



# The second engraver of the library of congress mystery map

A. Terry Bahill 

Systems and Industrial Engineering, University of Arizona

## ABSTRACT

The Library of Congress has a map that they credit to Gerald Mercator and André Thevet with a creation date of 1569. Visual inspection suggests that this map had two engravers. One was the original cartographer who engraved the whole map placing toponyms where appropriate. Later, the second engraver added about five dozen toponyms. This paper identifies these two engravers and suggests the dates in which they did their work.

## RÉSUMÉ

La Bibliothèque du Congrès possède une carte qui est attribuée à Gerald Mercator et André Thevet avec une date de création de 1569. Une analyse visuelle suggère que cette carte a eu deux graveurs. Le premier était le cartographe original qui a gravé la carte entière en plaçant des toponymes si nécessaire. Ultérieurement, le deuxième graveur a ajouté environ cinq douzaines de toponymes. Cet article identifie ces deux graveurs et propose les dates durant lesquelles ils ont réalisé leur travail.

## ARTICLE HISTORY

Received 12 May 2021  
Accepted 28 September 2021

## KEYWORDS

Tradeoff study; sixteenth-century; nautical maps; systems engineering; modeling

## 1 . Introduction

The Library of Congress (LoC) has a unique map that they credit to Gerald Mercator and André Thevet with a guesstimated creation date of 1569 (<https://www.loc.gov/resource/g5200.ct006058/>). It is shown in [figure 1](#). We have not seen this figure elsewhere. TinEye<sup>1</sup> (<https://tineye.com/>) has only seen it reproduced on tee-shirts, coffee mugs, art prints, etc. We call it the LoC Mystery Map.

This map seems to have had two engravers. One was the cartographer and he engraved (or hired someone to engrave) most of the map. The second engraver added about five dozen islands and other toponyms. Philip D. Burden ([enquiries@caburden.com](mailto:enquiries@caburden.com)), an English map dealer and author, with the assistance of James Flatness of the Library of Congress, examined this map in 1994. Burden wrote that this map had two states because many toponyms in the oceans seemed to be engraved by a different person than those on the land.<sup>2</sup> The letters on the land were graceful, closely spaced, and often connected. The first engraver engraved the whole map placing toponyms where appropriate. Then he filled in the blank spaces in the oceans with small dashes (looking like tear-drops), leaving blank spaces behind his toponyms.<sup>3</sup> Later, a second engraver added toponyms. His letters were heavier, larger, and less graceful: their lines were thicker and there



**Figure 1.** This Library of Congress (LoC) Mystery Map is located at <https://www.loc.gov/resource/g5200.ct006058/>. This paper investigates the creators and the dates of this map.

were spaces between some letters. But most importantly, his labels were carved on top of the dashes in the oceans. Look particularly at the y<sup>a</sup> de sally, S. Felicis, and S. Nabor islands just east of the compass rose in figure 1. The letters of y<sup>a</sup> de sally are graceful and have no dashes behind them. Whereas the letters of S. Felicis and S. Nabor are heavy, clumsy, and are engraved on top of (indicating after) the small dashes filling the oceans. On this and all Renaissance world maps, small islands were deliberately exaggerated in size. Otherwise, you would not be able to see them.

Burden's assessment was that the first state of this map was made in 1569 by Gerard Mercator: his handwriting is similar to that on the map in both the toponyms and the large fancy script font of the ocean labels such as 'Mare Magellanicum sive Pacificum.' The LoC Mystery Map in the possession of the Library of Congress is the second state, modified most assuredly after 1579 by a different engraver, not Mercator or Thevet.

In the first part of this paper, we estimate the date of the first state of this map. Then we consider its authorship. In doing so, we only considered the maps themselves, not historical texts, religion, nationality, family relationships, friendships, geographical location, professional feuds, modern speculation, etc. Harris (2004) provides such historical information.

The personal pronoun 'we' is used in this paper because this study is based on a tradeoff assessment involving many cartographic and system engineering experts.

Incipient assumptions:

1. The LoC Mystery Map is not a hoax.
2. LoC Mystery Map was printed from an engraved copper plate.
3. The LoC Mystery Map is one section of a large wall map.
4. Features on a map often appear on other maps created by the same cartographer/engraver.
5. Usually, the cartographer was also the engraver.
6. This map was made by a currently known sixteenth-century cartographer/engraver.
7. When a cartographer is mentioned by name this includes others who helped him, such as apprentices, engravers, printers, and publishers.
8. Sixteenth-century cartographers usually copied from previous maps.
9. Maps presented in this paper were available to other sixteenth-century cartographers.
10. Communication between cartographers was through the public dissemination of maps. This is a weak assumption. Ortelius had a friendship network that extended throughout Europe. He used it to give away fancy copies of his atlas to influential patrons. Although this was expensive it enhanced the popularity of his atlas.

### 1.1. Determining the map's date

Determining the correct author and date of sixteenth-century maps is difficult. First, few of the maps were signed and dated by the cartographer/engravers, in contrast to Portolan charts. The title on the map was not very useful because, for example, Ortelius used the same title, *Typus Orbis Terrarum*, on dozens of versions of his maps.

Dating sixteenth-century maps was challenging. Which date should we use? The date when the plates were engraved? The date when the first edition was printed? The date when the map was printed? The date when the map was published? The date printed on the map? The date when the atlas containing it was published? The date given by the art dealer trying to sell the map? The date derived by the librarian/cataloger possessing the map? Furthermore, consider that Ortelius's *Typus Orbis Terrarum* had three editions or plates with 5, 3, and 2 states, respectively, published in six languages. In addition, the date 1587 was written on all of his *Typus Orbis Terrarum* maps published between 1592 and 1612! Translations of an atlas produced more confusion. In one



example, a *Theatrum Orbis Terrarum* in Latin was dated 1584 but its translation into French was dated 1587.<sup>4</sup>

These were our preferred methods for selecting the date of the map, in decreasing order of preference: (1) if the map is in our database, then we used the year ascribed to it by the owner of the URL giving its location, (2) the date when the *atlas* containing it was published (in the original language, usually Latin), (3) the date when the *map itself* was said to have been published, (4) the date written on the map and (5) a combination of forensic techniques, as described next.

The date of the LoC Mystery Map is particularly puzzling. Its Equator was divided into equal intervals, which first occurred in 1519 (Gaspar, 2021) and the lettering is in an Italic font that only became popular in the 1540s.<sup>5</sup> Charts and maps of this era were (1) drawn with ink on vellum<sup>6</sup> or parchment, (2) carved on woodblocks, or (3) engraved on copper plates (Woodward, 2007). But these craftsmen would emulate common fonts then being used for printing. So the shapes of these Italic letters suggest a date for the LoC Mystery Map after 1540. Because this map has the bulge on the southwest coast of Chile, we should date it between 1561 and around 1588. However, it does not have a latitude scale and this could place it in the first half of the sixteenth century. But the map possessed by the Library of Congress is probably just one of perhaps up to eight panels of one big map and the latitude scales could have been on the sides of the total map. If there were one equally-sized panel to the right and one and a half to the left, that would place the south label (MERIDIES) in the center of the whole map, as would be expected. The snake-like representation of the Amazon River puts its creation date between 1544 and around 1600. The map contains the Galapagos Islands and they did not appear on maps until 1569. The map contains the islands S. Felicis and S. Nabor. These islands were not identified until 1579 by Spanish mariners. The sea monster and its descriptive text were copied onto the map of De Jode 1593. Therefore, the first state of the LoC Mystery Map must have been made before 1593 (unless of course if the cartographer/engraver of the first state of the LoC Mystery Map copied the sea monster from the De Jode 1593 map!). Therefore, we think it is safe to surmise that the first state of this map was made before 1588.

If we imagine the map of figure 1 being slightly folded about the centerline of the cartouche with the light source coming from the left and slightly elevated, then we will consistently get the light (illuminated) and dark (shadow) regions on this cartouche. Further distinguishing it, this cartouche seems to be composed of metal machined mechanical three-dimensional parts, not wood carvings, rolled scrolls, and fleurs. This might suggest a late sixteenth-century origin.

Therefore, these eight clues imply that this map was made between 1569 and 1588.

## 1.2. The second assessment of burden

In Burden's second assessment of the LoC Mystery Map (Burden, 1996, pp. 60–61), he opined that the original map was made by Gerard de Jode in 1576 and that the additions were made later, possibly around 1595 by an unknown engraver.

Presently, the one section of this map shown in figure 1 (which is 1 m wide and 1.4 m high) is the only section in existence. From this one section, it is easy to hypothesize that this was one of eight sections of a large wall map. It would have had a fancy border three degrees of longitude wide around all four sides. Burden cites an inventory that may have

been for this map that lists six whole plates and two half plates. These could have been arranged in two rows of four sections each. If there were one and a half sections to the left of our map ([figure 1](#)) and one section to the right, then the label 'Meridies' would have been in the center of the whole map, as expected. With this arrangement, the full map would have covered from the Canary Islands in the East to the Solomon Islands in the West, from the Straights of Magellan in the South to Iceland in the North.

Let us compare some features on this map to those on the Mercator 1569 map and the Ortelius 1571 *Americae Sive* map. The Equator crosses the west coast of Peru at 294° of map longitude on this LoC Mystery Map, at 293° on the Mercator 1569 map and at 293° on the Ortelius 1571 map. The Galapagos Islands are at 277° of map longitude on this LoC Mystery Map, at 279° on the Mercator 1569 map and at 278° on the Ortelius 1571 map. Using these, and a few other points, we conclude that the zero-longitude meridian passes through the Cape Verde Islands at 24° W on all three of these maps.

Therefore, Burden's revised opinion of this LoC Mystery Map might affect our opinion about the creator of this map but it has not changed our opinion about its creation date: between 1569 and 1588.

## 2. Methods, a tradeoff study

Now we want to consider who created this map. When choosing amongst alternatives, where there are many criteria to consider at the same time, it is best to do a tradeoff study (Bahill & Madni, 2017; Giuliani et al., 2018). Tradeoff studies are a subset of multi-criterion decision-making (MCDM) techniques. First, we will describe the alternative candidates for the cartographer/engraver of the LoC Mystery Map. Then we will slowly develop the criteria that we used to determine the most likely candidates. The leading candidates are listed in [Table 1](#).

In identifying the LoC Mystery Map, the Library of Congress (LoC) evidently did an informal tradeoff study. They must have thought that Mercator was a prime candidate because the handwriting in the cartouche looked like his. In addition, they must have thought that Thevet might have been involved because (1) his name was in the cartouche, (2) he had drawn a sea monster like that on the map, and (3) several times he had drawn sloths like that on the map. We are now going to expand on their informal tradeoff study and do a formal tradeoff study.

## 3. Results, the original cartographer

As stated in the introduction, Burden's assessment was that the first state of this map was cartographed and engraved by the same person sometime between 1569 and 1573. The second state was created at a later date by a different engraver. In this section, we will only consider the first state of this map. Therefore, in this section, we will ignore the five dozen toponyms added by the second engraver.

### 3.1. Evaluation criteria

Let us now look at some criteria that might help identify the cartographer/engraver of the first state of the LoC Mystery Map. We assume that features on a map would appear on

**Table 1.** Alternative candidates for the cartographer/engraver of the LoC Mystery Map.

Cartographer/map	Year	Zero-longitude meridian	Has a bulge on the southwest coast of Chile?	Represents the Amazon River with a giant snake?
An 'x' in a cell means that there is not enough data to determine that item.				
Piri Reis	1513			No
Johannes Werner	1514	x	x	x
Peter Apian	1520	24° W	No	No
Bernard Wapowski	1526	x	x	x
Oronce Fine	1536	15° W	No	No
Gemma Frisius	1544	x	No	No
Sebastian Cabot	1544	x	No	Yes
Antonio Pereira	1545	x	No	Yes
Johannes Honter	1546	x	No	No
Guillaume Le Testu	1556	x	No	No
Girolamo Ruscelli	1561	22° W	Yes	No
Diego Gutiérrez & Hieronymus Cock	1562	14.5° W, Fuerteventura, Canary Islands	No	Yes
Abraham Ortelius	1564	16.5° W, Madeira, Tenerife	No	Yes
Gerard Mercator	1569*	24° W, Cape Verde Islands and the Azores	Yes	Yes
Abraham Ortelius, <i>Americae Sive</i>	1570, 1574, 1587	24° W, Cape Verdes and Azores	Yes	Yes
LoC Mystery Map		24° W, Cape Verde Islands and Azores, estimated	Yes	Yes
Domingos Teixeira		x	No	Yes
André Thevet	1573		Yes	No
Francois de Belleforest	1575	27° W, Terciera, Azores,		
Gerard de Jode	1575	x	x	x
Giovanni Massa	1580		No	Yes
Rumold Mercator	1587*	14.5° W, Fuerteventura, Canary Islands	No	Yes
Abraham Ortelius, <i>Americae Sive</i>	1588	23° W, Maio, Boa Vista and Sal	No	Yes
Cornelius de Jode	1589	23° W, Maio, Boa Vista and Sal	Yes	Yes
Petrus Plancius	1592	24° W, Cape Verdes and Azores	No	Yes
Theodor de Bry	1592	25° W, Santa Maria, Azores	Yes	Yes
Cornelius de Jode	1593, 1596	25° W, Santa Maria, Azores	No	Yes
Michael Mercator	1595*	x	1592 Yes, 1596 No	Yes
Arnold van Langren	1596	23° W, Maio, Boa Vista and Sal	No	No
Jodocus Hondius	1596	21° W, Cape Verdes and Canaries	Yes	Yes
Jon Baptist Vrients	1596	21° W, average	No	Yes
João Lavanha & Luis Teixeira.	1597	20.5° W	No	Yes
Van Wylliet & Magini	1597	25° W	No	Yes
William Barentsz	1597	x	x	x
Edward Wright & Emery Molyneux	1599	x	x	x
	1599/1600	23° W, Maio, Boa Vista, and Sal, in the Cape Verdes	No	Yes

\*The 1569 Mercator projection map was made by Gerald Mercator. The 1587 and 1595 maps were republished respectively by his son Rumold and his grandson Michael.

other maps created by the same cartographer/engraver. *This is an important assumption.* Some of these features are voluntary like the sloth and the sea monster and some are inherent like handwriting. Additionally, we must be careful to distinguish between cartographers who may have created the LoC Mystery Map and those who might have copied from it.

Each evaluation criterion is given a *weight of importance* based on the Decision Maker's preferences. These weights range from 0 to 10, with 10 being the most important.

Each alternative has a score for each evaluation criterion. Scores are based on expert judgments. They are subjective. It is very rare to have citations or references in evaluations of a tradeoff study (Bahill & Madni, 2017).

### 3.1.1. The Slow sloth

There is a drawing of a sloth just below the Equator on the right side of the LoC Mystery Map (Figure 1). This drawing is characteristic of André Thevet. A similar drawing of a sloth (called Haüti, Haut, or Haute) appeared in *Icones Animalium* (Gesner, 1553). It was credited to Thevet. Thevet's 1575 atlas *La Cosmographie Univeselle* has several different drawings of sloths. The description next to this sloth reads (our translation) 'This beast, called Haute, consumes neither food nor water but is fed by the wind.' Sloths are nocturnal and they move *very* slowly, so Thevet probably had never seen them eat or drink. This and similar drawings and descriptions were used many times by Thevet in his atlas of 1575.

In a tradeoff study, all criteria have a question and a grading scale. This is the question we asked for the Slow-Sloth criterion, 'Does this map have a drawing of a sloth similar to that on the LoC Mystery Map?' This is the grading scale that we used for the Slow-Sloth evaluation criterion:

- Plus two points if the map has a mammal,
- Plus four more points if the animal looks like the sloth of Thevet 1575.
- Plus four more points for a similar descriptive text.

The following maps have drawings of sloths, as shown in Figure 2:

- Thevet 1575, *Le Nouveay Monde Descuvert*,
- Plancius 1592, *Haec pars Peruviana, regiones Chicam & Chile ...*,
- De Jode 1593, *Brasilia et Peruvia Not the 1593 Hemispheriu Ab Aequinociali*, and
- Van Langren 1596, *Delineatio omnium orarum totius Australis partis Americae*.

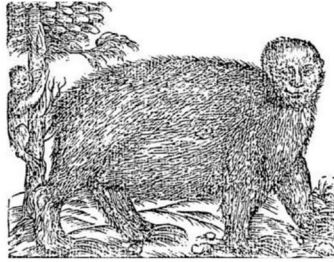
Our best candidates for the drawing of the sloth are Thevet, Plancius, De Jode, and Van Langren.

Each evaluation criterion has a weight of importance that is based on the preferences of the decision-makers of the tradeoff study. These weights range from 0 to 10, with 10 being the most important. These weights change with time as the tradeoff study progresses. These weights will be discussed further as this paper develops.

The weight of importance for the Slow-Sloth evaluation criterion is 10. It is the most important evaluation criterion.



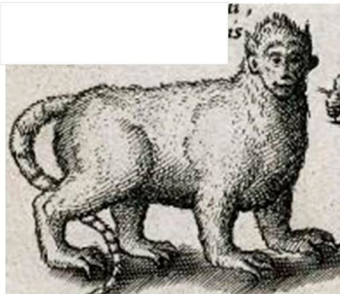
LoC Mystery Map



Thevet 1558

Piri Reis 1513  
Sami

De Jode 1593



Plancius 1592

Mercator 1569  
Opossum

Van Langren 1596

**Figure 2.** Drawings of animals from sixteenth-century maps. (These drawings are not realistic because a sloth does not stand upright. When crawling across the ground, his belly drags on the ground. They weigh between ten and twenty pounds).

### 3.1.2. Group of patagonians

Just below the sloth in [Figure 1](#), there is a group of Patagonians. We have not seen this particular group elsewhere, nor has TinEye (<https://tineye.com/>).

This is the question we asked for the Group of Patagonians evaluation criterion, 'Does this map have a drawing of a group of Patagonians similar to that on the LoC Mystery Map?' This is the grading scale that we used for the Group of Patagonians evaluation criterion:

- Plus two points if the map has a group of two to five people near the bottom of South America,
- Plus six more points if their stature, dress, and accessories (e. g. bow and arrows) are like those of the LoC Mystery Map,
- Plus two more points if there is a similar descriptive text.

The following cartographer/maps have a group of Patagonians:

- Cabot 1544, Mappemunde / par Sébastien Cabot en guise de titre,
- Gutiérrez & Cock 1562, Americae Sive Quartae Orbis Partis Nova et Exactissima Descript,



- Mercator 1569, *Nova et Aucta Orbis Terrae descriptio ad Usus Navigantium ...*,
- Plancius 1592, *Haec pars Peruviana, regiones Chicam & Chile ...*, and
- C. De Jode 1593. *Brasilia et Peruvia Not the 1593 Hemispheriu Ab Aequinoctiali*.

The group of Patagonians at the south end of South America in Figure 1 is most similar to that on De Jode 1593 and Gutiérrez & Cock 1562 maps.

The weight of importance for the Group of Patagonians evaluation criterion is 9.

### 3.1.3. Coyote-platypus sea monster

The sea monster below the compass rose is unique. For one thing, it is completely above water. Also, it has a coyote-like head and platypus-like feet.

This is the question we asked for the Sea-Monster evaluation criterion, 'Does this map have a drawing of a sea monster similar to that on the LoC Mystery Map?' This is the grading scale that we used for the Sea-Monster evaluation criterion:

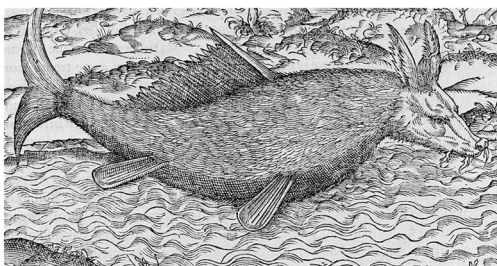
- Plus two points if the map has a similar sea monster,
- Plus four more points if it is the same sea monster,
- Plus four more points if it has a similar descriptive text.

Figure 3 has candidate sea monsters from the following cartographers/maps:

- Mercator 1569, *Nova et Aucta Orbis Terrae descriptio ad Usus Navigantium ...*,
- Ortelius 1570, the URL for this sea pig is missing,



LoC Mystery Map



Thevet 1575



Mercator 1569



De Jode 1593



Ortelius 1570

**Figure 3.** Coyote-platypus sea monsters on sixteenth-century maps.

- Thevet 1575, *Le Nouveay Monde Descuvert*, and
- C. De Jode 1593, *Brasilia et Peruvia*.

The sea monster of Ortelius is *not* a good candidate: its feet, ears, and snout are the wrong shapes: it looks like a sea pig. The sea monster of Mercator is indistinct and only one ear is visible. De Jode not only has the sea monster, but he also has the same descriptive text. The best candidates for drawing the sea monster are Thevet and De Jode or someone in their groups. This statement applies to all of our conclusions, when we give the name of the cartographer we are not excluding many others who helped him, such as apprentices, engravers, printers, and publishers.

The weight of importance for the Coyote-platypus Sea monster evaluation criterion is 10. It is important.

### 3.1.4. *Compass rose*

Compass roses appeared on maps made between AD 1300 and 1600. Compass roses with their interconnecting rhumb lines formed the framework for Portolan charts of the fourteenth, fifteenth, and sixteenth centuries. With the addition of parallels of latitude and meridians of longitude in the sixteenth century, the network of rhumb lines gradually disappeared. The compass roses then assumed simpler roles.

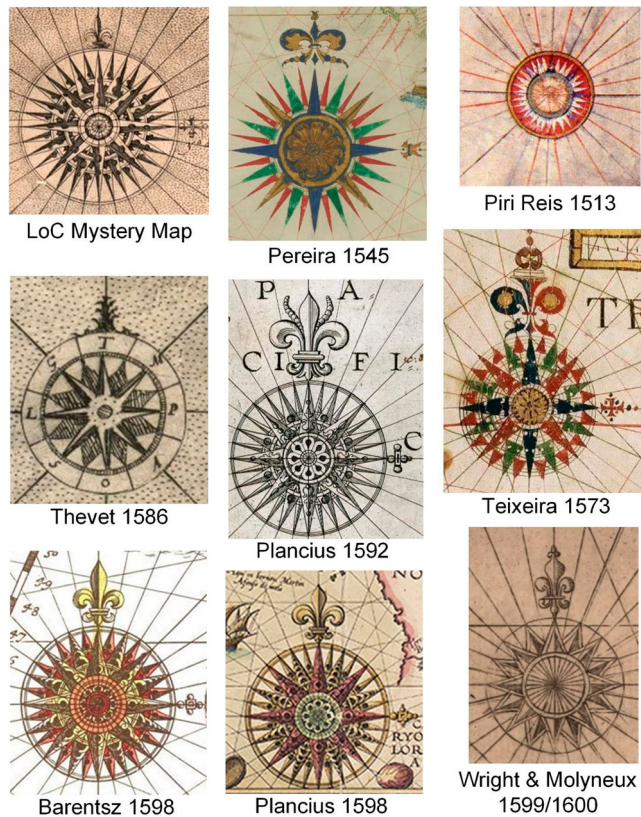
The LoC Mystery Map compass rose of [figures 1 and 4](#) has 32 pointers as on most sixteenth-century maps. It has a fleur de lies indicating north *and also* a symbol indicating east: this is unusual. Multiple direction indicators were common in the fourteenth and fifteenth centuries, but not in the sixteenth after latitude and longitude scales were adopted.

All criteria have a question and a grading scale. This is the question we asked for the Compass-Rose evaluation criterion, 'How similar is the compass rose on this map to that on the LoC Mystery Map?' This is the grading scale that we used for the Compass-Rose criterion.

- Plus two points if the compass rose on this map has 32 compass pointers,
- Plus two more points if the compass rose has a fleur de lies indicating north,
- Plus two more points if the compass rose has a symbol indicating east,
- Plus two more points if each compass pointer reaches the edge of the surrounding circle and continues with a rhumb line,
- Plus two more points if the pointers indicating the eight-principle directions (called winds) are the longest, the pointers indicating the eight half-winds (directions) are middle-sized and the pointers indicating the sixteen quarter-winds are the shortest.

The following maps have compass roses similar to the LoC Mystery Map as shown in [Figure 4](#):

- Pereira 1545, *Early representation of Newfoundland, Lower California, the Amazon ...*,
- D. Teixeira 1573, *World map*,
- Plancius 1592, *Haec pars Peruviana, regiones Chicam & Chile ...*,
- Barentsz 1598, *Deliniatio Cartae Trium Navigationum per Batavos ...*, and
- Wright & Molyneux 1599/1600, *By the discoverie of Sr Francis Drake made in the yeare 1577 ...*,



**Figure 4.** Some compass roses on sixteenth-century maps.

and many others, but not L. Homan 1554, Mercator 1569, Ortelius 1570, Martines 1582, or De Jode 1593.

The compass rose of the LoC Mystery Map is matched best by Teixeira 1573, Plancius 1592, and Barentsz 1598. But not Thevet 1586, which has no East indicator and only 16 pointers.

The weight of importance for the Compass-Rose evaluation criterion is 7.

### 3.1.5. Galapagos Islands

The Galapagos Islands (Insulae de los Galopegos) were discovered in 1535 (Jackson, 1993). However, the first maps we have seen with them labeled are Ortelius 1570 (both *Typus Orbis Terrarum* and *Americae sive*) and Mercator 1569.

This is the question we asked for the Galapagos-Islands evaluation criterion, 'How similar are the Galapagos Islands in shape and location on this map compared to that on the LoC Mystery Map?' This is the grading scale that we used for the Galapagos-Islands criterion:

- For maps made after 1569,
  - Plus nine points for having the Galapagos Islands in about their actual location (Table 2).

- Plus one more point for having I. de Cocos, or y<sup>a</sup> de los pegas, or y<sup>a</sup> de los galapagos nearby to the northeast.
- For maps made before 1569
  - The average value of all the other alternatives.

The following maps placed the Galapagos Islands in about the correct location:

- Mercator 1569, *Nova et Aucta Orbis Terrae descriptio ad Usum Navigantium ...*,
- Ortelius 1570, *Typus Orbis Terrarum*,
- De Bry 1593, *Americae pars magis cognita*,
- Plancius 1594, *Orbis\_Terrarum Typus de ...*, and
- Vrients 1596, *Orbis terrae compendiosa descriptio ex peritissimorum ...*,

and many others, but not Gutiérrez & Cock, Gastaldi, Forlani, Bertelli, Thevet, Van Langren, Wright & Molyneux, or Hondius.

The weight of importance for the Galapagos Islands evaluation criterion is 5.

### 3.1.6. Bulge on the southwest coast of Chile

In 1561, something radical happened: Girolamo Ruscelli in his *Orbis Descriptio* map put a big bulge on the southwest coast of Chile. See [figure 1](#). In 1569-70, Abraham Ortelius and Gerard Mercator followed suit with the same bulge on the southwest coast of Chile.

In 1570, Ortelius published his atlas *Theatrum Orbis Terrarum* with revisions just about every year thereafter. They all had this big bulge until 1588 when he removed it from *Typus Orbis Terrarum* P2S3. He also removed it from *Americae sive* in 1587. He never included it on *Maris Pacifici*, which was first published in 1589. Most cartographers followed suit in removing the bulge. A few stragglers had this bulge later, including M. Mercator 1595.

This is the question we asked for the Bulge on the Southwest Coast of Chile evaluation criterion, 'How similar is the bulge on the southwest coast of Chile in shape and location on this map compared to that on the LoC Mystery Map?' This is the grading scale that we used for the Bulge on the Southwest Coast of Chile criterion:

- For maps made between 1561 and 1588,
  - Plus ten points for having the bulge on the southwest coast of Chile,
- For maps made after 1588

**Table 2.** Position of the Galapagos Islands.

Cartographer/map	Date	Coordinates of Galapagos Islands corrected for the location of the zero- longitude meridian
Actual	2021	(0.8° S, 91° W)
Gerard Mercator	1569	(1° N, 105° W)
Abraham Ortelius	1570	(1.4° N, 105° W)
LoC Mystery Map		(0.7° N, 97° W)
Cornelius de Jode	1589	(1.8° N, 109° W)
Theodor de Bry	1593	(1.2° N, 104° W)
Petrus Plancius	1594	(1.8° N, 106° W)
Jon Baptist Vrients	1596	(1.5° N, 102° W)



- Plus ten points for having removed the bulge on the southwest coast of Chile,
- Plus four points for still having the bulge on the southwest coast of Chile,

The final weight of importance for the Bulge on the Southwest Coast of Chile evaluation criterion is 8.

### ***3.1.7. Snake-like representation of the amazon river***

Chronologically, the first maps that we found with the Amazon River represented prominently are the maps of Antonio Pereira and Sebastian Cabot, which were made around AD 1544–45 (Cortesao, 1939). On them, the Amazon River is shaped like a giant snake with its tail in the Andes Mountains and its head in the Atlantic Ocean. In the next twenty years, more maps with this snake-like shape were published. In 1564 Abraham Ortelius represented his Amazon river this way. Another dozen map makers followed his lead. The map of [figure 5](#) shows this snake-like shape for the Amazon River (Bahill & Gitzen, 2021).

The LoC Mystery Map is missing the eastern part of Brazil, so we cannot numerically evaluate its snake-like representation of the Amazon River, but we do note that its western part has a bigger slope than the other models.

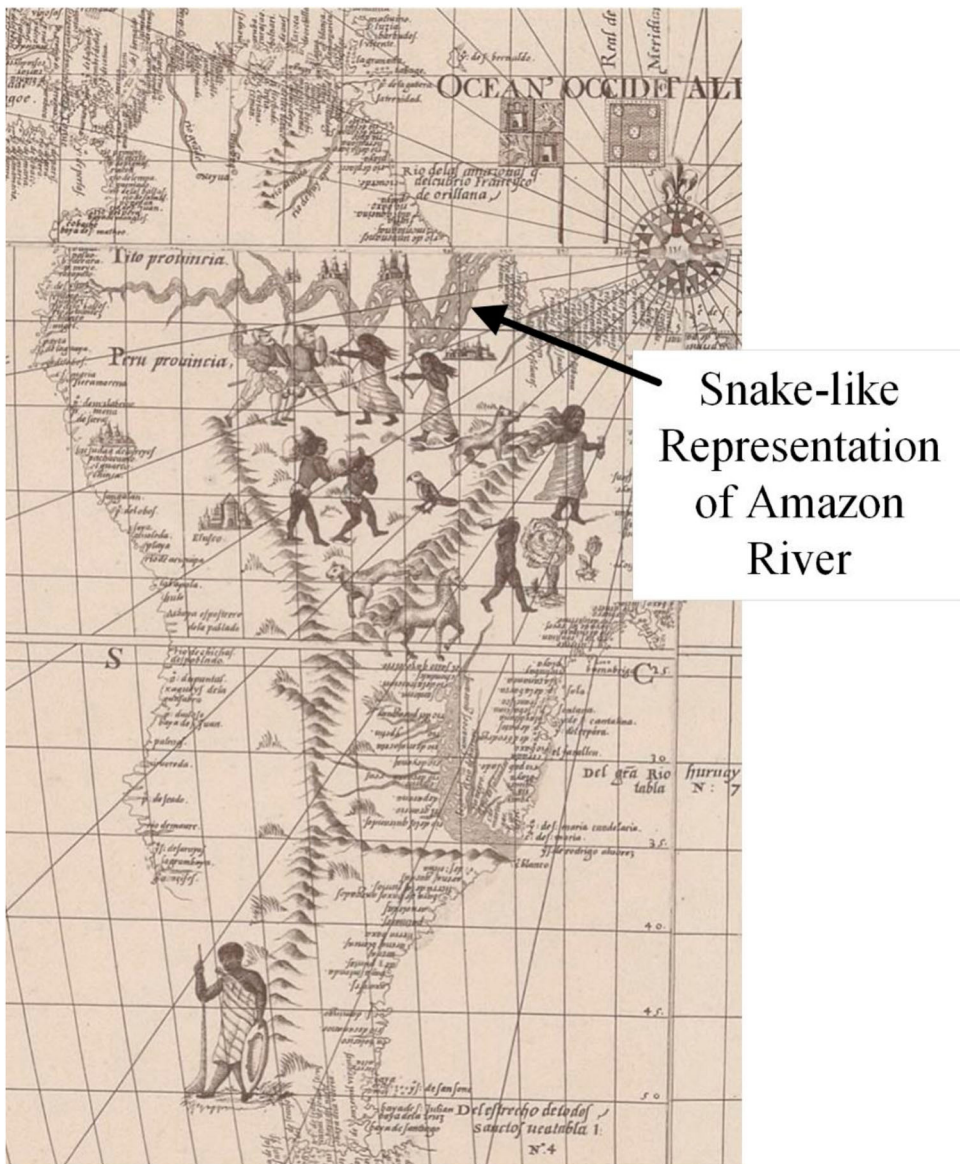
We found more than two dozen maps with this snake-like representation for the Amazon River (Bahill & Gitzen, 2021). Cabot was the first to label it 'Río de las amazona.' So he probably created the name. This name was then used by Gutiérrez & Cock 1562 and most followers. For Ricci 1602<sup>7</sup>, the map is in Chinese and the name next to the Amazon River (馬良溫河) sounds like its tributary (Rio Marañón).

Other mapmakers like Forlani 1565, Bertelli 1568, and Domingo Teixeira 1573 had wiggly lines representing the Amazon River. But their wiggly lines have different amplitudes, periods, number of cycles, and most importantly directions. Visually they are totally different.

The snake-like representation of the Amazon River was on most mainstream maps published between 1544 and 1602. The giant snake first appeared on the maps of Cabot and Pereira 1544–45. The snake gradually disappeared after 1600, after more people explored the Amazon River. In the seventeenth century, it was replaced by more accurate representations of the Amazon River. We have seen only a dozen maps that were published after 1602 that had a snake-like shape for the Amazon River (California as an Island, 2011).

This is the question we asked for the Snake-like Representation of the Amazon River evaluation criterion, 'How similar is the snake-like representation of the Amazon River in shape, number of cycles, distance from the Andes to the Atlantic, average period of the river, and the average amplitude of the waveform on this map compared to our mathematical model?' This is the grading scale that we used for the Snake-like Representation of the Amazon River criterion:

- Plus two points for a horizontal snake-like representation of the Amazon River,
- Plus two more points for between 5.5 and 7.5 cycles from the source to the ocean,
- Plus two more points for an average distance from the Andes to the Atlantic between 2000 and 2500 miles, (Distances were computed assuming the distance between the Equator and the Tropic of Capricorn to be 23.44° or 1621 statute miles.)
- Plus two more points for an average period between 230 and 350 miles, and
- Plus two more points for an average amplitude between 150 and 300 miles.



**Figure 5.** A portion of the map of Sebastian Cabot 1544. The mouth of the Amazon River is about 170 miles west of its actual geographical position. However, it is right on the Equator, as in reality.

The weight of importance for the Snake-like Representation of the Amazon River evaluation criterion is 7.

### 3.1.8. Cartouches

Cartouches are the frames that contain titles and notes on maps. Many cartouches have flowers, naked women, and other organics. Of those that do not (the ones that we are interested in), most

- have symmetry about the vertical axis (mirror images)
- have shadows created by light coming from the left or the right and
- were made by cartographers who had mental models of the light source that created the light and dark patterns on the cartouche.

These features are shown in [figure 6](#).

Cartouches were popular on sixteenth- seventeenth- and eighteenth-century maps. Primitive versions were created by Waldseemüller 1516, Ribero 1529, Mercator 1534, Mercator 1546, Gastaldi 1560 (and of course Forlani and Bertolli in subsequent years), Helwig 1561, Jenkinson 1562, and Ortelius 1570. Each of these showed growth and refinement from previous versions. Finally, the Gutiérrez & Cock 1562 map got it right. Cartouches fell out of favor at the end of the eighteenth century. Only a few were found on nineteenth-century maps.

As in [figure 6](#) most cartouches of the sixteenth century were symmetric. However, of the 50 cartouches made between 1703 and 1852 shown in the David Rumsey Map Collection at Stanford University, <https://www.davidrumsey.com/blog/2010/2/25/cartouches-decorative-map-titles>, only three were symmetric. Symmetry seems to have gone away after the sixteenth century.

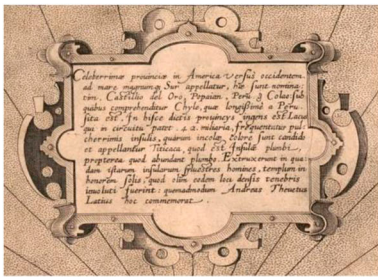
The cartouche in the LoC Mystery Map has André Thevet's name in it. But it is not Thevet's handwriting. It describes places in Peru and Chile. But Thevet only spent ten weeks in South America and that was in Brazil. So Thevet's link to this map is tenuous.

The following cartouches were chosen for [figure 6](#) because they exhibit features that are similar to those on the LoC Mystery Map.

- Gutiérrez & Cock 1562, *Americae Sive Quartae Orbis Partis Nova et Exactissima Descript*,
- Mercator 1569, *Nova et Aucta Orbis Terrae descriptio ad Usum Navigantium ...*,
- Thevet 1575, *Le Nouueay Monde Descouvert*,
- Belleforest 1575, *Description Generale de Toute la France*,
- De Bry 1593, *Americae pars magis cognita*,
- M. Mercator 1595, *America sive India Nova ad magnae Gerardi Mercatoris aui ...*,
- Van Langren 1596, *Delineatio omnium orarum totius Australis partis Americae* and
- Wright & Molyneux 1599/1600 *By the discoverie of Sr Francis Drake made in the yeare 1577*

**3.1.8.1. Lettering.** The letters in the cartouche of the Gutiérrez & Cock 1562 map are in an Italic font with upper and lower case letters with an average 12-degree rightward slant. The letters on the LoC Mystery Map slope, on average, 8° to the right: they are also in an Italic font. In the Mercator 1569 map, most letters slope about 5° to the right but there is a lot of variability. In the Thevet 1575 map the letters are straight up and down, 0°: they are not in an Italic font. On the Thevet map, the lettering is closest to the modern regular Garamond font. The fonts on Ortelius' maps vary because he hired many different engravers. Of cartographers whose cartouches are in [figure 6](#), the lettering of Mercator, Gutiérrez, Ortelius, Van Langren, and Wright & Molyneux most closely matches that on the LoC Mystery Map. (Other cartouches on the M. Mercator 1595 and Wright & Molyneux maps have upper and lower case Italic lettering.)





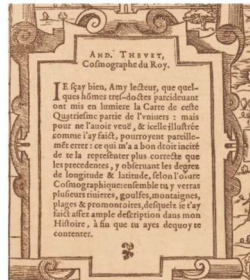
LoC Mystery Map



Gutierrez &amp; Cock 1562



Mercator 1569



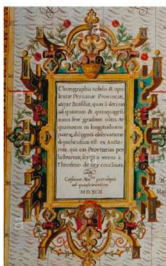
Thevet 1575



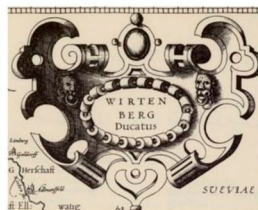
Ortelius 1574



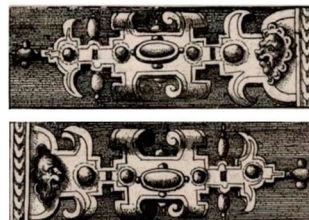
Belleforest 1575



De Bry 1592



Mercator 1595



C. de Jode 1593



Langren 1596



Linschoten 1596



Wright &amp; Molyneux 1599/1600

**Figure 6.** Cartouches that are similar in simplicity and style to that on the LoC Mystery Map. The M. Mercator 1595 cartouche exaggerates the light surfaces and dark shadows.



**3.1.8.2. Shadows.** Cartographers started to experiment with shadows in the 1550s (Sancho Gutiérrez 1551, Agnese Battista 1541, Guillaume Le Testu, 1555, Diogo Homen 1559 and Abraham Ortelius 1560). The cartouche on the Gutiérrez & Cock 1562 map looks like it was made of three-dimensional machined metal parts. The whole cartouche is drawn as if there were a point light source shining from the top-left. The shadows are consistent with that. The Gutiérrez & Cock 1562 is the best example in [figure 6](#) of what shadows should look like.<sup>8</sup>

The LoC Mystery Map cartouche also looks like it was made of three-dimensional machined metal parts. There are eight holes 'drilled' in the cartouche. The four on the left side have light shining on the inside of the right sides of the holes. The four holes on the right side of the cartouche have a shadow on the inside of the left side of the holes. This is inconsistent. This could be caused by a point light source located to the left and on top of the cartouche and slightly above it (out of the paper) **and** quite unlikely either the holes were drilled at an angle or the cartouche was folded about the vertical centerline. Continuing along, the inside edge of the base (the area nearest the text) of the cartouche has a sharp dark shadow on the inside of the left and top sides of the text area. This would be caused by a point light source shining from the top-left. However, the outside edge of the base has a grey fuzzy shadow on the outside of the right side. This would be caused by an extended (or area) light source shining from the top-left. This is a contradiction. The right sides of the middle-top and middle-bottom also have fuzzy shadows: more contradictions. Stated differently, if the cartouche were lying flat and the holes were drilled straight in, then the shadows on the two lugs and two holes on the very bottom are inconsistent. In summary, the shadows on the LoC Mystery Map are inconsistent.

The Mercator 1569 map seems to have been drawn with a mental model of an extended light source shining from the right. But there are many contradictions in the shadows within this map.

The Thevet 1575 map has some light coming from the left and some from the right. It is inconsistent.

The De Jode 1589 map has no cartouches. The De Jode 1593 map has a title cartouche with, however, only a few shadows.

The M. Mercator 1595 map seems to have been drawn with a mental model of a much-brighter light source. The ring of beads in the center has a grey fuzzy shadow on the outside-right-bottom. This would be caused by an extended (or area) light source shining from the top-left. There are no major contradictions on this cartouche. This suggests that with time he (they) learned how to draw shadows. Except that the 'drilled' holes have the same mistake as on the LoC Mystery Map.

On the Van Langren 1596 cartouche, the inside edge of the base (the area nearest the text) has a sharp dark shadow on the inside of the left and top sides of the text area. This would be caused by a point light source shining from the top-left. Also, the outside edge of the base has a grey fuzzy shadow on the right side. This would be caused by an extended (or area) light source shining from the top-left. This mistake is very similar to that made on the LoC Mystery Map cartouche.

The Wright & Molyneux 1599/1600 cartouche is consistent with one light source in the top-left.

Cartographers who created their cartouches in color as in [figure 6](#) did not understand shadows.

Summarizing the shadow findings, the cartouches of Gutiérrez & Cock, LoC Mystery Map, and Van Langren have sharp dark shadows next to the left and top sides of the cartouche surrounding the text area. This would be caused by a point source of light on the top-left side. Equally important, holes ‘drilled’ in the cartouches of LoC Mystery Map, Van Langren and M. M. Mercator 1595 have the same incorrect perspective and shadows.

All criteria have a question and a grading scale. This is the question we asked for the Cartouche evaluation criterion, ‘How similar are the cartouches on this map to those on the LoC Mystery Map?’ This is the grading scale that we used for the cartouche criterion. We did not apply it to map title cartouches.

- Plus two points if the cartouche on this map has symmetry about the vertical axis,
- Plus two more points if the cartouche has no people, flowers, or animals, just simple machine-like parts,
- Plus two more points if the cartouche contains lettering in an Italic font with upper and lower case letters,
- Plus two more points if the cartouche has illuminated parts and dark shadows where the illuminating light shines *consistently* from the top-left,
- Plus two more points if the cartouche looks as if it were made of three-dimensional machined metal parts.

Overall, the Gutiérrez & Cock, Mercator, and Van Langren cartouches seem to be the best matches to the LoC Mystery Map cartouche.

Each cartographer used different cartouches on each of his maps. Furthermore, on maps with more than one cartouche, they are usually all different. Therefore, for example, the Mercator *atlas* of 1595 contains over three dozen different cartouches. Given the large number of different cartouches, it is not surprising that we have not found an exact match for the LoC Mystery Map cartouche.

The weight of importance for the Cartouches evaluation criterion is 8.

### 3.1.9. Fancy fonts labeling oceans and seas

Sixteenth-century cartographers often labeled oceans and seas with big fancy script fonts. These fonts put swashes on some or all of their capital letters. Bickham Script and Great Vibes are modern examples. Often these labels would look like Calligraphy.

This is the question we asked for the Fancy Fonts Labeling Oceans and Seas evaluation criterion, ‘How similar are the Fancy Fonts Labeling Oceans and Seas on this map to those on the LoC Mystery Map?’ This is the grading scale that we used for the Fancy-Fonts criterion.

- Plus two points if the labels use a big, fancy, calligraphy-like font with lots of big swashes and all upper-case letters,
- Plus two more points if the font has a cooked right side of the M,
- Plus two more points if the font has an A with a slab serif at the bottom of the right leg,
- Plus two more points if the map has an E with a plain-block shape,
- Plus two more points if the I looks like a fishhook with a long curly tail.

The fancy lettering on the LoC Mystery Map is most closely matched by the lettering in [Figure 7](#) from the following maps:

- Ortelius 1570, *Typus Orbis Terrarum*, and 1589, *Maris Pacifici*,
- Massa 1580, *America et Proximar Regionum orae Descriptio*,
- R. Mercator 1587, *Orbis Terrae Compendiosa Descriptio* copied from G. Mercator by Rumoldus Mercator,
- Lavanha-Teixeira 1597, *Atlas-cosmografia*, 1597 and 1612. Biblioteca Reale, Turin, and
- Wytfliet 1597, *Hispania Nova*.

Only the maps of LoC Mystery Map, Ortelius 1589, Massa 1580, Plancius 1594, and Wytfliet 1597 have a cooked right side of the M. The LoC Mystery Map, and the maps of Ortelius 1589, Plancius 1594, and Wytfliet 1597 have the same shape for the A with a slab serif at the bottom of the right leg. The LoC Mystery Map and the maps of Lavanha-Teixeira 1597 have the same shape for the E. Van Langren, Vrients and Wytfliet have the fishhook shaped J.

Based on the shapes of the letters in the Fancy Fonts Labeling Oceans and Seas, we think that the best candidates for the cartographer of the LoC Mystery Map are Ortelius 1570 and 1589, Massa 1580, R. Mercator 1587, Plancius 1594, Lavanha-Teixeira, and Wytfliet.

The weight of importance for the Fancy Fonts Labeling Oceans and Seas evaluation criterion is 8.

### ***3.1.10. Number of Toponyms Along the South American Coast***

The LoC Mystery Map has a large number of toponyms along the coast. To quantify this we counted the number of toponyms (cities, villages, rivers, capes, ports, and islands) on the Peru-Chile coast from the Equator down to the Strait of Magellan. Here are the results.

- LoC Mystery Map = 127
- Gutiérrez & Cock 1562 = 64
- Mercator 1569 = 63
- Thevet 1575 = 28
- Ortelius, Amer Sive 1587 = 48
- Ortelius, Amer Sive 1571 = 47
- Plancius ave 1590 and 1594 = 24
- De Jode 1593 = 117
- Van Langren 1596 = 112
- Wright/Molyneau 1599/1600 = 49

The LoC Mystery Map has more toponyms than the other maps. In the tradeoff study, maps with a larger number of toponyms get higher scores according to this equation:

$$\text{Score} = 0.08 \text{ number of toponyms}$$

The weight of importance for the Number of Toponyms Along the South American Coast evaluation criterion is 7.

The large number of toponyms along the South American coast of the LoC Mystery Map is bothersome. The normal progression among Medieval and Renaissance charts and maps is that cartographers add toponyms, seldom do they remove them. The large number of toponyms on the LoC Mystery Map calls into question the creation date, perhaps it was created closer to the seventeenth century.

### 3.1.11. Strait of Magellan

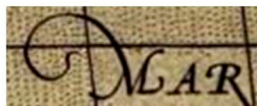
In 1520 Ferdinand Magellan sailed from the Atlantic Ocean to the Pacific Ocean using this eponymous strait at the bottom of South America.

This is the question we asked for the Strait of Magellan evaluation criterion, 'How similar is the representation of the Strait of Magellan on this map to that on the LoC Mystery Map?' This is the grading scale that we used for the Strait of Magellan criterion:

- Plus two points if this map has South America and a large landmass on the bottom separated by water,
- Plus two more points if this map has the strait about the same length and width as the LoC Mystery Map, which is much wider than the actual strait,
- Plus two more points if the Strait of Magellan is labeled,
- Plus two more points if the strait is labeled *Estrecho de la Victoria*<sup>9</sup> in the Pacific (only Mercator, the LoC Mystery Map and Cornelius de Jode used this old fashioned name),



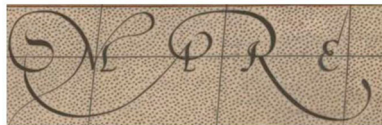
LoC Mystery  
Map



Ortelius 1570



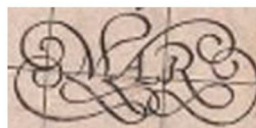
Mercator 1587



Ortelius 1589



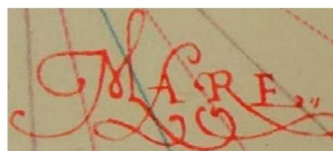
Massa 1580



Plancius 1594



Vrients 1596



Lavanha-Teixeira 1597



Wytfliet 1597

**Figure 7.** Samples of the Labels for Oceans and Seas on sixteenth-century maps.



- Plus two more points if the strait is convex upwards. The actual strait is highly convex.

The weight of importance for the Strait of Magellan evaluation criterion is 3.

### 3.1.12. Zero-longitude meridian

It was not until 1884 that the line passing through the Greenwich Observatory in England was accepted as the Prime Meridian of the world. Before that, each cartographer chose his own zero-longitude meridian. The most popular choices were specific places in the Canary Islands, the Cape Verde Islands, and the Azores Islands. Table 3 shows some common choices.

This is the question we asked for the Zero-longitude Meridian evaluation criterion, 'How similar is the zero-longitude meridian on this map to that on the LoC Mystery Map?' This is the grading scale that we used for the Zero-longitude Meridian criterion:

- Plus six points if this map has its zero-longitude meridian passing through the island groups of the Cape Verdes and/or the Canaries and/or the Azores,
- Plus two more points if the zero-longitude meridian passes through a particular island in only one of these Atlantic island groups,
- Plus two more points if that island is Maio, Boa Vista, or Sal, at 23° W.

Originally we thought this would be the most important evaluation criterion: it was not. In fact, it was not even a good criterion. First, the zero-longitude meridian does not appear on the LoC Mystery Map; its location was estimated using the locations of the Galapagos Islands, the Unfortunate Islands, and the coast of Peru at the Equator. Second, few maps drew this meridian deliberately through any particular island. Third, and most importantly, most maps have the Azores, Madeira, the Canary Islands, and the Cape Verde Islands misplaced. For example, many maps have their zero-longitude meridian passing through both the Cape Verde Islands and the Azores.

The weight of importance for the Zero-longitude Meridian evaluation criterion is 2.

### 3.1.13. Font with the letter z representing the number 2

In some medieval and renaissance fonts, the letter z represented the number 2, as in the maps of figure 8. We thought this would be an important evaluation criterion.

This is the question we asked for the evaluation criterion of using a font with the letter z representing the number 2, 'Does this map use a font with the letter z representing the number 2?' This is the grading scale that we used for the letter z representing the number 2 criterion:

- Plus ten points if this map uses a font with the letter z representing the number 2.

The following cartographers used a Font with the Letter z Representing the Number 2:

- Werner 1514, *Charta Cosmographica, Cum Ventorum Propria Natura et Operatione ...*,
- Apian 1520, *Tipus Orbis Universalis iuxta Ptolemei Cosmographi Traditionem ...*,
- Wapowski 1526, *Map of Sarmatia*,
- Mercator 1538, *no name*,

**Table 3.** Zero-longitude Meridian.

Cartographer/map	Date	Zero-longitude Meridian
Diego Gutiérrez & Hieronymus Cock	1562	14.5° W, Fuerteventura, Canary Islands
Gastaldi, Forlani and Bertelli	1568	14.5° W, Fuerteventura, Canary Islands
Gerard Mercator	1569	23° W, Cape Verde Islands or Corvo in the Azores
Abraham Ortelius	1570 TOT	23° W, Cape Verdes and Azores
LoC Mystery Map		23° W, Cape Verde Islands, estimated
André Thevet	1575	27° W, Terceira, Azores
Gerard de Jode	1593	25° W, Cape Verdes and Azores
Petrus Plancius	1594	25° W, Santa Maria, Azores
Arnold van Langren	1596	21° W, Cape Verdes and Canaries
Wright & Molyneux	1599/1600	23° W, Maio, Boa Vista, and Sal, in the Cape Verdes

- Frisius 1544, *Carte Cosmographique ...*,
- Honter 1546, *Universalis Cosmographia*,
- Le Testu 1556, *Cosmographie Universe*,
- Gutiérrez & Cock 1562, *Americae Sive Quartae Orbis Partis Nova et Exactissima Descript*, and
- D. Teixeira 1573, *World map*.

Note that these are all before 1573.

This was the first evaluation criterion that we investigated because it was so visually obvious. In the end, it differentiated maps from the first and last halves of the sixteenth century, but not so much between cartographers. For example, Mercator's 1538 map uses the letter z to represent the number 2, but none of his later maps did. Therefore, the weight of importance of this evaluation criterion was reduced.

The weight of importance for Font with the Letter z Representing the Number 2 evaluation criterion is 2.

### 3.1.14. Background of empty oceans

Most of these maps have large areas of empty oceans. How did the cartographers handle this? Some did nothing and the base parchment was the background: some did nothing and the texture of the paper on the portions of the copper plate that were not engraved served as the background; in these cases, the background just looked like a uniform dirty pattern. Some cartographers filled the oceans with patterns to make them look darker than the land. Gutiérrez & Cock filled in the oceans with beautiful (not to scale) waves (see [Figure 8](#)). Tear-drop shapes (or triangles) were used by the LoC Mystery Map (see [Figure 8](#)), Ruscelli 1561, Mercator 1569, Ortelius 1570, and 1587, Van Langren, Wytfliet & Mangini, and Ricci 1602. These marks were probably made by a copperplate engraving tool, not a woodblock knife. Dashes were used by Belleforest and Gastaldi et al. Hondius 1597 filled the oceans with dots. However, most cartographers left the oceans blank. Caution: unless your world map comprises at least a megabyte, then you might not see the dashes and dots in the oceans: the background may just look like dirty paper.

The question we asked was, 'Did the engraver fill the oceans with tear-drop shapes as the LoC Mystery Map first state engraver did?'

- Ten points for a random distribution of tear-drop shapes.
- Eight points for a random distribution of short dashes.

- Six points for a random distribution of dots.
- Four points for a random distribution of long dashes.
- Two points for a regular distribution of dashes or dots.

The weight of importance for the Background of Empty Oceans evaluation criterion is 9.

### 3.1.15. Topology

On the LoC Mystery Map mountain ranges are indicated with a string of rounded pyramids. Therefore, the question we asked was, 'Did the engraver represent mountain ranges with a series of rounded pyramids?'

- Six points if the engraver represented mountain ranges with a string of rounded irregular pyramids, with shadows on the east side created with short parallel lines.
- Four points if the engraver represented mountain ranges with a string of rounded irregular pyramids.
- Two points if the engraver represented mountain ranges with a string of some other shape.

On the LoC Mystery Map, the Rio de San Miguel goes through S. Miguel and then heads south. Therefore, we asked, 'Did the engraver carve the Rio de San Miguel through S. Miguel and then southward?'

- Four points if the engraver carved the Rio de San Miguel through S. Miguel and then southward.

The weight of importance for the Topology evaluation criterion is 7.



**Figure 8.** Examples of the number 2 being represented by the letter z on sixteenth-century maps. The match between the Equators on the LoC Mystery Map (top) and the Gutiérrez & Cock map (bottom) is quite remarkable!.

### 3.1.16. Handwriting

Each engraver had characteristics that made his engravings look different. Because this is similar to handwriting; *handwriting* is what we will call it. We looked at the thickness of the engraved lines, the slant of the letters, the uniformity of height of the lower case letters, letter spacing, and the shape of individual letters. These characteristics in the first state of the LoC Mystery Map are matched best by those on the Cornelius de Jode 1593 map. These traits were worth six points. We also used a panel of experts to weigh the goodness of fit between the alternative engravers and that of the LoC Mystery Map. Their evaluations were worth four points.

We had to be careful in using this evaluation criterion because some cartographers did not engrave the maps themselves. For example, Hieronymus Cock was the engraver for Diego Gutiérrez. Frans Hogenberg engraved all of the maps in Ortelius's *Theater Orbis Terrarum* 1570 atlas including the *Americae sive*, but Jan Wierix engraved the 1587 *Americae Sive*.<sup>10</sup>

The weight of importance for the Handwriting evaluation criterion is 4. It is low because it was hard to evaluate and therefore its reliability is low.

That is the last of our 16 evaluation criteria that we will use to help identify the cartographer/engraver of the first state of the LoC Mystery Map.

## 3.2. Killer criteria

Killer criteria are evaluation criteria that are so powerful they eliminate a slew of alternative candidates. For example, at the beginning of our study, we used the general killer criterion that the map must be a sixteenth-century nautical map that includes the west coast of South America. This eliminated hundreds of alternatives.

### 3.2.1. Date of creation

The first state of the LoC Mystery Map was surely created after 1569. The LoC Mystery Map in the possession of the Library of Congress (LoC) is a second state, which was probably produced between 1579 and around 1588 by someone other than the original cartographer.

The first state Date of Creation killer criterion was, 'Was the candidate cartographer alive and active between 1569 and 1573?' Killer criteria responses must be yes or no, all or none. There can be no maybes.

Of the cartographers referenced in Table 1, Reis, Werner, Apian, Wapowski, Frisius, Fine, Honter, and Ruscelli were dead before 1569, therefore they were ruled out as cartographer/engravers of the LoC Mystery Map. Le Testu, Gutiérrez & Cock, and D. Teixeira were alive and active in 1569. Le Testu died in 1573, Gutiérrez officially retired in 1569, and Cock (Gutiérrez's engraver) died in 1570. If the LoC Mystery Map was made between 1569 and 1573, which we continually checked, then Cornelis de Jode (born in 1568), Wright (born in 1561), and Hondius (born in 1563) would have been too young to have made it. This Date of Creation killer criterion tentatively eliminated half of the alternative cartographers in Table 1, those who were born too soon or born too late. This shows that it is important to use the killer criteria early in the tradeoff study before a lot of effort has been invested in evaluating alternatives. However, this killer criterion was continually reevaluated as the date of creation became more certain.



### 3.2.2. Method of creation

Between the fourteenth and eighteenth centuries, charts and maps were made with ink on velum, woodcuts, copperplate engraving, copper etching, and lithography. The LoC Mystery Map was made with copperplate engraving. Therefore this killer criterion is, 'Is there evidence that this cartographer made maps with the copperplate engraving technique?'

Gutiérrez did copperplate engraving: Hieronymus Cock was his engraver. Mercator and Ortelius also used copperplate engraving. This killer criterion should have eliminated Thevet and Belleforest because they had used woodcuts. But because of the special status given to Thevet by the Library of Congress, we left him in the tradeoff study.

### 3.3. Unused evaluation criteria

#### 3.3.1. Type of map projection

We identified the type of map projection based solely on the map's visual appearance. Some map projections like Cordiform and Mercator were easy to identify, others were difficult. For example, the Ortelius 1589 *Maris Pacifici* map has an unusual projection function. The parallels are equally spaced straight lines, as usual. However, the meridians are straight lines that are closer together toward the poles and make unequal angles that are not perpendicular to the Equator. This is probably a trapezoidal map projection. Ortelius used this projection on several maps.

In the sixteenth century, the most common map projections were the Ortelius Oval map projection used in the *Typus Orbis Terrarum*, 1570, and the bi-hemispheric equatorial stereographic map projection by Rumold Mercator, used in *Orbis Terrae Compendiosa Descriptio*, 1587 (Snyder, 2007) and subsequently by Plancius 1590, Plancius 1594, De Bry 1596, Vrients 1596, and M. Mercator 1596. Oval projection maps have parallels that are straight not equally-spaced horizontal lines and meridians that are curved not equally spaced vertical lines. The meridians are equidistant at the Equator and perpendicular to it. The meridians are *circular* arcs (not ovals) (with unspecified centers) connected at the poles (Snyder & Voxland, 1989, pp. 178–79). The oval part probably refers to the outer boundary of the map.

The bi-hemispheric stereographic projection of Mercator is similar but not the same as the Nicolosi globular projection reinvented in 1660 by Giovanni Battista Nicolosi. The Nicolosi globular projection is made with only a compass and a straightedge. First, you draw a bounding circle to contain the map. Then place the north and south poles at the top and bottom of the circle. Draw the central meridian and the equator as straight lines bisecting the circle. Draw each remaining meridian as a circular arc going through both poles and the equator, such that the meridians are equally spaced along the equator. (In Mercator's bi-hemispheric stereographic projection they are not equally spaced.) Finally draw each remaining parallel as a circular arc (the center of the arc is unspecified) from the left edge of the circle through the central meridian to the right edge of the circle, such that the parallels are equally spaced around the perimeter of the circle and also equally spaced (but with different spacing) along the central meridian (Snyder & Voxland, 1989, p. 176). That was a big simplification because this projection function is based on equations.

Because projection functions are difficult and confusing, we set the weight of importance for the Type of Map Projection evaluation criterion to 0. It was not useful in differentiating between the alternatives because many cartographers used multiple map projections. Indeed, Mercator used his eponymous projection function on less than 1% of his maps. Also, it is often difficult to assess the projection function based solely on visual inspection of the map. But we did not want our readers to think that we ignored it.

Furthermore, we do not even know what type of map projection was used on the LoC Mystery Map. Sometimes it even looks like an equirectangular portolan chart (Table 4).

### ***3.3.2. Name of the candidate cartographer and the amazon river***

The cartouche in the LoC Mystery Map has André Thevet's name in it. But that does not seem to be a signature. Rather, the translation implies that it is a reference or an acknowledgment. It is not in Thevet's handwriting. It describes places in Peru and Chile. But Thevet only spent ten weeks in South America and that was in Brazil. So containing a person's name does not indicate that they were involved in its cartography/engraving.

Many of the maps referenced in this paper labeled the Amazon River as Rio de las Amazons. The second state of the LoC Mystery Map does not have the eastern part of Brazil. So we do not know how they labeled it. Therefore, this was of no use.

### ***3.3.3. Initial slope of the amazon river***

On the LoC Mystery Map, the Amazon River is represented as a sine wave. The initial portion of this sinusoid slopes to the southeast. Please compare Figure 1–3. A line connecting the centers of the first 2.5 cycles of this sinusoid has an average slope of  $-0.78$ . This is much bigger than slopes on other maps. For the 27 maps analyzed by Bahill and Gitzen (2021) that represent the Amazon River as a giant snake, the average value for the slope is  $-0.20$  with a standard deviation of 0.13. Furthermore, the range for this slope is  $-0.42$ – $0.07$ . So, no other map has a slope that is even close. The map with the nearest slope to that on the LoC Mystery Map was the map of Van Langren with a slope of  $-0.42$ . Therefore, the initial slope of the Amazon River does not help identify the cartographer of the LoC Mystery Map.

### ***3.3.4. Miscellaneous***

Most of these maps had titles and cartouches containing text written in Latin and toponyms written in Latin or Spanish. So this did not help to differentiate the maps. On many maps, the letters used for place names are Italic whereas letters in cartouches and those used for labeling regions, etc. are not necessarily Italic. This criterion was not used. Also, the shape of the icons used to indicate cities or villages was not used. We did not notice anyone being right or left-handed

### ***3.3.5. Label for the South pacific***

The LoC Mystery Map has a label in the ocean off the southwest coast of Chile naming it 'Mare Magellanicum sive Pacificum.' Only the map of Gutierrez & Cock has these same words and spellings. Therefore, it is not worth including this in our tradeoff study. We will simply use it in the end if that alternative is close to the top. The most useful evaluation criteria are those with a variety of answers among the candidate alternatives.

**Table 4.** Characteristics of the LoC Mystery Map.

Like portolan charts it	Unlike portolan charts it
has rhumb lines emanating from the compass rose	does not have intersecting rhumb lines from other compass roses
lacks latitude indicators	has indications of longitude
does not have parallels of latitude or meridians of longitude	does not have horizontal or vertical scales of distance
	has the Equator marked in degrees
has dense toponyms along the inland coast	has many toponyms inland
	has toponyms in the oceans
	does not have flags indicating sovereignty
does not use a cardioid or Mercator projection. The projection might be equirectangular.	
	was made with copperplate engraving, not ink on vellum

**3.4. Tradeoff study**

When choosing amongst alternatives, where there are many criteria to consider at the same time, it is best to do a tradeoff study (Bahill & Madni, 2017). In a tradeoff study, there is a list of candidate alternatives and a list of evaluation criteria. In our first iteration, we used about 100 competing alternatives (cartographer/engravers). Our goal was to answer the question, ‘Who was the most likely cartographer/engraver of the first state of the LoC Mystery Map?’ After months of continual measurements and computations, we narrowed the list of alternatives down to 30.

Next, we will list the criteria that we used, and then we will suggest how well each of the alternatives answered our question of ‘For a modern-day cartographer, trying to identify the cartographer/engraver of the LoC Mystery Map, how well does this alternative satisfy this evaluation criterion in order to help identify *who done it?*’

In this tradeoff study we used the following evaluation criteria to determine who was the most likely cartographer/engraver of the first state of the LoC Mystery Map:

- the Slow Sloth
- the Group of Patagonians
- the Coyote-platypus Sea Monster
- the Compass Rose
- the Galapagos Islands
- the Bulge on the Southwest Coast of Chile
- the Snake-like Representation of the Amazon River
- the Cartouches and the Lettering Inside
- the Fancy Fonts Labeling Oceans and Seas
- the Number of Toponyms Along the South American Coast
- the Strait of Magellan
- the Zero-longitude Meridian
- the Font with the Letter z Representing the Number 2
- the Background of Empty Oceans
- Topology and
- Handwriting

The following are preliminary qualitative results of our analysis of the 30 alternatives.

Based on the drawing of the sloth, the best candidates are Thevet, Plancius, Van Langren, and De Jode.

Based on the drawing of the group of Patagonians, the best candidates are Gutiérrez & Cock, Mercator, and De Jode.

Based on the drawing of the coyote-platypus sea monster, the best candidates are Thevet and De Jode.

Based on the drawing of the compass rose, the best candidate is Plancius.

Based on the existence and location of the Galapagos Islands, the best candidates are Mercator and Ortelius.

Based on the existence of a big bulge on the southwest coast of Chile, the best candidates are Ruscelli, Mercator, Ortelius, Plancius, Van Langren, Wright & Molyneux.

Based on the representation of the Amazon River as a giant snake (see also Bahill & Gitzen, 2021), the best candidates are Mercator, Ortelius, Plancius, De Jode, Van Langren, and Wright & Molyneux.

Based on the shadows on and lettering in the cartouches, the best candidates are Gutiérrez & Cock, Mercator, and Van Langren.

Based on the fancy fonts labeling oceans and seas, the best candidates are Ortelius, Plancius, and Van Langren.

Based on the number of toponyms along the South American coast, the best candidates are De Jode and Van Langren.

Based on the Strait of Magellan evaluation criterion, the best candidates are Mercator and De Jode.

Based on the location of the zero-longitude meridian, the best candidates are Mercator, Van Langren, and Wright & Molyneux.

Based on the font representing the number 2 with the letter z, the best candidate is Gutiérrez & Cock.

Based on the Background of Empty Oceans criterion, the best candidates are Mercator, Ortelius, and Van Langren.

Based on the Topology criterion, the best candidates are Gutiérrez & Cock, Mercator, and, Ortelius.

Based on the Handwriting criterion, the best candidate is De Jode.

What a mess! How can we possibly use this data to determine the most likely cartographer of the LoC Mystery Map?

### ***3.4.1. Explanation of the tradeoff study***

The purpose of a tradeoff study is to help select one or a few alternatives as the best of many candidate alternatives using a multitude of evaluation criteria. We originally considered around 100 candidate alternatives. Then we used our general killer criteria and eliminated all but 30 alternatives.

Next, we spent months exercising a tradeoff study using these 30 alternatives. We examined the results and eliminated the lowest scoring alternatives, which were: Reis 1513, Werner 1514, Apian 1520, Wapowski 1526, Fine 1536, Frisius 1544, Cabot 1544, Pereira 1545, Honter 1546, Le Testu 1556, Ruscelli 1561, Belleforest 1575, Domingos Teixeira 1573, Gerard de Jode 1578, Massa 1580, Cornelius de Jode 1589 (not C. de Jode 1593),

de Bry 1593 and 1596, M. Mercator 1595, Hondius 1596, Vrients 1596, Lavanha & Teixeira 1597.

This set overlapped our Date of Creation killer criterion set, which also eliminated Reis 1513, Werner 1514, Apian 1520, Wapowski 1526, Fine 1536, Frisius 1544, Cabot 1544, Honter 1546, Gastaldi 1560s, Ruscelli 1561, Hondius 1596, and Wright & Molyneux 1599/1600. However, we kept Wright & Molyneux in the tradeoff study just in case our dating for the LoC Mystery Map was wrong.

The Method of Killer Criteria should have eliminated Pereira because he used ink on vellum and Belleforest and Thevet because they did woodblock cutting. But because of the special status given to Thevet by the Library of Congress, we left him in the tradeoff study. This left us with the eight alternatives shown in Table 5.

Our tradeoff study matrix is shown in Table 5. The *alternative cartographers/maps* are listed along the top row. The *evaluation criteria* are listed in the left column. They are phrased so that more (or yes) is better. In the next column, each evaluation criterion is given a *weight of importance* based on the Decision Maker's preferences. These weights range from 0 to 10, with 10 being the most important. Next these weights of importance are normalized so that their sum is 1.0. These *normalized weights* are given in the third column, which is labeled 'w.' Each alternative is given a *score* that answers the question, 'For a modern-day cartographer, trying to identify the cartographer/engraver of the LoC Mystery Map, how well does this alternative satisfy this evaluation criterion in order to help identify who done it?' Scores range from 0 to 10, with 10 being the best. These scores are put into the fourth column labeled 's.' Next the spreadsheet computes *weight times score* and puts these numbers into the fifth column, labeled 'ws.' The spreadsheet then sums the weight times scores (ws) for the column and puts this sum in the bottom row labeled *Alternative Ratings*.

Expert opinion was then used to reevaluate the weights and assign scores for all of the alternatives, 128 evaluations. These evaluations were done iteratively dozens of times. Finally, the row labeled Alternative Ratings was examined. The alternatives with the highest numbers were the best.

In this case, Cornelius de Jode (6.30) and Gerald Mercator (6.09) were the top scorers and were, therefore, the most likely cartographer/engravers of the LoC Mystery Map. The score for De Jode is around three percent higher than the score for Mercator. Such small differences are normal in tradeoff studies (Bahill & Madni, 2017). Finally, the last step in the tradeoff study was to get more expensive experts to redo the 128 evaluations.

Based on age, physical condition, and mental state, we suggest that if Mercator were the cartographer/engraver of the LoC Mystery Map, then a creation date of 1569–1578 is most reasonable: he stopped engraving in 1578. If C. de Jode were the cartographer/engraver of the LoC Mystery Map, then a creation date of 1588 is most reasonable: he was born in 1568.

In summary, Cornelius de Jode received more points than Gerald Mercator on the following criteria: the Slow Sloth, the Group of Patagonians (because his describing text was closer to that on the LoC Mystery Map), the Coyote-platypus Sea Monster, and the Number of Toponyms Along the South American Coast. De Jode received fewer points than Mercator on the criteria the Background of Empty Oceans and Topology.

Originally we thought that the Font with the Letter z Representing the Number 2 evaluation criterion would be the criterion that eliminated the most competing alternatives.



**Table 5.** A tradeoff study matrix.

Tradeoff Study Matrix for discovering the creator of the first state of the LoC Mystery Map using a Sum Combining Function with the number of alternatives equal to 88																					
Alternative cartographers → w means weight, s means score and ws means weight times score	Weights of Importance	Normalized Criteria Weights	LoC Mystery Map		Gutiérrez & Cock 1562		Mercator 1569*		Thevet 1575		Ortelius <i>Amer Sive</i> 1587		Plancius 1592		De Jode 1593		Van Langren 1596		Wright & Molyneux 1599/1600		
			s	ws	s	ws	s	ws	s	ws	s	ws	s	ws	s	ws	s	ws			
			w																		
Evaluation Criteria ↓																					
Slow Sloth	10	0.094	10	0.94	2	0.19	2	0.19	10	0.94	0	0.00	10	0.94	10	0.94	10	0.94	0	0.00	
Group of Patagonians	9	0.085	10	0.85	8	0.68	9	0.76	4	0.34	0	0.00	8	0.68	10	0.85	10	0.85	0	0.00	
Coyote-platypus Sea Monster	10	0.094	10	0.94	0	0.00	4	0.38	10	0.94	0	0.00	2	0.19	10	0.94	0	0.00	0	0.00	
Compass Rose	7	0.066	10	0.66	0	0.00	0	0.00	2	0.13	0	0.00	10	0.66	0	0.00	10	0.66	6	0.40	
Galapagos Islands	5	0.047	10	0.47	0	0.00	10	0.47	0	0.00	10	0.47	0	0.00	1	0.05	0	0.00	0	0.00	
Bulge on the Coast of Chile	8	0.075	10	0.75	0	0.00	10	0.75	8	0.60	10	0.75	10	0.75	10	0.75	10	0.75	10	0.75	
Snake-like Representation of the Amazon River	7	0.066	10	0.66	6	0.40	10	0.66	0	0.00	10	0.66	0	0.00	7	0.46	0	0.00	10	0.66	
Cartouches	8	0.075	10	0.75	10	0.75	6	0.45	6	0.45	9	0.68	10	0.75	8	0.60	7	0.53	6	0.45	
Fancy Fonts Labeling Oceans	8	0.075	10	0.75	0	0.00	0	0.00	0	0.00	8	0.60	0	0.00	0	0.00	0	0.00	2	0.15	
Number of Toponyms Along South American Coast	7	0.066	10	0.66	5.1	0.34	5	0.33	2.2	0.15	3.8	0.25	5.4	0.36	9.2	0.61	8.8	0.58	3.9	0.26	
Strait of Magellan	3	0.028	10	0.28	8	0.23	10	0.28	7	0.20	6	0.17	8	0.23	10	0.28	6	0.17	0	0.00	
Zero-longitude Meridian	2	0.019	10	0.19	8	0.15	10	0.19	8	0.15	8	0.15	0	0.00	8	0.15	0	0.00	10	0.19	
Font with the Letter z	2	0.019	10	0.19	10	0.19	1	0.02	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	
Representing the Number 2																					
Background of Empty Oceans	9	0.085	10	0.85	0	0.00	10	0.85	0	0.00	10	0.85	2	0.17	1	0.08	0	0.00	0	0.00	
Topology	7	0.066	10	0.66	9	0.59	8	0.53	1	0.07	10	0.66	6	0.40	4	0.26	6	0.40	0	0.00	
Handwriting	4	0.038	10	0.38	5	0.19	6	0.23	5	0.19	7.5	0.28	8	0.30	8	0.30	4	0.15	3	0.11	
Column Sum	106	1.000																			
Alternative Ratings			10.00		3.70		<b>6.09</b>		4.16		5.53		5.43		<b>6.30</b>		5.03		2.97		
Performance index PI <sub>3</sub> =	4.90																				

\*Mercator's 1538 map used the letter z to represent the number 2. But his newer maps did not. We gave it a score of 1.

Indeed, if we had used that as a killer criterion, it would have eliminated Mercator himself! Therefore, we simply treated it as any other criterion, but with a weight of only 2. Mercator created over one hundred maps in his lifetime. Indeed his atlas of 1595 *Atlas Sive Cosmographicae Meditationes de Fabrica Mundi et Fabricati Figura* contained 107 maps. We found only one of his maps (the 1538) that used a Font with the Letter z Representing the Number 2. In fact, the old-style font that he (actually his grandson Michael) used in the 1595 atlas used a symbol for '1' that has a hook on the bottom and a serif on the top that makes it look like a 'j' In other words Mercator's fonts for the numbers '1' and '2' were nothing like the ones on the LoC Mystery Map.

This criterion actually separated the maps by year of creation. Of the maps in [Table 1](#) that used the letter z for the number 2 the average year of creation was 1538 with a standard deviation of 20 years. So maps that represented the number 2 with the letter z were mainly made in the first half of the sixteenth century.

The result of our tradeoff study is that Cornelius de Jode or Gerald Mercator was the most likely cartographer/engraver of the first state of the LoC Mystery Map.

### 3.4.2. Sensitivity analysis

The results of a sensitivity analysis can be used to validate a model; flag unrealistic model behavior; identify the most significant evaluation criteria, weights of importance and scores in a tradeoff study; point out important assumptions; help formulate model structure; simplify a model; suggest new experiments; guide future data collection efforts; suggest accuracy for calculating parameters; adjust numerical values of parameters; choose an operating point; allocate resources; detect critical criteria; suggest tolerance for manufacturing parts and identify cost drivers. A sensitivity analysis reveals which inputs and parameters are the most important and most likely to affect system behavior and/or model predictions (Smith et al., 2008).

The sensitivity analysis showed that the most important *evaluation criteria* are the Bulge on the Southwest Coast of Chile, the Cartouches, and the Slow Sloth.<sup>11</sup>

Next, applying the numerical methods given in Smith et al. (2008) to our tradeoff study given in [Table 5](#), we found that the most significant *weights of importance* for determining the cartographer/engraver of the LoC Mystery Map were those for the Bulge on the Southwest Coast of Chile, the Cartouches, and the Slow Sloth. It is not just a coincidence that these are also the most important criteria. We reevaluated those weights in many iterations. [Table 5](#) gives the final values that we used.

We found the most significant *scores* were for (1) the Slow Sloth evaluation criterion for Thevet, Plancius, De Jode, and Van Langren, (2) the Coyote-platypus Sea Monster criterion for Thevet and De Jode, (3) the Group of Patagonians criterion for Mercator and De Jode and (4) the Background of Empty Oceans evaluation criterion for Mercator, Ortelius, and Van Langren. Therefore, we did extra research and consulted other experts to get better values for these scores. Our final values are in [Table 5](#).

Surprisingly the outcome of the tradeoff study is not sensitive to the evaluation criterion of the Background of Empty Oceans or its weight of importance. So we did not spend extra time and money trying to differentiate between the marks filling the oceans.

In summary, the first half of this paper was devoted to determining the cartographer/engraver of the first state of the LoC Mystery Map. We decided that if this map were made between 1569 and 1578, then Gerard Mercator was the most likely cartographer/

engraver. However, if this map were created around 1588, then Cornelius de Jode was the most likely cartographer/engraver. The sensitivity analysis showed that the most significant evaluation criteria were the Bulge on the Southwest Coast of Chile, the Cartouches, and the Slow Sloth. We are now ready to start the second part of this paper: determining the second engraver of the LoC Mystery Map.

## 4. Identifying the second engraver

Philip Burden examined and described the LoC Mystery Map in 1994 (Burden, 1996). He wrote that this map had two states. The first state had lands, oceans, toponyms, cartouches, and other letterings. The second state had about sixty additional toponyms added in a second different handwriting. Look at the  $y^a$  de sally, S. Felicis, and S. Nabor islands just east of the compass rose in figures 1 and 9. The letters of  $y^a$  de sally are graceful and most importantly have no tear-drop shapes filling the oceans behind them. Whereas the letters of S. Felicis and S. Nabor are heavy, clumsy, and are engraved on top of (implying after) the tear-drop shapes filling the oceans.

The second engraver added around 30 toponyms in the Pacific Ocean off the coast of South America. He added C. d. S. Frñcesco (also found on Ortelius 1564, Mercator 1569, Massa 1580, De Jode 1593, and Van Langren 1596) and S. Felicis and S. Nabor (also found on the Ortelius *Americae Sive* maps of 1587, 1588, etc., De Jode 1593, and Mercator & Hondius 1608). There are many toponyms on the land that were probably added by the second engraver. We did not list them in Table 6 because of the lack of tear-drop shapes in the oceans to unequivocally identify them.

On the *Americae Sive* maps, between 1584 and 1587, Ortelius added the islands of S. Felix and S. Nabor, removed the bulge on the southwest coast of Chile, and took one of the Ins. de los galepegos and corrected its name to Ins. de Cocos (5.5° N, 87° W), as did De Jode 1593.

### 4.1. Evaluation criteria

We are going to use a tradeoff study to help identify the second engraver of the LoC Mystery Map. Our first step is to create evaluation criteria.

#### 4.1.1. Saint felicis and saint nabor

In 1579, Captain Pedro Sarmiento de Gamboa wrote in his ship's log, 'We passed 18 leagues to the westward of the Isla Desventuradas, which lie 25° 20' [S] ... They are now called St. Felix and St. Ambor.' (Corney, 1920).

None of the Ortelius *Typus Orbis Terrarum* maps in the *Theatrum Orbis Terrarum* atlas have these islands. Likewise, none of his *Maris Pacifici* maps have these islands. However, most of his *Americae Sive Novi orbis, nova descriptio* maps do. Those published between 1570 and 1587 do not. Whereas those published in 1587, 1588, 1595, 1596, 1598, 1603, 1606, 1612, and 1630 do have these islands.<sup>12</sup> Ortelius named them S. Felix and S. Nabor. Mercator's atlas did not include them until Hondius inserted them in 1607 and 1608. Therefore, these islands were apparently first inserted on the second state of the LoC Mystery Map certainly after 1579 and probably around 1587.



**Figure 9.** Toponyms carved by the first engraver (left part of the top image), the second engraver (right part of the top image), Ortelius 1587 (middle image), and De Jode 1593 (bottom image).

This is the question we asked for the S. Felicis and S. Nabor evaluation criterion, ‘Does this map contain the islands S. Felicis and S. Nabor?’ This is the grading scale that we used for the S. Felicis and S. Nabor evaluation criterion:

- Plus ten points if the map contains the islands labeled S. Felicis and S. Nabor in the approximately correct position,
- Plus eight points if the map contains these islands with a variant spelling such as S. Felix and S. Nabor.

The following maps contain the islands S. Felicis and S. Nabor.

- LoC Mystery Map second state,
- Ortelius 1587, *Americae Sive* 1587 and later,
- C. De Jode 1593, *Brasilia et Peruvia*, and
- Mercator & Hondius 1608, *Americae Descrip.*

The weight of importance for the S. Felicis and S. Nabor evaluation criterion is 10.

#### 4.1.2. Handwriting of the second engraver

The second engraver added about five dozen toponyms to the LoC Mystery Map. The ‘handwriting’ of this engraver does not match that of Mercator or Thevet. To identify the second engraver we compared his handwriting on these five dozen toponyms to that of



**Table 6.** Overlapping Toponyms on the LoC Mystery Map and the maps of Mercator 1569, Ortelius 1587, and C. de Jode 1593 from north to south, from the Equator to the Straits of Magellan. Toponyms added by the second engraver are in boldface.

LoC Mystery Map	Mercator 1569	Ortelius, <i>Americae Sive</i> 1587	De Jode 1593
y <sup>a</sup> de los pegas	y <sup>a</sup> de los galopegos	Ins de Cocos	I. de Cocos
y <sup>a</sup> de los galopegos	y <sup>a</sup> de los galopegos	Ins de los galopegas	
Quinto	Quinto	Quinto	Quinto
<b>C. d. S. Frñcesco</b>	C de S Frañcisco		C. de S. Frácesco
We are not certain if the third letter should be ñ, ñ or á.			
Equator	Equator	Equator	Equator
Tomebariba	Thomebamba	Thamebam	
<b>Piina In</b>			I. de Puina
Tumbes	Tumbes	Tumbes	
S. Miguel	S. Miguel	S. Miguel	S. Miguel
Puchio	Puchio	Puchio	
Montupe	Motupe	Motupe	
Trugillo	Trugillo	Trugillo	Trugillo
<b>Carinas</b>			Carinas
Cosma	Cosma	Cosma	Cosma
Chontal	Chontal	Chontal	
Los Faraldones	Los Farallones de Guaura	Los Farallones	Farillones
Lima	Lima	Lima	Lima
<b>Pescadores Formigis</b>			Pescadores Formigis
<b>I de lobos</b>			I de lobos
Pachacama	Pachacama	Pachacama	Pacachama
<b>S. Galleno</b>			S. Galleno
<b>La Anasca</b>			La Anasca
<b>I de Curao</b>			I. de Curaos
Lago de Titicacha (170 miles inland)	Titicacha lacus (16° S, 70° W)		Titicara lac.
Arica	Arica	Arica	Arica
<b>Tarapaca</b>	Terapaca p <sup>o</sup>	Tarapaca	
<b>Cunbainuco</b>			Cunbainuco
Tropic of Capricorn	Tropic of Capricorn	Tropic of Capricorn	Tropic of Capricorn
<b>S. Felicis and S. Nabor</b>		S Felix and S Nabor	S. Felicis and S. Nabor
<b>B de Chili</b>	Cabo de Chili	Badiade de Chili	Baja d. Chili
<b>Tapica</b>		Tapica	
<b>R. de Pieros</b>		R de Pi'ros	R. d. Pieros
<b>C Raso</b>		C Rasso	
<b>Corao</b>		Caroao	
<b>C delo do los baxos</b>		C. de todos los baxos	C. de todo I. baixos
<b>R d S Augustin Montanas</b>		Rio de Montañas	R. de S. Angustin
R. de S. Moñtannas			
Arboledas		Arboledas	Arboledas
<b>Curúbana</b>			Curumbano
<b>I de Lobos</b>		P de los Lobos	I de Lobos
Lucengo	Lucengo		
<b>Seralta</b>			Serralte
R. Grande		Rio Grande	R. Grande Mababrigo
Farillones		Las Farillones	Farillones
<b>Baldiva</b>		Baldivia	Baldevia
Islas Alegadas		Las anegadas	Isla Alagadas
Strait of Magellan	Strait of Magellan	Strait of Magellan	Strait of Magellan

our 30 prime alternative engravers. We compared each alternative candidate map and asked if (1) the engraved lines were thicker than normal as on the LoC Mystery Map, (2) the letters in toponyms were slanted as in an Italic font, (3) letters were separated, none flowed into others, (4) the lower case letters varied slightly in height, (5) the words were not graceful as on the Mercator and De Bry maps, (6) capital letters matched those

added in the second state of the LoC Mystery Map and (7) most importantly the toponyms on the alternative maps were carved *on top of* (implying after) the patterns filling the oceans. Look particularly at y<sup>a</sup> de sally, S. Felicis, and S. Nabor in [Figure 9](#).

The handwriting on the De Jode 1593 map best matches the handwriting of the second state of the LoC Mystery Map.

The weight of importance for the Handwriting evaluation criterion is 7.

#### 4.1.3. Overlapping toponyms

[Table 6](#) shows the Overlap of Toponyms in the Pacific Ocean and on the coast of South America on the LoC Mystery Map and the maps of Mercator 1569, Ortelius *Americae Sive* 1587, and De Jode 1593. We did not include all of the toponyms. That would have taken 130 lines. We only included most of the toponyms introduced by the second engraver and other selected toponyms.

We counted the number of toponyms on each alternative map that matched those on the second state of the LoC Mystery Map between 4° N latitude and the Strait of Magellan. In the tradeoff study, maps with a larger number of overlapping toponyms get higher scores according to this equation:

$$\text{Score} = 0.56 \text{ number of toponyms.}$$

The largest number of matches were on the maps of De Jode 1593 and Ortelius 1587. The number of overlapping toponyms is large and their spellings are a good match.

[Table 6](#) lists toponyms along the west coast of South America from the Equator to the Straights of Magellan: the 22 toponyms in boldface were engraved by the second engraver of the LoC Mystery Map; of these, three only appeared on the Ortelius *Americae Sive* maps of 1587, 1588, etc.; nine only appeared on the C. de Jode 1593 map; and six appeared on both the Ortelius and De Jode maps and nowhere else.

#### 4.1.4. Labeling the cape of San Francisco

- Ten points for labeling the Cape of San Frñcesco.

The weight of importance for Labeling the Cape of San Frñcesco evaluation criterion is 10.

#### 4.1.5. Abbreviation for Island

- Ten points for using 'I.' as the Abbreviation for Island.

	Abbreviations and Diacritical Marks				
	LOC Mystery Map first state	LOC Mystery Map second state	Mercator 1569	Ortelius <i>Americae Sive</i> 1587	De Jode 1593
Abbreviation for island	y <sup>a</sup>	Mostly I.	y and y <sup>a</sup>	Ins	1. I.
Cape of San Francisco		1. C. de S. Frñcesco.	2. C. de S Frਾਂcisco		1. C. de S. Frácsco.

The weight of importance for the Abbreviation for Island evaluation criterion is 5.

#### 4.1.6. Diacritical marks

- Ten points for using Diacritical Marks such as a tilde or a grave over the 'n' or an accent over the 'a' in C. de S. Frñcesco.

The weight of importance for the Diacritical Marks evaluation criterion is 5.

#### 4.2. Second tradeoff study

We did a tradeoff study to identify the second engraver of the LoC Mystery Map. Our evaluation criteria were (1) the presence of S. Felicis and S. Nabor islands, (2) a match to the Handwriting of the Second Engraver, (3) the Number of Overlapping Toponyms, (4) a Label for the Cape of San Frñcesco, (5) the Abbreviation for Island, and (6) the use of Diacritical Marks.

First, we applied these evaluation criteria to our 30 top alternative cartographers. This eliminated most of them and left Gutiérrez & Cock 1562, Mercator 1569, Thevet 1575, Ortelius *Americae Sive* 1571 and 1587, C. de Jode 1593, Plancius 1594, Van Langren 1596, Wright & Molyneux 1599/1600, and Mercator & Hondius 1608.

This tradeoff study indicates that Cornelius de Jode (with a rating of 9.66, wow!) was the most likely second engraver of the LoC Mystery Map with Mercator & Hondius and Wright & Molyneux running a distant second place (with ratings of 4.54). Differences this large are unusual in a tradeoff study. This also establishes the date of the second state as around 1588.<sup>13</sup>

The most important *evaluation criteria* were for the islands of S. Felicis and S. Nabor, the Cape of San Frñcesco, and the Number of Overlapping Toponyms. The results of the sensitivity analysis of our tradeoff study given in [Table 7](#), showed that the most significant *weights of importance* for determining the second engraver of the LoC Mystery Map were those for the islands S. Felicis and S. Nabor and the Cape of San Frñcesco. Therefore we reevaluated those weights in many iterations. We found the most significant *scores* were those for (1) the Mercator and De Jode alternatives of the S. Felicis and S. Nabor evaluation criterion and (2) the Mercator, De Jode, Van Langren, and Wright & Molyneux alternatives for the Cape of San Frñcesco criterion. Therefore, we did extra research and consulted other experts to get better values for these scores.

### 5. Date of the LoC Mystery Map

The earliest and latest feasible creation dates for the *first* state of the LoC Mystery Map can be estimated as follows.

- The division of the Equator into equal intervals indicates a date after 1519.
- The use of an Italic font indicates a date after 1540.
- The snake-like representation of the Amazon River indicates a date after 1544.
- Depending on the geographic region, politics, and scientific knowledge, most cartographers switched from woodblock cutting to copperplate engraving around the middle of the sixteenth century. This map is from an engraved copper plate. Therefore, it was probably made in the last half of the sixteenth century.

- Many of its features make it look like a portolan chart, which would place it in the first part of the sixteenth century.
- Its cartouche has light (illuminated) and dark (shadow) regions. This creates an illusion of three-dimensionality. This map's cartouche seems to be composed of metal, machined, mechanical, three-dimensional parts, not wood carvings, rolled scrolls, and fleurs. This suggests a date after 1560.
- The bulge on the southwest coast of Chile requires a date between 1561 and 1588.
- The map contains the Galapagos Islands and they did not appear on maps until 1569.
- The sea monster and its descriptive text were copied onto the map of Cornelius De Jode 1593. Therefore, the first state of the LoC Mystery Map must have been made before 1593.

Therefore, we think it is safe to surmise that this map was made between 1569 and 1588.

So far in this paper, all conclusions were based only on things contained on the maps themselves. We will now digress and consider some historical texts. If the engraver were Mercator, then the creation date must have been before 1578, because after he finished translating, correcting, and updating Ptolemy's *Geographica*, because of lack of time and physical frailty, he continued *drawing* maps but he stopped *engraving* maps and left that to relatives and associates (Taylor, 2004).

The earliest and latest feasible creation dates for the Library of Congress *second* state of the LoC Mystery Map can be estimated as follows.

- The second state must have been made after the first state.
- The map contains the islands S. Felicis and S. Nabor in the second engraver's 'handwriting.' These islands were not identified until 1579 by Spanish mariners. They did not appear on maps until the Ortelius 1587 *Americae Sive* map.
- Twenty-two specific toponyms (Table 6) were carved by the second engraver along the Pacific coast of South America from the Equator to the Straights of Magellan. Eighteen of these toponyms did not appear on any maps of Table 1 except on the *Americae Sive* maps of Ortelius 1587, 1588, etc., and the 1593 Cornelius De Jode map.
- *C. de S. Frñesco* (0.65° N, 80.08° W) just above the Equator is only labeled in the second state of the LoC Mystery Map and the maps of Mercator 1569, Massa 1580, De Jode 1593, Van Langren 1596, and Wright & Molyneux 1599/1600. Only De Jode 1593 and the second engraver of the LoC Mystery Map put a tilde over the n in *C. de S. Frñesco*.

Therefore, we think it is safe to surmise that this second state was produced after 1587 and before 1588.

Once again let us forsake the maps and consider historical texts. If the second engraver was Cornelius de Jode, then the creation date would most likely be 1588. Because he was born in 1568, he would have been 20 years old when he made this map.

Radiocarbon dating of the paper that the map was printed on and the ink of the second engraver would be a welcome addition to our knowledge of this map.

## 6. Discussion

In the first half of the sixteenth century, world maps began to appear containing the western coasts of South and North American. Most subsequent maps were similar. They just slowly



**Table 7.** A tradeoff study matrix for discovering the creator of the second state LoC Mystery Map.

Tradeoff Study Matrix for discovering the creator of the second state of the LoC Mystery Map using a Sum Combining Function with the number of alternatives equal to 10																								
Alternative cartographers → w means weight, s means score and ws means weight times score Evaluation Criteria ↓	Weights of Importance	Normalized Criteria Weights w	LoC Mystery Map		Gutiérrez & Cock 1562		Mercator 1569		Mercator & Hondius 1608		Ortelius, Americae Sive, 1571		Ortelius, Americae Sive, 1587		Thevet 1575		Plancius 1594		De Jode 1593		Van Langren 1596		Wright & Molyneux 1599/1600	
			s	ws	s	ws	s	ws	s	ws	s	ws	s	ws	s	ws	s	ws	s	ws	s	ws	s	ws
S. Felcis and S. Nabor Handwriting of Second Engraver	10	0.23	10	2.27	0	0.00	0	0.00	10	2.27	0	0.00	8	1.82	0	0.00	0	0.00	10	2.27	0	0.00	0	0.00
Overlapping Toponyms	8	0.18	10	1.82	1	0.18	2	0.31	2	0.31	4	0.68	6	1.02	1	0.18	1	0.18	10	1.82	2	0.40	2	0.31
Cape of San Francisco	10	0.23	10	2.27	0	0.00	10	2.27	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	10	2.27	10	2.27	10	2.27
Abbreviation for Island	5	0.11	10	1.14	0	0.00	0	0.00	10	1.14	0	0.00	0	0.00	0	0.00	0	0.00	10	1.14	10	1.14	10	1.14
Diacritical marks	5	0.11	10	1.14	0	0.00	3	0.34	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	10	1.14	0	0.00	0	0.00
Column sum	44	1.00																						
Alternative Ratings			10.00	0.45	3.06				4.54		1.16		3.72		0.73		0.86		9.66		4.49		4.54	

added details. There seemed to have been no lead cartographer. Then in 1569–70 Mercator and Ortelius engraved a big bulge on the southwest coast of Chile. A dozen other cartographers followed their lead and produced maps with a big bulge on the southwest coast of Chile. Finally, in 1588, Ortelius removed the bulge and again everyone followed suit, except for M. Mercator 1595 and a few other stragglers. Ortelius realigned the coast of Chile on his 1587 *Americae Sive* and his 1589 *Maris Pacifici* maps to be approximately north. The other cartographers followed suit. At about this same time he also dropped the latitude of San Pablo and Isla de los Tiburones about six degrees (on *Typus Orbis Terrarum* and *Maris Pacifici* but not on *Americae Sive*) and removed the cities and villages with American-Indian sounding names: again the whole group of cartographers followed him. In 1587, he added the Chesapeake Bay to his *Americae Sive* map and corrected the name of one island from Ins de los galopegas to Ins de Cocos. These seven items (adding and removing the big bulge on the southwest coast of Chile, straightening the coast of Chile, ‘moving’ San Pablo and Isla de los Tiburones, removing the American-Indian sounding names, adding the Chesapeake Bay, and correcting the name of Ins de Cocos) indicate that Ortelius was the instigator and a dozen cartographers followed his lead.

*Who copied from whom?* In the Middle Ages and the Renaissance, it was common for map makers to copy from each other. There were no copyright laws. In this era, a printer could be given a monopoly, privilege, or patent for a lifetime or a certain number of years by the crown or in the Netherlands the State General. Copying was not considered stealing. In fact, it was considered good practice because the overall worldwide quality of maps improved. Furthermore including details from previous maps indicated that the cartographer was aware of these previous maps. A similar practice is used today when authors cite previous papers to show that they are cognizant of the relevant literature. In addition, no one person could have visited all of the places on these maps. Indeed most of these mapmakers had never been to sea. Within this community, judging by the dates, we suggest that Abraham Ortelius was the originator of most of the changes made between 1570 and 1590.

### 6.1. Assumptions

The following assumptions have been made throughout the formulation and writing of this paper.

1. The LoC Mystery Map is not a hoax.
2. LoC Mystery Map was printed from an engraved copper plate.
3. The LoC Mystery Map is one section of a large wall map of the world.
4. Features on one map would often appear on other maps created by the same cartographer/engraver.
5. This map was made by a currently known sixteenth-century cartographer/engraver and not by some unknown sixteenth-century person.
6. Unless stated otherwise, the cartographer was also the engraver.
7. When we mentioned a cartographer by name we meant to include others who helped him, such as apprentices, engravers, printers, and publishers.
8. If copying were done, then the newer map was copied from the older map and not vice versa.

9. Maps analyzed in this paper were available to other sixteenth-century cartographers. We did not use secret maps from, for example, the Spanish *Patron Real* except possibly for the Cabot 1544 and S. Gutiérrez 1551 maps.
10. Communication between cartographers was through the public dissemination of maps. There were no private exchanges of information. This is the weakest assumption.

Now that this paper is finished, we look back at these assumptions and judge that they are reasonable.

*Future research.* With a little effort, this tradeoff study could be modified to show which maps Mateo Ricci 1602 copied from.

## 7. Conclusions

The results of our first tradeoff study on the first state of the LoC Mystery Map showed that Cornelius de Jode (with a rating of 6.30) or Gerald Mercator (with a rating of 6.09) was the most likely cartographer/engraver of the LoC Mystery Map.

Physical and mental states suggest that if Mercator were the cartographer/engraver, then a creation date of 1569–1578 is most reasonable because he stopped engraving in 1578. If Cornelius de Jode were the cartographer/engraver, then a creation date of 1588 is most reasonable because he was only born in 1568.

The results of our second tradeoff study on the second state of the LoC Mystery Map showed that Cornelius de Jode was the overwhelming candidate for the second engraver.

This now leaves two interesting scenarios: (1) Gerald Mercator was the first engraver between 1569 and 1578 and Cornelius de Jode was the second engraver around 1588. Or (2) Cornelius de Jode was the first engraver in 1588 and someone else was the second engraver a few years later.

In this paper, we introduced a new tool, tradeoff studies, into the field of cartography. The tradeoff study allowed us to consider hundreds of possible alternative cartographers. The tradeoff study unearthed a candidate who was not previously considered in the literature, namely Cornelius de Jode.

## 8. Summary

If the LoC Mystery Map is not a hoax, then its first state was surely created between 1569 and 1578 by Gerald Mercator or around 1588 by Cornelius de Jode. If Mercator created the first state, then De Jode created the second around 1588. If De Jode created the first state, then an assistant created the second state around 1590

## Notes

1. TinEye is an Internet tool that can compare your image to over a trillion images on the Internet.
2. The Library of Congress kindly gave Bahill a copy of Philip Burden's letter to James Flatness dated 12 April 1994. Bahill is willing to share this letter: [terry@sie.arizona.edu](mailto:terry@sie.arizona.edu).
3. Some of the map details may be too small to see on the published figures of this paper. Therefore, we have provided a list of the sources for the maps mentioned. This list/database is located here: <http://sysengr.engr.arizona.edu/> This list contains URLs for large-size original

maps that are mostly in the public domain, that is, being free of known restrictions under copyright law.

4. Translations usually refer to translations of an atlas not of an individual map. In an atlas a single map might have say a dozen pages of text associated with it. The translation would be of the text pages and perhaps the text on the verso side of the maps. They probably did not change the maps or the words on them.
5. By using the word *font*, we are not implying that this map was printed using Gutenberg's invention of moveable type. There were dozens of fonts before Gutenberg. Today, the most common font for printed material is probably Times New Roman and United States school children use Zaner-Bloser® or D'Nealian®. Mercator published his book on the Italic font in 1540. He may have been the first to engrave copper plates in an Italic font. The Kunstmuseum IV planisphere published in 1519 was the first map to show (1) the whole equatorial circumference of the Earth and (2) the Equator divided into equal intervals of longitude (Gaspar, 2021).
6. The First World Map of Pîrî Reis 1513 was meticulously drawn with color on antelope skin (Reis, 1526; McIntosh, 2014; YÜRÜKÇÜ, 2019). It is mentioned here because it is one of the earliest maps containing South America. However, it was written in Turkish so we cannot compare its letters to the Italic lettering introduced in the 1540s. Pîrî Reis is not a good candidate for the second engraver of the LoC Mystery Map. But we will continue to present this map just to set the frame of the maps we discuss.
7. Lee (2015) used a traditional cartographical technique of studying historical texts about explorations, biographies, birth and death dates of emperors, and political texts to analyze Ricci's map. Lee asserted that the Ricci map was made in 1430. Our traceability tool (Bahill & Gitzen, 2021) of studying the maps themselves concludes that the snake-like representation of the Amazon River dates this map to between 1544–45 and the early seventeenth century. No map out of this range has this snake-like representation of the Amazon River.
8. Leonardo da Vinci had mastered shadows and perspective drawing in the early sixteenth century. In his *Mona Lisa*, painted between 1503 and 1506, he used *sfumato* which is the subtle gradation of tone used to obscure sharp edges. Furthermore, away from the focal point of the painting, the mid-tones blend into shadows and color dissipates into monochromatic blacks. But evidentially, sixteenth-century cartographers were not aware of da Vinci and his work on shadows. See Leonardo da Vinci, *Codex Leicester*, CORBIS, Bellevue WA, 1996.
9. Magellan's ships entered the strait on All Saints Day, 1 November 1520. Therefore, Magellan named the strait *Estrecho de Todos los Santos* (Strait of All Saints) others called it *Estrecho de la Victoria* (Strait of Victoria) commemorating the first ship that entered, Magellan's *Victoria*. The *Victoria* was also the only one of Magellan's ships to complete the circumnavigation of the world. On his map of 1529 Diego Riberio labeled it *Estrecho de la Fernan Magellanes* in honor of Magellan. Fine followed suit in 1536. Another subcriterion that we considered for this region was "Does this region look like a big landmass (South America and Antarctica) pierced by the Strait of Magellan (which is two to 20 miles wide) or does it look like two big landmasses separated by 500 miles?" The first was proposed by Magellan in 1520. The second by Drake in 1580. This turned out to be a bad metric because no sixteenth-century maps had the Drake Passage. It did not appear until Speed 1627 and Blaeu 1635.
10. Notes accompanying the Abraham Ortelius 1587 *Americae Sive Novi Orbis* quote Koeman as writing "This atlas of ancient geography must be regarded as a personal work of Ortelius. For this work he did not, as in the *Theatrum*, copy other people's maps but drew the originals himself which were later engraved by Jan Wierix i.a." Koeman Ort 38; van der Krogt 31:651. <https://www.davidrumsey.com/luna/servlet/s/r95ge0>. The following web site has a listing and images of most maps by Ortelius Background on Ortelius Maps
11. We invented a new technique for computing the sensitivities of criteria that are verbal, not numeric. We chose a performance index that had been previously validated (Smith et al., 2008), namely the sum of all of the weights times scores in the tradeoff study matrix,  $PI_3$ . Then we used zeros to replace all of the scores in the row for the evaluation criteria being studied. We computed the change in the performance index. This change was the sensitivity

of the tradeoff matrix with respect to that criterion. The most sensitive criteria were the Bulge on the Southwest Coast of Chile, the Cartouches, and the Slow Sloth.

12. Ortelius's *Americae Sive* map was published many times between 1570 and 1630. Some modern historians (Shirley, 1983) do not reference them by year, but rather they reference them by copper plate number (edition) and state number (version). For example, the first map to remove the bulge from the western coast of Chile was *Typus Orbis Terrarum* 1588 P2S3. Ortelius's *Americae Sive* had three plates, editions. The first was published in the atlas of 1570. The second was contained in the 1579 atlas. And third was in the 1587 atlas. The third plate had two states: published in 1587 and sometime after 1612. Plates and states are analogous to editions and printings in modern book publishing. A book will have a first edition that will go through 10 or 20 printings as shown on the copyright page, which is the back of the title page. Each printing might have small changes correcting typographical errors etc. But if the book is successful and there are large changes, then they will be incorporated into a second edition. This second edition will then go through multiple printings. <https://www.raremaps.com/gallery/detail/68217/americae-sive-novi-orbis-nova-descriptio-ortelius>
13. Gerald de Jode was a well-respected cartographer, printer, and publisher. His first notable maps were published in his 1578 atlas *Speculum Orbis Terrae*. Many of his maps in this atlas were engraved by the brothers Johannes and Lucas Doetechum. None of Gerald de Jode's maps in this atlas scored well enough to place him in our tradeoff studies. His son Cornelius de Jode was born in 1568. That would have made him 21 years old at the time of his first major map publication *Totius Orbis Cogniti Universalis Description* in 1589. This map is usually attributed to Cornelius although his Father's name also appears on the map. This map had little similarity to the LoC Mystery Map. It was his 1593 map *Brasilia et Peruvia* published after his father died in 1591 that put Cornelius's fingerprints all over the LoC Mystery Map.

## Acknowledgments

We are grateful to Joaquim Alves Gaspar for pointing out the Mega website <https://mega.nz/folder/moN3iSjL#0a57E0iCJijqGqtCKT67ww>, which contains over 140 sixteenth-century maps. We thank Jim Close for his valuable comments on the manuscript.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Funding

This work was supported by none: [Grant Number none].

## Notes on contributor

**Terry Bahill** is an Emeritus Professor of Systems Engineering and Biomedical Engineering at the University of Arizona in Tucson. He served for ten years in the United States Navy leaving as a Lieutenant. He received his Ph.D. in electrical engineering and computer science from the University of California, Berkeley. He is the author of eight engineering books and over two hundred and fifty papers, over one hundred of them in peer-reviewed scientific journals. Bahill has worked with dozens of high-technology companies presenting seminars on Systems Engineering, working on system development teams, and helping them to describe their Systems Engineering processes. He holds a U.S. patent for the Bat Chooser™, a system that computes the Ideal Bat Weight™ for individual baseball and softball batters. He was elected to the Omega Alpha Association, the



systems engineering honor society. He received the Sandia National Laboratories Gold President's Quality Award. He is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), of Raytheon Missile Systems, of the International Council on Systems Engineering (INCOSE), and of the American Association for the Advancement of Science (AAAS). He is the Founding Chair Emeritus of the INCOSE Fellows Committee. His picture is in the Baseball Hall of Fame's exhibition 'Baseball as America.' You can view this picture at <http://sysengr.engr.arizona.edu/>.

## ORCID

A. Terry Bahill  <http://orcid.org/0000-0003-4057-2479>

## References

- Bahill, A. T., & Gitzen, G. D. (2021). The Amazon River modeled as a giant snake, accepted for publication in *J. of Cartography and Geographic Information*.
- Bahill, A. T., & Madni, A. M. (2017). *Tradeoff Decisions in System Design*. Springer Publishing Company, ISBN 978-3-319-43710-1. Chapter 5 is on Tradeoff Studies.
- Burden, P. D. (1996). *The Mapping of North America: A List of Printed Maps 1511–1670*, vol. 1, no. 47. Raleigh Publications, Rickmansworth, Hertfordshire, UK. ISBN 0952773309.
- California as an Island in Maps. (2011) Maps from the Glen McLaughlin collection of California as an Island, Stanford University Libraries, August 2021. <https://exhibits.stanford.edu/california-as-an-island>.
- Corney, B. G. (1920). The isles of San Felix and San Nabor. *The Geographical Journal*, 56(no. 3), 196–200. JSTOR, [www.jstor.org/stable/1781535](http://www.jstor.org/stable/1781535). 15 August 2021. <https://doi.org/10.2307/1781535>
- Cortese, A. (1939). António Pereira and his map of Circa 1545: An unknown Portuguese Cartographer and the early representation of Newfoundland, Lower California, the amazon, and the Ladrões, *Geographical Review*, Vol. 29, No. 2, pp. 205–225. Taylor & Francis, Ltd. Stable URL: <https://www.jstor.org/stable/209943>.
- da Vinci, L. (1996). *Codex leicester*. CORBIS.
- Gaspar, J. (2021). MEDEA-Chart, April 22, 2021, <https://www.medeia-chart.org/single-post/chart-of-the-week-kunstmann-iv-chart-anonymous-circa-1519-lost>.
- Gesner, K. (1553). *Icones animalium quadrupedum viviparorum et oviparorum*. Froschauer. 1553. However, Thevet did not visit Brazil until 1555.
- Giuliani, F., De Falco, A., Landi, S., Bevilacqua, M.G., Santini, L. and Pecori, S. (January–February 2018). Reusing grain silos from the 1930s in Italy. A multi-criteria decision analysis for the case of arezzo. *Journal of Cultural Heritage*, 29, 145–159. <https://doi.org/10.1016/j.culher.2017.07.009>
- Harris, J. (2004). Reading the first atlases: Ortelius, De Jode and TCD volume M.aa.9. *The Long Room*, vol. 49, 28–53.
- Jackson, M. (1993). *Galapagos, a natural history*. University of Calgary Press. 1
- Lee, S. L. (January 20 2015). Maps that turn world history upside down. *Midwestern Epigraphic Society Journal*, 24–29.
- McIntosh, G. C. (2014). The Piri Reis Map of 1513: Art and literature in the service of science. In D. Couto, F. GunerGun, & M. P. Pedani (Eds.), *Seapower, technology and trade* (pp. 367–379). Piri Reis University Publication. [https://www.researchgate.net/publication/286455909\\_The\\_Piri\\_Reis\\_Map\\_of\\_1513\\_Art\\_and\\_Literature\\_in\\_the\\_Service\\_of\\_Science](https://www.researchgate.net/publication/286455909_The_Piri_Reis_Map_of_1513_Art_and_Literature_in_the_Service_of_Science)
- Reis, P. (1526). Kitab-I Bahriye (Book of Navigation), <https://dl.wdl.org/9210/service/9210.pdf>, 14 August 2021. This appears to be a 775-page atlas written in Turkish. A Piri Reis map of the Mediterranean Sea appears to be on pages 133 and 134.
- Shirley, R. W. (1983). *The Mapping of the world: Early printed world maps, 1472–1700* (1st ed). Holland Press.
- Smith, E. D., Szidarovszky, F., Karnavas, W. J., & Bahill, A. T. (2008). Sensitivity analysis, a powerful system validation technique. *The Open Cybernetics and Systemics Journal*, <http://benthamopen.com/tocsj/articles/V002/39TOCSJ.pdf> 2:39–56.

- Snyder, J. P. (2007). Map projections in the renaissance, Chapter 10. In D. Woodward (Ed.), *The History of Cartography* (Volume 3, pp. 365–381). Cartography in the European Renaissance, the University of Chicago. free download at [https://geography.wisc.edu/histcart/volume-3-cartography-in-the-european-renaissance/https://press.uchicago.edu/books/HOC/HOC\\_V3\\_Pt1/Volume3\\_Part1.html](https://geography.wisc.edu/histcart/volume-3-cartography-in-the-european-renaissance/https://press.uchicago.edu/books/HOC/HOC_V3_Pt1/Volume3_Part1.html).
- Snyder, J. P., & Voxland, P. M. (1989). Professional Paper 1453, An album of map projections, USGS Publications Warehouse, <http://pubs.er.usgs.gov/publication/pp1453>.
- Taylor, A. (2004). The world of Gerard mercator. *Walker*, ISBN 0-8027-1377-7, OCLC 55207983.
- Woodward, D.(2007). *The History of Cartography: Volume 3, Cartography in the European Renaissance*, Chicago, available free for download at [https://geography.wisc.edu/histcart/volume-3-cartography-in-the-european-renaissance/https://press.uchicago.edu/books/HOC/HOC\\_V3\\_Pt1/Volume3\\_Part1.html](https://geography.wisc.edu/histcart/volume-3-cartography-in-the-european-renaissance/https://press.uchicago.edu/books/HOC/HOC_V3_Pt1/Volume3_Part1.html).
- YÜRÜKÇÜ, A. (2019). Kitab-ı Bahriye (Book of Navigation), Commemoration of the Piri Reis and Understand His World Map of 1513, 29th International Cartographic Association Conference (ICC 2019) DOI: 10.5194/ica-proc-2-154-2019.