COMMUNICATING THE VALUE OF KNOWLEDGE: "VENUS AND MARS" WHISPERING TO OUR SENSES

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Abstract

In the Strada Nuova Museums, one of the major oil paintings hosted in Palazzo Bianco Gallery, *Venus and Mars* by Rubens, was analysed on site for identifying its current state of conservation after a number of restoration interventions and the installation of controlled microclimate.

The diagnostic method, based on a non invasive acoustic imaging technique, and the results of the study were exposed to the visitors during usual museum exhibition time: an opportunity to transmit an extended knowledge regarding both the cultural patrimony and the scientific advancement in the conservation process.

Keywords: Field Diagnostics, Acoustic Imaging, Panel Painting, Heritage Communication, Science Communication

Introduction

Nowadays the Cultural Heritage Value Chain needs to experiment new strategies for its empowerment, occurring when the different actors interact sharing their expertises in a process of mutual enrichment.

The synergy between Cultural Patrimony and Science discloses an added value, representing a great potential for the human experience. The amount of knowledge carried by the innovative scientific methodologies adds dimensions to the traditional perception and interpretation of an artwork. The conservative and the diagnostic activities of many professionals as restorers, conservation scientists and researchers are part of those cultural assets that need to be disseminated and conveyed to the general public, also using exhibition environments such as museums or archaeological sites. More and more frequently, examples can be found where the conservation process becomes part of the exhibitions widening their purpose and scope. Citing only few recent cases, in the exhibition "*RUBENS The Triumph of the Eucharist*" (organized by the Museo Nacional del Prado and the J. Paul Getty Museum)[1] the panel paintings conceived by Rubens as *modelli* for the realization of the tapestries are left "naked" and visible also from the rear side in order to give evidence to the relevant interventions on the surface and on the backing structure. Similarly, movies describing the phases of the restoration process complete the exhibition. The Acropolis Museum in Athens has chosen to realize the structural restoration and the laser cleaning of the Caryatids inside the Museum Galleries, avoiding the risks due to additional move, but also to provide visitors with the opportunity to observe procedures that are usually undertaken in the laboratory[2].

[1] (Woollett et al., 2014).
[2] (Caskey, 2011).

In this paper the tradition of the Palaces of Genoa will be recalled in a new interpretative frame, where its legacy seems renewed in an original form of hospitality during one of the greatest international events in Italy dedicated to science, the Genoa Science Festival. In this scenario an on-site investigation on one of the major oil paintings of the remarkable collection of the Strada Nuova Museums hosted in Palazzo Bianco Gallery, *Venus and Mars* by Pieter Paul Rubens, was realized with the participation of the visitors of the museum and of the science festival during usual exhibition time.

The Territory

The legacy of the Genoa Territory finds its major expression in the tradition of the Strade Nuove and the Palazzi dei Rolli, UNESCO World Heritage Site since 2006 as the first European modern system of unitary urban architecture. The site includes a great number of aristocratic residences representing the financial power of the Republic of Genoa, during the 16th and 17th century, with an urban plan defined by a public authority. This great number of renaissance and baroque palaces belonged to official lists (called *Rolli*) and were chosen to host state visits and exponents of the international culture. It represented a model of a finely distributed hospitality for the promotion of the culture, the economy and the patrimony of an entire territory. The relevance and the influence of this urban design model spread out over the entire Europe in the following period, attracting particular attention. Remarkable is the collection of drawings realized by Pieter Paul Rubens and published in 1622 as "Palazzi di Genova"[3]. The Flemish painter is among the first men of culture who gave evidence to the relevant fine architecture, inspired to the classic culture, of the private residences in the urban design model that "[...] due to their quantities, constitutes the body of the whole town".

Re-interpreting the territorial aptitude

The awareness of the territorial aptitude, its legacy and historical value, allows to reinterpret its peculiarity through modern contexts. This is the case of the Genoa Science Festival: being one of the greatest international events in Italy dedicated to science, it has the mission to spread a high scientific public awareness. The intensive participation of the whole city, covering both the organization and the participation aspects, represents its distinctive character. All the activities are distributed throughout the city hosted in historical buildings and museums, also increasing tourism and allowing the international participation. This type of events brings science outside research laboratories and closer to the public, thus reaching a larger number of people. Every year these events attract an increasing number of guests witnessing the success of this work and, at the same time, answering to the public's curiosity towards "the science around us". The traditional hospitality of the *Palazzi dei Rolli* revives nowadays in a new and more extensive hospitality for the promotion of the scientific culture. This context was the framework of our experience: the union of Art and Science in a field experimentation, which was participated by both the professionals of the CH domain and the visitors. The aim was the promotion of a new form of art fruition, not separated from the diagnostic activity or the conservation process, offering to anyone a deeper interaction with the artworks. As the value of such masterpieces resides in the ability to penetrate history, revealing different historical contexts, the employment of scientific tools is able to penetrate their tangible aspects, letting these objects unveil the hidden tracks that time has left on them, as fascinating *story tellers*.

[3] (Rubens, 1622).

***Venus and Mars* by Pieter Paul Rubens (1632 - 1635)**

Painted in Antwerp during the last period of Rubens' life, this *oil on panel* is conceived as a portrait probably of a member of the Van den Wijngaerd family, that Rubens reproduces also in another work. It is simply inventoried as "Lansquenet with his Sweetheart" (as reported also in the Corpus Rubenianum Ludwig Burchard) and only recently in terms of mythological subject. The man and the lady wear contemporary garments but the myth of Venus and Mars is clearly recalled (fig. 1a). With its distinctive vivacity, the ability of Rubens in capturing snapshots of the real world and interpret it through the myths of the classical culture clearly emerges, thus providing his reading of the power of life between opposite tensions. As a great number of his masterpieces, the initial nucleus of this painting is likely restricted to the central characters while other ones are introduced later through the insertion of an additional board on the right side. The oak substrate measures 142×133 cm^2 and, at present, its mean thickness is 3.5 mm. The preparatory layer and the painted film are very thin as well. As a great number of panel paintings of that period, it is thinned and heavily cradled in order to prevent the bending of the wood. The support presents four horizontal boards and a vertical one having grain running normal to the first, (fig. 1b); the arrangement of the boards thus denotes a high sensitivity to possible change of the environmental parameters.

A brief chronology: the artwork remains in Antwerp until the death of the painter (1640), and then begins a long travel across Europe, first in London then in Madrid, in the collections of the most important royal families of the time. It arrives in Genoa after 1691, property of *Francesco De Mari* and then passes to *Giovanni Francesco II Brignole Sale*, Doge of Genoa. The painting undergoes, for unknown reasons, a reduction of 60 cm in the lower part. As part of the private collection of the last descendant of the Brignole Sale family, the *Duchess of Galliera*, follows her to Paris in 1874 until her death in 1888. In 1889 the entire private collection of paintings of the Duchess and the Palaces are donated to the Municipality of Genoa; since 1892 the Rubens' masterpiece is visible in Palazzo Bianco Gallery.

Restoration interventions: the artefact undergoes important events that cause significant deterioration. Between 1909 and 1939 only partial restorations are carried out: the static conservation of the wood, insertions to repair the voids and to consolidate the joints, the consolidation of the pictorial film, while the need to intervene on the existing chestnut wood cradle is evidenced. The major interventions are later and here summarized[4]:

1952-55 – the chestnut cradle is removed, visible in (fig. 2a), disclosing the actual arrangement of the support, as shown in (fig. 1b). Butterfly inserts and a new oak wood structure, visible in (fig. 2b), are placed. Surface conservation is accomplished.

1965 – constraints by the new cradle are present, substituted by a third one in pitch pine, (fig. 2c), guaranteeing independent movements of the vertical board with respect to the other ones.

1981 – relative humidity as low as 23% is revealed in some rooms of the Gallery. Glass doors between the rooms are installed to reduce the rate of thermo hygrometric variations.

1981-84 – restoration realized by the Istituto Centrale del Restauro. The substrate is only treated for infestation (gassing) while the cradle is left unchanged. Although it is not completely adequate, it is considered in equilibrium with the thinned panel, and the risks due to its displacement are avoided. Surface conservation is accomplished. An environment with stable thermo hygrometric conditions is recommended for a proper preservation of the panel.

[4] (Cordaro et al., 1985).

The acoustic imaging technique

The present investigation aims at identifying the current state of conservation of the *Venus and Mars* after about thirty years from the last restoration intervention completed in 1984[5].

The applied diagnostic method is based on the determination of the acoustic energy absorption coefficient, using a non-contact setup[6]. The method provides acoustic images of multilayer structures (frescoes, ceramics, panel paintings) affected by detachments and flaws, localizing the defects where the absorption coefficient is considerably high. Acoustically speaking, a detachment is a sub-surface air cavity which behaves as a selective acoustic absorber, vibrating at specific frequencies when it is excited by an external pressure field. As a *mass - air spring* system, its fundamental resonance frequency depends on the density of air inside the cavity, on the surface layer's density and thickness, and on the air cavity depth.

The device (ACoustic Energy Absorption Diagnostic Device) automatically scans an area, while an acoustic source S radiates towards the surface an acoustic wave with audible frequency content. A microphone M, aligned with the source S, records both the incident wave $p_i(t)$ and the reflected wave $p_r(t)$, with a delay time τ due to the difference of the two acoustic paths. Both the reflection and the absorption coefficient are calculated from the acoustic impulse response $h_S(t-\tau)$ of the analysed surface. For each i-th point, the result is expressed in terms of the total reflected energy Σ_i[7], and in terms of the absorbed energy percentage $ABS\%_i$ with respect to the most reflecting point over the entire analysed area

$$\Sigma_i = \int_W \left| h_S(t-\tau) \right|^2 dt, \qquad ABS\%_i = (\Sigma_R - \Sigma_i)/\Sigma_R. \qquad \text{(1a, 1b)}$$

The two indicators are also extracted as functions of frequency, providing an insight into many aspects regarding the conservation state of the artefact. The frequency analysis may evidence different elements, where smaller defects size is related to high frequency bands.

The study of panel paintings must conjugate a suitable extension to cover wide analysed surfaces and a high spatial resolution for revealing small defect size. The acoustic imaging system equipped with an innovative acoustic source, the parametric acoustic array[8 9], shows a great potential in on site non-destructive applications thanks to the small size and the high directivity of the acoustic source, and to the great flexibility of the instrumentation which can be easily used where the artefact is placed (fig. 3a).

The experimental results

In the case of panel paintings, the properties of the wood substrate must be taken into account, since it greatly influences the experimental methodology and the results interpretation. A preventive evaluation of the acoustic behaviour of the wood substrate is recommended, in order to discriminate its response from that of possible detachments of the pictorial film. This is accomplished restricting the incident acoustic field to a suitable frequency band, thus avoiding the excitation of normal modes of the entire support (approximately below 3kHz).

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5 (Cordaro et al., 1985).

6 (Calicchia et al., 2013).

7 Σ_i is calculated by integrating the square modulus of the impulse response over a suitable time window W as wide as the delay time τ. For the Parseval's theorem, the integral in equation (1a) equals the integral over frequency of the square modulus of the Fourier Transform of the impulse response, $H(f)$, related to the reflection coefficient $r(f)$. Physically, Σ_i represents the total reflected energy, regardless of the frequency component.

8 (Calicchia et al, 2012).

9 (Calicchia et al., 2014).

The measurement on *Venus and Mars* was carried out in its standard location, characterized by a very stable environment (T = 22°C and RH% = 56%), as conservation protocols recommend[10]. A chirp signal with high frequency content (4 – 16) kHz was selected, and the system examined a surface of (1.36 × 1.1) m^2 scanning a sequence of vertical profiles comprising 15207 points, 1 cm apart. The measurements were carried out during few days, according to the scheduled visits, and a fast scanning procedure was adopted to make its duration more compatible with the exhibition. For evaluating the accuracy of the experimental data, two selected profiles were repeatedly acquired, and the dispersion of values calculated. According to the result of this repeatability test, a proper post-processing[11] has been applied in order to obtain a suitable accuracy (Σ_i distribution with mean standard deviation of 6%).
The visitors had the opportunity to assist to the measurement, (fig. 3b), and to discuss about the outcomes of the examination: as expected, an overall good state of conservation was actually assessed. The distribution of values of the indicator ABS% and the corresponding acoustic image superposed on the painting's image are shown in (fig. 4). The histogram evidences a good degree of homogeneity of the overall acoustic response, with a high fraction of analysed surface presenting low absorption percentage (basing on previous knowledge, ABS% ≤ 30% is frequently found also in homogeneous reflecting materials). Anyhow a slight asymmetry towards higher absorption percentage indicates that some defects has been revealed. The acoustic image displays the ABS% data using a colour palette with a first threshold at 35% (green) and a second one at 45% (yellow), where the most critical points (fading to red) are mainly located in the upper part of the painting. A light weakness appears in the upper half panel, while the most damaged portion runs horizontally over the heads of the principal characters. Observing the reverse (fig. 1b) of the panel, this portion corresponds to a flaw inside the upper board between the two lines of butterfly inserts. This defect slightly appears in the photograph taken during the '50s but, on the basis of the present investigation, it can be assumed that a periodic monitoring of the evolution of the deterioration process in this area can be useful to prevent further damage. On the contrary, the red vertical portion on the left boundary results a fake caused by a light rotation of the painting that, in this restricted region, irregularly cuts and scatters the incident acoustic beam along the vertical axis.
Frequency-resolved data may help the understanding of the causes of deterioration. The (fig. 5) shows the resulting acoustic images in the most relevant frequency intervals: expressed in 1/3 octave bands, the nominal central frequencies and the approximated bandwidths are here reported f_a [6.3kHz, 1.5kHz]; f_b [8kHz, 1.8kHz]; f_c [10kHz, 2.3kHz]; f_d [12.3kHz, 2.9kHz].
The images at the two lower bands, (figg. 5a-5b), confirms the weakness in the upper half of the panel disclosing an unexpected periodic structure. A deeper exam of this feature will indicate if this effect can be ascribed to the cradle structure, that might have lost adhesion to the oak substrate. Indeed the current approach prefers the removal of the heavy cradles for the thinned panels, replaced by light and flexible structures connected to the panel through springs [12]. As frequency shifts towards higher values, see (figg. 5c-5d), the narrow horizontal flaw becomes more and more evident. Moreover also a vertical stripe on the right side clearly appears, running along the entire length of the vertical board.

[10] (Reeve, 1998).
[11] The uniformity of the lower half of the painting, evidenced in the unprocessed data, allowed a normalization of Σ_i in the vertical profiles, with respect to the mean value calculated over the lower 30 cm of each profile.
[12] (Phenix et al. 2011).

Assuming for example the same order of magnitude for the thickness of the air cavity and for that of the superficial layer, assigning to this last an approximate density of 0.9g/cm^3, the thickness of the detached area can be estimated about 1.6mm for the higher frequency band (12.3kHz) and about 3.2mm for the lower frequency band (6.3kHz). For this last, assuming the oak wood density of about 0.7 g/cm^3, for the superficial layer, the defect size results about 3.6mm. For an accurate evaluation of these quantities, the knowledge of more realistic values of density and thickness both of the support and of the painted layer is required.

Conclusion

The acoustic imaging system, described in this work, conjugates a relatively low cost equipment and a great flexibility for diagnostic investigations feasible where the artefact is placed. The study of the *Venus and Mars* confirms a relatively good state of conservation of the artwork, although a structural weakness in the upper board may require periodic test in the future. Moreover the defects of the wood support can be discriminated by those of the pictorial film by studying the acoustic images in the frequency domain.

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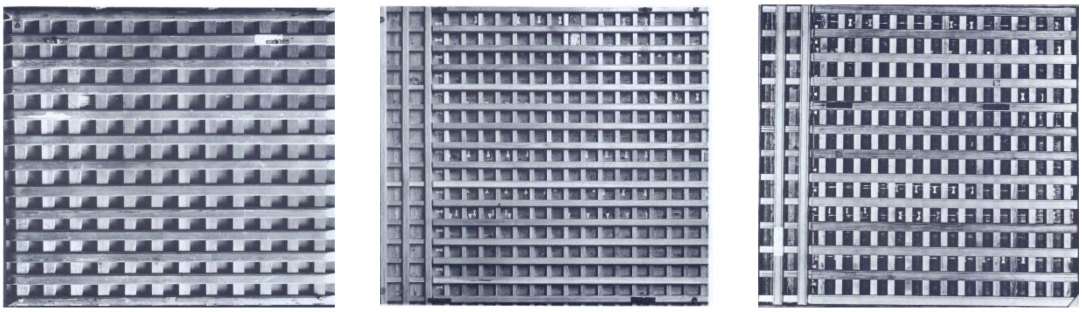
FIGURES

Figure 1. Venus and Mars, Rubens, oil on panel, 142 ×133 cm^2: front (a) and reverse[13] showing the arrangement of the oak wood boards (b).



(a) (b) (c)

Figure 2. Reverse with the cradle structures: chestnut wood cradle (a); oak wood cradle (b); pitch pine wood cradle (c).

Figure 3. The acoustic diagnostics equipment (left), and visitors during the on-site experimentation in the Palazzo Bianco Gallery (right).

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[13] (Cordaro et al., 1985).

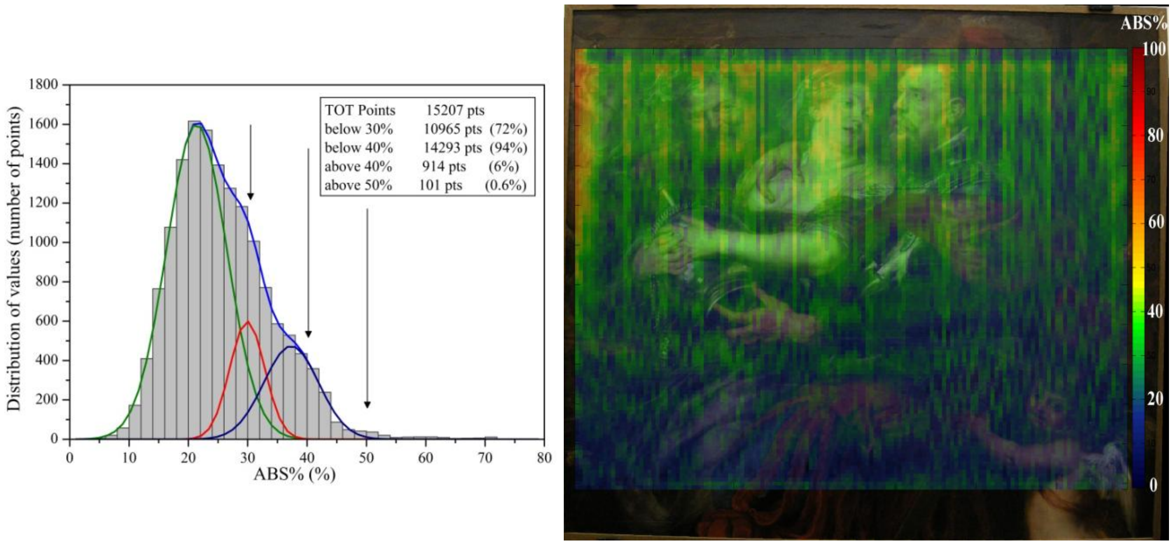

Figure 4. Distribution of values of the ABS% indicator in the whole map, where relevant thresholds are marked with arrows (left); acoustic image superposed on the painting's front surface (right).

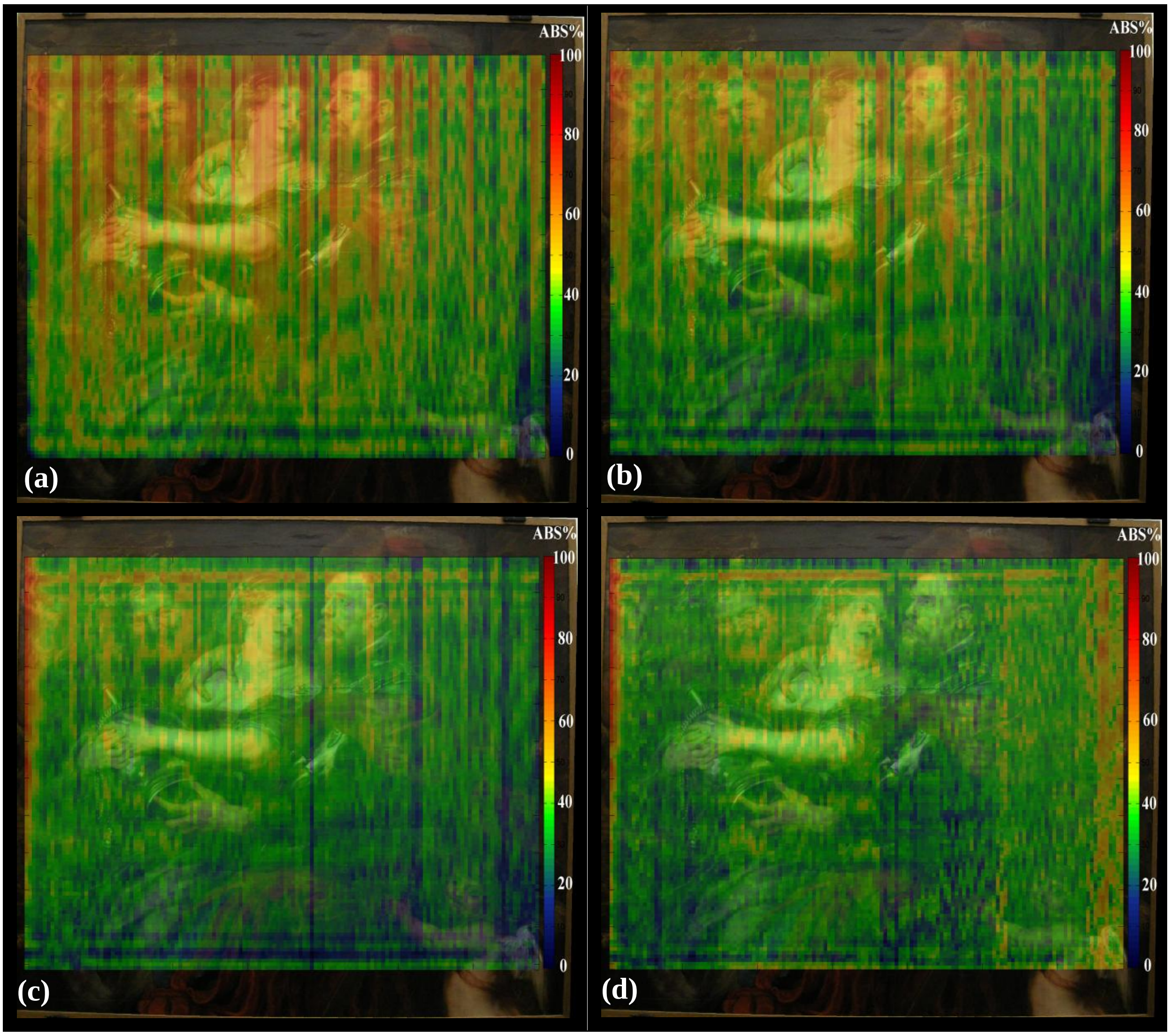

Figure 5. Frequency resolved acoustic images: 6.3kHz (a), 8kHz (b), 10kHz (c), 12.5kHz (d).