Constructing Cosmography: The Printed Image as a Visual Tool in Peter Apian's *Cosmographicus Liber*

Alexandra Challenger

Peter Apian's *Cosmographicus Liber* (Figure 1), a popular didactic text on cosmography, helped to expand the discipline from a relatively small group of practitioners to a largely non-professional audience.[1] First published in 1524, Apian's illustrated volume purported to teach its readers the basics of cosmography, a mathematical study of the earth and the cosmos that used latitude, longitude, and the orbits of the planets to map geographic locations.[2] This particular text was remarkable for the variety of illustrations and tools that introduced the reader to an innovative method of conceptualizing the heavens; it even included working paper instruments with multiple moving parts. Because its audience was generally less familiar with the mathematical foundations of cosmography, the older, schematic diagrams and written descriptions used by professional astronomers were less effective in conveying the concepts needed to fully engage with the discipline. Therefore, the success of the *Cosmographicus* for a lay readership hinged upon Apian's ability to translate his method of conceptualizing the cosmos into an easily understood and convincing visual system.

As a text that broadened existing visual conventions with great commercial success, Apian's *Cosmographicus* provides an ideal case study of how images came to play a larger, more authoritative role in scientific manuals. Yet despite the graphic innovation apparent in his text, Apian added little new information to the cosmographic discipline in the *Cosmographicus*. It is perhaps for this reason that discussions of this volume pertain largely to its relevance within the history of science and cartography.[3] This study, however, argues that Apian's illustrations and tools within the *Cosmographicus* indicate his awareness of the need for an understanding of the cosmos in which abstract concepts and theories were expressed in pictorial terms. It claims that Apian's visual program made use of advances in print technology to integrate new forms of imagery and tools into the medium of the book. In doing so, his *Cosmographicus Liber* not only altered the relationship between illustration and text, but also indicated that in fields like cosmography, which required the use of instruments to mediate between observed phenomena and scientific interpretation, the printed image itself was a vital instrument in conveying knowledge.

While Apian's visual program in the *Cosmographicus* has been the subject of two recent studies that examined how images played a more prominent part in the construction of meaning, the role of the print medium in facilitating this development has yet to be fully developed.[4] Of crucial importance for this study is Susan Dackerman's recent exhibition catalogue, *Prints and the Pursuit of Knowledge* (2011), which examines the collaboration of scientists, artists, and printers in developing new visual conventions for scientific texts.[5] As a manual that took advantage of the reliability of the printed image to create calibrated and precise visual

I would like to thank Dr. Stephanie Leitch under whose direction this paper was conceived. Her encouragement and guidance has been invaluable for this project and many others.

1 Apian's *Cosmographicus Liber* was first published in 1524 and expanded by his student, Reinier Gemma Frisius, in 1529. The text was published in four languages and over thirty editions until 1609. For a list of editions, see Robert W. Karrow, *Mapmakers of the Sixteenth Century and Their Maps: Bio-Bibliographies of the Cartographers of Abraham Ortelius,1570* (Chicago: Speculum Orbis Press, 1993), 52. In this essay, all images are taken from the 1524 edition unless otherwise noted.

2 According to Denis Cosgrove, cosmography was a term whose meaning changed between authors. Originally derived from the work of Ptolemy, cosmography could refer to "the mathematical description of both cosmos and earth through their relation as established by spherical projection," as well as "the terrestrial globe understood mathematically through lines of latitude and longitude." As such, it became a relevant discipline for understanding the construction of maps and charting of territories. Denis E. Cosgrove, "Images of Renaissance Cosmography, 1450-1650," in *Cartography in the European Renaissance* in *The History of Cartography,* ed. David Woodward (Chicago: University of Chicago Press, 2007), 3.1:56.

3 See Cosgrove, "Images of Renaissance Cosmography," and Karrow, *Mapmakers of the Sixteenth Century*, for examples of how the *Cosmographicus* is understood within the context of the history of science.

4 In particular, I refer to Steven Vanden Broecke's thorough article examining Apian's use of "realistic depiction" and paper instruments; as well as Tom Conley's investigation of the implications of cosmography on the reader's relation to space and topography. See Steven Vanden Broecke, "The Use of Visual Media in Renaissance Cosmography: The *Cosmography* of Peter Apian and Gemma Frisius," *Pedagogica Historia* 36, no. 1 (2000): 131-150; and Tom Conley, *An Errant Eye: Poetry and Topography in Early Modern France* (Minneapolis: University of Minnesota Press, 2011), 53-80.

5 Susan Dackerman, ed., *Prints and the Pursuit of Knowledge in Early Modern Europe*, exhibition catalogue (Cambridge, MA: Harvard University Press, 2011). Although it does not address the *Cosmographicus* specifically, the exhibition is useful in that Apian's text can be positioned at the beginning of a growing interest by the sciences in expressing ideas visually and, more specifically, in utilizing printed images as tools to aid the production of knowledge.

tools, the *Cosmographicus* is useful for understanding how printed illustrations could substantially alter the means of conveying information.

The impetus for change in illustrative authority was also rooted in the intended audience for books of this kind. As Samuel Edgerton argues, trained mathematicians and astronomers were not inclined to move beyond standard abstract diagrams. It was not until technical disciplines gained the attention of "humanistically educated, aristocratic tastemakers" as well as self-taught "artisan-engineers" that illustrated didactic texts became essential.[6] Unlike professional cosmographers, these readers lacked a thorough understanding of the mathematical principles on which cosmography was founded. In order to educate this new audience, Apian had to account for the fact that unlike the study of anatomy, which was primarily descriptive, cosmography could only be conveyed to the reader when observations over time, along with systematic measurements and theory (often requiring the use of specialized astronomical instruments), were combined into a single, often highly conceptual image.[7] In other words, the illustration of cosmographical themes emphasized a "rhetoric of irrefutable precision," by using diagrams and tables to lend an authoritative patina to theoretical models for tracking the movement of celestial bodies.[8] Like the astronomical instruments from which they took their cue, Apian's illustrations had to convey a new type of spatial understanding as well as instruct readers in how to use measurement and mathematical models to inform their observations.

The *Cosmographicus* first accomplished this textually through Apian's descriptions within the book. Here, the explanations for cosmography were directly connected to the images. Thus the illustrations seen in the book do not necessarily relate to nature itself but to the *Cosmographicus'* specific interpretation of it. Nowhere is this connection more apparent than in the first chapter of the book, where Apian defines the role of his discipline. For the author, cosmography relied upon the "circles of the sky"—imaginary lines used to chart the motion of celestial bodies—in order to mathematically calculate the coordinates of an observer's position.[9] Like geography, cosmography provided a way to integrate the discovery of new territories into an existing illustrative structure. However, while geography relied upon terrestrial markers such as rivers and mountain ranges to determine location, cosmography used a grid of lines projected onto the earth as well as the unchanging stars to provide an ever-expanding list of coordinates from which maps and globes could be constructed. The ultimate goal of these disciplines was the observation and mapping of the whole earth.[10]

Apian's *Cosmographicus* was unique because the author also chose to illustrate this point visually. Alongside his textual descriptions, cosmography (Figure 2) was depicted as a disembodied eye whose line of sight illustrated the imaginary grid dividing the heavens and earth. The globe on the left was presumably the product of such cosmographic observation and demonstrated how cosmography could illustrate the terrestrial globe mathematically through the use of longitude and latitude.[11] This image stands in contrast to those of geography and chorography on the following pages (Figures 3 and 4). In these illustrations, Apian uses a visual metaphor to depict geography as a description of the whole earth just as a portrait is an image of an entire head. Chorography, on the other hand, was the description of a particular place, similar to an artist's rendition of an eye or ear.[12] The comparison to the painter's craft is noteworthy here since it distinguishes the type of vision required for the different disciplines. While geography and chorography were cast here as largely descriptive—entailing the reproduction of observed features—cosmography required both observation and complex spatial reasoning to balance what the viewer actually saw in the sky and how it was translated into useful information. It is fitting that while geography is compared to an image of the earth, cosmography is situated next to a globe. The products of this discipline were not simply descriptive images but instead functioned as tools to further man's knowledge of the world.

Although these illustrations make up only the first few pages of the *Cosmographicus,* they point towards two very important techniques for Apian's cosmographic instruction. Firstly, the book combined schematic diagrams with representational images in order to show how observation related to reality. Secondly, Apian's inclusion of *volvelles,* actual instruments made of rotating paper parts, called attention to the need for tools to mediate and enhance human observation. Here, the act of looking was not sufficient and had to be measured and collected for meaningful observa-

6 Samuel Edgerton, *The Heritage of Giotto's Geometry: Art and Science on the Eve of the Scientific Revolution* (Ithaca, NY: Cornell University Press, 1991), 163-166. Vanden Broecke also notes that the interest in cosmography might have been further driven by those involved in the voyages of discovery during the 15th and 16th centuries. Since cosmographic practice was used in the making of maps, it would have been particularly useful here. See Vanden Broecke, "Use of Visual Media," 134n9.

7 Martin Kemp, "Vision and Visualization in the Illustration of Anatomy and Astronomy from Leonardo to Galileo," in *1543 and All That: Image and Word, Change and Continuity in the Proto-Scientific Revolution,* ed. Guy Freeland and Anthony Jones (Boston: Kluwer Academic Publishing, 2000), 19-20.

8 Ibid., 20.

9 Christine R. Johnson, *The German Discovery of the New World: Renaissance Encounters with the Strange and Marvelous* (Charlottesville: University of Virginia Press, 2008), 52 and 220n20.

10 Vanden Broecke, "Use of Visual Media," 135.

11 Cosgrove, "Images of Renaissance Cosmography," 56.

12 Apian's definitions for cosmography, geography, and chorography were quite popular. Even at the end of the sixteenth century, mapmakers adopted the definitions verbatim. Francesca Fiorani, *The Marvel of Maps: Art, Cartography and Politics in Renaissance Italy* (New Haven, CT: Yale University Press, 2005), 100.

tion to take place. Together, these illustrative techniques offered a cosmography that could be understood and replicated by the reader solely through the pages of the book. When combined, these visual innovations repositioned the *Cosmographicus* as both an instructional text as well as an actual tool.

Apian differed from his predecessors in that he recognized the potential of representational images to augment and clarify abstract diagrams. While earlier works, such as Martin Waldseemüller's *Cosmographiae Introductio* (1507), contained a few standard diagrams, they largely consisted of simple, schematic images.[13] Within the *Cosmographicus*, the usual diagrams picturing climate zones, latitude, and longitude were accompanied by instructional images thereby making the illustration a primary means of conveying information. In one such image, Apian demonstrates the proper use of a Jacob's staff (Figure 5). As Steven Vanden Broecke explains, the illustration is broken into several parts; the bottom portion shows how to align the staff with the intended celestial bodies, while directly above it, a diagram of two observers on the earth demonstrate the mathematical principle behind the illustration.[14] Here the reader can see that the difference in the angles of vision equals the difference in longitude. The idea of demonstrating an instrument's function was certainly not new; early printed broadsheets predate the use of this instrument by several years (Figure 6). Yet Apian's images differ by juxtaposing the physical bodies of the observers with the conceptual presentation of lines and measurements.

This innovation is significant because it alters the relationship between the image and text. While the broadsheet demonstrates the proper way to hold the instrument, and even shows the tactic of using an implement to mark one's position on the ground, it ultimately illustrates information which could easily be demonstrated in the text. Apian's images depart from this descriptive tendency and further clarify concepts in a way that the text could not. As one can see in the upper right portion of the illustration, what the observer was actually viewing with his Jacob's staff, the moon and the stars, had to be reconciled with the less visible idea of his position on the earth (and within the cosmos). Apian uses this image to show both what the reader could *see* and what he should *know*. The image is neither fully conceptual nor entirely representational and instead makes use of both techniques in order to provide multiple ways of understanding the concepts at hand. His inventive illustrations suggest that proper visualization was imperative for study of cosmography.

Although it is always difficult to gauge the effectiveness of these images among the readership, it is worth mentioning that this particular method of illustration appears several more times in later editions of Apian's *Cosmographicus*, after it was expanded by his student, Gemma Frisius. Illustrations such as this later edition (Figure 7), which demonstrate various practical methods of calculating height, appear in a 1553 edition as well as many others. In this rather odd image, a figure uses an astrolabe to gauge the height of a building. Once again, the viewer could see the angles of vision represented on the page as well as the details of the instrument itself, expanded here to the size of its user in order to better convey its function. The inclusion of this particular technique several more times after the initial printing may indicate that it resonated with readers, in part because the methods of observation espoused by the text could be verified by following the instructions demonstrated on the page.

Apian's illustrations not only exhibit a uniquely cosmographic vision, they show the necessity of scientific instruments to perform calculations. The frontispiece, for example, shows the earth metonymically represented as a globe with a quadrant at its base. When positioned together on the first pages of the book, these tools act as substitutes for the discipline thereby reinforcing the constructed nature of scientific observation. In fact, cosmography required the use of a number of different devices making it a rather costly field of study for the average reader. The process needed to construct and calibrate astronomical tools required the expertise of a professional, and perhaps the association of scientific tools with the people who used them allowed readers to view them as authoritative devices. They certainly conveyed the importance of observing with one's own eyes while using technology to ensure accuracy.

This association would have been made explicit with Apian's inclusion of three printed paper *volvelles* (Figure 8).[15] These devices allowed readers to practice cosmographical techniques within the very space of the book. In many cases, the instruments allowed the user to understand the movements of the sun and stars relative to their position on the

13 Indeed Waldseemüller's work also served as a popular introduction to cosmography and was an important precursor to Apian's. The *Cosmographicus Liber* differed in its inclusion of a more extensive illustrated program. Cosgrove, "Images of Renaissance Cosmography," 76-77.

14 Vanden Broecke, "Use of Visual Media," 139. According to the reference website, Epact, the Jacob's staff, also called a cross staff, "was mainly used for finding the latitude by measuring the altitude of the polar star and for measuring the altitude of the sun. To measure the altitude of a celestial body, the eye-end of the staff was placed near the observer's eye and the other end half way between the horizon and the celestial body. The vane was then slid along the staff until its upper edge appeared to touch the celestial body, while the lower edge appeared to touch the horizon. The altitude could then be read off the staff." See *Epact: Scientific Instruments of Medieval and Renaissance Europe,* "Cross-Staff," by Silke Ackerman, accessed 27 April 2013, https://www.mhs.ox.ac.uk/epact/article.php?ArticleID=5.

15 Three were contained within the original publication, and a fourth was added to Frisius' expanded edition. See Owen Gingerich "Astronomical Paper Instruments with Moving Parts," in *Making Instruments Count: Essays on Historical Scientific Instruments presented to Gerard L'Estrange Turner,* ed. R. G. W. Anderson *et al*. (Brookfield, VT: Variorum, 1993), 64. The illustration pictured shows a rotating world map with parts that could be moved in different directions to demonstrate the positions and movements of celestial bodies. See Cosgrove, "Images of Renaissance Cosmography," 78.

earth. By using these tools they could develop practical skills such as the calculation of time and estimation of the beginning and end of twilight.[16] The inclusion of *volvelles* within the *Cosmographicus* transformed the book from a guide to a tool used to practice and develop a better understanding of the subject matter. While the author was not the first to include these rotating paper devices in a printed manual, it is quite possibly because of his book that these instruments made their way into astronomy textbooks.[17] Like the image of a Jacob's staff, Apian's *volvelles* gave readers an additional means of grappling with cosmographical visualization.

Despite their fairly simple design, these tools may have contributed to the increased interest in printed paper instruments during the first half of the sixteenth century. When the *Cosmographicus* is examined in light of other endeavors, it is clear that the trend toward affordable paper instruments must have appealed to a wide audience. For example, Apian's contemporary, Georg Hartmann, made a living producing over seventy-five individually printed instruments that users could assemble themselves and paste onto boards to produce cheap and functional devices.[18] With interactive tools now available to a larger audience, it is unsurprising that the rise of cosmography coincided with the proliferation of printed materials. Unlike instruments created by hand or copied into manuscripts, printing allowed for a level of standardization that resulted in a greater number of inexpensive alternatives for scientific instruments. They could be designed by a skilled professional and quickly produced in large quantities. Apian's guidebook, which was published throughout the century, served as a useful means of understanding and using the now widely available paper instruments. Since it prefigured many of the later creative uses for printed materials, it must have primed its readership to understand their function and to associate their use with the scholarly practice of observing the cosmos.

Within the trajectory of Apian's own career, the importance of images and tools became more pronounced over time. In 1526, he petitioned the University of Ingolstadt—where he was employed as a professor—for a loan to purchase his own printing press.[19] This would give him more control over the production of his tools and allow for greater accuracy and complexity of his products. He would go on to produce a series of paper tools, and his *Instrument Buch* of 1533 contained nine woodcuts that could be cut out and attached to wooden supports to create three dimensional paper instruments.[20] Some of these, like the quadrant, were even pictured on the title page illustrating their use (Figure 9). This volume was printed in the more accessible German rather than Latin, and many of the remaining copies only contain the text since the woodcuts had been assembled and used by the owner.[21] Unlike the *Cosmographicus*, which served as an introduction to the discipline, the *Instrument Buch* focused more on explaining the use of each instrument included with the text.

Apian would take this interest in instruments even further with his *Astronomicum Caesareum* of 1540. This book, described by Ronald Brashear and Daniel Lewis as "perhaps the most beautiful scientific book ever printed," contains an incredible number of illustrations including twenty-one images with moving parts as well as additional non-moving diagrams.[22] Several even had multiple layers of rotating discs (Figure 10). Each volume was completely assembled and hand-colored in Apian's workshop to ensure that all pieces were uniform and correctly made.[23] Here, Apian's earlier interest in supplementing his diagrams with descriptive figures manifests itself in the high degree of artistry present in the individual diagrams. Furthermore, the *Astronomicus* yielded remarkably precise results when used. It was not merely a teaching tool but a highly sophisticated instrument in print form.[24] As Apian's masterpiece, it was geared toward an aristocratic audience and was designed to streamline the mathematical calculations needed to understand planetary movements.[25] In the preface, Apian shows his sympathy for the plight of the amateur cosmographer, "We see how much mathematics are hated because of their seeming difficulty. We tried to simplify and began to plan by what new methods the remedy would be found to help those, whom arithmetic has baffled up to now."[26] His book must have achieved some degree of success since its printing was paid for by Emperor Charles V, who then made him a knight of the kingdom shortly after its publication.[27] Although the *Cosmographicus* was obviously not made with this trajectory in mind, the

16 Gingerich, "Astronomical Paper Instruments," 64.

17 Some of the first printed *volvelles* were contained in Johannes Regiomontanus' *Calendarium* (Nuremberg, 1474), however they did not reach their apex until the sixteenth century. Ibid, 63-64.

18 Suzanne Karr Schmidt, "Art—A User's Guide: Interactive and Sculptural Prints in the Renaissance" (PhD diss., Yale University, 2006), 184.

19 Karrow, *Mapmakers of the Sixteenth Century,* 53.

20 Suzanne Karr Schmidt "*Title Page* in Apian, *Instrument Buch,"* in *Prints and the Pursuit of Knowledge in Early Modern Europe,* exhibition catalogue, ed. Susan Dackerman (New Haven, CT: Yale University Press, 2011), 304.

21 Ibid.

22 Ronald Brashear, Daniel Lewis, and Owen Gingerich, *Starstruck: One Thousand Years of the Art and Science of Astronomy* (Seattle: University of Washington Press, 2001), 81.

23 Gingerich, "Astronomical Paper Instruments," 71.

24 Ibid.

25 Michael Korey, *The Geometry of Power—The Power of Geometry: Mathematical Instruments and Princely Mechanical Devices from around 1600 in the Mathematisch-Physikalischer Salon* (Munich: Deutscher Kunstverlag, 2007), 50.

26 Quoted in Peter Apian and S. A. Ionides, "Caesars' Astronomy," *Osiris* 1 (January 1936): 359.

27 Karrow, *Mapmakers of the Sixteenth Century,* 62.

widespread interest that allowed Apian and others to form their careers around printed instruments surely must have also fueled the success of the earlier *Cosmographicus*.

While the subject matter of the *Instrument Buch* and *Astronomicum* was different from that of the *Cosmographicus,* their visual programs seemed to grapple with many of the same issues first presented in the latter volume. The unprecedented emphasis on the visual program in the *Cosmographicus* was expanded in the author's later publications. In these works, Apian seemed to understand that the interactive qualities tools provided helped readers to comprehend the mediated observation that was the hallmark of cosmography. While they were significantly more elaborate than Apian's early textbook, all point toward the importance of printed images in facilitating cosmographic understanding.

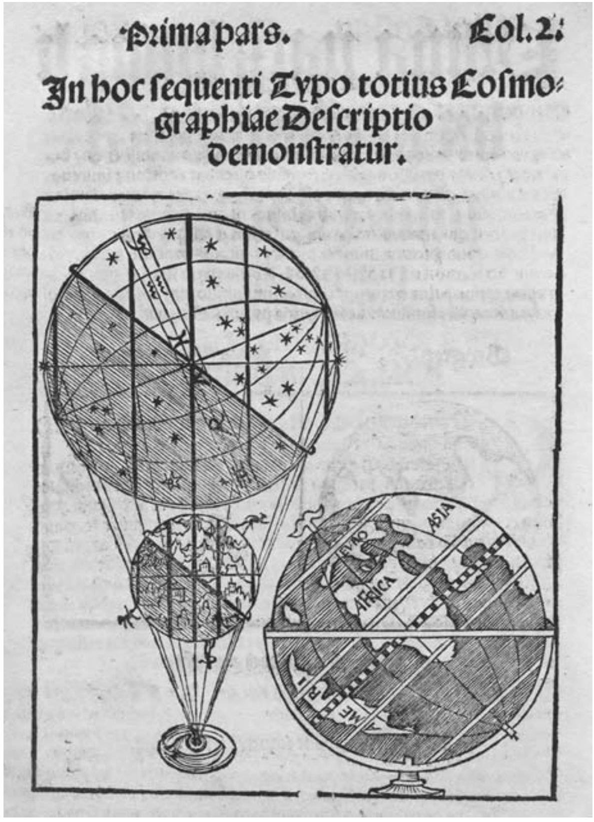
As one of the most popular instructional texts on cosmography, Apian's *Cosmographicus Liber* altered the notion of what an illustration could do. By focusing on reproducing astronomical images and instruments within his textbook, Apian changed the means by which a non-professional readership came to understand and interact with cosmography. His innovations expanded the audience for his discipline and altered the way in which many readers understood scientific observation. With rapidly developing technologies and the expansion of the European conception of the globe, there was never a more crucial time for the world to be charted. Although Apian's method of mapping the globe was soon to be replaced by new advances in understanding the cosmos, his book remained one of the most accessible guides available for almost a century.

Florida State University

Figure 1. Peter Apian, *Frontispiece* from the *Cosmographicus Liber* (Landshut: 1524), woodcut. Courtesy of the Smithsonian Libraries.

▶ Figure 5. [*facing page, top*] Peter Apian, *Use of a Jacob's Staff,* from the *Cosmographicus Liber* (Landshut: 1524), woodcut. Courtesy of the Smithsonian Libraries.

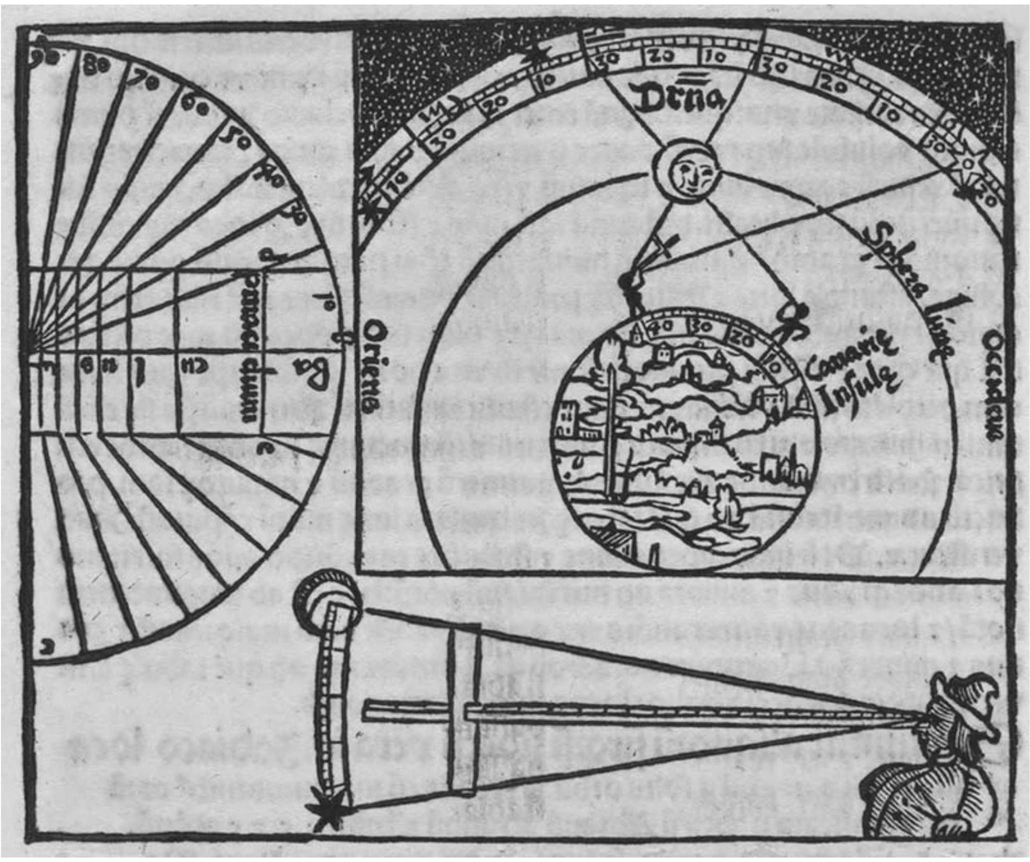
▶ Figure 6. [*facing page, bottom*] Unknown woodcutter, *On the Construction and Use of a Jacob's Staff*, woodcut and xylographic text, 1502. VI Aa43. Staatsbibliothek Bamberg. Photo credit: Gerald Raab.



◀ Figure 2. Peter Apian, *Description of Cosmography,* from the *Cosmographicus Liber* (Landshut: 1524), woodcut. Courtesy of the Smithsonian Libraries.

▶ Figure 3. Peter Apian, *Description of Geography* from the *Cosmographicus Liber* (Landshut: 1524), woodcut. Courtesy of the Smithsonian Libraries.

◀ Figure 4. Peter Apian, *Description of Chorography,* from the *Cosmographicus Liber* (Landshut: 1524), woodcut. Courtesy of the Smithsonian Libraries.


Oriens
Occidens
Sphera lune
Canarie Insule


BACVLVS·IACOB
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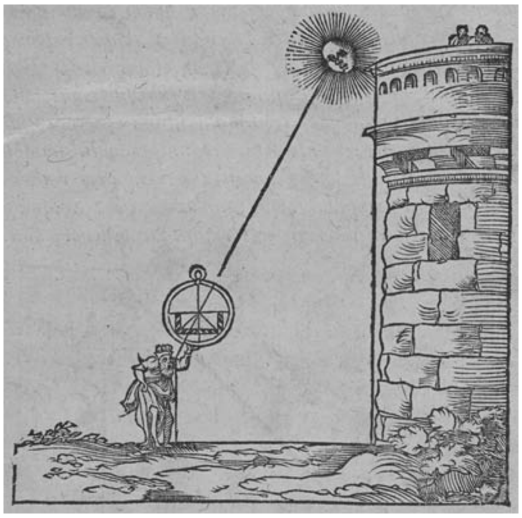

Figure 7. Peter Apian, *Methods of Calculating Height,* from the *Cosmographia Petri Apiani* (Paris: 1553), woodcut. David M. Rubenstein Rare Book & Manuscript Library, Duke University.

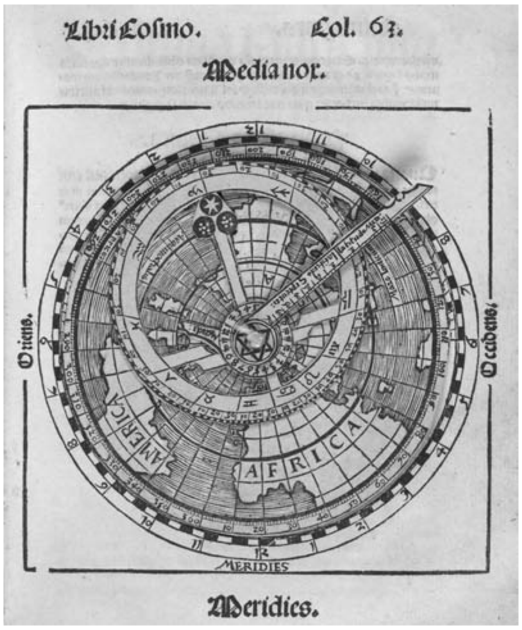

Figure 8. Peter Apian, *Volvelle,* from the *Cosmographicus Liber* (Landshut: 1524), woodcut. Courtesy of the Smithsonian Libraries.

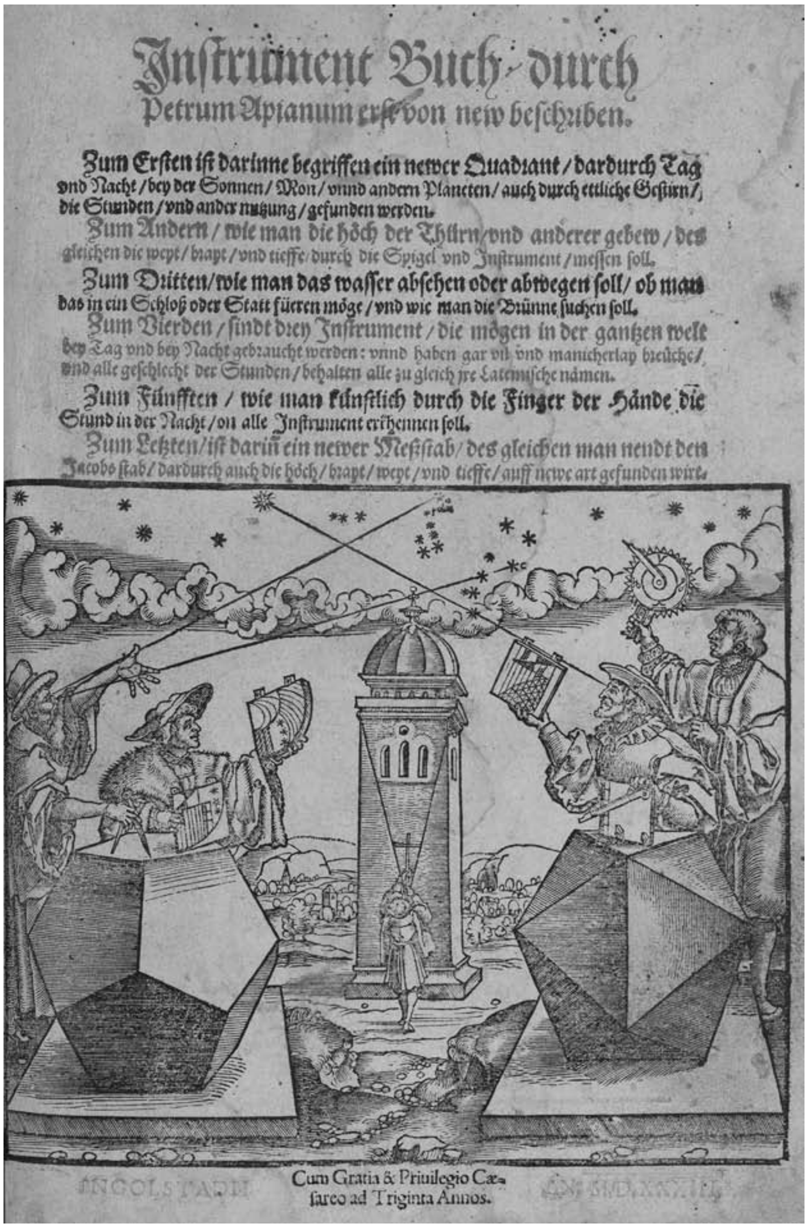

Figure 9. Peter Apian and Hans Brosamer, *Frontispiece,* from the *Instrment Buch* (Ingolstadt: 1533), woodcut. VD16 A 3111. Staatsbibliothek Bamberg. Photo credit: Gerald Raab.

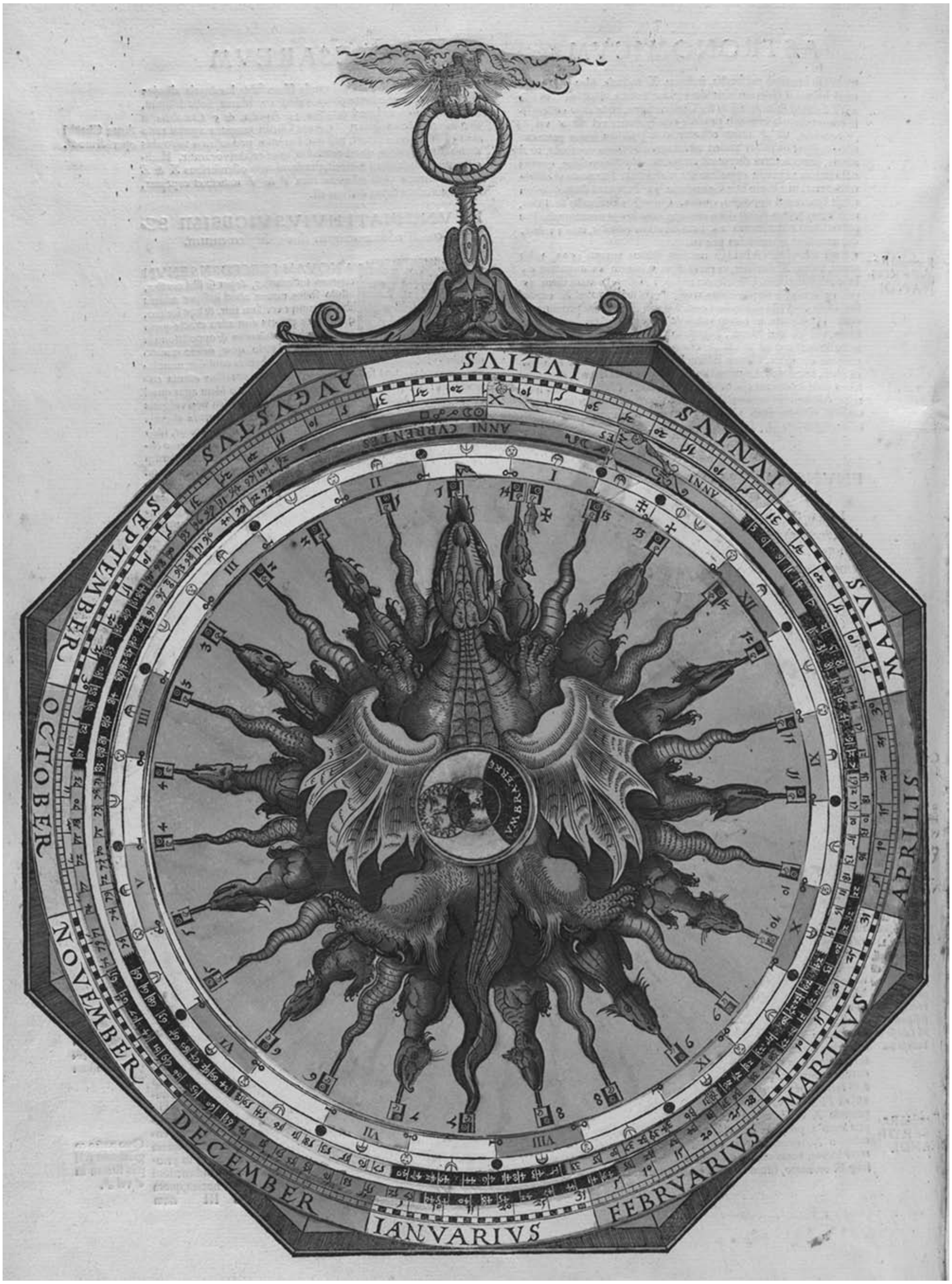

Figure 10. Peter Apian and Michael Ostendorfer, *Dragon Dial,* from the *Astronomicum Caesareum* (Ingolstadt: 1540), woodcut. Typ 520.40.150. Houghton Library, Harvard University.