Orthogonal maps and the shaping of the modern globalised world

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Orthogonal, orthographic and ichnographic views form the way we see the world today. The three synonymous terms denote perspectives onto a point from 90 degrees above. These projections' appearance has become so pervasive in modern life that they are often taken for granted as naturalistic. Consequently, how they shape perception and knowledge has remained curiously unexamined.

Orthogonal views predominate in both paper and digital maps. In our time, mapping apps provide orthogonal perspectives often as the default (fig. 1). Many millions of people therefore interact with these projections on a daily basis. Although the views are common, the three technical terms remain largely unused and obscure even to scholars. It is as if mapping and orthogonality have become so elided that even knowledge of the terms is unnecessary. Just the word *map* can evoke an orthogonal projection despite mapping coming in various forms and perspectives. Easily missed, therefore, is that orthogonal views are essentially unnaturalistic, so our perceptions and knowledge of the world derived from maps need to be investigated.

A spatial map constructs relations between two or more points. But if one point is viewed from a perpendicular position directly above, it is impossible to see a second point simultaneously from a 90-degree angle. In other words, if two or more points are viewed simultaneously, only one of them can be seen from directly above while the other points would necessarily be viewed obliquely. Nevertheless, orthogonal maps show all

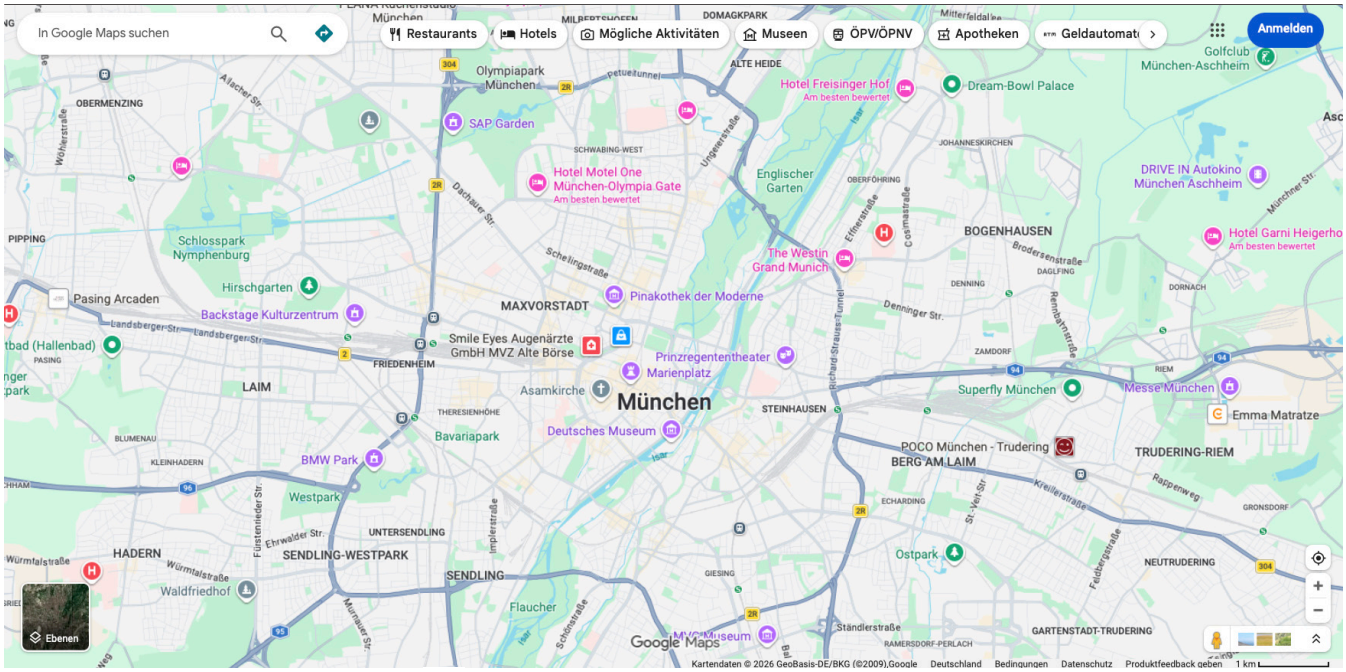


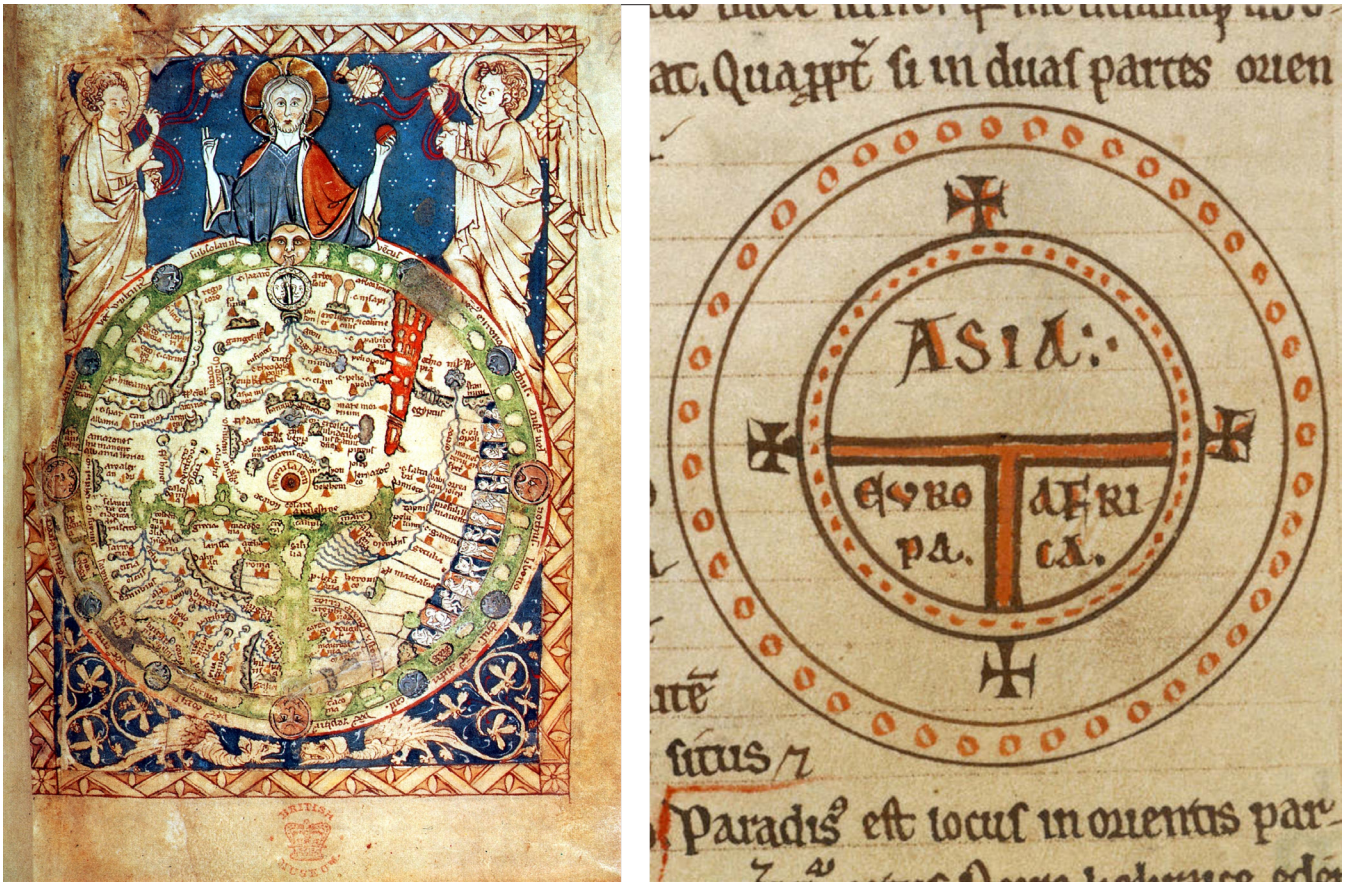
Fig. 01
Orthogonal view of Munich. Digital map, Google Maps, accessed 16 April 2026.

points from a perpendicular perspective. These images, then, are amalgamations of 90-degree projections cobbled together through intervention.

The early development of modern orthogonal world maps went hand-in-hand with the Age of Exploration and the beginning of the current age of globalisation. European encounters with unfamiliar waters, lands, communities and ecologies were represented on these maps. Orthogonality shaped how viewers understood these spaces. Scholars of cartography have long studied maps as devices that seek to convey accurate geographic information. More recently, researchers have come to recognise maps as abstractions that often take three-dimensional space and translate it into two-dimensional representations, as well as the ideologies and power dynamics that affect their production.[1] Yet, and perhaps reflecting the disuse of the three terms introduced above, we have not considered the choice of perpendicular projection to portray a world that is almost always experienced from eye-level, in profile or obliquely.[2] Clearly sighting orthogonality helps shift our understanding of how maps *dis:connected* perception and knowledge in unveiling a world and its unfamiliar dimensions at the dawn of modern globalisation.

1 John Brian Harley, *The New Nature of Maps: Essays in the History of Cartography* (Baltimore: The Johns Hopkins University Press, 2001).

2 Oblique views, also known as 'bird's-eye views', are perspectives from 90- to 0-degree angles, such as from an elevated position looking downward at a slant. For one of the few sustained discussions on orthogonality, see John Pinto, 'Origins and Development of the Ichnographic City Plan', *Journal of the Society of Architectural Historians* 35, no. 1 (1976).



The emergence of modern orthogonal maps

Humans have long been capable of producing orthogonal representations of their environments.[3] However, the nautical charts and grid-based mapping that abetted European voyages starting in the fourteenth century specifically applied perpendicular perspectives to depict expanding horizons. In the Middle Ages, oral and ephemeral itinerary mappings predominated.[4] Linear in character, they described paths that led from one point to another as a series of directional headings and encounters with landmarks. The clerical and scholarly elite also produced *mappae mundi* (fig. 2) that sought to illustrate the world. Though some were orthogonal, arrangements of geographical features nevertheless corresponded largely to classical and Biblical notions such as the tripartite division of the world with Jerusalem as its centre (fig. 3). In contrast, the development of nautical charts and grid-based mapping strove to more accurately depict spatial relations between different places, and these maps, particularly print versions, also brought orthogonal views to a broader viewership.

3 Catherine Delano-Smith, 'Cartography in the Prehistoric Period in the Old World: Europe, the Middle East, and North Africa', in *The History of Cartography*, ed. John Brian Harley and David Woodward, vol. 1, (Chicago: University of Chicago Press, 1987).

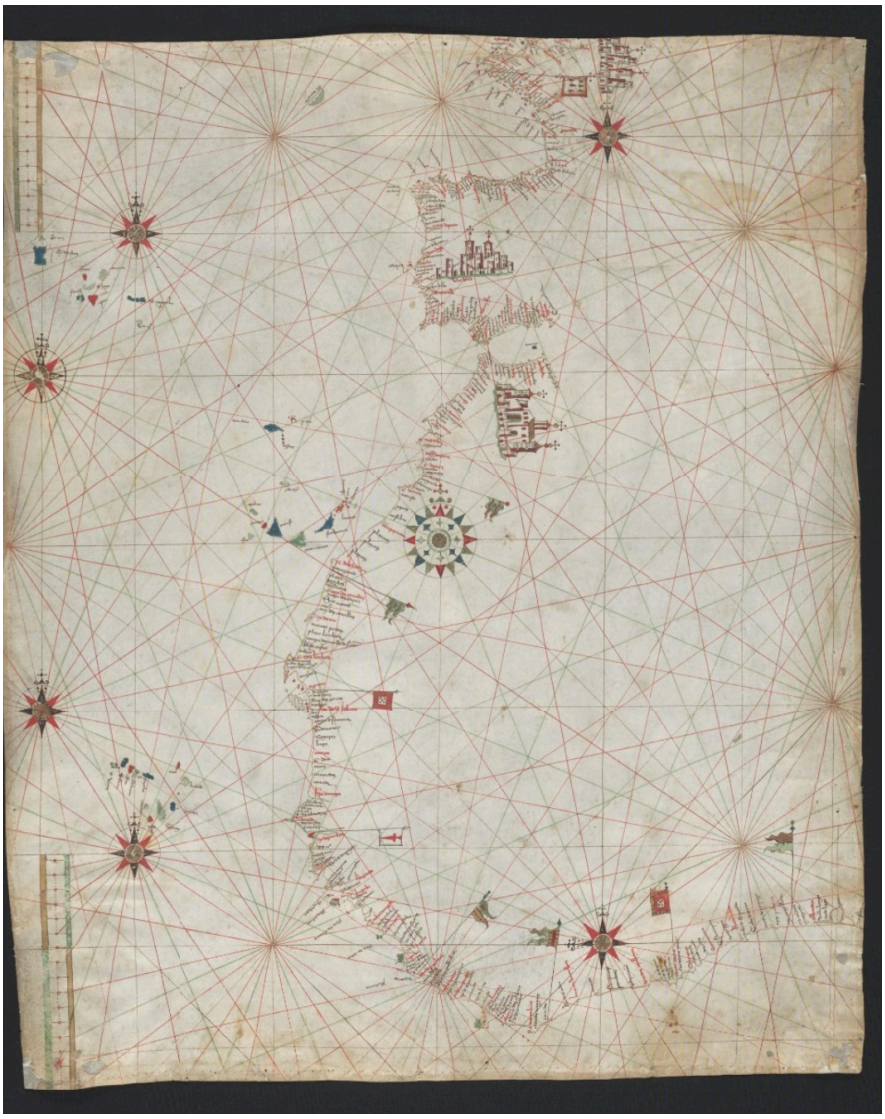
4 Ephemeral maps include sketches made on dirt.

Fig. 02, 03
Medieval mappamundi. (Psalter World Map), c. 1200-1250, manuscript, British Library Ms. 28681 fol-9r; 'T-O' mappamundi. From Isidore of Seville, *Etymologies*, 12th century, manuscript, British Library Royal 12 F. IV.



Nautical charts trace the contours of coastlines and emplace the location of ports, inlets, deltas, and other littoral features (fig. 4). Because they were used for navigational purposes, charts strove for accuracy in proportioning bodies of water and situating coastal topographical features. First produced to map the Mediterranean as well as the Black and Red Seas and the Atlantic littorals of southwest Europe-northwest Africa, the medium came to display information about new waters and shores as Europeans explored the world (fig. 5). Originally hand-drawn, these charts also began to be printed and more-widely circulated in the 16th century. Nautical charts seem to draw the world to a surprising degree of verisimilitude that our naked eyes today can favourably compare to satellite images.

Fig. 04
Nautical chart centered on the Mediterranean. Unknown, (*Carte marine portugaise de l'océan Atlantique Est, de la mer Méditerranée et de la mer Noire, connue sous le nom de portulan de Dijon*), 1510, manuscript, Bibliothèque Municipale de Dijon Ms. 5



Beginning in the early 15th century, the transmission of Claudius Ptolemy's *Geography* from the Byzantine Empire to Italy and its translation from Greek to Latin also introduced coordinate-based mapping to Europe. The *Geography* describes the world known to the classical author in the second century C.E. It included long lists of toponyms with corresponding coordinate points. Copies started to emplace these points on a grid and produce maps, again in orthogonal view (fig. 6).[5] Manuscript codices were followed by printed editions starting in 1477 (fig. 7). Though the coordinates created maps that look oddly shaped relative to today's satellite images (fig. 8), *Geography* revolutionised European mapping. In the Age of Exploration, new maps were produced with points plotted onto the proportionally-organised homogenous space of grids.

Fig. 05
Nautical chart of northwest Africa. Unknown, (*Carta nautica Francia, Spagna, Africa occidentali*), 1472, manuscript, Biblioteca Estense C.G.A.5.C.

5 Maps accompanying *Geography* also included conical views, particularly for the world map.





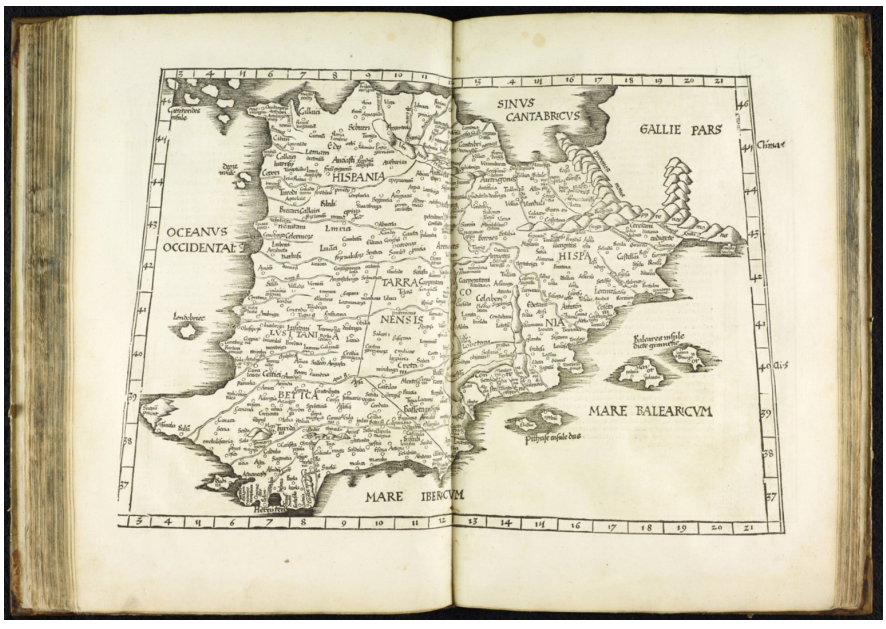


Fig. 06-08
Ptolemaic map of Africa. Claudii Ptolomei, *Cosmographiae*, 1460-77, manuscript, Universitat de Valencia BH Ms. 0693; Ptolemaic map of northern Africa. Albrecht Dürer (engraver), "Libyae Interioris Pars," from Claudii Ptolemaei *Geographicae enarrationis libri octo*, Strasbourg: Ioannes Grieningerus, *communibus Iohannis Koberger impensis excudebat*, 1525, print, David Ramsey Historical Map Collection 10891.043; Ptolemaic map of the Iberian Peninsula. Albrecht Dürer (engraver), "Libyae Interioris Pars," from Claudii Ptolemaei *Geographicae enarrationis libri octo*, Strasbourg: Ioannes Grieningerus, *communibus Iohannis Koberger impensis excudebat*, 1525, print, David Ramsey Historical Map Collection 10891.010.



Both nautical charts and Ptolemaic maps could absorb expanding knowledge of the world, and it is here that cartographic history tends to elide the striving for accuracy with a modern positivist notion of science and objectivity. Nonetheless, keeping the abstract and ideological nature of both kinds of maps in mind, we can now explore how their orthogonality constructed worldviews and shaped perception and knowledge in new ways.

Mis:seeing Africa

Scholars have long focused on Africa to assess late-medieval cartography's ability to accurately trace coastlines and emplace newly-encountered sites.[6] Africa was the test case because, unlike the Mediterranean and Black seas, the littoral south of Morocco was unknown to Europeans before the 1430s. Instead, classical knowledge passed down through the Middle Ages speculated on the shape of Africa, postulating a landmass that stretched far eastward to surround a foreshortened Indian Ocean and reach toward East Asia (fig. 9). Starting in the 1430s, Portuguese sailors on early exploratory voyages gathered new geographic information that rapidly appeared on maps, and Africa's shape astonishingly came to approximate contours familiar to us today. Modern scholarship has deterministically fixated on accuracy assessment;[7] however, it misses how orthogonality in these new maps constructed qualitative views of Africa.

Fig. 09
World map in conical view with southeastern Africa stretching to East Asia and enclosing the Indian Ocean. Nicolaus Germanus, (Ulm Ptolemy world map), from Cladii Ptolomei viri Alexandrini Cosmographie, Ulm: *Per ingeniosum virum Leonardum Hol prefati oppida civis*, 1482, printed, National Library of Australia MAP G3201.S1 1482, via Wikicommons.

6 Francesc Relaño, *The Shaping of Africa: Cosmographic Discourse and Cartographic Science in Late Medieval and Early Modern Europe* (Burlington: Ashgate, 2002).

7 Richard Betz, The Mapping of Africa: A Cartobiography of Printed Maps of the African Continent to 1700 ('t Goy-Houten: Hes & de Graaf, 2007).



Fig. 10
World map in Mercator projection. Edward Stanford, 'The World on Mercator's Projection', 1926, via Wikimedia Commons.

Again, the key characteristic of an orthogonal map is that every point framed in the image is seen from a 90-degree angle. Furthermore, if a map were not so large as to necessitate shifting around it to clearly visualise details, all the points of the map in perpendicular projection could simultaneously be viewed. In other words, the homogenised orthogonal space on sheets of parchment or paper could conjure the illusion of seeing thousands of kilometres of the Earth at one glance. This is the synoptical, God's-eye view afforded by orthogonal maps.[8]

In this synoptical orthogonality, however, not all features have the same value. Spatial maps describe relations, typically the direction and distance between points. Still, relational values also include placement, size and visibility. Synoptical orthogonality enables certain comparisons between Africa and, for example, Europe, on a world map. Regarding the latter three qualities, acknowledgment of Eurocentrism in early modern European maps has now become commonplace. Europe almost always occupies the centre of an early modern world map. The size of the landmass is also often enlarged in proportion to that of other continents, with the Mercator projection further amplifying the magnitude of these northern lands (fig. 10). The characteristics defied medieval *mappae mundi* conventions that often marginalised Europe and Africa in relation to Asia, with Jerusalem in southwest Asia as the centre of the world (fig. 3). Yet this view of nautical charts and Ptolemaic maps' Eurocentricity is itself Eurocentric and does not fully visualise the relational values revealed through orthogonality.

8 Denis Cosgrove, *Apollo's Eye: A Cartographic Genealogy of the Earth in the Western Imagination* (Baltimore: The Johns Hopkins University Press, 2001).



A survey of some of the earliest world maps produced after Christopher Columbus's and Vasco da Gama's voyages clearly shows that Africa looms large. Europe, though also centrally positioned on the horizontal axis, is nonetheless relegated to the upper edge of the vertical axis in these images. Juan de la Cosa's 1500 world map is the first nautical chart to stretch to the shores of the Americas and embrace the burgeoning field of vision (fig. 11). Through placement, size, and visibility, Africa occupies the centre of the world. Africa receives the same treatment in the so-called Cantino Planisphere from 1502 (fig. 12).

Not only do the position and size of the landmass dominate these and other maps, the illustrations that frequently fill the orthogonal interior space draw even more attention compared to the interiors of other landmasses like Asia. The Cosa and Cantino world maps are replete with geographical features, vignettes of lords and towns, flags suggesting political affiliation, flora and fauna, imaginary creatures, and labels and texts. Notably, most elements are easily recognisable because they are shown in profile in the orthogonal projection. The two charts are joined by many subsequent regional and world maps, both manuscript and print, that present Africa similarly. There are many reasons for these kinds of illustrations on maps, ranging from ideology, aesthetics and patrons' preferences. However, a survey of regional and world maps demonstrates that the interior of Africa was

Fig. 11-12
World map. Juan de la Cosa, (Carta Universal), 1500, Museo Naval de Madrid MNM 0257; World map. Unknown, (*Cantino Planisphere*), 1502, manuscript, Biblioteca Estense C.G.A.2.



Source gallica.bnf.fr / Bibliothèque nationale de France

consistently used for these purposes, so much so that in 1749, the French cartographer and royal geographer Jean-Baptiste Bourguignon d'Anville deliberately omitted these illustrations as well as specious geographic information in order to visualise the 'unknownness' of African's interior (fig. 13).[9] The blanking of Africa in this homogenised orthogonal space then suggested an emptiness that demanded to be exploited.

Africa's placement, size and visibility in orthogonal maps have long been in front of us, though a Eurocentric critique of Eurocentrism has obscured its position. Orthogonal projection has likewise been a fundamental attribute of world maps. How it shapes perception and knowledge also needs closer scrutiny. Orthogonality enables the creation of world maps by letting them exhibit the whole world in one view. These images, then, should not be taken for granted as naturalistic. The Earth is spherical, and cartographers could have centred the world map on any part of the globe and created different qualities or relational values. Indeed, up to the 18th century Islamicate cartographers produced world maps that were both oriented to the south and centred on southwest Asia, placing Europe and Africa to the side (fig. 14).[10] Centring a map on

Fig. 13
Map of Africa. Jean-Baptiste Bourguignon d'Anville, 'Afrique publiée sous les auspices de Monseigneur le Duc d'Orléans', 1749, print, Bibliothèque Nationale de France Cartes et plans, GE DD-2987 (7779 B).

9 Petter Hellström, 'A New New World: Unmapping Africa in the Age of Reason', *Journal for the History of Knowledge* 5 (2024).

10 Karen Pinto, *Medieval Islamic Maps: An Exploration* (Chicago: University of Chicago Press, 2016).





the Europe-Africa axis, the orthogonal projection of a world map was a deliberate choice made by European cartographers and it gradually became a global convention.

Orthogonal and profile views compared

Orthogonal maps' relational values become more clear when compared to mapping based on profile views. Navigation used nautical charts as well as coastal profiles, also known as rutters (fig. 15). These images illustrate coastal topography in profile from the vantage point of a vessel transiting along the littoral. Since ships often hugged the shore, the pictures could be used to recognise location. Coastal profiles mimic how we perceive the heights, widths and to an extent depths. Rather than creating a homogenous orthogonal space, profiles show the undulations of topography, including the built environment of maritime communities (fig. 16). At the same time, coastal profiles can only show what the eyes can see, that is the topography that abuts the coast but not the interior.

Fig. 14
Islamicate map of the world. Unknown, (World map), in *al-Idrīsī, Nuzhat al-mushtāq fī ikhtirāq al-āfāq*, 1153, manuscript, Bodleian Library MS. Pococke 375.

Fig. 15-16
Coastal profile of Atlantic Morocco. Unknown, 'Veües des côtes de Barbarie depuis le Cap Cantin jusqu'au Cap Spartel, a trois lieues de terre', 1737, manuscript, Bibliothèque Nationale de France Cartes et plans, GE D-3738; view of Algiers. Daniel Havell, 'This View of the City of Algiers', London: Published August 29 1816 by A. Smith 39 Fleet Street, London, 1816, print, British Library Maps K.Top. 117.73.e.



Source gallica.bnf.fr / Bibliothèque nationale de France

Furthermore, even though some compilations purport to trace the coastal profiles of entire continents, these works could not display all the coastlines at one glance. Instead, the viewer had to leaf through sheet after sheet of illustrations.

Despite their synoptic quality, orthogonal world maps' scale limits finer topographical details. Whole oceans and continents are visible at one glance, but not the heights, depths and details of individual landforms except as abstractions and numbers. Topography in profile could fill representations of the interior space of Africa and insets lining margins of world maps (fig. 17), but these elements were selective. Still, orthogonal views capture the interplay of different *types* of topography and land regimes. Though the *Neptune françois* is not a world map, it offers a comprehensive set of nautical charts depicting France's coastline. Many elements illustrated by lines, dots and bubbles indicate waterways, sand dunes, sandbars, shoals, tidal flats, marshes, plots of land and roads in orthogonal view (fig. 18). Vignettes and cartoons of hills, woodlands and settlements are also drawn in profile view.

These coastal charts reveal early modern orthogonal maps' ability to knit together different topographies, though not so much the precise boundary between, for example, tidal flat and dry land. Rather, orthogonal views emphasise relational values, such as those between ecological and built features, which suggests interwoven social, economic, political and military activities at the level of concept. Orthogonal maps can visualise relations between conceptual abstractions that the profile view cannot replicate.

Fig. 17
Map of Africa with insets of harbors. Jodocus Hondius II, 'Africae nova tabula', Amsterdam: *sumptiubus et typis aeneis Joannis Janssonii*, 1632, print, Bibliothèque Nationale de France Cartes et plans, GE BB-246 (I, 46-47).



Conclusion

Orthogonality is a means to convey knowledge, but it cannot be taken for granted as objective, empirical or naturalistic. More than merely abstracting, orthogonality selects for information that can be reduced and simplified into type, rather than representing the local specificity of profile views. Selection highlights particular details while limiting others. While this is true for all abstractions and representations, orthogonality has not received the scrutiny that other developments shaping the early globalising world has, from vanishing point perspective to mechanised print, and from the development of the early modern bureaucratic state to the rise of joint-stock companies and insurance instruments. Cartography went hand-in-hand with the Age of Exploration. It produced map-images of the expanding world. Orthogonality was used to represent new places and peoples that were encountered, shaping perception and knowledge of the modern era of globalisation.

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Fig. 18
Detail of Britanny. '7.me Carte Particuliere des Costes de Bretagne depuis l'Isle de Groa Jusqu'au Croisic contenant le Port Louis Bell'Isle et le Morbian', in Charles Pene, *Le Neptune François ou atlas nouveau des cartes marines*, Paris: Jaillot, 1693, print, Ludwig-Maximilians-Universitätbibliothek 0014/W 2 Mapp. 4