

Introduction

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The proliferation of maps and the development of new kinds of maps between 1650 and 1800 indicate that the producers and consumers of maps shared in the great intellectual and social changes that were then transforming Europe. These changes form the core of what is commonly known as the Enlightenment: the development of modern scientific practices, the formation of bureaucratic states, the remarkable growth and integration of the national economies, and the reformulation of the nature and locus of social and cultural authority with the rise of the public sphere. Yet we cannot say that either the Enlightenment or cartography in the period constituted coherent and uniform phenomena. In particular, there was a great deal of variation in how mapmakers and map users participated in and contributed to these trends. Moreover, even as new modes of cartographic practice evolved, notably the geodetic surveys that measured the size and shape of the earth and the nascent thematic mapping pursued by natural philosophers and political economists, so other modes continued with little change from earlier periods, notably those of property and urban mapping. And while maps themselves generally acquired a new authority as reliable and truthful images, the logic underpinning any “factual” status was not monolithic but relied variously on reason, observation, and a newfound professionalism among practitioners.

Cartography in the European Enlightenment, volume 4 of *The History of Cartography*, has been carefully designed and assembled so that its detailed studies and assessments of cartographic practices contribute to the ongoing reassessment of the nature of the Enlightenment as a period and as an intellectual movement. The volume explores the social and cultural ramifications of mapping in different parts of Europe and its overseas territories, in urban and rural sites, and in private councils and emergent publics. These insights require that we not only follow other scholars in abandoning the concept of the Enlightenment as a single endeavor, but that we abandon the apparent uniformity of cartography as well. This introduction therefore offers several ways to delineate the complexities and dissonances that characterized Enlightenment cartography.

A TALE OF TWO IMAGES

Two images from the mid-eighteenth century incorporate the primary characteristics of European cartography in the period between 1650 and 1800. Each image references a distinct category of mapping activity that experienced significant changes during the Enlightenment period. At the same time, many aspects of both images would not have been completely foreign to a map reader from 100 or even 150 years earlier.

The first image appeared in Paris in 1753, when a French engineer with the corps des Ponts et Chaussées and a contributor to the *Encyclopédie*, Nicolas-Antoine Boullanger, published a *Nouvelle mappemonde* or “new world map” (fig. 1). He framed this double-hemisphere world map with flowery swags and abundant fruits and vegetables placed on architectural cornices. The personification of Reason, the *génie des sciences*, equipped with her attributes of dividers, globe, and telescope heralds the title of the map: she raises up her hands and exclaims the well-known phrase from Genesis, *Fiat lux* (Let there be light); the clouds respond by opening to reveal the sun, that is, the light of knowledge, an interpretation reinforced by the map’s dedication “to the progress of our knowledge” (Boullanger 2006, 398–99; see Palsky 2017). A long textual passage printed below the map explaining its content is integral to the overall composition.

The graphic syntax of the *Nouvelle mappemonde* would have been familiar to a reader in the Renaissance: the representation of the world’s hemispheres in matched circular frames; the use of the term *mappemonde* in the title; a surrounding decorative motif with an emblematic personification to emphasize the words of the title; a dedication and explanatory text; areas of incomplete geographical outlines. All these were staple elements of cartographic design from medieval *mappae-mundi* to the baroque-style printed maps of the early sixteenth to mid seventeenth century. Even the celebration of new knowledge repeated the manner in which Renaissance Europe distinguished between the present and the past, to be considered and mapped separately (Woodward 2007, 16–17).

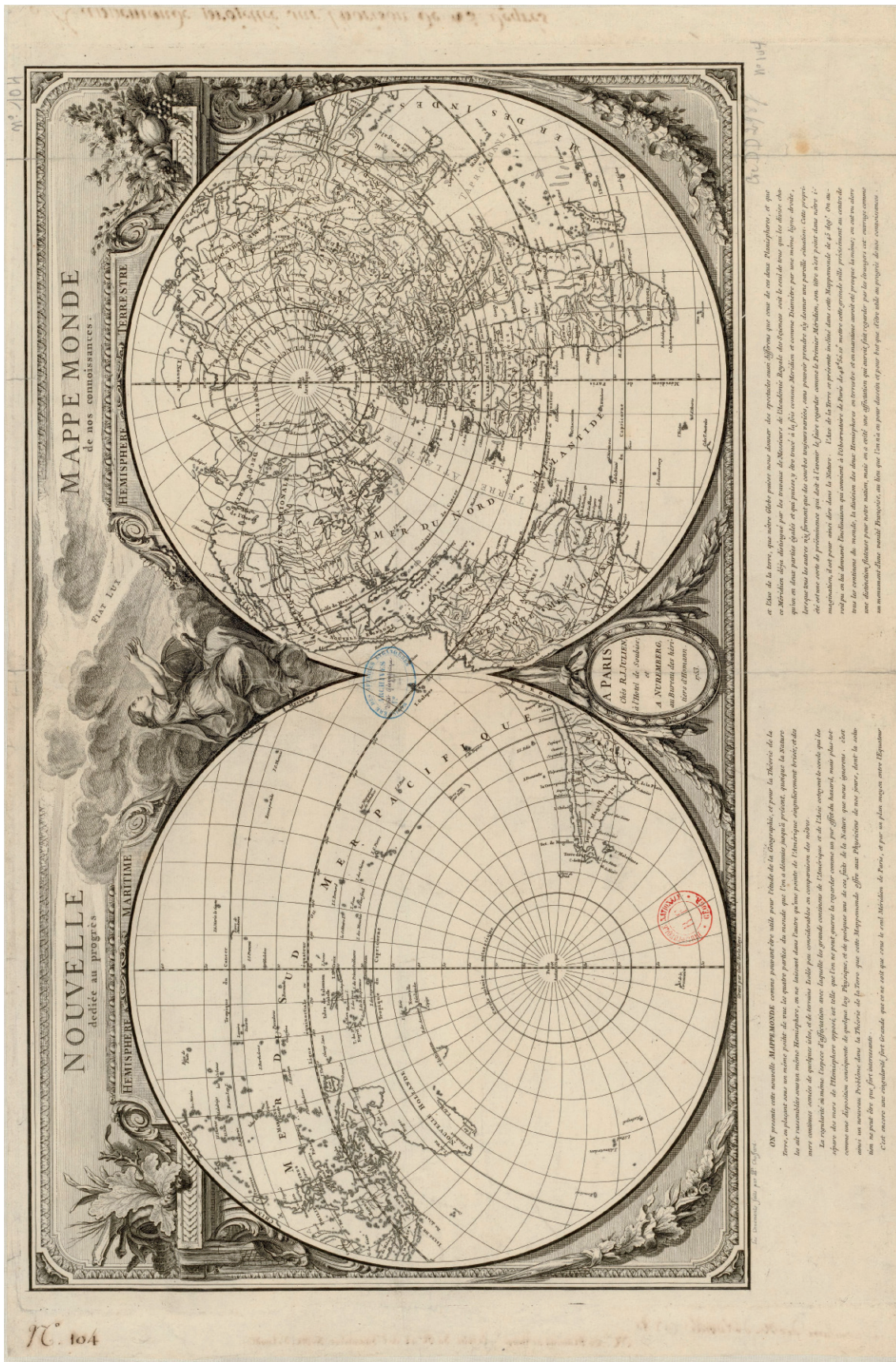


FIG. 1. NICOLAS-ANTOINE BOULLANGER, NOUVELLE MAPPE MONDE DEDIEE AU PROGRES DE NOS CONNOISSANCES (PARIS: R. J. JULIEN, 1753).

Size of the original: 39 × 65 cm. Image courtesy of the Bibliothèque nationale de France, Paris (Cartes et plans, Ge DD 2987 [104 B]).

Yet Boullanger's map modified and changed these standard elements in order to accommodate new ways of thinking about the earth and its properties. In particular, while he used the long-established double-hemisphere format, he employed the oblique stereographic projection, whose construction was understood but unused in the Renaissance (Snyder 1993, 24–27). Boullanger explained this structure's metaphorical function in an accompanying pamphlet, *Mémoire sur une nouvelle mappemonde* (Boullanger 2006, 383–99). For readers without access to the memoir, Boullanger helpfully included an explanatory text at the bottom of his map, which begins: "This new world map is presented as being useful to the study of geography and for the theory of the earth." It was useful because of the way in which Boullanger had adjusted the oblique projection of the two hemispheres so that one contains almost all of the world's ocean (*Hemisphere maritime*) and the other, almost all of the land (*Hemisphere terrestre*). In his memoir, Boullanger postulated that this remarkable pattern in the distribution of land and water across the earth was not accidental but resulted from the earth's elasticity, which responded in an architectural way to the earth's dynamic and fluid core and so was defined by the actions of Nature herself (Boullanger 2006, 383). His map thus demonstrates the power of theoretical science as a driver of geographical research and the map as a tool and recording device for scientific research. Boullanger's *mappemonde* encapsulates the eighteenth-century's turn away from studying the earth as an integral element of the cosmos toward studying it as a self-contained "terraqueous globe" (Boullanger 2006, 392; Broc 1975, 187–229; Porter 1980).

If the Renaissance was the era in which Europeans discovered and mapped both the world and the self (Woodward 2007, 6), the Enlightenment was when they discovered an autonomous earth and understood more fully the power of the state. The latter is evident in the precision with which Boullanger constructed the oblique projection. As he noted in the map's lower register, he achieved the earth's division into land and water hemispheres by centering the former at 45°N on the meridian of Paris, the latter on the antipodes. He wrote that he consciously chose this natural point, halfway between the equator and the north pole, rather than center the hemisphere on Paris itself (at 48°50'10"N) because such blatant flattery of the French state would only discourage foreigners from engaging with his larger argument.

Boullanger's dedication of the map to "the progress of knowledge" and his invocation of *Fiat lux* further places his work between two worlds: that of received wisdom based on biblical tradition and the authority of religion, and that of knowledge based on observational inquiry. He was sensitive to the fact that his memoir and car-

tographic ideas, which tried to synthesize biblical flood myths with his theories about the fluidity of the earth's core, touched "certain theological chords," as he wrote to his immediate supervisor (Boullanger 2006, 373–74). Thus he felt it would be inappropriate and perhaps indelicate to dedicate the map to his ultimate supervisor, the director of Ponts et Chaussées; instead he dedicated it, more safely, to the spirit of inquiry.

Boullanger's *Nouvelle mappemonde* exemplified one category of mapmaking that resulted in smaller-scale representations based on the compilation of a wide variety of sources with the goal of visualizing and comprehending geographical patterns or ideas. He employed an array of representational devices from map projections to iconographical decoration to achieve his goal.

The second image indicative of Enlightenment cartography appeared in the first edition of *De re ichnographica* (1751), Johann Jakob Marinoni's treatise on surveying. The frontispiece summarizes Marinoni's pedagogic approach to observing and measuring landscapes (fig. 2). In it we see a student of geometry at his desk in a study, surrounded by the iconography of book learning and theoretical knowledge: a filled bookcase behind him and two geometrical solids (a cone and a dodecahedron) on the floor below. A textbook lies open in front of him, and he measures its geometrical figures with a pair of dividers. Similar dividers adorn the brow of Geometria, who stands before him, hand outstretched to draw him from the study to the world outside, where a pair of putti are ready to survey the land, one bearing measuring rods, the other the stakes used to align the rods properly. In case the viewer misses the visual point, the Latin epigram below states that once one knows the theory, the work can only be completed by labor in the field. This image replicates and reinforces the structure of Marinoni's text and that of many other contemporary surveying manuals, such as Johann Wilhelm Zollmann's *Vollständige Anleitung zur Geodæsie oder practischen Geometrie* (1744), in which a theoretical treatment of geometry is followed by more practical instruction in surveying techniques. The tools of such geometrical work are displayed in the foreground on a separate pedestal: a terrestrial globe, surveyor's circle, dividers, book, and rolled and unrolled sheets of paper, ready for maps. Marinoni's image thus encapsulates the second category of mapmaking: larger-scale representations of the world based on direct observation and measurement.

The iconography of Marinoni's frontispiece would have been familiar to some educated readers even in the sixteenth century: the allegory of geometry, identified by the key attribute of a pair of dividers and the globe; the angelic putti representing the perfect act of measurement (Heilbron 2000, 5–11); and the geometrical figures that were icons of the perfect solids that could give structure



FIG. 2. FRONTISPIECE TO JOHANN JAKOB MARINONI, *DE RE ICHNOGRAPHICA, CUJUS HODIERNIA PRAXIS EXPONITUR, ET PROPRIIS EXEMPLIS PLURIBUS ILLUSTRATUR* (VIENNA: LEOPOLDUM KALIWODA, 1751). Designed and engraved by Franz Mayr in 1749.

Size of the original: 25.2 × 16.4 cm. Image courtesy of the Department of Special Collections, Memorial Library, University of Wisconsin–Madison.

to the cosmos. The very idea of a treatise explaining the techniques and instruments of surveying had been part of the general attempt by Renaissance mathematical practitioners to apply geometrical principles to all aspects of daily life. The obsession with geometry and its potential for understanding physical nature was established well before 1699, when Bernard Le Bouyer de Fontenelle celebrated what he called the new *esprit géométrique*. The uses of surveying in the Enlightenment were also broadly the same as in the Renaissance—to measure and map properties, cities, fortresses, and even regions—and the surveyor’s circle in the foreground was one of two basic instruments inherited from the Renaissance. The other was the plane table, which Marinoni described in great detail in his treatise, along with the improvements that he had made to it.

What was different about the observation and measurement of the world after 1650 was the pragmatic strides made by European states to implement geometrical principles. Enlightenment practice actively embraced Geometria’s invitation to apply theory to the practice of creating knowledge about the world. While Gemma Frisius had described the surveying process of triangulation in 1533, for example, it was widely adopted—both graphically and trigonometrically—only after 1650. Although Renaissance surveyors had described many complex instruments to execute geometrical principles, it was after 1650 that surveyors and instrumentmakers worked to improve the quality of simple instruments and to systematize their use. This last effort included the progressive application of telescopes, first to the high-quality quadrants used for geodetic surveys and later to the graphomètres and theodolites of common field surveyors.

Trends in surveying were similarly oriented to the Enlightenment consideration of the autonomous globe and the emerging power of the state, best seen in the emergence of geodetic surveys, which employed innovative technologies to answer new questions about the measurement of the terraqueous globe, to determine its size and shape, the heights of its mountains, the depths of its rivers and seas, and the variation across its surface of the compass (magnetism) and the pendulum (gravity). Mathematicians turned their attention to the problems of numerically combining and graphically presenting large numbers of measurements of the physical environment. The geodetic surveys also exemplify the capacity of developing state institutions to employ large numbers of surveyors and the support labor needed to survey and map large areas. They were paralleled by another new mode of cartographic practice, thematic mapping, which sought to depict and comprehend the spatial distributions of both physical and social phenomena.

As engineers, both Boullanger and Marinoni were

members of that class of Renaissance “superior artisans” (Woodward 2007, 22; see Long 2011) that proliferated within the Enlightenment state. They represent a new type of technologically trained and mathematically educated military and civil engineer who, working both in the study and in the field, embraced maps as basic tools and made innovations to their graphic language and mathematical foundations. Marinoni taught the rulers of the Austrian monarchy the benefits of visualizing and quantifying their territories. Boullanger used reason and logic to assess both observed and theoretical information within a framework of meridians and parallels, to replace one set of man-made concepts, such as the distinction between the old and new worlds, with another that illuminates hypothetical natural principles.

It was precisely this novel spirit of inquiry that informed much Enlightenment thought. The elevation of Reason to a status alongside, if not superior to, the Deity, provoked the most profound debates of the period. In its own way, cartography reflected and responded to the shifting intellectual ground by inventing new methods to answer new questions and, by retaining older systems of measurement and representation, to provide a framework of comparison and utility. As in Boullanger’s hypothetical world, where some lands rose up as others fell to be submerged by the sea, all in reaction to forces at the earth’s core, so cartography preserved older methods and forms and developed new ones to accommodate new conditions. Continuity and change are the hallmarks of any periodization of the mapmaking process and therefore become key rubrics for understanding cartography in the period of the long eighteenth century.

THE EUROPEAN ENLIGHTENMENT AS A DISTINCTIVE PERIOD IN THE HISTORY OF CARTOGRAPHY

We have chosen to call this period the “European Enlightenment” for reasons similar to those that persuaded David Woodward (2007, 5–6) to retain “European Renaissance” for volume 3 in this series, even though the Renaissance has similarly been discredited as a coherent phenomenon. The term “Enlightenment” is understood by many to refer to both a general chronological period and an intellectual process informed by a frame of mind or way of thinking (Withers 2007, 2). In its various forms (*Aufklärung*, *Illuminismo*, *Lumières*, Enlightenment) the term was used by scholars and commentators in the eighteenth century to describe the intellectual and philosophical framework of the moment they lived in (Stewart 2001, xi–xii). Enlightenment thinking focused on sources of knowledge and on ways of understanding and using knowledge. Concerns about the authority of sources and the processes of gathering information

joined considerations of how to use knowledge once acquired and how to accommodate conflicting information. In addition, Enlightenment thinkers faced the conundrum of how natural philosophy's propensity toward the creation of general rules could accommodate the seemingly infinite variety of data being gathered about the natural world. Cartography, encompassing a wide variety of processes for making and using maps of different sorts, was deeply implicated in questions of how to acquire, display, and disseminate knowledge and the more intractable problem of choosing which knowledge (see the entry "Enlightenment, Cartography and the"). How maps and mapmaking reflected and affected Enlightenment thinking and action is a core focus of this volume. Just as the roots of the Enlightenment extend deeply into the Renaissance and thereby necessarily reach ancient writers, so this volume has its roots in volume 3 of this series: *Cartography in the European Renaissance*.

The chronological range of volume 3 extended from ca. 1480 to ca. 1640. The contents of volume 4 continue from the middle of the seventeenth century (ca. 1650) to the end of the eighteenth (ca. 1800); the two volumes thus incorporate a period of transition in intellectual history emerging from the "Scientific Revolution" of the early seventeenth century and extending to the liberation philosophies of the end of the eighteenth century. However, the chronological limits are highly variable according to political, economic, and social differences between regions and the intellectual developments occurring during the entire period.

The starting date of this volume is well defined by the Peace of Westphalia (1648), which ended the Thirty Years' War and inaugurated a new era of comparative economic and political stability, especially in the German states but also in the Netherlands, France, Scandinavia, and the Austrian monarchy. The cartographic effects of this stability are clearly indicated throughout this volume, for example in the steady growth of Europe's commercial markets for maps and property. For some parts of Europe, this volume tends to start coverage somewhat later, notably after 1660 in Great Britain, with the Restoration of Charles II, and in Russia with the reforms of Peter I in about 1700. Intellectually, the midcentury moment of ca. 1650 marks the publication of significant geographical works with applications to mapmaking, such as the *Geographia generalis* (1650) of German geographer Bernhardus Varenius, which set out principles of small-scale geographical mapmaking, and the work of Italian Jesuit father Giovanni Battista Riccioli, whose *Geographiae et hydrographiae reformatæ* (1661) and *Astronomiae reformatæ tomus duo* (1665) reassessed the state of understanding of the measurement of longitude and latitude and of the resultant co-

ordinates. As these works were translated from Latin into the vernacular at different times and in different places, their impact on literate elites was considerable. Even with these varied starting points, many entries in this volume necessarily root their narratives firmly in the Renaissance.

In retrospect, 1750 marks something of a cartographic watershed within the Enlightenment. Entries throughout this volume suggest that the cumulative effects of economic growth, state centralization, and shifting military strategy began to make themselves felt by midcentury, producing an appreciable increase in the commercial publication of maps and atlases and in the official undertaking of regional surveys. What we think of as the intellectual ideology of Enlightenment might have had its origins in the later seventeenth century but that "quantifying spirit"—Fontenelle's *esprit géométrique*—was not widely accepted beyond natural philosophical circles until after 1750 (Heilbron 1990; see Edney 1999, 166). By midcentury, emergent publics were asserting their interest in the constitution and affairs of their respective states, an interest that extended not only to general knowledge of the world but to specific and detailed knowledge of their own countries. The Seven Years' War (1756–63) seems to have been particularly significant in promoting new initiatives, standards, and renewed efforts on all fronts: military, administrative, and commercial. Among geographic writers, the midcentury marks a shift in their focus away from cosmology, the earth's place in the universe, and toward consideration of the physical nature of the planet and its parts, as intimated above with respect to Boullanger's *Nouvelle mappemonde* of 1753. As these new interests were reflected in maps and mapping projects, it has therefore appeared to many commentators that geography and cartography entered a new era in 1750, that of transition to a demonstrably post-Enlightenment cartography with nationalized projects, standardized methods, state agencies, increasing professionalization, academic geography, and commercial consolidation (e.g., Godlewska 1999; Besse, Blais, and Surun 2010).

Yet in terms of the various processes whereby maps were produced, circulated, and consumed, there remain substantial similarities between the early and late eighteenth century in the nature of the public discourse fed by maps, the organization of the map trade and institutionalized surveys, and the technologies of mapping. If there was a period of transition then it was the era of the French Revolution and the convulsions of the Napoleonic Wars (i.e., from 1789 through 1815). Significant historical, technological, and spatial changes throughout Europe after 1789 mark a turning point for cartography as it entered the nineteenth century. Revolutionaries set out to reconfigure territory as well as society,

as seen in France and the newly independent United States of America, as well as emerging Caribbean and South American countries; the postwar realignment of Europe's states engendered the modern, territorially obsessed national state. Military and governmental needs prompted the widespread undertaking of new, extensive, and systematic surveys, whether topographical, cadastral, or hydrographic. The work of the Commission topographique in 1802 standardized official mapping practices in France before they spread to the rest of Europe. The mathematical technique of least squares analysis was first applied to a survey in 1815, inaugurating ever more accurate geodetic surveys. The invention of lithography by Alois Senefelder in the 1790s altered the technology of map production, allowing the common use of printed color and increased printing runs. The results of Alexander von Humboldt and Aimé Bonpland's expedition to the Americas in 1799–1804 prompted profound changes in the nature of the field sciences and in the rapid development of thematic mapping. These features of nineteenth-century cartography allow the entries in this volume to close their discussion as appropriate around 1800 or in the decades just before or after.

ENLIGHTENMENT CARTOGRAPHY AND THE DANGERS OF OVERSIMPLIFICATION

With its equal concern for continuity as well as for change, this volume seeks to prevent a misplaced emphasis on change from promoting a distorted view of Enlightenment cartography. Such distortion would situate Boullanger's and Marinoni's images within a progressive narrative of continuous "improvement" and an ongoing quest for "factuality" and an elusive "accuracy." Since the end of the nineteenth century (e.g., Mackinder 1895, 368–70; Sandler 1905), map historians have given the European Enlightenment special significance as the period when the Enlightenment's rationality and "quantifying spirit" thoroughly imbued European cartography with a scientific ethos. As the essential locus of cartographic practice seemed to move from mapmakers in the studio to military engineers in the field (Valerio 2007), so the Enlightenment appears to have been when "science claimed cartography" and extirpated older elements of art, craft, myth, and religion (Rees 1980, 60).

To support this progressivist argument, map historians have provided a checklist of technical accomplishments and so-called firsts: the problem of determining longitude solved, both on land and at sea; multiyear geodetic surveys at home and abroad, measuring the size and shape of the earth itself; the first national survey accomplished; the first thematic mapping of physical features; the dramatic improvement in the precision of surveying instruments, even those of the meanest surveyors.

Changes in the graphics of maps add to the rhetoric of progress as impressionistic sketches of hills and mountains seem to give way to measured hachures and contours. The tenuous conclusion is that mapmakers eliminated imagination, belief, and artistry from their maps, leaving them austere, unadorned, and "factual." This triumphal but erroneous story projects an intellectual and technological transformation, claiming it to be integral not only to the "Enlightenment Project's" progressive disenchantment of nature but more fundamentally to its disenchantment of the mechanisms of knowledge acquisition and representation (Edney 1999, 167; 2015, 609–10).

There are two major problems with this argument. First, as many scholars have demonstrated at length, the Enlightenment was never a unified intellectual movement (Hunt and Jacob 2003). Broadly speaking, it comprised several cultural and intellectual developments, expressed through burgeoning networks of print and material exchange that sought to shift the sources of knowledge-making from the theological and authoritarian to the rational and experiential. These movements thus articulated some radical conceptions that prefigure modern liberal democracy. However, the geography and chronology of these intellectual movements were complex, as they must account for developments in different continents and countries, in different places within those countries, at different times and in different ways, all to different ends (Withers 2007). Second, the narrative of progress and of the rise of cartographic science requires historians to emphasize the new and to overlook the persistence of the old; it distorts precursors, it sees crises where none exists (e.g., Shirley 2010), and it forces what should be careful analyses of complex cultural, social, and technological changes to fit a predefined teleology.

Our response, which we have sought to implement in this volume, is to understand cartography as comprising a series of discrete sets—or modes—of mapping practices (see entry "Modes of Cartographic Practice"). Each mode featured specific processes for producing, circulating, and consuming maps that developed over the course of the Enlightenment in sometimes similar, sometimes different ways as established practices variously resisted and embraced innovations. Having a wide diversity of goals and interests, the multiple modes deny teleological interpretations: there was no single endeavor that could be transformed and no single Enlightenment Project to accomplish such a transformation.

Some generalities are nonetheless possible. Boullanger's world map (fig. 1) is representative of the several modes concerned with the "top-down" organization of knowledge about extensive regions that are beyond the capability of a single individual to know directly. In particular, world maps such as Boullanger's were typical

of the mode of geographical mapping, which compiled information about the world and its regions within a framework of meridians and parallels. The same practice of compilation of multiple sources was also characteristic of the modes of marine charting, celestial mapping, and thematic mapping. By contrast, Marinoni's frontispiece (fig. 2) exemplified the "bottom-up" observation and measurement, enhanced by instruments wielded by individuals, of the world at a more human scale. This second category encompassed the cartographic modes of property mapping, topographical surveying, urban mapping, and boundary surveying. One mode of mapping—geodetic surveying—straddled the two categories.

The oversimplification of the history of Enlightenment cartography lies in the common conflation of these two primary sets of mapping practices. Erwin Raisz (1938, 40–41, 45–54) unified these otherwise distinct practices into a wholesale "reformation" of all cartography driven, he argued, by the Enlightenment's scientific ethos. In this context, Raisz reinterpreted the now-famous quatrain by Jonathan Swift (1733, 12):

So Geographers in *Afric*-Maps
With Savage-Pictures fill their Gaps;
And o'er unhabitable Downs
Place Elephants for want of Towns.

Raisz turned what Swift had originally written as a metaphorical diatribe against poets who stuffed too much extraneous matter into their work into an equally derisive comment about the practices of geographers. Raisz's literal reading of Swift seems to praise the new Enlightenment concern for cartographic science and empirical rectitude and the rejection of what might seem to be the overly decorative character of Renaissance mapping. Overall, Raisz depicted the Enlightenment as the period when the Age of Reason extirpated Renaissance cartography's overtly artistic and "unscientific" elements. Post-war authors, notably Lloyd Brown in his *The Story of Maps* (1949), G. R. Crone in his *Maps and Their Makers* (1953), and R. A. Skelton in his edition of Leo Bagrow's *The History of Cartography* (1964), further developed and popularized the sentiment that the traditional art and craft of cartography was transformed into a rigorous science through the 1700s (Edney 2015, 609–10).

However, the common omission of cartography as a unified subject from general histories of science in the era (e.g., Clark, Golinski, and Schaffer 1999; Porter 2003) makes it clear that this argument by map historians constituted an ideological privileging of cartography rather than a historically valid description of Enlightenment mapping. In fact, the one sustained account of eighteenth-century cartography by a historian of science did argue for the unity of the era's mapping practices,

but it has proven to be inadequate. Eric Forbes (1980) coined the term "mathematical cosmography" for the intertwining of geographical and astronomical practices, including geodetic and territorial surveys (Edney 1994 followed suit). Forbes had realized that the activities described in 1752 by Philippe Buache under the heading of "*géographie mathématique ou astronomique*" (Buache 1761, pl. 5) were precisely the same as those listed under "*mathematische Astronomie*" by Johann Gabriel Doppelmayr in the same year (posthumously), and that both were closely akin to the range of activities pursued by the *Societas cosmographia* in Nuremberg (1746–54) in association with the publishing firm of Homann Heirs. However, Forbes's realization has proven difficult to recreate. Not only were his citations incomplete, so that Doppelmayr's account remains unidentifiable, but the concept of mathematical cosmography refers less to a unified practice of Enlightenment cartography than to the idealization of geographical mapping and its cosmographical foundations (see entry "Geographical Mapping in the Enlightenment"). That is, Forbes's work addressed only one half of Enlightenment mapping practices. A full accounting of Enlightenment mapping practices must consider both halves.

CHARACTERISTICS OF CARTOGRAPHY IN THE ENLIGHTENMENT

The two major categories of mapping modes identified above reveal the shared characteristics of European cartography in the Enlightenment. The differences between them were not hard and fast, but represent strong tendencies one way or another with a great deal of overlap in between (table 1). The more conceptual modes (as fig. 1) were generally the preserve of the educated and more literate members of society, mostly men and mostly from the aristocracy, the gentry, and the wide compass of the middling sort; they were generally integrated into the commercial marketplace for printed goods, and their maps could circulate widely. The more observational modes (as fig. 2) were generally pursued on behalf of landowners, bureaucrats, and royalty by the middling sort of surveyors and engineers, and even laborers trained in basic surveying skills; they were less integrated into the marketplace and the maps tended to circulate in small numbers in manuscript.

These patterns of circulation and consumption are broadly descriptive. To understand how and why they changed and the degree to which they changed, we must study each mode separately. And when we do, we realize that some modes barely changed at all over the course of the Enlightenment. The techniques and instruments used in property mapping, celestial mapping, and urban mapping did become more refined, but their respective

TABLE 1. Summary of major differences between the two main categories of mapping undertaken in the European Enlightenment. SMALL CAPITALS indicate significant changes.

	Boullanger, <i>Nouvelle mappemonde</i> (fig. 1)	Marinoni, frontispiece, <i>De re ichnographica</i> (fig. 2)
representational context	smaller-scale representations based on “top-down” compilation to visualize broad geographical patterns and situations	larger-scale representations based on direct, “bottom-up” observation and measurement
resolution	gross, coarse resolution mapping of extensive areas	detailed, fine resolution mapping of precise areas
modes	celestial mapping; geographical mapping; marine mapping; THEMATIC MAPPING	boundary surveying; coastal charting; GEODETIC SURVEYING; property mapping; topographical surveying; urban mapping
actors	produced by a wide range of educated individuals, from specialized scientists to the general public interested in the nature of the world; their numbers INCREASED THROUGH EDUCATION AND LITERACY and expansion of published texts	produced by expanding number of surveyors and civil and military engineers; INCREASED ACCESS TO TRAINING AND EDUCATION through academies, military institutions, and textbooks
purposes and users	produced for wide array of interests, from the dedicated student to the general public; INCREASED APPEARANCE OF MAPS IN PUBLIC DISPLAY, in literature, and periodicals	produced for a wide range of land owners, civil and military officials, politicians, and royalty with dedicated interests; INCREASED ADMINISTRATIVE DEMAND for information most efficiently presented by maps
distribution	BROADER AND MORE WIDELY DISTRIBUTED CIRCULATION, therefore most maps reproduced in print and many reproduced further	largely limited and directed circulation, therefore most maps produced in manuscript, with the major exception of maps of places of interest to the public
observational technique	observations of latitude and LONGITUDE (more convincingly established) to control the compilation of texts, maps, and theoretical structures; the process explained by accompanying texts	direct observation and measurement of physical and cultural landscapes using distance-, angle-, and height-measuring INSTRUMENTS
geometric technique	used spherical geometry of meridians and parallels (projections) graphically and intellectually structured by cosmography	used plane geometry, treating earth as flat space
map concept	metaphorical use of “map,” as when trees of knowledge were called “maps of knowledge”	metonymic use of “plan” as strategy

flavors altered little. It was as common in 1800 as it had been in 1650 to display cities in view as opposed to orthogonal plan, the choice between the two representational strategies being a question of particular function and consumer taste. The manner and style of property mapping simply became more precise in many parts of Europe in response to increasing property values. Astronomers in 1800 knew many more stars with greater exactitude than did their predecessors, but this had little effect on the function and form of star charts. It could also be argued that the practicalities of marine navigation did not change until about 1800, so that marine charting changed little in form, though much more in content. What led to substantial changes in the functions and type of activities within each mode and to the creation of new modes of mapping was the increasing centralization of European states and the growth of the public sphere.

Profound changes in the art of war, the growth of armies and navies, and the associated growth of centralized bureaucracies to manage and pay for the enlarged military increasingly turned civil and military authorities toward mapping as an administrative tool. Large areas of European territory were mapped in detail, a process extending even to some of the colonial territories, in particular the great Josephinische Landesaufnahme covering some 570,000 square kilometers of Austrian Habsburg territory. Europe’s states established new institutions and promoted new techniques in support of their mapping endeavors. The Académie des sciences and the royal observatories in Paris and Greenwich were all founded at the start of our period in large part to solve fundamental mapping problems: the size (and later shape) of the earth, the determination of terrestrial longitude by observations of Jupiter’s satellites, and the

determination of maritime longitude by observations of lunar distances.

Military and civil engineering corps were steadily established to meet the demand for skilled surveyors and mappers, as were military academies, civil academies (notably the *École des Ponts et Chaussées*), and private schools specializing in “mathematical practice.” As the Renaissance had witnessed the development of “superior artisans,” so the Enlightenment saw this group expand in almost every region of Europe. Their work, so often encouraged and promoted by state or provincial interests, ensured that maps assumed a role in administrations as tools for decision making, political dialogue and dispute, and diplomatic purposes in treaty and boundary negotiations. Conversely, the pursuit of mapping activities became a means of professional and social advancement for lowborn men.

We can see how several further cartographic innovations during the Enlightenment stemmed from this expansion of state sponsorship of mapping. Some of these innovations have long been celebrated by historians of cartography. The cartographic work of the *Académie des sciences* led both to the initiation of an entirely new mode of geodetic surveying and to the pioneering of triangulation-based topographical surveys in the form of the post-1750 Cassini surveys. At the same time, the *géographes de cabinet* supported by the French state actively fostered a conception of small-scale mapping as an innately progressive, critical, and rational process. This “reform” originated in Riccioli’s work (Dainville 1940, 447), but would be celebrated by contemporaries (e.g., Robert de Vaugondy 1755, viii) as the product of Jean-Dominique Cassini (I)’s successful implementation of the method of determining longitude by observing Jupiter’s satellites, as often symbolized by Jean Picard and Philippe de La Hire’s 1693 map of the “corrected” French coastline (see fig. 625); but even before this new technique could be widely deployed beyond France, French geographers also developed new methods of critical map compilation, inaugurated by Guillaume Delisle’s recalculation of longitudes from mariners’ logs.

Moreover, state mapping activities produced an international community of peripatetic engineers and other mapmakers who sold their services to whichever state could afford them; these men produced an international style of military mapmaking. Several new or refined technological innovations were introduced, initially at state cost before being more widely adopted, notably the telescope and angle-measuring instruments, all to make the necessary surveys both better and easier to complete. Finally, in this respect, the application of cartographic methods to display the results of inquiries into the nature of populations and natural resources, whether by state agents directly or by their proxies, led to the for-

mation of another entirely new mode, that of thematic mapping.

The diffusion of authority and fragmented responsibility endemic to early modern governments meant that there could in fact be no coherent attempt to unify mapping activities within governments. The weight of official mapping activities lay with the larger-scale cadastral surveys for taxation and military topographical surveys, although plenty of civil and military officials undertook smaller-scale regional mapping for planning and logistical purposes, as did naval officials in their efforts at marine mapping. Moreover, mapping projects directed by central government officials were augmented by those undertaken by provincial authorities and urban corporations. The success and particular character of these efforts depended on each state’s financial and institutional capacities. Thus, while the European Enlightenment witnessed a significant upsurge in official mapping activities, we cannot say that these activities entailed an attempt at the kinds of coherent systems that would characterize the nineteenth century.

The growth of European states was paralleled by the formation of the European public, the increasingly literate middling sort who claimed what had been the strictly royal privilege of setting cultural and social (military, religious, economic) policy. Europe’s burgeoning public provided a hungry market for printed materials, the cost of which nonetheless remained sufficiently high to exclude most of the laboring classes from acquiring and consuming them. Within the genteel circumstances of salons, coffee houses, masonic lodges, and most especially the printed page, men and some women of means could come together and debate the events and issues of the day. To this end, their appetite for information was vast, and they consumed a wide array of material that emphasized the kinds of small-scale mapping with which people organized and structured the world and its regions. In their consumption of geographical maps within political debates, the new publics evinced a protonationalism that in turn shaped the production of new maps. The result was the steady expansion of the map trade in much of Europe, whose participants reflected the innovations in mapping technologies and practices in claims that their work was indeed (if, however, rarely) based on “science” and the “latest surveys” to distinguish and sell their stock.

Such intellectually minded work underpinned the widespread metaphorical use of “map” as a hierarchical structure of knowledge, most famously in the preface to the influential *Encyclopédie* (see the entry “Metaphor, Map as”). Smaller-scale maps based on compilation were produced and consumed within multiple communities, whether scholarly or public or governmental. Yet the public continued to be interested in larger-scale im-

ages, for example, urban maps, news maps, and maps of warfare and military campaigns. Public interest in how maps were made spurred a strong market for printed textbooks about surveying practices of property and place mapping. Geographical texts and atlases included instructions in how to read maps, opening up the code of graphic symbols to a wider public and encouraging the standardization of a map's system of signs.

VOLUME DESIGN AND STRUCTURE

Faced with a rapidly expanding amount of information about the world, its inhabitants, and their habits and activities, eighteenth-century scholars focused on ways to clarify and evaluate sources of knowledge and on different methods to organize knowledge in a way that showed hierarchies, relationships, and dependencies (Siskin 2016). To present knowledge in book form in a way that conserved these relationships, they turned to the encyclopedic format, beginning with Ephraim Chambers's *Cyclopædia* (1728) and Denis Diderot and Jean Le Rond d'Alembert's grand *Encyclopédie* (1751–72). Similar reasons led Woodward in 2001 to adopt, appropriately enough, an encyclopedic format for *Cartography in the European Enlightenment*. In short, its goal, as with the *Encyclopédie*, is “to change the common mode of thinking” (Diderot 1755, 635). Two particular factors led to the structural change.

First, given our desire to create an intellectual guide to the cartographic practices of the period, we found the secondary research literature to be of only limited use. Studying the eighteenth century, map historians have tended to emphasize certain modes of mapping (notably geographical, marine, urban, geodetic, and topographical) and downplay others (especially boundary, thematic, and celestial); they have tended to privilege the printed map; and their interpretations have been strongly shaped by a triumphal, progressive, and teleological narrative. In addition, many treatments focused on the mapping of particular areas or regions rather than on the practices of mapping pursued *in* those areas or regions. Lacking consistent and comprehensive road signs to a burgeoning subject matter, we set out to create them by defining conceptual principles built around mapping practices rather than around regional histories. This design, which undergirds the encyclopedia format, permits the reader to discern trends and to compare and contrast similar activities in a diachronic way, observations that would be more difficult in a volume of regional essays. Because encyclopedias possess multiple entry points (explained below), the reader enjoys a wider range of efficient starting points that help create a more nuanced and subtle tale of “cartography in the European Enlightenment,” one that resists over-

simplification and progressivist history. In this respect, *Cartography in the European Enlightenment* embodies another stage in *The History of Cartography* as it seeks to build a strong foundation for the development of new historiographical interpretations without advocating for any particular theoretical or conceptual approach.

Second, mapping practices in the long eighteenth century became more international in scope and achievement and began to lose the regional and cultural distinctions that had permitted previous volumes of *The History of Cartography* to be organized primarily by cultural and state contexts. The last three volumes of the series accommodate this increasing internationalization of mapping practices by turning the established, regionally focused historiography on its head: the primary organization of volumes 4 through 6 is by mapping practices, whether of particular modes or institutional endeavors, and only secondarily by regional context. Thus, treatment of each mode and endeavor is introduced by a broad, interpretive entry (e.g., “Property Mapping in the Enlightenment”) followed by more detailed accounts of how the mode was expressed in particular spatial contexts (e.g., “Property Mapping in France,” “Property Mapping in New France and the French West Indies”).

In designing the volume, we sought to treat all types of mapping equally, ensuring that the diverse systems of map production and consumption receive equal attention, without unduly privileging any one cartographic mode or endeavor, and also giving due weight to each of the national traditions. This required us to be disciplined in our selection and framing of entries. A particular example of such discipline that needs to be explained is how we determined whether people and institutions deserved their own entries. We established specific criteria: did they contribute prominently in more than one mode or endeavor; did they possess special significance for a single mode or endeavor; or did they exemplify aspects of Enlightenment cartography in a particularly revealing manner? If a mapmaker was associated with only one main work, then we let the entry on the work include the relevant biographical information; thus, the entry “*Neptune oriental*” also discusses the life of Jean-Baptiste-Nicolas-Denis d'Après de Manneville.

At the same time, we wanted to structure the volume so that its connective tissue would permit readers to make new connections. To achieve this, we followed a procedure long used for designing encyclopedias. We first identified major conceptual groupings or clusters, which allowed us to identify topics for individual entries ranging from the general and interpretive to the specific and focused. The primary groupings are the representational contexts of the modes of cartographic practice and the political contexts of the institutional endeavors, as indicated by the general characteristics of cartogra-

phy in the Enlightenment. Secondary groupings cover topics that run across the modes: methodologies, people and institutions, the regions within which cartographic activities took place, and finally how historians have studied the era's cartography. The resulting hierarchy of conceptual clusters is as follows:

Historiographic Context (*how eighteenth-century cartography has been studied*)

Representational Contexts

Larger-scale representations based on direct observation and measurement, including modes

- Property Mapping
- Boundary Surveying
- Topographical Surveying
- Urban Mapping

Smaller-scale representations based on compilation to show broad geographical patterns and situations, including modes

- Geographical Mapping
- Celestial Mapping
- Thematic Mapping
- Marine Charting

Methodological Contexts (*production of maps*)

Art, Craft, and Cartography
Science and Cartography, including the mode
 Geodetic Surveying

Political Contexts

Public Sphere and Cartography, including endeavors

- Map Trade
- Map Collecting

State Formation and Cartography, including endeavors

- Administrative Cartography
- Military Cartography

Individuals, Institutions, Artifacts (*requiring special treatment as exemplary of particular modes or endeavors, or embracing multiple modes or endeavors*)

Spatial Contexts (*accounts of regions in Europe and its colonial possessions within which cartography of all sorts was practiced*)

The expanded conceptual groupings are found in the back matter and endpapers of the volume, which the editors intend as a road map to guide the reader, who may locate the particular entries within each grouping.

This design has informed many of the volume's composite entries, in which each cartographic mode or endeavor can be compared region by region. Whereas in volume 3, for example, readers read about marine charting by the French in conjunction with other essays on French cartography, in volume 4 readers find informa-

tion about marine charting by the French in the midst of a series of entries on the same mode, permitting readers to directly make their own connections and to draw contrasts between national schools within the context of similar and related practices. This innovative approach is, we feel, a major strength of the volume.

Our definition for most of the regions into which we have divided the world, and by which modes and endeavors are studied, is explained in the respective entries. But some regions do require special explanation here. We have included Russia in our European embrace: the westward turn of Peter I led to significant changes in the nature of cartography in that empire; our Russian entries outline the rapid adoption of European processes of mapmaking in almost every mode of cartography. Coverage of Ottoman mapping in volume 2.1, *Cartography in the Traditional Islamic and South Asian Societies*, ended at about 1650, so we have included mapping within the Ottoman Empire in the present volume, even though a narrative of adoption of European methods was much slower than in the Russian case and occurred largely in a military capacity. A pragmatic distinction is drawn between areas of extensive European territorial control in and around the Atlantic Basin, which are treated as extensions to European states (e.g., New France, Portuguese America), and the work of commercial companies, especially those in the Indian Ocean and China Sea (e.g., East India Company). Because indigenous mapping practices were addressed in volume 2.3 of this series, *Cartography in the Traditional African, American, Arctic, Australian, and Pacific Societies*, volume 4 considers them only in the context of European cartographic practices.

The encyclopedic format, and especially the structure of discussing different mapping modes within specific spatial contexts, has made it impracticable to continue with the practice followed in volumes 1 through 3 of providing detailed maps showing the locations of places mentioned in the text. Eighteenth-century territorial boundaries were, however, fluid and often quite different from the present; we therefore refer readers to standard historical atlases to identify the period's territorial arrangements. We especially recommend works such as the *Times Atlas of World History* (several editions, 1978–98) and the many editions of Friedrich Wilhelm Putzger's *Historischer Schul-Atlas* (1887–1960), which are especially useful for the territorial complexities of central, eastern, and southern Europe in the early modern era.

THIS IS JUST THE BEGINNING

Our work in implementing this large reassessment of Enlightenment cartography has echoed the experience of the editors of the great *Encyclopédie*:

As we worked, we watched as the subject matter expanded before our eyes; the nomenclature became obfuscated; objects were brought in with a multitude of different names; instruments, machines, and processes multiplied beyond measure; and innumerable detours of an inextricable labyrinth became increasingly complex. We saw how difficult it was to be certain that the same objects were in fact the same, and, likewise, how hard it was to be sure that things that appeared very different were not actually different. We saw that the alphabetical format not only brought us peace of mind, variety, and fundamental advantages but it also brought certain hurdles that had to be constantly overcome. (Diderot 1755, 644)

Similarly, we found that our nomenclature was indeed obfuscated by the manner in which the literature has long used words such as “accurate,” “modern,” and “scientific” as terms of approbation rather than of explanation. We accordingly encouraged our contributors to be more careful and analytical when using such terms so as to reveal the nature of eighteenth-century practices rather than impose twentieth-century preconceptions. The same concern applied to the application of terms such as “good,” “better,” “best,” or “first” because of their evaluative and teleological ramifications.

We too were drawn by the “innumerable detours of an inextricable labyrinth” and were tempted to tell the inexhaustible backstories of every map and to develop a complete *dramatis personae*. We therefore encouraged the contributors to summarize and explain, clearly and cogently, their complex stories. In doing so, we have allowed the bibliography of some 2,700 works to bear the weight of the volume, each cited work offering further access to the substantial scholarly literature. Every cited work has been carefully vetted by the authors and the editors; moreover, authors have been asked to update the bibliography for each entry, as best they could, in the final round of editing.

Discerning similarities and differences was equally elusive. In the first place, discrepancies in the bibliographical description of certain maps and atlases, both in the history of cartography literature and in library catalogs, led to uncertainty and confusion, often solved only after careful analysis. Furthermore, there has been ambiguity in the terms applied to some mapping practices. In resolving these problems, we have tried to refine our vocabulary to be specific and in line with contemporary practice, as for example in distinguishing between triangulation *per se* and trigonometrical surveying. It was not always possible to draw such neat distinctions because contemporary usage was itself not always clear. For example, German usage used *Geodäsie* (geodesy) to refer to land surveying in general; by contrast, French

usage accepted this general meaning yet emphasized *géodésie* as the practice of measuring and defining the size and shape of the earth, the precise definition that we have adopted for this volume.

And like Diderot, we also found peace of mind in the alphabetical format, which for all its difficulties has indeed been advantageous for this long work. Nonetheless, an alphabetical format does not preclude clear demarcations between topics and so has required the editors to eliminate overlapping material and to fill unintended lacunae.

Our goal of promoting a new way of thinking about eighteenth-century cartography was in some respects impeded by the current state of the literature and critical apparatus in the field. Inevitably this volume has not been able to include every topic encompassed by its conceptual structure and design. In particular, some larger interpretive entries have been unattainable for several reasons: a lack of conceptual framework hindered the desired entry on “Law and Cartography”; unclear definition of concepts prevented an entry on “Mathematics and Cartography”; and the frustrating lack of existing scholarship, especially in comparison with the Renaissance and nineteenth century, doomed the entry on “Literature and Cartography.” When our contributors identified gaps and silences in the literature, we encouraged them to suggest avenues for new research, and as a result many of our entries outline outstanding historiographical needs. At the same time, the last decade has seen a great increase in the kinds of scholarship this volume has sought to promote, and keeping up with the bibliography has been an exciting and gratifying editorial challenge. This volume should at least provide a foundation from which to initiate new scholarly trends.

USING THIS VOLUME

How might readers approach and use this dauntingly large volume? After all, we have emulated the challenge posed by the *philosophes* to received authority by consciously breaking with traditional historiographic practices in order to make new connections and to promote new interpretations. In other words, this is a book designed not to be read from beginning to end but to be explored. For readers who are entirely new to the field, or who come to the volume without a specific theme or question in mind, we recommend browsing through the books until a particular image grabs one’s attention! Dipping into the book in this manner is highly rewarding, as reading the associated text will reveal terms and concepts that demand further investigation and exploration.

Several sets of signposts guide readers in exploring the volume:

- **Entries in alphabetical order:** Each entry has a title that reflects its primary subject matter, and entries are arranged throughout the volume in alphabetical order by these titles. Some titles have been inverted; for example, entries on map projections are titled “Projections. . . .” The titles are listed, in order, in the table of contents at the front of each of the volume’s two parts.
- **Entries in conceptual groups:** The endpapers in each part also list the entries according to the conceptual groupings by which the volume was designed (as explained above); a reader interested, for example, in celestial mapping will find that this concept is treated across a variety of dedicated entries under a range of titles.
- **See also lists:** At the end of every entry, a *See also* list points to one or more entries that are substantially and generally concerned with related matters, without seeking to duplicate the specificity of the index; *See also* references are not provided to other entries within the same composite.
- **Illustration cross-references:** When appropriate, cross-references are provided that direct the reader to specific maps that are reproduced and discussed elsewhere in the volume.
- **Index:** The index, at the end of Part 2, is comprehensive and covers all elements of the volume—from concepts to people to artifacts—and provides the best way to access specific topics as well as topics that might be covered in multiple entries; individuals are listed in the index with the year of their birth and death, if known, rather than repeating this information throughout the volume.
- **Keywords:** Readers of the e-book of the volume can also search the full text by keyword.
- **Editors and contributors:** The list of contributors, preceding the index, also indicates the entries each authored and can be used to identify related entries.

The alphabetical ordering of entries by title is modified slightly for entries within each of thirty “composite entries.” Composite entries are internally arranged in a logical but not necessarily alphabetical sequence; each composite entry therefore begins with a list of the constituent entries in sequence. The regional entries within each composite entry for a mode or endeavor are arranged consistently: the general entry (e.g., “Urban Mapping in the Enlightenment”) is followed by each region in alphabetical order (ignoring “the”), but with colonial regions following immediately after the parent country (so that “Urban Mapping in British America” follows “. . . in Great Britain” and comes before “. . . in the Italian States”).

With these signposts and guiding principles in place,

we wish the reader an enjoyable and intellectually productive journey through the remarkable history of mapping in the European Enlightenment.

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