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DIGITAL RECONSTRUCTION AT THE SERVICE OF MEMORY: MESSINA 1780

LA RICOSTRUZIONE DIGITALE AL SERVIZIO DELLA MEMORIA: MESSINA 1780

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Abstract

In recent years, the study of the evolution of the appearance and conformation of cities over the centuries has found new forms of representation through the use of digital modelling and related immersive techniques. These technologies, spread through the gaming industry, are now finding more and more space also in the world of archaeology and the rediscovery of cultural heritage to allow us to catapult ourselves into scenarios that belonged to the past. These investigation methods lend themselves remarkably well in the case of large urban places that no longer exist due to destructive events but of which there is a sufficient amount of documentation such as to be able to reconstruct its appearance with excellent detail and high reliability. This project aims to rebuild the city of Messina as it appeared in the eighteenth century before being razed to the ground by natural disasters.

Keywords: Sicily; Lost cityscape; Architecture; Urban archaeology; Digital modelling; Earthquake.

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1. INTRODUCTION

The development of modern technologies for visualization and immersive use of digital environments has opened the way to new and surprising areas of research, not only in the purely technological scope or merely linked to the entertainment sector, but also in the teaching, learning (Chang 2011) and scientific fields. In general, the most advanced uses of multimedia and virtual simulations can be seen in the medical (Le, 2018) and military fields (Girardi 2019), extremely active and innovative in defining new proposals. These technologies, briefly attributable to *Virtual Reality* or *Mixed Reality*, are a galaxy of digital structures sharing the same goal, namely the creation of a real environment through the use of electronic technologies. The point is creating a system where the user is immersed in a digital environment in its totality. In the archaeological and cultural heritage fields, the concept of museumization is being reconstituted, that is, a path capable of showing and letting people learn, bringing the observer into an environment similar to the real one (Empler 2018). A necessary condition to define the rules for this process and passing it from an entertainment experience to a scientific experience is to ensure an effective correspondence between the reconstructed environment and the existing one, or, in this case, the one which existed once. To demonstrate the scientific nature of the reconstruction process, the choice of the subject and its context is decisive (Lo Turco 2019). It may ask about moving into the research field of what former *"existed"*, with the archaeological methods entering the scene, or at least to gain a proper control on the sphere of knowledge about the specific subject.

Digital reconstruction projects concerning about a vast archaeological environment are as effective as the interpretation of the original state is correct: the *Perpetuity* project led by *Arc/k Project* (contents available at https://arck-project.org/), which focus is the reconstruction of the archaeological site of Palmyra sadly destroyed in 2015 (Munawar 2017). Such a work originates directly from the surveys conducted on the site before suffering destructions. These considerations allow realizing how a virtual reconstruction aimed to be experienced in the first person, should present a rich body of finds and sources from which drawing its contents. In this way, it will offer to the user proven veracity of the environment, however not overshadowing the surprise and novelty arising from the observation of an environment that is no longer present. A condition that may fit well the purpose of museumization or any educational purposes. The relationship between *"existing"* (or known) and *"existed"* must be balanced, that

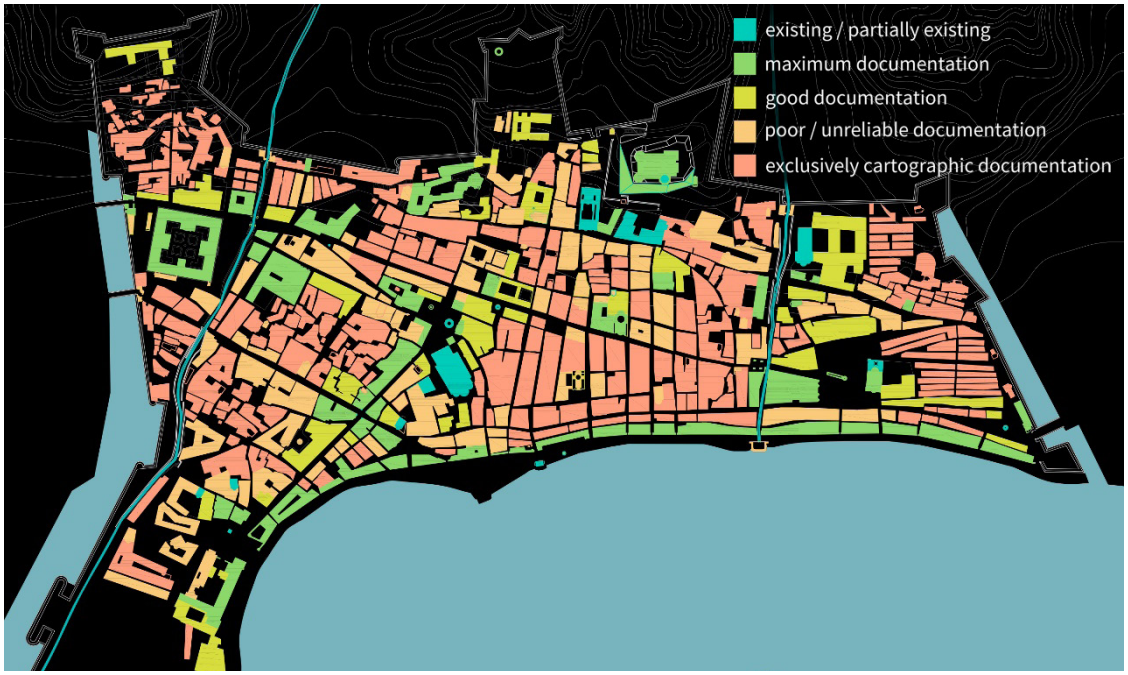

Fig. 1. Plan view of the Messina in 1780, with the mapping of the documentation quality. (Source: L. Giannone 2020).

is, able to perfectly match the rigour of scientific research with the curiosity of entertainment. Respect for this balance is an intrinsic character of the subject that is going to be reconstructed; from the point of view of a project capable of involving a large environment, such as a city, a subject that may have undergone recent destruction of its built heritage, but able to have very reliable documentation, a condition that is optimal for any further virtual (or even real) reconstructions, while it can be supported and accompanied by descriptive, photographic or even detailed survey documents.

The choice of the virtual reconstruction of the city of Messina is based on these aspects. Its historic centre was destroyed by two strong earthquakes, the first in 1783 and the second in 1908; before these two events the city was one of the most prosperous cultural centres in the Mediterranean area and this allowed an intense architectural and monumental development of the city. Some traces from the past asset remained, while the past artistic, architectural and urban richness of the city stimulated the production of documentation, which things, in our time, allows a complete and detailed reconstructive process.

2. HISTORICAL NOTES

Founded by Greek colonists in the VIIIth century B.C., Messina owed its development thanks to its natural harbour, a hinge between East and West (Ioli Gigante 2010). It was precisely the intense traffic that favoured the economic and urban growth of the city starting from the XIIth century, favoured by the establishment of the Kingdom of Sicily by the Norman kings of Altavilla, who contributed to the re-foundation of the city, spreading a precise architectural style which merged with the Byzantine and Arab pre-existence and which constituted the stylistic matrix of the most ancient and important religious complexes such as the Cathedral and the seats of the monastic and knightly orders, and civil and military buildings such as the castle of *Matagrifone*. During the medieval era, urban development concentrated mainly around the area between the *Duomo* (Cathedral) and *Palazzo Reale* (Royal Palace), corresponding to the ancient district called Grecìa, only starting from the Swabian period did the urban expansion continue northwards, stopping along the banks of the *Boccetta* stream (Pispisa 1996).

Fig.2. Messina painted by A.Casembroot, designed by Simone Gullì in 1623 (Grosso Cacopardo 1826).

Fig.3. Messina: ruins of the city after an earthquake, 1783. Coloured aquatint, 1809, after L. Mayer.

Fig.4.The Cathedral destroyed after the earthquake in 1908 (Raccolte Museali Fratelli Alinari, Firenze).

In the XVIth century, there was a period of greatest intensification of urban activity, corresponding to the era of maximum splendour and wealth of the city and the permanent presence in the city, especially

in the second half of the century, of illustrious architects such as Andrea Calamech, Michelangelo Montorsoli, Giacomo del Duca, Martino da Firenze and Polidoro da Caravaggio who instilled in the artistic culture of the city the imprint of the mature Renaissance spreading it in the multitude of construction sites that interested Messina in those years. This fervent architectural environment helped to create a school that accompanied the transition between Renaissance and Baroque with shining architectural masterpieces such as the *Jesuit College* and the *Monte di Pietà* by Natale Masuccio and the *Palazzata* or *Maritime Theater* by Simone Gullì, continuous monumental elevations, over one kilometre long built by merging the buildings overlooking the port and corresponding to the layout of the ancient walls: a symbol of a city that opened towards the sea, the primary source of wealth and city development (Catalioto 2016). The flourishing season of the Baroque continued in the second half of the century with the work of Guarino Guarini, who, in the religious buildings designed for the Theatine order, introduced in Sicily that iconic style that will contaminate the island during the reconstructions following the earthquake of 1693 (Accascina 1964).

The artistic and cultural intensity of the city suffered an abrupt interruption after the anti-Spanish revolt of 1674-78, which repression wiped out the ruling class by suppressing the commercial traffic and the wealthy patrons that had prevailed until then. The building activity, however, regained momentum in the first decades of the eighteenth century also thank the artistic freshness proposed by the works of the young Filippo Juvarra and Paolo Filocamo, both active in the construction site of the most remarkable construction of the eighteenth century in Messina: the Church of St. Gregorio (Lenzo 2005).

On February 5th, 1783, a violent earthquake hit the city, accompanied by an intense seismic shock that lasted for over a month (Aricò 1988). This telluric event left the city reduced to a heap of ruins the most prestigious buildings of the city collapsed: the Royal Palace, the *Palazzata*, most of the Cathedral and the Senatorial Palace, as well as an unspecified number of civil and religious buildings with their domes and bell towers. The subsequent reconstruction of the city paid no attention to renew the tortuous urban layout or gave attention to the construction techniques of the walls, simply restoring, where possible, the damage caused by the earthquake and rebuild, with canons tending to neoclassicism, the most prestigious buildings. When on December 28, 1908, a new earthquake struck Messina, it was more powerful than the previous one, with a magnitude of 7.2 (Mercalli intensity scale). The city was razed to the ground, causing about 80,000 victims (Hobbs, 1909). Once the government and the people left the first intentions about abandoning the city, it was chosen to rebuild it. The removal of the rubble, brought to a hasty and controversial systematic demolition of almost the entire city area, erasing the millennial historical stratigraphy of Messina. The reconstruction plan was defined by a strategy of renewal, but also of removal of the urban and architectural traces. It was the occasion for a series of architectural and urban planning proposals based on old and new ideas and solutions (Arena, 2011), where traditional and experimental forms of construction were mixed and experimented, the intention to leave behind the old city and the memory of the monstrous destructive event brought to the use of local and national conventions with the involvement of foreign models of management and planning of the city. The intention of creating a new urban context is clear, it was tried keeping the previous environment just like a palimpsest where some main places were kept and just some monuments rebuilt or restored, with a new system of buildings taking the place of the destroyed ones.

The architectural languages, coming from a mixed set of styles, defined an eclectic environment, pushed by the will of presenting the reconstruction as a result, but also mixing different interest and tendencies. The new image of the town would not have an easy existence, while some decades later, with the World War 2 the city would have suffered from new massive destructions caused by attacks and bombing in 1943. The following reconstruction with urban and industrial transformation and expansion brought the city to the present asset, with a difficult and very complex reading of the former contests, with an element from different periods and styles coexisting with parts, traces and fragments, all afflicted by old and new decays and issues, making quite hard to interpreter the phases of the urban development to visitors and the people living the downtown as well. The impact on the social environment was strong and created articulated relationships between people, society, government and urban spaces, a condition that brought to the development of weird and even twisted behaviorus (Farinella, 2019).

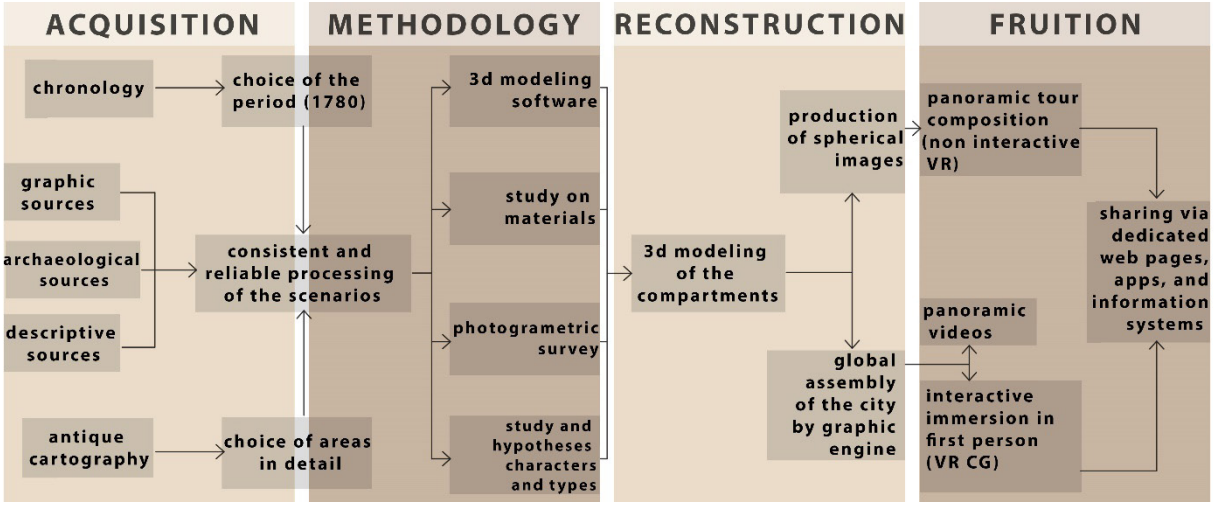

Fig.5. Methodological scheme of the virtual reconstruction process (Source: L. Giannone 2020).

3. ACQUISITION AND SOURCES

After defining the main events that shaped the appearance of the city and the causes that led to its destruction, it is necessary to reorganize and classify the traced sources to analyze the appearance of Messina at a precise moment in its history; in fact, the goal was to freeze the integrity of the city on a specific day in its history, as if it may be possible to visit it through a time machine. This moment was chosen to be drawn from the most accurate and reliable sources, fixing the city in a time before the destructive telluric event. Choosing the year 1780, which is for sure the better choice for reconstruction, while it is the year offering the most refined and tangible sources available for such a task, presenting the city of Messina few years before the events of 1783. In between the various and precious references, it is worth to underline the "*Vedute e prospetti della città di Messina*" (Views and fronts of Messina) by Francesco Sicuro, published in 1767 (Aricò 2014), 21 tables in which the main views of the city are represented with precision and reliability,

Fig. 6. Screenshot from the virtual tour application: panoramic view form a terrace towards the digitally reconstructed city (Source: L.Giannone 2020).

Fig. 7. Matching between historical sources and reconstructions: on the left, the Palazzata, depicted by Louis François Cassas, in "View of Messina Harbor with the Palazzata, designed by Simone Gullì in 1623" (1782-1783), and digital reconstruction by L. Giannone, 2020; on the right Chiesa del Purgatorio (Church of the Purgatory) in a drawing by Nicola Francesco Maffei, c. 1650 and digital reconstruction by L. Giannone, 2020. Both the views of the digital models are extracted from the specific virtual tour application "Messina 1780", which preview is available at https://sapphiruslab.altervista.org/ (Source: L. Giannone 2020).

an essential document to outline the image of the downtown; furthermore, in those years, in the wake of the development of encyclopedic treatises, a large number of authors were producing historical volumes and atlases with the description of Messina and its surrounding area; among these, the *Annali della Città di Messina, Capitale del Regno di Sicilia* (Annals of the City of Messina, Capital of the Kingdom of Sicily), a work from 1755 by Caio Domenico Gallo (Gallo 1755), represent the most prestigious and exhaustive document on the subject, describing in detail all the monuments, civil and religious buildings in Messina, a precious source for the definition of all the parts neglected by painters or engravers. About the urban and cartographic reconstruction, the best sources come from those same years: the first planimetric map of Messina was printed in 1675 by Sieur de la Vigne, while the city map by Colonel Pietro Bardet representing the first purely modern survey of the city is dated 1773, an essential document, in a scale of about 1:800, tracing the plan of the city in the second half of the XVIIIth century (Ioli Gigante 1980).

These documents, together with their other antecedents, provide a valid basis on which set up the reconstructive process. Entire areas of the city can be defined with a high level of details, being able to count on multiple documents that are compared to each other to recognize any fictitious or false interpretations; it is evident that the areas in which the most prestigious buildings, the main squares and the other more *"picturesque"* environments insisted are also those offering more detailed information and in-depth references, while for the other "poorer" districts the resources are minimal and therefore it is more difficult to make a high-level reconstruction if not applying logic or even arbitrary hypothesis.

To prevent a summary and imaginative interpretation, the reconstruction area received a subdivision in nine parts, for each of these portions a highly detailed group of digital models come to processing, receiving a proper level of

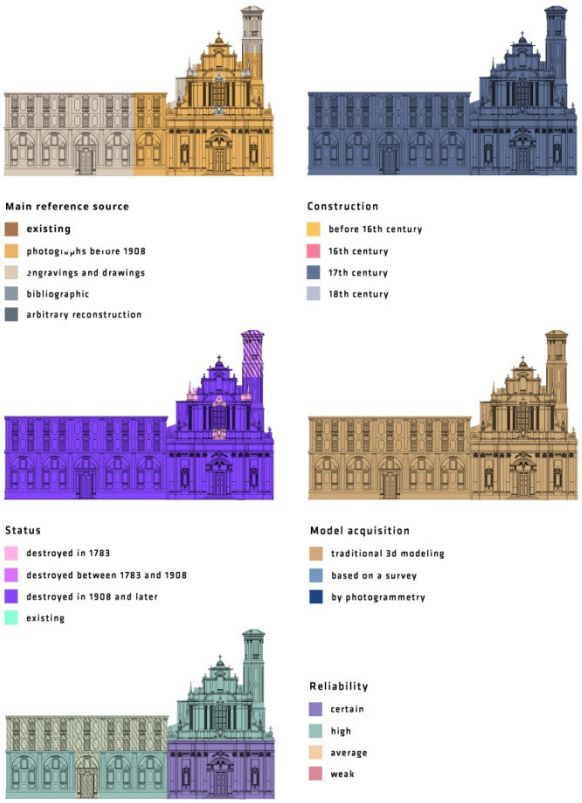

Fig.8. Methodological schemes: front of the *Santissima Annunziata* Church, founded in 1604 then completed by Guarino Guarini in 1660 (source: L. Giannone 2020).

details, with a definition satisfactory enough to make it possible to enjoy in "first-person" the visit to these digitally "resurrected" neighbourhoods. For the rest of the other blocks defining the minor urban tissue of the city, the reconstruction would have been purely volumetric and based on morphological references, in these parts the modest amount of documentary materials was not sufficient to allow the modelling with a good level of details, thus the interpretation based on similarities and the minimal evidence coming from drawings and maps were enough for allowing a massive, but complete reconstruction of the urban tissue and of its main features.

4. METHODOLOGY

However, not all the built heritage of Messina got lost, many elements, especially fountains, portal, statues and sculptural elements have been recovered, some of them still stand today in the places where they were originally designed, others were dismantled over the years and reused or transferred to other places in the city or to the vast warehouses of the Regional Museum.

The different conditions of the historical monuments still present in Messina allow a simple subdivision between existing elements, partially existing elements, existing elements transferred to another location. The whole set of these three categories was treated, within the study of each of the eight compartments, through a different graphic rendering. For the parts still existing a specific photogrammetric survey was operated to obtain three-dimensional models to be further used as a reference base for the reconstruction and as "original" parts to start the development of the model and to remain integrated into the final reconstructive solution. This task required a photographic campaign spreading throughout the territory. Shooting techniques were performed with proper procedures to have the best results from software like *Agisoft Photoscan/Metashape*. Whenever it was possible the shooting was done after an evaluation of the lighting conditions; in facts, high contrasts between lights and shadows and excessive reflections caused by intense lighting should be avoided, reduce aligning issues with the point cloud generation and in the following quality of the texture; so, in this case, all the operations were brought on during days with an overcast sky. The positioning of the camera was accurately planned; when the site was allowing it, the different parts of the object were photographed homogeneously and preferably from different positions; in general, in the case objects with a mainly linear development, like a front along a street, the acquisition has to be carried out by having a generous overlapping between shots (about a third or at least a quarter) from one click to the other while remaining aligned parallel to the front; in the case of an isolated element, such as a statue, the acquisition was carried out by moving in circles around it, while remaining in axis with the centre of the object, while reducing to the minimum any rotations of the focal plane for each full turn. The sensor of the camera settings was on medium-low ISO values, adjust the aperture to have a depth of field covering the special extension of the subject, reserving out of focus blur to the background and the secondary, or not interesting, elements. The focal length was blocked on fixed values for each set of shots dedicated to a single subject. Once the acquisition phase is completed,

the following processing is quite classic: the photos are imported into the software within a new "chunk"; here it is possible to perform some preliminary operations such as inserting masks, to exclude from the calculation those pixels in which disturbing elements such as the sky or people may be present, or group together the photographs taken from the same position. Then the image alignment process is selected from the workflow menu, at the end of which the sparse cloud will be available for a first preview of the results if some photos turn out as not correctly aligned, it is possible to insert markers to carry out a manual alignment of the individual photos. The following phase is dedicated to the construction of the Dense Cloud, it will allow the visualization of the complete point cloud generated by the Structure from Motion/Image Matching processing (Guidi 2014), the accuracy of the results is here directly depending from the size of the pixel over the object (smaller pixel will produce a higher level of details) and by the quality and Depth Filtering settings (higher values will bring to better results, but with longer or even very longer calculation times); subsequently, after eventually eliminating points not belonging to the detected object, the mesh is built by choosing the polygon count. The last operation is the generation of the texture map, also, in this case, the quality is set on the base of the size and count parameters (effective resolution of each "texture atlas" and how many of these are planned to well describe the aspect of the final model). Once the three-dimensional model with its textures is ready and put in scale (using some measurements taken in place during the shooting and identified over the polygonal model) it is exported for use in other programs, in case of need, it is possible to optimize the model using software for polygonal mesh management and reverse engineering, like applying some refinements and/or simplify the models, one of these is *Geomagic Wrap*, developed by *3D Systems*, through its processes it is possible to obtain a fast and accurate decimation and interpolation of the mesh, optimization of the texturing (including normal mapping and other procedures ideal for reducing the complexity of the polygonal model without losing its level of details) and to reduce the "weight" of the model making it easier to be managed and suitable for inserting in large-size scenes within *Autodesk 3D Studio Max* or other modelling/rendering software. Bringing the photogrammetric model in

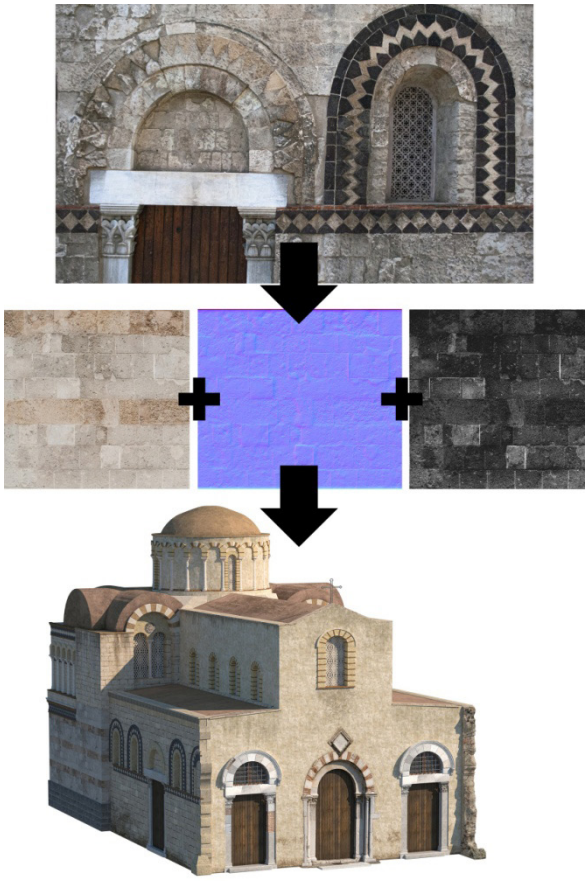

Fig.9. Process of material acquisition of a still existing building. The Catalan's Annunziata Church, founded in the XIInd century (source: L. Giannone 2020).

such a final software is the fundamental premise to start the reconstruction operations, using the rendering and modelling function of the program to produce bases for studying the alignments, the proportions and the relationships between parts in each model. In other words to have an efficient modelling space where read and understand the "project" of the lost architecture and then apply a sort of "regressive" design to reach the original aspect of the lost building, understanding the project behind che complex sequence of changes happened to the building (Verdiani 2017). When the concepts are fixed, it will start the completion of the missing parts, using all the advanced tools needed to create a realistic component for the visual finalization of the reconstruction proposal.

The operations just described were carried out for a large number of monuments in Messina (fountains of the Quadrivio, Orione, Nettuno, di Gennaro, portals and windows of the Cathedral, statue of Don Giovanni, Stele Immacolata, etc.).

This acquisition process took care also of many minor sculptural elements present in the deposits of the Regional Museum such as capitals, carved corbels, medallions, coats of arms and city and imperial insignia.

In the case of the model of the equestrian statue of Charles II, destroyed in 1848, the photogrammetric survey of the draft model by the same author Giacomo Serpotta was carried out at the Pepoli Museum in Trapani. Similarly to these considerations, historical and typological studies were addressed also to buildings with poor documentation: in the case of missing information, the arbitrary reconstruction started from a preliminary typological study. In the interpretation of all the minor urban fabric, it is possible to assume that up to 1783 Messina was still largely made up of a considerable medieval origin and appearance: the great expansion following the construction of the Norman walls and the absence of destructive seismic phenomena since 1169 if not the slight effects of the tremors happened in 1562 and 1693, allow to hypothesize that at that time many examples of Gothic and late Gothic architecture could be observed, it is possible to imagine the presence of shining examples of those *Chiaramontano* and later Catalan styles that flourished in parallel to the urban development and of which precious testimonies remain in Taormina (Sánchez Regueira 1956).

The second great urban development of Messina took place starting from the mid-sixteenth century through architects who came from a Roman and (above all) Tuscan renaissance training, many of them were students and collaborators of Michelangelo Buonarroti and Bartolomeo Ammannati. This Renaissance influence is perceptible in many documentary testimonies (Pane 1975). Moreover, a good number of buildings built according to the Renaissance language along the XVIth century are still existing in the nearby villages, often they are the results of the work of masters who worked in the most important courtyards, and which testify how the Renaissance attitude was so well established and diffused to have the possibility to transcend the city walls. In example, the architects from Messina collaborated to the construction of the architecture of Palazzo Biscari, to the Benedictine monastery, to the Cerami house and the Cathedral. In these buildings, it can be seen the reflection of the building culture present in Messina in the same years.

At the same time, the new architectures built in Catania, after their earthquake, were reinforced by robust cantonals, perfectly aligned openings and decorated with stucco and dripstones, took shape by reflection also in Messina, as it can be seen from the early drawings to 1783.

Once that all the traces, information, elements, materials, evidence, contents and draft ideas about the models were ready and defined, the development strategy was aimed to the production of a scientific digital reconstruction with the vocation to be the central part of the virtual exploration of the disappeared downtown, a very versatile and original virtual space expanding to the urban scenario the creation procedures of the virtual museum (Barsanti 2018). “Messina 1780” would have offered the visit to an impossible museum, proposing solutions going beyond the complex communication and understanding of the urban transformation, in the scenario of a past, in a certain way, ideal, virtualization of Messina.

The digital modelling phase, after studying the individual monuments, was entirely carried out using Autodesk 3D Studio Max. The primary objective was to obtain very accurate three-dimensional models but at the same time with a reduced number of polygons, so to keep the projects quite handy and versatile.

This was obtained with careful use of the specific parameters and modifiers available in 3D Studio Max, avoiding procedures capable of significant increase of the “weight” of objects, to modifiers like *Turbosmooth*, or other functions well suitable for creating realistic refinements of the models but characterized by a large increase of the complexity of the elements. It was preferred a modelling strategy focused on defining the edges and morphological characteristics of the architectures.

These considerations have been followed for all those elements characterized by widespread seriality. In example, in the case of the windows of the *Palazzata*, distributed on the between floors of the façade for a length of over one kilometre, the procedure has privileged the point of view, with a variable level of details. So, after selecting the point of views, two modelling modes have been created for the same elements: a high poly model in the areas close to the privileged point of view

Fig.10. Rendering image from the 3D digital reconstruction: The Cathedral (Source: L. Giannone 2020).

Fig.11. Rendering image from the 3D digital reconstruction: San Gregorio (Source: L.Giannone 2020).

and basic modelling in the case of those windows located far away from the explorable area.

These observations were found to be of fundamental importance when bringing together the entire city sector with all the various models insisted on it for the production of the various outputs (video, 360 panoramas), a neighbourhood composed exclusively of high poly models would have involved considerable difficulty for the software, especially in cases wherein the same scene there are a considerable amount of models obtained by photogrammetry and therefore composed of meshes. The materials were applied using 3D Studio Max.

The definition of the many textures required various tests and studies. Modelling an XVIIth century city built mainly in stone materials requires an intense study of native and most widespread materials from the territory: the absence of quarries in the nearby of the city centre brought to the use of river pebbles mixed with cement mortar, it became the prevalent construction technique, with poor mechanical resistance and often used in the most humble buildings. There is a large use of the stone of Syracuse and a sandstone widespread in the area of Taormina, as well as the lava stone from the Etna volcano, often used in inlays and decorations. From the south-eastern area of the island, it came the Tufo, a magmatic rock with poor resistance to atmospheric agents but easily workable. There was no shortage of valuable materials such as Carrara marble, which began to be imported in large quantities from the times of the Tuscan Giovanni Montorsoli and Andrea Calamech. The texture and appearance of these materials have been recreated through the creation of detailed textures and mainly including diffuse maps, roughness, reflection, dirt, normal, bump and displacement to best render the physical characteristics of the materials and often obtained through a photographic survey on the original materials. The modelling of the entire urban fabric of Messina, object of the survey, constitutes a complete sample through which it is easily possible to produce multiple types of output. The various models have been assembled to compose different environments in the same software or exported in FBX format in other software according to the type of desired final output.

Starting from the model of “Messina 1780”, the visualization of the ancient city can be proposed through various digital elaborations; from single rendering views to the production of videos through which the city of Messina is captured as a whole in detailed bird’s eye explorations of entire neighbourhoods; these short movies have been

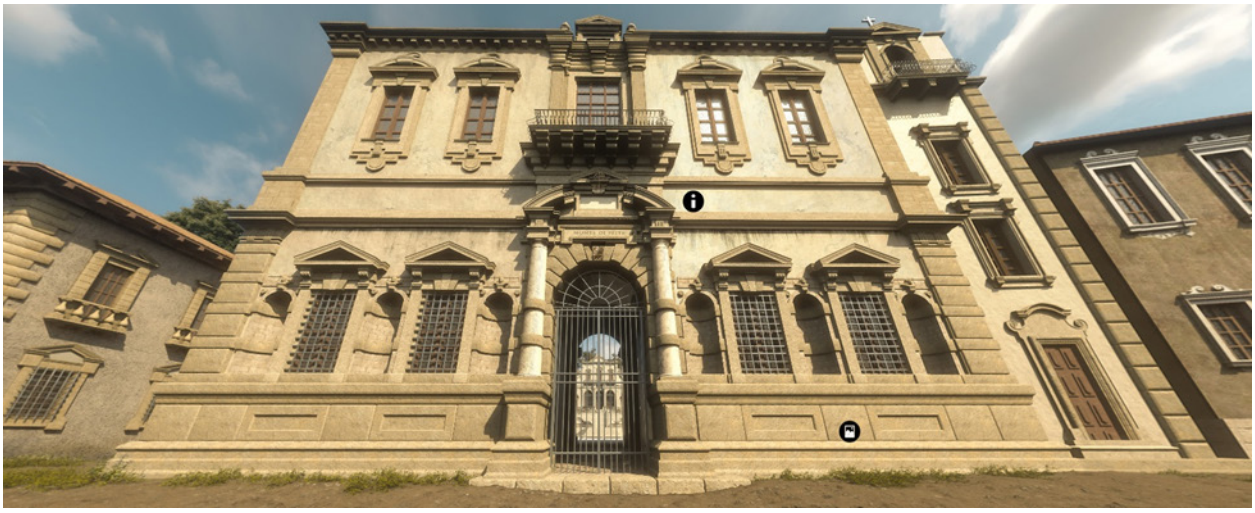

Fig. 12. Screenshot from the Virtual Tour application: Palazzo del Monte di Pietà (Source: L.Giannone 2020).

produced directly within Autodesk 3D Studio Max as animations or with the aid of real-time immersive 3D architectural visualization software such as Unreal Engine Twinmotion.

The most complete and exhaustive final processing on the work done is however the virtual tour of the city consisting of an application in HTML language and freely available at https://sapphiruslab.altervista.org/.

This tour consists of 16 different scenarios located within the city, each of which is visible at 360 degrees through compatibility for VR viewers; each scene also contains informative texts, images showing the sources of reference and the comparison with the same area nowadays to offer the observer both an entertaining and informative experience. The virtual tour is optimized for desktop and mobile visualization was developed using Garden Gnome Pano2VR, an extremely versatile and customizable tool for this kind of products. The reconstruction can thus be used for educational purposes and tourist use, to be able, in a few steps, inside a virtual equipped station or in front of a billboard with a QR Code and with a basic smartphone, view and immerse inside a large city of the eighteenth century today almost disappeared. The views of the city, presented in the aspect of 360-degree panoramic images can be visited through virtual reality, they could be further developed as scenes within which it is possible to move and walk, interact with animated objects and characters, using a complete and immersive VR. The direct vision of the urban scenes would allow an instant acquisition of knowledge concerning the historical-urban reality of Messina, which, to date, would only be possible after long readings and studies.

REFERENCES

Accascina, M. 1964. *Profilo dell'architettura a Messina dal 1600 al 1800*, Roma: Edizioni dell'Ateneo.

Arena, A. 2011 *I disegni dei progetti per la ricostruzione di Messina. Analisi delle tecniche di rappresentazione tra Otto e Novecento: tra linguaggio accademico e nuove istanze figurative*, Messina: Ed. Magika, ISBN 978-8889525302.

Aricò, N., Bellantoni, E., Guidoni, E., Molonia, G., Salemi, G. 1988. *Cartografia di un terremoto: Messina 1783*, Milano: Electa.

Aricò, N. 2014. *Una città in architettura. Le incisioni di Francesco Sicuro per Messina*, Palermo: Edizioni Caracol snc.

Barsanti, S.G., Malatesta, S.G., Lella, F., Fanini, B., Sala, F., Dodero, E., Petacco, L. 2018. "The WINCKELMANN300 Project: Dissemination of Culture with Virtual Reality at the Capitoline Museum in Rome". *International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences*, 42(2), 371-378. https://doi.org/10.5194/isprs-archives-XLII-2-371-2018

Catalioto, S. 2016. *Messina nel 1672: storia urbanistica, architettonica e monumentale dal 1623 al 1674*, Messina: Di Nicolò edizioni.

Chang, M., Hwang, W.Y., Chen, M.P., Müller W. (Editors). 2011. "Edutainment Technologies, Educational Games and Virtual Reality/Augmented Reality Applications", In *Proceedings of the 6th International Conference on E-learning and Games, Edutainment 2011*, Taipei, Taiwan, September 7-9, 2011, Springer-Verlag, Berlin. https://doi.org/10.1007/978-3-642-23456-9

Empler, T. 2018. "Traditional Museums, virtual Museums. Dissemination role of ICTs.", in *DISEGNARECON*, vol. 11, n. 21, Italy.

Farinella, D., Saitta, P. 2019. *The Endless Reconstruction and Modern Disasters, The Management of Urban Space Through an Earthquake – Messina, 1908–2018*, Springer Nature, Switzerland. https://doi.org/10.1007/978-3-030-19361-4

Gallo, C.D. 1755-1896. Gli annali della citta di Messina / C. D. Gallo, G. Oliva, Ristampa anastatica, Sala Bolognese: A. Forni, 1980, Tip. Filomena, (1877-1893), Messina, Italy.

Grosso Cacopardo, G. 1826. *Guida per la città di Messina: scritta dall' autore delle Memorie de' pittore Messinesi*, Messina: G. Pappalardo.

Girardi, R., de Oliveira, J.C. 2019. "Virtual Reality in Army Artillery Observer Training", 2019 *21st Symposium on Virtual and Augmented Reality (SVR)*, Rio de Janeiro, Brazil, 2019, pp. 25-33, IEEE. https://doi.org/10.1109/SVR.2019.00021

Guidi, G., Gonizzi, S. 2014. "Image pre-processing for optimizing automated photogrammetry performances", in *ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci.*, 145-152. Volume II-5. https://doi.org/10.5194/isprsannals-II-5-145-2014

Hobbs, W.H. 1909. "The Messina Earthquake", in *Bulletin of the American Geographical Society*, 1909, Vol. 41, No. 7 (1909), pp. 409-422, Taylor & Francis, Ltd., USA. https://doi.org/10.2307/199619

Ioli Gigante, A. 1980. *Messina*, Bari: Editori Laterza.

Ioli Gigante, A. 2010. *Messina. Storia della città tra processi urbani e materiali iconografici*, Messina: Libreria Ciofalo.

Le, D.N., Le, C.V., Tromp, J.G., Nguyen G.N. 2018. *Emerging Technologies for Health and Medicine, Virtual Reality, Augmented Reality, Artificial Intelligence, Internet of Things, Robotics, Industry 4.0*, John Wiley & Sons, USA. https://doi.org/10.1002/9781119509875

Lenzo, F. 2005. *Il campanile di San Gregorio e Paolo Filocamo, in Lexicon. Storie e architettura in Sicilia n. 1: Messina tra Seicento e Settecento*, Palermo: Edizioni Caracol.

Lo Turco, M., Piumatti, P., Calvano, M., Giovannini, E.C., Mafrici, N., Tomalini, A., Fanini, B. 2019. "Interactive Digital Environments for Cultural Heritage and Museums. Building a digital ecosystem to display hidden collections", in *DISEGNARECON*, vol. 12, n. 23.

Munawar, N.A. 2017. "Reconstructing Cultural Heritage in Conflict Zones: Should Palmyra be Rebuilt?" In *Ex Novo Journal of Archaeology*, Volume2, December 2017: 33-48, Associazione Ex Novo, Rome, Italy. https://doi.org/10.32028/exnovo.v2i0.388

Pane, R. 1975. *Il Rinascimento nell' Italia Meridionale*, Ivrea: Edizioni di Comunità.

Pispisa, E. 1996. *Messina medievale, in Le città del Mezzogiorno medievale*, Volume 1, Galatina: Congedo editore.

Sánchez Regueira, M. 1956, *La arquitectura gotica civil del levante de España en Sicilia*, Instituto Español de Estudios Eclesiásticos, España.

Verdiani, G. 2017. *Retroprogettazione. Metodologie ed esperienze di ricostruzione 3D digitale per il Patrimonio Costruito*, Firenze: Dida Press.

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