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Perin del Vaga, His Workshop and Patterns of Fresco Painting in the Farnese Tower cycle through Multiple Non-Invasive Analyses

[Giulia Iorio[1, 2], *Noemi Zappalà*[3], *Valerio Graziani*[1, 2], *Luca Tortora*[1, 2,4], *Costanza Barbieri*[3]]

[1] National Institute for Nuclear Physics - INFN, Roma Tre department, via della Vasca Navale 84, 00146, Rome, Italy; giulia.iorio, valerio.graziani)@roma3.infn.it

[2]Surface Analysis Laboratory Roma Tre - LASR3, via della Vasca Navale 84, 00146, Rome, Italy

[3]Academy of Fine Arts in Rome - Via Ripetta, 222, 00186, Rome, Italy; (n.zappala, c.barbieri)@abaroma.it

[4] Department of Science, Roma Tre University, via della Vasca Navale 84, 00146, Rome, Italy; luca.tortora@uniroma3.it

Abstract

The aim of this work, carried out within the framework of the ENACTING ARTISTIC RESEARCH (EAR) project, is to presents preliminary results from ongoing analyses conducted on a 16th-century fresco cycle originally located in the Tower of Pope Paul III Farnese and now housed at the Academy of Fine Arts in Rome. The artworks are being investigated through an integrated approach combining art, science, and non-invasive diagnostic techniques, thanks to the collaboration between the Academy of Fine Arts in Rome and the National Institute of Nuclear Physics of Roma Tre. To address the numerous diagnostic questions, concerning the uncertain attribution of the artworks, the multiplicity of execution techniques, and the complex conservation history, several analytical methods have been employed, including multispectral imaging, digital microscopy and X-ray fluorescence (XRF).

1.Introduction

The EAR project (PNRR_INTAFAM00060, Italian Ministry of University and Research) involves collaboration among various institutions (Academies, Conservatories and Universities), including the Academy of Fine Arts in Rome (lead partner), Florence and Milan-Brera, the National Institute of Nuclear Physics at the Roma Tre University, the Polytechnic University of Marche, with the aim of analysing the problem of artistic and musical research in the stratification of ideas, materials and techniques. For the first time, the analysis and understanding of creative processes are being addressed in the field of Higher Education in Art and Music (AFAM-MUR) using non-invasive diagnostics and broadening the approach of *technical art history* and the interaction between art and science according to the genetic criticism. This method of analysis has been applied to the works of art in the heritage of the Fine Arts Academies, project's partners. The first phase of this ongoing research concerns a particular case relating to a cycle of paintings of great interest, belonging to the Academy of Fine Arts of Rome: the detached frescoes from the Tower of Paul III Farnese from the mid-16th century, which are still debated today as to their authorship. However, it is not just a question of attribution: at the heart of the investigations conducted by a team from the INFN of the Roma Tre University and the Academy of Fine Arts in Rome, together with restorers, conservation scientists, art historians and experts in the field, is the reconstruction of the creative flow of the work as if still in progress, tracing the paths of its creation, both according to traditional methods of transposing the invention and revealing a continuous reformulation of figurative ideas, right up to the last brushstroke, in a relentless effort of formal elaboration and compositional perfection.

2. Materials and Methods

2.1. History of the frescoes

The Tower of Paul III Farnese was conceived as a papal summer residence, and its construction dates to 1534. Work on the tower began immediately after its completion in 1542. It has been suggested that the realization of the decorative cycles were entrusted to Perin del Vaga, an artist trained in Raphael's workshop and then the official artist of Paul III. It is no coincidence that his work in the Farnese Tower overlaps chronologically, at least in part, with Perino's workshop's activity in Castel Sant'Angelo. [Par86]. In the Farnese Tower's frescoes, as in the Castel Sant'Angelo decorative cycles, the work was carried out by a workshop coordinated by Perino, consisting of several working hands [Pic12]. After the unification of Italy, the Farnese Tower was confiscated and demolished in 1870 to make room for the Vittoriano [Bra02]. The frescoes, which were destined for destruction, were saved by Filippo Prosperi, director of the Royal Institute of Fine Arts, who obtained their transfer to the Institute for educational purposes. Since 2005, these frescoes have been

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kept in storage at the Giacomo Acqua Barracks in Piazza del Popolo. The decorative core currently consists of twelve panels, five executed in monochrome, and seven as an articulated polychromy. Recently, the frescoes have been published as belonging to the sphere or circle of Perin del Vaga, and to Michele da Lucca, whose authorship cannot be confirmed in the current state of studies [Pic12].

2.2. Diagnostic questions and techniques

The diagnostic investigations currently underway on the cycle of frescoes aim to shed light on a series of questions on the creative process that emerged during the first phases of the study.

The first question concerns the nature of the constituting materials at the surface of the paintings such as the pigments realizing the colour palette and the possible restoration materials. X-ray fluorescence (XRF) spectroscopy yields X-ray spectra that reveal the elemental composition of each investigated point [Giu*21]. This technique is currently being conducted using a portable Olympus Vanta handheld XRF analyzer C Series, equipped with a 4 W X-ray tube featuring an Ag anode, operating within a voltage range of 8–40 kV, and an integrated Silicon Drift Detector (SDD). The device enables the identification of elements ranging from magnesium (Mg) to uranium (U).

A second question concerns the identification of eventual underlying designs and the different techniques adopted for the transposition of the drawing. To investigate this aspect, the artworks were analysed by Infrared Reflectography. The examination was conducted with a Xenics Bobcat 320 TE0 GigE 400 infrared camera, a SWIR uncooled camera based on an InGaAs detector with a 320 × 256-pixel resolution, operating within a spectral range of 900–1700 nm. The 'reflectograms' obtained allowed for the detection of eventual underdrawings and potential compositional changes not visible to the naked eye[VADB68].

The third chance of investigation concerns the organisation of the compositional space, through the search for traces of informative marks such as those left by thread beating, incisions, and *giornate* borders. Such questions were investigated by employing multiple and complementary non-invasive techniques. As regards the study of the incised lines a Keyence laser profilometer is being used (ongoing). The tool, which operates at 72 ± 20 mm, projects a laser line (405 nm) on the surface of the artwork. The reflected light is captured by an angled CMOS to generate a detailed surface profile, with lateral resolution of 12.5 μm and height resolution of 1.6 μm [Maz*24]. As regards the multispectral imaging, a 20-megapixel Samsung-NX3000 modified camera is being employed. To selectively manage the wavelengths captured, two types of optical filters are utilized to isolate respectively the visible spectrum, and the NIR spectrum from 950 nm.

From the point of view of the way the pictorial materials were employed, the heterogeneity of the paint layers alternating between smooth, compacted surfaces and more liquid, transparent areas raise questions about the technique and layering. Similarly to what is stated above, such information can be got by investigating in greater depth multispectral images and profilometry [Gra*24]. In addition, specific areas of interest in the artworks were investigated using a Dino-Lite Edge digital microscope. This device features a 5-megapixel sensor, offers magnification ranging from 10x to 220x, and is equipped with adjustable polarized LED illumination. Finally, it remains crucial to investigate the complex conservation history of the artworks, particularly in terms of how they were detached and transferred, which multispectral investigations may help to clarify.

2.3. Data elaboration

Given the considerable size of the frescoes (the main procession fresco measures 5.08 × 1.08 m), the acquisition and processing of hundreds of images, both reflectograms and multispectral images, proved challenging. When analysing large areas of interest, a substantial volume of high-resolution data has to be managed, which often requires significant time and computational resources to process [Dis*20].

To address these issues, a Python-based framework is currently under development, primarily leveraging OpenCV and NumPy libraries (fig. 1). This tool aims to simplify and accelerate the mosaicking of large image datasets (using either cv2.Stitcher_PANORAMA or cv2.Stitcher_SCANS functions), while preserving high resolution and visual consistency, and offering advanced post-processing features.

During the stitching phase, exposure normalization can be performed using an algorithm based on average brightness values to equalize lighting across different images (via the cv2.convertScaleAbs function). This preliminary correction helps eliminate overexposed or underexposed areas, improving the overall quality of image alignment.

The graphical interface includes interactive sliders that allow users to apply filters to the final image. Brightness, contrast, and tonal adjustments are handled directly through arithmetic operations on NumPy arrays, applied selectively to relevant pixels. Sharpness is enhanced using an unsharp masking algorithm that combines cv2.GaussianBlur and cv2.addWeighted to emphasize edges. Highlights and shadows are adjusted through grayscale thresholding (cv2.threshold), which creates binary masks to selectively fine-tune areas that are too bright or too dark. The integration of a user interface allows for user-friendly management of even complex datasets. This tool is intended as an alternative to commercial software, which is often expensive and not well optimized for lower-performance hardware.

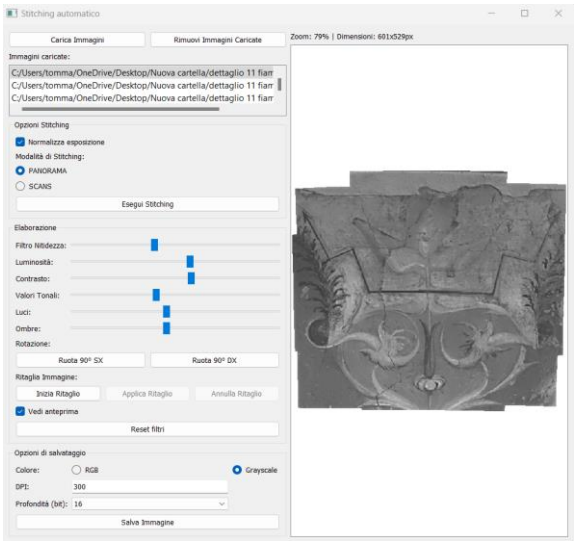

Figure 1: *Graphical User Interface (GUI) of the software under development.*

3.Results and discussion

The diagnostic investigations carried out until now have produced a significant starting set of data, both from an executive and attributional perspective. As regard the study of the drawing transfer methods, preliminary results from multispectral analyses have revealed traces of *spolvero* in the monochrome fresco depicting the sphinxes. In contrast, the outlines of the putti were likely transferred using indirect incisions techniques from the preparatory cartoon. In the case of the monochromes, incised lines run along the entire edge of the artwork; specifically, in the depiction of the sphinx, there is also a central incision that vertically divides the figure into two largely symmetrical parts, following the cartoon's edges. These lines are traced by indirect incision, but there is also evidence of direct ones.

The situation observed in the polychrome large fresco of the main procession is notably different: infrared investigations and raking light images revealed outlines executed using a variety of methods, including direct incisions into the preparatory layer, incisions made with the compass, and freehand brushstroke drawings still visible in the final version. At the same time, these incisions allowed to identify geometric elements used either to frame the space in which the artist worked or to give it a rhythmical structure. The main fresco, which is larger in width, is divided into a sequence in which each figure in the ritual procession is placed inside a niche decorated with racemes and foliage. The semicircular niches have been created using auxiliary tools such as a compass. In some architectural partitions, lateral framing elements were also engraved directly into the plaster. As stated above, the use of the compass has also been recognized as an aid for tracing elements of particular regularity, such as the menorah (fig. 2).

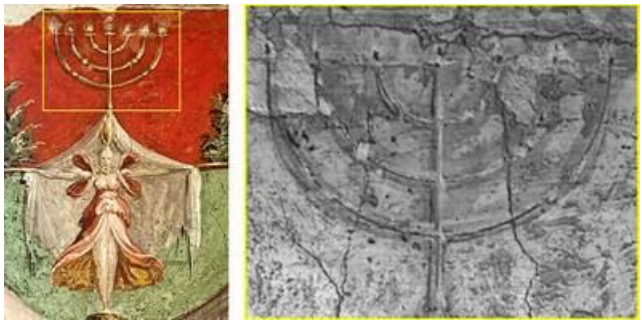

Figure 2: *Detail in visible light image (left) and reflectogram showing evidence of compass use (right).*

In a general view, the heterogeneity in the methods used to transfer the drawing, comparable to the stylistic variety observed within the workshop, suggests the involvement of at least three or four different hands within the same artistic site. This hypothesis will be tested through ongoing diagnostic investigations and will be compared with data emerging from parallel diagnostic campaigns conducted on other fresco cycles, in particular the 2024 diagnostic campaign in Castel Sant'Angelo [AG*24]. Moreover, the absence of evidence related to the *spolvero* in the main fresco, in light of this technical variety, points to a different executional approach compared to other scenes in the cycle.

The surface of the fresco shows significant variations: there are areas where the colour is applied with a textured and thick quality, alternating with more liquid and transparent brushstrokes, often finally enriched by dry techniques paint layers or applications of whitewash. Some surfaces appear smooth and glossy, suggesting a technique involving plaster compression to slow down evaporation and extend the working time, whereas in other areas; the brushstrokes create a more evident plastic modelling effect. To investigate these aspects more thoroughly, an early level of analysis was conducted using a Dino-Lite microscope, which allowed for a detailed examination of the surface texture and the relationship between the various layers of paint. It was determined that the painting was created on a base of dark toned plaster, due to the presence of sand aggregates. On this base, the main colour fields were outlined in red, green, and black, while leaving the areas of the human figures untouched. These figures (main lines) were presumably sketched using brushstrokes of very dark colour, and then gone over with colours. Evidence of such sketching are visible in short traces left uncovered or showing through the colours over (in some cases highlighted by reflectography, as in fig.3). By contrast, as regard the black field, vegetal details were drawn using limewater, visible as light marks where the overlapping colours fell.

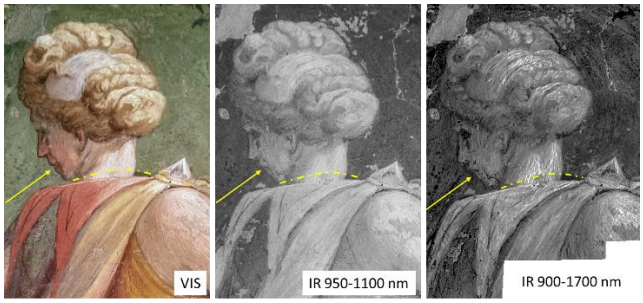

***Figure 3**: Detail in visible light (left), infrared 950-1100 nm(centre) and infrared 900-1700 nm (right) showing evidence of a darker base colour (yellow dot lines) and face details traced 'a secco' (yellow narrows).*

Conclusions

The results obtained until now confirm that the combined use of non-invasive diagnostic technologies can significantly contribute to understand the creative processes of the artworks under study. The coexistence of different drawing and painting techniques within a single decorative cycle requires attributing individual hands and reconstructing the operational dynamics among the people of the artistic workshop. In particular, comparing the results of these investigations with those obtained in 2024 from frescoes attributed to the same workshop of Perin del Vaga, active at Castel Sant'Angelo, could offer a variety of insights and input to be analysed in depth into routinary, situational and other operational practices of Renaissance workshops.

The use of laser profilometry will allow us to overcome the perceptual limitations of the human eye and provide objective documentation of painted surfaces. The micrometric resolution of the instrument offers a replicable and objective system for surveying and interpreting the marks left by the artists on the plaster surface. In addition to distinguish the type of incisions, it is also possible to visualize variations in the thickness of paint layers, the tactile texture of the colour, and the presence of later interventions. This data will be particularly useful not only for reconstructing the execution phases but also for analysing the different hands involved.

In light of the stylistic discrepancies observed with respect to Castel Sant'Angelo frescoes, the question of attribution remains open: the main hand responsible for the execution has not yet been definitively identified. However, the renewed scientific attention on this cycle has generated new investigative perspectives, fostering a revived interest in the contribution of Perino's workshop to the decoration of the Torre Farnese. The ongoing analyses, together with comparisons to contemporary contexts, are expected to play a crucial role in advancing our understanding of the operational dynamics of artistic workshops in the mid-sixteenth century.

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