping services. In technical matter it was rarely if ever a matter of Dutch independent invention since in many aspects of ship design Low Countries shipwrights relied on Iberian precedents. That reliance on what had been done before in Iberia was even more impressive in the learned tradition, in thinking about matters to do with building a ship.

Shipbuilding was a practical trade throughout the Middle Ages but starting in the fifteenth century people familiar with practice began writing about the trade, describing design work. The manuals they produced like that of Michael of Rhodes and Zorzi "Trombetta" da Modon in Venice were not necessarily very helpful or even accurate and they were not intended as guides on how to build ships.[29] In the sixteenth century and especially in Iberia written works were more closely related to work on wharfs, just when Iberians became the leaders in writing about the shipbuilding trade. The first printed book which described how to build a ship came from Havana, that in 1587. It was one of a number of how-to books produced for people in the growing empire who lacked the pool of skilled artisans that existed in Europe and who needed practical and useful knowledge to create their mini-Europes in other parts of the world. The combination of a rising interest in day-to-day practice among people of leisure and the needs of an expanding society moved books about shipbuilding in the direction of explaining how the job was done and away from ex-post descriptions of the final result. That was obvious in the major shipbuilding treatise that came from Portugal, the *Liuro da Fábrica das Naus* by Fernando Oliveira dating from 1580. Fernando Oliveira was another of those Portuguese learned men identified by Onésimo Almeida as leaders in advancing science and technology in tandem.

While the Dutch might have taken the lead in shipbuilding they were slow to produce books on how to build ships. Cornelis Van Yk's 1697 book was a work by a practical man writing down what he learned from a lifetime of working in Dordrecht shipyards. The only earlier effort and the first in the Dutch Republic was by a prominent

[29] In general on treatises Ferreiro, *Ships and Science*, 46-49.

and wealthy Amsterdam politician, Nicolas Witsen. He never practiced the trade so in his "Former and Contemporary Shipbuilding..." he recorded what an anonymous experienced Amsterdam practitioner of the trade told him. When Witsen wanted to describe the general progression of the shipbuilding process he went to the library of Leiden University and there he found a copy of Fernando Oliveira's 1580 book. He copied exactly what he found, even the drawings, saying he was describing the trade in 1520.[30] Intellectual property rights were not an issue in the seventeenth century. Witsen felt no compunction in representing Oliveira's work as his own. It was for him a matter of relying on the best source of knowledge, even if he did get the date wrong. So when it came to shipbuilding the Dutch learned tradition, even more than in practice, relied on Portuguese roots.

The conclusion that the Dutch were successful and the Portuguese failed in seafaring in the aftermath of the Middle Ages is hard to sustain. Despite their apparent differences in performance there were close connections between the two. Differences in religion, in the role of Jesuits, in government structure, in the kinds of trades in which they specialized all had an impact on the performance of shipping and shipbuilding in the two parts of western Europe. The differences had a powerful impact on the kinds of ships built and used in Spain and the northern Low Countries but when Dutch authors came to discuss shipbuilding in tracts and lengthy texts it was Iberian models which they followed. That was true in the kinds of works they produced and more specifically, in the case of Nicolaas Witsen, there was direct copying from the learned tradition of Portugal. Even if Dutch practice was different from Iberian, thinking about shipbuilding in the two parts of Europe showed some significant similarities. It was easy to borrow and the Dutch sought precedents, background and insight from the burgeoning nautical science that emanated from Iberia. By the end of the seventeenth century the learned tradition in the highly successful Dutch Republic was turning to and basing work on practical experience as van Yk's book showed. There the gulf between theory and practice had finally narrowed but already in the late Middle Ages that gulf was being bridged among Portuguese mathematicians and map makers and sailors and by the sixteenth century among writers and practitioners of the art of shipbuilding. It took a while but Portuguese experience did over time influence practice and thinking in the Dutch Republic.

"The Dutch Republic originated in the opposition of the rational elements of human nature to sacerdotal dogmatism and persecution - in the courageous resistance of

[30] Vogel, Walther. "Ein neuendecktes Lehrbuch der Navigation und des Schiffbaues aus der Mitte des 16. Jahrhunderts," *Hansische Geschichtsblätter*, XVII (1911): 370–74.

historical and chartered liberty to foreign despotism."[31] So wrote John Lothrop Motley in his 1856 *The Rise of the Dutch Republic*. That member of Boston's intellectual, cultural and Republican elite found the sources of American democracy in the Dutch Republic.[32] To him the torch had passed from the residents of the sixteenth-century northern Netherlands to the Puritans in the English Civil War and then to the American Founding Fathers. The Iberian empires collapsed along with the economy over the long term and the center of global politics and the economy, justly, moved and in the first instance to the Dutch Republic. Motley's sharp distinction between the Iberian lands of Phillip II and the Netherlands may but only may possibly have been true for religion and politics but in matters maritime and especially in nautical science no such divide existed.

Despite all reasons for the differences between apparently successful Dutch and failed Iberian seafaring in the aftermath of the Middle Ages there were close connections between the two. Differences in religion, in the role of Jesuits, in government structure, in the kinds of trades in which they specialized all had an impact on the nautical science in the two parts of western Europe. Even if Dutch practice was different from Portuguese, thinking about navigation and how to do it better in the regions showed some significant similarities. The learned tradition of science in the highly successful Dutch Republic turned to and based work on practical experience in the seventeenth century. The gulf between theory and practice narrowed but already in the late fifteenth century Portuguese mathematicians and map makers and sailors worked on bridging that gap. In the sixteenth and seventeenth centuries what had started in Iberia among theoreticians and practitioners, what had been done in applying mathematical ideas to cartography and what was the norm in decorating maps among other aspects of the art of nautical science became part of the fabric of Dutch success.

[31] Motley, John Lothrop. *The Rise of the Dutch Republic A History*, London: G. Bell and Sons, Ltd., 1913 [1856]: liv.

[32] See Guberman, Joseph. *The life of John Lothrop Motley*, The Hague, Martinus Nijhoff, 1973.