

Digitalization of Bernini's drawing Tondo depicting St. Joseph with the baby Jesus. Increasing knowledge and monitoring Surface Cracks

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Abstract - The main goal of the study carried out by the ICT Laboratory of ENEA described in this paper has been to define a method, applied on the Bernini's sanguine drawing, useful to define the conservation actual status of an artwork and to facilitate the medium and long-term monitoring of the damages that have been highlighted and measured, using Photogrammetry technique. Thus, the collected images have been post-processed to create a three-dimensional virtual model of the drawing with the aim of helping the wider fruition, showing up details that will support further in-depth analysis to better know also the historical, material, and iconographic characteristics of this drawing, crossing scientific data with archival data.

I. INTRODUCTION

Nowadays, Photogrammetry is a technique consolidated and effective in monitoring in a very quick and low-cost way the state of conservation of artworks even located in places difficult to access or inaccessible, in which more complex and cumbersome instrumentation (or that require power supply) cannot go into so easily. In addition, another advantage of photogrammetry is the ease of retrieval of software with which images are post-processed to be analysed. For these reasons it was chosen by the ENEA ICT Laboratory to investigate the state of conservation of Bernini's Tondo (dated 1663): a sanguine and one of the few drawings attributed to Gian Lorenzo Bernini [1], well known by the experts also because it seems to be the only signed work of the artist [2]. Furthermore, the digitalization of this artwork was obtained by applying

the Structure for Motion technique (SfM), that has made possible to produce a 3D reconstruction, which will benefit its knowledge and fruition. In fact, the 3D model will allow, in a second moment, to make the work accessible to a wider audience.

The photogrammetric campaign described in this paper was carried out within the ADAMO Project [3], financed by the Lazio Region, through the Technological District for Cultural Heritage – DTC [4]. The District has planned a series of diagnostic investigations aimed at improving the knowledge and preservation of some artworks on the territory of the Lazio Region. In this context, the ADAMO Project involved different cultural and scientific institutions, universities, and research centres (such as ENEA) that applied some advanced non-destructive and non-invasive technologies on the ancient manufactures, both pictorial and sculptural, hosted in the Baroque Museum, located in the Chigi Palace of Ariccia [5], including the Bernini's Tondo. Thus, besides photogrammetry, different diagnostic techniques were integrated to obtain more complete and better-quality results. Roma Tre University and The National Institute for Nuclear Physics (INFN) applied specific tools and methods on the drawing: XRF (X-ray Fluorescence), LIF (Laser-induced fluorescence) and FT-IR (Raman and Infrared vibrational spectroscopies), collecting data on the chemical composition of the materials used by the artist, the pigment of the preparatory background of the drawing, the one of the sanguine and those used for the chiaroscuro [6]. In particular, the different elements detected in the background would probably mean that the 'signature' was affixed later, which could mean that it was not written by Bernini himself [7]. Moreover, thanks to these diagnostic applications the graphite

section below the sanguine was also discovered. Even the conservation state of the materials used in previous restoration treatments were studied by using Ultraviolet–visible spectroscopy imaging analysis (UV–VIS). In fact, the Bernini's wall painting was object of a conservative restoration treatment in 1998, in the occasion of the exhibition “L'Ariccia del Bernini” [8].

As documented in the restoration schedules, conservative treatments involved filling some cracks on the painted surface. These cracks were caused by a window underneath the artwork, which was closed during the restoration to avoid future damages [9].

Furthermore, the Laboratory of Non-Destructive and Environmental Analysis for Cultural Heritage of the Department of Industrial Engineering of the University of Rome Tor Vergata (LANDAC) has applied Thermogram and Reflectogram to map the structural conditions of the manufact. These surveys have shown the presence of a later grouting (perhaps a sign of a restoration) and of numerous holes [10].

Considering also some of the results achieved by the surveys described so far, the photogrammetric campaign conducted by the ENEA ICT laboratory aimed at measuring accurately the dimensions of all the cracks and damages identified on the drawing, and at monitoring them and prevent any future deterioration.



Fig. 1 The drawing 'Tondo' by Bernini: the object of the investigation.

II. THE ARTWORK

The Bernini's drawing (Fig. 1) is located on a wall in the chapel on the first floor of Palazzo Chigi in Ariccia (a village near Rome) where Bernini worked in the

second half of the seventeenth century, at the service of the Chigi family and especially of Pope Alexander VII [11]. The Tondo depicts Saint Joseph with the Child Jesus and measures 1.11 m by 1.10 m. The technique of realization is that of the sanguine, commonly used by the artists for sketches and preparatory drawings. The autograph would seem to be demonstrated both by the inscription «EQUES IO LAURENTIUS BERNINI FAC: ANNO DNI MDCLXIII, » (Fig. 2) which means «Me Cavaliere Bernini done: Anno Domini 1663», that can be read inside the Tondo, and by the comparison with another autograph drawing of Bernini, depicting the same iconographic theme, preserved in the Chigi Archive of the Vatican Apostolic Library [12]. The frame that surrounds the artwork is dated 1771 and was painted in fake marble by Luigi Baldi, commissioned by Sigismondo Chigi [13].

The drawing has been described for the first time by Stanislao Frascchetti as "very curious for its originality" [14]; in fact, to find Saint Joseph and the Child in such pose must be considered a rarity with very few precedents. According to the foremost expert of the Tondo (art historian, and director of the Baroque Museum located in Palazzo Chigi) Francesco Petrucci, Bernini's choice of this iconography would be linked to the birth of Augusto Chigi, the first son of Agostino Chigi; therefore, the two – father and son - would be identifiable with the sacred figures, portrayed in a gesture of great humanity and naturalness [15].

Even though the profile of the old Saint holding the baby Jesus sleeping seems to reveal evident affinities with the 'Portrait of frate cappuccino' owned by a private collection [16], from a recent comparison made during the present research, a remarkable similarity seems to be emerged between the profile of Saint Joseph, portrayed in the Tondo and the marble relief (Fig. 3) placed on the tomb of Agostino Chigi, sculpted by Bernini himself in 1652, and still visible inside a chapel located into the Basilica of Santa Maria del Popolo in Rome [17].

The choice of the round shape seems to be singular: in fact, traditionally it was used since the Renaissance more commonly to contain depictions both of saints and prophets, and scenes of the Holy Family and Motherhood. It is well known that the circular shape originally derives from the 'birth chart' that was used to be gifted to either the new mother or to spouses, as a good omen. Bernini instead uses it with a certain frequency to contain portraits, especially reliefs placed on tombs. Based on these observations, it could be possible to hypothesize that the round shape of the sanguine initially may have had a different purpose, such as to contain a portrait of a deceased member of the Chigi family. Otherwise, it could be that the original shape was changed afterwards when the framework was added.

According to Petrucci's studies, the execution of the drawing was carried out impromptu, without a preparatory drawing, an act presumably confirmed by the horizontal line (pointed out by the surveys described

below) in the middle of the child's face [18]. However, in the recent thermographic investigations carried out during the diagnostic campaigns conducted for the ADAMO Project, a graphite section below the more evident sanguine drawing was revealed, which would attest the existence of a further preparatory sketch [19]. Certainly, the sanguine, as usual for Bernini, was the trace for a fresco, but it was never completed, presumably because of the artist's trip to France or the death of his patron Pope Alexander VII Chigi [20]. In fact, the Pope commissioned many works to Bernini, most sculptural and architectural, including reconstruction of the Baronial Palace, and the renovation of the Court Square of Ariccia, the Collegiate Church of the Assumption, the Sanctuary of Galloro and other buildings in the municipality of this town [21]. The first interventions on the urban planning dates back to 1661-1663, when the architect worked on the Alessandrine Roads with the aim of connecting Ariccia to neighbouring countries [22]. It is also interesting to notice that in the same years the artist drew the sanguine too.

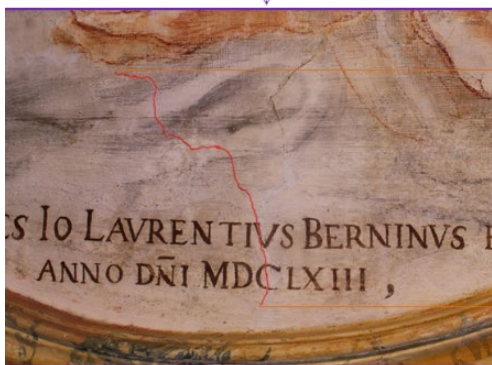


Fig. 2 Detail of the writing with highlighted a lesion.



Fig. 3 Portrait of Agostino Chigi (marble relief) compared to the profile of St. Joseph made with the sanguine in the Tondo.

III. THE PHOTOGRAMMETRIC CAMPAIGN

In 2019 a group of experts, technicians and researchers from the ENEA ICT Laboratory carried out a photogrammetric campaign on the Tondo del Bernini, in order to highlight any damage, crack and weakness, so that these can be monitored over time, in future measurement campaigns. Therefore, during this first photogrammetric campaign 136 images of 5184x3456 pixels and 6MB each were taken. The photos were postprocessed with the software Agisoft Photoscan Pro 1.4.5 following the workflow from the alignment of the individual photos to the return of the texturized 3D model in high resolution. The point-cloud obtained in the post-processing phase is made of about 8 million and 500 thousand points and has been edited and cleaned with Mesh Lab software, which allowed to redefine graphically the edges of the Tondo, because they appeared irregular; then, it has been straightened in the digital model, which has facilitated the measurement of real dimensions. Lastly, Photoshop software was used to create a grid that has been superimposed on the digital twin because it results useful in mapping injuries and damage present on the surface of paintings and drawings.

In general, the method used demonstrates that the use of the Photogrammetric technique, assisted by the

software MeshLab, highlights both areas with damage from engraving, and portions of the wall in which the colour is detached. Lesions of different severity have been identified on the Tondo surface (Fig. 4): from those of very small extent (about 0.002 m), to others much more serious (from 0.05 m to 0.09 m) for which it was already possible to predict a worsening in the short term.

In the last phase, using the Structure from Motion technique (SfM) a 3D model (Fig. 5) has been created with the main objective of assisting restorers in some possible future conservative intervention on the drawing; moreover, it can help historians and experts in their research to improve the knowledge of this artwork, supporting, for example, the vision of details not easy to detect by naked eye. Thus, all the results obtained - images, numerical data, and the 3D model - has been stored in the virtual lab IT@CHA [23] - a dedicated hardware and software infrastructure for Cultural Heritage - hosted in the integrated computational infrastructure ENEA GRID [24] managed by ICT ENEA Laboratory, which allowed, on one hand, the access to the software resources, useful for post-processing photogrammetric data and for the realization of the 3D model of the artwork; on the other hand, in this infrastructure the results of the survey campaign are stored in a completely safe way, into a dedicated area reserved only to authorized users.

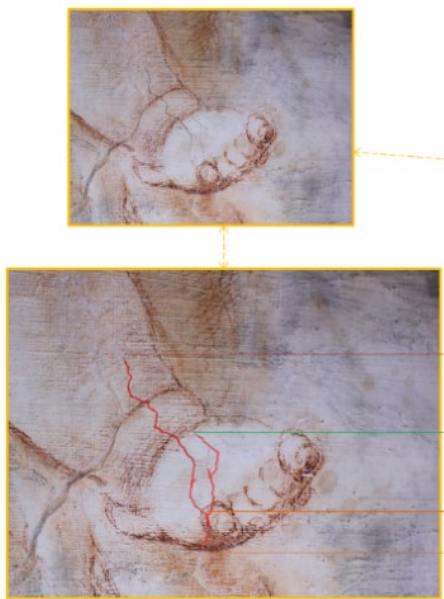


Fig. 4 A detail of a lesion highlighted with the use of photogrammetric technique.



Fig. 5 3D model of the Tondo.

IV. THE RESULTS

Thanks to the application of the photogrammetric technique the current state of conservation of the painting has been fixed both in pictures and in the 3D model of Tondo. In fact, for each single damage that has been found, a slide with a picture of the painting has been created. Thus, on each slide, the damaged can be easily enlarged to be analysed in a deeper way even remotely. Then, the grid overlapped on each slide permits to locate exactly the single crack and to measure it. Finally, all data and measures have been collected in a table with size in meters of the damage detected (Table 1).

One of the more relevant goal achieved by our photogrammetric campaign - and by the related method of investigation - is that it will be easily replicated in the future directly by the staff of the museum, even without the help of external experts and without complex technologies, by using a normal photo camera. to catch measures that will be compared with the previous ones, already uploaded into the dedicated section of the virtual lab IT@CHA, to following up the possible evolution of the single crack over time. This also avoid processing quantities of data that would require too much economic and time-consuming efforts for small cultural sites, such as the museum in Ariccia.

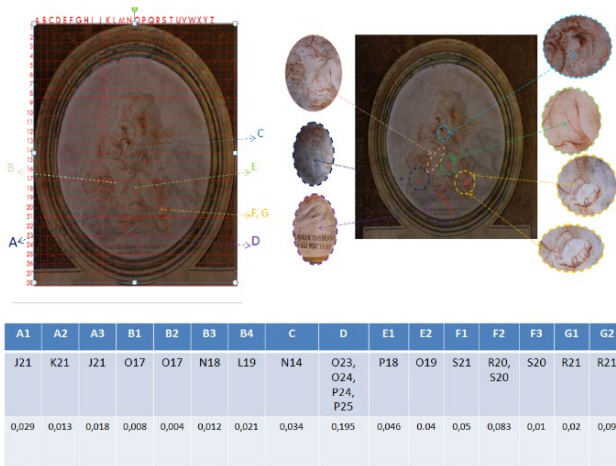


Table 1 and the table with the data collected and the grid overlapped the painting to control the damages by measuring the width of each crack.

Another goal that would be achieved thanks to the production of the 3D model of the Tondo is the development of a multimedia project for the cultural promotion of the museum, focused, at the beginning, on the single digital twin of the wall-drawing, both inside the building in which it is located, reproduced on screens for three-dimensional vision, and remotely, on a web platform.

Looking ahead, a more complete promotion plane, that would involve the entire collection located into the Barocco Museum, would be developed including the digitalization of other artworks, even sculptures and mobile artefacts, replicating the same methodology already applied on the Tondo.

V. CONCLUSIONS

The photogrammetric campaign carried out by ENEA ICT laboratory on the Bernini drawing in Palazzo Chigi in Ariccia, had the double advantage of, on one hand, collecting quickly numerical data on the current state of conservation and, on the other hand, of showing the effectiveness and the replicability of the method applied, useful both to improve the knowledge and to help in monitoring even when artworks are in conditions of limited accessibility, thanks to the three-dimensional digital twin that benefits a better fruition, even by a wider audience of non-experts. Thus, all the information collected about an artwork will remain accessible to researchers and conservators, together with the 3D model, because they are stored in total security into the ENEA-GRID infrastructure. This infrastructure, and especially the virtual lab IT@CHA dedicated to Cultural Heritage, makes available hardware and software resources useful to postprocess images and to realize digital models of artworks.

REFERENCES

- [1] V. Martinelli, "Gian Lorenzo Bernini", in *Enciclopedia Universale dell'Arte*, II, ed. Sansoni, Firenze 1959, col. 535, tav. XXXIX.
- [2] F. Petrucci, "Considerazioni sulla sanguigna del Bernini nella cappella del Palazzo Chigi di Ariccia" in *Echi del Barocco*, numero monografico della rivista Castelli romani 1995, xxxv, Ariccia, 1997, pp. 120-25.
- [3] <https://progettoadamo.enea.it/>
- [4] <https://dtclazio.it/>
- [5] <https://www.palazzoChigiAriccia.it/>
- [6] S. Frascchetti, "il Bernini: la sua vita, la sua opera, il suo tempo", Milano 1900, pp. 234 – 235.
- [7] The only previous similar artworks are by Guido Reni: *Il putтино che dorme* in Barberini house, *Il San Giuseppe con il Bambino*, at the Museo Arcivescovile in Milan and *Il San Giuseppe con il Bambino*, from the private Houston collection. S. Pepper, "Guido Reni. L'opera completa", Istituto Geografico De Agostini, 1988.
- [8] D. Petrucci, F. Petrucci, "Palazzo Chigi in Ariccia, guida illustrata", Ariccia, 2010.
- [9] M. Romani, M., Pronti, L., Sbroscia, M., Petrucci, F., Tarquini, O., Verona-Rinati, G., et al., "St. Joseph with the Child by Gian Lorenzo Bernini: A definitive artwork or a preparatory drawing? A multidisciplinary study of the only autograph painting of the Artist, preserved at Palazzo Chigi of Ariccia (Rome)", *Journal of Cultural Heritage*, Volume 46, November–December 2020, pp. 283-288.
- [10] Indagini termografiche e riflettografiche nel medio infrarosso su un disegno del Bernini (<http://progettoadamo.enea.it/wp-content/uploads/2019/04/task-4.6-Report-sintetico-Palazzo-Chigi-Ariccia-Zammit-LANDAC.pdf>)
- [11] R. Lefevre, "Il Bernini ad Ariccia e la Piazza di Corte dei Chigi", Te Roma Sequor, Roma, 1981.
- [12] F. Petrucci, "Dipinti del Barocco romano da Palazzo Chigi in Ariccia", Gangemi, Roma, 2012.
- [13] F. Petrucci, "Bernini pittore: dal disegno al meraviglioso composto", Ugo Bozzi, Roma, 2006.
- [14] F. Petrucci, 1997, pp. 120-125.
- [15] F. Petrucci (a cura di), "L'Ariccia del Bernini: Ricostruzione dell'attività del Bernini per i Chigi, valorizzazione del patrimonio di Ariccia in vista dell'apertura definitiva del Palazzo e del Parco", Catalogo della mostra, Ariccia, 1998.
- [16] A. Angelini, "Un ritratto 'familiare' dipinto da Gian Lorenzo Bernini (con una nota sulle relazioni dell'artista con la pittura)", *Prospettiva*, Centro Di Della Edifimi SRL, Gennaio-Aprile 2005, No. 117/118, pp. 165-172.
- [17] J. Shearman, "The Chigi Chapel in S. Maria del Popolo", *Journal of the Warburg and Courtauld Institutes*, Vol. 24, No. 3-4, Jul. - Dec., 1961, pp. 129-160.
- [18] F. Petrucci, 2006.

[19] Indagini termografiche e riflettografiche nel medio infrarosso su un disegno del Bernini

<https://progettoadamo.enea.it/wp-content/uploads/2019/04/task-4.6-Report-sintetico-Palazzo-Chigi-Ariccia-Zammit-LANDAC.pdf>

[20] F. Baldinucci, “Vita del cavaliere Gio. Lorenzo Bernino scultore, architetto, e pittore”, Firenze, 1682.

[21] R. Lefevre, “Sulla Costruzione del Palazzo Chigi già Savelli” in Lunario Romano, XX, Ariccia, 1991.

[22] F. Petrucci, “Il Palazzo Chigi di Ariccia”, Ariccia, 1998, pp.17-42.

[22] <http://www.laboratorivirtuali.enea.it/it/prime-pagine/it-cha-virtual-lab>

[24] <https://www.eneagrid.enea.it/>