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## Coronelli's Virtual Globe

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### *Summary*

Nowadays globes are an important subject to study both for their history, their cartographic content and their artistic aspects. Moreover some softwares, such as Google Earth, Virtual Globe and many others, are very widespread because of their usability and, above all, because they represent a complex object, the Earth, in a intelligible way. This works deals with the possibility of applying digital technologies to the cartographic globes, especially Coronelli's one, to obtain a virtual copy to navigate and to query.

Cartographic spheres, terrestrial and celestial, have aroused a big interest both for their artistic features and for different application and function they were planned. Anyway the first and the most important interest about these objects is concerning their application as a cartographic tool for navigation, for astronomy and, above all, for geography and geodesy studying. Moreover the possibility of representing the earth in a 3d view makes these objects almost unique: in fact they give an intuitive and immediate understanding of an "object" (the sphere) that cannot be represented in many other ways.

One of the most representative globe-makers of the 17th century is the monk Vincenzo Maria Coronelli. He is well-known for the production of many maps and for a big project of an encyclopedia but, above all, he produced spheres with different sizes. On the cartographic surface he related not only geographic information, but also different themes such as exploration courses, journeys, news from far places and other information not strictly geographical. Among his works the most well-known cartographic spheres are the ones with a diameter of 382 cm realized for Luigi XIV which is the stencil for the following small globes.

The exhibition at the Museo Correr in Venice "*Sfere del cielo, sfere della terra. Globi celesti e terrestri dal XVI al XX secolo*" proves a renewed attention due to the new possibilities of digital approach. Computer technologies allow new developments in the fields of the circulation and the study of historical cartography concerning more immediate and intuitive interfaces but also new instruments for the analysis.

It's important not to consider the globes only a cartographic instrument, but to give them an artistic and historical value. In this way it is necessary to face specific problems connected with their conservation, their restoration and, if possible, their use: the hard rotation of the wooden sphere around the main axes, the deformation of the surface and as result the deformation of the map, the hard readability of the map because of the decay of the ink pigment and the continuous exposure to the light.

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In this contest Circe, University IUAV of Venice, started a research focused on the historical globes, in particular Coronelli's sphere, in cooperation with the Museo Correr and the Biblioteca Nazionale Marciana. The aim of this research is to apply new computer technologies and new survey instruments to preserve and to study the globes, in their different aspect of historical wooden sphere, cartographic instrument and also artistic object.

The first approach to the globes is concerning their cartographic value. For the above-stated reasons now it is almost impossible to use the sphere and so the realization of a virtual globe has been the first step of the research in order to look at the map and to give the studios a new admittance to its historical, social and geographical content.

The study has been focused on an historical globe, kept in the Museo Correr, of the Venetian monk. In particular the globe belongs to the set with a diameter of about 108 cm and it is a terrestrial sphere so it represents all the known lands above the sea level with a rich geographic and social description. This sphere belongs to the group called "printed globe" because the map is not designed directly on the spherical surface, but it is made of printed paper gores which are applied on the wood using some sticks. In this way it was possible to increase the production of the spheres (the globes were very diffused also like a piece of furniture in the most important houses) by the use of printing. Moreover using a book with the printed globes, it was possible to send all the necessary for the globe in every place without the difficulties of moving a wood sphere.



Figure 1 Virtual globe

This characteristic has been crucial in the solving of the virtual globe. In fact starting from a book of gores it has been possible to build a virtual copy of the sphere. The work has been divided into several steps concerning:

- Digitalization of printed gores;
- Analysis of projective content;
- Reconstruction of the virtual sphere;
- Exploration and visualization of the globe.

The digitalization of printed gores has been realized starting from a copy of the book of gores, called *Libro dei Globi*, in the venetian edition of 1705 of the Biblioteca Nazionale Marciana.



Figure 2 Original image of one sheet with the colorimetric scale

The first aspect of the study was the analysis of the book. Before the whole acquisition of all sheets, it has been necessary to check the way of digitalization. The first experiment was made with the handyscan, a range camera which works by the principle of triangulation, in order to acquire the real, deformed, surface of the sheet. Using the 3d model of the paper and the pictures acquired by an high resolution camera it has been realized an orthophoto which has been compared to a simple picture to check the amount of the errors. This test showed the errors were quite small. For this reasons, in order to acquire all the 50 sheets of the terrestrial globe, the photographic method was preferred considering also the restricted times of acquisition. The images have been acquired by an high resolution camera, Nikon D2X, 12 Mpixel, with a calibrated optics and then every picture has been undistorted. In such a

way the final images have an high resolution and a pixel size of 0,1 mm. In each shots there is also a Kodak colorimetric scale in order to check not only the thematic content of the gore, but also the radiometric aspect.

After this first step, the focus was the analysis of projective content of gores to discover how Coronelli built his gore. The search for a known cartographic projection, as considered nowadays, didn't give any result. Instead in his writings<sup>1</sup> the mapmaker declares of using a modified geometric construction expounded by Glareanus in 1527 in the XIX chapter entitled "*De inducenda papiro in globo*" of his "*D. Enrici Glareani poetae laureati de Geographia liber unus*". Particularly the method consists in drawing a line with the dimension of 2,5 the terrestrial equator, dividing the line in 25 parts and using 12 parts to build the gores. In such a way the drawn gores cannot cover exactly the sphere so it was necessary to dampen and stretch the paper during the application on the sphere, causing some deformations in the cartographic content as observed by Fiorini in 1893<sup>2</sup>.



Figure 3 Sx: original sheet from "Libro dei Globi" ; dx: transformed gore

<sup>1</sup> Vincenzo Coronelli, *Epitome Cosmografica*, 1963 Venezia. In particolar "la seconda parte del Libro Terzo che contiene la pratica".

<sup>2</sup> Matteo Fiorini, *Sfere Terrestri e Celesti di autore italiano o conservato in Italia*, in *Bollettino della Società Geografica Italiana*, 1893-94.



The absence of a known cartographic projection involves that it is not possible to use an exact transformation for the reconstruction of the virtual sphere. So the only chance to take all the gores in a clearly defined projection has been the use of local transformation defined by the correspondence of the drawn cartographic reticulate with the ideal one of a equi-rectangular projection (or Plate Caree) through an algorithm of triangulation<sup>3</sup>. This kind of projection has been chosen because most of commercial softwares use the equi-rectangular for the mapping of spherical surfaces. In this way all the gores (12 gores, each one divided into 4 sheets) and the Polar icecap (north and south icecap) have been transformed in a known projection, keeping the metrical control of the cartographic content and setting the pixel size to 0,1 mm.

Then it was necessary to map the images on a spherical surface. For the first application the software used was NASA WORLD WIND<sup>4</sup>. It is a freeware software, realized by NASA, which allows to view the whole Earth mapped by satellite images or thematic maps. It works like the most famous Google Earth and it implements the possibility of adding new maps, to overlay the surface with the latitude and longitude lines and to zoom to read the details of maps. All imaged have been georeferenced and applied on the spherical surface using a file with the specification of latitude and longitude for each corner of the picture. In order to obtain the best performance from the software and the hardware, the image has been recorded in a PNG format and with different dimension of pixel connecting with the power of the pc.

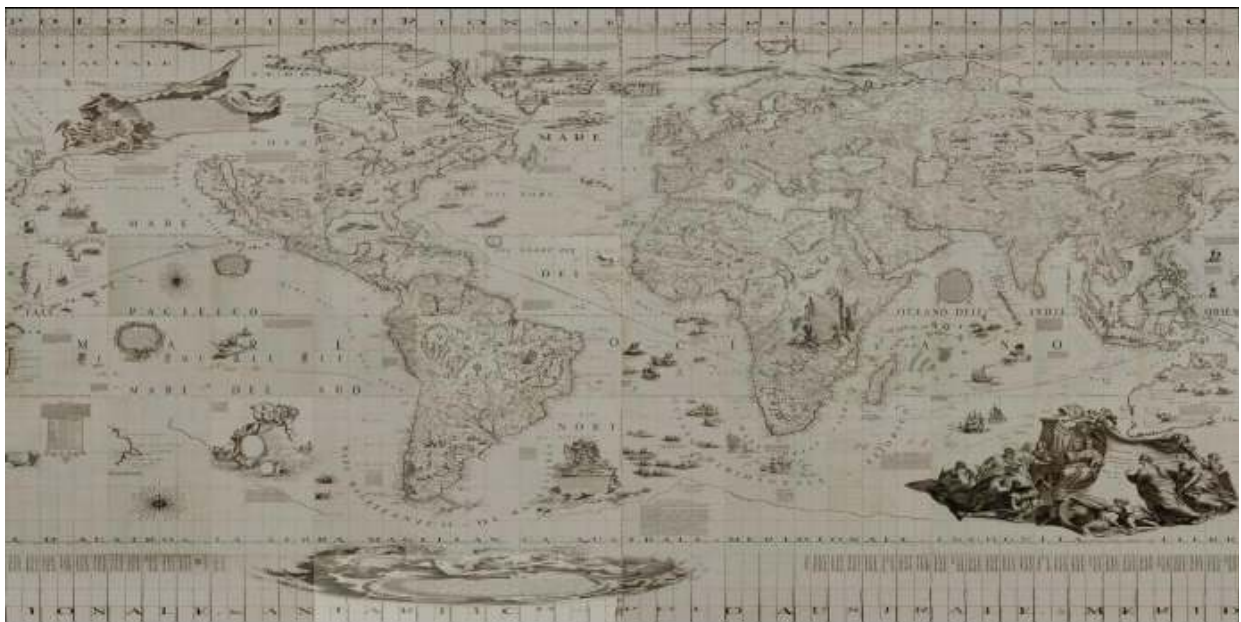


Figure 4 Equi-rectangular representation of the map of the globe

In such a way the exploration and visualization of the globe becomes really immediate and intuitive thanks to very simple interface of the software. Moreover the high resolution of the images allows to

<sup>3</sup> realised by the software Ermapper.

<sup>4</sup> [www.worldwind.arc.nasa.gov](http://www.worldwind.arc.nasa.gov)

read each note written by Coronelli, to follow the exploration courses and to look at the features of each country.

This instrument, the digital-virtual copy of the globe, is an important instrument for geographers that can study the sphere without the difficulties of managing a fragile object. It is also a way to widespread the knowledge of the cartographic spheres between non-specialized users.



Figure 5. Screenshot from World Wind, with the mapped globe

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Furthermore the software allows particular analysis to underline some aspect of Coronelli's world. Overlaying the actual images of the Earth, like a satellite image, on the historical map it is possible to notice some details. First of all, it is evident that Coronelli, following the instructions of Luigi XIII of France, fixed the main meridian (longitude zero) in the "Isola del Ferro" in the Canaries instead of Greenwich and so there is a translation of about 20 degrees towards the west. By the operation of transparency between overlaid maps, it is interesting to compare the coastline of the European countries. As regards Italy, for example, the orientation and the shape of the country are different. But focusing on the whole world, it is evident that there are many errors in the description of countries concerning not their position in latitude (which is quite exact), but in longitude (because of the difficulty of counting the distance along the parallels).



Figure 6. Overlay of satellite image and Coronelli's Map

The second application, which is still in progress, will be exhibit at the 3rd International Workshop on “Digital Approach to Cartographic Heritage”. It is interactive software, realized in Delphi, with the aim of enable an immediate and customized navigation around the globe. It offers many possibilities such as the texturing of different historical maps on the spherical surface, the zoom for reading the smallest notes, the rotation and moving of the whole sphere. Moreover it is possible to change the visualization of the sphere from a spherical view to a cartographic-plane view. Finally this new software allows to overlay not only raster maps (like historical, satellite...) but also vector themes such as shape file to represent important cities, river and lakes and features in order to deepen the analysis.



Figure 7. Different step of the animation: from the 3d virtual model of the globe to the final result

Considering a wide spreading knowledge on historical cartography a virtual animation introduces to the main cartographic problem of transforming a sphere on a plane<sup>5</sup>. The storyboard of the animation

<sup>5</sup> The animation can be found at the following link: [www.iuav.circe.it](http://www.iuav.circe.it).



shows an introduction to the main problem with a little note written by Coronelli himself and then some images of the book of Globes. Successively there is a representation of Glareanus geometrical construction and a scheme concerning Coronelli's Globe. At the end the texturing of a wooden sphere with the map and the visualization of the virtual globe reconstructed.

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