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Cartography, Geometry, and Communication: How to Narrate the Shape of the World Before and After the Journey of Magellan and Elcano

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Abstract

Introduction: An analysis of the maps of the first passage around the world is undoubtedly an essential objective in explaining knowledge about newly discovered land. These maps are one of the greatest demonstrations of the visual communication of the era. **Methodology:** With this objective, this article seeks to provide an analysis of 16th-century world maps related to the circumnavigation by Magellan and Elcano and produced by the cartographers of the *Casa de Contratación de Sevilla* [“House of

Trade of Seville”], paying special attention to the differences between maps produced before and after the journey. The technique used is content analysis. **Results and conclusions:** The differences between maps appear in contextual elements, such as the presence of titles and production dates inserted in the maps and ordinal semiotic elements. However, it should be noted that this analysis does not include the design of the maps or the reliability of their representation.

Keywords: Cartography; around the world; communication; geometry; semiotics.

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Translation: **AJE**, American Journal Experts.

1. Introduction

“Good parents give their children roots
and wings; and also a map”.
Chinese proverb from Miranda Bonilla,
López Lara & Canto Ruiz (2010).

At the end of the 15th century, the image of the known world underwent a radical transformation under the sole initiative of the Iberian kingdoms. Within a period of just thirty years, the discovery of America on Columbus’ first journey (1492), Vasco da Gama’s arrival to India (1497-1499), and the first terrestrial circumnavigation by Magellan and Elcano (1519-1522) took place.

After three years of travel, only 18 sailors and one ship from the original 250 men and five ships that began the journey around the world returned. Among those lost along the way was Ferdinand Magellan, the promoter of the expedition, who was killed in a battle on the island of Mactan in the Philippines. Among the survivors was Antonio Pigafetta, who, aware of the importance of the enterprise, wrote the official diary of the journey, “The First Voyage Round the World”, (Pigafetta, 1800), which was accompanied by maps representing, among other places, the Strait of Magellan and the Maluku Islands.

The initial objective of finding a new route to the Maluku Islands for the spice trade that would avoid the Portuguese monopoly would be widely surpassed by the scientific achievements resulting from the journey, such as the confirmation of the shape of the Earth and the connectedness of all of the oceans, as well as the discovery of new constellations, resources, ethnicities, and territories. The voyage by Magellan and Elcano represents the consolidation of scientific navigation and is considered one of the most important instances of exploration in history (Olmedo Granados, 2015; Sánchez Sorondo, 2006; Zweig, 2015).

The feat of terrestrial circumnavigation was only possible with the support of cartography as a guide to travelling to the limits of the known world; beyond these limits, astronomical and topographical data and the systematic creation of new maps based on a scientific method ensured that the new knowledge achieved would be beneficial for the sponsoring kingdoms and all subsequent navigators.

The representation of the world during the 14th and 15th centuries appears mainly in the basic instruments of navigation, the so-called nautical or portolan charts created in the 13th century. These are flat projection maps oriented towards the magnetic north, most of which portray the coasts of the Mediterranean and the main ports along them with a multitude of lines radiating out from the ports following the directions of the compass rose represented on the same map (Sellés, 2007). Their main characteristic is that they are topographical representations; that is, they are based on the presentation of data from reality to paper, considering the Earth to be flat. The revolution entailed by Christopher Columbus' discovery, with the impetus of so-called altitude navigation, would lead to the need to address the geometric challenge of projecting the terrestrial sphere onto a plane.

Also notable is the rediscovery, in the mid-15th century, of the geographical work of Claudius Ptolemy (2nd century), which, thanks to the support of the printing press, achieved wide distribution, revolutionizing interest in representations of and knowledge about the Earth. As a result, the first world atlases based on latitude and longitude coordinate systems were made during that century, providing increasingly abundant data due to the progress of maritime and terrestrial explorations.

The exploration of the “New World” would make it necessary to overcome the Ptolemaic view, accepting the existence of a new continent, the representation of which would be gradually refined. The first attempt to represent the territories that were discovered is the work by Juan de la Cosa, a cartographer who accompanied Columbus' expeditions. Speculation would soon emerge regarding the possibility that the lands discovered represented a new continent. In 1507, the German publisher Martin Waldseemüller named these new lands on his world map after Amerigo Vespucci, whose works he was translating, Latinized and with the feminine grammatical gender, according to the custom. Finally, Gerardus Mercator, the cartographer who developed an innovative projection system to correct the deficiencies of the portolan maps, leading to so-called spherical maps, took that initial reference and popularized the term “America”, forsaking the figure of Christopher Columbus.

It is clear that in this context, scientific advances in fields such as astronomy, topography, navigation, and cartography provide a strategic advantage for the kingdoms that dominate them. The Catholic kings themselves foresaw the importance of registering and visualizing the new territories on maps as sources of information with which to improve political decision making (Gómez Martín, 2015; Martín-Merás, 2000). For this reason, since its beginnings, they made the *Casa de Contratación de Sevilla*, founded in 1503, responsible for training cosmographers, cartographers, and pilots under the direction of the Head Pilot. The cartographer Amerigo Vespucci would be the first of these, and would receive the mission of creating the so-called *Padrón Real* [General Register], a model navigation map that would remain in Seville to be updated with the information resulting from each maritime exploration once recruited. This Sevillian institution would later give rise during the eras of Charles V and Philip II to great cosmographers such as Juan Vespuccio, Diego Ribero, and Alonzo de Santa Cruz, who would contribute notable works to the history of world cartography.

Cartography is a science that goes beyond its instrumental use; maps not only contain information for improved visualization but also are authentic modes of communication and the dissemination of ideas.

Kolicny (1969) made the pioneering proposal that the information contained in and the use of the map should be treated as a whole since its construction, as maps are not only a source of data but also a means of communicating them. As a science, cartography represents and describes spatial phenomena in a symbolic way, thereby modelling the reality described.

In the context of the era of discovery, maps not only record the spaces discovered but also create them through their representation (Bryan, 2009; Crampton, 2010), and this characteristic gives rise to the close relationship forged between cartography and colonialism. Harley (1990) notes as an example the work of taking possession of the lands discovered and the conversion to Catholicism of their inhabitants that Christopher Columbus carried out in the name of King Ferdinand and Queen Isabella. Columbus renamed islands and places with indigenous names with Christian names such as “San Salvador”, “Santa María de la Concepción”, and “Trinidad”. His work, expressed on maps such as the world map by Juan de la Costa, was so successful that very few American geographic features have retained their original indigenous names to this day. The cartography created serves not only as a document for knowledge and the recording of information but also as a tool of Spanish imperial power over the new territories. We can consider in a similar way the aforementioned case of the baptism and birth of the American continent thanks to the cartographic work of Waldseemüller and Mercator.

Indeed, the cartography of the time has been considered a basic element for describing and explaining the economic, political, and scientific pre-eminence of Spain and Portugal during that era (Sánchez Martínez, 2009) and, specifically, the semiotics of cartography for the understanding of territories (Nates Cruz and Raymond, 2006) and the communicability of the cartographic product, model, or image (Azocar Fernández, 2017:71-72); however, there have also been warnings about the inaccessibility of current semiotic cartography to the average reader (Lois, 2000).

The Magellan undertaking took as its sources the most precise maps of the era developed at the *Casa de Contratación de Sevilla* for the *Padrón Real*. The inventory of scientific instrumentation listed by Pigafetta in his diary (1800) notes “23 nautical charts made by Nuño García”. Nuño García de Torenó was the Head Pilot of the *Casa de Contratación* in the period 1519-1527, sharing his post with Juan Vespucio, and thus, it is normal that his work served as the official documentation from which the expedition was supplied.

Of interest in this article are not only the maps created prior to the terrestrial circumnavigation that served as a source of information for that journey but also the cartography created subsequently by the *Casa de Contratación de Sevilla* with updates based on the findings of the journey. The selection made was carried out based on the following criteria: the works created by the *Casa de Contratación de Sevilla* or by cosmographers trained there; world maps or complete representations of the Earth; works that were used for the preparation of the Magellan expedition or that are directly related to information gathered in it.

The first world map selected is the First Map of the New World created by Juan de la Cosa, the cartographer on several of Columbus’ expeditions. His map, dated to approximately 1500, was made to provide an account of Columbus’ findings to the Catholic kings and became the initial prototype of the entire production of the *Casa de Contratación* (Martín-Merás, 2000). De la Cosa represents on his map the new names devised by Columbus for the settlements and islands discovered. The map also includes numerous semiotic elements that have a prominent role in the communicative objective of the map, such as the character of Saint Christopher carrying the Christ child in his arms located at the

map's axis of symmetry; the national flags of Spain and England, which at the time were allies; and the parallel representation of the Portuguese and Spanish discoveries. After its loss and a perilous international journey, the map was recovered by the Ministry of the Navy and is currently located at the Naval Museum of Madrid.

Magellan prepared for his departure from Seville with his compatriots Pedro Reinel and his son Jorge, with Diego Ribero in charge of the preparation of the *Padrón Real* at the *Casa de Contratación*, and thus he possessed the most recent and accurate data for his undertaking (Olmedo Granados, 2015). These cosmographers are the authors of the next maps selected:

The map by Jorge Reinel in 1519 was probably created in Seville. It represents the South Sea recently discovered by Nuñez de Balboa and a fictitious passage towards it that appears to coincide with the Río de la Plata. The Spice Islands and the Malukus appeared to be not far away in the South Sea, which was a distance error that resulted in one of the greatest hardships of the Magellan expedition. This map can currently be found at the National Library of France in Paris.

The world map of the Miller Atlas (1519) is a meticulous and visionary work carried out for King Manuel I of Portugal. The cartographer Lopo Homem is identified as the author, although it is thought that Pedro and Jorge Reinel were also involved in its creation. It portrays a large proportion of landmass in relation to the oceans. The New World is connected with the East Indies, although a canal or possible passage is shown to the south of Brazil. This map is also held at the National Library of France.

The maps mentioned thus far were sources of information for the Magellan expedition. The following maps are noted for their precision and scientific nature, made possible after their journey thanks to the gathering of new data from around the terrestrial globe.

The next map selected was the Castiglioni Planisphere, created in 1525 in Seville by Diego Ribero, a Portuguese-born cosmographer in the service of the *Casa de Contratación* (Vigneras, 1962). It contains a precise documentation of the initial findings that were recorded as a result of the first voyage around the world. The maritime space between America and the Malukus is extended, reaching the actual dimensions, and the Strait of Magellan is drawn. Three oceans are named, corresponding to the Atlantic, Indian, and Pacific, and it is adorned with astronomic and navigational instruments that made the feat of Magellan and Elcano possible, such as the quadrant, the astrolabe, and the solar circuit. This map is housed at the Biblioteca Universitaria Estense de Módena.

The “Map of the Known World” is a portolan map by Juan Vespucio, the son of Amerigo, created in 1526. It consists of a decorated copy of the *Padrón Real* with the coat of arms of the Germanic empire of Charles V crowning America and the flags of Castile and León and Portuguese flags marking the territories of each kingdom based on the Tordesillas meridian. It includes two compass roses and various ships, buildings, and animals decorating the land and the oceans. It incorporates the discoveries of the Strait of Magellan (1520), the city of México-Tenochtitlán (1521), and the Ayllón expedition to South Carolina (1521). The original document is found in the possession of the Hispanic Society of New York (Instituto Geográfico Nacional - Servicio de Documentación, n.d.).

As its title indicates, the “Universal chart in which it is contained all that has been discovered in the world until now. Diego Ribero, Cosmographer of His Majesty, made it in the year 1529 in Seville” contains all of the information obtained from the chronicle by Pigafetta. Similar to the previous map from 1525, it features the flags of Castile and León and Portugal and decorations with compass roses,

ships, fauna, and buildings. It especially highlights the line of division of the world derived from the Treaty of Tordesillas. An original copy given to the Pope by Charles V is found at the Museo del Palazzo di Propaganda Fide in Rome.

The oval projection world map included in the Portolan Atlas by Battista Agnese, created in Venice approximately 1544, was commissioned to commemorate the Magellan-Elcano voyage. The map includes the route followed by the exploration from Sanlúcar de Barrameda to the Strait of Magellan, the Pacific Ocean, and the Maluku Islands, and the return trip through the Indian Ocean and the South Atlantic. Around the map are twelve angels or wind cherubs representing the twelve cardinal points. It is currently held at the Royal Library of Turin.

Finally, a principal work by the Sevillian cosmographer Alonso de Santa Cruz was created for the *Casa de la Contratación*, probably between 1539 and 1560, and was called the “General atlas of all the islands in the world”. This atlas was begun during the time of Charles V and finalized under and ultimately dedicated to his son, Philip II; it contains a precise description of the entire known world as of the mid-16th century. The maps include scales of sea leagues and latitude and longitude in degrees, in addition to orientations with compass roses. Santa Cruz concludes his atlas with special chapters in its fourth section dedicated to America, the description and representation of the Strait of Magellan, and the city of Tenochtitlán. Two original copies of the work reside at the National Library of Spain, and other partial manuscripts are found at the Municipal Library of Besançon and the National Library of Vienna (Cuesta Domingo, 2016).

Recent studies of the maps of the era have usually concentrated on the trials, successes, and mistakes made by the cartographers in designing the new lands, particularly the American continent (Lois, 2007). In this sense, cartographic praxis was part of the process of intellectual construction that Europeans engaged in to imagine the New World, to give it “textual tangibility” (Craib, 2000).

However, we should highlight the research carried out by Lois (2007) regarding the representation of the Atlantic Ocean on these maps and the fact that it notes that the closure of the Atlantic is “a sign of the grasp of the finitude of the world experienced in the 16th century.”

We also highlight the work of Padrón (2015) on the cartography of the Philippines and the East Indies in the maps made up to the 18th century, which highlights above all the conscious omission of those territories from the cartographic production of the era.

In relative accordance with the above, the fundamental objective of this article is to perform an analysis of the communicative value of 16th-century world maps related to the journey of circumnavigation by Magellan and Elcano and what was produced by the cartographers of the *Casa de Contratación de Sevilla*, paying special attention to the difference between maps produced before and after that journey. The analysis is offered from a dual perspective: on the one hand, it adopts a formal perspective, which includes elements that should be found on all maps, essential contextual elements, and elements that are used selectively to help communicate more efficiently; on the other hand, it adopts a cartographic semiotic approach, which includes the analysis of nominal, ordinal, and other signs that add significant value to maps. Therefore, the following working hypotheses are presented:

H1: Notable differences exist between the maps made before and after the journey around the world with regard to the formal, essential, and accessory elements of the maps that help them communicate more effectively.

H2: Notable differences exist between the maps made before and after the journey around the world with regard to the nominal and ordinal elements of cartographic semiotics.

2. Method

2.1. Methodological strategies

With the objective of analysing the maps, particularly exploring the difference in dating the maps before or after the journey, an analysis table was created based on Bertín (1983), Board and Taylor (1985), and Cleveland and McGill (1985) regarding the design, perception, and semiology of the maps. The method for analysing the maps was content analysis.

2.2. Population and sample

The sample consists of eight maps that emerged from or were related to the *Casa de Contratación de Sevilla*. The sample of pre-trip maps consists of that of Juan de la Cosa, which is the oldest (approximately 1500) and that of Jorge Reinel and the world map by Lopo Homem with the participation of Pedro and Jorge Reinel, both dated 1519.

The sample is completed with several maps from immediately after the journey, specifically the Castiglioni Planisphere, a universal chart by Diego Ribero created in Seville in 1525, the world map of Seville Vatican Apostolic Library by the same author in 1529, and the map dated 1526 by Juan Vespuccio (nephew of the famous Amerigo, for whom the New World was named).

Finally, the world map of the Portolan Atlas drafted in Venice by Battista Agnese in approximately 1544 and the General atlas of islands by the cosmographer Alonso de Santa Cruz (1539-1560), which is not a map in the strict sense, but rather, an encyclopaedia or collection of explained maps, are analysed. Excluded from this analysis are the illustrations that Pigafetta created during the journey that portray the Maluku Islands and the Strait of Magellan, among others, as these are partial cartographies, not world maps, and they were also created with the exclusive purpose of recording data to be later transferred to other documents.

In summary, eight maps related to the first journey around the world were analysed, three of which were created prior to the Magellan-Elcano circumnavigation and five of which were created subsequent to it.

2.3. Information gathering instruments

The analysis table is comprised of different parts. The first issues in the table address elements that should be found on all maps, such as scales or orientation. Essential contextual elements, elements that are used selectively to improve the efficiency of communication, and finally, different semiotic elements of cartography (nominal, ordinal, etc.), are subsequently described. The table includes 24 elements of analysis.

2.4 Procedure

The analysis was carried out during September 2018 with the maps printed in high resolution, supported by digital images. Subsequently, the data were entered into the statistical analysis program IBM SPSS (2012) for the analysis of the data obtained and the generation of the corresponding tables.

3. Results

The structure of the results presented below corresponds to the same order as the table described above. Thus, we first highlight the results related to the elements that should be found on all maps. The first of these is the presence of an explicit scale, which is essential when establishing the relationships of distance and proportion among the map elements.

Table 1. Elements that should be present on all maps.

<i>Survey – No. of Maps</i>		Pre-trip	Post-trip	Total
Does the map include some type of explicitly stated scale?	Yes	2	4	6
	No	1	1	2
Total		3	5	7
Is there a compass rose or indicator of cardinal directions?	Yes, in a prominent location	1	1	2
	Yes, small, in the lower left quadrant	2	3	5
	No	0	1	1
Total		3	5	8
Is there a legend indicating the meaning of the symbols?	Yes, small, in the lower left quadrant	0	1	1
	No	3	4	7
Total		3	5	8

Source: author's own elaboration

In this case, it is not possible to speak of a variable situation between pre- and post-trip maps. Thus, in the case of the pre-trip maps, the map by Juan de la Cosa (1500) does not possess an explicit scale of proportion, nor does the map by Agnese (1544), although in this case, relationships of proportion can be seen between the elements, and the lines of the parallels and meridians are also delimited.

The same situation is seen regarding the presence of a compass rose indicating the cardinal directions on the maps, as all of the maps possess this element, with the exception of the 1544 map by Agnese.

Finally, according to Bertín (1983), Board and Taylor (1985), and Cleveland and McGill (1985), one final element—a legend that explains the meaning of the symbols—should be present on all maps, but its general absence is noted on both the pre-trip and the post-trip maps, with the exception of the general atlas of islands by Alonso (1539-1560), which explains at length all of the elements of the maps comprising the atlas.

Continuing with this issue, we now analyse the essential contextual elements, such as the presence of the title of the map, the number of words on it, and its date of production.

In this regard, and in accordance with the data presented in the table below, we observe the first difference between the pre- and post-trip maps: while the pre-trip maps do not include a title, titles can be clearly observed on three post-trip maps, namely, the map by Ribera in 1525, the map by Vesputio in 1526, and the atlas by Alonso in 1539-60. The maps have a long title, between 12 and 15 words in length, and therefore are more descriptive than strictly enunciative, with the exception of the title of the map by Juan Vesputio, which is seven words in length and enunciative in nature.

Similarly, the date of production of the map is not observed on the pre-trip maps, although it is present on the map by Ribera (1525) and the map by Vesputio (1526), and it is not explicitly stated but suggested through frequent temporal references on the atlas by Alonso (1539-60).

However, the Castiglioni Planisphere (1525) and the map by Agnese (1544) do not contain any of the aforementioned elements, and thus, one cannot speak of a generalized concern for contextual elements in maps produced after the journey.

Table 2. Essential contextual elements.

<i>Survey – No. of Maps</i>		Pre-trip	Post-trip	Total
Does the map include a title?	Yes, at the top and centred	0	2	2
	Yes, at the bottom and centred	0	1	1
	No	3	2	5
Total		3	5	8
Does the map include a production date?	Yes, but only the year	0	2	2
	No	3	3	6
Total		3	5	8

Source: author's elaboration

Regarding the third group of elements analysed, elements used selectively to improve the efficiency of communication, we analyse the presence or absence of frames surrounding the maps, the presence of locator maps, inset maps, and bibliographic elements or elements related to the production of the map. In accordance with the table below, we observe the frequent use of frames for the maps. Given that when frames are present, there is only one, it should be noted in this case that it is a resource that is more stylistic than communicative in nature.

Additionally, of note in the case of the pre-trip maps is a lack of general use of the rest of the elements, the locator map, and inset map. Bibliographic elements or elements related to the production of the maps can be observed in the map by Reinel (1519), but not in the others.

In the case of the post-trip maps, there is greater variability. Thus, while locator maps and inset maps are only seen in the General Atlas of Islands in the World by Alonso (1539-60), bibliographic or production elements are seen on that map and the maps by Ribera (1525) and Vesputio (1526). The Castiglioni Planisphere and the map by Agnese present the same situation as the pre-trip maps, with a

complete absence of elements that help improve the efficiency of communication, except for the aforementioned frame around the map.

Table 3. Elements used selectively to communicate more efficiently.

<i>Survey – No. of Maps</i>		Pre-trip	Post-trip	Total
Does the map include boxes that frame the map?	Yes, 1	2	5	7
	No	1	0	1
Total		3	5	8
Does the map include a locator map?	Yes, in a prominent place	0	1	1
	No	3	4	7
Total		3	5	8
Does the map include an inset map?	Yes, in a prominent place	0	1	1
	No	3	4	7
Total		3	5	8
Does the map contain bibliographic or production elements?	Yes, in a prominent place	1	3	4
	No	2	2	4
Total		3	5	8

Source: author’s elaboration

Continuing with the analysis of the maps mentioned, we now turn to the study of the semiotics of cartography. This study analysed the nominal and ordinal data and finally, another set of data.

Regarding the first of these, the nominal data, it is notable that all of the maps, both pre- and post-trip, have points, areas, and lines of nominal symbology. Therefore, it should be noted that there is a generalized use of symbols on the maps, using all of the resources available at the time.

The ordinal elements, unlike the previous elements, present a very different situation. Specifically, we analysed whether there are classification criteria in the points on the maps, if there are colours or patterns that indicate size criteria on the maps, and finally, if there are elements in the lines that also express classification criteria.

In accordance with the data presented in Table 4, neither intense nor graded colours were used on the maps analysed, for both pre- or post-trip maps.

However, unlike with the previous item, on the post-trip maps, the sizes of points are used as a resource for classification in all cases, with the exception of that of Agnese (1544). In the case of the pre-trip maps, this resource is not used.

Finally, the thickness of the line as an ordinal criterion is a relatively frequently used resource on both the pre- and the post-trip maps. Thus, in the case of the pre-trip maps, this appears on the maps by Lopo Homen and Reinel, both dated 1519, and in the case of the post-trip maps, it is present in the

cases of the map by Agnese (1544), the map by Vespuccio (1526), and the General atlas by Alonso (1539-60).

Table 4. Semiotics of cartography. Ordinal data.

<i>Survey – No. of Maps</i>		Pre-trip	Post-trip	Total
Are there classification criteria in the points on the map?	Yes, related to the size of the point	0	4	4
	No	3	1	4
Total		3	5	8
Are there colours that indicate size criteria on the map?	No	3	5	8
Are there elements in the lines that indicate size criteria?	Yes, the thickness of the line indicates different sizes	2	3	5
	No	1	2	3
Total		3	5	8

Source: author’s elaboration

Finally, other visual elements were analysed, such as the ease of reading the text of the map, whether the lettering is in uppercase or lowercase, whether polychromy is observed in the text, whether the text overlaps the drawing of the map, whether the difference between the figure and background of the map can be seen clearly, and whether the map is monochromatic or polychromatic. Regarding the first four elements, which involve aspects of the text of the maps, the sumptuousness of the text is notable, making it difficult to read.

The use of polychromy is an aspect on which there are great differences among the maps, whether pre- or post-trip. Polychromy was observed in the texts of the maps by Juan de la Cosa (1500), Reinel (1519), Ribera (1525), Vespuccio (1526), and the General atlas by Alonso (1539-60).

Table 5. Semiotics of cartography. Other data.

<i>Survey – No. of Maps</i>		Pre-trip	Post-trip	Total
Is the text on the map clearly legible?	Yes	0	1	1
	No	3	4	7
Total		3	5	8
Is there polychromy in the text of the map?	Yes	2	3	5
	No	1	2	3
Total		3	5	8
Is the lettering in uppercase, lowercase, or both?	Uppercase	1	0	1
	Lowercase	1	0	1
	Both	1	5	6
Total		3	5	8

Source: author’s own elaboration

Regarding the use of uppercase and lowercase lettering, both are used on all of the post-trip maps, and their use varies on the pre-trip maps. In any case and to finish with the issue of the use of text on the maps, it is notable that all of the authors took care to situate the text in places that do not coincide with lines, notably facilitating the legibility of the maps.

Table 6. Semiotics of cartography. Other data (II).

<i>Survey – No. of Maps</i>		Pre-trip	Post-trip	Total
Can the difference between the figure and the background in the map be seen clearly?	Yes	2	5	7
	No	1	0	1
Total		3	5	8
Is the map in colour?	Yes	3	5	8

Source: author's elaboration

Similar to the previous element, the distinction between figure and background was clearly observed on all of the maps, with the exception of that by Juan de la Cosa (1500).

Finally, it is notable that polychromy was observed on all of the maps, providing them with an illustrative and stylistic nature in addition to their strictly informative mission.

4. Discussion and conclusions

The essential objective of this article is to consider the differences regarding certain aspects of maps created before and after the first journey around the world created by the school of cartography that emerged from the *Casa de Contratación de Sevilla*. With this idea in mind, the maps considered most representative and directly related to the Magellan-Elcano circumnavigation were selected.

First, we emphasize the similarity of the different maps regarding the formal elements that in principle should be present on all maps, at least from the perspective of the modern analysis by Bertín (1983), Board and Taylor (1985), and Cleveland and McGill (1985). The similarities between the maps are first based on the absence of certain elements, since both pre- and post-trip maps do not contain legends that explain the symbology of the maps. However, on this point, it must be noted that the symbology present on the maps is descriptive in nature, and hence, one might question whether in effect that legend or additional explanation is necessary in light of the evidence of the meaning of the symbol on the map.

Other elements considered essential by the authors are generally present, particularly explicit scales and compasses or similar elements of cardinal direction.

Another group of elements studied are found under the heading of essential contextual elements, in which differences are seen between the pre- and the post-trip maps. In this matter, we note the absence of titles and production dates on the pre-trip maps, while those elements are found on two of the four post-trip maps. Meanwhile, the titles provided on these maps are long and descriptive.

Regarding the final group of formal elements studied, elements used to communicate effectively, there is a similar situation in pre- and post-trip maps. In both cases, there is a frequent use of a frame around the map. However, locator maps and inset maps are not used. Finally, bibliographic and production

elements are used in a variable way, being found in one of the pre-trip maps and two of the post-trip maps.

Consequently, we can only partially accept the first hypothesis (H1), which refers to notable differences that are of importance regarding the aforementioned elements. Although it is true that such differences occur with respect to the essential contextual elements, they do not occur with respect to elements that should be present on all maps or elements used selectively to make communication more efficient. In conclusion, there are differences between the maps regarding these aspects, but to consider them notable or important would be questionable at the very least.

The second hypothesis (H2) highlights the relevant and notable difference between the cartographic semiotic elements analysed. These elements are divided into three groups: nominal, ordinal, and other types that contribute significant value to the map.

Regarding the nominal elements, it can be concluded that there is similarity between the pre- and post-trip maps, as both groups of maps use symbolic elements in a generalized way, using a multitude of resources that lend expressiveness to the maps.

Unlike the previous point, regarding the ordinal elements, differences are indeed observed between the maps, with a frequent use of the size of points as classification criteria for size in the post-trip maps, but not the pre-trip maps. When the element analysed is the thickness of lines, the situation is variable, as this ordinal criterion is common in pre-trip maps and present in only half of the post-trip maps analysed.

However, both types of maps coincide in not using colour as an ordinal source, whether through its intensity or through a scale of different colours.

The final group of semiotic elements analysed presents different situations. Thus, while colour is present in all of the maps, the difference between the figure and background is clear in the majority of them, and the typography used is similar in nearly all of them, differences also exist. Polychromy in the text is common in the pre-trip maps but is only seen in half of the post-trip maps analysed. Meanwhile, the use of uppercase and lowercase lettering also differs in pre- and post-trip maps.

In conclusion, and coinciding with the previous hypothesis, the second hypothesis (H2) can only be partially accepted for the same reason. There is a difference between the pre- and the post-trip maps with regard to the elements of cartographic semiotics analysed, but this difference is of questionable importance.

In relation to the above, and considering that a map is above all an instrument of visual communication that relates journeys carried out and communicates their findings, it is necessary to provide brief commentary regarding the contextual reality surrounding the development of both pre- and post-trip maps.

In the time before the journey, it was highly important to Spain to begin Magellanic navigation, in large part because the Portuguese had already completed their conquest and were already arriving at the Maluku.

At that time, and this is reflected in the maps, the Earth's diameter was thought to be smaller, although its sphericity was not in doubt—indeed, it was considered a perfect sphere. Thus, the size of the Earth

was not truly known. Although Eratosthenes had measured it accurately approximately 230 BC, Ptolemy subsequently reduced its size considerably.

Additionally, cartography and geography were the sciences of the moment, fuelled by the outstanding work of the *Casa de Contratación* in Seville, a city that was a world leader in technology and logistics in each new journey of exploration. That was undoubtedly the essential factor that attracted a great number of Portuguese with significant nautical experience who brought with them the knowledge acquired on their explorations, which may have provided important advancement in the aforementioned sciences.

Indeed, Magellan is credited with vast knowledge in navigation and cosmography, as demonstrated in a document found in the General Archive of the Indies (Seville) that is attributed to him and that provides geographic knowledge that would demonstrate that the Malukus were within the Spanish demarcation under the Treaty of Tordesillas and would also make it clear that Magellan was aware of the size of the Pacific Ocean.

Therefore, while the differences found in the maps are undoubtedly of questionable magnitude, they do not entail an obstacle to highlighting differences in other elements, such as the design or the consideration of the size of the Earth, which were remarkable because knowledge, however broad, was in any case lesser in the case of the pre-trip maps.

It should be noted that this work has limitations. The analysis carried out only addresses one set of communicative elements of the maps, leaving aside others that could suggest greater differences between the maps, such as those related to the type of design used to represent the land discovered.

To some extent, in the poetry of the design and the map lies the discovery of reality and one of the most interesting areas of future research. Undoubtedly, changes in the design of the continental shapes represents changes in the hypothesis of what was expected to be discovered to the reality of what was discovered, which is certainly the most significant visual expression of one of the greatest adventures ever undertaken by humankind: a trip around the world.

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