Contributions to Map History

Vol. 5, January–June 2021

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23 July 2023

https://www.mappingasprocess.net/contributions

Contents

What Is a "Planisphere"?

Disambiguating a commonly used term that is potentially culturally biased

Originally posted: 9 January 2021

https://www.mappingasprocess.net/blog/2021/1/9/what-is-a-planisphere

The Medea project recently inaugurated a weekly blog, "Chart of the Week," with a post by Joaquim Gaspar on the "Cantino planisphere (1502)." (The image in the blog roll is a detail of that map.) The announcement prompted me to post a series of tweets (@mhedney) about how map historians have used "planisphere" to refer to different kinds of maps. This variety of usages is evident not only in the Anglophone literature but also in French (*planisphère*), Dutch (*planisfeer*), German (*planisphäre*), and so on. (German also has featured *planiglobii*, which Keuning (1955, 5) translated as "planiglobe.") I thought I should expand on the tweet, giving sources, references, and further commentary. A closer look into the term's usage reveals that it has in part been strongly politically and culturally inflected; "planisphere" should be used in a careful and precise manner.

The history of the usage of "planisphere" follows a pattern I've found to be rather common in the field: a word is used a precise way by a certain community; later, people outside that community see the word, parse it literally, and then use the word accordingly. The result is a mix of usages, frequently overlapping, none precise, all complicating historical understudy.

The literal, intuitive meaning of "planisphere" is a flattened sphere, a sphere converted in some way to a plane. It was originally used to refer specifically to a map of the celestial sphere, although in the early modern era its usage was expanded; in the modern era, it has been interpreted more generically by historians. This process is evident in the *Oxford English Dictionary* (art. "Planisphere" *n*) which presents a quite general meaning:

> A map, chart, or scale formed by the projection of a sphere, or part of one, on a plane; a representation of a hemisphere of the earth, the sky, or the solar system, on a flat surface, usually as a circle.

However, in this instance, the *OED* does give a further note about specific usage in celestial mapping:

> *spec.* (a) a polar projection of half (or more) of the celestial sphere on to a plane surface, so that the equator and circles parallel to it appear as circles on the plane, esp. as used in a common form of astrolabe; (b) a flat device consisting of a polar projection of the whole of that part of the celestial sphere visible from a particular latitude, viewed through a movable cover with an elliptical opening that can be adjusted to show the part of the heavens visible at a given time of night and season of the year.

The *OED's* definitions allude to technical elements (in the references to the recreation of the celestial circles as circles on the plane, and the depiction of hemispheres), but these need to be foregrounded in order to develop a history of the term and of its usage.

Origins: Celestial Mapping

The original, technically precise meaning of "planisphere" stems from the title of a twelfth-century translation into Latin of one of the Arabic manuscripts that have preserved Claudius Ptolemy's Ἅπλωσις ἐπιφανείας σφαίρας, or *Simplification of the Sphere*. In 1143, Hermann of Carinthia gave the work the Latin title of *Planisphaerium*. This title was later perpetuated in the Renaissance, in printed editions of Hermann's text (Edson and Savage-Smith 2000; Sidoli and Berggren 2007, 37–38).

Stated simply, what Ptolemy described was the stereographic projection, one of the four azimuthal projections used in Antiquity and the Classical era to represent the celestial sphere on a plane. None of the three—the other three being the gnomonic, orthographic, and equidistant projections—were originally used for mapping the terrestrial sphere of the earth. The particular benefit of the stereographic projection was that it was, in modern terms, conformal. That is, shapes are preserved in the transformation from sphere to plane, so that a circle in the heavens (both great circles such as the ecliptic, celestial equators, and the colures and small circles, such as arctic circle) are still circles in the plane (see Lorch 1995). Also, the shapes of the constellations were not distorted. The stereographic projection was used in the construction of the main plates (mater and climates) of astrolabes; the rete of the astrolabe (the mesh of lines and pointers) indicated the locations of particular stars. It was perhaps also used in other formats to map the stars.

Usage 1: Star Map on the Stereographic Projection

That is, coming out of the medieval period and into the Renaissance, in the Latin West, a planisphere was *specifically* a star map on the stereographic projection centered on a celestial pole (either equatorial or ecliptic) and generally embracing both the northern celestial hemisphere and those parts of the southern celestial hemisphere that were revealed by the tilt of the earth's axis (fig. 1). Some early modern star maps covered precisely a hemisphere. Also, a few hemispheres were constructed on the azimuthal equidistant projection, and as such should not be called planispheres (Friedman Herlihy 2007, 105n26). Not that early modern scholars were themselves consistent in their usage.

The *planisphere* in figure 1 depicts one half of the southern celestial sphere, centered on the pole of the ecliptic; the darker solid lines converge at the pole of the equator. Figure 2 shows another one, made in a physical casing reminiscent of the astrolabe (but not actually replicating the astronomical instrument; see also Kidwell 2009).

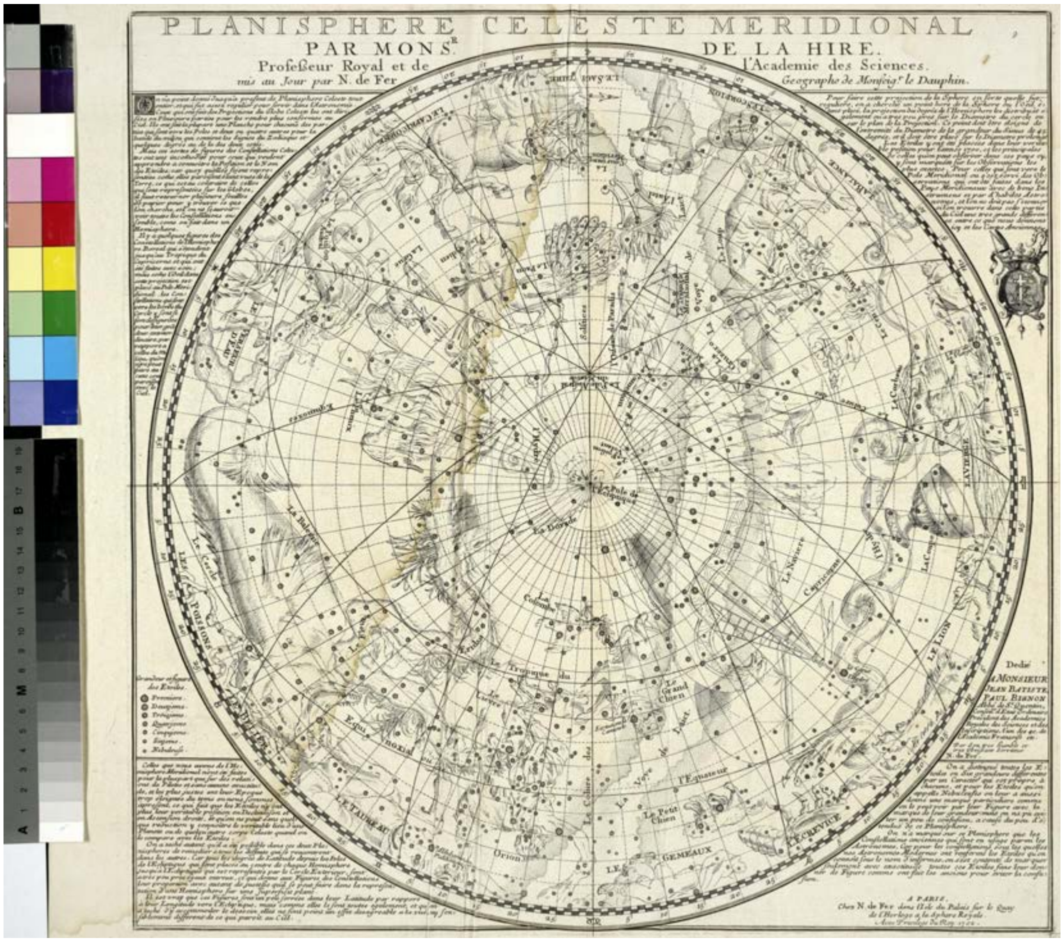

Figure 1. Philippe de La Hire, *Planisphere celeste meridional* (Paris: Nicolas de Fer, 1702); University of Michigan, Ann Arbor.

Usage 2: Double Hemisphere World Maps on the Stereographic Projection

At the end of the sixteenth century, Rumold Mercator introduced a new form of world map. Previous geographers had mapped the world in hemispheres, using various projections to shape the hemispheres. Mercator now used the stereographic projection to construct those hemispheres (fig. 3). As this style of world map rapidly became dominant among Western map makers, Usage 1 was extended into Usage 2: world map in circular hemispheres on a stereographic projection (fig. 4).

But such maps did not have to be called a planisphere. Generic terms for world maps continued to be used in the titles of such maps, such as *mappemonde* or *universal map*.

Figure 2. Whittaker's Planisphere Showing the Principal Stars Visible for Every Hour in the Year (1890); Osher Map Library and Smith Center for Cartographic Education, University of Southern Maine.

Figure 3. Rumold Mercator, Orbis terrae compendiosa descriptio (Cologne, 1596); Osher Map Library and Smith Center for Cartographic Education, University of Southern Maine.

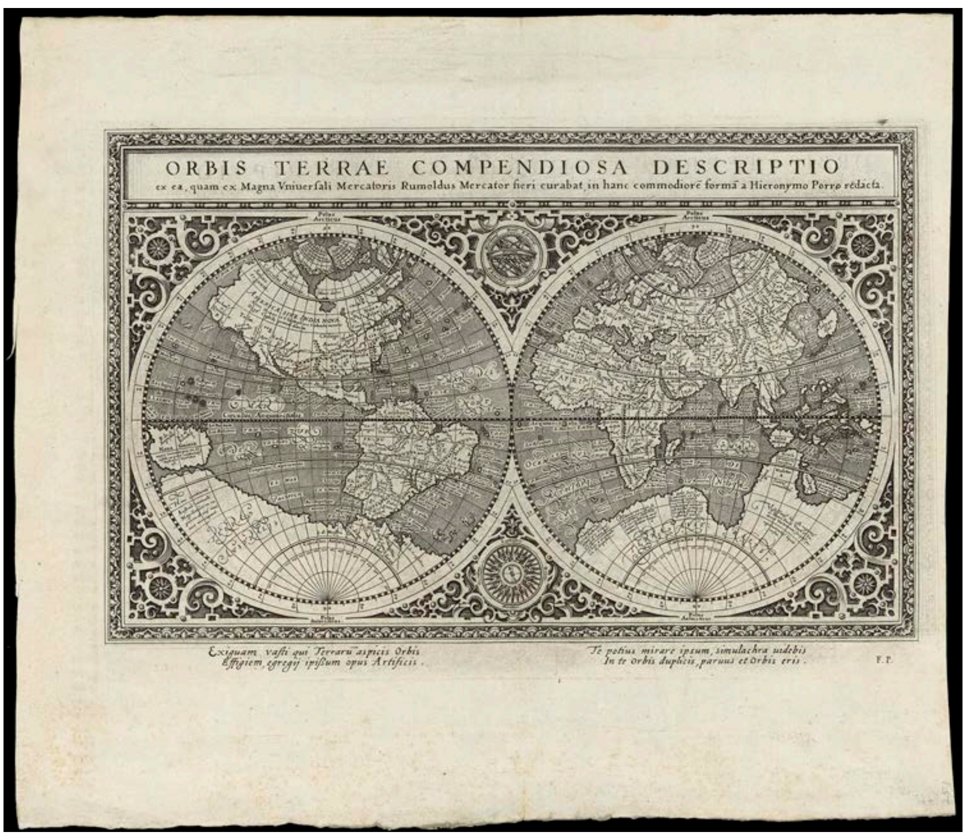

Figure 4. Pierre du Val, *Planisphere, ou Carte generale du Monde* (Paris, 1684); Osher Map Library and Smith Center for Cartographic Education, University of Southern Maine.

When map makers began to make maps of the entire night sky in a similar manner, as pairs of hemispheres, they entitled them "planispheres" in the plural, one planisphere per hemisphere (see examples in Warner 1979). This implementation was an appropriate extension of Usage 1. But one work I encountered in my rapid search for this post reveals a possible moment where Usage 2 overwrote proprietary in celestial mapping; in the title to figure 5, "planisphere" is resolutely singular, suggesting the influence of Usage 2.

Usage 3: Certain World Maps on the Azimuthal Equidistant Projection

The emergence of Usage 3 can be precisely dated. Several early modern map makers produced hemispherical or world maps on the azimuthal equidistant projection. In the 1580s, Urbano Monte made a series of manuscripts, including one in sixty sheets, that would be printed in reduced formats, in which the severe distortion at the extremities of the map were ameliorated by a series of interruptions

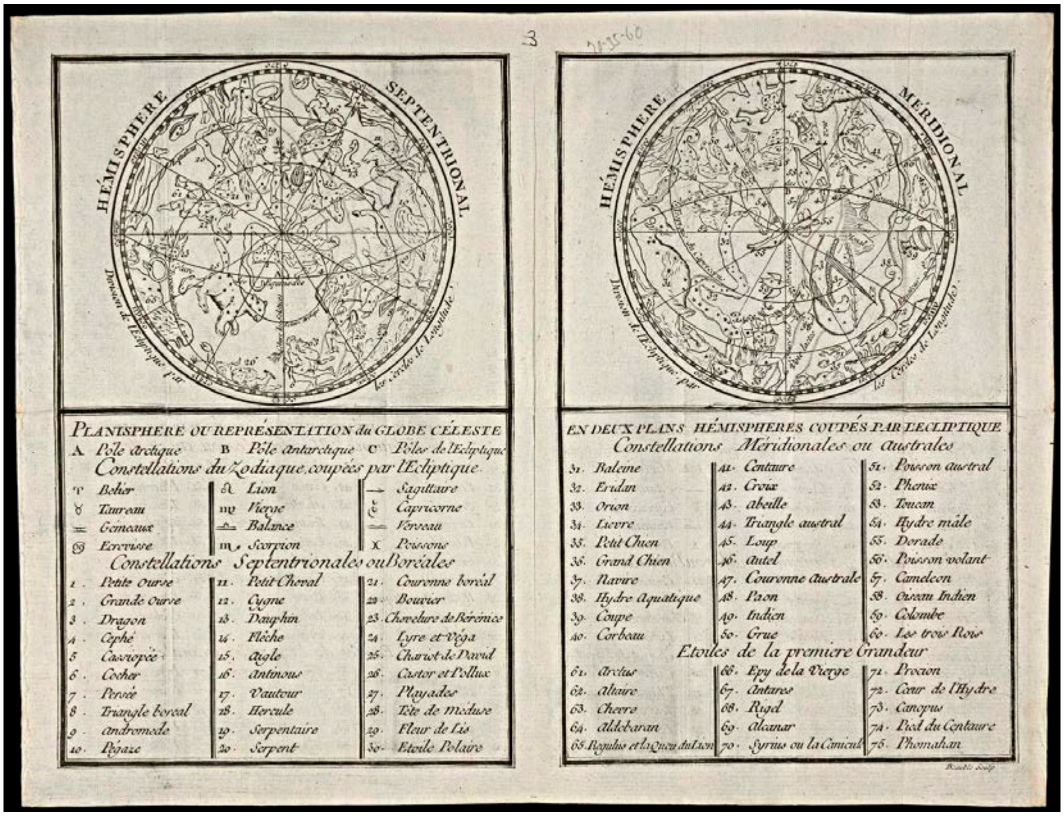

Figure 5. *Planisphere ou représentation du globe céleste en deux plans hémispheres coupés par l'ecliptique* (Paris, 1712); Osher Map Library and Smith Center for Cartographic Education, University of Southern Maine.

to make lobes (Anon. 2017; Van Duzer 2020). In 1648, Louis de Mayne Turquet presented this projection as a new invention for which he claimed credit (fig. 6).

This map seems to have influenced Jean Domenique Cassini (I), who in the 1680s famously constructed such a map on the floor of one of the towers in his newly built Paris Observatory. Cassini used this map to plot those locations whose latitudes and longitudes had been carefully determined through astronomical observations; more particularly, those locations whose longitudes had been determined by means of the technique that Cassini I had perfected, of observing the eclipses of the moons of Jupiter as they pass behind the body of the planet. His son, Jacques Cassini (II), had a reduced version of this map engraved and printed in 1696 (fig. 7).

Here is Usage 3: the literal meaning of the flattened earth, the circularity, and the astronomical connection seem to have worked together to permit this map to be called a planisphere. Derivative maps of Cassini II's map were generally also entitled "planispheres."

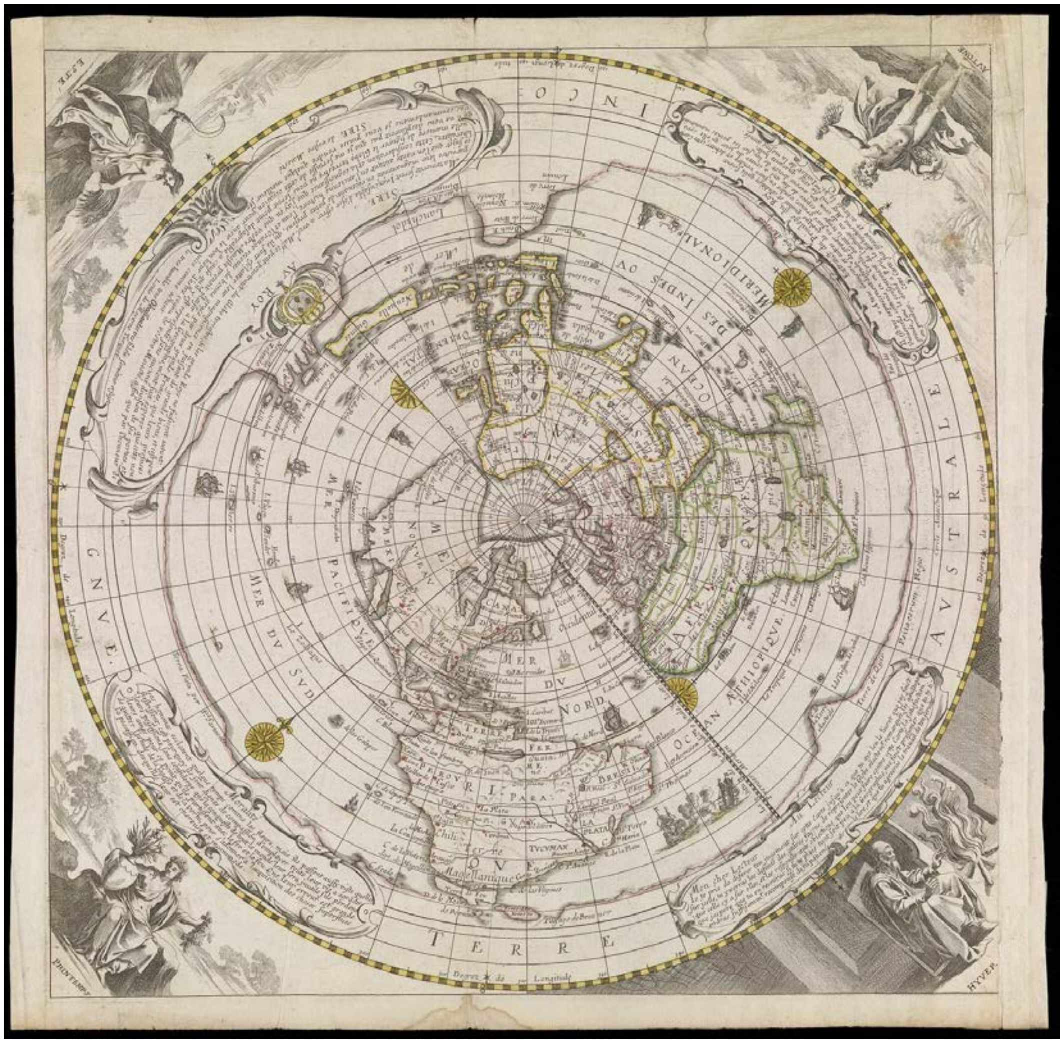

Figure 6. Louis de Mayne Turquet, untitled world map, from his *Discours sur la carte universel* (Paris, 1648); Osher Map Library and Smith Center for Cartographic Education, University of Southern Maine.

Figure 7. Jacques Cassini, *Planisphère terrestre ou sont marquées les longitudes* (Paris: Jean Baptiste Nolin, 1696); Bibliothèque nationale de France, département Cartes et plans, GE DD-2987 (112 B).

Usage 4: Any World Map

This is where life gets confusing, much more than I indicated in the original tweet roll. I've been looking through my stash of early writings in the history of discoveries and map history, and have realized that commentators, rather than practitioners, began in the later eighteenth century to refer to almost *any* flat map of the world as a *planisphere*, in distinction to a globe. (This puts a new slant on the occasional usage of *planiglobii* or even "planiglob" in English.) That is, they took the word at its etymological, literal, face value.

In 1783, for example, Vincenzio Antonio Formaleoni referred to the circular world map by Andrea Bianco (1436) as a *planisferio* (see one of my earlier posts), and Placido Zurla (1806, 92) similarly referred to Fra Mauro's ca. 1450 world map. Such practice followed suit until well into the early nineteenth century.

Usage could become quite confusing. For example, the geographer Marie Armand Pascal d'Avezac inverted eighteenth-century practice:

> L'oeuvre ainsi produite reçoit le nom de *mappemonde*, lorsqu'elle offre les deux hémisphères terrestres projetés côte à côte sur le plan de l'un des grands cercles du globe; on l'appelle *planisphère* lorsque toute la surface Terrestre y est representée sur une projection plate ou reduite. (Avezac 1835, 11)
>
> The work thus produced receives the name *mappemonde* when structured as two terrestrial hemispheres projected side by side on the plane of one of the great circles of the globe; it is called a *planisphere* when the entire Earth surface is represented on a flat or reduced projection.

In other words, d'Avezac made the generic term for "world map" and applied to specifically to world maps of the sort sometimes previously known as planispheres, even as he suggested that planisphere was the generic term for any *uninterrupted* world map. In the following entry, the Baron Walckenaer (1835, 15, 17) used planisphere to refer to both medieval *mappaemundi* and to Jacques Cassini's planisphere, in the latter case again referencing ideas of uninterruptedness, unity, and circularity.

But do not think that a sense of circularity is a crucial element to Usage 4. Edme François Jomard (1844, 449–51) used planisphere to refer to large *mappaemundi* (Bianco 1436, Hereford, Fra Mauro) and also to Mercator's great rectangular wall map of 1569 (the one on *that* projection). This usage was then repeated by d'Avezac (1867) in his summary of Jomard's great facsimile project, *Les monuments de la géographie* (1854–62).

Conversely, others were more precise. In writing about the first maps to show Tasmania, R. H. Major (1859, xcv) distinguished between "the mappemonde of Louis Mayerne Turquet, published in Paris in 1648" (see above) and (in the only use of "planisphere" in the entire book) a world map in two hemispheres, the "planisphere, inlaid in the floor of the Groote Zaal, in the Stad-huys at Amsterdam, a building commenced in 1648":

Other scholars mixed "mappemonde" or "*mappamundi*" with "planisphere," using the latter to refer to items from the tenth century, to fourteenth-century marine charts. And so on.

Usages 5 and 6: Post-Medieval World Maps

Usage by commentators settled down somewhat towards the end of the nineteenth century. The prospect of the quadricentennials of Columbus, Vasco da Gama, and Cabotian quadricentennials prompted a significant upsurge in the study of early maps in the 1880s and 1890s that whole heartedly embraced the myth created early in the nineteenth century that medieval scholars believed in a Church-mandated flat earth (Letronne 1834) and the idea that medieval *mappaemundi* were literal depictions of a flat earth. And as that concept was consolidated, then commentators sought to differentiate the world maps of the Renaissance from those of the benighted middle ages. In this context, usage of "planisphere" shifted to refer to any world map that was *not* a medieval world map.

So, Usage 5: a planisphere is any world map based on a mathematical projection, as in the *OED* definition with which I began this post.

And Usage 6: alternatively, a planisphere a map of the world that was drawn in an early marine style (i.e., without the projected graticule of meridians and parallels) and that demonstrated the empirical observation and measurement of the world. Such planispheres might have lacked a proper mathematical structure, but they were manifestly in a different class to the *mappaemundi* with their crude outlines, imaginary and mythical features, and all-round inadequacies. They proclaimed the rational foundations of the Great Discoveries that contributed to Western rationality. Only at the end of the nineteenth century, with the quadricentennials, do we start to find references to the planispheres of de la Cosa, Cantino, Verrazano, etc. (e.g., Winsor, 1883, 167; Collingridge 1895, 89; Harrisse 1898, 48):

"Cantino planisphere" (1502); Biblioteca Estense, Modena. Image from Wikipedia.

Summary:
a) Avoid Usages 5 and 6
b) Use Only Usage 1 to Refer to a Genre or Style of Map
c) Use Usages 2 and 3 when Recording a Map's Title
d) Usage 4 Is too imprecise to be Used

Both Usages 5 and 6 are problematic because of the manner in which they construct a dichotomy between medieval and modern mapping that we now know to be false. Both usages are part of the utterly Eurocentric argument that the roots of modern Western culture lie in the Renaissance achievement and the birth of Western rationality, which is to say the same argument that has been used to justify Western imperialism and colonialism with all of their inherent violence physical and enforced distortions of non-Western cultures and societies. Is someone who uses "planisphere" a Eurocentric racist just for using the term in Usages 5 or 6? No, of course not. But I strongly recommend the use of other terminology. In English, we might point to:

• "world map" works quite well, although this can be annoying vague (and "world" is thoroughly malleable!)

• or, for Usage 6, "world map in a marine style."

I'm ending this post on a strong note because only now, in digging into the literature, have I realized the complexity of Usage 4 and the circumstances in which Usages 5 and 6 developed. At the very least, these usages of "planisphere" are intellectually naive, at worst they embody a distressing Eurocentrism. I need to do much more work on the pattern of usage of this word, and if anyone has counter data, please let me know.

Usage 1 is the only permissible manner in which to refer to a generic group of maps as "planispheres." Usages 2 and 3 are inconsistent in the early modern record and should appear only in transcriptions of titles.

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COMPARATIVE CARTOGRAPHY

A Succinct Example of the Core Methodology of Traditional Map History

Originally posted: 19 January 2021

https://www.mappingasprocess.net/blog/2021/1/19/comparative-cartography

Another thing cut from the book ms for length …. I'm not lacking for examples. This is from the chapter explaining the history of traditional map history, which is to say the mainstream of the field of "the history of cartography" as practiced in the nineteenth and twentieth century, as opposed to the internal map histories of academic cartographers and the substantive map histories of historical geographers.

Henry Phillips Jr. (1838–95) was a businessman and numismatist from Philadelphia who became an officer in the American Philosophical Society (Smyth 1900). In browsing the APS's library he encountered two maps that he felt moved to describe and to assess (Phillips 1880). His brief, three-page statement encapsulated the tenets of traditional map history: maps are reproductions of the earth's surface; the history of map making is the history of the progressive growth of geographical knowledge; the task of the traditional map historian is therefore to assess the quality of early maps in order to situate them within the overall narrative of map history. The methodology that Phillips used was that used by dedicated map historians to examine and evaluate early maps: "comparative cartography." Phillips' succinct essay provides a great example of this fundamental practice.

The goal of comparative cartography is to establish the quality of an early map by comparing its contents, in *absolute* terms, to modern geography and, in *relative* terms, to the content of other early maps. The map historian can then situate the map in its proper place within the progressive development of geographical knowledge. This methodology is a naïve or intuitive extrapolation from the commitment to maps as statements of geographical fact. Intuitive: Phillips was not really a map student, yet he implemented it as if the study of maps was his primary avocation. Naive: few dedicated map historians bothered to codify the practice.

Absolute Comparison

The first was the map of the new world published in editions of Sebastian Münster's version of Ptolemy's *Geography* and of his own *Cosmographia* between 1540 and 1575:

Sebastian Münster, *Novae Insulae XXVI. Nova Tabula*, from his edition of Ptolemy's *Geography* (Basel, 1545). This is state 2 of the map (Burden 1996, no. 12); Phillips (1880) described the variant in the American Philosophical Society's copy of the German-language edition of Münster's *Cosmographia* (Basel, 1563). Woodcut, 26 × 35 cm. Courtesy of the Osher Map Library and Smith Center for Cartographic Education, University of Southern Maine (Smith Collection); click on image for high resolution.

Phillips found this map to be "so quaint, so singularly inaccurate, yet with all its faults so suggestive that a description cannot fail to be of interest to all who care to retrace the early history of our country." His evaluation was implicitly against a modern map, in terms not only of the outline of features but also of the toponyms (if present) and their positions:

> The peninsula now known as Florida is quite correctly drawn, although it does not bear any name, but a region of country corresponding with the south-western parts of North Carolina, the north-western and northern portions of Georgia, the upper portions of

> Alabama and Mississippi, and the lower parts of Tennessee, receives the appellation of *Terra florida*.

Phillips proposed various equivalencies between the map's unnamed or poorly executed features and modern geography: "To the west" and "some distance" away from what he supposed by its location to be the Mississippi, "is a large but nameless river taking its rise in a range of mountains which run from east to west. This may be the Rio Grande del Norte, the Texan boundary line."

Error in lands remote from European activity is a sign of ignorance, a lack of knowledge that will be filled eventually (as implied by the "yet" in the following):

> The configuration of Mexico is but poorly preserved, and the Pacific coast is dotted with random indentations of rivers and bays. Lower California does not appear, nor *yet* the Gulf which separates it from Mexico. (emphasis added)

To this passage, Phillips appended a footnote to suggest that the spread of new information had evidently been slow: "According to Humboldt, Lower California had been recognized as a peninsula as early as 1539–41."

Errors in otherwise known areas must be the result of confusion. Here, Phillips asserted that the "Sea of Verrazano"—the incursion of the ocean across North America almost to the eastern seaboard, derived from the observations of Giovanni da Verrazano in 1524—probably derived from confusion over information gleaned from native informants:

> A very large body of water, a continuation of that which forms the boundary of the Northern Continent, in shape and position not unlike to Hudson's Bay, stretches far down to within a short distance from the sea-coast, no great way off from the present site of New York city, New York. Probably this was placed upon the map in conformity with Indian reports of vast interior bodies of water, confusing the Great Lakes of the Northwest, with Hudson's Bay.

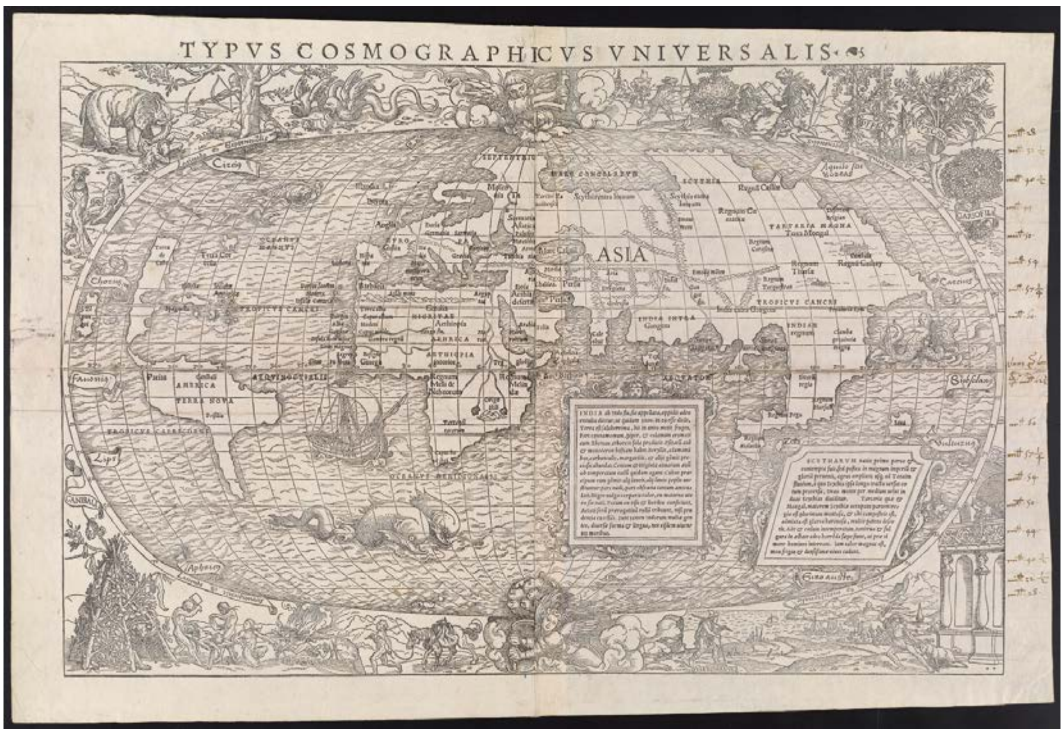
It should perhaps be made clear that even when Phillips thought the map was produced, in 1550, European knowledge of the Americas was still scanty, and certainly they had no knowledge of Hudson's Bay and the Great Lakes. Nonetheless, Phillips' untoward expectations were not out of line with other map historians. Maps *should* be correct:

> The Isthmus of Central America is delineated as somewhat larger than it really is. South America is very incorrectly drawn, being too "squat" in appearance. A large river empties on its northern shores into the ocean, and on the land, at the easternmost projection of the Continent there stands a hut constructed of boughs, leaves and branches, from one of which latter a human leg is pendant. Lest there should be any doubt in the mind of the reader as to what all this meant, the word *Canibali* is printed upon this region to show the nature of its inhabitants. The bay of Rio Janeiro, although nameless, is shown, but appears to penetrate much farther into the main land than it really does.

Curiously, Phillips does not identify the "large river" in South America, just north of the cannibals, with the Amazon.

Relative Comparison

The second map was Münster's world map from Johann Huttich and Simon Grynäus' *Novus Orbis regionum* (Basle, 1532), although Phillips followed the common strategy of narrowing his focus to consider only the depiction of America:



Sebastian Münster, *Typus cosmographicus vniversalis*, from the 1555 edition of Johann Huttich and Simon Grynäus' *Novus Orbis regionum* (Shirley 2001, no. 67). Phillips (1880) described only this work's delineation of the Americas. Woodcut, 35.5 × 54.5 cm. Courtesy of the Osher Map Library and Smith Center for Cartographic Education, University of Southern Maine (Osher Collection); click on image for high resolution.

At this still early stage of the study of early maps, it was not known that the map was by Münster, but Phillips nonetheless thought it aesthetically similar to Münster's map of the Americas. The crudity of the world map's depiction of the Americas—crude even for 1532 when the map was made, and certainly crude by 1555, when Phillips thought it had been produced—perhaps prevented him from attributing the entire work to Münster. In addition to describing the map's poor geographical depiction in absolute terms, Phillips also evaluated it relative to a later map known through a facsimile:

> The inaccuracy of this map is really surprising, when we consider the facilities then already in existence for verification. A Spanish *mappa mundi* and hydrographic chart published in 1573 (Lelewel. I. p. cxxxvi),[*] presents the North American coast not badly delineated from Newfoundland down, although exhibiting some uncertainty. The Peninsula of Florida appears under that name, and Lower California is separated from Mexico by a body of water, and Mexico and Central America are quite correctly drawn. Yucatan is shown as a peninsula, and in its proper position. The conformation of the Gulf of Mexico is reasonably accurate. South America is justly drawn, although the portion below the Straits of Magellan is only partially exhibited. The *Canibales* still are attributed to the northern part of Brazil. The Amazon river appears under that name.

As with Münster's contorted map of the Americas, Phillips concluded that the world map was definitely poor for its time.

This methodology of relative comparison—of comparative cartography—was *the* methodology employed by traditional map historians in the study of the content of early maps. There would of course be methodological complexities, as in the study of toponyms and in the dating of maps. Nonetheless, comparative cartography provided the core ritual of examination. (Yes, a hint of Foucault; more in the book!)

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[*] Phillips mistranslated the original reference, to "Orbis terrarum a hydrographo hispano 1573 in plano delineatus" (The earth delineated in a plane [map] by a Spanish mariner 1572), which was a reduced copy by Joachim Lelewel (1852–57, 1: after cxxxvi) of a much larger original. Lelewel described the entire manuscript atlas (§263, i.e., 1: ci–cvi) and identified it (§173, i.e., 2: 114n252) as having been the property of Józef Sierakowski, a diplomat and historian, who had intended to donate it to a Polish library, although Lelewel did not know whether he had actually done so before his death in 1831. Lelewel used a tracing he had made some time previously to reproduce the map. Had Sierakowski indeed donated the atlas to the Towarzystwo Przyjaciół Nauk (Society of the Friends of Science) in Warsaw, it probably ended up either in the Polish national library, which was destroyed in 1944, or in a Russian collection. My thanks to Steven Seegel for his assistance.

Cartographica 7 (1970): 327–31. This essay is also readily available via Google Books.

Shirley, Rodney W. 2001. *The Mapping of the World: Early Printed World Maps, 1472–1700*. 2nd ed. Riverside, Conn.: Early World Press.

Smyth, Albert H. 1900. "Henry Phillips, Jr." *Proceedings of the American Philosophical Society Memorial Volume* 1: 26–35.

BAUHAUS AND MAP COLLECTING

Yes, they're connected!

Originally posted: 24 January 2021

https://www.mappingasprocess.net/blog/2021/1/24/bauhaus-and-map-collecting

This is a bit I just encountered, and which is staying in the book, but it's such a tasty little morsel that I can't stop myself from sharing it now.

I have long thought that there's a great study to be done of the interrelations of art deco and mapping, although I really don't have the background to do it myself.

I have long known, for example, that the main uses of early maps in the twentieth century has been for interior decoration. This is apparent from several bits of data:

• the practice of certain antiquarian dealers (R. V. Tooley comes to mind) to apply color to uncolored maps, so that they appeal to interior designers seeking to match a particular color palette (and cared little about the region mapped).

• the sentiment I have heard expressed by map collectors: you know you're a real collector when you run out of wall space for your maps.

• the significance of the practice of breaking early atlases and selling off the individual plates at fairs and markets, in department stores, and in antique stores, etc., is attested in the entries on the map trade and collecting in *Cartography in the Twentieth Century*, Volume Six of *The History of Cartography* (Baynton-Williams 2015; Karrow 2015).

It is clear that this practice began in the economic boom of the 1920s. What I have not realized, however, is that the phenomenon of collecting early maps for decoration was motivated, at least in part, by a change in aesthetics entailed by the art deco movement and, more especially, by the Bauhaus (1919–33).

I learned of the connection when a book arrived in the mail, yesterday. Hans Wertheim (1897–1938) was an art and antiquarian book dealer in Berlin, who also ran a company specializing in printing art books called Der Bibliographikon (Bagrow 1939). In 1931, he organized an exhibition of early maps in his store. At the same time, he published a small book to educate potential clients about the nature of maps and map history and to serve as a catalog of the maps he had available to sell (Wertheim 1931a). He also published it in English (Wertheimer 1931b). (Library and dealer catalogs all say/imply that only fifty delux, hand-colored, linen-bound copies of the English book were produced, as per the colophon; however, what arrived yesterday was an unnumbered, uncolored, and soft-cover copy, suggesting that the English translation was more widely distributed.)

Wertheim opened the book with a short section about the aesthetics of space, the hanging of art, and the appeal of maps:

The New Interest in Old Maps

> Nowadays there is undoubtedly a marked tendency to eliminate ornament and by emphasising space on the one hand and the essential forms of the object on the other to arrive, as it were, at the "thing in itself." The use of pictures in decorating rooms has likewise been revolutionised along these lines. The predominance of the oilpainting has been shaken. The broad pretentious gold frame which so often destroyed the effect both of the picture and the room as a whole has disappeared. Today everything is subordinated in some way ot other to the effect of space as a whole, to spatial harmony. The function of all forms of wall ornament is now to break up the wall surfaces artistically and decoratively in order to emphasize the significance and unity of the wall, whereas formerly a wall was rather something on which to hang a picture. The more self-contained character of the graphic arts, the fact that their very nature makes them more suitable for treatment as part of the wall itself, the relative unimportance of the frame, have brought them much closer to the modern man.
>
> This explains why now, after so many years, old maps are again attracting attention. Although they are not pure works of art but, being intended for practical purposes, really a form of applied art, the appreciation of their charm and of the artistic qualities which are to be found in the works of the old map-makers is steadily growing.
>
> However much old maps act at first sight more as a purely decorative breaking up of the wall surface than as an intellectually conceived subject, nevertheless to whoever studies them more closely they give a vivid impression of the countries treated in consequence of the quaint, fantastic details they contain. They reveal the open-eyed and open-eared vitality of the Renaissance men who made them, who conquered the world and depicted it then with all the childlike belief in fairy-tales, miracles and superstitions which was characteristic of them. It is this which, perhaps more important and more attractive than their decorative quality, makes old maps, particularly of any given period, so extraordinarily fascinating. They, the last living witnesses of a past age, enable us to appreciate it and its landscape, which they show us as it appeared then and in process of development or discovery, better than many a picture or book could do.
>
> Some idea of the history of the period in which the modern vision of our globe arose, and the main dates in connection with hte development of cartography as such, are necessary for a full appreciation of oldmaps. (Wertheim 1931b, 3–4)

Wertheim's reference to the "'thing in itself'" indicates his influence by the Bauhaus. The idea is from Immanuel Kant—*Ding an sich*—to refer to an object as it exists independent of observation. It became a key concept in Walter Gropius's architectural theories. Design, it was argued, should reveal the object, not obscure it behind ornamentation. Decoration was thus recast as a means to emphasize and reveal the nature of the object, not to obscure or mistreat it.

This passage certainly expands for the me the discussion of art and cartography in the twentieth century.

Note also that Wertheim's modernist aesthetic led him to recast the traditional narrative of map history. In that narrative, already a century old by the 1930s, medieval map makers (at least of world maps, *mappaemundi*) had been "childlike" in their productions, but that childishness had fallen by the wayside with the Renaissance raising of the West into rational adulthood. Wertheimer extended the era of supposedly juvenile mapping. At the same time, in directly equating map makers with the grand explorers and adventurers—who were rarely the same people, especially in the context of the makers of the maps he was selling, who were all Dutch craftsmen and publishers—Wertheim still adhered to the established narrative's insistence the those explorers and adventurers were integral to the transition from medieval European culture to modern Western culture. Like all summary narratives of the history of "cartography," it's complicated!

There's a lot more that might be said about this connection between aesthetics and mapping in the early twentieth century. Please let me know if you should go romping about in this field!

p.s. I encountered Wertheim and his book as I was reading up on the formation of the journal *Imago Mundi*. The journal is generally remembered as the brainchild of Leo Bagrow, the Russian émigré in Berlin. but it is clear that the journal was jointly created by Bagrow (who had the academic pretensions) and Wertheim (who also funded the first issue) (Heffernan and Delano Smith 2014). But after the first issue of the journal was published by Bibliographikon in 1935, the Jewish Wertheim finally left Berlin. (The Nazi regime had already ended the Bauhaus.) Unfortunately, having found refuge in Brussels, Wertheim fell ill and died in 1938.

p.p.s. I also appreciate Wertheim's pun—whether intended or not—that maps provide "vivid impressions," given that the kinds of maps he sold were all printed (i.e., "impressed").

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Baynton-Williams, Ashley. 2015. "Map Collecting in Europe." In *Cartography in the Twentieth Century*, edited by Mark Monmonier, 248–51. Vol. 6 of *The History of Cartography*. Chicago: University of Chicago Press.

Heffernan, Michael, and Catherine Delano Smith. 2014. "A Life in Maps: Leo Bagrow, Imago Mundi, and the History of Cartography in the Early Twentieth Century." *Imago Mundi* 66 supplement: 44–

69.

Karrow, Robert W., Jr. 2015. "Map Collecting in Canada and the United States." In *Cartography in the Twentieth Century*, edited by Mark Monmonier, 245–48. Vol. 6 of *The History of Cartography*. Chicago: University of Chicago Press.

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———. 1931b. Wertheim, Hans. 1931. *Old Maps and Charts: A Short Guide for Collectors*. Berlin: Das Bibliographikon.

IRENE JEAN CURNOW (ACTIVE 1921–30)

A Forgotten Internal Map Historian

Originally posted: 31 January 2021

https://www.mappingasprocess.net/blog/2021/1/31/irene-jean-curnow-active-192130

In researching the single-volume, book-length narratives of the history of cartography, I encountered *The World Mapped* (1930) by one I. J. Curnow. I have dug around a bit to find out more about this author, discovering that she was a geographer who taught cartography. What follows is a brief account of her academic career, as far as I can reconstruct it through the wonders of the Internet, and an analysis of her book. Clearly, much more work would be needed in several archives to properly fill out this inadequate sketch. (The Royal Geographical Society archives contain SSC/29, "I J Curnow, Papers relating to cartography.")

Irene Curnow

Traces of Curnow's career are fragmentary:

> She appears, for example, in several advertisements for the geography program at University College London [UCL]. In the first, she appears as just "Irene Curnow, Assistant" (*Geography Teacher* 10, no. 6 [1920]: end matter), but in later ones she is "Irene J. Curbow, B.A., Assistant in Cartography" (*Geography Teacher* 11, no. 5 (1922): 324; *idem*, 12, no. 1 [1923]: [41]; *idem*, 12, no. 2 [1923]: [113]).
>
> She was elected to the Royal Geographical Society at its meeting of 4 June 1923 (*Geographical Journal* 62, no. 1 [1923]: 66).
>
> Thereafter, she is twice identified both in *The Victoria University of Manchester. Calendar, 1923–1924* (Manchester: University Press, 1923), 22 and 69, and again in the same for *1924–1925* (1924), 24 and 70: first, in an advertisement for "Ashburne Hall (Hall of Residence for Women Students)" which lists as resident, "Miss I. J. Curnow, B.A. (University Lecturer in Cartography)"; and, second, in the list of professors and lecturers is the entry for geography: "Reader, W. H. Barker, B.Sc. (London) | Assistant Lecturer, Irene J. Curnow, B.A. (London)."

From these references it seems that Curnow received her BA in Geography from UCL in 1920, and then stayed on as an instructor in cartography before moving to Manchester in 1923–25.

This corroborates a brief note by Hugh Clout in his biography of Prof. Lionel William Lyde in *Geographers: Biobibliographical Studies* 30 (2011): 15. Clout recorded that Lyde had trained several women at UCL, notably Margaret Shackleton, and then:

> Less well known was Irene Jean Curnow, who researched aspects of modern cartography that led to a doctorate from the University of London in 1925 (Curnow 1930). After assisting Lyde she taught geography at Wellesley College, Massachusetts.

The University of London ("Senate House") Library identifies Curnow's dissertation as

> I. J. Curnow, "Aspects of Modern Cartography (PhD thesis, University of London, 1925).

It is not certain that Clout was correct to think that this dissertation was the same work as the history of cartography published in 1930.*

While in Manchester, Curnow published two essays on the contemporary mapping of Africa:

> "Topographical Mapping in Africa," *Journal of the Manchester Geographical Society* 41 (1925): 32–37.

> "The Progress of Topographic Mapping in the Gold Coast." *Scottish Geographical Magazine* 43, no. 2 (1927): 91–97.

Despite the PhD, Curnow continued to be called "Miss" when she then went to the USA as a visiting lecturer at Clark University, in Worcester, Mass., and also at Wellesley College. Here the evidence is in part from the newsletter of the Clark geography students:

> *Monadnock Magazine* 1, no. 1 (Jan. 1927): [4]: "Miss I. J. Curnow, (Ph.D., London) formerly lecturer in Geography, University College, London, and in the Victoria University, Manchester, has been special lecturer at Wellesley College this year. She is also assisting Dr. Atwood in his course on Regional Physiography. While at Clark she is auditing various courses."

Given that this newsletter was issued in January 1927, "this year" would imply that she was resident in 1926–27. A later entry in the same newsletter, however, referred to her time at Clark as 1927–28. Perhaps she was there for two years.

> *Monadnock Magazine* 21, no. 2 (May 1947), 7 (alumni news): "Irene J. Curnow (Mrs. C. Marsingall-Thomas) ('27–'28) at home, coaching or sometimes even lecturing. Northwood, Middx., England. WS [wartime services]: Section Officer, WAAF Intelligence. (Mrs. Massingall-Thomas wrote a very interesting letter, predicted the miserable winter which hit England. It is hoped that this summer will find some improvement!)"

> **Update 24 August 2022**. I *think* that Irene's husband was Cyril Marsingall-Thomas (1893–1965), an electrical engineer. She and her husband traveled to Singapore in 1930; the *Monadnock Magazine* 4, no. 2 "alumni number" (June 1930), [5], noted that before returning

* On a personal note, I received my BSc from UCL, and worked in part with Hugh Clout.

to London she had given a lecture to the Malayan Teachers' Association on "As Seen On the Map." The issue identified their address as 3 Grosvenor Place, London, in the very heart of the West End.

While in the USA, Curnow gave an historically inflected paper to the 23rd meeting of the Association of American Geographers, held in Philadelphia 28–30 December 1926. **[n1]** The *Geographical Review* 17, no. 2 (1927): 311, recorded that "Miss I. J. Curnow (introduced), a pupil of Professor Lyde of the University of London and now lecturing at Wellesley College, contrasted the standard topographic maps of Great Britain and the United States." The *Annals of the AAG* 17, no. 1 (1927): 24–25, recorded the abstract:

> I. J. CURNOW (Miss).—(Introduced by Chas. F. Brooks.)
>
> A Contrast of the Standard Topographic Maps of Great Britain and the United States of America.
>
> The standard maps of the Ordnance Survey and of the United States Geological Survey originated in different cartographic epochs. The first Ordnance Survey map dates from 1801, that is to say, the first sheets of the standard 1/63360 were published while methods of topographic surveying and mapping were still in an experimental stage. The U. S. Geological Survey was instituted in 1879. By this time the possibilities of topographic maps were more accurately known, more widely appreciated, and the American cartographic department was able to benefit by the experiences of others.
>
> The incentives underlying the work of the two bureaus were different. In Great Britain military needs gave the first impetus to topographic mapping, and proved the dominating influence in the evolution of cartography. In the United States economic considerations were paramount.
>
> Different geographic conditions have conduced to a different evolution and different results. Great Britain is a small area, long settled, with no great range of height.. Therefore it was feasible to attempt large scale accurate maps of the whole country. Such a policy was not warranted in the United States. The resultant differences between the standard maps of Great Britain and the United States are justifiable.
>
> The Ordnance Survey presents the most varied, the most complete and the most accurate series of small scale topographic maps in the world: while the large scale issues are unique in their uniform excellence and accessibility. The U. S. Geological Survey presents a number of maps as special responses to the varied needs of a country in the making.

And Curnow soon published the paper under her married name—"Mrs. Thomas (Née Miss I. J. Curnow)" and still not recognized as holding a PhD—as "Some Contrasts in Standard Topographic Maps of Great Britain and the United States of America," *Geography* 15, no. 4 (1929): 274–81.

[The Geographical Review report's labeling of Curnow as "Miss" was in marked contrast

> to the reference to "Dr." Helen Strong in the same passage. The difference perhaps related to age or fixity of career.][*]

In this period, Curnow also published a couple of reviews in *Economic Geography* 4 (1928): 209–10, 5 (1929): 207. Her last project, published in 1930 under her maiden name, was *The World Mapped* (1930). From the 1947 reference in the *Monadnock Magazine*, she seems to have settled into domestic middle/upper-class life in the UK, although she contributed to the war effort like so many other geographers.

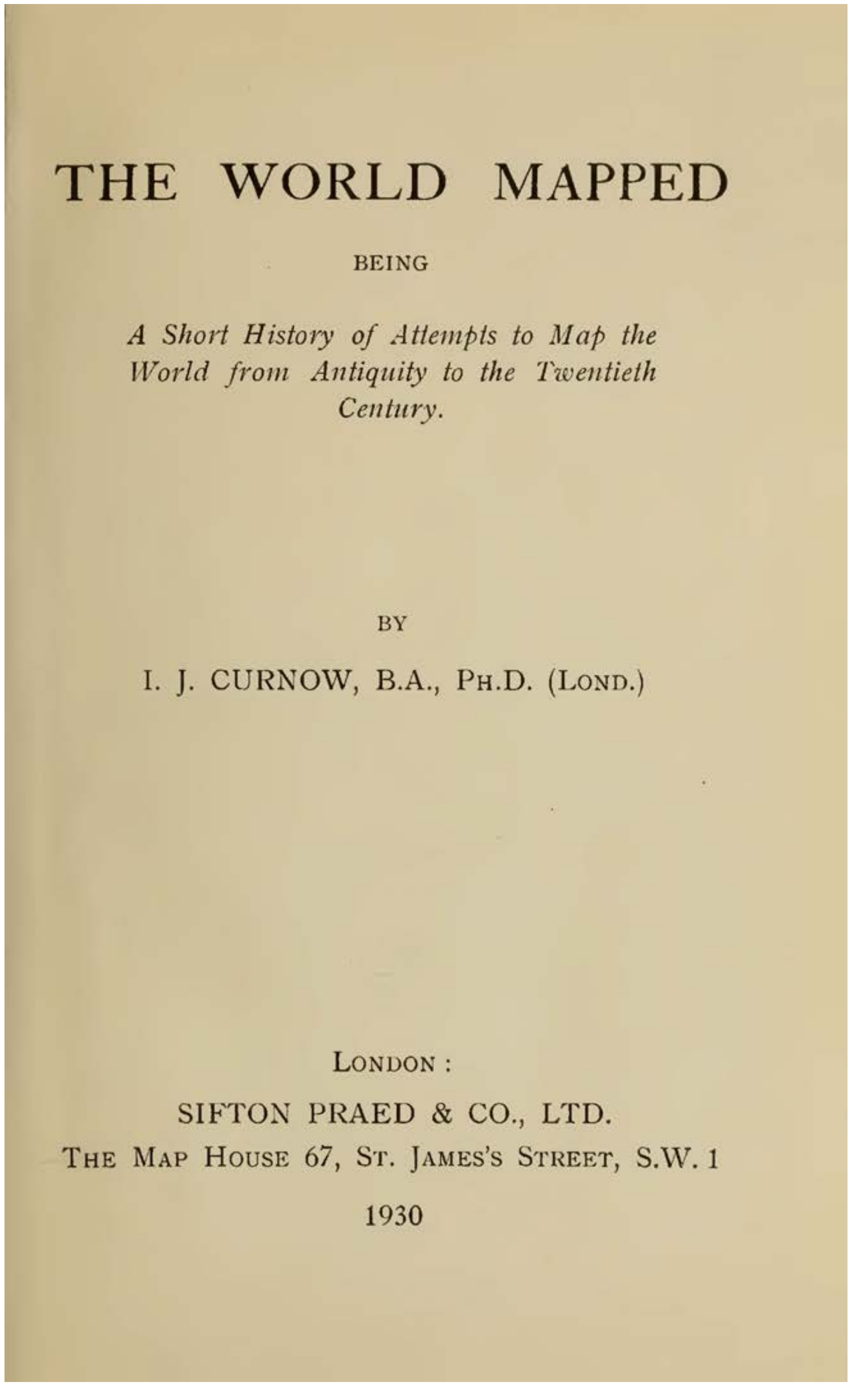
> **Update 24 August 2022**. Prof. Clout just sent me images of two entries from the RGS Minute Books which refer to Curnow.
>
> > 14 March 1922: Curnow gave a lecture to the RGS on "Western China," based on her childhood experiences in the region; her father was in the audience. Daughter of a missionary?
> >
> > 24 November 1927: Curnow addressed the RGS on "New England," based on her experiences during her visit to the USA, "with numerous humourous touches."

The World Mapped

Curnow's approach to map history was that of the practicing or academic map maker. Whereas traditional map historians were interested in geographical and world maps and their depiction of geographical information up to about 1800, internal map historians like Curnow were especially interested in the practices of map making and in the development of finer resolution map making. She continued this interest in her 1930 book. Here's the title page:

[*] The account of the meeting in the *Geographical Review* indicates that this would have been an interesting meeting to attend, full of internal map history:

> Three papers and the presidential address dealt with cartography. Professor Goode's address, given at the evening dinner on December 29 in joint session with Section E of the American Association for the Advancement of Science and entitled "The Map as a Record of Progress in Geography," presented an admirable rapid survey of the whole development of cartography in all its phases. Mr. S. W. Boggs (introduced), geographer of the State Department, presented "A New Equal Area Projection for a Map of the World." This projection is an interrupted net outwardly similar to Professor Goode's sinusoidal projection (see *Geogr. Rev.*, Vol. 14, 1924, p. 293), intermediate between it and the homolographic (Mollweide's). Dr. Helen M. Strong of the Bureau of Foreign and Domestic Commerce dealt with "Maps and Business." After a brief survey of the development of cartography among the trading nations of the sixteenth and seventeenth centuries she dealt with the use of maps in modern business, with special reference to the activities of the Bureau of whose staff she is a member. Miss I. J. Curnow (introduced), a pupil of Professor Lyde of the University of London and now lecturing at Wellesley College, contrasted the standard topographic maps of Great Britain and the United States.



THE WORLD MAPPED

BEING

A Short History of Attempts to Map the World from Antiquity to the Twentieth Century.

BY

I. J. CURNOW, B.A., PH.D. (LOND.)

LONDON:

SIFTON PRAED & CO., LTD.

THE MAP HOUSE 67, ST. JAMES'S STREET, S.W. 1

1930

Curnow's small book was published by Sifton Praed, not "S. Praed" as one unfortunately finds in library catalogs but the company founded 1907 by Alfred Sifton and Francis Praed, and which they were calling "The Map House" by the end of the 1920s. Although now claimed to be the "oldest specialist antiquarian map seller" in London, Sifton Praed were actually general publishers and sellers of maps and geographically related books. In 1975, the Map House was still primarily interested in modern maps and guidebooks, but the low profit margin and high labor costs then led the directors to refocus "The Map House" on antiquarian maps (Jonathan Potter in 2016 lecture).

Sifton Praed's publishing of Curnow's book places it within a still new drive to make early maps appealing to a more popular clientele. The aesthetics of interior design changed significantly after World War I, and early maps became very popular as decoration. A number of antiquarian dealers published small histories of cartography to inform and cultivate a map-collecting public. Perhaps the first were Louis A. Holman's *Old Maps and Their Makers Considered from the Historical and Decorative Standpoints: A Survey of a Huge Subject in a Small Space* (Boston: Charles E. Goodspeed & Co., 1925; 2nd ed., 1926; 3rd ed., 1936), and Arthur L. Humphreys' *Old Decorative Maps and Charts* (London: Halton & Truscott Smith, New York: Minton, Balch & Co., 1926), which reproduced many maps sold by Henry N. Stevens to A. G. H. Macpherson, whose collection became the core of the map library in the National Maritime Museum. (Humphrey's book was republished as *Antique Maps and Charts* [London: Bracken Books, New York: Dorset Press, 1989].)

But whereas those books were more about the kinds of maps that were deemed collectible—the printed maps produced in Renaissance and eighteenth-century Europe—Curnow offered a more academic take on the sweep of the history of cartography from Antiquity to the early twentieth century and she was especially concerned with the development of surveying. That is, she addressed the history of the kinds of maps that Sifton Praed published and sold. Curnow began with a chapter on "The 'Common Problems'" of determining distance and direction, diverted into questions of geographical and world mapping in Antiquity and the medieval era (repeating the erroneous claim that medieval geographies believed the earth to be flat; pp. 41–42), and then settled into a more internal history of the making of maps from experience and observation: the route and detailed maps produced by the Crusades, medieval marine maps, the great discoveries, and then the mapping of nations and empires. (There was a penultimate chapter on "map-making as a business concern" that addressed generally collectible maps.)

It might surprise some people to know that Curnow's history of map making techniques and surveying was really rather pioneering. There were essays that provided summary narratives of the history of cartography, such as that by E. G. Ravenstein, Charles F. Close, and Alexander Ross Clarke under "Map" in *Encyclopaedia Britannica*, 17: 629–63, 11th ed. (Cambridge: Cambridge University Press, 1911), but a full-length study was still lacking. The common sentiment was expressed by one "A.D." in a review of Curnow's book:

> There is urgent need of an adequate history of Cartography, for up till now one has had to refer to numerous pamphlets, articles, etc., in various publications. (*Geography* 17, no. 3 [1932]: 232)

Curnow did not herself claim to be fulfilling this need, but even so, her work must be acknowledged as the first step in that direction. Both A. D. and E. G. R. Taylor (*Geographical Journal* 77, no 5 [1931]: 485) appreciated the attempt yet found the popular approach and limited size led to oversimplification and some errors.

To end, here is Curnow's reproduction of a part of the OS 1-inch map. This detail happens to cover part of my old stomping grounds as a kid (my mother's primary school would be built just off the detail's lower edge, across from the cross [chapel or church without spire or tower, which happens to be where George Vancouver is buried]):

PLATE X.

Part of the First Ordnance Survey Map, A.D. 1808.

A "Radically Different" World Map?

Not actually so different, after all. A mindboggling, gobsmacking claim!

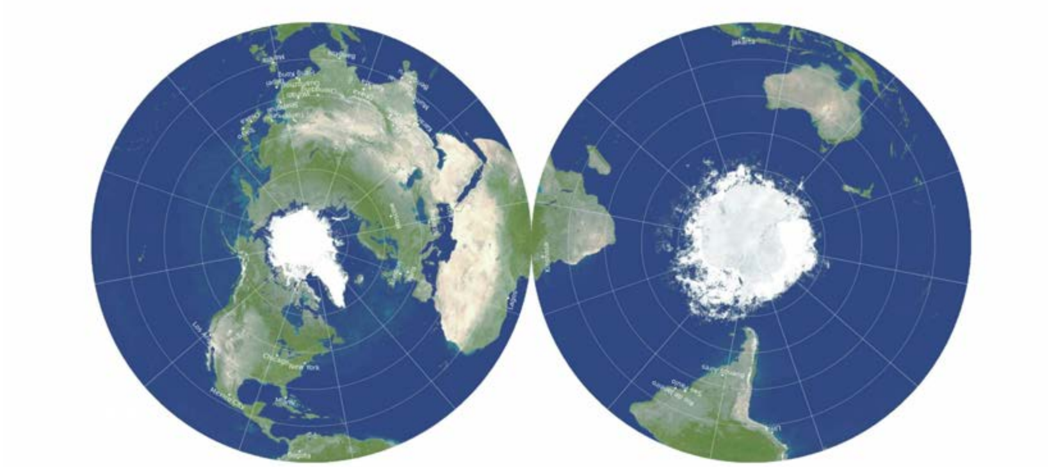
Originally posted: 17 February 2021

https://www.mappingasprocess.net/blog/2021/2/17/a-radically-different-world-map

Consider my mind boggled, and my gob smacked. I have just learned, through the miracles of Twitter, of a press release from Princeton University, that has me hyperventilating at the sheer audacity of the PR work and the chutzpah of the claims being made. I am sure that much of the breathlessness of the piece and the claims to intellectual and mathematical glory—by astrophysicists no less!—stem from being filtered through the PR machine, but I nonetheless feel thoroughly physplained!

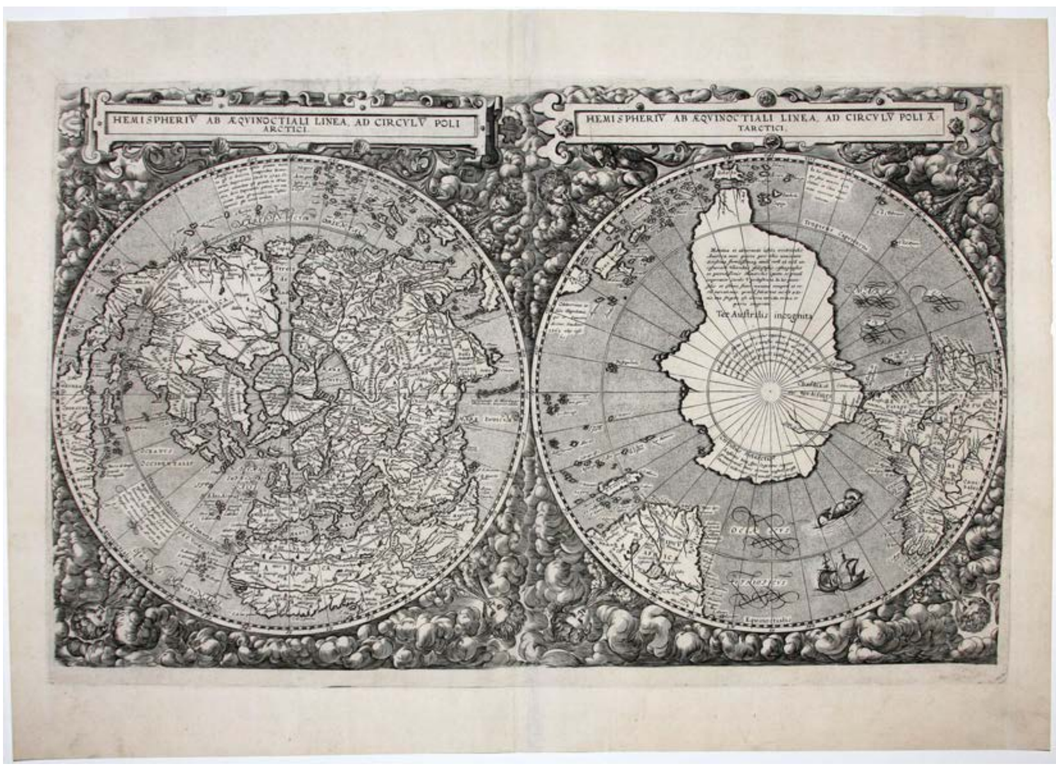
> **[update 20 February 2021]** My brain was so amazed by the post, that I failed to recognize a link to the actual paper by the astrophysicists; see end of the post for more info.
>
> **[update 21 February 2021]** I have written a commentary on the paper in which the astrophysicists explain the metric that underpins their claims to radical difference etc. (tl;dr the metric is not valid)

The piece is, "Princeton astrophysicists re-imagine world map, designing a less distorted, 'radically different' way to see the world" and it was published by Princeton's Office of Communications on 15 February 2021. Let me start not as the article does, with the remarkably lame video of a two-sided world map being flipped, but with the image of "Gott, Goldberg and Vanderbei's revolutionary, double-sided disk map" that "minimizes all six types of map distortions":



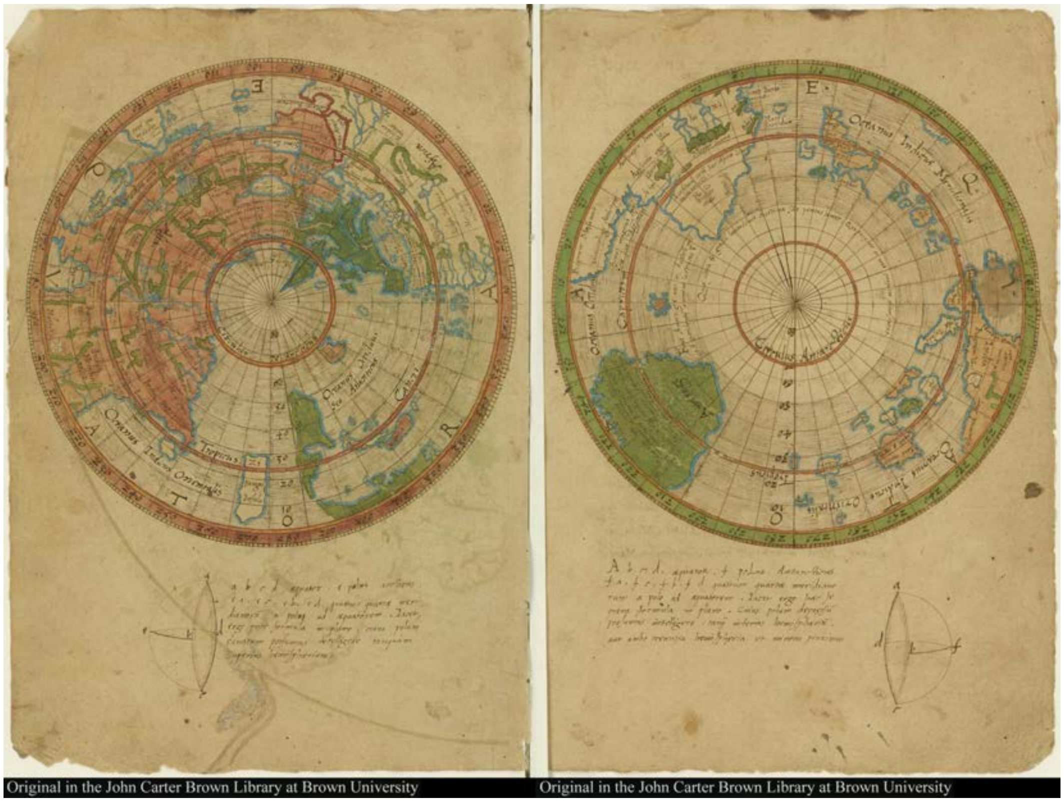
Rather than using some nifty statistical technique to balance out distortions in shape and area, as has been done since the nineteenth century, which is what the PR lingo implies, the creators have actually used the azimuthal equidistant projection in polar aspect to show the northern and southern hemispheres separately. When applied to the whole earth, this is the same projection as used on the UN flag and also, as it happens, by Flat Earthers. In a polar aspect, the pole is surrounded by equally spaced, concentric circles of parallels of latitude, so that "scale is correct" along the meridians; it is thus "equidistant" along the meridians. (In "equidistant" projections, distances are consistently scaled only along certain lines; a more general equidistant map is called a globe.)

Now, tell me, how is this map different from Gerard de Jode's 1593 world map in two hemispheres, polar aspect, on the azimuthal equidistant projection? (While this map has few parallels of latitude to reveal their consistent spacing, it does show the circles, and the distances from pole to Arctic/Antarctic circles is the same as the distances from the tropics to the equator, so it is equidistant.)

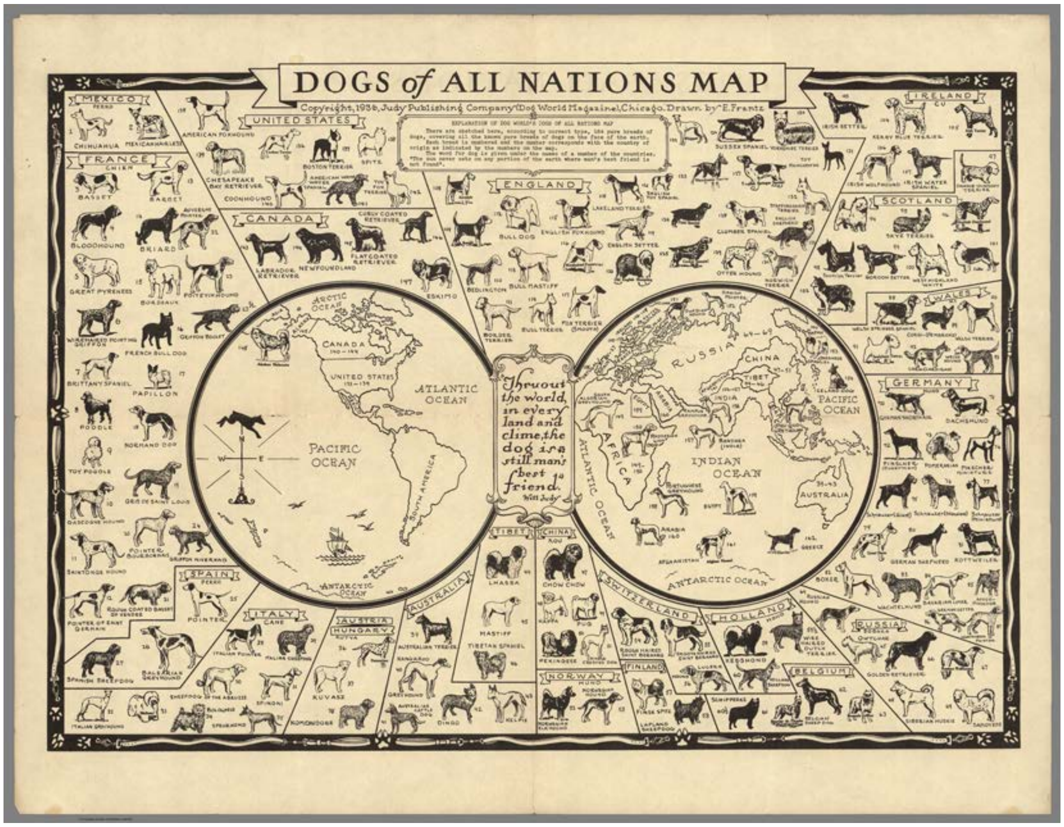


This map is Shirley 184. Sorry to say, I'm not sure of the source (I've had the file since 2011).

[update 20 Feb 2021] Luis Robles has shared on Twitter an even earlier double hemisphere, polar aspect, azimuthal equidistant projection, by Henricus Glareanus in 1513, now in the John Carter Brown Library (click on image to see all of the maps in Glareanus's manuscript - they're v cool!):



The PR release also states, that the new map "can be displayed with the Eastern and Western Hemispheres on the two sides," in which case you're looking at the basic orientation of over 75% of all world maps printed in Europe between 1600 and 1800 (although almost all of these used the [conformal] azimuthal stereographic projection) and about 50% (my estimate) of world maps in the nineteenth century (mostly on Arrowsmith's "globular" minimum-error projection). Here's one from 1936, care of www.davidrumsey.com:



The PR blurb states:

> To the best of [the astrophysicists'] knowledge, no one has ever made double-sided maps for accuracy like this before. A 1993 compendium of nearly 200 map projections dating back 2,000 years did not include any, nor did they find any similar patents.

This "1993 compendium" links to the sales page at the University of Chicago Press for John Snyder's text, *Flattening the Earth*. A great book, to be sure, but not one that covers every single map projection and how each was used.

[update 9 August 2022]

> In reading Wellman Chamberlain's *The Round Earth on Flat Paper: Map Projections Used by Cartographers* (Washington, D.C.: National Geographic Society, 1947), I just found the following passage. Originally thinking that it described the idea of hemispheres pasted back-to-back, I realized that it presents a *better* way of doing things!
>
> > In answer to requests for the best world map for showing airlines, Natinal Geigraphic Society cartographers suggest that the hemispheres of this map [azimuthal

> equidistant] can be cut out, mounted on heavy board, and pivoted on the poles so that any meridian can be made continuous,…. With this arrangement it is possible to turn the hemispheres so that any airline which crosses the equator can be shown in unbroken line, and many useful distances can be measured upon it. (p. 94)

A cross-reference points to p. 71, and a photograph of this arrangement.

> By rotating the two hemispheres about the poles, one can see the uninterrupted airline route across the erstwhile interruption of the equator. Measuring the length of that airline route is not, however, all that feasible, as the azimuthal equidistant is only true-to-scale along great circles radiating out from the center of projection (meridians on the polar aspect, as here). Only of the route is north/south, as shown in the NGS image, is the measurement at all close to true!

The creators compare their new map to world maps on Mercator's Projection (conformal, so shapes are correct, but of course at the expense of tremendous areal distortions) and also the Winkel Tripel, which is a minimum-error projection and is (I think) currently used by National Geographical Society for their world maps. By comparison, they argue that their map, especially when the two hemispheres are pasted together back-to-back, means that "distances across oceans or across poles are both accurate and easy to measure, unlike one-sided flat maps." In fact, there is the comment that one can take a string and wrap it around the edge to measure distances from one hemisphere to the next.

And the PR flack concludes with a quote from one of the creators:

> "Our map is actually more like the globe than other flat maps," Gott said. "To see all of the globe, you have to rotate it; to see all of our new map, you simply have to flip it over."

As I say, I am utterly and thoroughly gobsmacked.

Underpinning all this sheer stupidity and naivety are some serious points about what these astrophysicists understand maps to be. It is not that they are ignorant of the mathematical principles; two have published a paper in a map journal on their measures of map distortion (Goldberg and Gott 2007; also Gott, Mugnolo, and Colley 2007). But it seems that from their highly mathematized perch they have realized that world maps are actually useful for imaging and visualizing the world. But they want the maps to also be as accurate as possible, according to their own idiosyncratic criteria. Antarctica should be shown round, as it is; Buckminster Fuller's faceted dymaxion map meets that criterion, but at the cost of "shattering" the oceans.

Interestingly, the astrophysicists are open to interrupting the world map. Interrupted world maps, such as Goode's homolosine, have been unpopular in the twentieth century precisely because they don't show the earth's surface in a continuous manner. Interrupted maps contravene the modern desire to see the entire world as one, as an act of surveillance. But they have not been unknown, especially as a means to prevent distortions from accumulating. This was one of the reasons that the double-hemisphere world map was so popular, with each part of the map projected separately. (Modern topographical map series similarly depend on the repeated projection of portions of the earth's surface, only they do it in such a way as to hide the interruptions.) But it seems that they are willing to accept the single interruption that divides the earth into two hemispheres *only* if the two halves are then glued together.

Ultimately, once one has stripped away the immense amount of PR guff and hyperbole, there's little to recommend this as a "new" and "different" – other than the proposal to paste the two halves together. And I'm pretty sure I've seen an eighteenth- or nineteenth-century hand-held fan with hemispheres drawn on either side …

They have really only reinvented the wheel.

[update 20 February 2021]

The three astrophysicists have submitted a paper to *Instrumentation and Methods in Astrophysics* and is available at ArXiv. I am not *au fait* with pre-pub services in the natural sciences, so I think it was only submitted on 15 February and I don't think that it has passed peer review yet. Now that I am dealing with the actual work and not a puff piece by a publicist, I am comfortable with giving the astrophysicists' names: J. Richard Gott III, David M. Goldberg, and Robert J. Vanderbei. The paper is entitled, "Flat Maps that improve on the Winkel Tripel."

The authors have previously developed a set of mathematics for defining 6 kinds of error in map projections, by which to produce a summary score or "fidelity metric" (Goldberg and Gott 2007), that they applied in a quest to determine the map projection with the smallest error scale. They had found that the Winkel Tripel had the lowest score, and since modified certain attributes to create the Gott-Wagner projection with a fractionally lower score (Gott and Vanderbei 2010). To be honest, their proliferation of error factors in addition to the usual two (in shape and area) smacks of the kind of extraneous qualities that Arno Peters invented to puff up his own projection.

The rhetorical crux of the paper is the assertion that in getting further improvement in error score without resorting to making terrible maps will only produce small increments. What is needed is a radical new approach. They look to a recent solution to the impossibility under Euclidean rules of trisecting an angle, which uses Euclid's straight edge and compass *plus* allows folding of the paper. They therefore investigate the radical approach of *folding* the map. Polyhedral maps, like Buckminster Fuller's famous dymaxion map, already employ folds (or is this simply folding separately projected facets along mutual edges to approximate a globe?) but such maps have poor error scores.

To cut a long story short, the double-sided map is a physical manifestation of a mathematical conception, in which the value of a map is defined solely by its fidelity metric. They note that the key innovation is the separate projection of each hemisphere which minimizes the four factors of isotopy (shape correctness = conformality), area, flexion ("the apparent bending of great circle routes on the map"), and skewness ("lopsidedness"). The error in "boundary cuts" they take to be zero because, mathematically speaking, there is no interruption in the map, only a *fold*. Distance measures from one hemisphere to another are therefore also very low as the line of measurement is continuous. **All one has to do is forget the physical implementation of the map requires not a fold but an interruption.**

"Boundary Cut" is an interesting concept, and I think that I need to ponder it more and maybe write a separate blog post. For now, it stands as a factor whose conceptual significance is undefined but that adds significant weight to the statistics. A regular double-hemisphere map has a boundary cut of 360° (for a "boundary penalty, B" of 0.5); a cylindrical or pseudo-cylindrical world map projection like the Winkel Tripel that shows the poles but ends at a meridian on either side has a boundary cut of 180° (B = 0.25). Although the authors have multiple illustrations of the new projection as two hemispheres placed side by side (B = 0.5), the *concept* of pasting them back to back means that B = 0. This is all just word play and sleight of hand.

But is it not obvious that, when properly created as two hemispheres pasted back-to-back, the new projection does not show the whole world—which is to say that the fold is, in fact, an interruption? Yes it is, but the authors dismiss the problem with a rhetorical trick: one can't see the entire globe either, so what's the problem? Here's the bit:

> A disadvantage of our map is that you can't see all of the map at once. This is often cited as an advantage of flat maps, in addition to their zero volume. Should an error for this be applied to our map? Should it be part of the error budget for maps? In the Goldberg and Gott (2008) paper the six errors considered are errors made in depicting, on a flat map, the spherical surface of the globe: the smaller the sum of squares of errors, the higher the verisimilitude (fidelity) to the actual spherical Earth. Of course, the globe itself, by this token, must have zero errors. It is a perfect map of itself. *And the globe can't be seen all at once, only half at most. So, in that sense, our double-sided flat map is actually more like the globe of the Earth than the other flat maps*. Thus, it would not seem proper to introduce such an error term. Also, as we have commented before, our map has the same topology as the globe and wastes no paper surface. (pp. 21–22, *original emphasis*)

The point of world maps is to show the whole earth, but one can't see the entire earth, so the most accurate world map doesn't show the whole earth. This intellectual whiplash is a distorted extrapolation of the pictorial preconception of the ideal of cartography (Edney 2019). The rhetorical nature of the exercise is reinforced by the appearance of two further criteria for assessing maps: of topology (not in the 6 error factors and woefully undetermined) and of paper wastage (wait, what, really?). This paper is not as logically structured as the authors might think.

And then there's the intellectually insulting part:

> Finally, it is not even quite true that you can't see all of our map at once. That is because you have two eyes! Tip the disk vertically with its equatorial edge aligned with your nose. Your left eye can see the entire Northern Hemisphere and your right eye can see the entire Southern hemisphere. It appears as splayed outward like butterfly wings, because of the parallax angle between your stereo eye views. You can use this trick when inspecting the continuity of South America and Africa as they drape across the equator. (p. 22)

The authors want their maps to be properly scientific and mathematically correct reproductions of the world, very much in accordance with the ideal of cartography (Edney 2019), and they dismiss similar maps in this format because they were only "drawings" and not real maps (p 21). They seem to recognize that the value of world maps is the visual display of the earth's surface, but they cannot comprehend that visual display is *the* reason for world maps and that world maps are not instrumental devices. (They are confused by air-age polar maps that display and make understandable the transpolar routes of airplanes and ICBMs in the northern hemisphere, as if those maps were actually used to plot routes — no, other maps were used that were *not* even of hemispheric extent, let alone global.) The purpose of the world map is not to be as mathematically correct as a sheet from a territorial survey like the OS or USGS.

The language of the actual paper is not quite as egregious as the press release, but the same overblown claims are nonetheless there. The paper is a triumph of mathematical imagination over the realities of mapping as a cultural and social phenomenon. It fails because the authors do not understand that that imagination is itself a product of the cultural idealization of cartography.

The argument is like Zeno's paradoxes: a walker cannot reach the destination, because they must first cross half the distance to it, and then the next half, and the next half. Of course, there comes a point when the remaining distance is less than the length of a step and, lo!, the walker reaches and crosses the finish line. Zeno's mathematical imagination triumphed, in the pure world of math. But reality is not, of course, pure and the authors fail in attending to the one without thinking about the other.

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PERFECTING THE WORLD MAP?

On Ideas and Measures of "Distortion" and the Recent Claims Made for a Two-Sided Hemispheric Projection

Originally posted: 21 February 2021

https://www.mappingasprocess.net/blog/2021/2/21/perfecting-the-world-map

To continue the criticism of the physplaining Princeton astrophysicists' take on map projections, I have looked at the two previous papers in *Cartographica* by Richard Gott and his colleagues, especially Goldberg and Gott (2007) in which they introduce the metric on which their claims rest. I am not concerned with the mathematics — I'm not qualified — but with why they think that paying attention to distance errors and what they call "boundary cuts" is important. These are the two factors, in addition to the general metric, that underpin their claim to have created the most accurate map to date. (See my previous post.)

1. The *Unobjectionable* Treatment of Map Projection Distortions by Goldberg and Gott (2007)

A persistent element of any general text on map projections is that each projection is defined in part by how it "distorts" the surface of the earth in transforming it from a curved surface in three dimensions to a plane in two. One set of projections do not distort angles and shapes; they are variably called as eumorphic, conformal, or isotropic projections. Another set do not alter the relative areas of defined entities; they are generally called equal-area. A further set is often defined, but not always, in which the scale factor along many meridians or parallels, or other great or lesser circles, is constant; this is not to say that scale factor is consistent along any and ever circle on such "equidistant" map projections, just on a defined subset. Another set are those projections designed in the nineteenth and twentieth centuries to balance or in some other way minimize shape and areal distortions; these are called "compromise" or "minimum-error" projections. And then there are a great many other map projections that have some other special properties, or none at all.

(Important: Goldberg and Gott [2007] quite properly refer to lines across the ellipsoid as geodesics; given that for most purposes the difference in mapping the entire earth approximated as an ellipsoid or approximated as a sphere is negligible, I'll continue using standard geographical terms like "great circle" intended for the earth approximated as a sphere.)

Goldberg and Gott (2007) extended the usual discussion of conformality and equal-areaness to also consider further kinds of distortion that are evident "on continental scales" and on world maps. Specifically, they defined and gave examples of "flexion" (or the degree of bending of great circles from the straight line of the great circle across the earth's surface) and of "skewness" which they gloss as "lopsidedness" (i.e., scale factors are not equal to either side of a point, so that the weight of distortion at a point leans one way or another). Flexion and skewness are interesting concepts and are mathematically defined. So far, so good. And, actually, the authors' application of these factors to modify the usual Tissot indictrix generates revealing nuances and precision in the pattern of distortion on a map projection.

2. Problems with Goldberg and Gott (2007)

Things start to get weird when Goldberg and Gott (2007, §6) pursue a numerical analysis to define the "overall quality" of any given projection. Mercator's projection makes a good fit close the equator (or central meridian in transverse aspect, which is one reason it is used for the multiply projected zones of UTM), so that the fact that it goes off to infinity at the poles does not make it "infinitely bad" (p. 315). What then, the author's ask is the overall quality of the projection as compared to others?

They create a single metric in two steps. First, they randomly selected 30,000 points across the globe and calculated the root mean square (RMS) of all their isotropic and areal distortions (I and A) and also the indices for flexion and skewness (F and S). **But then they also throw in two other undefined factors:**

> D, "corresponding to distance errors," which is to say the RMS of the ratio of map to globe distances along the great circles between the pairs of points;
>
> B, "corresponding to the average number of map boundary cuts crossed by the shortest geodesic connecting a random pair of points" which is calculated as $B = Lb/4\pi$ where "Lb is the total length (in radians) of the boundary cuts" **It is not explained how this calculation gives the specified correspondence.**

They presented these metrics in a big table for a number of common map projections (fig. 1). Science, amirite?

Finally, Goldberg and Gott (2007, 317) combine all the summary metrics for the different kinds of distortion, I, A, F, S, D, B to create a single metric, what the recent pre-pub paper called the "fidelity metric" (Gott, Goldberg, Vanderbei 2021). How did they weight these different values in combining them? **Equally: each kind of error is as important as the rest.**

Table 1. The errors in isotropy, area, flexion, skewness, distances, and boundary cuts for some standard projections

Projection	*I*	*A*	*F*	*S*	*D*	*B*
Non-interrupted projections						
Azimuthal equidistant (Figure 5)	0.87	0.60	1.0	0.57	0.356	0
Gott-Mugnolo azimuthal (Figure 13)	1.2	0.20	1.0	0.59	0.341	0
Lambert azimuthal (Figure 20)	1.4	0	1.0	2.1	0.343	0
Stereographic (Figure 1)	0	2.0	1.0	1.0	0.714	0
One 180° boundary cut						
Briesemeister (Figure 6)	0.79	0	0.81	0.42	0.372	0.25
Eckert IV (Figure 7)	0.70	0	0.75	0.55	0.390	0.25
Eckert VI (Figure 8)	0.73	0	0.82	0.61	0.385	0.25
Equirectangular (Figure 10)	0.51	0.41	0.64	0.60	0.449	0.25
Gall-Peters (Figure 9)	0.82	0	0.76	0.69	0.390	0.25
Gall stereographic (Figure 11)	0.28	0.54	0.67	0.52	0.420	0.25
Gott elliptical (figure 15)	0.86	0	0.85	0.44	0.365	0.25
Gott-Mugnolo elliptical (Figure 14)	0.90	0	0.82	0.43	0.348	0.25
Hammer (Figure 16)	0.81	0	0.82	0.46	0.388	0.25
Hammer-Wagner (Figure 17)	0.687	0	0.789	0.518	0.377	0.25
Kavrayskiy VII (Figure 18)	0.45	0.31	0.69	0.41	0.405	0.25
Lagrange (Figure 19)	0	0.73	0.53	0.53	0.432	0.25
Lambert conic (Figure 21)	0	1.0	0.67	0.67	0.460	0.25
Mercator (Figure 2)	0	0.84	0.64	0.64	0.440	0.25
Miller (Figure 22)	0.25	0.61	0.62	0.60	0.439	0.25
Mollweide (Figure 23)	0.76	0	0.81	0.54	0.390	0.25
Polyconic (Figure 24)	0.79	0.49	0.92	0.44	0.364	0.25
Sinusoidal (Figure 25)	0.94	0	0.84	0.68	0.407	0.25
Winkel-Tripel (Figure 26)	0.49	0.22	0.74	0.34	0.374	0.25
Winkel-Tripel (*Times Atlas*) (Figure 27)	0.48	0.24	0.71	0.373	0.39	0.25
One 360° boundary cut						
Lambert azimuthal (2 hemispheres)	0.36	0	0.52	0.11	0.432	0.5
Stereographic (2 hemispheres)	0	0.39	0.37	0.37	0.692	0.5
Multiple boundary cuts						
Gnomonic cube (Figure 12)	0.22	0.37	0.12	0.87	0.43	0.686

Figure 1. Summary table of projection distortions (Goldberg and Gott 2007)

So, the problems:

1. It is unexplained why "distance error" is important to consider. Although, Gott, Mugnolo, and Colley (2007) state as axiomatic that "Maps convey important information about distances between pairs of points. It is therefore desirable to minimize the errors made in representing distances between pairs of points on maps."

2. It is unexplained why "boundary cuts" are a significant kind of error.

3. Nor is it explained how the provided formula matches the verbal definition. As stated, B seems to require the calculation of intersections cutting boundaries/edges along many great circles and then taking the RMS.

4. And the big one: the equal weighting of the contributory factors is neither explained nor justified. At all. Just a brief statement that someone else made such a single metric, so we can

too. No analysis of how that previous scholar had constructed his metric, how it succeeded, and how it failed (because why else do they present their own?).

5. If flexion and skewness are derivatives of isotropy and areal distortions, as the authors state right up front, then they are dependent variables and have no place in the (un)weighted metric alongside the independent variables I and A.

Problems 1–3, at minimum, should in my book have been occasion for revisions. Problem 4 is such a basic flaw that the paper should be rejected, or the entire discussion and conclusions (together §6) should be cropped in its entirety. And, if I am correct, problem 5 is just bad and a sign the journal editors should have just run away from the paper. Screaming.

All of this is to say:

the metric of quality

that these authors present

on which they have determined the absolute quality (from 6 to 0 [perfect]) of any map projection and

by which they have exalted their own new map as the best thing since sliced bread,

features six parameters

two of which are of undefined relevancy (D and B)

two more of which are probably dependent and as such have no place in the metric (F and S)

that are combined by weighting that

is simply unjustified and unexplained and

has been made up at the drop of a hat to give equal weight to the spurious parameters.

To base any comparison of the quality or value of different map projections through this metric is a load of fetid dingoes' kidneys. (To quote the late, great Douglas Adams.) It simply cannot be taken seriously as a mathematical exercise.

To then base claims of the amazingly quality of one's own map projection by relying primarily on the disputable parameters D and B, especially when B is dropped to zero by simply declaring the interruption to be a fold, is mathematically sloppy, utterly self-serving, and borders on the disreputable.

3. Why Bother?

And we haven't even started on issues of **why** world map projections should be subjected to a competition for "the best." If you want the best world map, when "best" is defined strictly by geometrical parameters, then buy a globe (and squish it a bit to make it an ellipsoid). If you want a flat world map, then accept that you are engaging in one of several different spatial discourses in which geometrical accuracy and mathematical principles are largely irrelevant, beyond the basic issue of visual propriety (using equal-area projections in analytical mapping) and thoroughly idiosyncratic reactions to shapes. World mapping is ineluctably a social and cultural act and social and cultural considerations should take precedence.

A map projection manifests in two ways: as the graphic network of meridians and parallels, and as a set of two or more mathematical formulae. Under the modern idealization of cartography, discussion of the projections of world maps means discussion of their formulae and their geometry and their "accuracy." These are indeed matters of absolute importance to certain communities of mapping, notably engineers seeking to modify the earth's surface contours, artillerymen seeking to lob shells against an enemy, or hikers seeking to know how far they have yet to walk to get to food, drink, and rest. But they are not important at all in world mapping. World maps do not just denote the earth's features, they *connote* "the world." Treating world maps as anything else is a fool's errand.

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From an Art to Science (How Mapping Acquired Its Fiber)

An Early, Popular, Pictorial Statement of the Romance of Old Maps

Originally posted: 13 March 2021

https://www.mappingasprocess.net/blog/2021/3/13/from-an-art-to-science-how-mapping-acquired-its-fiber

Last week, I ran across a fun little thing from 1921—more on the then-new popularity of early maps for decorative purposes and, along with it, an interest in map history. It offers a naive view of map history, one filtered through the lens of the antiquarian marketplace, several years before dealers began to publish narratives of map history to entice and educate potential customers and expand their business. (For Karrow 2015, the first such work would be Louis Holman's *Old Maps and Their Makers* [1925].)

The Map of Silk by Coulton Waugh

This pictorial map is from *Women's Wear*, a trade journal for the rag trade, published in 1921. The organizers of a forthcoming exhibition on the history of silk had commissioned a pictorial map from the textile designer, cartoonist, painter, and commercial artist Coulton Waugh (1896–1973). Stephen Hornsby discussed Waugh as a pioneer of the genre of pictorial maps in the USA, which is where I encountered the map (Hornsby 2017, 14). This map of silk was one of Waugh's first. Thinking about illustrating the map (as a modern equivalent of an "*Afric* map" with "elephants for want of towns"), I went looking for images and information. Waugh's papers are now in the special collections department at Syracuse University, which has placed online images of the map of silk and of Waugh's similar map of cotton from his clippings file.

Waugh's work is very much of its time. Racist stereotypes abound. People, animals, and places are drawn in a faux naivete, a childishness that sought to emulate the childish iconography of early maps. There are windheads and "Parts Unknown"; a large compass rose-cum-title; the sea is as full of critters as the land, and the whole is covered in icons of non-modern travel and transportation.

Hornsby gave a precise reference to the journal—*Women's Wear* 22, no. 30 (5 February 1921): 11 (full image at end of th epage)—so I looked it up to see it in context, care of Proquest, and found not only the map, but a short piece explaining it. Hornsby quotes from this, but it really is worth presenting in full:

Silk's Romantic Realty [sic] Vies with Ancient Mapmaker's Wierd [sic] Imagery

Central Exhibit at International Silk Show* Traces Paths by Which This Fabric and Fibre Found its Way From Ancient China to Other Parts of World.

By M. D. C. Crawford.†

> Here is a map of the Roads of Silk, done in the spirit of romance and gaiety. The old mapmaker and the new fibre.
>
> There was a time when the art of mapmaking was a highly imaginative occupation, and the draftsmen considered less the actual fact of continental outlines, positions of rivers and mountains than the general superstitions and weird tales that comprised at that time the science of geography.
>
> The world was an island surrounded by the sea of darkness, at the outer fringe of which

* International Silk Exposition, 1921. Catalog is Crawford (1921).

† Morris De Camp Crawford (1882–1949). "Research editor" for *Women's Wear*. Worked extensively with Culin; his collections are at Brooklyn Museum of Art. According to the Brooklyn Museum, Crawford wrote *The Heritage of Cotton* (1924) and *The History of Silk* (1925), but I find only an obscure 1923 work in WorldCat.

> dwelt all the hobgoblins, demons and furies that the imagination could conjure up.
>
> But a history without maps is an unintelligible jumble of names, and from Strabo's time down to the last official map, changes that represent the applied science of the age have been recorded on maps and charts. However quaint the inaccuracies of the old maps may be, they show not only a progressive knowledge of fact, but an artistry that has been but little appreciated. We might with profit, in our more accurate maps of today, retain some of the gaiety, interest and splendid draftsmanship of the old calligraphers.
>
> The roads of silk were the paths of romance, and yet to show them in our maps of today seems a slight concession to the gaiety and elegance of this fibre. But a map we must have. No historical exhibition of silk could be complete without some record of how fabric and fibre found its way from China to other parts of the world.
>
> Under the direction of Stewart Culin,* who has been an enthusiastic student of all matters connected with silk, and also an ardent admirer of old maps, Coulton Waugh made a map of silk, and made it in the finest spirit of old maps. This map in color, rich in gold leaf, will be the central exhibit at the historic exhibition at the International Silk Show, and the black and white illustration above but lamely reflects the interest and beauty of the original.

One can have a mini field day with this text. The references to "Roads of Silk" plainly alludes to the Silk Road, the famous overland trade route from China through Central Asia to Persia and Turkey. The Silk Road is indicated on the map,† but it is neither labeled nor explained. Marine routes—the routes controlled and used in the present by Western merchants for hauling raw and finished silk around the world—are all labeled; the sting is taken out of the global-imperial economic project by having the sea routes in Asian waters sailed by junks, although Arab dhows might have been more appropriate, but the lie is revealed with the indication, off the Cape of Good Hope, of Vasco da Gama "open[ing] the sea route to India." All the other labels are in the passive voice ("Here silk is brought to America") or otherwise anonymized ("Here silk comes to Japan"). The only individual to be named and given agency is the the European explorer and founder of modern Western global trade networks.

Running throughout is a sense of historical change in mapping over time that seems relatively common in the post-World War I era: specifically, the progressive replacement of imagination and myth through experience and science with geographical fact. (Wright 1947 would later codify this sense of

* [Robert] Stewart Culin (1858–1929) was an ethnographer and curator with the University of Pennsylvania Museum of Archaeology and Ethnology (1890–1903) and then with the Brooklyn Museum (of Art) in 1903–28. The Brooklyn Museum's finding aid to Culin's papers is full of interesting details: Culin worked closely with Crawford.

† There is also an overland route from China through Assam into South Asia, which does not, I think, represent a real trade corridor; my understanding of China-India trade was that it was either marine or an offshoot from the Silk Road passing back through the Khyber Pass into South Asia. I might well be wrong on this, though.

change, evident in his doctoral dissertation published in 1925, under the term, *geosophy*.) The simultaneous growth of interest in early maps as decorative elements adds a further dimension to this process, that of the declining *art* of maps and their ever more scientific nature. As Crawford wrote, the "old mapmaker" acquired "new fibre" (in the sense of substance, moral fiber, resolution, and firmness). The development of mapping from the ancients ("Strabo") to the modern era of cartographic sophistication ("official maps") was not expressed as "art to science" before World War I. Crawford's essay stands as an early expression of the concept, as something in the air that would later be elaborated and explained by map scholars.

Hornsby (2017, 4–5) identified the influence of the highly decorative printed maps of the early modern era as an influence on the creation of pictorial maps, and further (46–50) noted how such maps were actively marketed as decorative works to be displayed. A major component of the popular maps that Hornsby reproduced from the 1920s and 1930s, and not only in his category of instructive maps, were analytical maps of the past, like Waugh's map of silk, that purported to mimic early maps. Many depicted particular moments and places in the US or the US-global past, such as Waugh's full-color 1922 map of the New York city region in 1609 when Henry Hudson entered the now eponymous river. A further point of connection, is that the rise of pictorial mapping was interwoven with the rise in the antiquarian map trade.

I must admit that the number of books and essays by Crawford and Culin from the 1920s and 1930s, listed in WorldCat, about the "philosophy of dress" and the history of clothing as an imperial/global phenomenon is thoroughly intriguing and could quite distract me if I were not already obsessed with maps and their history!

Should someone have the energy, and eventual access, there's likely a nice little project in Crawford's and Culin's papers in Brooklyn about maps, history, and textiles. Who knows: perhaps Waugh's silk map, with all its gold thread, still survives!

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Cognitive Maps in Bemazed Rats, and Humans

How the Cartographic Ideal shaped Tolman's (1948) interpretations of the nature of human spatial cognition

Originally posted: 5 April 2021

https://www.mappingasprocess.net/blog/2021/4/5/cognitive-maps-in-bemazed-rats-and-humans

In quickly looking at some of the origins of the post-1945 study of cognitive maps—commonly but misleadingly called "mental maps"—I was led to a classic paper in behavioralist psychology: Edward C. Tolman's "Cognitive Maps in Rats and Men" (1948). [All page references here are to this essay.] Tolman (1886–1959; PhD Harvard 1915) was a pioneer of behavioral psychology, working at UC–Berkeley (where he began in 1918), and was especially known for his studies of rats in mazes that greatly complicated the nature of the rewards system (Ritchie 1964).

The photographs that one can find online depict Tolman very much in the formal genre of the serious-humorless-conservative academic, but he was by modern standards a liberal—who staunchly defended academic freedom at Berkeley against McCarthyites in 1949–50—and he possess a marked sense of humor that he let shine in his scholarly writing. His sense of humor and social justice are evident in the opening paragraph of his 1948 essay:

> Most of the rat investigations, which I shall report, were carried out in the Berkeley laboratory. But I shall also include, occasionally, accounts of the behavior of non-Berkeley rats who obviously have misspent their lives in out-of-State laboratories. Furthermore, in reporting our Berkeley experiments I shall have to omit a very great many. The ones I shall talk about were carried out by graduate students (or underpaid research assistants) who, supposedly, got some of their ideas from me. And a few, though a very few, were even carried out by me myself. [189]

The empirical study of maps in mazes led to certain conclusions about spatial cognition in rats. But as much as Tolman claimed to be following empirical procedures in applying those conclusions to human spatial cognition, his extrapolations were very much shaped by the ideal of cartography.

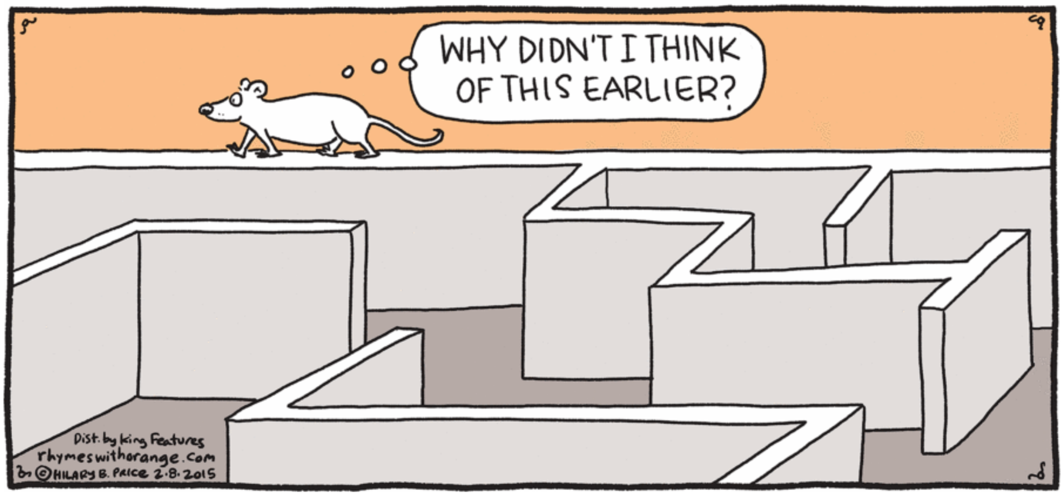
Tolman and his students used rats in mazes to study a wide variety of behavioralist topics, all ultimately concerned with understanding the relationship of stimulus to response. Tolman argued against overly simple constructions of that relationship. After several decades, he was able to synthesize a great deal of work that had implications for rats' spatial cognition. The basic experimental model was to measure rats' learning under different conditions (fed/hungry, expecting/not expecting a reward), but with judicious design a number of issues might be elucidated. In general terms, basic tests revealed:

> the central office [brain] itself is far more like a map control room than it is like an old-fashioned telephone exchange. The stimuli, which are allowed in, are not connected by just simple one-to-one switches to the outgoing responses. Rather, the incoming impulses are usually worked over and elaborated in the central control room into a tentative, cognitive-like map of the environment. And it is this tentative map, indicating routes and paths and environmental relationships, which finally determines what responses, if any, the animal will finally release. [192]

That is, rats learn the maze not by direct stimulus-response but by building up a *flexible* cognitive map, one that might accommodate new information.

The further question for Tolman was whether rats develop a cognitive map from "relatively narrow" strips or "relatively broad and comprehensive" structures. Both kinds of cognitive map allow for learning and efficient action, but a comprehensive cognitive map offers greater flexibility and adaptability:

> The differences between such strip maps and such comprehensive maps will appear only when the rat is later presented with some change within the given environment. Then, the narrower and more strip-like the original map, the less will it carry over successfully to the new problem; whereas, the wider and the more comprehensive it was, the more adequately it will serve in the new set-up. In a strip-map the given position of the animal is connected by only a relatively simple and single path to the position of the goal. In a comprehensive-map a wider arc of the environment is represented, so that, if the starting position of the animal be changed or variations in the specific routes be introduced, this wider map will allow the animal still to behave relatively correctly and to choose the appropriate new route. [193]



Ultimately, after describing many more experiments designed to elucidate this question, Tolman concluded that it was possible for rats to expand their strip cognitive maps into more comprehensive cognitive maps, but not fully so:

> The spatial maps of these rats, when the animals were started from the opposite side of the room, were thus not completely adequate to the precise goal positions but were adequate as to the correct sides of the room. The maps of these animals were, in short, not altogether strip-like and narrow. [205]

That is, the strip cognitive map represented a lower or primary level of cognitive development, the comprehensive map a more fully developed level of cognition. Add to this conclusion an unspecified quantity of other research, and Tolman felt competent to make some comments about

> the humanly significant and exciting problem: namely, what are the conditions which favor narrow strip-maps and what are those which tend to favor broad comprehensive maps not only in rats but also in men?
>
> There is considerable evidence scattered throughout the literature bearing on this question both for rats and for men. Some of this evidence was obtained in Berkeley and some of it elsewhere. I have not time to present it in any detail. I can merely summarize it by saying that narrow strip maps rather than broad comprehensive maps seem to be induced: (1) by a damaged brain, (2) by an inadequate array of environmentally presented cues, (3) by an overdose of repetitions on the original trained-on path and (4) by the presence of too strongly motivational or of too strongly frustrating conditions. [205, 207]

That is, a cognitive map oriented by strips is *prima facie* indicative of poor or inadequate cognitive development. Anything less than a fully developed cognitive map must therefore indicate either childishness (not really defined, just dropped into the discussion) or psychological malfunction:

> My argument will be brief, cavalier, and dogmatic. For I am not myself a clinician or a social psychologist. What I am going to say must be considered, therefore, simply as in the nature of a *rat* psychologist's *rat*iocinations offered free.
>
> By way of illustration, let me suggest that at least the three dynamisms called, respectively, "regression," "fixation," and "displacement of aggression onto outgroups" are expressions of cognitive maps which are too narrow and which get built up in us as a result of too violent motivation or of too intense frustration. [207]

If nothing else demonstrates the metaphorical nature of the "cognitive map" it is the manner in which reason and spatial understanding are ineluctably interconnected:

> What in the name of Heaven and Psychology can we do about it? My only answer is to preach again the virtues of reason—of, that is, broad cognitive maps. And to suggest that the child-trainers and the world-planners of the future can only, if at all, bring about the presence of the required rationality (i.e., comprehensive maps) if they see to it that nobody's children are too over-motivated or too frustrated. Only then can these children learn to look before and after, learn to see that there are often round-about and safer paths to their quite proper goals… [208]

Ever the behavioralist, Tolman concluded,

> We must, in short, subject our children and ourselves (as the kindly experimenter would his rats) to the optimal conditions of moderate motivation and of an absence of unnecessary frustrations, whenever we put them and ourselves before that great God-given maze which is our human world. [208]

There is so much here to unpack. Somehow the conflation of "cognitive map" with "world view" has led us from an instrumental practice of way finding and experiencing place as one moves through a landscape to the nature of one's moral and global outlook. We have jumped scale, from place to space, from local intimacy (and what is more intimate than eating and rewards) to global empathy (or lack thereof). All collapsed within a metaphor that's clearly actually more than a metaphor: it is the normative concept of "the map" rather than of specific spatial construct.

It might be logically acceptable that rats are not neurologically capable of possessing different kinds of cognitive map at the same time, but in presuming that humans are so cognitively limited, Tolman implied that the human cognitive map is grounded solely in experience and observation of spaces. This is the observational preconception of the ideal repackaged and wedded to the individualistic preconception. Indeed, Tolman seems to hold that cognition can only be a single process: all thought occurring in the same way, through the same set of cognitive wiring.

I also have to wonder about Tolman's conclusions in light of the psychological study of cognitive development, à la Jean Piaget in the 1920s and 1930s. In laying out the stages of cognitive development as a series of spatial attainments, Piaget placed strip-cognition way finding as a marker of childish and non-Western cognition, a stage which Western children would outgrow as they developed a fuller and more flexible cognitive map. Tolman does not reproduce Piaget's racist formulation, but the implications are there. Certainly, he reveals the same conflation of a flexible, comprehensive cognitive map with a flexible, adaptable world view. Rats can't quite achieve that flexibility, but humans can, and should.

The lesson: don't let the metaphor of the cognitive map cease to be figurative and become literal.

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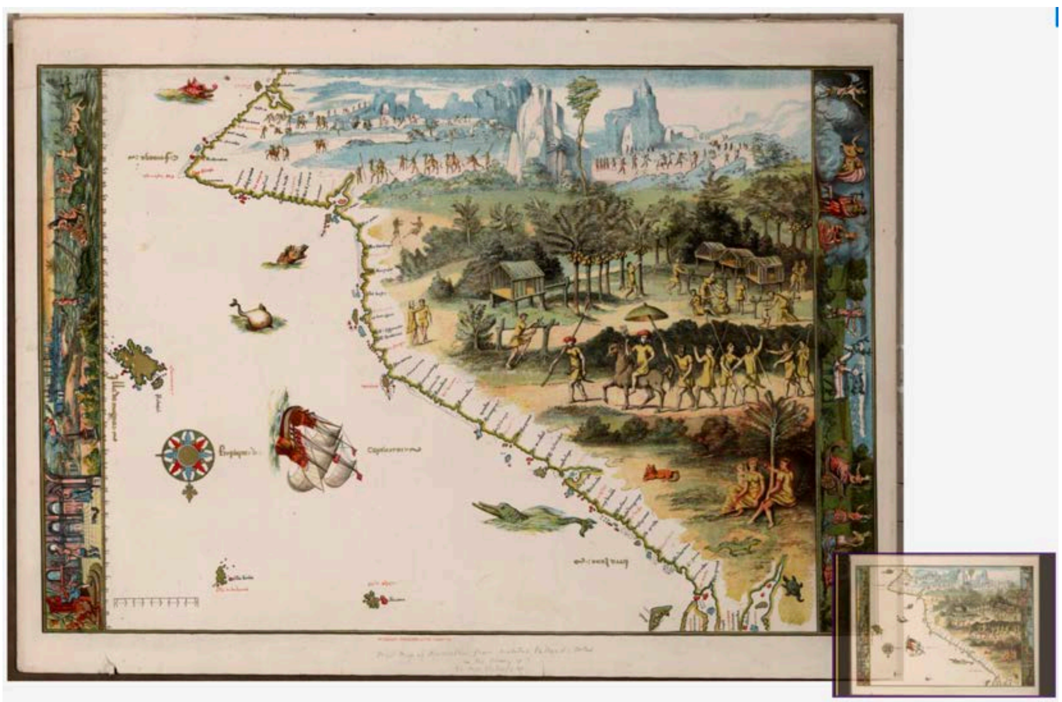
An Early Color Facsimile: Hand-Applied or Printed?

Originally posted: 18 May 2021

https://www.mappingasprocess.net/blog/2021/5/18/an-early-color-facsimile-hand-applied-or-color

A little thing has distracted me from the ongoing struggles with the current book. For "Map Monster Monday," Twitter threw up a facsimile of one of the sumptuous "Norman" or "Dieppe" school maps, in the anonymous ca. 1547 atlas owned by Nicolas Vallard:



1856 facsimile of Nicolas Vallard's untitled map of Jave-le-grande of 1547. National Library of Australia (map RM 2393). Click on map to see at the NLA website.

What intrigued me was the fact that the facsimile was made in color in 1856: was it printed color or hand-applied? Damien Bove and Catherine Delano Smith (2020) have recently explained the difficulties faced in the color reproduction from photographs of the "Gough Map" of Britain (ca. 1400) by the UK's Ordnance Survey in 1871/2. The OS used its photo-zincographic method which required extensive mediation of the negatives for each color to eliminate extra artifacts (such as the texture of the vellum substrate). This facsimile was much earlier. So what technique was used?

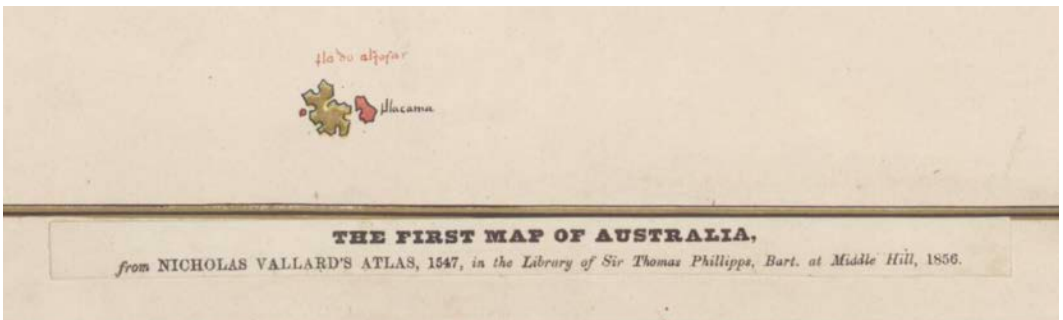
Also, why was the map reproduced, in aid of what piece of map historical scholarship?

In response to my request for more information, the original tweeter, @whitdurham, responded with the link to the above image. A bit more digging, aided by the National Library of Australia's catalog record, reveals a relatively simple history. The "Vallard Atlas" itself was acquired by the omnivorous British collector of books and manuscripts, Sir Thomas Phillipps (1792–1872) in 1849; it was later acquired by Henry Huntington during the prolonged dispersal of Phillipps' huge collections and is now in the Huntington Library, San Marino, California, as mssHM 29, and the particular map is chart 1 (fols. 5v–6r): catalogue and image. Phillipps had tried to get the British Museum to acquire his collections, and apparently had the facsimile made in order to entice the BM's librarians, albeit unsuccessfully.

Some impressions of the facsimile bear a title in the lower margin, from a paste-on slip:

> The First Map of Australia, from Nicolas Vallard's Atlas, 1547, in the Library of Sir Thomas Phillipps, Bart. at Middle Hill, 1856

Here's a detail of another impression from the NLA (map RM 1819 (copy 1)), showing a paste-on title:



In the initial copy to which @whitdurham directed me (above), a pencil annotation was provided instead, reproducing most of the title on the paste-on slip; the lower margin of the Huntington's impression of the facsimile remains blank. Both NLA and the Huntington give the place of publication as Middle Hill (near Broadway, Worcestershire), which is to say Phillipp's country seat. At the same time, a printed imprint covered by the poaste-on title slip reads "McGahey, Chromo. Lith. Chester." This is John McGahey (1816–86).

An examination of the NLA's digital image of the facsimile quickly demonstrates that it was indeed chromolithographed, but not from a photograph. All the line work was traced and then transferred to one lithographic plate, and further plates used for each (spot) color. The look of the foliage in the lower right of the facsimile (below) is really quite similar to the results of copper-plate etching, with tightly curving squiggles for the leaves. But note that the width of the squiggles are variable: this is indeed a lithographic product. And compare the detail with the original to see the impact of the technique:

Detail of facsimile. National Library of Australia (map RM 2393). Click on image to view on NLA website.

Detail of original chart. Huntington Library (mssHM 29, fol. 6r). Click on image to view on the Huntington website.

The color was not hand-applied to the lithographic facsimile: in the above detail, see the texture to the red below the feet of the men in procession, and on the arms of the women by the tree…that texture does not come from a watercolor brush and is a clear indication of lithographically printed color. Also, the registration of the colors to the line work in the key plate is excellent, with that red being further overprinted to shade the image.

So, well-done chromo-lithograph of a pretty map!

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SUPPOSITIONS OF LOCATION AND OF SIMILITUDE

Key tests in the assessment of old maps

Originally posted: 28 June 2021

https://www.mappingasprocess.net/blog/2021/6/28/suppositions-of-location-and-of-similitude

I have briefly mentioned George Collingridge for his 1907 world map centered on Australia, to which I was drawn via his work on Java and Jave-le-grande. Let's talk about that work more, especially as it pertains to the suppositions of location and similitude as widely deployed by traditional map historians. The supposition of location has the following logic:

X is in *this* location on an early map,

on modern maps, *this* location is occupied by Y, therefore

X == Y.

The supposition of similitude has a similar logic featuring the visual form of features on old and modern maps:

X looks like *this* on an early map,

on modern maps, Y also looks like *this*, therefore

X == Y.

The two suppositions have been widely applied. They are most apparent when people with little understanding of the nature of maps have looked at old maps. One instance of the supposition of similitude was the argument by Charles Hapgood (1966) that the presence on early maps of a circumpolar *terra australis* that rather looked like Antarctica was proof that Antarctica had been mapped well before the Renaissance (and indeed before the formation of the ice sheets). From that conviction, Hapgood had to build up a huge superstructure of conjecture and fancy to account for the fact that the location of Antarctica was not actually the same as the *terra australis* on early maps.

Collingridge's work suggests that appeals to similitude and location were strategic rather than principled. He was committed to the argument, *contra* Australia's burgeoning nationalistic origin story, that Australia had been "discovered" not by the Dutch but by the Portuguese, and indeed perhaps by still earlier peoples from the West.

In one essay, Collingridge disputed the standard identification as Japan of Marco Polo's Zipangu (or Cipango). Setting aside what he thought were spurious etymological similarities—without any linguistic expertise—he argued that this identification rested only on the coincidence of the islands' locations "*on maps*" (Collingridge 1894, 404, original emphasis). That is, the argument rested only on the supposition of location; unsupported by other evidence, the equivalency must be dismissed. Of course, other scholars (as Oldham 1894) thought the linguistic evidence solid and therefore the supposition of location valid.

At the same time, Collingridge (1895) followed the equivalency drawn of many scholars—starting with a tangential note by Alexander Dalrymple (1786, 4n) and continuing in a more critical manner with such authorities as Conrad Malte-Brun (1810–29, 1:509–11) and R. H. Major (1859, xxvii–xxxv}—between Australia and Jave-la-grande, the large landmass extending southwards from Asia on maps from the sixteenth-century Dieppe school. Collingridge sustained the equivalency of Australia with this large land mass with appeals to both suppositions.

The difference in Collingridge's application of the supposition of location, adhering to it in his own study but disagreeing with it in someone else's, stemmed from the need to present Zipangu as Java, so that that island could be isolated and distinguished from Marco Polo's Java major, which Collingridge took to be the much larger Jave-la-Grande. At the same time, Collingridge argued that the presence on Jave-le-grande of Portuguese toponyms indicated that the mapped knowledge had to have derived from otherwise unrecorded Portuguese voyages that had independently discovered Australia well before the "official" Dutch encounter with its western coast in 1606.

See the works of Bill Richardson below for a sustained argument against Collingridge and later persistent scholars. Richardson, a professor of Spanish and Portuguese, conducted careful linguistic analyses and demonstrated that all the placenames in Jave-la-grande were of known places in the East Indies and had nothing to do with Australia. See Richardson's own bibliography for more information and for his more general statements concerning map analysis.

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MODERN HISTORIES OF GEODESY AND SURVEYING

An overview

Originally posted: 30 June 2021

https://www.mappingasprocess.net/blog/2021/6/30/modern-histories-of-geodesy-and-surveying

The internal history of surveying—the history of surveying written by practicing and academic surveyors—is an important part of map history generally, but it is only in part relevant to the ways in which "the map" has been conceptualized in theory and practice within map studies, so I have finally decided to present this material in the blog. I previously wrote on the early history of geodetic surveying.

update 5 July 2021: I added a few further bits that proved to be extraneous as I reconfigured the chapter.

The professions and academic disciplines concerned with the observation and measurement of the earth's surface—in short, the amalgam of practices that have often been grouped together as "land surveying"—have promoted extensive studies of mapping practices and institutions. The "higher order" surveys undertaken for geodesy and for systematic state mapping have long been the traditional focus. The history of geodetic surveys has been undertaken by scientists who have written their disciplinary histories from an internal perspective; the histories of high order surveying have tended to blur into the treatment of surveying generally by historians of science as they achieved disciplinary autonomy in the twentieth century. Other, basic kinds of surveying have had a more varied historiographical occurrence.

The modern stereotype of the internal map historian is the older practitioner or scholar who has become an administrator of others, who perhaps witnesses the loss of institutional memory as colleagues retire or die, or who seeks to explain something about the past of a particular institution, or perhaps of an entire field, to younger colleagues. Much of this work, especially when undertaken through the medium of the after-dinner speech (Oliver 2007), has comprised nostalgic reminiscence and is marked by a pronounced romanticism if not outright hagiography. A former director of the Ordnance Survey justified this approach because it adds "enchantment to the memories" and because "some, at least" of the former map makers who were lauded had indeed been "great men" (Wintherbotham 1944, 186). The stereotype, however, obscures several other reasons why practitioners have sought to address the history of their craft: to position themselves at the forefront of their community and enhance their professional self-esteem; to demonstrate their quality and worth to paymasters, whether patrons, clients, bureaucrats, or a more nebulous public; to fulfill an intellectual curiosity about the origins of particular mapping techniques; and to define and delimit the scope of professional practice or academic study vis-à-vis other professions or disciplines.

Geodesy within Histories of Mathematics and Astronomy

In 1720, Jacques Cassini (II, 1677–1756) announced that the completed measurement of the arc of the meridian through Paris, from Perpignan in the south to Amiens in the north, provided empirical proof that the earth is elongated, or squeezed at the equator, rather than being flattened at the poles, as Isaac Newton and others had theorized (Cassini 1720). The announcement had profound implications for the field of geodesy. Further investigation of the precise shape of the earth split into two distinct components. Mathematical or geometrical geodesy has entailed the measurement of the earth's dimensions and figure; this is the arena of geodetic surveys and it is closely aligned with both astronomy and official territorial mapping projects. Dynamic or physical geodesy is the study of the earth's constitution and gravitational field, which is closely aligned with the fields that would coalesce as geophysics in the nineteenth century (Perrier 1939, 3). Geodetic surveyors henceforth abandoned the limited historical reflections by which their predecessors had firmly situated their measurements of the earth's size within a scientific tradition originating in ancient Greece and instead turned to new proofs of authority, specifically the great quality of their increasingly precise instruments and the supreme subtlety of the techniques they painstakingly followed. To this end, geodetic surveyors provided accounts of how each survey had proceeded, the conditions they faced, and the problems they had overcome (Delambre 1798, vi) without reference to previous geodetic surveys (see my early history of geodetic surveying).

Yet even as eighteenth-century geodetic surveyors ceased their historical reflections, newly professionalizing mathematicians and astronomers created a new discursive thread in which they used historical accounts of geodesy to sustain the innately progressive character of their sciences. Astronomers had of course been interested in the earth's size since Antiquity, because it provides the basic yardstick for determining distances from the earth to the moon, sun, the planets, and the fixed stars. The wide variation in the earth's size postulated by ancient scholars was nonetheless of little significance because they employed geometrical methods to determine the shapes and dimensions of the orbits of the planets and of comets *relative* to each other; they did not require the earth's size to be known in absolute terms (Delambre 1814, 3:512). Early cosmographers made their calculations with whichever size they deemed most appropriate (Van Helden 1985, 4–8, 24, 30–31, 34).

This situation changed dramatically when Newton published the inverse-square law of gravitational attraction in his *Principia* (Newton 1999 [1689]). Newton could not have formulated nor have applied this law without the determination of precise, *absolute* magnitudes for the distances between objects in the solar system, distances based in turn on a precise, *absolute* size of the earth. Geodesy rapidly became a central activity for astronomers because it was an essential contribution to the refinement of the theory of gravitational attraction and of the theory's implications for tracing and determining the motions of the planets. Moreover, Newton's theory of gravitational attraction established a causal link between the earth's material constitution and its shape, such that the determination of the earth's shape served to prove Newton's theories. As a leading British astronomer would later summarize the situation:

> But by the discoveries of Newton the Figure of the Earth was shown to depend on the same theory which explains with such wonderful accuracy the motions of the Planets and their satellites. The investigations of the most profound Mathematicians have since been directed to its [the earth figure's] determination, from the Principles of Gravitation [i.e., theoretical studies of fluid dynamics]; and the labours of the most able experimenters have been employed in ascertaining it from actual observation [i.e., geodetic surveys and pendulum observations]; and the comparison of the results of theory and of observation shows that their agreement, though not perfectly exact, is sufficiently so to enable us to assert with confidence, that the Principle of Gravitation is well founded. Indeed, for one part of that Principle, (*viz.* that the attraction of a Planet is not a force directed to its centre, but is the resultant of all the forces directed to every one of its particles,) it may be considered as affording the most satisfactory proof that we can expect ever to have. (Airy 1845, 165)

The history of geodesy thus became a major part of pioneering histories of astronomy prepared in large part to justify and to delimit the subject as a specific and innately progressive discipline (Kragh 1987, 7–8; Laudan 1993, 7–9). The proto-disciplinary histories set out to define "what we have done and what we can do" (Bailly 1779, 3:315; quoted by Kragh 1987, 3).

The past was to be known for how science had developed into the contemporary era, but only those details that were immediately relevant to present-day practices were important. In this respect, mathematicians and astronomers drew a sharp divide between geodetic works undertaken since Jean Picard's initial survey of part of the Paris meridian in 1668–70—i.e., surveys that possessed a degree of precision sufficient to fuel inquiries into the fundamental question of gravitational attraction—and all earlier works that were simply too imprecise and inaccurate. The results of the surveys before Picard's were indeterminate because the units of measurement remained undefined and obscure, and they could be readily dismissed as having been made only to satisfy innate curiosity and to fulfil the merely pragmatic need to make better land maps and sea charts (e.g., Montucla 1758, 2:230–31, 506–7).

The presentism and progressivism of the histories of mathematics and astronomy were on full display in both Jean Le Rond d'Alembert's long essay on the figure of the earth in the *Encyclopédie* and Jean Étienne Montucla's wide-ranging history of mathematics to 1700 (Laudan 1993, 5–7). D'Alembert (1717–83) declined to discuss geodetic surveys before Picard, because the "imperfection of [their] methods and instruments" made their results of no significance to contemporary natural philosophy. Should any reader still be interested in the early measurements, d'Alembert referred them to earlier works for details (Alembert 1756, 749–52, esp. 752; citing Riccioli 1672; Cassini 1720).* Instead of an historical essay, d'Alembert devoted his essay to calculating the earth's precise figure from the more

* "Nous n'avons pas besoin de dire que les mesures des anciens doivent être regardées comme très-fautives, attendu l'imperfection des méthodes & des instrumens dont ils se servoient; mais nous avons cru que le lecteur verroit avec plaisir le progrès des connoissance humaines sur cet objets."

recent measurements (Passeron 1996).

Montucla (1725–99) did discuss each of the pre-triangulation measurements of the earth's size, extolling their originality and the audacious efforts of their undertakers, but he found severe problems with each—in their instrumentation, project design, and execution—such that none could compare favorably with contemporary measurements. The early surveys thus served to mark the primitive and unsophisticated beginnings of the mathematical sciences. Montucla did give close attention to Willibrord Snellius's early seventeenth-century survey: first, the survey provided an excuse to explain the process of triangulation, which Snellius had deployed for the first time in a geodetic survey; second, Snellius's shortcomings as a calculator had been overcome by the recalculation of his work by his countryman, Petrus van Musschenbroek (1729, 398–420; see Haasbroek 1968, 68–85).* Finally, Montucla hailed the triangulation of the Paris meridian, starting with Picard's initial survey, as indicating the contemporary progress in mathematics that had been achieved through the application of reason (Montucla 1758, 1:253–54, 1:343–44, 2:230–35, 2:507–10).

Dedicated histories of astronomy had the room to consider geodetic surveys in more detail and so were able to assess their quality. This in turn required determining the modern equivalents of the units of measure deployed, so that the early results could be meaningfully compared against modern values for the earth's dimensions. The analyses by Jean Sylvain Bailly (1736–93)—who would become first mayor of Paris, during the Revolution, before his execution in 1793—were complicated by his conviction that ancient units of measure all stemmed from a supposed *ur*-measure based on the size of the earth. Modern geodesy was for Bailly bound up with Tycho Brahe's and Johannes Kepler's refinements of Copernicus's heliocentric cosmology, with the perfection of pendulum clocks, with debates over recreating (in his view) a universal measure, and the new geodetic surveys, all explicated in far more detail than any previous scholar had done. However, by ending his history in 1720, Bailly avoided having to retell the dispute over the shape of the earth and the complicated ways in which the earth had been modeled as a rotating fluid (Bailly 1779, 1:143–68, 2:337–76).

The prominent geodesist and astronomer Jean Baptiste Joseph Delambre (1749–1822) continued Bailly's historical work, although not his view of the ancient origins of astronomy (Laudan 1993, 11; Raina 2003). An introduction composed of "purely historical details" was integral to defining geodesy's innately progressivist character in the chapter on the subject in his textbook on contemporary astronomical methods (Delambre 1814, 3:512–25, esp. 525). He expanded this argument in several parts of his exhaustive volumes on the history of astronomy (Delambre 1817, esp. 1:90–91 re Eratosthenes; Delambre 1819, 2 and 66 re the measurement ordered by the caliph al-Mamûn ca. 830, 382–83 re Jean Fernel; Delambre 1821, 2:92–110 and figs. 22 and 26 re Snellius and van Musschenbroek, 598–613 and fig. 63 re Picard). These volumes were so very large because Delambre gave very full abstracts of his

* However, Haasbroek (1968, 79–84, esp. 83–84) found that van Musschenbroek had actively falsified his reworking of Snellius's triangulation, so that the recalculation must be "fully condemned" as "entirely unreliable and contrasts very badly with the faithful work carried out by Snellius a century earlier."

predecessors' publications—explaining, in particular, how both Snellius and Picard had themselves written about early geodetic measurements (Delambre 1821, 2:92–96, 599)—but he did also make has own assessments of previous measurements, in which he addressed questions of metrology and the quality of each survey by comparison to modern techniques and reinvestigations. Delambre was especially interested in Picard's geodetic survey, which he had revisited during his own 1792–98 resurvey of the Paris meridian to define the length of the meter. Delambre intended to treat the complex debates and surveys prompted by Newton's *Principia* in two further volumes, one covering the Newtonian revolution in astronomy, the other post-Newtonian geodesy (Delambre 1821, 1:li). However, both volumes remained incomplete at his death in 1822. When finally edited and published almost a century later, the volume on geodesy consisted entirely of detailed abstracts of the accounts of each geodetic survey, with little consideration of the mathematical modeling of the earth's gravitational attraction and its figure (Delambre 1912). Those theoretical concerns were also understandably absent from the posthumous volume dedicated to eighteenth-century astronomy (Delambre 1827).

Issues of gravitation, the earth's figure, pendulum experiments, and geodetic surveys remained of concern to what became known in the early nineteenth century as physical astronomy. In the United Kingdom, the future astronomer royal, George Biddell Airy (1801–92), regarded geodesy as integral to the kind of mathematical study of physical phenomena that needed to be pursued in Britain (Airy 1826, 61–116). In 1830 he prepared an exhaustive account of geodetic work in which he calculated a new set of parameters for the earth's figure, but only after a detailed summary of previous works both to measure and to mathematically model the earth (published as Airy 1845, esp. 165–74). Airy's account is memorable as the first to actually consider the history of dynamic geodesy and the mathematical modelling of the earth's form as a rotating fluid. His concerns were at once progressivist and nationalistic, as he saw the history of geodesy as proving the validity of Newton's celestial mechanics. Robert Grant (1814–92), in his history of physical astronomy, simply ignored geodetic undertakings before Picard and similarly focused on the application of geodetic results to Newtonian theories (Grant 1852, esp. 66–76). The Ordnance Survey's Alexander Ross Clarke (1828–1914) followed suit in his textbook on geodesy in which an evaluation of geodetic measurements since Picard prefaced the use of their results in calculating the earth's figure anew (Clarke 1880, 1–36). As the Newtonian theory of gravitational attraction became incontrovertible, physical astronomy increasingly looked solely to the phenomena found in the night skies (Smith 2003) and left the geodetic study of the earth's gravitational field to an emergent geophysics (Oreskes and Doel 2003, 538).

Practicing geodesists, like their eighteenth-century forebears, addressed the progressive qualities of their own surveys—in their instrumentation, survey design, and results—rather than the history of their field. General histories of geodesy fell within the purview of the history of mathematics, for which they demonstrated the development of the modern science and its techniques. The prominent British mathematician Isaac Todhunter (1820–84) produced several histories of elements of mathematics: the theory of probability, the calculus of variations, elasticity, and more particularly of the theory of gravitational attraction and the figure of the earth (Todhunter 1873). For Helge Kragh (1987, 8–9), Todhunter exemplified a new kind of specialist historian of science: the "professional scientist" who writes for the benefit of the present-day student by producing "accurate specialist account[s]" that are "impressive" and "still profitably consulted" but whose "technical level renders them unreadable for the non-mathematicians." Even though he focused solely on geophysical models and gave very little attention to the geodesy's geometrical components, Todhunter's work was very much in the same vein as previous histories, comprising as it did more "a chronicle with textual glosses, not a history," and his presentism misconstrued key works in the debate (Greenberg 1995, 402). A further, more straightforward history of geodetic arc measurements by a much lesser mathematician plainly announced its presentist and progressivist agenda:

> The results here gathered are intended to show the progress and development of the work, thus enabling one to obtain a comprehensive idea of what has been accomplished in the subject, and to note the progress in methods and the precision attained. (Butterfield 1906, unpaginated preface)

Twentieth-century historians of mathematics continued their internalist interest in specific elements of the mathematics of geodesy, especially in the particular context of the work of Carl Friedrich Gauss (Müller 1918; Galle 1924; Miller 1972; Goe et al. 1974; Breitenberger 1984).

Geodesy and Official Surveys

The initial organization of mathematics and astronomy as disciplines and the new histories of their past progress by Jean Étienne Montucla (1758) and Jean Sylvain Bailly (1779) mark the onset of the "second scientific revolution" and its profound intellectual and institutional changes (which I summarize from a mapping perspective in Edney 2020). Indeed, Bailly (1779, 1:144) prefigured the later formation of the ideal of cartography when he stated, in reference to the contemporary project to map the territory of France, led by César François Cassini (III) de Thury, that early geodetic measurements had integrated astronomical phenomena with geographical knowledge of the earth as a whole, and more particularly of his own country. "Man has found in astronomy," he wrote, "in the correspondence of heaven and earth, the method of measuring the world, without abandoning one's country, and almost without leaving home."* Bailly recognized how geodetic surveys apparently unified geography and topography in a single, systematic mapping practice (Edney 2019, 106–11, 199–205). As Western governments increasingly pursued systematic surveys of their territories and inshore waters, they integrated specifically geodetic work within larger systems of surveying intended to map landscapes, cadasters, and hydrography (Edney 2017, 164–70). As the idealization of the unity of cartography took hold, a new kind of official history of governmental surveying institutions blurred with both the history of geodetic surveys and with accounts of the history of land surveying generally.

* "L'homme a trouvé dans l'astronomie, dans la correspondance du ciel & de la terre, la méthode de mesurer le monde, sans abandonner sa patrie, & presque sans sortir de ses foyers."

In the second half of the nineteenth century, as official surveys transitioned from specially funded, *ad hoc* projects into formal government agencies with permanent budgets, leading scientist-surveyor-bureaucrats increasingly engaged in institutional histories of their geodetic surveys and of the more detailed territorial surveys that depended on them (Edney 2012, 295–96). Many such institutional histories have been written, and continue to be written, for example of surveys in India (Markham 1878; Phillimore 1945; Chadha 1990), Great Britain (White 1886; Close 1926; Seymour 1980), France (Berthaut 1898–99; Huguenin 1948), Italy (Mori 1903; Mori 1922), Belgium (Hennequin 1891), Netherlands (Linden 1981), Norway (Harsson and Aanrud 2016), Canada (Thomson 1966), and the United States (Evans and Frye 2009 [1955]; Rabbitt 1979; Woodford 1991).

Such institutional histories have pursued several different lines of argument, depending on their perspective, but all sought to put the surveyors and their institutions in the best light possible. Most were not limited to bureaucratic history, but provided detailed accounts of how each particular survey had been undertaken, and as such blur into historical accounts of individual surveys. In an opinion piece written for his fellow surveyors, H. S. L. Winterbotham (1878–1946), formerly director general of the Ordnance Survey of Great Britain, explained the benefits of such historical work:

> Survey history gives a yard-stick by which to assess the value, the authenticity and the precision of such measurement or topography as still underlies our work. It encourages us by showing what obstacles can be overcome, and it also teaches us to avoid the dangers, delays or mistakes we may, all unwittingly, repeat. The last are many indeed.…
>
> Naturally every important original trigonometrical survey is described. How else could posterity add to it, adjust it to fit new conditions, or judge when its useful days are numbered? In every survey, however, there are many matters concerning methods arid processes which are rarely described, and which yet reflect a lot of patient trial and error. The reasons for their adoption are apt to get lost, and the same trial and error may be repeated.…Then, again, who ever heard of a Survey Department so liberally financed that it could put the proper amount of work into each field survey?…That means that the town plan of X, or the topographical map of Y, had to be finished off without proper revision or an adequate framework. It is essential that these makeshifts should be recorded, or the whole may be rejected because a part is faulty. (Winterbotham 1944, 186)

Some institutional histories were written by retired, senior officers with professional development in mind. For example, Reginald Phillimore (1879–1964) "intended" his monumental *Historical Records of the Survey of India* "first for professional surveyors now working in India, and their successors, that they may know…how the modern system came to be built up. They will want to know all the work-a-day details, and many will be interested in the human lives of their predecessors" (Phillimore 1945, 1:x). Such works present a forbidding array of facts organized around three primary themes: who surveyed which areas when; with what instruments and techniques; and how well they did so. A persistent topic of discussion is the vicissitudes that surveyors had to overcome, especially those imposed by constantly shifting government policies and cheese-paring accountants. After reading the modern official history of the U.K.'s Ordnance Survey, one reviewer summarized this consistent theme:

The Survey was fortunate in having Directors General who played significant roles in [its] history.…If it were not for their skillful defence of the spending of [their] funds, and their lobbying for additional funds, the survey would not have carried forth its impressive mapping programmes. (Dubreuil 1987, 30; re Seymour 1980)

Institutional histories have frequently verged on the hagiographic, as surveyor after surveyor is lauded for their triumphs.

Other institutional histories were written by active officers with a keen sense of having to keep the purse strings open and the funding flowing. Winterbotham (1944, 187) explicated the situation: "properly kept histories are of the utmost help in discussing survey programmes with the financial authorities.…[T]o show how ultimate economy is to be found thereby is inevitably a matter of history." A good early example is a report prepared in 1851 by the surveyor general of India as part of a successful defense against the existential threat to the Great Trigonometrical Survey of India posed by a member of parliament who sought to slash or eliminate its budget (Waugh 1851; see Edney 1997, 23). Such official accounts were careful not to imply that political and bureaucratic overseers were ever inconstant or contrary. Rather, as Jos Gabriels (2019, 259) observed with respect to Henri Berthaut (1848–1937) and his history of French military engineers (Berthaut 1898–1902), the accounts always emphasized the contributions of the surveys to the state and to science. Thus, Berthaud "offers an extremely detailed inventory of the epic accomplishments of these employees, who—while overcoming numerous problems of various natures in the field—served geographic science in general and French Army command in particular."

In a few instances, surveyor-bureaucrats took on a comparative analysis and evaluation of the many geodetic and territorial surveys undertaken in Europe, North America, and their colonies, each time for a specific purpose. Cyrus B. Comstock (1831–1910) of the US Corps of Engineers undertook such an historical review of the various European surveys then under way to demonstrate that the corps' hydrographic survey of the Great Lakes—the US Lake Survey (1841–1882)—had indeed been adhering to established best practices (Comstock 1876). A decade later, another US military engineer, Major George M. Wheeler (1842–1905), engaged in an extensive review of official European and colonial surveys. Wheeler had been in charge of one of the four "great surveys" of the West during the 1870s, whose duplication had prompted the eventual formation of the US Geological Survey in 1879. The USGS's first superintendent was little interested in territorial mapping and, even as the second superintendent was beginning a mapping program, starting in 1884, Wheeler sought to step into the breach and argue that a systematic survey of the entire United States should be done, just as such surveys were done in Europe and their colonies, by military engineers and not by civilian scientists (Wheeler 1885). By the end of the nineteenth century, European geodesists and government mapping agencies were collaborating in two main areas: in pan-European geodetic measurements and in the International Map of the World at one to one million (1/M). A retired Prussian engineer and surveyor, Captain Willibald Stavenhagen (1859–1922), argued that there remained a need for still greater international collaboration, in the production of more detailed territorial surveys. To do so, he undertook a comparative review of topographical surveys outside of Germany, outlining the similarities and differences in practice (Stavenhagen 1904).

A specific arena of surveying that has been subject to internal institutional histories has been the history of marine charting and of hydrography in the modern era, once Western governments engaged in their systematic prosecution. Just within the British tradition, for example, we find (auto)biographical memoirs (Ritchie 1992) and accounts of particular voyages and expeditions (Somerville 1928; Ritchie 1958), heavy on the tale-telling common to sailor's memoirs; detailed chronologies to serve as a "hydrographic reference" (Dawson 1883, esp. [iii]; Tizard 1900); and narrative history (Ritchie 1967). Such work has maintained a clear divide between the romantic pre-history of the modern chart (Blewitt 1957; Robinson 1962) and the more organized and scientific work of the post-1800 hydrographic surveys.

This general pursuit of internal institutional history extends to the modern concern for the history of international cooperation among geodesists. A number of articles in the professional literature have rehearsed the narrative of how a memorandum to the Prussian government by General Johann Jacob Baeyer (1794–1885) led to the formation first of the *mitteleuropäische Gradmessung* and then of the International Association of Geodesy (Baeyer 1861; see Buschmann 1994; Torge 2007, 213–40), and how that association has weathered the fraught history of international relations over the long course of the twentieth century. This literature is integral to the self-organization and perpetuation of an intellectual community of geodesists that is too rarified to be sustained at a national level (Tardi 1963; Levallois 1980; Torge 1993, 1996, 2005, 2012, 2015; Beutler et al. 2004; Drewes and Ádám 2016, 2019).

In the USA, the role of exploration in the country's westward expansion, combined with the fact that federal survey organizations—first the US Coast Survey and also the geological surveys of the post-Civil War era—were a major site of scientific activity for much of the nineteenth century, gave rise to a particular concern among US historians of science for the intersection of science and government, in which the surveys featured prominently. The connection was initially made by the historian of mathematics, Florian Cajori, via his interest in the work on the US Coast Survey by his follow Swiss emigré, Ferdinand Hassler (Cajori 1929; Cajori 1930), and expanded significantly after World War II (e.g., Dupree 1957; Manning 1967; Daniels 1972; Kevles 1978).

General Histories of Surveying

Modern geodesy has further encouraged general historical accounts of geodesy, both dynamic and geometrical. Some of the earlier accounts in this vein have taken a broad view of surveying and mapping, as in the general history of surveying in Germany by Wilhelm Jordan (1842–99) and Karl Steppes (1882)[*] and the history of surveying and terrestrial photogrammetry by Aimé Laussedat (1898).

[*] I have been quite unable, working from home through the internet, to find even birth and death dates for Karl Steppes.

Others have focused more specifically on geometric and dynamic geodesy, ranging from General George Perrier's *Petite histoire de la géodesie* (1939)* to a number of later twentieth-century accounts (e.g., Bachmann 1965; Levallois 1988; Danson 2006; Boccaletti 2019). The emphases in the latter have inevitably varied depending on their authors' particular interests, but there is a definite narrative common to all of them. Thematically, these works tend to emphasize three or four periods: first, the initial ancient Greek recognition that the earth is spherical and then Eratosthenes' determination of its size; second, the heroic work of the French in the eighteenth century to solve the issue of the earth's figure, whether flattened or elongated (e.g., Perrier 1908; Smith 1986); third, the development of the international trigonometrical networks, beginning with Friedrich Georg Wilhelm von Struve's great meridional arc from the Arctic to the Black Sea (1816–55) and then the *mitteleuropäische Gradmessung*; and, fourth, the more pronounced geophysical work of the modern era, especially with the rise of modern satellite measurements of gravity. There has also, as might be expected, something of a nationalistic flavor to these internal studies of geodesy, with the French emphasizing French work (Perrier 1908; Levallois 1988), the Germans German work (Galle 1924; Buschmann 1994; Torge 2007), and so on.

Beyond institutional and general histories, practicing and academic geodesists and surveyors have undertaken a variety of internal historical studies that have revolved, in various ways, around the progressive nature of surveying. Both general textbooks on surveying, beginning with works such as Ágoston Tóth's (1869)† manual of topography, with its historical introduction (see Papp-Váry 1983), and more especially on geodesy (e.g., Smith 1997, 1–26; Torge 2017) contain brief summary histories of their subject matter that emphasize their development and essential function within modern society. As with the historical introductions in cartographic textbooks, discussed in detail below, these accounts have served to position the student at the forefront of a progressive science where they are poised to make their own contributions to an ongoing, forward-looking communal endeavor. None have adopted a sociocultural perspective to consider the ways in which surveying is a major constituent in creating and sustaining capitalism and modern states (Rose-Redwood 2004).

More precise historical studies have addressed issues of particular importance to each community of surveyors. A useful guide to the kinds of these issues is the listing of historical presentations to the congresses and working weeks of the International Federation of Surveyors (FIG) in 1985–2009, in a 2010 report on the activities of the federation's permanent institution, the International Institution for the History of Surveying and Measurement (IIHSM). This review reveals persistent interests in remarkable individuals and their surveys, the evolution of geometry and mathematics and their application to surveying techniques, and the evolution and progressive improvement of surveying

* On [Anton François Jacques Justin] Georges Perrier (1872–1946), see Tardi (1946).

† Ágoston Rafael Tóth (1812–89) was an Hungarian military engineer. He fought in the unsuccessful revolution, 1848–49, and was jailed until the 1856 amnesty; after the reinstatement of civilian government (1867), he founded the topographic department of the Ministry of Public Works and Transport (predecessor of the Honvéd Mapping Institute).

instruments (Graeve and Smith 2010, esp. 8, 28–31). The emphasis in all this work is on the taking of angular and linear measurements across the earth, and on their combination within organized surveys. The drafting of the maps is of much less importance, being generally understood as an algorithmic reduction of those measurements to paper.

The choice of subject matter by internal historians of surveying is generally related to their particular experiences and concerns. British surveyors have long paid homage to the Ordnance Survey, yet with little interest in the history of the property and engineering mapping, save for a history of the Royal Institute of Chartered Surveyors (Thompson 1968). By contrast, the historically recent process of property creation in the colonies settled by the British has sustained a persistent interest among local surveyors in the work and instruments of their predecessors during the colonial era and independence. In the USA, for example, land surveyors have been especially interested in the origins and practices in particular states (Uzes 1977; Hughes 1979) of the rectangular surveys of the General Land Office (see White 1983; Minnick 1985).

Finally, a persistent interest for geodesists has been in evaluating old geodetic surveys. The heart of each investigation is the recalculation of an historical survey, much as geodesists have routinely carried out when absorbing an older survey into a new triangulation, as Cassini (1720) had done when working with Picard's original survey of part of the Paris meridian. But now, looking back on surveys undertaken with instrumentation and techniques quite different from those of the later twentieth century, some geodesists have undertaken intellectual exercises to answer the question, just how good were those old surveys? To this end, they have recalculated old surveys using the modern statistical technique of least-squares analysis. Prominent examples include N. D. Haasbroek's (1968, 1972, 1974) studies of the triangulations undertaken in the Netherlands, James Smith's (1986) general reassessment of early modern geodetic surveys through 1750, and more subtle reconstructions of triangulations by early surveyors (e.g., Leenders and Graeve 2012).

The interest of historians of mathematics has extended, on occasion, to histories of lesser, more common kinds of surveying. The two classic English-language texts on early modern surveying were both written by US professors of mathematics, Edmond Kiely (1900–88) and A. W. Richeson (1897–1966) (Kiely 1947; Richeson 1966). Both works read as a history of published manuals and instrumentation, and in this respect merge with the interests of historians of technology, navigation, and of the early modern "mathematical practitioners" who sought to apply geometry to all aspects of life. There are several chapters on maps and navigation in Charles Singer's multivolume *History of Technology* (in vol. 3, Singer et al. 1957; and Taylor 1957; vol. 4, Skelton 1958; vol. 5, Fryer 1958), and there has been a consistent internalist concern with the astronomical and horological question of the determination of longitude at sea (e.g., Marguet 1917; Chapin 1952; Howse 1980). By far the largest body of work in these regards is that of the distinct community of historians of technology and museum curators concerned with preserving scientific instruments, such as Maurice Daumas (1953), J. A. Bennett (Bennett and Brown 1982; Bennett 1987), and Silvio Bedini (1975, 1986 [1966], 2001), and also instrument manufacturers, notably Charles Smart (1962; see Skerritt 1996).

Overall, the internal pursuit of the history of geodesy and surveying has established an apparently single, universal process of the observation and measurement of the earth and its features practiced from ancient Greek and Hellenistic antiquity to the present. Over time, knowledge of the earth, its shape, and its features have been determined with ever greater precision and accuracy. The changing intellectual foundations of surveying—the reconceptualization of the earth from a plane to a sphere to a regular spheroid to an irregular geoid—make manifest the rise and achievements of Western civilization. Surveying itself is presented as a tool of civilization, a technology necessary if states and marketplaces are to develop any degree of complexity and sophistication. Thus, the title page to the FIG-IIHSM application to UNESCO to grant world heritage status to the entire Struve arc featured a vignette from the title page of Aaron Rathborne's *The Surveyor* (1616), explicitly construing early modern property mapping to have been the lineal precursor to nineteenth-century high geodesy (Ratia et al. 2004, 2) (see image in the blog roll). From this perspective, all surveying activities are simply manifestations of a Platonic ideal of measurement, destined to get ever closer to perfection.

Such a progressivist and presentist perspective perhaps makes inevitable an historical awareness. As the geographer and map maker Clements Markham (1830–1916) opined early in the twentieth century:

> The foundation and basis of geography is the work of surveying and of map-making. Such work is attractive, because a great part of it must be done in the field, and because it carries us back in imagination to its gradual development, and to thoughts of what we owe to those who have gone before us. While we are working with theodolites and sextants exquisitely graduated by machinery, our thoughts ought to go back to the great men of old who turned out work almost as good as ours without those aids. Our curiosity should be aroused, and we should seek to know with what means they achieved their successes, and in what way their appliances were developed and improved until we became the inheritors of their labours and discoveries. (Markham 1905, 594)

These sentiments apply for much of the nineteenth and twentieth century, when surveyors continued to use refined versions of instruments long used by surveyors and geodesists.

But what happens when radically new instrumentation is introduced? Anecdotal evidence suggests that there has been a decline in interest among current practitioners in older instrumentation with the widespread adoption of digital-based technologies after 1980. First, laser-equipped "total stations" reduced the once elaborate protocols for using different survey equipment to an almost point-and-click level of simplicity, then of high-precision GPS (global positioning systems), and still more recently of sophisticated drones. In particular, several US dealers in surveying and other mathematical instruments have indicated to me, since the turn of the last century, that the demand for old instruments has declined significantly as surveyors have less and less experience with the older kinds of instrumentation, with theodolites and levels, with chains and tapes, with barometers and plane tables.* Even so, if geodesists' recent historical work is indeed representative of the larger communities of land surveyors, internal interest in other aspects of surveying history seems not to have substantially abated with the rise of digital technologies. Surveyors' professional needs to relate their own work to previous surveys has required them all to maintain an interest in the institutions, quality, and techniques of their predecessors.

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* Plane tables and chains were already thoroughly antiquated when I was taught their use in 1980–81 as a highly effective way to instill the basic geometries of field surveying in the student.

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