SETTING THE STAGE

1 · Cartography and the Renaissance: Continuity and Change

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Around 1610, Giuseppe Rosaccio—a Florentine physician and scholar known for his popular cosmographies, two editions of Ptolemy's *Geography,* a ten-sheet world map, geographical textbooks, and a description of a voyage to the Holy Land from Venice—published an image that, in its counterpoint of ideas if not in geographical sophistication, represents a cartographic *summa* of the Renaissance (fig. 1.1).[1] Rosaccio's maps have not been lauded in the canon as have those of Gerardus Mercator or Abraham Ortelius, but he is of interest here because he represents a common figure in the late sixteenth and early seventeenth centuries—a professional who moonlighted as a cosmographical author and who wrote for a general audience. This image will serve as a touchstone to several themes discussed in this introduction relating to continuities and changes in cartography between the middle of the fifteenth century and the middle of the seventeenth. Several aspects of this image make it impossible that it could have been produced a century and a half earlier, while other features would have been familiar to a mid-fifteenth-century audience.

A cosmographer living in 1450 would have been familiar with several allusions in Rosaccio's image. Roundels representing the four Aristotelian elements of fire, air, earth, and water—with the two lighter elements at the top—anchor the corners of the world. Figures declaring the diameter and circumference of the earth as 7,000 miles and 22,500 miles, respectively, are attributed to Ptolemy's 62.5-mile degree. The fascination with the different lengths of shadows at different latitudes merits its own small roundel, as does an explanation that people in the northern hemisphere have east on their right hand when facing the sun, while those in the southern hemisphere have the opposite. The two maps showing climatic zones, with the equator, the tropics, and the Arctic and Antarctic circles, would hold no surprises. The eighteen climatic zones, five degrees wide, surrounding the map on the right and their equivalent lengths of the longest day, from twelve hours to six months, would have made sense. On the left map, the iconography of the eight classical wind-heads—the southwest, south, and southeast winds look appropriately desiccated and sick (or even dead)—would all have been familiar, as would the signs of the zodiac sporting around the edge. The Ptolemaic map at the bottom center might have been somewhat familiar from manuscripts circulating around the time, and its classical geographical content would have been well known to the cosmographer. Likewise, the geographical and chorographical terms annotating their own ideal maplet in the lower left corner—continent, river, mountain, lake, gulf, sea, peninsula, cape, island, shoal, rocks, plain, city—would have not been new. The shield of the powerful Florentine Medici family, then under the leadership of Cosimo the Elder, would have been familiar, and COSIMO, spelled out on the balls on the shield, would have made sense, even if all the names of the continents they represented would not.

Yet there the familiarity of our 1450 cosmographer with this document would have ended. The map structure is dominated by two circular nets of parallels and meridians, each centered on the equator and central meridian (i.e., nowhere in particular) and oriented with the north pole at the top. The maps have been drawn, not in a perspective view of the world as one might see it from space, but as a constructed geometric globular projection that approximates the spherical shape of the earth.

The name labels on the map are in the vernacular Italian except for the Ptolemaic map, where they are appropriately in Latin. Unlike medieval maps, which showed elements from different historical periods in the same map space, there is a desire to show information cosynchronously. So the map in the double hemisphere projection and the Ptolemaic map have been carefully separated into contemporary and historical compartments. The map stands in opposition to a Ptolemaic view of the world beneath. "This is how much Ptolemy knew about the world," it explains, implying it was not much. The

The abbreviation *Plantejaments* is used in this chapter for David Woodward, Catherine Delano-Smith, and Cordell D. K. Yee, *Plantejaments i objectius d'una història universal de la cartografia = Approaches and Challenges in a Worldwide History of Cartography* (Barcelona: Institut Cartogràfic de Catalunya, 2001).

1. Rodney W. Shirley, *The Mapping of the World: Early Printed World Maps, 1472–1700,* 4th ed. (Riverside, Conn.: Early World Press, 2001), 287 (no. 268).

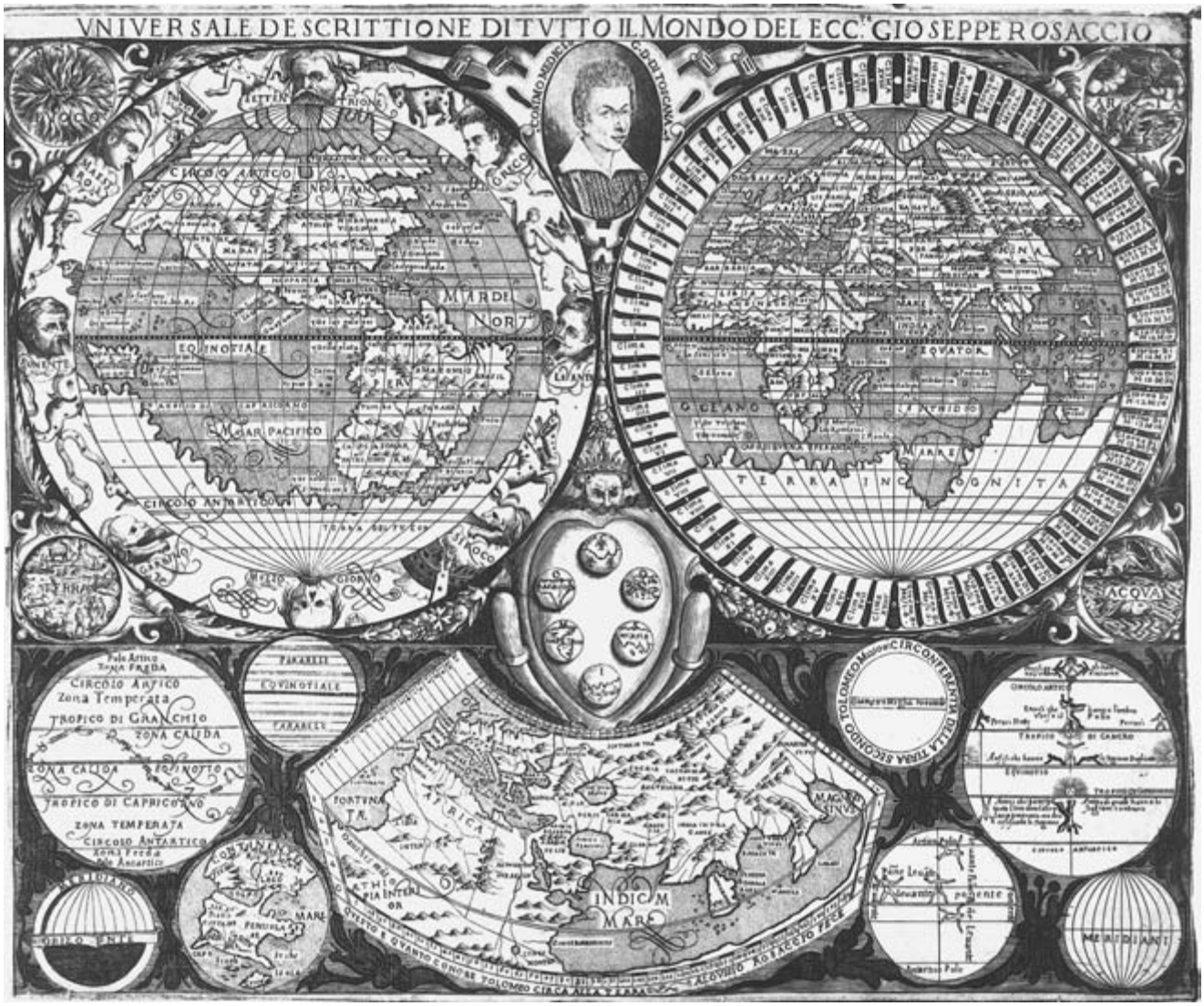

FIG. 1.1. COLLAGE OF WORLD MAPS AND GEOGRAPHICAL DIAGRAMS BY GIUSEPPE ROSACCIO, CA. 1610. Rosaccio's geographical collage epitomizes in many ways the European cartographic Renaissance. The Ptolemaic world is set against the modern two-hemisphere map reflecting the geographical discoveries of the fifteenth and sixteenth centuries. Some of the images, such as the Aristotelian concept of the elements and the Ptolemaic calculation of the earth's circumference, still reflect classical learning. But the overall aim is to celebrate the modernity of cartography. The collage is proudly dedicated to Cosimo II de' Medici, whose heraldic arms incorporate Tuscany and five continents, as if to imply the universal scope of his influence.
Size of the original copper engraving: 26.5 × 31.5 cm. Photograph courtesy of the Maritiem Museum, Rotterdam (W. A. Engelbrecht Collection 849).

map sets its own time apart from a previous time and defines itself against it. Rosaccio does not call it the "Renaissance," but he clearly sees his own geographical view of the world as being very different from that of a previous age.

But the new map does not claim to know everything. In the south looms a huge and empty "terra incognita." Indeed the map is reminiscent of Henri Lancelot de La Popelinière's *Les trois mondes* (1582), which divides the world into three equal parts: Old World, New World, and Antarctica. There is much to be discovered, but the inexorable parallels and meridians of the map indicate exactly what needs to be found, inviting new observations to be fitted into the empirical puzzle.

The most dramatic change is that the known area of the world had more than doubled since 1450. Although our mid-fifteenth-century cosmographer was familiar with the Old World, the notion of a sea route from Europe to India and China might have intrigued him. But the hemisphere on the left is totally new, and its land area appears even larger than that of the old world, even in the habitable temperate zones, ripe for economic development by

merchants such as the Medici. Indeed the map has been dedicated to Cosimo II de' Medici, Grand Duke of Tuscany, whose youthful portrait (he was 20 in 1610) surveys the whole scene. He is flattered by having the letters of his name, COSIMO, divided among the five continents and Tuscany on the Medici shield, with its familiar six balls, although Tuscany has been promoted to the rank of "continent," and the great southern continent is named "T[erra] Australa." The imagery alludes quite clearly to his influence not only over Tuscany but also optimistically over the whole world. It should be remembered that Cosimo II became Galileo Galilei's patron after the publication of the *Sidereus nuncius* in 1610 and that Galileo proposed to name the four largest moons of Jupiter—Io, Europa, Ganymede, and Callisto—the Medicean stars in honor of Cosimo.

As our 1450 cosmographer held this piece of paper in his hand, he would not have failed to be struck by the fineness of its engraving (by Alovisio Rosaccio, presumably a relative of Giuseppe) and printing. Printing of texts was still a novelty, and maps were not yet engraved. The small explanatory diagrams on the broadsheet indicate a wide audience for the print—not necessarily the scholar, but the geographical beginner. The combination of a number of images into one summary broadside and the use of the Italian language confirm this.

Rosaccio's map is typical of the hundreds of maps of no particular originality made by polymath-artisans capable of writing about their experiences, but it nevertheless provides a window on the geographical culture of the day. It looks back over the sixteenth century and seems to capture many of the main themes that emerge in this volume: cartographically speaking, the Renaissance was an age that had not yet liberated itself from the authorities of its medieval and classical past, but some of the components necessary to achieve that liberation were already in place. The remainder of this introduction examines in greater depth what continued and what changed.

The "Renaissance" as a Concept

The Renaissance, given the literal meaning of the word as "rebirth," has traditionally been interpreted as a decisive and rapid period of positive change in all aspects of Western history. Several scholars and artists in the fifteenth century perceived that their era was, in the words of Matteo Palmieri (1406–75), "a new age, so full of hope and promise, which already rejoices in a greater array of nobly gifted souls than the world has seen in the thousand years that have preceded it."[2] In his treatise on Italian geography and antiquities, "Italia illustrata" (1448–53), Flavio Biondo may have established the idea that a thousand-year period from A.D. 412 to 1412 constituted a "media aetas" or "Middle Ages," although the dates chosen by later historians of course varied. By the time Giorgio Vasari wrote his *Le vite de piv eccellenti architetti, pittori, et scvltori italiani* in 1550, the notion that medieval artists were very different from "modern" ones in a *rinascità* had taken firm root.[3]

Many books and articles have argued whether or not the term "Renaissance" is useful, and this history of cartography is not the place to rehearse all sides of the debate, which usually starts with a discussion of the dramatic model of cultural change presented in Burckhardt's 1860 *Die Cultur der Renaissance in Italien.*[4] In the "anti-Renaissance" debates of the 1970s, often as a corrective to Burckhardt (or at least to a simplified perception of what Burckhardt said), this dramatic model progressively collapsed. The debates raised several questions, including to what extent the period described by Burckhardt ushered in the age of modernity, whether the period might better be viewed as transitional, and whether the term "Renaissance" should be used at all.

Few historians would now defend either the traditional model of a sharp discontinuity between the medieval and Renaissance periods or the notion that one was a general progressive improvement over the other that eventually culminated in our "modern" age.[5] The objection to the view of the period as "transitional" was that every period might be viewed as transitional, and, although Renaissance historians replied that the Renaissance was especially transitional, they neglected to state the criteria by which one age might be regarded as more transitional than another. The other extreme was to deny that such a short period of two or three centuries was useful and to propose, as Le Roy Ladurie did, a "longue durée" from the eleventh to the nineteenth century, a period of relatively little change in which population was largely limited by the productivity

2. The quotation from Matteo Palmieri is in the *Libro della vita civile* (Florence: Heirs of Filippo Giunta, 1529).

3. Wallace Klippert Ferguson, *The Renaissance in Historical Thought: Five Centuries of Interpretation* (Cambridge: Harvard University Press, 1948), 8–14. On Flavio Biondo and the first use of the term "Middle Ages," see Roberto Weiss, *The Renaissance Discovery of Classical Antiquity,* 2d ed. (New York: Basil Blackwell, 1988), 66; Denys Hay, "Flavio Biondo and the Middle Ages," *Proceedings of the British Academy* 45 (1959): 97–128, esp. 116–17; and Angelo Mazzocco, "Decline and Rebirth in Bruni and Biondo," in *Umanesimo a Roma nel Quattrocento,* ed. Paolo Brezzi and Maristella de Panizza Lorch (Rome and New York: Istituto di Studi Romani and Barnard College, 1984), 249–66.

4. This debate is well rehearsed in Ferguson, *Renaissance,* and in the later book of essays edited by Wallace Klippert Ferguson, *The Renaissance: Six Essays* (New York: Harper and Row, 1962). The essays cover political, cultural, scientific, religious, literary, and artistic aspects of the period.

5. See William J. Bouwsma's own comments to the *American Historical Review* forum referred to in note 8, in his "Eclipse of the Renaissance," *American Historical Review* 103 (1998): 115–17.

of agriculture.[6] Many medievalists agreed, stressing the continuity of thinking in such a period, although it is doubtful that they would claim expertise in the latter parts of it. Seeing the label "Renaissance" as an implication that the period heralded our modern world, many historians replaced it with the term "early modern," which unfortunately bears the same implication.

So, after a period in which the use of the term "Renaissance" fell out of favor, it has now been revived, particularly for cultural history. Coming to its defense was the view that Burckhardt's contributions far outweighed his shortcomings, and that the criticisms merely introduced a plea for flexibility and an appreciation that historical revolutions rarely happen abruptly.[7] Further support comes from the realization that the term "Renaissance" is widely used in popular literature and the media, especially when dealing with the material culture of art and collectible artifacts.[8]

The choice of the term "Renaissance" and not "Early Modern" for the title of this volume of *The History of Cartography* responds to such arguments, on the grounds that "Renaissance" remains a useful practical term that is intuitively understood by many people, even if the period to which its characteristics might apply varies by European state. This decision has been made with full knowledge of the fact that the seamless narrative of history cannot be arbitrarily carved up into hundred-year installments. We cannot somehow uncover the "Renaissance" as an independently existing external reality waiting to be discovered. Neither can we effectively pinpoint great events, documents, or individuals that had an immediate impact. But for this volume of *The History of Cartography,* the practicality of dealing with a period extending from approximately 1480 to approximately 1640—even with significant regional adjustments—has been confirmed by the experience of our authors in writing their chapters, for they have all produced internally coherent accounts.[9]

The investigation of how maps were conceived, made, and used in this period provides a case study highlighting some of these historiographical issues in a new way. Indeed it is surprising that Burckhardt completely ignored these cartographic aspects even when stressing the importance of the discovery of the world and its relationship to the discovery of the self, both topics on which the history of cartography has much to say.[10]

The Progressive Model and a Suggested Compromise

The word "Renaissance" implied a rebirth of classical models of thought in philosophy as well as the practical arts, such as architecture and medicine. For historians writing about maps, this dramatic model of change seemed particularly appropriate, for it set the allegorical, nonmetrical world maps of the Middle Ages, the *mappaemundi,* in opposition to the secular, measured, projected, scaled maps that Claudius Ptolemy had proposed in the second century A.D. and that had been "rediscovered" by the Latin West at the beginning of the fifteenth century. The cartographic Renaissance of the sixteenth and seventeenth centuries was thus portrayed as a record of geographical progress, meaning an improvement in measuring the observed location of places and natural features in the world. For this reason, and for the prestige

6. William J. Bouwsma, "The Renaissance and the Drama of World History," *American Historical Review* 84 (1979): 1–15, esp. 7.

7. Jacob Burckhardt, *The Civilization of the Renaissance in Italy,* trans. S. G. C. Middlemore, intro. Peter Gay (New York: Modern Library, 2002). Gay introduces the edition thus: "More telling have been recent objections by economic historians that Burckhardt paid too little attention to economic realities, and to the lives of common people. This is true enough: the range of historical investigation has broadened since Burckhardt's time—a never-ending process of enlarging the terrain open to historians to which Burckhardt himself made impressive contributions" (xix).

8. For a valuable overview of this question, see Paula Findlen, "Possessing the Past: The Material World of the Italian Renaissance," *American Historical Review* 103 (1998): 83–114. This article was part of a series arising out of a panel, "The Persistence of the Renaissance," convened to discuss the state of Renaissance studies at the end of the twentieth century. The panel met twenty years after Bouwsma's presidential address to the American Historical Association in 1978, asking what could be salvaged from the idea of the Renaissance as the great turning point in European history.

9. I side with the pragmatic views of Elizabeth L. Eisenstein, *The Printing Press as an Agent of Change: Communications and Cultural Transformations in Early-Modern Europe,* 2 vols. (Cambridge: Cambridge University Press, 1979), 172: "Far from holding that the term 'Renaissance' should be discarded, I would oppose this suggestion as both futile and undesirable. . . . To write an article questioning the use of the term 'Renaissance' only swells the bibliography that is filed under the questionable term." Likewise, Gay, in Burckhardt, *Civilization of the Renaissance,* forthrightly states: "There was a Renaissance, its best name is 'Renaissance,' and it took place in the Renaissance" (xix).

10. Jacob Burckhardt, *Die Cultur der Renaissance in Italien* (Basel: Schweighauser, 1860). Burckhardt mentions Petrarch's geographical contribution as making the first map of Italy but says nothing about cartography in relation to the geographical discoveries of the late fifteenth century. Previous general books and collections of essays focusing on geography and cartography in the European Renaissance include: Numa Broc, *La géographie de la Renaissance (1420–1620)* (Paris: Bibliothèque Nationale, 1980); David Buisseret, *The Mapmaker's Quest: Depicting New Worlds in Renaissance Europe* (New York: Oxford University Press, 2003); Robert W. Karrow, *Mapmakers of the Sixteenth Century and Their Maps: Bio-Bibliographies of the Cartographers of Abraham Ortelius, 1570* (Chicago: For the Newberry Library by Speculum Orbis Press, 1993); Frank Lestringant, *Mapping the Renaissance World: The Geographical Imagination in the Age of Discovery,* trans. David Fausett (Berkeley: University of California Press, 1994); Monique Pelletier, ed., *Géographie du monde au Moyen Âge et à la Renaissance* (Paris: Éditions du C.T.H.S., 1989); and W. G. L. Randles, *Geography, Cartography and Nautical Science in the Renaissance: The Impact of the Great Discoveries* (Aldershot: Ashgate, 2000).

Table 1.1 Text and Image in Three Main Functions of Maps in the Renaissance

Use	Text	Image
General description (small to large scale)	Cosmography	Cosmographic map
	Geography	Geographic map
	Chorography	Chorographic map
	Topography	Topographic map
Sea navigation	Portolan, rutter	Portolan chart
Land navigation	Itinerary	Route map
Property management	Terrier	Estate plan
	Cadaster	Cadastral map

it afforded nationalistic interests, scholars in the history of cartography found the progressive model suggested by the period of much appeal. A count of articles in the only international journal devoted to the field, *Imago Mundi* (1935–2003), reveals that fully a quarter of the articles dealt with maps made in the sixteenth century.

The progressive model is easy to accept when viewing maps as a vivid record of geographical exploration and discovery. By 1600, the European map of the world had literally doubled in size within just over a century, a development that Sarton called "an achievement of incredible pregnancy."[11] What used to be represented in one hemisphere now required two. Europe's exploitative treatment of that other half politically and ethically is a different story, but the sheer increase in geographical knowledge about the world within a very short time was astounding, and—in the sense that knowledge is generally better than ignorance—a clear sign of progress.

On the other hand, in terms of the history of cartography, this view of mapmaking in the Renaissance as a model of metrical progress has blinkered our vision by focusing only on those maps that support such improvements in geographical accuracy. In so doing, we tend to impose our present-day standards of "accurate maps" onto the past, usually forming a self-perpetuating canon of "great maps" that conform to our limited notions of positional accuracy. Equally distorting has been a biographical focus on elite political, military, or scholarly figures engaged in cartography, to the exclusion of the everyday artisan or map consumer. Another defect of the progressive model has been that, by focusing only on the dramatic changes or events (such as the translation of Ptolemy's *Geography* into Latin in 1409), it has masked important continuities in mapping practice that can be discerned from the fourteenth to sixteenth century. All these prejudicial approaches unfortunately ignore many of the richly cultural aspects of the history of cartography, such as how ordinary people viewed the world and their place in it.

The remainder of this introduction thus seeks a compromise by pointing not only to the often profound changes that took place in the Renaissance but also to the striking continuities in practice that remained from the Middle Ages. The advantages of discussing the continuities as well as the changes in a complex and sometimes ambiguous collage are that they counter the oversimplification of the Renaissance as a sudden and monolithic revolution in cartographic thought in all its aspects and throughout Europe.

Continuities

texts

A striking continuity between the medieval and Renaissance periods involves the persistence of textual descriptions of the world, which were by no means replaced by their graphic equivalents. Table 1.1 shows the textual and graphic equivalents of three main categories of map function in the periods in question: general description, navigation, and property management. Examples of the continued use of texts in the Renaissance period can be cited for all these categories of function, such as general descriptions of the world, chorographies, land itineraries, portolans (sailing directions), and land surveys.

In Volume 1 of this *History,* the point was made that the word *mappa* or *mappamundi* in the Middle Ages could be used to describe either a text or a map.[12] This practice continued into the sixteenth and seventeenth centuries, as with Sebastian Münster's *Mappa Evropae* (Frankfurt, 1537), John Smith's *A Map of Virginia* (Oxford, 1612), or Thomas Jenner's *A Map of the Whole World* (London, 1668). Indeed the metaphorical use of the word "map" to describe not only geographical descriptions but also other activities has exploded even in our own day, as we hear almost daily of the "road map" to peace in the Middle East.[13]

Similarly, the word "chorography" could mean a written or graphic description of a small region (Greek *khôros* = region or district), often at a larger scale than implied by "geography" or "cosmography" but usually at a smaller scale than implied by "topography"; all these terms had textual and graphic equivalents. It is important to realize, however, that the notion of scale hierarchy in

11. George Sarton, "The Quest for Truth: Scientific Progress during the Renaissance," in *The Renaissance: Six Essays,* ed. Wallace Klippert Ferguson (New York: Harper and Row, 1962), 55–76, esp. 58. Sarton lists "The Discovery of the Earth" as the first of twelve vignettes in the Renaissance history of science, but he does not mention cartography.

12. David Woodward, "Medieval *Mappaemundi,*" in *HC* 1:286–370, esp. 287.

13. See the list in David Woodward, "'Theory' and *The History of Cartography,*" in *Plantejaments,* 31–48, esp. 35, n. 11.

these various terms is by no means explicit; it was the approach to the proportionality of the representation that was important. "Chorography" could include local and regional representations; its scope was not limited to the amount of landscape that could be observed in one view.

In the Middle Ages, the best-known work including "chorography" in its title was Pomponius Mela's first-century A.D. *De chorographia,* a written description of regions of the known world, which had little effect on medieval cartography (the first printed edition of 1471 contained no maps).[14] Ptolemy's *Geography,* in drawing a distinction between chorography and geography, on the other hand, implied that both were primarily graphic tools for description of the world at different scales and relying on different sets of skills. Chorography was to be the qualitative (*to poion*) work of the artist or painter, geography the quantitative (*to poson*) work of the mathematician; these are the same terms for quantity and quality that are found in chapters 6 and 7 of Aristotle's *Categories.* But even in Ptolemy's *Geography,* which has been touted as responsible for the improvement of maps in the fifteenth and sixteenth centuries, the text was initially of more interest to the Italian humanists. When the *Geography* was translated by Jacopo Angeli around 1409, the maps were not included. It was not until 1427 that Cardinal Guillaume Filastre's copy of the work contained maps. Humanists were just as interested in geographic texts, such as those by Strabo and Pomponius Mela, that had few cartographic components but more literary style. Strabo's *Geography* was introduced into Florence by George Gemistus Plethon in 1439, but its novelty lay not in maps but in the vast amount of textual information it contained, even though its geographic content was dated to the first century A.D.

In the sixteenth and seventeenth centuries, the textual meaning of the word "chorography" continued to predominate and was not supplanted by its growing use in the titles of maps, as exemplified in such works as Michael Drayton's *Poly-Olbion; or, A Chorographicall Description* (London, 1622), William Camden's *Britain; or, A Chorographicall Description* (London, 1637), or William Gray's *Chorographia; or, A Survey of Newcastle upon Tine* (Newcastle, 1649).[15]

Likewise, the classical and medieval written land itineraries continued to be a robust tool for wayfinding, and these were by no means replaced by their graphic equivalents. Although we have a famous example of an assemblage of graphic and written itineraries in the Tabula Peutingeriana, an image whose pedigree goes back to the fourth century, written directions of how to get from one place to another predominated over maps in the medieval period. One may even question the extent to which graphic itineraries were actually used on the road. For example, the four versions of Matthew Paris's "strip map" of the pilgrimage route between London and Apulia (Italy) on the way to the Holy Land may have been drawn to act as a kind of surrogate pilgrimage for the reader rather than as a wayfinding device.[16] Written itineraries were much more common. A prominent example is the fourteenth-century Bruges itinerary with mercantile routes from Bruges to the rest of Europe.[17] Such written itineraries remained popular in the Renaissance. Indeed verbal directions have continued to be popular to the present day, depending on the cognitive styles of users or the street layout and major structural features of cities. A request for directions in Venice is still met by "giù il ponte e poi chiede" (down to that bridge and then ask again), while a similar explanation in New York City will reference the coordinate system of its street grid. And the debate is still ongoing as to whether it is more useful in car navigation systems to have a moving map or spoken directions.

Finally, textual sailing directions, known as *periploi* in classical times and portolans (*portolani*) in the Middle Ages, continued to be favored by many sailors over their graphic equivalents into the sixteenth and seventeenth centuries, particularly in northern European waters, where they became known as rutters. The confusion still persists today, as the term "portolan" is often used when "portolan chart" is intended, leading some to propose that the term be abolished altogether.[18] As Fernández-Armesto argues in this volume, maps and charts were not used for navigation in the Renaissance as much as written sailing directions.[19]

GRAPHICS

A graphically compelling logical challenge to the progressive model of cartographic development between the Middle Ages and the Renaissance is posed by the early development and persistence of the Mediterranean sea charts. Campbell's study of these charts in Volume 1 of *The History of Cartography* has been continued by Astengo in this volume, but the use of the year 1500 as the dividing line between the two treatments is arbitrary.

14. F. E. Romer, *Pomponius Mela's Description of the World* (Ann Arbor: University of Michigan Press, 1998), 20–21.

15. For an excellent and wide-ranging philosophical discussion of the historical relationship of chorography to landscape painting, topographical views, and the mapping of small regions, see Edward S. Casey, *Representing Place: Landscape Painting and Maps* (Minneapolis: University of Minnesota Press, 2002), 154–70.

16. Daniel K. Connolly, "Imagined Pilgrimage in the Itinerary Maps of Matthew Paris," *Art Bulletin* 81 (1999): 598–622.

17. P. D. A. Harvey, "Local and Regional Cartography in Medieval Europe," in *HC* 1:464–501, esp. 495.

18. Patrick Gautier Dalché, "D'une technique à une culture: Carte nautique et portulan au XII^{e} et au XIII^{e} siècle," in *L'uomo e il mare nella civiltà occidentale: Da Ulisse a Cristoforo Colombo* (Genoa: Società Ligure di Storia Patria, 1992), 283–312.

19. See chapter 30 in this volume, esp. pp. 749–50.

Gautier Dalché has argued convincingly for an appearance of such charts around 1200, even though the earliest extant chart—the so-called Carte Pisane—appears to date from the late thirteenth century, in any event squarely within the period normally thought of as "medieval."[20] From the earliest extant example, the charts were structured with rhumb lines and inscribed place-names perpendicular to the coastline, unlike other maps of the period. Although the number of rhumb lines was customarily doubled beginning in the mid-fifteenth century and the alignment of the Mediterranean on the charts changed by some ten degrees in the sixteenth century, the positional accuracy with which the charts were plotted changed little over the next three centuries. Neither did the signs for rocks and shoals around the coasts. Except for the number and choice of place-names and the extent of coverage beyond the Mediterranean, the style and content of the charts were notably resilient.[21]

Another continuity that belies a favorite myth about radical cartographic changes in the Renaissance is the persistence of the oblique or elevation view of cities over planimetric or orthogonal representations. Different viewpoints or geometric structures of city representations were largely experimental in the sixteenth century. Certainly there was no simple progress from an oblique viewpoint toward a planimetric representation, as some authors have proposed.[22] The examples of orthogonal maps from the ancient and classical world (Neolithic rock art, Babylonian clay tablets, the Forma Urbis Romae [203–208 A.D.]) or from the Middle Ages (the Plan of Saint Gall [ninth century], the plan of Venice in the "Chronologia Magna" [before 1346], a plan of Siena's port city Talamone [1306]) are eloquent witnesses against this model. Arguably the pinnacle of Renaissance town representation in terms of both popularity and sophistication was the *Civitates orbis terrarum* (1572–1618), in which the oblique view and elevation, not orthogonality, were the viewpoints of choice.[23]

Celestial maps and globes enjoyed a degree of continuity during the Middle Ages and Renaissance because the principles on which they were constructed did not materially change. Ptolemy's *Almagest,* or at least a shortened version of it, the *Epitome,* was available throughout the Middle Ages and Renaissance, and coordinates of right ascension and declination continued to be used in the Renaissance for specifying star positions, although the base line from which to compute declination changed from the ecliptic to the celestial equator. What really changed in celestial mapping was the number of new star positions that could be added as a result of the telescope, which was developed at the beginning of the seventeenth century.

Likewise, the principles of surveying associated with the Roman *agrimensores,* in manuals that can be traced back to the fourth and fifth centuries, were remarkably resilient, even though they were purely descriptive representations of landed property and did not lend themselves to the calculation of distances or areas. In the early thirteenth century, surveys began to provide area measurements, and tables exist that give the length of an acre of land for any given width. The "Practica geometriae" (1220) by Leonardo of Pisa (Fibonacci) describes how to use a plumb-bob level to find the horizontal area of a slope and shows how a quadrant can be used in surveying. Although we cannot infer from works such as Fibonacci's that the recommended instructions were routinely practiced, their appearance does reflect a rudimentary knowledge of measurement units and techniques needed in producing land descriptions. The method of the land surveyor involved measuring angles and distances in a traverse from one point to another, preferably closed. Surveying manuals in the Middle Ages include the French treatise by Bertrand Boysset, "La siensa de destrar" (1405). In "De fluminibus seu tiberiadis" (1355), the Italian jurist Bartolo da Sassoferrato describes how plans might be used to settle disputes over the division of watercourses. In the mid-fifteenth century, Leon Battista Alberti described several methods of land survey, probably based on the practical manuals, but also hinting at the possibilities of triangulation surveys to fix positions, a technique that was not systematically explained until the *Libellus de locorum describendorum ratione* of Gemma Frisius (1533). But the extent of the use of these manuals and their translation into graphic maps is difficult to document.[24]

Even in the mid-sixteenth century, when ground measuring instruments and techniques had been commonly

20. See chapter 7 in this volume and Patrick Gautier Dalché, *Carte marine et portulan au XII^e siècle: Le* Liber de Existencia riveriarum et forma maris nostri mediterranei *(Pise, circa 1200)* (Rome: École Française de Rome, 1995).

21. Tony Campbell, "Portolan Charts from the Late Thirteenth Century to 1500," in *HC* 1:371–463.

22. Denis Wood, "Now and Then: Comparisons of Ordinary Americans' Symbol Conventions with Those of Past Cartographers," *Prologue: The Journal of the National Archives* 9 (1977): 151–61. This progressive view is endorsed by P. D. A Harvey in *The History of Topographical Maps: Symbols, Pictures and Surveys* (London: Thames and Hudson, 1980).

23. Lucia Nuti, "The Mapped Views by Georg Hoefnagel: The Merchant's Eye, the Humanist's Eye," *Word and Image* 4 (1988): 545–70.

24. See F. M. L. Thompson, *Chartered Surveyors: The Growth of a Profession* (London: Routledge and Kegan Paul, 1968), 33–34; Derek J. de Solla Price, "Medieval Land Surveying and Topographical Maps," *Geographical Journal* 121 (1955): 1–10; H. C. Darby, "The Agrarian Contribution to Surveying in England," *Geographical Journal* 82 (1933): 529–35; P. Pansier, "Le traité de l'arpentage de Bertrand Boysset," *Annales d'Avignon et du Comtat Venaissan* 12 (1926): 5–36; Patrick Gautier Dalché, "Bertrand Boysset et la science," in *Église et culture en France méridionale (XII^e–XIV^e siècle)* (Toulouse: Privat, 2000), 261–85; and Bartolo da Sassoferrato, *La Tiberiade di Bartole da Sasferrato del modo di dividere l'Alluuioni, l'Isole, & gl'aluei* (Rome: G. Gigliotto, 1587). Leon Battista Alberti's plan of Rome, although using

described in such books as Leonard Digges's *A Boke Named Tectonicon* or Abel Foullon's *Vsaige et description de l'holometre,* the interest in surveying was often still qualitative. In England, although land surveying developed dramatically after the massive land transfers following the Reformation, mapping lagged behind until the end of the sixteenth century. Henry VIII spent large sums on fortifications, of which a significant amount went toward mapping, but it was not until the reign of James I that maps were routinely made for civilian purposes, such as the delineation of forests or private residences. There were differences in practice between countries. In the seventeenth century, English surveyors, perhaps influenced by the textbooks of John Norden and Aaron Rathborne, tended to stress the precise recording of land use, land resources, and quantitative acreage data in their plans. French surveying differed in that far more attention was paid to the rendering of buildings and their place in the topographical landscape, as in Jacques Androuet du Cerceau's *Les plus excellents bastiments de France* (1576), with less interest in the precise calculation of acreage and maps for estate planning.[25]

Local land surveying owed its roots more to the practical needs of measurement than to the philosophical works of classical scholars. It was intended to solve problems of tunneling, land subdivision, road and bridge building, mine layout, river channeling, and other tasks of civil engineering. It was not derived from Ptolemy's *Geography,* for Ptolemy stressed that local maps (chorographies) should not be based on measurement, but should instead be made by artists. Rather, land surveying's instrumentation and practice were closely tied to hydrographic surveying, with one crucial difference. While hydrographers could survey coastlines and oceans with impunity, a large part of the land surveyor's job involved obtaining permission from landowners to cross their land and placate local inhabitants.[26] The surveys of England and Wales under Christopher Saxton in the 1570s or of Bavaria by Philipp Apian (1568) were undertaken with noble patronage so that such access could be granted. These detailed large-scale land maps constituted the discovery of the homeland and contributed to the consolidation of the idea of political unity.[27] If the number of maps is in any way a measure of discovery, Europe, not the New World, was the place "most" discovered in the Renaissance, as Karrow points out.[28]

A final graphic continuity lies in the sacred function of maps. There was no clean break from the sacred *mappamundi* to the secular world map that can be pinpointed to a single time and place. As Watts shows in her chapter, maps with religious content in the Renaissance were not simply quaint holdovers from the *mappaemundi,* and the usual dichotomy between religious maps as belonging to the Middle Ages and secular ones as belonging to the Renaissance may be misleading.[29] If printing is deemed to be a quintessential Renaissance trait, of the 222 maps printed between 1472 and 1500 in the West listed by Campbell, only about a third (72) are from other than classical or early medieval sources, only a tenth (23) if we exclude the maps of islands in the Greek archipelago in Bartolommeo dalli Sonetti's *isolario,* which are in the portolan chart tradition and derived from a 1420 manuscript of Cristoforo Buondelmonti.[30] In the sixteenth century, the most popular country portrayed on maps was arguably the Holy Land. Certainly more maps were made of it during the century than of France, Spain, or Portugal. Almost as many maps of the Holy Land were made as world maps or maps of the African continent.[31] Maps with religious themes were not limited to maps of the Holy Land; the great map murals of the Vatican made for Pope Gregory XIII—particularly in the Galleria del Belvedere and the Terza Loggia—when taken together are seen as a statement of the ecclesiastic leadership of the church over not only the Italian peninsula but the world at large.[32] And thousands of printed maps were sold to the pilgrims who visited Rome; mapsellers in the printers' and publishers' quarter of the city, the Parione, were strategically located to take advantage of the pilgrims' presence. While many of these were secular in nature, serving to remind the pilgrims of the city of Rome, some had a specific

a polar coordinate system to plot the distances and bearings of buildings from a central point (in the same way that surveyors might plot a traverse), bears little geometrical relationship to the rectangular coordinate system proposed for maps in the *Geography.* Indeed Alberti's interest in the *Geography* appears to have been more as a target of satire than as a methodological source, for his major allusion to the treatise appears in his irony in *Praise of the Fly,* where he says that the beautiful patterns on the wings of flies may have inspired Ptolemy's maps. See Anthony Grafton, *Leon Battista Alberti: Master Builder of the Italian Renaissance* (New York: Hill and Wang, 2000), 244. It is more likely that Alberti relied on the methods of land surveyors rather than the principles of Ptolemy.

25. Renzo Dubbini, *Geography of the Gaze: Urban and Rural Vision in Early Modern Europe,* trans. Lydia G. Cochrane (Chicago: University of Chicago Press, 2002), 39.

26. Marica Milanesi, "La rinascita della geografia dell'Europa, 1350–1480," in *Europa e Mediterraneo tra medioevo e prima età moderna: L'osservatorio italiano,* ed. Sergio Gensini (Pisa: Pacini, 1992), 35–59.

27. Richard Helgerson, "The Land Speaks: Cartography, Chorography, and Subversion in Renaissance England," *Representations* 16 (1986): 50–85.

28. Robert W. Karrow, "Intellectual Foundations of the Cartographic Revolution" (Ph.D. diss., Loyola University of Chicago, 1999), 240.

29. See chapter 11 in this volume.

30. Tony Campbell, *The Earliest Printed Maps, 1472–1500* (London: British Library, 1987), 232–33 (table 2).

31. Karrow, "Intellectual Foundations," 241–42 and fig. 6.2.

32. See chapter 32 in this volume.

FIG. 1.2. ANTONIO LAFRERI, *LE SETTE CHIESE DI ROMA*, 1575. Size of the original: ca. 39.8 × 50.8 cm. Photograph courtesy of the BL (Maps 23807.[1]).

religious purpose, such as the map showing the seven churches in Rome to be customarily visited (fig. 1.2).[33]

Changes

Between 1400 and 1472, in the manuscript era, it has been estimated that there were a few thousand maps in circulation; between 1472 and 1500, about 56,000; and between 1500 and 1600, millions.[34] The significant increase in the sheer number of maps available for viewing calls for an explanation. Certainly maps began to serve a huge variety of political and economic functions in society. As administrative bureaucracies became more complex in meeting an array of needs related to public works, town planning, resolution of legal boundary issues, commercial navigation, military strategies, and rural land management, these functions intertwined with each other, and the demand for customized maps grew. (It is for this reason that most of these administrative maps remained in manuscript.) The structure of regional archives in countries such as Italy, France, or Great Britain reflects these administrative needs even today.[35]

In addition, it is the *changing* relationship between text and image that is central to understanding the shift in worldview from primarily aural to visual. De Certeau views the transition from itinerary to map as the hallmark of the Renaissance: "If one takes the 'map' in its current

33. See pp. 775–79 in this volume.
34. Karrow, "Intellectual Foundations," 8–9.
35. Detailed descriptions appear in the following chapters.

geographical form, we can see that in the course of the period marked by the birth of modern scientific discourse (i.e., from the fifteenth to the seventeenth century) the map has slowly disengaged itself from the itineraries that were the condition of its possibility."[36] We have discussed the ways in which such textual equivalents of maps as itineraries, sailing directions, and written chorographies, popular in the Middle Ages, persisted into the Renaissance. It is not that the huge increase in graphics usurped the functions of the written word, but rather that a new idiom was added to the old. Although much has been written recently about the affinities of graphic maps with verbal or textual passages that serve the function of maps (including the section on maps and literature in this volume),[37] we should not lose sight of the growing importance in the Renaissance of a general reorientation toward spatial analogies and the culture of objects. In Ong's view, a book now became an object rather than a record of what someone had said, "belonging more to the world of things and less to the world of words," and the interest in plotting the surface of the globe "makes this same Gutenberg era the great age of cartography and exploration. . . . The new world was a world of objects as nothing before had ever been."[38]

How did the nature of maps change in this period, and what was behind the changes? There were a multiplicity of nested periods, regions, and scales of activity, with different criteria for periodization. The timing of the cartographic Renaissance in the Italian states was very different from that in England, for example, so it is difficult to pinpoint transforming events that affected all parts of Europe. Despite these caveats, fundamental changes did take place between the fifteenth and sixteenth century, and we can generalize about them.

These changes are discussed under three broad categories that concern the ways people saw and knew about their world by means of maps: (1) changes in the internal relationships of map structure or graphic syntax: the internal logic, language, and arrangement of parts or elements of maps; (2) changes in the relationship of the map to its sources in the observed world, including the individualization, globalization, quantification, and valorization of experience; the erosion of the authority of classical geographical texts; and the conflict between theory and practice (both qualitative and quantitative) from direct observation; and (3) changes in the relationship of maps and society through the dissemination, publication, patronization, and commoditization of geographical knowledge and culture. In some respects this categorization reflects a simplified threefold system of syntactics, semantics, and pragmatics, relating approximately to the study of maps as artifacts, representations, and texts, although that is as far as the language of semiotic theory will be invoked in this chapter.[39]

The Internal Relationships of Map Structure or Graphic Syntax

One variety of cartographic changes that took place can be broadly discussed under the topic graphic syntax. This involved changes in the way that the parts or elements of maps were systematically arranged in terms of (1) the conception of space as an abstract geometric transformation, (2) how labels and graphic elements were related on maps, and (3) an increasing assumption that the elements represented on a map should be cosynchronous—a separation of time and space, of geography from history.

Space as an Abstract Conception

The change in the abstract conception of space—from the center-enhancing *mappaemundi* to the Ptolemaic isotropic structure of mapmaking—has often been called the quintessential modernity of Renaissance cartography. The evidence for this lies in the relative scarcity of terrestrial maps bearing longitude and latitude before the fifteenth century. No terrestrial maps using longitude and latitude survive from thirteenth- and fourteenth-century Europe, despite Roger Bacon's description of one on a sheepskin with cities shown by small red circles in the "Opus maius" (ca. 1265).[40] In comparison, by the mid-seventeenth century, the observation of latitude and longitude as control points for topographical surveys had been introduced in France. What happened in the intervening four centuries is routinely ascribed to the rediscovery of Ptolemy's manual of mapmaking in the first decade of the fifteenth century.

Coordinates

The terrestrial coordinate system that Ptolemy describes—applied to the mapping of the heavens since Hellenistic times—assumes an isotropic, uniform surface on which abstract positions are plotted on maps of the world or regions of it larger than the chorographies. The implications of this apparently prosaic statement are complex and far ranging. It implies that the position of one place is no more important than that of another, and that both geometric center and bounding frame are arbitrary constructions re-

36. Michel de Certeau, *The Practice of Everyday Life,* trans. Steven Rendall (Berkeley: University of California Press, 1984), 120.

37. See chapters 12–18 in this volume.

38. Walter J. Ong, "System, Space, and Intellect in Renaissance Symbolism," *Bibliothèque d'Humanisme et Renaissance* 18 (1956): 222–39, esp. 229–30 and 238.

39. This analogy is explored in three of my essays in *Plantejaments:* "'Theory' and *The History,*" 31–48; "Starting with the Map: The Rosselli Map of the World, ca. 1508," 71–90; and "The Image of the Map in the Renaissance," 133–52.

40. David Woodward with Herbert M. Howe, "Roger Bacon on Geography and Cartography," in *Roger Bacon and the Sciences:*

sulting from the assumptions about the reference lines from which longitude and latitude are measured. The frame either completes the map or is necessary to draw a clear boundary between the space of the map and the space of the world outside. The notion of a bounded uniform space also implies that the objects placed in it are cosynchronous, a concept that, as we shall see, led to the idea that historical and "modern" maps could and should be separate documents. Since the surface is represented as a uniform space, scale and proportion are also possible. The statement also implies some kind of geometric transformation from the spherical globe to the flat map. Furthermore, the map now has not a single viewpoint, but multiple (strictly speaking, infinite) viewpoints with orthogonal lines of sight (perpendicular to the surface).

The resulting world and regional maps had a number of theoretical advantages. Because they were broadly based on a proportioned structure (Ptolemy does not go into the problem of maintaining absolute scale on flat maps derived from a spherical surface), new places could be fitted in as their coordinates became available without "stretching" or extending the map. Furthermore, since the concept was based on a spherical earth in the first place rather than on the more restricted inhabited world known to the Greeks, the Ptolemaic frame could theoretically accommodate discoveries worldwide. This is why the apparently modest world map signed by Francesco Rosselli (ca. 1508) is so important.[41] The ca. 1507 globe gores by Martin Waldseemüller are a similar kind of graphic device, perhaps the first such conception of how to make a globe. Both these maps show the whole world in the blink of an eye, in such a way that the viewer does not have to move (figs. 1.3 and 6.5). It is a humanly impossible view, even from space, achieved by an arbitrary unfolding transformation—a kind of exploded diagram—of the sphere, requiring the reader to suspend the apparent reality of a single viewpoint. Rosselli's map is a fundamentally different representation of the earth than a globe, which is a scale model of the world not requiring a sphere/plane transformation, and which assumes we will move around it or twirl the object in order to obtain a "whole" view. Rosselli's map was a new idea requiring a different, highly constructed, episteme.[42]

One of the telling features of the Ptolemaic cartographic system was that the world was shown to the viewer in a net of numbered parallels and meridians that implied its systematic order and orientation. This numbering is a crucial difference between the graticule of a map projection and the grid of a perspective system that artists were developing in the fifteenth century. It implied a scale.[43]

Measurements of sufficient precision to take full advantage of the Ptolemaic paradigm were not available until astronomical measurements of latitude and longitude had become routine. Even while stressing the advantages of astronomical observations over travel records, Ptolemy himself realized that the gathering of longitude and latitude information by astronomical means, particularly longitude measured by the simultaneous observations of eclipses, was severely lacking (*Geography* 1.4). The establishment of east-west distances on land had relied in large part on the reports of merchants, who, Ptolemy quotes Marinus of Tyre as saying, "often exaggerate[d] the distances out of boastfulness," requiring revision (*Geography* 1.11–12). For similar calculations by sea, the source was likely the *periploi* or sailing directions.[44]

The map projection system also induced in the reader confidence that the map was representing the world in just proportion. But this confidence was clearly misplaced unless observations had been made using measurements. The rhetorical phrase "from actual surveys" came to be a hallmark of quality in maps of the seventeenth century. Before careful measurement, distances from one place to another could be roughly paced; the position of a place could be described in relation to a natural feature (at the confluence of two rivers, for example, or where a river enters the sea). The realization of the need for careful measurement arose in part from the advent of commercial trade enterprises that attempted to standardize units of length and weight.

Geographic coordinates were thus mainly of scholarly and not practical concern until reliable astronomical measurements of both longitude and latitude became available in the late eighteenth century, after a satisfactory chronometer had been developed. Coordinates and projection grids certainly were powerful rhetorical devices in the fifteenth and sixteenth centuries, but the data behind them was often questionable.

Maps and Perspective

The visual similarity of the diagrams in the *Geography* illustrating how map "projections" are constructed and the diagrams used to illustrate linear perspective have led to a great deal of confusion in relating the two. One author directly linked their origin, arguing that Filippo Brunelleschi's experiments in perspective occurred at about the same time that Ptolemy's *Geography* reached Florence.[45] The arguments center around Ptolemy's

Commemorative Essays, ed. Jeremiah Hackett (Leiden: E. J. Brill, 1997), 199–222.

41. Woodward, "Starting with the Map," 71–90.

42. See p. 371 in this volume.

43. David Woodward, "Il ritratto della terra," in *Nel segno di Masaccio: L'invenzione della prospettiva,* ed. Filippo Camerota, exhibition catalog (Florence: Giunti, Firenze Musei, 2001), 258–61.

44. J. Lennart Berggren and Alexander Jones, *Ptolemy's* Geography: *An Annotated Translation of the Theoretical Chapters* (Princeton: Princeton University Press, 2000), 30, 62–63, and 70–74, esp. 72.

45. Samuel Y. Edgerton, "Florentine Interest in Ptolemaic Cartography as Background for Renaissance Painting, Architecture, and the

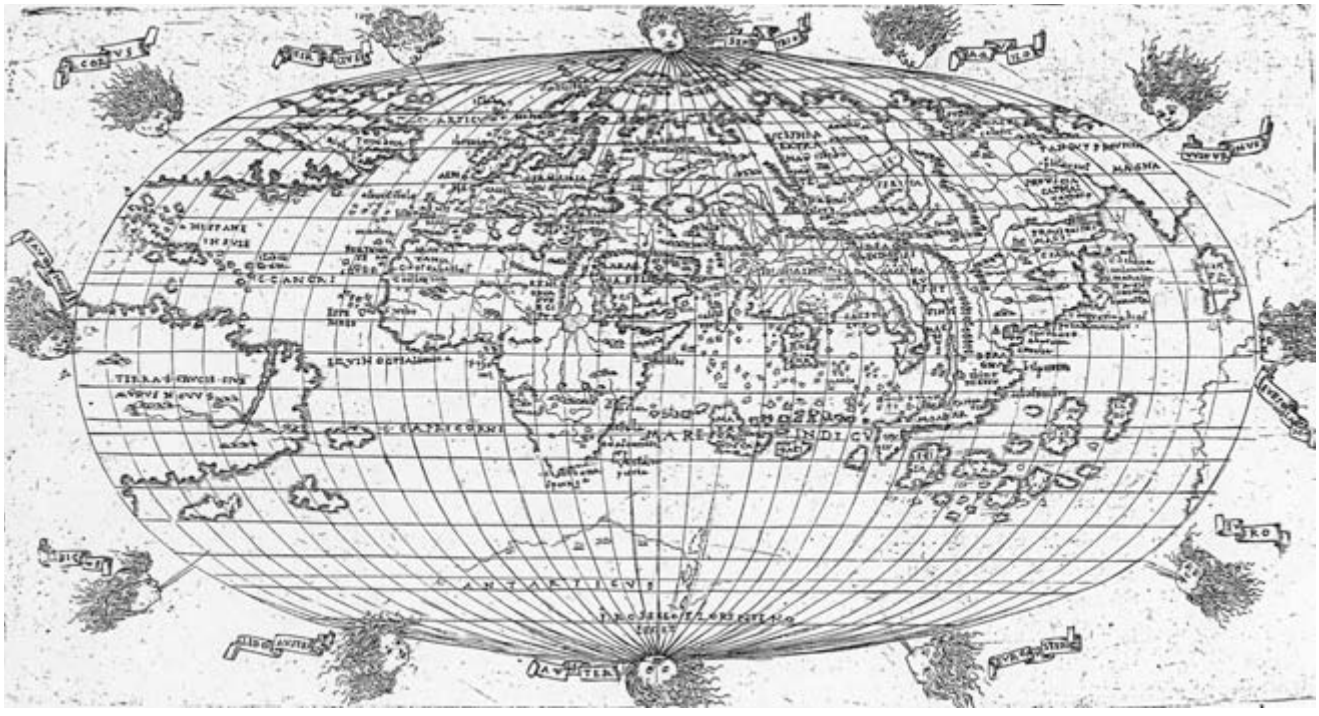

FIG. 1.3. WORLD MAP BY FRANCESCO ROSSELLI, CA. 1508. Rosselli's ovoid world map, although modest in size and engraving style, signals a revolutionary change in representing the whole world. It is the earliest surviving map to project all 360 degrees of longitude and 180 degrees of latitude of the earth's sphere onto a flat plane. It thus enables the viewer to obtain an otherwise impossible view of the whole earth and confronts the viewer with the possibility of the potential discovery of any place on earth. Three examples of this map have been mentioned in the literature; the other two are in the National Maritime Museum, London, and the Biblioteca Nazionale Centrale, Florence (see plate 16).
Size of the original copper engraving: 20.5 × 34.5 cm. Photograph courtesy of the Arthur Holzheimer Collection.

so-called third projection, which is described in book 7 of the *Geography,* the only one of the transformations described in that book that is actually geometrically projected from a single origin point. Ptolemy's aim was to show how the inhabited world would look as seen through an armillary sphere, as in a perspective picture.

The conceptual similarities between the construction of Ptolemy's third projection and linear perspective are beguiling, but the historical links have yet to be convincingly documented. Humanists did not show much interest in rigorous map projections for terrestrial use in the first half of the fifteenth century. There was no documented interest in the third projection, and indeed it failed to be illustrated in an important manuscript of the *Geography,* the Codex Urbinas Graecus 82.

Furthermore, other mathematically rigorous perspective projections, such as the stereographic, had been introduced much earlier for nonterrestrial mapping, as in the plotting of retes (coordinate nets for different latitudes) for astrolabes. Despite the conceptual similarities of stereographic projection to linear perspective, such as a single origin point, the common use of stereographic projection during the Middle Ages failed to result in the invention of perspective.[46]

Centering and Framing

The adoption of systematic map projections introduced a variety of centering and framing issues. The center of a projection did not usually imply either the author's viewpoint or the most important feature to be portrayed. Unlike *mappaemundi,* in which Jerusalem, Delos, Rome, or some other holy place might be at the center of the map, a map such as Rosselli's ovoid world map was centered on no particular place (the center is off the coast of modern Somaliland). What could be manipulated was the field of view of the projection. Since graduation in longitude and latitude forced the hand of the cartographer to some extent, the area to be covered by a projection had to be carefully calculated. Jodocus Hondius's two-hemisphere map of the world, for example, was designed to show the voyages of Francis Drake and Thomas Cavendish to advantage by including the Americas and Europe/Africa in the same hemisphere, an arrangement that is not to my knowledge repeated on any other double hemisphere maps during the Renaissance (fig. 10.7).

Discovery of America," *Journal of the Society of Architectural Historians* 33 (1974): 274–92.

46. Woodward, "Il ritratto della terra."

The innovative shapes of map projections in the early sixteenth century—oval, ellipse, double hemisphere, cordiform, double cordiform—may have had something to do with the parallel desire in astronomy for a perfect geometrical concordance of objects in the heavens. Georg Joachim Rheticus, for example, believed there were six planets because six was a perfect number (its factors of 1, 2, and 3 add up to 6). Johannes Kepler also postulated a link between the number of planets and geometry: the five Platonic regular solids plus the sphere.[47] Leonardo da Vinci and Albrecht Dürer seem to have experimented with map projections that interrupted the sphere using regular solids, in exercises echoed by Buckminster Fuller in the twentieth century. These examples underline the concordance between terrestrial and celestial cartography that is stressed in this volume by Dekker.[48]

Orientation of the map was another issue. The public often asks why north is now routinely placed at the top of world maps, considering that the world has no "up" or "down." The most straightforward answer is that, during classical times, the people who cared about such things lived in the northern hemisphere and represented their hemisphere uppermost on globes. Since Ptolemy tells us that world maps should be made from globes, it made sense to orient such maps in the same way, with north at the top. Ptolemy's model was eventually accepted as the norm in medieval and Renaissance Europe, and by the twentieth century it had become the most widely disseminated system of world map orientation, even in the southern hemisphere. Its influence now often extends to maps of smaller areas.[49]

Orthogonality

Another aspect of structure associated with coordinate systems and their implied systematic measurement was orthogonality, which we can define as a property of representation according to which every point on a surface is viewed from a direction perpendicular to that surface. In the cartographic context, this means that points are viewed from directly above the earth. This issue has been most frequently rehearsed in discussions about city plans and views and has generated a bewildering array of terms for describing whether a town is seen directly from above, directly from the side, or from somewhere in between (fig. 1.4).[50] The very few examples of printed or manuscript orthogonal plans in the fifteenth and sixteenth centuries—Leon Battista Alberti's reconstructed "Descriptio urbis Romae," Leonardo da Vinci's plan of Imola, the 1545 manuscript plan of Portsmouth, Leonardo Bufalini's plan of Rome, or Antonio Campi's plan of Cremona—are frequently held up as quintessential city plans of the Renaissance, whereas the usual method of portraying a city was as an oblique view, in which the angle of view is less than ninety degrees.[51]

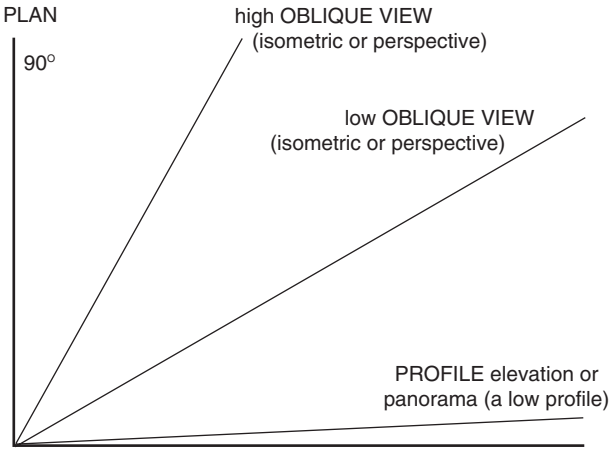

FIG. 1.4. VIEWPOINTS USED IN CARTOGRAPHIC AND LANDSCAPE REPRESENTATIONS. The terms "plan," "oblique view," and "profile" are preferred over the options listed in parentheses below them. Oblique views may be high or low, depending on their purpose, and drawn isometrically or in linear perspective. Each element in the representation—street network, buildings, or other features in the landscape—may have its own view.
After Richard L. Kagan, *Urban Images of the Hispanic World, 1493–1793* (New Haven: Yale University Press, 2000), 5 (fig. 1.4).

47. George Molland, "Science and Mathematics from the Renaissance to Descartes," in *The Renaissance and Seventeenth-Century Rationalism,* ed. G. H. R. Parkinson (London: Routledge, 1993), 104–39, esp. 115.

48. See chapter 6 in this volume.

49. An alternative explanation is offered by Casey, who says (in *Representing Place,* 172) that maps became oriented to the north because "this is where the primary magnetic pole is to be found." But the puzzling notion of a "primary magnetic pole" perhaps *derives* from the convention and is not the cause for it. Magnetic compasses align themselves with the earth's magnetic field; they do not "point" to either pole.

50. Terms for "viewed from directly above" include plan, plan view, geometric plan, ichnographic plan, and orthogonal plan. Terms meaning "viewed directly from the side" include elevation, profile, or panorama (which is a long profile, even 360 degrees). "From somewhere in between" depends on whether the view is from a high or a low angle: either a high oblique view or a low oblique view. The terms plan, profile, view, and oblique are preferred. The complication enters when dealing with how features are represented to scale. *Plans* are drawn to a constant scale, or at least as constant as the projection will allow. *Profiles* also have a consistent scale if the information in them is at a constant distance from the viewer. *Oblique views* may be either *isometric* or *perspective*. In the perspective view, the scale of things nearer in the view is larger than that of things farther away. In an isometric view, the scale of elements from the front to the back in the view is the same as the scale of elements from side to side. The vague terms "bird's-eye view" or "perspective view" are thus to be avoided. An additional complication enters when dealing with different elements in the view, such as the street network, buildings, or other features in the landscape (e.g., trees, hills). Each element can be represented from different views and at different scales. Thus it is possible to have a street network that is constructed in plan while the buildings on the street are seen either in profile or obliquely.

51. See chapter 27 in this volume.

In this context, it is useful to draw a distinction between views that are made from a single known viewpoint (such as might be achieved by an artist viewing the city from a vantage point outside it and representing it as a camera obscura might) and views that are reconstructed as if from a viewpoint only available to one flying above the scene, as in Cornelis Anthonisz.'s celebrated view of Amsterdam. The former constructs a mimetically analogous space by direct observation. The latter requires a mathematical construction and an understanding of perspective geometry in which positions on a planimetric map are plotted onto a perspective grid. In practice, as in the view of Venice by Jacopo de' Barbari (1500), the construction was not as mathematically rigorous as the theory suggests, with various aerial viewpoints being employed for different parts of the view.[52]

The oblique view or elevation was also the easiest way of representing the third dimension, the earth's topographical irregularities on a flat surface, in a "lifelike manner."[53] In a plan view map, hills and valleys are difficult to portray in three dimensions, as the history of relief representation well illustrates.[54] Commensurable hachures and contours were not in common use until the nineteenth century, when military and civil engineers found them useful for measuring slopes. In the Renaissance, the artist might use shading or chiaroscuro, assuming a light source illuminating the mountains from the side and shading them as they might appear from above. Regional maps by Leonardo da Vinci, such as his map of Tuscany, are frequently illustrated as examples.[55]

Labels

In the syntax of the map, it is also possible to distinguish between cartographic and epicartographic elements. Both contribute to the meaning of the whole map, and one is not more important than the other. Cartographic elements are graphic signs within the map frame or on the map plane and can be transformed by generalization and projection, while epicartographic elements are not subject to graphic generalization or projection and lie outside the graphic space or layer of the map. Epicartographic elements include inscriptional names, labels, legends, scales, orientation devices, titles, dedications, notes to the reader, decorative items, or descriptive text about map features. They are usually regarded as being ancillary to the map and have thus not received the analytical attention they deserve. The willingness to include words in the visual space had certainly been present in medieval didactic and narrative painting for the same reasons of clarity in communication. Presumably they were to be read aloud to the viewing audience. For a larger and increasingly literate audience, the inclusion of text posed several issues. One was the choice of language. The increasing use of the vernacular is evident in the late fifteenth century and the sixteenth century for most classes of printed maps, with the exception of those that were intended for scholarly, clerical, or international audiences, for which Latin still remained the language of choice. Latin was displaced by the vernaculars, first in literature, then in law and administration. In maps, the use of language related to the wider market for such books as Sebastian Münster's *Cosmography*. Latin was used for scholarly editions of Ptolemy's *Geography,* except for Francesco Berlinghieri's version in Italian rhyme and Giacomo Gastaldi's pocket edition published in Venice in 1548. Maps of the world and of islands, for which there might have been a more multilingual market, remained in Latin.

Cosynchronicity

A third change in graphic syntax involved what could be called the "tense" of the map—whether the map refers to the past, present, or even future. The tense of medieval *mappaemundi* usually covered a broad span of historical time. No strong distinction between a location and an event was drawn.[56] Places that had once been important in history but no longer existed were shown side by side with currently important places. The map told a story, often a very long one. In the fifteenth and sixteenth centuries, as the atlas became a major genre, this storytelling role was still enormously important in maps.

In the Renaissance, we see an increasing distinction between the representation of current and historical geographies on maps. As the past came to be viewed as something other than the present, it became an object of study in its own right. Collections of Ptolemy's maps began—with Francesco Berlinghieri's *Septe giornate della Geographia* and the Ulm edition of Ptolemy's *Geography*

52. Juergen Schulz, "Jacopo de' Barbari's View of Venice: Map Making, City Views, and Moralized Geography before the Year 1500," *Art Bulletin* 60 (1978): 425–74, and Francesco Guerra et al., "Informatica e 'infografica' per lo studio della veduta prospettica di Venezia," in *A volo d'uccello: Jacopo de' Barbari e le rappresentazioni di città nell'Europa del Rinascimento,* ed. Giandomenico Romanelli, Susanna Biadene, and Camillo Tonini, exhibition catalog (Venice: Arsenale Editrice, 1999), 93–100.

53. Lucia Nuti, "The Perspective Plan in the Sixteenth Century: The Invention of a Representational Language," *Art Bulletin* 76 (1994): 105–28. Nuti discusses the preference for oblique views over planimetric maps in the sixteenth century, on the grounds they were "lifelike" ("ad vivum"), and the eventual merging of the plan view with oblique pictures of buildings and monuments superimposed on it.

54. Eduard Imhof, *Cartographic Relief Presentation,* ed. Harry Steward (Berlin: De Gruyter, 1982).

55. Woodward, "Image of the Map," 142.

56. Evelyn Edson, *Mapping Time and Space: How Medieval Mapmakers Viewed Their World* (London: British Library, 1997), and Alessandro Scafi, *Mapping Paradise: A History of Heaven on Earth* (Chicago: University of Chicago Press, 2006), 84–124.

(both published in 1482)—to include *tabulae novellae* or *tabulae modernae* (modern maps) side by side with the classical maps of Ptolemy.[57] By the time Mercator's edition of Ptolemy was published in 1578, the modern maps had disappeared. Ptolemy was now to be valued as a historical figure.[58] The use of the word "modern" in map titles became much more common, along with such other commercially attractive catchwords and phrases as "universal," "new," and "everything known up until now." Accompanying such words in titles were those intended to convince the consumer that the cartographer was representing the truth: "True description," "faithful," "with the utmost accuracy." This genre of modern maps was consciously constructed to represent current geography. Information depicted within the frame of the map—within the limits of the sources—was assumed to be up to date.

In the sixteenth century, a separate cartographic genre arose: explicitly historical maps depicting places as they once had been. The roots of the genre lay partly in the antiquarian interests of the Italian humanists of the fifteenth century, such as Flavio Biondo, whose fascination with the ruins of Rome drove them to reconstruct the city's past geography. As Rome recovered from its sack by Charles V's troops in 1527, maps of ancient Rome were among the most popular items sold by Antonio Salamanca and Antonio Lafreri, the printsellers who emigrated to the printing district of Rome and set up a successful partnership.[59] Likewise, historical maps of the Holy Land depicting the lands as they had appeared in biblical times were among the most widely distributed maps in the Reformation.[60] In the late sixteenth century, historical maps were gathered into a separate section known as the *Parergon* (1579–1606) of Abraham Ortelius's *Theatrum orbis terrarum*.[61] Maps were now either ancient or modern; the blending of time and space we saw in medieval world maps had translated into a compartmentalizing of old and new, of history and geography.

The Relationship of Maps to Sources in the Observed World

Maps as a Metaphor for Science

The use of intersections of longitude and latitude that Ptolemy proposed as control points for mapmaking is not unlike the process by which a researcher gathers observations about the world and compares them against the framework of the laws of nature. It is not surprising that the map has been used as a metaphor for modern science.[62] If "science" in the Renaissance meant the pursuit of knowledge about the natural world, the model of cartography built upon the cumulative observations of others.[63] Implied also is the importance of collaboration with contemporary colleagues. For cartography in the sixteenth century, the two best examples are Sebastian Münster and Abraham Ortelius. Toward the end of the preface to his *Cosmography,* dedicated to Charles V, Münster tells us that he relied on correspondence with observers in countries outside Germany to provide him with corrections and updates based on their local knowledge.[64] Ortelius included in the *Theatrum orbis terrarum*—for the first time—a list of authors whose maps he relied on for his compilations.[65]

An illustration of this approach to compilation using widely different sources is provided by Nicolaus Cusanus's intriguing image of the cosmographer as creator, which we find in the *Compendium,* written in the year of his death, 1464. Nicolaus chose the metaphor of a cosmographer as a man positioned in a city with five gates, representing the five senses. Messengers bring him information about the world using these senses, and he records the information in order to have a complete record of the external world. He tries to keep all the gates open so as not to miss information gathered by any particular sense. When he has received all the information from the messengers, he "compiles it into a well-ordered and

57. The "novella" maps in Berlinghieri were of France, Italy, Palestine, and Spain. The Ulm Ptolemy "moderna" maps added one of northern Europe. See Campbell, *Earliest Printed Maps,* 124–25.

58. Claudius Ptolemy, *Tabulae geographicae: Cl. Ptolemei admentem autoris restitutae et emendate,* ed. Gerardus Mercator (Cologne: G. Kempen, 1578).

59. David Woodward, *Maps as Prints in the Italian Renaissance: Makers, Distributors & Consumers* (London: British Library, 1996), 41–44; see also pp. 775–77.

60. Catherine Delano-Smith and Elizabeth Morley Ingram, *Maps in Bibles, 1500–1600: An Illustrated Catalogue* (Geneva: Librairie Droz, 1991).

61. Jeremy Black, *Maps and History: Constructing Images of the Past* (New Haven: Yale University Press, 1997), and Walter A. Goffart, *Historical Atlases: The First Three Hundred Years, 1570–1870* (Chicago: University of Chicago Press, 2003).

62. Stephen Edelston Toulmin, *Knowing and Acting: An Invitation to Philosophy* (New York: Macmillan, 1976), and David Turnbull, *Maps Are Territories, Science Is an Atlas: A Portfolio of Exhibits* (Geelong, Australia: Deakin University Press, 1989).

63. Edgar Zilsel, "The Genesis of the Concept of Scientific Progress," *Journal of the History of Ideas* 6 (1945): 325–49, esp. 326. Zilsel explains that the idea of progress comes about most clearly in the notion that "scientific knowledge is brought about step by step through contributions of generations of explorers building upon and gradually amending the findings of their predecessors." Zilsel uses the metaphor of "explorers," but of course this is precisely the way in which maps of geographical exploration are made.

64. Sebastian Münster, *Cosmographiae universalis* (Basel: Henri Petri, 1559), praefatio.

65. Zilsel, in "Concept of Scientific Progress," 344–45, regards Ortelius's list of authors as "the first extensive bibliography in modern scientific literature. . . . [It] too manifest[s] the modern idea of scientific coöperation." See also Karrow, *Mapmakers of the Sixteenth Century.*

proportionally measured map lest it be lost."[66] He then shuts the gates, sends away the messengers, and turns to the map, meditating on God as the Creator who existed prior to the entire world, just as the cosmographer existed prior to the appearance of the map. Nicolaus concludes that, "in so far as he is a cosmographer, he is creator of the world," a carefully worded phrase whose sentiment would get cosmographers such as Gerardus Mercator and André Thevet into trouble with the church a century later.[67] Nicolaus's story illustrates the notion that by creating maps people saw, perhaps for the first time, that they could influence events and create worlds, that they could have the freedom to do things, rather than accept passively whatever God had ordained. Implicit in this passage is the realization that the world and the human representation of it were two different things.

Open and Closed Systems

The cartographer could create a representation of the world by systematic observation and could control the marks on paper that referred to things in the real world. The cartographer was in control of the situation, as we see from one of those rare glimpses of what was going on in the cartographer's mind. On the map of the siege of Algiers, Paolo Forlani addresses his readers: "I have respect for the proportions of Italy and Spain vis-à-vis the bridge marked A, but to show all its details to your eyes in the true method of chorography, we have made it the [exaggerated] size and form that you see."[68]

This awareness of the representation itself and of how it relates to the world is certainly not absent in the Middle Ages. Matthew Paris once drew the attention of the reader to the fact that he would have made his map of Britain in the correct proportion had the size of the page allowed it.[69] Roger Bacon understood such a need when he indicated that he had represented cities on his thirteenth-century world map with red circles.[70] And the makers of the portolan charts, which as we have seen exemplified one of the great continuities between the Middle Ages and the Renaissance, were clearly aware of the system of signs that they created. What appears to have been missing in the Middle Ages was the inclusion of a formal legend or map key that makes explicit the relationship between a sign and what it signifies. For example, for some categories of information, portolan charts had a monosemic system of color and sign, as in the use of small crosses for rocks and dots for shoals off coasts. A small cross never meant a shoal. But there are no legends. This is not because a legend was not possible, but because none was necessary. The cartographer and the intended users of the map belonged to a highly specialized closed system of communication involving a deeply initiated audience; coding could prosper, but a legend was unnecessary because the audience already knew the code. In an open system, in which a wider audience is targeted, it is much more difficult to omit the legend. For example, in Sebastian von Rotenhan's map of Franconia in the late 1520s, published by Peter Apian in 1533, the cartographer tells the reader that a particular sign means a city with a bishopric.[71] A modern analogy of closed and open sign systems is the contrast between modern tourist maps, with their mimetic pictures of buildings, presumably intended for a broad international audience, and an aeronautical chart, with its arcane array of signs, designed for an initiated and highly trained audience.

As the variety of specialized uses for maps multiplied in the fifteenth and sixteenth centuries, maps increasingly relied on special cognitive "agreements" between the mapmaker and map user in the form of legends implied or explicit. Joining sea charts as examples of closed sign systems were globes, armillary spheres, celestial maps, engineering plans for public works, military and fortification maps for strategic planning, legal maps to address resource and boundary issues, historical maps for scholars, and biblical maps for exegesis. Each type of map required the development of its own arcane coding system.

This difference between open and closed sign systems is analogous to the perceived difference between natural and artificial languages. Since natural images are considered to mimic nature (a line represents a horizon or some other kind of boundary), an external reality, their authority is also external and God-like. The human creation of an artificial representation, such as a technical map with a legend, challenged this authority and spoke to the independence of the mapmaker.

Geographical Exploration and Trade

Part of the independence of the mapmaker involved an increasing reliance on firsthand accounts of geographical phenomena in an ever-expanding world. This reliance on observations from personal experience is usually placed in opposition to the tradition of medieval book learning

66. Nicolaus Cusanus, *Compendium,* ed. Bruno Decker and Karl Bormann, *Nicolai de Cusa Opera omnia,* vol. 11/3 (Hamburg: Felix Meiner, 1964), 17–20.

67. Cusanus, *Compendium,* 17–20, and Lestringant, *Mapping the Renaissance World,* 5–6.

68. David Woodward, *The Maps and Prints of Paolo Forlani: A Descriptive Bibliography* (Chicago: Newberry Library, 1990), 26 (map 38).

69. Harvey, "Local and Regional Cartography," 496.

70. Roger Bacon, *The* Opus Majus *of Roger Bacon,* 3 vols., ed. Henry Bridges (London: Williams and Norgate, 1900), 1:300.

71. Eila M. J. Campbell, "The Development of the Characteristic Sheet, 1533–1822," in *Proceedings, Eighth General Assembly and Seventeenth International Congress: International Geographical Union* (Washington, D.C.: International Geographical Union, 1952), 426–30, and Catherine Delano-Smith, "Cartographic Signs on European Maps and Their Explanation before 1700," *Imago Mundi* 37 (1985): 9–29.

in which a received wisdom derived from a source external to the individual, such as the scriptures, the church, or the philosophers of Antiquity (Ptolemy, Vitruvius, Strabo, Pomponius Mela, and a host of others).[72] The theory of the valorization of experience was not new in the fifteenth and sixteenth centuries, of course. It was in fact a restatement of Aristotle's proposed empirical method for knowing the world (which, however, was of less importance in the early Middle Ages than the textual authority of his works on natural history). But this desire to describe the world from direct experience was often an unattainable doctrine of perfection, unfulfilled by the observations themselves. Thus Roger Bacon—despite his insistence in the "Opus maius" on the theoretical importance of seeing natural phenomena with one's own eyes or at least relying on the accounts of travelers who had actually been to the regions they described—rarely employed this method in his geographical writing. Rather he preferred to weigh the descriptions of the scholarly authorities.[73]

Renaissance cartography has often been linked to the colonial and religious expansion of Europe.[74] Mapping supported a sense of territorial self-entitlement that allowed religious and political leaders to claim vast areas of land overseas in the name of Christian European states. In Brian Harley's words, "Maps were also inscriptions of political power. Far from being the innocent products of disinterested science, they acted in constructing the world they intended to represent. . . . Cartographic power was also a metaphor. It was expressed as imperial or religious rhetoric, as part of the creation ritual of taking possession of the land." [75] Such ceremonies of possession varied with the colonial power. The Portuguese relied on the abstract means of description, measured latitudes, to claim land. Their argument was that they had developed the technological knowledge to do so and hence had the right to wield it to their advantage.[76] Mapping and surveying knowledge seem such an obvious form of evidence for colonial claims that their lack of treatment in some works is puzzling.[77]

A major theme in the history of exploration cartography has been the encounter with the indigenous traditions of mapping and spatial knowledge.[78] Indeed, in the planning for volumes 3–6 of this *History,* Harley maintained that "there should be no separate volume dealing with the indigenous cartographies of the African, American, Arctic, Australian, and Pacific cultures. He believed they could be satisfactorily explained only in the context of European contact. . . . Harley believed this was the only satisfactory way to bring out the contrasts and connections in the worldviews of natives and colonists." [79] I have defended the decision to create a separate volume for these traditions on the grounds that it provides a convenient comparative treatment.[80] Although several of our authors allude to the encounter in the present volume, the work reflects the development of largely European cartographic cultures.

In the view of some scholars, geographical discovery has loomed too large in many accounts of the Renaissance. As Condren put it, "The notions of Renaissance and discovery have retained an almost colloquially close relationship which has done little to aid the rigour of historiography." [81] Commenting on this, Hay argued that historians were becoming skeptical of the view that "the geographical discoveries of the Renaissance . . . were in any genuine sense a product of the new thought of the period. A fresh interest in the text of Ptolemy may have been influential—but less so, we may suppose, than the writings of Marco Polo." [82] In contrast to the idea of discovery as an end in itself, Hay asserted that "the motives behind Portuguese exploration . . . were, to say the least, mixed; scientific cartography, a disinterested wish for geographical knowledge were certainly there, but were equally certainly subordinated to a programme dominated by politics, religion and (increasingly) commercial advantage." [83] It is thus important to separate the different kinds of influence that Ptolemy's text might have had from those of Marco Polo's writings. Ptolemy's text, in

72. Anthony Grafton, *New Worlds, Ancient Texts: The Power of Tradition and the Shock of Discovery* (Cambridge: Belknap Press of Harvard University Press, 1992).

73. Bacon, *The* Opus Majus, 295.

74. J. H. Parry, *The Age of Reconnaissance* (Cleveland: World, 1963).

75. J. B. Harley, *Maps and the Columbian Encounter: An Interpretive Guide to the Travelling Exhibition* (Milwaukee: Golda Meir Library, University of Wisconsin, 1990), 2.

76. Patricia Seed, *Ceremonies of Possession in Europe's Conquest of the New World, 1492–1640* (Cambridge: Cambridge University Press, 1995), 115.

77. For example, James M. Blaut's *The Colonizer's Model of the World: Geographical Diffusionism and Eurocentric History* (New York: Guilford Press, 1993), is silent on cartographic evidence, although its cover sports an attractive map and his approach is significantly geographical.

78. See especially Walter Mignolo, "Putting the Americas on the Map (Geography and the Colonization of Space)," *Colonial Latin American Review* 1 (1992): 25–63; J. B. Harley, "Rereading the Maps of the Columbian Encounter," *Annals of the Association of American Geographers* 82 (1992): 522–36; idem, "New England Cartography and the Native Americans," in *American Beginnings: Exploration, Culture, and Cartography in the Land of Norumbega,* ed. Emerson W. Baker et al. (Lincoln: University of Nebraska Press, 1994), 287–313; and David Turnbull, "Local Knowledge and Comparative Scientific Traditions," *Knowledge and Policy* 6, no. 3–4 (1993–94): 29–54.

79. David Woodward, "Preface," in *HC* 2.3:xix–xxi, esp. xix.

80. David Woodward, "The 'Two Cultures' of Map History—Scientific and Humanistic Traditions: A Plea for Reintegration," in *Plantejaments,* 49–67, esp. 51–53.

81. Conal Condren, "The Renaissance as Metaphor: Some Significant Aspects of the Obvious," *Parergon,* n.s. 7 (1989): 91–105, esp. 101.

82. Denys Hay, "Introduction," in *The New Cambridge Modern History: The Renaissance, 1493–1520,* ed. George Reuben Potter (Cambridge: Cambridge University Press, 1961), 1–19, esp. 2. Note the dates of Potter's volume bracketing the "Renaissance."

83. Hay, "Introduction," 2–3.

retrospect, was not primarily of value as a source of geographical information, no matter the esteem in which his data was held in the fifteenth and sixteenth centuries as the product of the archetypal geographer. Indeed, it was perhaps Ptolemy's anachronistic information that provided a negative impetus for reform. Ptolemy's positive influence was far subtler, implying through a mathematicization of the known inhabited world by means of longitude and latitude a measured—albeit faulty—estimate of what remained beyond the Greco-Roman inhabited world.

Marco Polo's book, on the other hand—even granted its author's penchant for exaggeration—provided a narrative description of renewed trading possibilities with the East. Marco's travels, in turn, were prompted by the Crusades (1096–1270), which enormously widened the geographical horizons of many classes of people, increased mobility, and fostered a culture of trade and travel.

In the thirty years between Columbus's departure in 1492 and the return of Magellan's flagship *Victoria* in 1522, a huge amount of new geographic data had been gathered. The immensity of the ocean between America and Asia was recognized by Europeans for the first time. The West Indies could no longer be confused with the East Indies on world maps with any pretension to accuracy, and the Americas had to be represented as a separate entity, except by those whose commercial minds were still rooted in the idea that Cathay was simply part of the American mainland. But the cartographic record of this period is remarkably slim, particularly in the 1490s, even granted the amount of wastage that must have taken place through secrecy and destruction. Perhaps a dozen key maps survive.[84]

The globalization of cartography involved what Parry called "the discovery of the sea" in the sense of the realization that the oceans were connected. This involved a cumulative piecing together of key voyages of exploration and trade, including the route to the East and the awareness that the Americas were a fourth continent.[85] In his article on the origins of modern science, Hooykaas stresses the importance of the geographical discoveries:

> When the Portuguese seafarers discovered that the tropical regions were habitable and inhabited, that there was much land south of the equator, that there was more dry land on the globe than had been taught them, that Southern India protruded much farther into the "Indian Sea" than Ptolemy had told them and that the shape of West Africa (the Gulf of Guinée) was widely different from what ancient maps indicated—all this gave a severe shock not only to them but to the learned world as well. . . . [Francis] Bacon was firmly convinced that the voyages of discovery had coincided with the beginnings of the new natural history, and that the latter inevitably had to be followed by a new philosophy (i.e., science).[86]

Much European discovery was driven by the enormously lucrative trade in spices, especially pepper and cloves, in the subtropical regions of India and Southeast Asia.[87] Discovery of a route to those areas to avoid the overland Eurasian route, which was controlled by a series of middlemen, originally stimulated the competing efforts of the Portuguese and Spanish, later primarily the English and Dutch, in mapping their commercial interests. A web of trade in exotic gems, rare metals, foodstuffs such as sugar, and materials such as cotton and silk fueled the growth of a capitalist world economy in the Renaissance whose cartographic role has been recently stressed by Jardine and Brotton.[88] Harris has made the point that cartography was a paradigmatic "big science" in the sense that it employed long-distance networks. He uses the concept of the "geography of knowledge," by which he means the spatial connections between artifacts and people associated with a particular branch of knowledge, to explain how large corporations operated. He gives four examples, all of which have strong cartographic associations: the Casa de la Contratación de las Indias, the Consejo Real y Supremo de las Indias, the Verenigde Oostindische Compagnie (VOC), and the Society of Jesus.[89]

THE RELATIONSHIP OF MAPS AND SOCIETY

Printing

Printing was obviously the controlling technical factor in the enormous increase in the number of maps made in Europe from a few thousand between 1400 and 1472 to millions by 1600. In his influential essay on the role of prints in culture, Ivins stated: "It is hardly too much to say that since the invention of writing there has been no more important invention than that of the exactly repeatable pictorial statement."[90] Since prints have been regarded largely in antiquarian and aesthetic terms, he ar-

84. They are fully analyzed in several of the following chapters.

85. J. H. Parry, *The Discovery of the Sea* (New York: Dial Press, 1974), xii.

86. Reijer Hooykaas, "The Rise of Modern Science: When and Why?" *British Journal for the History of Science* 20 (1987): 453–73, esp. 459, 470.

87. For a useful summary, see Harry A. Miskimin, *The Economy of Later Renaissance Europe, 1460–1600* (Cambridge: Cambridge University Press, 1977), 123–54.

88. Lisa Jardine, *Worldly Goods: A New History of the Renaissance* (New York: Doubleday, 1996), and Jerry Brotton, *Trading Territories: Mapping the Early Modern World* (London: Reaktion, 1997).

89. Steven J. Harris, "Long-Distance Corporations, Big Sciences, and the Geography of Knowledge," *Configurations* 6 (1998): 269–304, esp. 279.

90. William Mills Ivins, *Prints and Visual Communication* (New York: Routledge and Kegan Paul, 1953), 3.

gued, they have been viewed as a minor art in comparison to painting and sculpture. This depreciation has masked their fundamental value of conveying information. Once defined in this way, "it becomes obvious that without prints we should have very few of our modern sciences, technologies, archaeologies, or ethnologies—for all of these are dependent, first or last, upon information conveyed by exactly repeatable visual or pictorial statements." [91] As an example, Ivins cited Pliny's description of the inability of the Greek botanists to disseminate exact descriptions of botanical specimens. To paraphrase Pliny, the various distortions at the hands of successive copyists hindered the ability to reconstruct the original. They thus gave up describing plants with pictures and chose words instead. Since verbal description could not provide positive identifications of species, this set up a roadblock to classification and taxonomy that could only be cleared by the development of a system to make exact copies.

Eisenstein's thoughtful commentary on Ivins's dictum on the exactly repeatable pictorial statement was particularly welcome to historians of cartography as it used the example of printed maps to enlarge the context. She introduced the topic by stating that "the fact that identical images, maps and diagrams could be viewed simultaneously by scattered readers constituted a kind of communications revolution in itself." [92] Eisenstein's view of the importance of printing for the cumulative gathering of information is echoed by Olson, whose general book on the implications of writing and reading unusually contains a section on maps. According to Olson, "The 600 or so maps which have survived from the period before 1300 show no sign of general developmental progression towards a comprehensive map of the world. The principal stumbling block to such a map was the lack of reliable means of duplicating maps, an obstacle overcome only with the invention of printing and engraving, and the invention of a common, mathematical, frame of reference which would permit the integration and synthesis of information being accumulated on the voyages of discovery." [93]

The portolan charts again demonstrate that they form a different map genre. Portolan charts existed from before 1300 and were not routinely printed until the late sixteenth century in the form of the sea atlas, the *Spieghel der zeevaerdt*. The sporadic exceptions are the *isolario* of Bartolommeo dalli Sonetti (1485), a few early sixteenth-century Dutch charts, charts of the Mediterranean by Giovanni Andrea Valvassore (1540), and an engraving based on a chart by Diogo Homem (1568). The major world charts, such as those associated with the various trade *casas* of Spain and Portugal, remained in manuscript. Olson's thesis also ignores the fact that centuries of printed maps in the Song dynasty in China did not remove a similar obstacle in the "general developmental progression towards a comprehensive map of the world."

The impact of print has usually been described in terms of the wider dissemination of content. While this is partly true, we must not succumb to the convenient view that the advent of printing produced an instant revolution. The concept of publishing did not depend on printing; Pliny the Younger refers to an "edition" of a thousand copies of a manuscript text. But when viewed as conveyors of information, Ivins and Eisenstein argue that the advantage of printed images lay more in the production of versions free from the corruption of the copyist, which could be used for comparative study. When map compilers had at their fingertips several standard printed sources of geographical data, such study was bound to benefit. As maps from different regions, scales, and epochs were brought into contact with each other in the course of compiling successive editions of atlases, contradictions became more visible, and divergent traditions more difficult to reconcile. As Latour has pointed out, the ability to lay out images side by side is extremely powerful: "There is nothing you can *dominate* as easily as a flat surface of a few square meters; there is nothing hidden or convoluted, no shadows, no 'double entendre.' In politics as in science, when someone is said to 'master' a question or to 'dominate' a subject, you should normally look for the flat surface that enables mastery (a map, a list, a file, a census, the wall of a gallery, a card index, a repertory) and you will find it." [94]

Ivins and Eisenstein perhaps overemphasized the relative weight of the role of feedback and the value of comparison, given the sheer numbers of maps produced. Although copper engraving was able to reproduce basically identical impressions from a plate, the images on these plates constantly became corrupted. Maps were pirated and roughly copied, and it is impossible to trace a clear "improvement" or progressive feedback in their content, as a glance at illustrated bibliographies of printed maps, such as those compiled by Shirley or Burden, will readily confirm.[95] Here the corruptive tendencies of the manuscript era would remain, until images could be mechanically reproduced, an advance that would await the invention of photography in the nineteenth century.

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91. Ivins, *Prints,* 3.

92. Eisenstein, *Printing Press,* 53.

93. David R. Olson, *The World on Paper: The Conceptual and Cognitive Implications of Writing and Reading* (Cambridge: Cambridge University Press, 1994), 205.

94. Bruno Latour, "Visualization and Cognition: Thinking with Eyes and Hands," *Knowledge and Society: Studies in the Sociology of Culture Past and Present* 6 (1986): 1–40, esp. 21.

95. Shirley, *Mapping of the World,* and Philip D. Burden, *The Mapping of North America: A List of Printed Maps, 1511–1670* (Rickmansworth, Eng.: Raleigh, 1996).

It is easy to assume that maps in the period of discovery had an impact only through their content or lack of it. Some claim that, because few accounts of the discoveries appeared in print until after 1550, the public was not interested in them.[96] Others believe that Europeans were so overwhelmed by the sheer novelty of the new information—accounts of new plants, animals, peoples, and indeed of a whole new continent—that they could only assimilate it gradually. Some argue that, because printed maps often did not represent the cutting edge of new geographical information, map printing did not have great consequences in the sixteenth century. The lack of printed nautical charts in the sixteenth century supports this argument, as does the random superimposition on printed maps of rhumb lines that bear no relation to the geographical information underneath or to any nautical function, implying perhaps that the nautical tradition might have been considered more reliable. People were also aware of the subjectivity of such maps. Richard Hakluyt knew of the conflicting claims of the Portuguese and Spanish in their official nautical cartography: "I have caused that your Lordshippe shall receyue herewith a little Mappe or Carde of the worlde: the whiche, I feare mee, shall put your Lordshippe to more labour to understande, then mee to make it. . . . For these coasts & situations of the Islands, euery of the Cosmographers and pilots of Portingall and Spayne doe set after their purpose." [97]

However, if one focuses not on the content of maps but on their economic role as consumer commodities, a different picture emerges. Here their graphic form as well as their function was important in establishing a holistic vision of the world.[98] Such a vision of the general layout of countries and continents might not have been particularly accurate (a limitation that persists today not only in the general population but also in political leaders), but it engendered a culture of cosmopolitanism in a larger range of social classes. Geography also became an essential part of general education, and the accoutrements of the cartographer (surveying instruments, globe, and armillary spheres) became icons of learning.[99]

The Role of the "Superior Artisan"

The tendency for map historians to focus on cartography as an activity by or for the elites—princes, military commanders, and scholars—has clouded the point that cartography was fundamentally a technology, along with other practical or industrial arts, undertaken by a middle class of artisans. The role of these artisans—engineers, printers, physicians, alchemists, cartographers, pilots, engravers, and instrumentmakers—was connected with the new configuration of natural history as experimental philosophy and with a shift from an organic to a mechanistic world as described by Hooykaas.[100]

I agree with Zilsel, who believes that, far from being technically straightforward, these technologies can be credited not only with driving the development of natural philosophy in the sixteenth century, but also with the origin of "the ideal of scientific progress." Zilsel calls these technologists "superior artisans," capable of writing about their personal and practical experiences and publishing them in the form of manuals.[101] He also stresses the importance of the breaking of the guilds in disseminating information. Under the guild system, apprentices learned a trade but did not necessarily improve on it. Capitalism and economic competition stimulated technical improvement. Sometimes the authors of the manuals explicitly declared that they intended to further the craftsmanship of their colleagues by publishing them. The number of illiterate master craftsmen was surprisingly small in the sixteenth century, for the incidence is usually mentioned only as a curiosity.[102]

A study by Westfall, a historian of science, confirms this view of the importance of the "superior artisan" for both the Renaissance and the Enlightenment:

> The most developed scientific technology during the 16th and 17th centuries, in my opinion the first truly scientific technology, was cartography. . . . I think of Gemma Frisius, Willebrord Snellius, Philippe de La Hire, Jean Picard, the two [elder] Cassinis [Jean-Dominique Cassini and Jacques Cassini], and other lesser ones. All of the important steps in the development of a scientific cartography, such as the method of triangulation, the determination of latitude by celestial observation, the determination of longitude by means of the satellites of Jupiter, came from these men. Any person known to be skilled in mathematics was apt to find some chore in cartography thrust upon him. For the 630 as a whole [people listed in the *Dictionary of Scientific Biography* for the sixteenth and seventeenth centuries], about one out of eight engaged in some cartography. If we eliminate the physicians, who did very little cartography, the figure was more than one in five. There is no doubt that my data has convinced me that

96. Lucien Febvre and Henri-Jean Martin, *The Coming of the Book: The Impact of Printing, 1450–1800,* trans. David Gerard (London: New Left, 1976), 278–82.

97. Richard Hakluyt, *Divers Voyages Touching the Disouerie of America, and the Ilands Adiacent vnto the Same* . . . (London: T. Woodcocke, 1582), B4v and C3.

98. Chandra Mukerji, *From Graven Images: Patterns of Modern Materialism* (New York: Columbia University Press, 1983), 97–98.

99. Lesley B. Cormack, *Charting an Empire: Geography at the English Universities, 1580–1620* (Chicago: University of Chicago Press, 1997).

100. Hooykaas, "Rise of Modern Science," esp. 471.

101. Zilsel, "Concept of Scientific Progress," 326 and 332. See also Molland's commentary on Zilsel, "Science and Mathematics," 104–39.

102. Zilsel, "Concept of Scientific Progress," 331–32, and n. 12.

> we need to approach the whole issue of science and technology in a way different from that of the past.[103]

Conclusion

If we return to Rosaccio's modest 1610 broadsheet, with which we introduced this chapter, our discussion confirms that it speaks to many of the issues that need to be covered in a volume on the history of cartography in the European Renaissance. Rosaccio's collage of images clearly demonstrates that—even if he viewed the geographical knowledge of his own time as revealing dramatic changes in content and form from that of the classical scholars—several continuities remained. Central among them were the Aristotelian system of elements, winds, and climatic zones as well as the correspondence between the celestial circles (tropics, poles, ecliptic, and equator) and those that described positions on the earth. Other changes and continuities have been provided with different examples.

Geographic information in graphic form was in general slower to catch on than the conventional model of swift, dramatic change in the cartographic Renaissance has led us to believe. Textual descriptions of the world at all scales were long favored by scholars. Maps rarely illustrated geographical texts, and those that were included were often added as an appendage rather than to clarify the meaning of the text. Even the maps accompanying Ptolemy's *Geography* were slower to excite interest among humanists than has been supposed, as Leon Battista Alberti's satirical allusion to the graticule, mountains, and river systems on Ptolemy's maps might suggest.[104] Terms such as *mappa* and *chorographia* confusingly applied to either texts or graphics. Itineraries to plot courses on land or sea were favored over their graphic equivalents.

Those graphics that were employed tended to be extremely conservative and follow models that had already been established in the Middle Ages. The portolan charts changed little as long as they were confined to the Mediterranean, and views of cities continued to be impressionistic and lacked information based on direct observation, despite the oft-quoted exceptions to the rule. Scholarly celestial maps and globes continued to be compiled in the same fashion as had been prescribed by Ptolemy's *Almagest,* with coordinates. (However, the number of star positions increased, particularly toward the end of the period covered in this volume, when telescopic lenses were introduced.) Although methods for compiling land survey maps were described and copious depictions of surveying instruments were included in several manuals in the sixteenth century, theory was far ahead of practice. Ptolemy's theoretical exhortation to use longitude and latitude to plot new observations was well heeded in the sixteenth century, but obtaining good data for these coordinates—particularly longitude—was another matter. One could maintain that the use of maps to plot observations lagged as much as the sacred uses of maps persisted.

This is not to say that profound changes in cartographic method and practice did not take place in the Renaissance. The fact that the abstract theory of geographical coordinates was accepted as a way to make maps was in itself a significant change, as was the construction of maps orthogonally, from an infinity of impossible human viewpoints in space. The implications of this geometric view of cartography for the centering, framing, and orientation of maps were far reaching in the public perception throughout the world.

Likewise, a distinct separation on maps of historical from contemporary information took place in the Renaissance, favoring the idea that things represented in the map space should all have the same "tense." This separation was no doubt motivated by a desire to set aside the antiquarian as being worthy of study in its own right, and to portray it in overtly "historical" maps, while recognizing the need to compile maps with the most up-to-date information possible.

Related to this idea is the concept of using the map as a metaphor for accumulating empirical data about the world. Once the theory of the earth's graticule had been accepted, it became clearer how longitude and latitude positions could be collected to fill in the gaps in geographical knowledge. This procedure of plotting data underlay the main assumption of the new natural philosophy, although it would take more systematic efforts to gather data in the eighteenth century to achieve a more coherent world picture. Nowhere was this issue more relevant than in the demands of European expansion in the Renaissance in the interests of trade, settlement, and proselytization; geographical knowledge was essential to economic, political, and social power.

Coincident with this new way of plotting data arose an awareness of the representation itself and of how it related to the world, or an awareness that representations of the world and the world itself were two different things. This resulted in a greater reliance on or more thought given to using artificial codes in cartographic representation. It is not that a fully fledged system of conventional signs was created—this had to await the beginning of the nineteenth century—but that the complexity

103. Richard S. Westfall, "Charting the Scientific Community," in *Trends in the Historiography of Science,* ed. Kostas Gavroglu, Jean Christianidis, and Efthymios Nicolaidis (Dordrecht: Kluwer, 1994), 1–14, esp. 12–13.

104. See Grafton, *Leon Battista Alberti,* 244.

of representation required the invention of the map key or legend, as a kind of contract between mapmaker and map user. As increasingly specialized genres of maps came to be used, it also became clear that there were open and closed systems of representation, depending on which skills the reader could be assumed to possess.

The readership of maps was inevitably broadened by the rapid development of graphic printing and of a commercial map trade that became increasingly independent of elite patronage. Although the new idiom of printing certainly played an increased role in feedback and quality control, it is important not to underestimate the effect of an enormous increase in the sheer number of maps in circulation by 1600 compared to a century earlier.

The extension of the map market to the middle classes and even, for cheaper types of maps, the working classes has not traditionally been studied in the history of cartography; greater attention has been paid to the role of maps in the elite European courts of the Renaissance. But it is becoming increasingly clear that, if we are to understand fully how maps were used in this period, new research will need to focus wherever possible on these everyday uses. In addition, when studying the mapmaker in the Renaissance, our attention must sometimes shift from the grand canon of well-known maps to the maps of the "superior artisans" like Giuseppe Rosaccio, of which this volume contains many examples.