Assessing 3D Geovisualization for the Communication of Public Art

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Abstract: This paper presents the assessment of a 3D geovisualization framework and system for the documentation and communication of contemporary public art. The paper reviews the specific requirements of the contemporary public art and discusses the critical issues connected to the visualization of such artworks. The framework implements a visualization pipeline that relies on both a semantic representation of the artworks and a mixture of graphic elements acquired from reality or designed for the application. The web-based visualization system realizes a geolocalized 3D layout that selects the relevant traits that characterize the contemporary public artworks. The system is implemented in a prototype applied to the visualization of contemporary public artworks of the municipality of Turin (Italy). The assessment is achieved through the evaluation of a number of typical tasks that general audiences engage with contemporary public art, the system has revealed to be more adequate to its design goals.

1 INTRODUCTION

In the last decades, contemporary public art has been a very dynamic area, involving both public and private subjects and originating a novel professional artist category. Public art is peculiarly planned for and staged in some specific public space, usually open air or in publicly accessible buildings, for all people to enjoy it (Miles, 1997). Contemporary art in general lacks, on the one hand, an effective documentation for the institutions (documentation needed for purposes of maintenance and re-installation), and, on the other, an effective communication to large audiences (communication needed because of its peculiar, sometimes obscure languages). We claim that the 3D geovisualization can effectively support these documentation and communication task for contemporary public art.

The usage of contextualized 3D graphics representation is not new in contemporary public art enterprise, especially in the design phase. The previsualization of projects (see, e.g., the reStacked project)[1] usually employs a 3D model that highlights the major features of the artwork to provide a quick overlook on its size, the materials employed, the perspectives from a number of relevant points of view, entrances/exit positioning, etc.. Also, 4D CAD technology (i.e. 3D plus time as fourth dimension on CAD software) is employed by designers and engineers to analyze and visualize construction projects in order to plan construction operations (Mahalingam et al., 2010). 3D graphics is also particularly appropriate for the case of reconstructions of cultural heritage items from the past such as in the case of the *Poème électronique* a multimedia installation that was hosted inside the Philips Pavilion at the 1958 Brussels World Fair, and never repeated because the pavilion was turned down at the end of the fair (VEP project (Lombardo et al., 2006)).

Public art also makes the case for geographic visualization (geovisualization for short), thanks to its close relationship with the urban setting. Geovisualization enriches that traditional static maps with the exploratory capabilities of the interactive maps, including several layer representation, zooming in/out, the possibility of changing the visual appearance (MacEachren and Kraak, 2001). For the visualization purposes, the representations of urban maps lately require a third dimension, which is necessary to represent the height of the new buildings (of increasing importance), and the visible and invisible phenomena that happen at several meters above and under the ground and can be represented using the surfaces of the buildings as a support (Donolo, 2014). Many large cities today exist in 3D geolocalized copies, though in general applications tend to focus on visual interpretations of statistical data as well as data

[1] http://www.njstudio.co.kr/main/project/2013_reSTACKed_[Competition]/2013_reSTACKed_[Competition].html

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from the urban infrastructure. Noticeable applications are "We Are Data"[2] and "OSM Buildings"[3]. "We Are Data", developed by UbiSoft on the environment backbone of the videogame "Watch_dogs", is a promotional website for the game, which visualizes the infrastructure data of three European cities (Paris, London, and Berlin), displaying data about message exchanging, tweets, public transportation timetable, on an interactive 3D map that also precisely characterizes the building heights and the major monuments[4]; "OSM Buildings" is a library that provides an additional layer to existing web maps, employed in urban projects to support the participation of administrators and citizens in planning processes.

In this paper, we present a 3D geovisualization framework and a system for the documentation and communication of contemporary public art. The major novelty of the system is a methodology for a 3D geopositioned system that allows the access to the documentation of the public artworks and communicates the attitude of a city towards the contemporary public art. The paper is organized as follows. The next section introduces the visualization framework, called Invisibilia, and the architecture required to implement it as a functioning system. The system features a three–layered visualization structure, with each visualization layer concerning a different information layer. Finally, we evaluate the visualization system design through an experimental test on a group of users. The paper ends with some reflections on the lessons learned and conclusion.

2 VISUALIZATION OF CONTEMPORARY PUBLIC ART

The visualization of public art monuments, and especially in the case of contemporary public art, is addressed by municipalities with simple methods. In most case, communication is limited to printed catalogues (mostly distributed through pdf files on web sites[5]), which report illustrations of the artwork and a few explanations. Usually, such catalogues are accompanied by interactive maps, that report the positions of the artworks with anonymous pins that provide access to further information, typically the archival sheet of the municipality or a simplified form of it (see Figure 1).

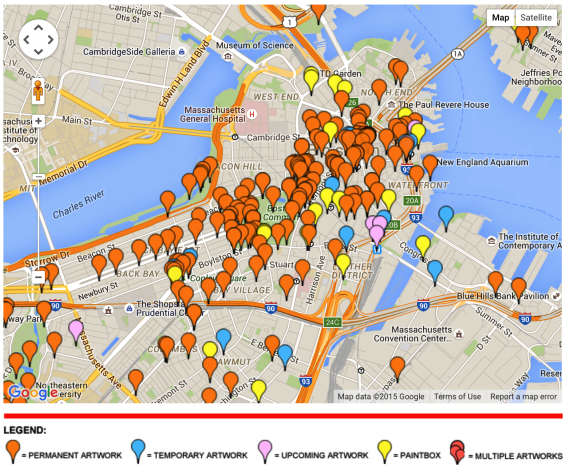

Figure 1: Interactive map of Boston public art (http://www.publicartboston.com/map/node). A similar map is available for public art in Turin (http://www.comune.torino.it/papum/).

However, the documentation, and thus the communication about contemporary public art can be more knowledgeable. The Invisibilia project[6] has investigated how the digital technologies can support the documentation of the "invisible" issues concerning contemporary art (including installations, performances, and site-specific situations), that are always at risk of vanishing. The name Invisibilia refers to the notion of the "intangible" cultural heritage promoted by UNESCO, and emphasizes the fact that in contemporary art the relationship between the aesthetic appreciation of the single "work" goes beyond its material visibility (Lughi, 2014). The artistic and aesthetic experiences connected and enhanced by digital media are the foundations for the reflexivity, a prerequisite to understanding the new logics of cultural production and consumption and the new forms of active citizenship that are taking shape in the contemporary landscape.

The project Invisibilia has investigated and developed a number of proposals to develop the study, maintenance, reuse and profitability of these particular heritage. In particular, for the case of contemporary public art, the project has addressed the issue of representing the layout of the artworks at the city scale and the urban setting of the individual artworks, together with the access paths (on foot, on a vehicle, mixed), and the media items that document the indi-

[2] http://www.wearedata.org

[3] http://www.osmbuildings.org

[4] Philippa Warr, Watch Dogs website maps your unprotected social data, 27 JUNE 2013, http://www.wired.co.uk/news/archive/2013-06/27/watch-dogs-wearedata

[5] See, e.g., the Chicago public art guide, http://www.cityofchicago.org/content/dam/city/depts/dca/Public20Art/publicartguide1.pdf

[6] http://www.invisibilia.unito.it

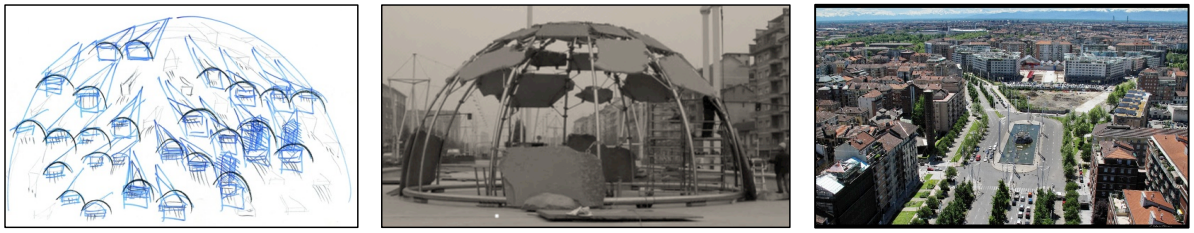

Figure 2: Merz's igloo fountain in Turin: design, construction, final.

vidual artworks. The approach has been to encode the intangible aspects of contemporary art into a rich digital semantic representation and exploit such a representation for several tasks. In this paper, we address the visualization framework, which exploits the spatial and urban components of the semantic knowledge (Lieto et al., 2014).

The case studies of project Invisibilia are four public artworks of the city of Turin: Merz's igloo–fountain "Fontana" (Fountain), Clegg's "Punti di vista" (Points of view), Kirkeby's "Opera per Torino" (Opus for Torino), and Levi/Cliostraat's "Baci urbani – Piercing" (Urban kisses – Piercing). The specific descriptions in this paper are exemplified through the artwork "Fontana" (Fountain) by the artist Mario Merz (see Figure 2). Released in 2002, it has the shape of an igloo with the surface consisting of a puzzle of plates of slate, emerging from a rectangular water tab, with water jets, located in a road widening; four red neon lights, that light up at evening, mark the cardinal points. Specifically conceived for the setting where it is located, this artwork intends to trigger in the audience a reflection on the meaning of urbanization though a basic, yet well construed type of house, the igloo.

2.1 The Invisibilia Visualization Framework and System

The visualization framework of Invisibilia (Figure 3) integrates knowledge about the artworks with the graphic elements representing them and the media documentation about them. We devised a three-layered system to visualize the contemporary public art. The Layer 1 provides a synoptic view of the contemporary public artworks in the city: we build the visualization on a thematic base map, providing a georeferenced distribution of the artworks (represented as 3D graphic elements) that exploits the knowledge (the GPS data) imported from the public data bases and additional knowledge from the artwork data sheet (height, diameter, etc.). The Layer 2 provides the view of the individual artwork through a graphic representation of the artwork itself in relation with the urban proximity; this representation, which includes the modalities through which the visitors access the artwork, exploits the knowledge about the artwork (its function, its components, etc.), and the knowledge about spatial layout of the urban area; while the artwork is a unique 3D model, the neighboring elements are serial iconic elements that are exploited throughout the artwork visualizations. The Layer 3 is the documentation view, staged as an image gallery, each image representing some media concerning the artwork.

The user directly accesses Layer 1 from the home page: here she/he is presented with the overall layout of public artworks across the city and explores the 3D map through automatic scene rotation and manual zooming in/out; the graphic elements corresponding to the contemporary public artworks are highlighted. Once she/he clicks on some artwork, she/he enters Layer 2, where she/he can explore the specific urban setting of the artwork, switching day/night views and activating the animations showing the visiting paths allowed for the artwork (on foot, by car or mixed). Finally, by clicking on the body of the artwork, the user accesses Layer 3, where she/he can view the media repository about the artwork.

The implementation of such a visualization framework is a standard semantic architecture (Figure 4, cf. (Damiano et al., 2014)): the ontology framework, implemented in the Stanbol framework[7], maintains the ontological knowledge base (the formal descriptions of the artworks), about the public art, which describes the artworks, their documentation and their spatial properties, including their relationship with the urban context that surround them; the visual renderer, developed in two versions (one based on the three.js library, with spatial data encoded in a json data file, another based on GoogleEarth, which requires a kmz file), displays the visual data, namely, 1) the 3D models associated with artworks and urban elements surrouding them in the visual scene, 2) the Maps downloaded from some repository and employed through the Leaflet libraries, 3) the GeoJSON data extracted from the Geoportal of the city and augmented with

[7]https://stanbol.apache.org

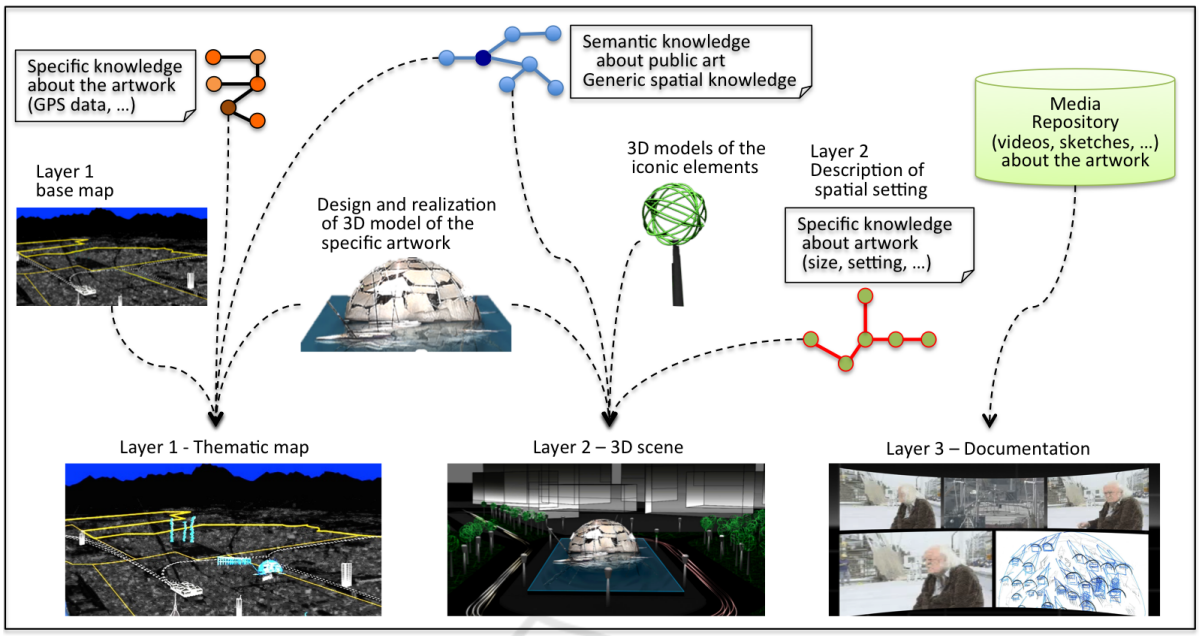

Figure 3: The visualization framework of Invisibilia.

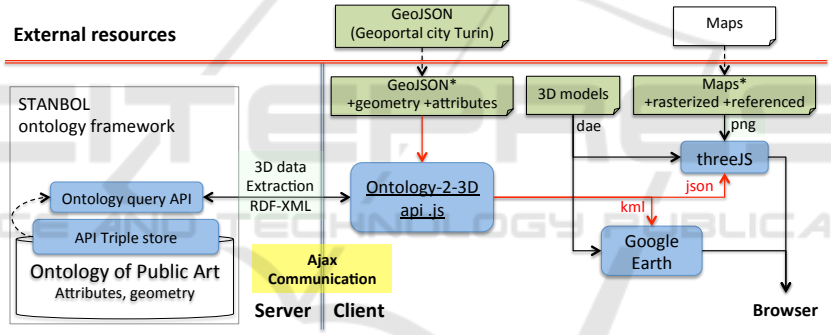

Figure 4: Prototype architecture of visualization framework.

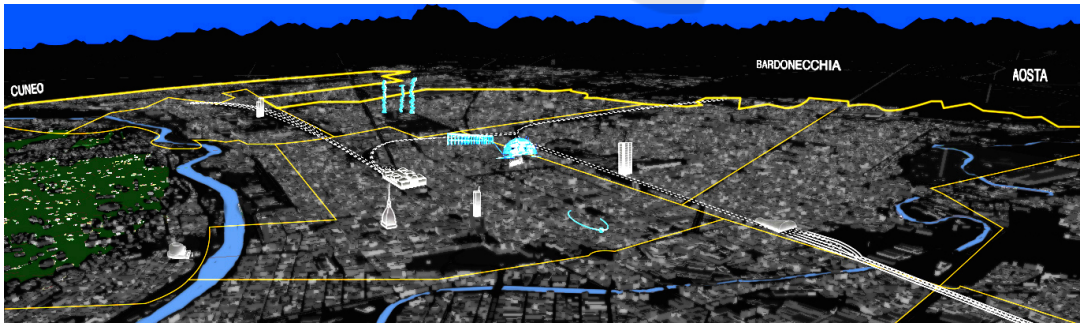

Figure 5: Top level view. Design in Blender, visualized in three.js.

information on geometry and other attributes.[8]

The user interface dynamically arranges the set of graphic items (artwork and contextual items), staging and setting them based on their spatial and visual properties, as extracted from the semantic knowledge. The presentation metaphor, provided by the "city map", drives the visual experience through: an *environment*, the base city thematic map, where the

[8]http://www.comune.torino.it/geoportale/

graphic elements are located; the *active elements*, the public art models, that can be clicked by the user; the *contextual elements*, i.e. the serial objects that are positioned in the environment. The interaction design is inspired by the notion of guided exploration, with iconic elements and controls inviting the user to click on the artworks posited in the urban landscape (in Layer 1), and on the most significant parts of the artwork (in Layer 2).

The design of the graphic elements and of the scene layout must reconcile the tasks of supporting the user in visualizing the invisible aspects of the artworks with the communication issues related with the documentation of the artworks. The public artworks come with a marked visual stance, which makes a visualization of the artwork documentation more challenging. We can sum up the following premises about the visualization: it cannot be a replacement for the original artwork, though exhibited in virtual terms; it has to balance between the goals of the visualization and the peculiarities of the artwork; it must adhere to the model (of the features) of the artwork; the authorial intervention should be limited to the documentation section. The visual components that represent the characteristics of the artworks are derived from the existing documentation and are augmented with the serial iconic elements, appropriately designed by the visualization artist. These elements must be in overt contrast with the original elements, though creating an environment that can visually host the original elements. The idea is to acquire from reality the graphic elements of the artworks, to design from scratch the simple iconic elements, and finally to integrate them into a single visual framework.

The synoptic view of Layer 1 provides a top-view cartographic representation of the public artworks on a city map, with their relative positions; the public artworks are represented by visual items that display the actual shape of the artwork; these items can be original (if they exist in the documentation) or introduced ex-novo. The inspiration for such solution is the tourist city map, that combine topological and topographical elements[9]: in our case, we decided to employ Geoportal data from the Geographical web portal of the Municipality of Turin. In order to recall sightseeing heritage–oriented thematic maps, which have a longstanding tradition in cartography and are effective in guiding tourists in picking the preferred sites in a city, we applied the Geoportal data some graphical transformations, by enlarging and highlighting the elements of interest for our domain, without any alteration on the geometry of other elements, Also, we

[9]http://www.torino.city-sightseeing.it/eng/percorsi 1.htm

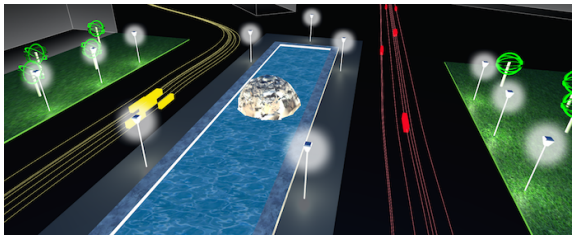

Figure 6: Invisibilia artwork level view: implementation of Merz's Fountain in three.js library.

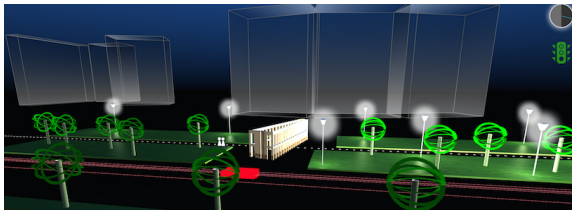

Figure 7: Invisibilia artwork level view: implementation of Kirkeby's "Opera per Torino" in three.js library.

augmented the thematic map with a 3D perspective, positioning the 3D models of the elements of interest. The base thematic map of the synoptic view (see Figure 5), includes topographic elements, such as the rivers (in blue), the major access as well as inner roads (in yellow and white), and the major reference buildings (in light grey) in order to provide orientation cues. The topological elements, one per public artwork, are colored in a light blue glow to give a sense of presence against a dark background. The implementation shown in the figure has been carried out with the three.js library, with maps from public repository imported through the Leafletjs library (actually, in the current implementation, personalized maps are rasterized to cover a plan with an exact match of the references, given the relocation from the central point through a simple javascript function).

The individual artwork view of the Layer 2 is a perspective view that is reached through a 3D-simulated camera motion: this view remains in the graphic style described above, with superimposed active icons for accessing the visualization of the media documentation. In Figure 6 we can see the artwork, with contextual elements represented as stylized icons, replicated over the several artwork visualizations (cf. Figure 7).

The object representing the artworks are 3D models with photographic texturing, obtained by means of photogrammetric techniques. The input data are sets of digital images, acquired through a compact digital camera, which have been processed through the software Photoscan (see Figure 8). This approach, which can be carried out by a non 3D professional, such as

the personnel of the city hall offices, makes the project sustainable from the operational point of view; as intended in the design phase, then, the visual appearance makes the object different from the iconic style adopted for the other elements.

The documentation about the artwork (Layer 3) can be accessed from the Layer 2 and it includes documents of various type, such as video clips, text documents, pictures, etc., (cf. images in Figure 2) which illustrate all the phases of the artistic creation, from conception to realization. In the next section, we provide an assessment of the visualization methodology for the layers 1 and 2, which are novel for the case of public art. The assessment will provide useful indications for the implementability of the methodology beyond the prototype level.

3 EVALUATION

Based on the paradigm of the user studies, we conducted a test to assess the effectiveness of the proposed visualization of contemporary public art.

Design and procedure. The test included a set of tasks, designed to test the achievement of the following objectives:

- on a *city* scale (Layer 1), enabling the user to understand the localization of the artworks and their spatial relations with the reference points of the city;
- on a *local* scale (Layer 2), enabling the user to understand the physical features of each artwork (e.g., location, size and shape), the values it conveys, and its interaction with the urban environment;

At the end of each task, the user was requested to answer some questions about the task and to express her/his liking for the specific functionality and the overall system. The test was conducted on the online prototype. The users were given a written description of the tasks and printed questionnaires. As part of the test methodology, the users were observed during the execution of the tasks, to collect observations for the qualitative evaluation of the system (Donolo, 2014).

The test was conducted in September 2015 on 10 users, 6 males and 4 women, with ages spanning from 21 to over 65. All users were acquainted with the city, since they either lived of studied in Turin. The average execution time for the testing session was about 20 minutes.

Description and results. The 6 tasks for Layer 1 (city map) were aimed at assessing the user's capability of locating the artworks at the city scale visualization and relating them to the relevant geographical information about the city (reference points, periphery/center, etc.).

1. Detecting a set of geographical and urban **reference points** (rivers, main roads, railways, etc.). The capability of users to orientate themselves on the map varied significantly depending on the reference point types: all users were able to detect the city rivers and the city center, most users were able to detect the main roads (7 users), but only few were able to find the north (4 users) direction on the map.
2. Detecting the **artworks** based on their pictures. The users were generally able to localize the artworks. In particular, all users were able to locate the best known artworks on the map (Piercing and Fontana), 9 and 8 users were able to locate, respectively, Opera per Torino and Punti di Vista.
3. Detecting a set of **cultural institutions** (museums and foundations). All users were able to locate the Contemporary Art Gallery, while only some (6 users) were able to locate the less known institutions.
4. Detecting the main **monuments** of the city. All users were able to detect the most famous monument (Mole Antonelliana) on the map, with high rates for other monuments as well; some of the city's main squares (e.g., Piazza San Carlo) were not recognized (3 users).
5. Marking the artworks that are to the city **center** and those situated on the **periphery** of the urban area. The selections made by the users (artworks in the city center and artworks on the periphery of the urban area) were all acceptable.

Also, the user was request to express her/his liking of the **rotation** functionality in the visualization system (Q1.1), on 5 point scale (1– disliking, 5 – liking). At the city level, most users preferred to rotate the scene manually, an observation that is consistent with the liking of the automatic rotation (3.6 avg.).

The test on the Layer 2 (artwork scale) was aimed at assessing the user's understanding of the features of the single artworks and included 5 tasks on two artworks (Fontana Igloo and Opera per Torino).

1. Providing a free **description** of the artwork. Fontana Igloo was described as an "igloo situated in a square water basin" by most users, with some variations concerning the material, opaque glass for some (1 user), stone for others (2 users), and unspecified for most. The shape and the color of the artwork were correctly perceived by all users.

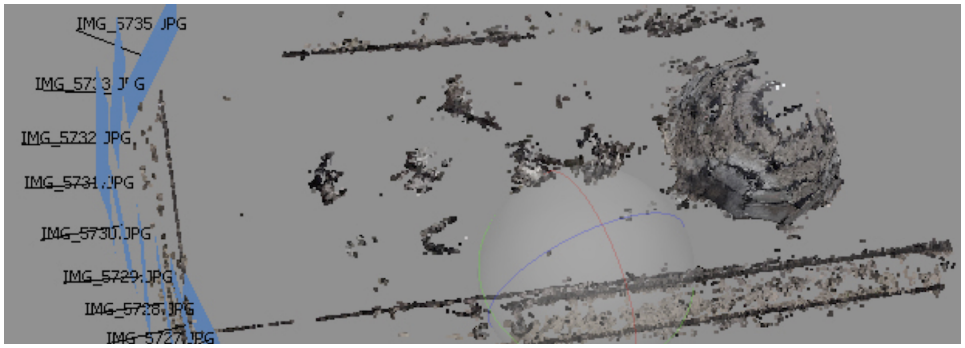

Figure 8: Composition of Merz's Fountain scans in Photoscan.

All descriptions of Opera per Torino shared the use of the word "arcades" or its synonyms; the references to an old industrial building and to a Roman aqueduct were often present.

2. Assessing the **size** of the artwork, given an approximate size scale (small, medium, large, extra large size). Given this scale, the size of Fontana Igloo was correctly described by the users as small-medium and the size of Opera per Torino was correctly described as medium-large. This task was accompanied by a question about the most useful elements for assessing the artwork size (pedestrians, buildings, roads, green areas, etc). For Fontana Igloo, the other buildings in the scene were considered useful by 7 users, while lampposts by 6 users; only 4 users chose the trees as a useful element of estimating the size. For Opera per Torino, streets were chosen by 7 users and trees by 6, and only 5 users chose the buildings. These choices depend on the actual context were the artworks are locate: while Igloo Fontana is surrounded by streets and buildings, Opera per Torino is situated in a green area, farther from buildings.
3. Activating the **day/night visualization** functionality and assessing whether the appearance of the artwork changed significantly from day to night or not. This functionality was quite effective in conveying the dynamic aspects of the artwork appearance: 9 users out of 10 correctly perceived Fontana Igloo different from day to night (the igloo is lit by night), while only 5 users perceived Opera per Torino as different by night (actually no difference, except for the light cast by the lampposts). The user was also asked to assess her/his liking of this functionality on a 5 point scale. The average liking of this functionality, however, is similar for both artworks (3.4 for Fontana Igloo, 3.9 for Opera per Torino).
4. Classifying the **localization** of the artwork with respect to the elements of the urban road system (roadside, pedestrian area, roundabout, etc.). Most user correctly classified Fontana Igloo as a traffic divider (7), and Opera per Torino (8) as located in a green area alongside a large road.
5. Activating the visualization of the pedestrian and vehicular **paths** across and around the artwork, and indicating the ways the artwork could be accessed (by car, on foot, or mixed). Most users correctly understood that it is not possible to get near Fontana Igloo on foot (6 users), and the large majority (9 users) correctly answered that it was possible to walk across the arcades of Opera per Torino. The user was also asked to assess her/his linking of this functionality on a 5 point rank. This functionality had a positive acceptance (3.7 avg. for Igloo Fontana and 4.3 avg. for Opera per Torino).

The user was also requested to rate the **verisimilitude** of the 3D visualization of the artwork on a 5-point scale (1 – not at all similar, 5 – very similar). In case the user was not familiar with the artwork, this question was reformulated as the liking of the 3D visualization of the artwork (again on a 5-point scale). The rating showed a difference between the two visualizations: 3.0 avg. for "Fontana Igloo" and 3.9 avg. for "Opera per Torino".

The final questionnaire concerned the **overall liking** of the system (Q1, 5 point scale) the easiness of the **navigation** (Q2, 5 point scale), a closed list question (Q3) about the **web sites** she/he would consult to get the same information (such as Google Street View or Wikipedia), a question (Q4) about the most **similar media** (scale model, promotional videoclip, map and leaflet). The analysis of the final questionnaire shows a good acceptance of the system (Q3.1, 4.1 avg.) and of the 3D navigation (Q4.2, 3.9 avg.). The most similar websites chosen by the users were Google Street View (10 users) and Wikipedia (6 users); the most similar media were the scale model (6 users), the pro-

motional videoclip (5 users), and the map (4 users).

Discussion. To sum up, the evaluation shows that the visualization system basically attained the goals that drove the design phase, i.e., conveying the overall layout of the public artworks in the city, their spatial and artistic values and their relations with the urban system. The 3D visualization of the artworks in the city worked well to locate the artworks and the other geographical and urban reference points, with the exception of the cardinal points, not explicitly shown on the map. The inability of users to localize the cardinal points provides a clear indication for redesign. As expected, the familiarity with the artworks and with the other reference points worked in favor of the users' ability to locate them on the map, as shown by the fact that the most frequently recognized entities are those located in the central area of the city.

At Layer 2, the visualization was effective in describing both the artworks and the urban context surrounding them, including the paths around and across the artworks, while the effectiveness of the night/day visualization can be improved, since it turned out to be slightly confusing about the dynamic aspects of the artworks. The analysis of the descriptions of the artworks provided by the users suggests that the 3D visualization of the artwork works well to communicate the appearance of the artworks and their values. However, the quality of the visualization seems to be relevant for the acceptance, as demonstrated by the difference between the two artworks: the users preferred the visualization of Opera per Torino, that is technically less challenging than Fontana Igloo, due to the presence of the water and of the stone plates that form the covering of the igloo. An indication for redesign is provided by the complaint about the scarcity of textual information in the visualization.

4 CONCLUSIONS

In this paper, we have described a framework for the documentation and communication of contemporary public art via a 3D geovisualization framework. The paper has analyzed the specific requirements of contemporary public art, discussing the critical issues connected to the visualization of art forms, that should not be eclipsed by the visualization.

The visualization framework is arranged onto three levels: a synoptic view, with the spatial layout of all the artworks at the city level; an artwork view, with the model of the artwork and standardized icons for the context model; a documentation view, with a dashboard of the documents about the artworks. The framework has been assessed through an implementation with off-the-shelf technologies and evaluated against a number of tasks that generic audiences address in the case of contemporary public art.

In the next future, we will test the visualization framework with professionals and users for the populating pipeline and the efficiency of the web site, respectively. It will also be interesting to address aspects related to system immersivity and alternative interaction methods, that provide access to further information about the public artworks.

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