The “Use of the Globes”: Mathematical Geography, the Mercantile Imagination, and Global Commerce in Postrevolutionary America

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The 1780s marked America's entry into truly global trade. In 1784, New York's *Empress of China* rounded the Cape of Good Hope and arrived in Canton. That same year the *United States* sailed east from Philadelphia for Pondicherry. In 1785, Salem's *Grand Turk* rounded Africa to reach Mauritius, initiating that town's flourishing East Indies trade. Two years later, two Boston-owned trading vessels, the *Columbia Rediviva* and the *Lady Washington*, completed the first US circumnavigation of the planet when they brought Northwest Coast furs to China before sailing around Africa for home. Frozen out of its colonial-era trading relationship with the West Indies, but now no longer bound by a British colonial relationship to monopolistic European East India companies, American merchants pursued markets around the world beyond the Capes. In so doing, they proudly announced their nation's entry into the global economy free from mercantilist restrictions, while deftly finding new ways to wealth.[1]

Although political and economic developments opened up a new logic to American participation in global trade, they did not guarantee it. To be sure, Americans genuinely delighted in venturing into the prestigious Asian trade "where George forbade to sail before,"[2] and the promise of Asian riches was a powerful motivator, but we should beware of peopling our

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[1]My characterization of America's postrevolutionary Asian trade draws on Susan S. Bean, *Yankee India: American Commercial and Cultural Encounters with India in the Age of Sail, 1784-1860* (Salem, Mass.: Peabody Essex Museum, 2001); Jonathan Eacott, *Selling Empire: India in the Making of Britain and America, 1600-1850* (Chapel Hill: University of North Carolina Press, 2016); James R. Fichter, *So Great a Profitt: How The East Indies Trade Transformed Anglo-American Capitalism* (Cambridge: Harvard University Press, 2010); David Igler, *The Great Ocean: Pacific Worlds from Captain Cook to the Gold Rush* (Oxford: Oxford University Press, 2013); Kariann Akemi Yokota: *Unbecoming British: How Revolutionary America Became a Postcolonial Nation* (New York: Oxford University Press, 2011), esp. chap. 3; and Dael A. Norwood, "Trading in Liberty: The Politics of the American China Trade, c. 1784-1862" (Ph.D. dissertation, Princeton University, 2012). The newly independent United States no longer had to recognize limitations placed by the British East India Company on trade east of the Cape of Good Hope, except in British-controlled areas of India, although in reality, BEIC officials in India often welcomed U.S. vessels as serving the interests of the British state and those of individual Britons. The Jay Treaty legalized American trade with British-controlled India, though not without (often ignored) restrictions. In 1784, France opened its Indian and Indian Ocean island ports to American vessels for its own geopolitical reasons. During the Anglo-French wars, European powers, including state-chartered EICs, made use of America's status as a neutral power to serve their own Asian import and export markets.

[2]Philip Frenau, "On the First American Ship, (Empress of China, Capt. Greene) That Explored the Rout to China, and the East Indies, after the Revolution, 1784," in Frenau, *Poems Written and Published during the American Revolutionary War*, 3d ed. (Philadelphia, 1809), 2: 181.

historical narratives with innately enterprising Yankees emboldened by patriotism and instinctively profit-maximizing economic men. Americans themselves did indeed tout their pioneering voyages as evidence of their citizens' independent spirit and resourcefulness, but reality was more complex. Not every voyage turned a profit, especially the early ones. Some apparently American voyages offered cover for foreign capital and agents. And many obstacles remained blocking entry into distant markets. U.S. merchants faced the navigational challenge of venturing "beyond the Capes." They lacked the silver or other commodities attractive to Asian buyers. They had no experience with and little knowledge of the commercial and diplomatic protocols of what was broadly termed the East Indies trade.

Recent scholarship has detailed how American merchants overcame these challenges. Shipmasters and mates consulted newly published charts, received guidance from experienced European mariners, and acquired new, advanced celestial navigation techniques. Merchants experimented with new commodities for the Asian markets, established new ways of consolidating and mobilizing capital, and gained experience in conducting Asian trade, often with European assistance. But we should also consider the conceptual obstacles Americans overcame in joining the select group of western nations engaged in global trade. Europe's centuries-old East India Company [EIC] monopolies set the pattern. Voyaging to Asia in the absence of the kind of resources the EICs had at their command—large-scale capital, bureaucracy, armed forces, and trading vessels--must have seemed literally outlandish.[3] Small wonder that some of the earliest American venturers looked to establish enterprises on the model of the European monopolies. There was talk of establishing an American factory in India, plans for a North American East India Company, and the conviction—sometimes followed by experimentation--that the East Indies trade required supersized cargo ships.[4]

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[3]In the mid-nineteenth century, Freeman Hunt noted that these American merchants "engaged in branches of business, which it was thought in Europe could only be safely carried on by great chartered companies, under the protection of government monopolies." Hunt, a propagandist for men of commerce, framed their actions as classically American, classically mercantile moxie, but he did draw attention to the conceptual shift required [Hunt, *Lives of American Merchants*, 2 vols. (New York, 1856), 1: 139].

[4]For early American interest in and efforts to imitate the EIC model, see Fichter, *So Great a Profitt*, 39-45; Eacott, *Selling Empire*, 256, 257, 330n, 361; Yokota, *Unbecoming British*, 123-24; Norwood, "Trading in Liberty," 84-87; John Adams [hereafter JA] to Richard Henry Lee, 6 Sept. 1785, in *The Adams Papers Digital Edition*, ed. C. James Taylor. Charlottesville: University of Virginia Press, Rotunda, 2008–2016 (hereafter *Adams Digital*); East India

By the end of the eighteenth century, however, U.S. merchants had developed a different and successful model of participating in world trade. Where Europe's massive East Indiamen executed a predetermined trading plan in their round trips to and from European trading capitals, America's much smaller vessels, whose captains and supercargoes made on-the-spot, market-dependent decisions, pursued globally diffuse, dispersed trade routes, loading and offloading freight in multiple ports on several continents. If the EICs sailed to and from discrete points around the globe in seasonal convoys, American merchants, with their decentered, multi-leg trade routes, covered it with a web of voyages.[5] The precedent for this strategy is not obvious. Vessels from the American colonies had shuttled around the Caribbean, but more in search of markets than as carriers. European vessels in the so-called "country trade," operating within the EIC regulatory structures, transported cargoes around Indian and Pacific Ocean ports, but Americans would have had limited firsthand knowledge of this auxiliary trade, nor did their Asian trade confine itself to Asian ports.[6]

None of this is to say that U.S. participation in global commerce was impossible to imagine, only that it in fact required imagination. As Sven Beckert has written of the global "empire of cotton," "globalization required globalizers," men of commerce whose transcendence of the "intensely local" orientation of planters and manufacturers in forging "global networks" was an act of "courage and imagination."[7] In creating a global web of commercial voyages, then, American merchants did not just trade more expansively than they had before independence; they also thought more expansively. What enabled them to do so? This paper suggests we consider one possible source of the merchant's global imaginary: globes themselves, or more

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Company of North America, *Constitutional Articles of the East India Company of North America* (Philadelphia, [1793]); Mercator, "From the New-York Gazetteer: Reflections on a Trade to India," *Freeman's Journal*, 22 June 1785.

[5]On the new patterns of trade, See especially Fichter, *So Great a Profitt,* and Eacott, *Selling Empire*, chaps 5, 7. Fichter focuses on these patterns as an adaptive and innovative strategy to pursue profit in the absence of capital. Eacott emphasizes the crucial role from the mid-1780s of the British--for motives ranging from individual gain to national benefit--in facilitating American entry into the Asian trade and shaping American patterns of commercial activity.

[6]On the country trade, see Bean, *Yankee India*, 37-38, 46-47; Shantha Hariharan, "Asian Maritime Trade—Portuguese and English Country Trade from Western India in the Eighteenth Century: A Study in Contrast," *International Journal of Maritime History* 18 (June 2006): 1-24; and B. R. Tomlinson, "From Campsie to Kedgeree: Scottish Enterprise, Asian Trade and the Company Raj," *Modern Asian Studies* 36 (Oct. 2002): 769-91.

[7]Sven Beckert, *Empire of Cotton: A Global History* (New York: Vintage, 2014), 226-27.

precisely, the quantitative science of geography in which the “the use of the globes” figured prominently.

Scholars have explored the origins of global—as opposed to the merely multi-continental—imagination, pointing to the nexus of science, trade, imperialism, and travel.[8] Mary Louise Pratt identifies the roots of what she terms the “construction of global-scale meaning” or a “planetary consciousness” in two scientific projects of the mid-eighteenth century, Charles de la Condamine’s expedition to South America to establish the shape of the Earth by measuring a degree of latitude at the Equator, and the worldwide efforts to encompass the entire world’s flora and fauna into the new Linnaean system. Joyce E. Chaplin focuses on the phenomenon of circumnavigation. What made these voyages distinctive in their own times was not distance or danger, she argues, but the fact that only a circumnavigator “thinks of himself or herself on a planetary scale, as an actor on a stage the size of the world.” In their distinctive experience of space and time--the loss of a day as they circle the globe--they alone made a “direct, tangible, and conscious connection to something usually perceived in the abstract, the whole Earth.”[9]

But was it really necessary to be a La Condamine or James Cook to experience the world on this scale? Merchants had long been perceived as “citizens of the world,” after all, and not because they traveled—many did not—but because of their far-flung network of informants and distinctively global knowledge. Daniel Defoe characterized “a True-Bred Merchant” as “a Universal Scholar” and “the most Intelligent Man in the World,” for by means of “universal intelligence”—letters, information--“a merchant sitting at home in his counting-house at once converses with all parts of the known world.” [10] The properly educated merchant, he argued,

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[8]Among the vast literature on this nexus and the imperial imagination, see for example, Benjamin Schmidt, *Inventing Exoticism: Geography, Globalism, and Europe’s Early Modern World* (Philadelphia: University of Pennsylvania Press, 2015); P. J. Marshall and Glyn Williams, *The Great Map of Mankind: Perceptions of New Worlds in the Age of Enlightenment* (Cambridge: Harvard University Press, 1982); and Larry Stewart, “Global Pillage: Science, Commerce, and Empire,” in *The Cambridge History of Science*, vol. 4: *Eighteenth-Century Science*, ed. Roy Porter (Cambridge: Cambridge University Press, 2003), 825-44.
[9]Mary Louise Pratt, *Imperial Eyes: Travel Writing and Transculturation* (London: Routledge, 1992), chap. 2; Joyce E. Chaplin, *Round about the Earth: Circumnavigation from Magellan to Orbit* (New York: Simon & Schuster, 2012), xvi, xviii.
[10]*Defoe’s Review* 3 (3 Jan. 1706): 6-7; Daniel Defoe, *An Essay Upon Projects* (London, 1697), 8. See also Srinivas Aravamudan, “Defoe, Commerce, and Empire,” in *Cambridge Companion to Daniel Defoe*, ed. John Richetti (Cambridge: Cambridge University Press, 2009), 45-63.

"may make the tour of the world in books," and from the knowledge thereby gained, he could "go round the globe with Dampier and Rogers and kno' a thousand times more doing it than all those illiterate sailors."[11] Besides narrowly commercial intelligence, much of this knowledge was geographical. Awareness of the earth's spatially diverse productions, natural environments, and inhabitants, after all, was critical to identifying commodities, developing markets, setting commercial routes, and conducting business with foreigners.[12]

But while familiarity and exchange with distant places may contribute to a more encyclopedic knowledge of the world, it does not necessarily prompt an apprehension of the planet as an abstract whole. Defoe alluded to this different kind of awareness when he argued that the gentleman-merchant may "make himself master of the geography of the *Universe* in the maps, attlasses [sic] and measurement of our mathematics."[13] Likewise in an entry for "Mathematics" in his *Universal Dictionary of Trade and Commerce,* Malachy Postlethwayt explained that by means of globes, "we are able to visit in our closet to judge of the celestial motions, and to visit the most distant places of the earth." What Defoe and Postlethwayt were describing was not the mercantile cosmopolitanism of a world teeming with geographical variety and particularity, but a planetary consciousness of the heavens and earth as a unitary system, bound by universal, mathematically-defined laws. That global perspective derived from a separate geographical tradition that has been largely forgotten, but in which merchants were

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[11]Daniel Defoe, *The Compleat English Gentleman*, ed. Karl D. Bülbring (London: David Nutt, 1890), 225.

[12]Mercantile cosmopolitan knowledge: David Hancock, *Citizens of the World: London Merchants and the Integration of the British Atlantic Community, 1735-1785* (Cambridge,: Cambridge University Press, 1995), 31-36; Deryck W. Holdsworth, "The Counting-House Library: Creating Mercantile Knowledge in the Age of Sail," in *Geographies of the Book,* eds. Miles Ogborn and Charles W. J. Withers (London: Ashgate, 2010), 135-56; Miles Ogborn and Charles W. J. Withers, "Knowing Other Places: Travel, Trade, and Empire, 1660-1800," in *A Concise Companion to Restoration and the Eighteenth Century*, ed. Cynthia Wall (Oxford: Oxford University Press, 2004), 14-36. See R. Campbell, *London Tradesman* (London, 1747), 292-93, for an example of the kind of cosmopolitan knowledge expected of the merchant.

[13]Defoe, *Compleat English Gentleman*, 225 [emphasis mine]. Defoe placed such knowledge—"the use of the Globes, or to speak more properly the study of Geography" along with 'Mapps" and "Astronomy"—at the very top of his "must know" list (197). For similar educational recommendations for mercantile life, see Thomas Watts, *An Essay on the Proper Method for Forming the Man of Business* (London, 1716), 34; Malachy Postlethwayt, *The Merchant's Public Counting-house: or, New Mercantile Institution* (London, 1751), 92; and M[artin] Clare, *Youth's Introduction to Trade and Business* (London, 1769), vi.

similarly steeped, often with the pedagogical tool of choice: terrestrial and celestial globes. The cognitive impact of such studies was distinct from the compendia of facts we associate with the merchant's cosmopolitan knowledge, for it dealt in the universal, not the particular; the whole, not the parts; the mathematical, not the descriptive; the abstract, not the concrete; and the three-dimensional, rather than the planar.[14]

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Until well into the nineteenth century, globes came in pairs, celestial and terrestrial [Image 1]. If we take a closer look at them, we can see that they were not the familiar free-standing orbs, atilt on a supporting column. Instead we see a number of added "appurtenances": the horizon ring, the meridian ring, the quadrant of altitude, the pointer or index, and the hour circle [Images 2, 3]. These were functional, not decorative, elements that turned globes into computing devices. By physically moving the globe and its elements into various positions, one could calculate a wide range of problems having to do with time and space. A typical problem on the celestial globe required the calculator "to tell how many hours any [given] star continues above the Horizon; from its rising to its setting, in any [given] Latitude." A typical problem on the terrestrial globe read "The latitude being given, to tell the rising and setting of the Sun, and the length of the day and night, at any [given] time of the year." This was the skill termed the "use of the globes."[15]

Thus the mathematical relationship between time and space in the solar system, not cartographic information as with maps, was the raison d'être for globes. One instructor therefore described a collection of "broken & decayed" globes as affording "the pupil no assistance, excepting what may arise from simple inspection." Since they were "unfit for the performance of

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[14]In his study of London's mid-eighteenth-century global merchants, David Hancock notes that "it is suggestive that, while 'global' denoted something globular or spherical in the seventeenth century, the word came to comprehend anything all-inclusive, unified, total, or which pertained to or involved the whole world by the nineteenth century" [Hancock, *Citizens of the World*, 15n].

[15]Daniel Fenning, *A New and Easy Guide to the Use of the Globes; and the Rudiments of Geography*, 5th ed. (London, 1785), 130; Thomas Stackhouse, *The Rationale of the Globes* (London, 1805), 93. For an introduction to the design, functioning, and history of globes, see Sylvia Sumira, *The Art and History of Globes* (London: British Library, 2014), 13-31, and Elly Dekker, *Globes at Greenwich: A Catalogue of the Globes and Armillary Spheres in the National Maritime Museum, Greenwich* (Oxford: Oxford University Press, 1999), chap. 1. "Pocket globes," a miniature terrestrial globe nestled inside a celestial globe casing, popular in the seventeenth and eighteenth centuries, could not be used as calculating devices.

problems," they were "entirely unfit for use."[16] That core function explains those mysterious accessories attached to globes in earlier centuries as well as why globes came in pairs. It also accounts for the fact that from the Renaissance into the nineteenth century, though voyages of exploration vastly increased knowledge of the world's oceans and continents, and cartographic techniques for representing three dimensions on a planar surface made great advances, globes retained their distinctive uses. The kind of knowledge they demonstrated and yielded was simply not the business of maps.[17]

That globes of this era were calculating devices also explains a number of their curious features. The surface of the celestial globe is not as the night sky is actually perceived, but as if the earth were at the globe's center and the viewer observing from beyond the heavens: calculations require that design. For the same reason, a spin of the terrestrial globe reproduces the (apparent) motions of the Sun—hence the Zodiac signs on the earth's horizon ring [Image 4]—not the rotation of the Earth on its axis.[18] We might think that the <u>surface</u> of the terrestrial globe would be free of reference to the solar system, but again we would be wrong. The wavy ecliptic line traces the annual route of the sun. The Tropics of Cancer and Capricorn, girdling the globe at 23˚ 27' north and south of the Equator, mark the northernmost and southernmost latitudes at which the sun can be directly overhead at some point in the year. Between these Tropics lies the Tropical or Torrid Zone, flanked by parallel slices termed the Temperate and Frigid Zones.

Given this astronomical conception of globes, it is not surprising that most globe-makers of eighteenth-century England—and only in 1810 would Americans begin to manufacture their

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[16]Parker Cleaveland to the Corporation of Harvard College, [12 Dec. 1804**],** Harvard University. Corporation. Harvard College Papers, 1st series, UAI 5.100 Volume 4, Item 202. On the computational vs. cartographic function of globes, see Elly Dekker, "Globes in Renaissance Europe," in *The History of Cartography*, vol. 3, *Cartography in the European Renaissance*, ed. David Woodward (Chicago: University of Chicago Press, 2007), 136; Sumira, *Globes*, 13, 18-20.
[17]Dekker, "Globes in Renaissance Europe," 136.
[18]Elly Dekker and Peter Van der Krogt, *Globes from the Western World* (London: Zwemmer, 1993), 15; Sumira, *Globes*, 17, 20; Dekker, "Globes in Renaissance Europe," 135-59; Dekker, "The Doctrine of the Sphere: A Forgotten Chapter in the History of Globes," *Globe Studies* 49/50 (2002): 25-44; and Dekker, "The Phenomena: An Introduction to Globes and Spheres," in *Globes at Greenwich*, 6-9, where it is noted that between the mid-fifteenth and the mid-nineteenth centuries, the design of globes changed little, even as the shift from the Ptolemaic to the Copernican system occurred (8).

own globes[19]--were not cartographers, but precision instrument makers, and that globes were sold by dealers in such instruments, not in maps [Image 5]. George Adams, the dominant figure in globe making in the latter half of the eighteenth century, served as the mathematical-instrument maker to George III and supplied Captain Cook with his instruments.[20] When Thomas Jefferson wanted to order a pair of globes, he wrote to a London firm whose catalog of optical, mathematical, and philosophical Instruments he had picked up years earlier.[21] In postrevolutionary America, at least one dealer specialized in such precision instruments, and he too stocked globes among his wares.[22] Most often, booksellers imported globes, generally adevrtising them alongside microscopes and telescopes, surveyors' compasses and theodolites, and air pumps, thermometers, barometers, and "electric apparatus."[23] Occasionally globes were sold along with nautical precision goods, such as chronometers and sea charts.[24]

Just as terrestrial and celestial globes were conceptually related, so also were geography and astronomy. From the Renaissance into the eighteenth century, the two fields constituted the

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[19]On American-made globes, see Dekker and Van der Krogt, *Globes*, chap. 8; Deborah Warner, "The Geography of Heaven and Earth," *Rittenhouse* 2 (Feb. 1988): 52-64, (May 1988): 88-104, (Aug. 1988): 109-37; and David Jaffee, "Curiosities Encountered: James Wilson and Provincial Cartography in the United States, 1790-1840," *Common-Place* 4 (Jan. 2004), http://www.common-place-archives.org/vol-04/no-02/jaffee/.
[20]Dekker and Van der Krogt, *Globes*, chap. 7; Sumira, *Globes*, 27; Gloria Clifton, "Globe Making in the British Isles," in Dekker, *Globes at Greenwich*, 46-50; Campbell, *London Tradesmen*, 253. Helen M. Wallis describes a transitional period in the late 1600s, when globe-makers included artisans from map-making, printing, and precision instrument production ["Geographie Is Better Than Divinitie: Maps, Globes, and Geography in the Diary of Samuel Pepys," in *The Compleat Plattmaker: Essays on Chart, Map, and Globe Making in England in the Seventeenth and Eighteenth Centuries*, ed. Norman J. W. Thrower (Berkeley: University of California Press, 1978), 4-19].
[21]Thomas Jefferson [hereafter TJ] to John Jones, 26 Dec. 1792, and William and Samuel Jones to TJ, 9 March 1793, *The Papers of Thomas Jefferson Digital Edition*, ed. James P. McClure and J. Jefferson Looney. Charlottesville: University of Virginia Press, Rotunda, 2008–2016.
[22]*Charleston Evening Gazette*, 27 July 1785.
[23]Advertisements for globes with optical, mathematical, and philosophical instruments: *North-American Intelligencer* (Philadelphia), 21 Aug. 1782; *Independent Gazetteer* (Philadelphia) [hereafter *IG*], 2 Aug. 1782; *Boston Gazette* [hereafter *BG*], 2 Feb. 1784; *IG*, 3 Apr. 1784; *Pennsylvania Evening Herald*, 8 Sept. 1785; [New York] *Daily Advertiser* [hereafter *NYDA*], 30 June 1786; *Pennsylvania Packet* [hereafter *PP*], 3 Sept. 1787; *Connecticut Journal*, 21 Sept. 1791 (quotation); *Salem Gazette*, 22 Oct. 1799; *New-England Repertory* (Newburyport), 6 July 1803. When globes came up for auction, they were often similarly grouped [*PG*, 27 June 1799].
[24]*Columbian Centinel* (Boston), 17 Apr. 1802; *Salem Impartial Register*, 29 Dec. 1800.

primary branches of what was known as cosmography, defined in one text published in Philadelphia in 1797 as the "construction, figure, disposition and connection of all the parts which compose the universe, and consequently the general system of the World." Under this intellectual construct, the difference between the two branches was primarily one of scale, descending from astronomy through geography, thence to what was called chorography, regional-scale analysis, and finally to topography.[25] But in truth, by 1797 cosmography had completed its run. A generation earlier, George Fisher's *American Instructor* had made use of that old organizational schema, but by the 1787 edition, cosmography was gone, replaced with a "System of Geography and Astronomy" in which the two fields, like the globes that embodied and explicated them, were still conceptualized as fundamentally connected in a single overarching system, but now paired and parallel.[26]

That pairing undergirded titles like English globe-maker George Adams' popular *Astronomical and Geographical Essays* (1789), Bostonian Caleb Bingham's *Astronomical and Geographical Catechism* (1795), and the educational flashcard set of 1795 titled *The Elements of Astronomy and Geography Explained on 40 Cards* [Image 6]. It shaped as well the contents of less obviously titled geography texts, like Philadelphian Benjamin Workman's *Elements of Geography*, which in response to criticism included a vastly expanded section on "the scientific or astronomical part" of geography in its second edition of 1790. As for the most popular geography text of the second half of the eighteenth century, that by Scotsman William Guthrie, it

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[25]*General View or Abstract of the Arts and Sciences* (Philadelphia, 1797), 206. The intellectual dominance of cosmography varied among European nations and even within nations, with Germany and Sweden as the most persistent strongholds. On cosmography, see Eric G. Forbes, "Mathematical Cosmography," in *The Ferment of Knowledge: Studies in the Historiography of Eighteenth-Century Science*, ed. G. S. Rousseau and Roy Porter (Cambridge: Cambridge University Press, 1980), 417-448; Robert Mayhew, "Geography Books and Georgian Politics," in *Georgian Geographies: Essays on Space, Place and Landscape in the Eighteenth Century*, ed. Miles Ogborn and Charles W. J. Withers (Manchester: Manchester University Press, 2004), 196; Dekker, "Globes in Renaissance Europe," 141-48; Roy Porter, "The Terraqueous Globe," in *Ferment of Knowledge*, 285-324; Matthew Edney, "Mathematical Cosmography and the Social Ideology of British Cartography, 1780-1820," *Imago Mundi* 46 (1994): 101-16.

[26]George Fisher, *The American Instructor: or, Young Man's Best Companion* (Boston, 1779), 298; Fisher, *The American Instructor: or, Young Man's Best Companion* (Philadelphia, 1787), v.

commenced with a chapter on “Astronomical Geography,” since, it explained, “the science of geography cannot be understood without considering the earth as a planet.”[27]

And what of the most famous American geography texts of the postrevolutionary era, those published by Jedidiah Morse? His first such, *Geography Made Easy* of 1784, also began with astronomy, for as Morse (cribbing from Guthrie) explained, “geography cannot be completely understood without some acquaintance with astronomy.” His *American Universal Geography* of 1793, far better known for its nationalistic focus on the United States, began with over forty pages on astronomy, including material on the solar system; the “figure, magnitude, and motion of the earth”; the length of days, and rising and setting of the “celestial luminaries”; the earth’s circles and zones; and dozens of problems on the use of the globes.[28]

How can we square these sorts of topics with the particularized descriptions of places and peoples more conventionally associated with geography? Until well into nineteenth century, the boundaries of geography as an area of inquiry were demarcated more by the intended audience than any fixed definition, but amid the resulting welter of geographies pursued--mathematical, physical, natural, historical, civil, biblical, sacred, ecclesiastical, classical, political, descriptive, general, universal, special, particular—two major branches emerge.[29] In one, geography was part

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[27]George Adams, *Astronomical and Geographical Essays* (London, 1789); Caleb Bingham, *Astronomical and Geographical Catechism* (Boston, 1795); *The Elements of Astronomy and Geography Explained on 40 Cards* (London, 1795); Benjamin Workman, *Elements of Geography*, 2d ed. (Philadelphia, 1790), iii; William Guthrie, *A New System of Modern Geography: or, A Geographical, Historical, and Commercial Grammar* (Philadelphia, 1794), 11. On the American use of Guthrie, see Yokota, *Unbecoming British*, 37-38.

[28]Jedidiah Morse, *Geography Made Easy* (New Haven, 1784), 7; Morse, *The American Universal Geography* (Boston, 1793), 17-48 [quotations, 29]. On the links between American geographies and national identity and self-representation in the early republic, see Martin Brückner, *The Geographic Revolution in Early America: Maps, Literacy, & National Identity* (Chapel Hill: University of North Carolina Press, 2006), and Yokota, *Unbecoming British*, chap. 1. For Morse’s works, see Ralph H. Brown, “The American Geographies of Jedidiah Morse,” *Annals of the Association of American Geographers* 31 (Sept. 1941): 145-217. For other American geographers, see Ben A. Smith and James W. Vining, *American Geographers, 1784-1812: A Bio-Bibliographical Guide* (Westport, Ct.: Praeger, 2003).

[29]On the disciplinary structure of and audiences for eighteenth-century geography, see Charles W. J. Withers, “Eighteenth-century Geography: Texts, Practices, Sites,” *Progress in Human Geography* 30 (Dec. 2006): 711-29; Robert J. Mayhew, “Geography in Eighteenth-Century British Education,” *Paedagogica Historica* 34 (July 1998): 731-68; Withers and Mayhew, “Rethinking ‘Disciplinary’ History: Geography in British Universities, c. 1580-1887,”

of the humanistic tradition, linked above all to history. It considered the particularities of the terrestrial world: the spatially defined differences in physical landscape, climate, flora and fauna, and human beings in all their physical, political, and cultural variety. That kind of information featured prominently in geographical dictionaries and gazetteers, as well as the so-called "special geographies" published by Guthrie and Morse. It is the kind of information we associate with the merchant's cosmopolitan knowledge. The other branch of geography was linked to mathematics. It focused on the earth as part of a unitary system, subject to universal physical laws described by universal mathematical truths, and it concerned itself with the mathematical relationships between time and space. Globes were the devices for just such calculations.

If we are to understand the implications and impact of this second kind of "global knowledge," we need to examine the many audiences for it and the multiple contexts in which it was acquired and used. We might begin with those Americans who actually owned globes in the later eighteenth century. Globe sellers presented globes as "elegant" additions to a gentleman's library [Image 7], expensive imports that could attest to their owners' refinement as much as to their knowledge.[30] Nevertheless, globes were not part of the standard equipage for gentlemen. Those who acquired them seem to have had some particular inclination to philosophical pursuits. They were the "Sons of Science" to whom an advertisement for "a handsome, intelligible PAIR of GLOBES" appealed in 1786. Men with established scientific reputations, like Thomas Jefferson [Image 8] and Benjamin Franklin, owned globes, but so did others whose level of interest exceeded their degree of achievement. In 1754, a Bostonian leaving for Europe sold off

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Transactions of the Institute of British Geographers 27 (2002): 11-29; Mayhew, "Geography Books"; and Ogborn and Withers, "Travel, Trade, and Empire."

[30]"Elegant": [New York] *Royal Gazette* {hereafter *NYRG*], 12 Jan. 1780; *PP*, 21 Nov. 1783; *New York Packet* [hereafter *NYP*], 28 Oct. 1784; [New York] *Independent Journal*, 29 June 1785; [Philadelphia] *Daily Advertiser*, 2 June 1687. William Logan's estate inventory of 1776 provides a sense of the monetary value of globes; Logan's globes were valued at £5, his silver watch at £5, and his tall-case clock at £13 [Frederick B. Tolles, Owen Jones, and James Reynolds, "Town House and Country House: Inventories from the Estate of William Logan, 1776," *Pennsylvania Magazine of History and Biography* 82 (Oct. 1958): 401, 407, 408]. We know of one female globe-owner, Martha Laurens, but when her father presented them to her, he felt obliged to write, "when you are measuring the surface of the world, remember you are to act a part on it and think of a plumb [sic] pudding and other domestic duties." Martha had studied the classics, geometry, and geography alongside her brother [Henry Laurens to Martha Laurens, 18 May 1774, quoted in Joanna Bowen Gillespie, "1795: Martha Laurens Ramsay's 'Dark Night of the Soul'," *William and Mary Quarterly* 48 (Jan. 1991): 78].

his globes along with his microscope, telescope, thermometer, barometer, and "electrical machine." At century's end, the sale of "the private Library of a gentleman" in New York included "a valuable Microscope" alongside a "pair of Globes." [31] Among those we know owned globes in the second half of the eighteenth century were Newburyport lawyer Theophilus Parsons, widely acknowledged for his sophisticated knowledge of mathematics; the clergyman and scientific instrument maker John Prince of Salem; the merchant-turned-statesman Elbridge Gerry of Massachusetts, a member of the American Academy of Arts and Sciences; William Burton, a New-York-based British army officer and surveyor; William Logan, a Philadelphia lawyer, gentleman farmer, and member of the American Philosophical Society; Philadelphia merchants George Mifflin, Jr., who also owned a microscope, and Peter Chevalier, who briefly belonged to Franklin's Junto; Maryland planter Edward Lloyd, who also owned telescopes and a microscope; and Charleston physician Thomas Ker.[32]

While a select few owned globes, many more encountered them in the classroom. Above all, globes were pedagogical tools used in conjunction with the study of mathematical

[31]*BG*, 21 May 1754; *NYDA* 7 Apr. 1786; [New York] *Commercial Advertiser*, 21 Dec. 1797.

[32]Parsons: Theophilus Parsons [Jr.], *Memoir of Theophilus Parsons* (Boston, 1859), 348-49 [where it is also noted that Parsons amused himself by teaching navigation, geography, and the use of the globes to selected private pupils]. Prince: Ronald K. Smeltzer, "The Library and Apparatus of John Prince," *Rittenhouse* 1 (Aug. 1987): 97. Gerry: "Catalogue of a Collection of Valuable and Scarce Books, Being Part of the Library of the Late Elbridge Gerry, Esq," excerpted in Charles Arthur Hammond, "'Where the Arts and Virtues Unite': Country Life Near Boston, 1637-1864" (Ph.D. diss., Boston University, 1982), 377; Burton: *Pennsylvania Journal*, 8 March 1775; *NYRG*, 8 July 1780. Logan: Tolles, Jones, and Reynolds, "Town House and Country House," 407. Mifflin: "Inventory of Goods and Effects belonging to the Estate of the Late George Mifflin, Junr., 1754, Notes and Queries," *Pennsylvania Magazine of History and Biography* 14 (Apr., 1890): 104; *PG*, 2 May 1754. Chevalier: *PP*, 23 Nov. 1778; Whitefield Jenks Bell, *Patriot-Improvers: Biographical Sketches of Members of the American Philosophical Society 1743-1768* (Philadelphia: American Philosophical Society, 1997), 207-8. Archibald: *Columbian Centinel* (Boston), 17 Apr. 1802; "Notes on Early Autopsies and Anatomical Lectures," *Publications of the Colonial Society of Massachusetts* 19 (March 1917): 282n. Lloyd: Jean B. Russo, "A Model Planter: Edward Lloyd IV of Maryland, 1770-1796," *William and Mary Quarterly* 49 (Jan. 1992): 66. Ker: *State Gazette of South-Carolina*, 17 Dec 1787. Ker may not in fact have had any medical training. In 1784, he was advertising his services in Bermuda, not as a physician, but as a teacher of navigation, astronomy, the use of the globes, and bookkeeping. In Charleston, his globes may have lent credibility to his claims to be a scientifically-trained professional [*Bermuda Gazette*, 9 Oct. 1784].

geography.[33] Their instructional value went beyond mere representation of the heavens and earth, but the calculations performed on them were part of a teaching, not a research, agenda. Working out problems on the globes allowed students to grasp and internalize the mathematically-defined relationship between time and space in the solar system. In the eighteenth century and stretching into the nineteenth, several categories of learners received such instruction: those preparing for and enrolled in college; those acquiring a polite education; and, most rigorously of all, those heading for careers in maritime commerce.

As part of a humanistic education, geography and the use of the globes had long accompanied the classical languages in the college preparatory curriculum. Thomas Jefferson may have critiqued the intellectual shallowness of many such "petty academies," deriding them as "places where one or two men, possessing Latin, & sometimes Greek, a knolege [sic] of the globes, and the first six books of Euclid, imagine & communicate this as the sum of science," but applicants for college admission were in fact examined in geography and the use of the globes.[34] Once in college, instruction in geography and the globes continued, again as part of the mathematical curriculum. At Harvard, both "the Mathematical Professr ," when instructing pupils

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[33]It follows that a significant proportion of globe-owners were teachers and educational institutions. One shopkeeper advertised globes "for Schools or private Gentlemen" [*Connecticut Journal*, 28 June 1786]. When Newburyport mathematical instructor John Vinal caught wind of a pair of globes mistakenly sent to a bookseller in Boston, he quickly offered to buy them, preventing the need to order them from London [Vinal to Henry Knox, 6 Aug. 1773, in *Proceedings of the Massachusetts Historical Society*, 3d. ser., 61 (June 1928), 266].

[34]TJ to JA, 5 July 1814. TJ supported instruction in the use of the globes at both the "intermediate" and collegiate levels [TJ to Adamantios Coray, 31 Oct. 1823, *Founders Online*, National Archives, last modified July 12, 2016 [hereafter *Founders Online*], http://founders.archives.gov/documents/Jefferson/98-01-02-3837].See also TJ to John Carr, 28 April 1807, *Founders Online*, http://founders.archives.gov/documents/Jefferson/99-01-02-5516. College admission: In 1766, for example, an applicant to Harvard was examined in Horace and Tully, but also in "the use of the Globes" [Harvard Faculty Records, III: 2, Harvard University Archives]. When John Quincy Adams applied in 1786, the mathematics tutor asked him "what was the figure of the Earth" along with other geography questions, not all of which Adams could answer. As a boy, his father had recommended that he defer his study of "Mathematicks," that is, "Geography, Geometry and Fractions." Years later, JQA wrote to his ten-year-old son, "I do not know whether you have begun to learn Geography and the use of the Globes—If you have, you will soon understand the causes why the days and nights are of such different lengths in different Countries" [John Quincy Adams to JA, 2 Apr. 1786, *Adams Digital*; Diary of John Quincy Adams, 15 March 1786, (quotation), *Adams Digital*; JA to John Quincy Adams, 17 March 1780, *Adams Digital* (quotation); John Quincy Adams to George Washington Adams, 10 May 1811, *Founders Online*, http://founders.archives.gov/documents/Adams/99-03-02-1962].

in "the apparatus chamber," and the college tutors, when assisting with the "the study of Astronomy or Geography," made use of the "very large pair of fine globes" donated to the college by merchant Andrew Oliver, Jr. At Princeton, President Samuel Stanhope Smith undertook some of this instruction.[35] "With Doctor Smith," wrote Princeton student George Washington Parke Custis, the president's step-grandson, in 1797, "I completely studied the use of the Globes and got a pretty tolerable insight into geography" [Image 9].[36]

Over the course of the eighteenth century, geography and the use of the globes acquired a second audience, taking their place with the "polite sciences" recommended to all with aspirations to gentility.[37] As such, globes figured in popular science lectures.[38] Even greater numbers encountered them as part of a polite education. Geography and "Knowledge of the Globes" were among the subjects offered by Boston's "English Grammar-School" as necessary preparation "for entering on the Stage of Life with Advantage" and making "an amiable Figure in the World." In New York, Sewall Chapin, A.B., put "Geography, the knowledge and use of the Globes, with an explanation of the Solar System" at the top of the list of subjects he would teach, noting that his curriculum was "particularly adapted for those in genteel circumstances

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[35] 15 Apr. 1755, Harvard Corporation Records II: 61, Harvard University Archives. For more on globes at Harvard, see David P. Wheatland, *The Apparatus of Science at Harvard, 1765-1800* (Cambridge: Harvard University, Collection of Scientific Instruments, 1968), 63-66. On such instruction in British universities—as late as 1821, the Cambridge Tripos included examination in the use of the globes—see Withers and Mayhew, "Geography in British Universities."
[36] Custis to Washington, 8 June [1797], *The Papers of George Washington Digital Edition*, ed. Theodore J. Crackel. Charlottesville: University of Virginia Press, Rotunda, 2008 [hereafter *Washington Digital*]. In 1789 Washington wrote a London firm: "I will thank you to send me by the first vessel, which sails for New York, a terrestrial globe of the largest dimensions and of the most accurate and approved kind now in use." The globe received stands out for its size (28-inch diameter, when 12- and 18-inch were more usual), its quality (made by George Adams, the best of the day), its cost (£25, when William Logan's cost £5), and the fact that it was not one of a pair [Washington to Wakelin Welch & Co., 16 Aug. 1789, and Wakelin Welch & Co to Washington, 8 Oct 1789, 14 Feb. 1790, *Washington Digital*].
[37] *NYP*, 12 Dec. 1785 [quotation]; Alice N. Walters, "Conversation Pieces: Science and Politeness in Eighteenth-Century England," *History of Science* 35 (June 1997): 121-54; C. W. J. Withers, "Towards a History of Geography in the Public Sphere," *History of Science* 36 (1998): 45-78; Wallis, "Geographie Is Better," 28-30; Simon Schaffer, "Natural Philosophy and Public Spectacle in the Eighteenth Century," *History of Science* 21 (March 1983): 1-43.
[38] "A Course of Experimental Philosophy," *PG*, 4 Dec. 1755; "A Geographical Lecture," *PP*, 13 Jan. 1772; "An Astronomical Apparatus," *BG*, 23 Feb. 1789; "Astronomical Lecture," *New-York Daily Gazette*, 13 July 1790. Gloria Clifton notes that a number of major English globe-makers got their start as popular science lecturers [Clifton, "Globe Making], 50.

who intend not to go through a Colledge [sic] education, and especially"—and this was critical to the contemporary understanding of politeness— "for the advantage of the Ladies."[39] In all-female settings, such instruction could take on more than a whiff of the ornamental. One Philadelphian lumped the use of the globes with French lessons as afternoon extras in his "little Seminary." A Bostonian offered a course for those "Ladies . . . who wish to acquire the elegant Accomplishments of GEOGRAPHY, the Use of the GLOBES, and English GRAMMAR." And the female pupils at Pennsylvania's Westtown School produced pairs of silk globes embroidered with ecliptics, horizon circles, and the networks of meridians and parallels termed graticules.[40]

Alongside colleges and academies, there existed a third, profoundly utilitarian setting for geography and the use of the globes [Images 10, 11].[41] These subjects featured prominently in what were sometimes explicitly identified as "mathematical" schools and courses, but it is clear from the other subjects routinely taught in these settings—commercial arithmetic, merchant's accounts, geometry, trigonometry, navigation, astronomy, and surveying—that the goal was not to produce mathematicians. Offered largely in coastal communities, this was practical education primarily geared to maritime commerce: how to navigate the seas and keep the books.[42] Globes

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[39]*BG*, 26 Nov. 1772; *NYP*, 12 Dec. 1785; [New York] *Independent Journal*, 12 June 1784 [quotations]. For further evidence of the place of geography and globes in college preparatory and "polite" curricula, see the advertisements for the grammar school in Hartford [*Connecticut Courant*, 2 Oct. 1781]; the East-Hampton (New York) Academy [*Connecticut Gazette*, 2 Dec. 1785]; Philadelphia academies [*IG*, 7 Sept. 1782; *Pennsylvania Evening Herald*, 29 July 1786; *PP*, 20 Sept. 1786]; Maryland's Washington Academy [*PP*, 19 Nov. 1784]; a school for "young gentlemen" in Hagerstown, Md. [*Carlisle Gazette*, 15 July 1786]; the York (Va.) Grammar School [*Virginia Gazette*, 8 Feb. 1787]; and Gaudenzo Clerici's "Academy of Learning" in Charleston [*Columbian Herald*, 10 Feb. 1785.

[40]*PP*, 23 Sept. 1786; [Boston] *Independent Chronicle*, 23 March 1780; Judith A. Tyner, *Stitching the World: Embroidered Maps and Women's Geographical Education* (Farnham, UK: Ashgate, 2015), 93-97, Appendix C.

[41]The first American newspaper advertisement for instruction in the use of the globes appeared in Boston in 1720, alongside instruction in arithmetic, bookkeeping, geometry, geography, trigonometry, astronomy, and navigation [*BG*, 21-22 March 1720].

[42] "Mathematical": [Boston] *Independent Ledger*, 14 Oct 1782; *Salem Gazette*, 7 Nov. 1782; *NYRG*, 22 Oct. 1783; [Boston] *American Herald*, 10 May 1784. See also *Boston Evening Post*, 2 Nov. 1782; *Massachusetts Centinel*, 8 Sept. 1787; and *State Gazette of South-Carolina*, 24 Sept. 1787. Some such schools and courses identified themselves as emphasizing navigational skills [*IG*, 27 Sept. 1788; *BG*, 28 March 1791]. A few teachers, seeking to appeal to a broad range of students, offered a visibly bifurcated curriculum, with Latin and Greek heading "liberal" studies, and geography and the use of the globes categorized with such "useful Branches of the Mathematics" as bookkeeping and navigation. Such schools signaled their hybrid curricula with

had long been associated with navigation; they depicted latitude and longitude lines as well as the heavenly bodies that formed the basis of celestial navigation. Many navigation instructors used them as teaching tools.[43] John Nathan Hutchins, a "Teacher of Mathematical Arts" in New York who owned "an excellent Pair of Globes," advertised his services to "Gentlemen Sailors," while Benjamin Workman included globes among the instruments he owned to teach navigation to "masters and mates of ships" as yet "not acquainted" with advanced methods. A few navigation teachers advertised their nautical credentials as retired sea captains, naval officers, or shipboard officers of the East India Company.[44]

More often, mathematical schoolmasters offering instruction in geography and the use of the globes reached beyond a narrowly nautical audience. They provided training for those entering maritime trade in a variety of capacities, not just future mates and shipmasters—who, we should remember, often settled down to engage in international commerce—but also ship's clerks, counting-house apprentices, supercargoes, and young men in waterfront businesses. The men who taught these courses and published related texts were commercially-oriented mathematical practitioners, hybrids of a sort that made sense in a world where quantitative expertise was there for practical use.[45] The first American-authored treatise on the use of globes was published in 1753 by Theophilus Grew, who, as a "Mathematical Professor" in Philadelphia,

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names like "Mercantile and Classical Academy" or the "New York Commercial, Classical, and Mathematical School," or by advertising a "course of Liberal and Commercial Education" [*Columbian Herald* (Charleston), 18 June 1791; *New-York Morning Post*, 30 July 1797; (New York) *Argus*, 24 Oct. 1796; (Philadelphia) *Independent Gazette*, 23 Apr. 17870]. See also *Hampshire Herald*, 6 Sept. 1785; *Charleston Evening Gazette*, 4 Nov. 1785; *Maryland Gazette*, 12 Jan. 1786. Sometimes, branches of mathematics with no obvious vocational content--algebra, and even "fluxions" --were offered, but these were overshadowed by vocationally oriented fields. Other practical skills sometimes offered include gauging, mensuration, and gunnery.

[43]Elly Dekker, "The Navigator's Globe," in Dekker, *Globes at Greenwich*, 33-43; Clifton, "Globe Making," 45. The Dutch East India Company made the most consistent use of terrestrial globes at sea for navigation, a practice that ended around 1650. However, globes remained standard issue on company vessels for another century, with celestial globes—and their updated information on the constellations used to establish latitude—of greater importance.

[44]*New-York Mercury*, 26 Feb. 1759; [Philadelphia] *Freeman's Journal*, 30 Aug. 1786; *Boston Evening Post*, 21 Nov. 1737, 3 May 1762; *Essex Journal* (Newburyport), 23 Nov. 1785.

[45]On mathematical practitioners, see Silvio Bedini, *Thinkers and Tinkers: The Early American Men of Science.* (New York: Scribner, 1975), and Larry Stewart, "Other Centres of Calculation, or, Where the Royal Society Didn't Count: Commerce, Coffee-houses and Natural Philosophy in Early Modern London," *British Journal for the History of Science* 32 (June 1999): 133-53.

also taught classes in arithmetic, bookkeeping, navigation, and surveying. Benjamin Workman, whose popular *Geography* included problems on the globes, was also a mathematics professor in Philadelphia. He taught navigation, published texts in commercial arithmetic and accounting, and proposed an "American Nautical Almanack." Bartholomew Burges taught navigation, surveying, geography, and the use of the globes in Newburyport, Portsmouth, and New York. Claiming expertise as a former navigator and surveyor "in the East-Indies . . . the Mediterranean, on the coast of Africa, and other parts of the Globe," he published both *A Short Account of the Solar System* and a *Series of Indostan Letters*, a lively first-person narrative that concluded with "a list of a few articles that . . . . could not fail of selling well in . . . India." Englishman Daniel Fenning, whose *New and Easy Guide to the Use of the Globes, and the Rudiments of Geography* was popular in postrevolutionary America, published texts in commercial arithmetic, algebra, mensuration, geography, and bookkeeping.[46]

For every George Washington Parke Custis who studied geography and the use of the globes at Princeton, then, there was a young man studying them in a "mathematical school" in order to become a sea captain, supercargo, or merchant. But in truth, with the exception of polite young ladies, all those who received instruction in these fields, wherever such instruction took place, could potentially play a role in international commerce. Many merchants who went on to engage in global trade entered a counting-house apprenticeship only after several years of study with a private college-preparatory tutor, at a Latin or Grammar school, an academy, or even at college. Others who bankrolled global commercial ventures, insured them, or defended their legal and political interests, were even more likely to have attended institutions with geography and globes in their curricula.[47] Together, liberal, polite, and commercial educations produced the

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[46]Grew: Theophilus Grew, *A Description and Use of the Globes, Celestial and Terrestrial* (Germantown, PA, 1753); *American Weekly Mercury* (Philadelphia), 23 March-1Apr. 1736; *PG*, 21 Sept. 1752. Workman: *New Jersey Gazette*, 5 Sept. 1785; [Philadelphia] *Freeman's Journal*, 30 Aug. 1786; Smith and Vining, *American Geographers*, 228-89. Burges: *Essex Journal* (Newburyport), 23 Nov. 1785; *Oracle of the Day* (Portsmouth), 3 Aug. 1793 [quotation]; Burges to JA, 19 June 1790, *Founders Online*, http://founders.archives.gov/documents/Adams/99-02-02-0994; Burges, *A Short Account of the Solar System* (Boston, 1789); Burges, *A Series of Indostan Letters* (New York, 1790). Fenning: Fenning, *Use of the Globes*; Frances Austin, 'Fenning, Daniel (1714/15–1767)', *Oxford Dictionary of National Biography*, Oxford University Press, 2004; online edn, Jan 2008 [http://www.oxforddnb.com/view/article/69580].

[47]Many of the global merchants of this era profiled by Freeman Hunt, for example, had this sort of education, including Thomas Handasyd Perkins (three years with a college preparatory tutor),

men who developed global trading enterprises [Image 12]. How did such studies shape their outlook?[48] Many scholars have examined the intellectual impact of one branch of geographical knowledge—descriptions of new lands, peoples, and natural productions emerging from European explorations of the globe—while overlooking the mathematical branch of geography. In that branch, students did not just look at globes. They physically manipulated them, solved problems on them, used them. Delving more deeply into the content of this training, we can speculate on how it might have shaped the imagination.

Let us start with an obvious point. If we look at a terrestrial globe of this era, its very surface seems to inspire travel to distant locales. Even the name contemporaries used to refer to our planet—the "terraqueous globe"—suggests movement from terra to terra via the aqua, and those movements were depicted on the so-called "artificial globe." We see them in the globes' latitude and longitude lines, navigational rhumb lines, and by the eighteenth century, currents, monsoons, and trade winds symbolized by arrows [Image 13].[49] The great circumnavigators also made their presence known, in the updated cartographic knowledge they brought home to be sure, but also the tracks of their voyages engraved on the globes' oceans [Image 14], sometimes annotated with textual comments ("Hitherto they had an Open Sea but hence South all but Ice between the and the Shore," "Owhyhee Here C. Cook was Kill'd") [Image 15].[50] Consumers favored globes that featured these voyages and their discoveries. In 1784, for example, competing Philadelphia shopkeepers advertised "a pair of nine-inch Globes, with all the latest

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John Bromfield and Patrick Tracy Jackson (Dummer Academy), and Jonathan Goodhue (Salem Grammar School). Kenneth Wiggins Porter traces a similar educational lineage for many other merchants, including Jonathan Jackson, George Cabot, Stephen Higginson, and Henry Lee [Hunt, *Lives of Merchants* , 1: 35,-36, 347, 557, 2: 471; Kenneth Wiggins Porter, *The Jacksons and the Lees: Two Generations of Massachusetts Merchants, 1765-1844*, 2 vols. (Cambridge: Harvard University Press, 1937), 1: 7-20].

[48]The point is not lost that, by the same token, many statesmen and diplomats of this era shared training in mathematical geography and the globes and that we might therefore inquire into the cognitive impact of these studies on their outlook as well.

[49]Sumira, *Globes*, 20, 54, 122; Dekker and Van Der Krogt, *Globes*, 111, 113. A rhumb line for any particular heading crosses each meridian at the same angle; on a globe, the resulting line spirals toward the poles.

[50]Chaplin, *Round about the Earth*, xviii, 41-42, 130-31; Sumira, *Globes*, 106-7, 110-13, 118-19, 128-31 [quotation, 130], 154-59, 178-81; Dekker, *Globes at Greenwich*, 267 [quotation].

discoveries" and "12 and 18 inch globes on the latest and most improved principles, describing Cook's last voyages."[51]

Of course, many such features could figure on maps as well, so that we are left to wonder if globes, and mathematical geography more generally, made a distinctive impact on conceptualizing the planet. Certainly, there were similarities. Both maps and globes could be used to assert political power and territorial dominance.[52] And the "hemispheric" projections popular in world maps of this era [Images 16, 17, 18], directly mimicking the look of a globe, present something of a conceptual gray area.[53] But maps, though drawing on the associations of precision mathematics to lend an aura of objectivity to their cartographic "facts," were not computational tools.[54] They belonged to the world of descriptive geography, the realm of terrestrial particularity, not the mathematical geography of the universe. Globes offered distinctive modes of manipulating the world, physically, intellectually, and imaginatively.

The most obvious distinction is that unlike maps, globes fostered thinking in three dimensions. Three-dimensional thinking had proven its impact on global commerce centuries earlier in the geographical concept of the Tropical Zone, that latitudinal slice of the earth defined

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[51]*IG*, 3 Apr. 1784; *PP*, 9 Nov. 1784. In 1799, London globe-maker William Jones explained to the American Philosophical Society that he had "deferred sending the globes till the Geography &c had received the latest additions, and discoveries" [Wm Jones to John Vaughan, 24 June 1799, APS Archives, Record Group IIA]. See also *NYDA*, 23 May 1786. Celestial globes, it should be noted, also had to be updated constantly. As explorers mapped the southern hemisphere, so did they map that hemisphere's constellations, heretofore unknown to Europeans. New more powerful telescopes revealed the existence of unknown celestial bodies, Herschel's Uranus most famously (1781), but also stars [Dekker and Van der Krogt, *Globes*, chaps. 3-6 passim; Sumira, *Globes*, 26, 132, 141, 144, 150, 195, 199].

[52]The literature on the ideological content and political import of cartography is vast. Brief introductions are provided in D. E. Cosgrove, "Introduction: Mapping Meaning," in *Mappings*, ed. D. E. Cosgrove (London: Reaktion, 1999), 1-23, and Matthew H. Edney, "Reconsidering Enlightenment Geography and Map Making: Reconnaissance, Mapping, Archives," in *Geography and Enlightenment*, eds. D. N. Livingstone and C. W. J. Withers (Chicago: University of Chicago Press, 1999), 165-98.

[53]For an example of this blurring, and of hemispheric projection [Image 18], see the manuscript map of the world executed in 1797 by thirteen-year-old Charles Barrell—son of the Bostonian who bankrolled the first American circumnavigation—noting in particular how Barrell's rendering was based on "the Encyclopedia and Adams's Globe" [Fol. 256 Joseph Downs Collection of Manuscripts and Printed Ephemera, Winterthur Library, http://commondestinations.winterthur.org/the-national-map/].

[54]Sarah Stidstone Gronim, "Geography and Persuasion: Maps in British Colonial New York," *William and Mary Quarterly* 58 (Apr. 2001): 373-74.

precisely by its relationship to the noontime sun. Because any particular tropical latitude is astronomically identical in every meridian, the West Indies and the East Indies were perceived as in some sense interchangeable. That notion in turn suggested that tropical flora, fauna (and diseases, and people) could be transplanted successfully to any other location in the Tropics, a claim that displaced the older idea that life forms flourish only in their native habitats. Hence "mandarin" oranges voyaged from China to Portugal in the sixteenth century, and in the eighteenth, Captain Bligh loaded his *Bounty* with Tahitian breadfruit for transport to the Caribbean. What might seem counterintuitive—China and Portugal are not only far apart, but also qualitatively different—made sense in the three-dimensional abstraction of the globe.[55]

In the colonial era, American merchants had little reason to conceptualize their trade in three-dimensional terms, confined as they were to the Atlantic box. Most colonial shipmasters relied on basic navigational techniques—the compass for direction, the logline and hourglass for distance --that assumed the ocean as a plane. On Caribbean routes, their vessels skirted the American coast. On European voyages, with no method extant besides dead reckoning to assess longitude, they sailed north or north to the desired latitude and then due east or west to their destinations.[56] Then in the mid-eighteenth century, astronomers developed the new lunar distance technique that enabled a skilled celestial navigator to establish both his latitude and longitude at sea, a breakthrough that greatly lessened the dangers of the voyages beyond the Capes.[57] Such voyages demanded knowledge of spherical geometry and trigonometry. If colonial

[55]Paul S. Sutter, "The Tropics: A Brief History of an Environmental Imaginary," in *Oxford Handbook of Environmental History*, ed. Andrew C. Isenberg (Oxford: Oxford University Press, 2014), chap. 7; Benjamin Breen, "Transplantations in the Torrid Zone: Diseases, Drugs, and Knowledge in the Atlantic World, 1640-1730," paper presented at the McNeil Center for Early American Studies Seminar Series, 26 Feb. 2016; Ashley L. Cohen, "The Global Indies: Reading the Imaginative Geography of British Empire, 1763-1871" (Ph.D. diss., University of Pennsylvania, 2013). For examples of this material in texts popular in post-independence United States, see Fenning, *Use of the Globes*, 69-70; Workman, *Elements of Geography*, 25-27; and Morse, *American Universal Geography*, 31-36. A related concept was that of the climate, the latitudinal limits of which represented a difference of half an hour in the length of the day.
[56]Matthew Gaston McKenzie, "Vocational Science and the Politics of Independence: The Boston Marine Society, 1754-1812" (Ph.D. diss., University of New Hampshire, 2003), 58-64, 156-58.
[57]In response to the new lunar distance method, London globe-maker George Adams modified his celestial globe for the benefit of mariners "who may have occasion to observe the distance of the moon from a fixed star, in the new method of discovering the longitude at sea." The globe played no active role in establishing longitude, but instead made it easier to remember the knowledge required for the method, the moon's track across the sky [Adams, *A Treatise*

American shipmasters sailed across the plane of the Atlantic, post-independence East Indies traders voyaged around the globe's spherical graticule. For those at sea, these imaginary lines were no abstraction. Sailors marked "crossing the line"—both the Tropic of Cancer and the Equator—with mock "baptismal" ceremonies. Back on land, the conceptual possibilities of three dimensions came alive in the "use of the globes."

Problems on the globes had many of the same implications as the geographical concept of the zone. Both brought all places on the planet within conceptual reach, and both presented widely distant locations as fundamentally, meaningfully <u>linked</u>—the raw conceptual material for creating trading networks--by virtue of their mathematically-defined relationship to the heavens. The student charged with locating all those places on the same latitude as Madrid, for example, comes up with "Pekin, in China, Tamarcand, in Tartary, Naples, in Italy, and Philadelphia, in America." Other problems had the calculator imagining simultaneous occurrences around the globe. "When it is 2 o'clock in the afternoon at London," read one, "I would know the time at Jerusalem, and at Port Royal, or Kingston, in Jamaica."[58] We should not underestimate the cognitive éclat created by such problems. Consider that the Copernican system was not universally familiar or accepted; that for many Americans, Jerusalem was more a religious concept than a geographical reality; and that in the era before the telegraph, separation by distance invariably entailed the passage of time. Such astronomical facts could be driven home in a visceral way. After noting that when it is 10am in Boston, it is 12:20 pm in Olinda, Brazil, Jedidiah Morse commented, "By this problem you may likewise see, at one view, in distant countries, where the inhabitants are *rising*—where *breakfasting*—*dining*—*drinking tea*; where going to *assemblies*—and where *to bed*."[59]

As the example from Morse illustrates, mathematical calculations of space and time could shade into representations of peoples, imagined in these scenarios as essentially equivalent, distinguished only be their differing relationships to heavenly bodies. That sense of simultaneity and equivalence, a kind of mathematical sympathy, likewise characterized two antique human classification schemes that curiously persisted in geography textbooks of this era, even as racial

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Describing and Explaining the Construction and Use of Our New Celestial and Terrestrial Globes (London, 1766), 5, quoted in Dekker, "The Navigator's Globe," 40].
[58]Fenning, *Use of the Globes*, 88, 111.
[59]Morse, *American Universal Geography*, 43, 44.

classification schemes were making their appearance. One scheme distinguished among the Amphiscii, Periscii, and Hetrosii, according to the differing direction their shadows cast at different times of the year [Image 19]. Another defined the Antoecians, Perioecians, and Antipodes relative to a reference set of inhabitants: respectively, along the same meridian, but the same distance on the other side of the equator; 180 degrees along the same latitude; and 180 degrees along the same meridian. Though many a text could not resist presenting the Antipodes as a truth-stranger- than-fiction tale ("persons who walk with their feet to our feet"), the pith of these lessons was neutrally astronomical, with nary a word about biological difference, let alone the qualitative ranking of differences.[60] Perhaps it was this outlook that shaped Senator William Maclay's belief that when it came to trade policy, the United States would do well to imitate the geopolitical impartiality of China, a nation Maclay--a surveyor, we should note--described as "geographically speaking, ... the counterpart to our American world."[61]

This sense of mathematics as an equalizer brings us to a second distinctive aspect of globes. As the physical embodiment of mathematical geography, globes partook of an Enlightenment vision that placed the earth within the unitary, rule-bound mechanism called the solar system. Because mathematically-defined natural laws exercised universal sway, space was essentially undifferentiated, a vision of mathematical uniformity given expression in the graticules of the celestial and terrestrial globes. This vision was hardly new to Americans in the late eighteenth century—it underlay the much earlier equivalence of the East and West Indies, for example—but new developments in that era may have strengthened its power. For one, Newtonianism itself, though not universally or uncritically adopted in America, held increasing sway.[62] Then too, globes themselves (along with maps) increasingly represented space as a mathematical abstraction. Sea monsters vanished from gridded oceans. Constellation-scientific instruments joined constellation-creatures [Image 20].[63] That rationalized design reflected

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[60]For examples in post-independence texts, see Fenning, *Use of the Globes*, 66-69 [quotation, 67], 116-18, and Workman, *Elements of Geography*, 27-29, 44-45.
[61]Journal of William Maclay, 18 June 1789, in *Journal of William Maclay: United States Senator from Pennsylvania, 1789-1791*, ed. Edgar S. Maclay (New York: D. Appleton, 1890), 82-83.
[62]Sara S. Gronim, "At the Sign of Newton's Head: Astronomy and Cosmology in British Colonial New York," *Pennsylvania History* 66 (1998): 55-85.
[63]Dekker and Van Der Krogt, *Globes*, 111,123. Thomas Stackhouse admitted that the traditional constellation figures were "absurd and obsolete," but might nonetheless be "usefully retained" [*Rationale of the Globes*, 66]. On the "cultural ideology of geographical disenchantment," see

notions of the terraqueous globe as part of mathematically regular systems, the solar system of course, but also the equally law-bound system of the world economy.

European craftsmen produced those newly rationalized globes, but Americans were responsible for creating a new kind of rationalized space: the grid. In the same years that American vessels were embarking on maiden voyages to Asia, the continental grid of the Northwest Ordinance--aligned with global lines of longitude and latitude--was conceptualized and implemented. In the same era, urban grids, advocated especially by merchants in port cities, were laid out and expanded.[64] Dell Upton has characterized the enthusiasm for gridded space in the new nation as more than an economic preference for efficient land development, but instead an artifact of a "republican spatial imagination." Americans of the early republic were drawn to orthogonal plans, he argues, as metaphorical expressions of Newtonian system, but even more distinctively, as congruent with republican social values. They valued what they perceived as the grid's transparency, its legibility and openness to all, including those with no prior familiarity of the space. To them, gridded cities, unlike the grand manner of urban planning with its broad boulevards anchored by ceremonial landmarks, assigned no superior value to one square of space over another. Relationships revealed by the grid were "flexible and individually manipulable," not predetermined and hierarchal. The "republican spatial imagination," Upton concludes, thus

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Edney, "Enlightenment Geography and Map Making." For the broader theoretical background, see Mary Poovey, *A History of the Modern Fact: Problems of Knowledge in the Science of Wealth and Society* (Chicago: University of Chicago Press, 1998).

[64]William D. Pattison, *Beginnings of the American Rectangular Land Survey System, 1784-1800,* Research Paper No. 50 (Chicago: University of Chicago Department of Geography, 1957); Hildegard Binder Johnson, "Gridding a National Landscape," in *The Making of the American Landscape,* 2d ed., ed. Michael Conzen (New York: Routledge, 2010), 142-46; John R. Stilgoe, *Common Landscape of America, 1580-1845* (New Haven: Yale University Press, 1982), 102-5; Dell Upton, *Another City: Urban Life and Urban Spaces in the New American Republic* (New Haven: Yale University Press, 2008), chap. 6. As originally conceptualized in 1784 by Thomas Jefferson and former mathematics professor Hugh Williamson, the grid would have made use of the nautical (or geographical) mile--equivalent to a minute of latitude--rather than the statute mile, and would therefore have further dovetailed with the "artificial" globe. Jefferson, schooled in mathematical geography, had been inspired by the notion that "the globe of the earth itself, indeed, might be considered invariable in its dimensions, and that its circumference would furnish an invariable measure," but by 1790 he had faced the reality that "no one of its circles, great or small, is accessible to admeasurement through all its parts" [Pattison, *Land Survey System*, 46-50; Thomas Jefferson, *Report of the Secretary of State, on the Subject of Establishing a Uniformity in the Weights, Measures and Coins of the United States* (New York, 1790), 9-10].

"sought to equalize spatial opportunity by conquering space, . . . eliminating differences to provide a clear field for the construction of intentional ones."[65]

This description bears a striking resemblance to the way American merchants of the same era perceived and conducted themselves in the globe as a commercial space. They wanted access, though they lacked familiarity with the world outside the Atlantic basin or superior power in it. They pursued a radically decentered commercial strategy, giving no particular preference to their home ports, or any port for that matter. Responding to on-the-spot information, they constructed trading routes on the fly, exporting and re-exporting goods from market to market in complex, multi-leg voyages. If European East Indiamen enacted "grand manner" processions of tribute from colonial periphery to metropolitan emporia, the American merchant fleet of diminutive trading vessels darted from square to square in the global grid, creating—not deferring to—superior value. American merchants knew this kind of space: mathematically predictable and therefore manipulable, mathematically uniform and therefore open-ended in economic possibilities. Instructed in the use of the globes, they could imagine how they might use the one they lived on for their own benefit.

By the turn of the nineteenth century, the intellectual regime that had sustained mathematical geography and the use of the globes began to break down. The signs were many. Astronomy and geography went their separate ways, the former expanding into the universe outside our solar system, the latter jettisoning mathematics for the particularities of places, products—and races. Globe-makers continued to produce globes in pairs, though the cosmographical basis for that pairing had long since expired, but the terrestrial singleton became increasingly dominant. Mapmakers took over from precision instrument-makers in manufacturing globes, a sign that globes were used not as calculating devices in the field of mathematical geography, but as spherical maps in the teaching of descriptive geography. By mid-century, a new kind of globe appeared that enhanced the visibility of those maps. It was perched on a single pillar, lacked the appurtenances and physical manipulability that enabled computation, and spun at a permanently fixed angle in an attenuated meridian ring [Image 21].

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[65]Upton, *Another City*, chap. 6 [quotations, 134, 135]. Upton makes clear that no particular organization of space inherently possesses particular qualities, but is instead invested with them, but that Americans of the early republic cast the grid above all in this light [135].

Over the course of the century, this new style gained dominance.[66] Teaching the "use of the globes" persisted, but as part of a learned or polite, not a practical, education. Indeed, in the ultimate sign that the "use of the globes" was of no real use at all, this branch of learning became associated with governesses, school marms, and "demoiselles" at boarding schools.[67]

While it was in force, however, critical sectors of the American population learned about their world by developing an astronomical, mathematical understanding of the "terraqueous globe" and by physically and arithmetically manipulating the "artificial globe." Among those Americans were merchants, supercargoes, navigators, investors, and statesmen promoting a newly global trade. Their geographical training gave them a way to imagine the entry of an economically undeveloped, politically and militarily weak new nation into a trade dominated by powerful European monopolies.[68] They had learned that the Earth is part of a larger system that, in its regularity and predictability, could be manipulated toward particular ends. They had absorbed a model of an interconnected but decentered system in which space is undifferentiated, a latticework of identical units subject to the same mathematical laws. Working out problems on the globes could stir the mercantile imagination. One could envisage the simultaneous existence of other people in far-flung places, impossibly distant but linked nonetheless in mathematical relations of time and space, in webs of longitude and latitude. Then, launching vessels into the

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[66]Dekker and Van der Krogt, *Globes*, 115, 116, 127, 146, 154-56; Sumira, *Globes*, 29-30, 194-99, 212-15; Clifton, "Globe Making," 53.

[67]This tentative conclusion is based on schools advertising such instruction, 1800-1880, in *Early American Newspapers*. For fictional examples of the "use of the globes" as a female accomplishment, see Sue Petigru Bown, *Lily* (New York: Harper, 1855), 119-20 [quotation]; Bret Harte, "Miss Mix," in *Condensed Novels* (New York: G. W. Carleton, 1867), 71; and Abraham Page, *What I Know about Ben Eccles* (Philadelphia: J. B. Lippincott, 1869), 99.

[68]Descriptive geography, with its focus on spatial variety and particularity, provided a different way to conceptualize international trade. Positing the mutual exchange of superfluities for necessities as the impetus for global commerce offered a model of economic activity characterized by Newtonian balance and harmony, but one premised on the uneven spatial distribution of commodities. In reality, those asymmetries lent a spatial dimension to preexisting inequalities of political, economic, and military power. If this was a system modeled on the solar system, it was one that emphasized the sun and its satellites. Much as Americans rejected this astronomical model to represent their political system in favor of a constellation of stars, so too did they reject it as an economic model [Eran Shalev, "'A Republic Amidst the Stars': Political Astronomy and the Origins of the Stars and Stripes," *Journal of the Early Republic* 31 (Spring 2011): 39-73].

global graticule, merchants could pursue new commercial tracks from ocean to ocean, heedless of established hierarchies of wealth, power, military might—and space.