PROJECT REPORT

Scientific Examination of Cultural Heritage Raises Awareness in Local Communities: The Case of the Newly Discovered Cycle of Mural Paintings in the Crucifix Chapel (Italy)

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Abstract

The preservation and conservation of cultural heritage material is matter of increasing civic importance, particularly in communities where public resources are scarce. Although this issue is generally considered a challenge for the humanities, scientific research also plays an invaluable and unique role in promoting and preserving cultural heritage in local communities. Because of recent advances in technology and methods of scientific analysis, a deeper understanding of fine art works can be achieved than was ever possible by a simple visual examination. Questions that were once difficult to answer, including precise materials and techniques or original and restored areas, can now be clarified through relatively straightforward scientific experiments using accessible technology. This development opens a new and fruitful avenue for enriching science education, in both formal and informal contexts, through the lens of a pressing civic issue: the investigation and preservation of endangered aspects of local history and culture.

This paper describes the scientific studies carried out on a cycle of 18th-century wall paintings discovered in 2012 in a small Italian village. An international team of research institutes (USA, Denmark, Portugal, and Italy) were involved in the technical examination of the cycle. The scientific findings, which were presented to the local community during a public conference, raised awareness of the value and significance of their unique cultural assets. This represents a successful model for civically engaged science that can bring international expertise to bear on a specific challenge to a local community.

Civically Engaged Science to Preserve Local Art and Archaeology

The preservation of cultural heritage is a critical civic responsibility, especially in Italy where the vast array of cultural treasures ranges from the renowned mega-cities of Rome, Florence, and Venice to almost every village. This rich distribution of material culture demands local civic

engagement simply because national and governmental institutions alone cannot effectively manage the sheer quantity and scope of artistic and archaeologic heritage sites. Consequently, the role played by local advocates and organizations is critical, though not always obvious to communities faced with other pressing needs. Advocacy and public education is needed to shed light on the connection between civic and economic wellbeing and the preservation and protection of cultural heritage (Bonacini et al. 2014). In Italy, as well as in other European countries, there have been significant cuts to public funding for art conservation. It is therefore more urgent than ever that local communities mobilize and provide adequate financing to appropriately conserve and maintain their cultural heritage.

Cultural Heritage Science (CHS) is a discipline that examines works of art and archaeology by means of technical and scientific methodologies. Information derived from these studies is used to understand not only when these artifacts were made, who made them, and how they were made but also, more importantly, how are they to be preserved, and what conservation treatment represents the best option and why. As a scientific practice CHS must draw on a wide range of disciplines and fields beyond the sciences, including history, art history, archeology, ethics, public policy, and law. This article outlines a project in Italy to promote the conservation of a cycle of early 18-century mural paintings. It discloses the role of Cultural Heritage Science in raising community awareness of material culture as a civic asset, as well as awareness of the importance of science and technology to the preservation of cultural heritage.

Innovative, Affordable and Sustainable Scientific Methods

Scientific examination and documentation of art is notoriously expensive. The most important and recognizable works of art are subjected to extensive scientific examination by highly trained experts, using state-of-the-art equipment that costs millions of dollars. This is clearly an impossible goal for the conservation and preservation of the vast majority of cultural heritage objects, which may not be rare or distinguished by global standards but are nonetheless critical to the identity and history of local communities, most of which lack the financial and technical resources of major capitals and their world-class museums. These large museums house "priceless" collections and maintain conservation departments equipped with cutting-edge technologies. In contrast, small to medium-sized cultural institutions have relatively limited access to advanced science and technology and conservation expertise.

Cultural Heritage Science Open Source (CHSOS) was launched in 2012 to bridge this technological divide, to develop and disseminate affordable and sustainable methodologies for art examination that can reach a much larger constituency of local cultural institutions This search for low-cost art examination and documentation is a rapidly expanding research topic, and a growing number of scholars are exploring affordable technical solutions for historical architecture documentation (Santagati et al. 2013). CHSOS disseminates methods for art examination in three significant ways, focusing specifically on low-cost technical solutions: through its popular blog, through publications in open access peer reviewed journals, and through training programs. The CHSOS blog has attracted a growing network of art conservation professionals interested in introducing Cultural Heritage Science concepts into their work. The blog has also inspired collaborative field projects with local stakeholders, such as the Catacombs in Syracuse (Cosentino et al. 2015; Stout et al. 2014) and the Sicilian carts museum (Cosentino and Stout 2014).

The Crucifix Chapel

A cycle of 18-century mural paintings was revealed in 2012 during maintenance work in the Crucifix Chapel of the Mother Church in Aci Sant'Antonio, Italy. The paintings have survived along the corners of the originally square chapel that was later altered, acquiring the current octagonal-shaped construction. All of the murals except the scenes on the corners have been destroyed and irretrievably lost (Figure 1).

CHSOS Studio is located in Aci Sant'Antonio. This discovery in the local chapel was selected as a pilot study to determine whether scientific research can promote better care of cultural heritage, even when financial resources are limited and the heritage material is of local,

FIGURE 1. (A) Crucifix Chapel, Mother Church, Aci Sant'Antonio (Sicily). Photo of the chapel from the transept after the renovation. The frescoes are visible through the windows on the walls facing the four corners. (B) Left border of the third scene, Agony in the garden. The original plaster was taken down in order to anchor the new wall. (C) Floor plan with the description of the remaining scenes. (D) Split panorama of the chapel

rather than regional or national, significance. From the moment of their discovery it was clear that the newly discovered murals were in critical need of conservation treatment. CHSOS advertised and solicited the international academic community for help in performing an accurate scientific assessment of the murals, which ultimately resulted in a well documented, informed conservation treatment strategy. The mural paintings were first documented in 2013 by CHSOS using technical photography (TP) (visible, raking light, infrared, ultraviolet fluorescence, and infrared false color).

TP represents a collection of broadband spectral images realized with a modified full spectrum digital camera and using different lighting sources and filters to acquire images useful for art diagnostics. TP imaging methods are non-destructive, fast, and use relatively inexpensive equipment and tools. CHSOS donated the time needed to perform the initial examination. The results served as a catalyst that gained the cooperation of three universities. A doctoral candidate at University of California San Diego (USA), Samantha Stout, provided on-site analytical pigment studies, which used a portable XRF spectroscopy system; analysis of paint fragments were provided by researcher Milene Gil from the Hercules laboratory at the University of Evora (Portugal), using optical microscopy, scanning electronic microscopy with x-ray spectrometry (SEM-EDS), X-ray diffraction (XRD) and μFT-IR; and finally, Terahertz examination of the plaster work was performed by Danish Technical University (Denmark) doctoral student Corinna Koch Dandolo.

FIGURE 2. Scientific research can promote community awareness and lead to better care of local art and archaeology.

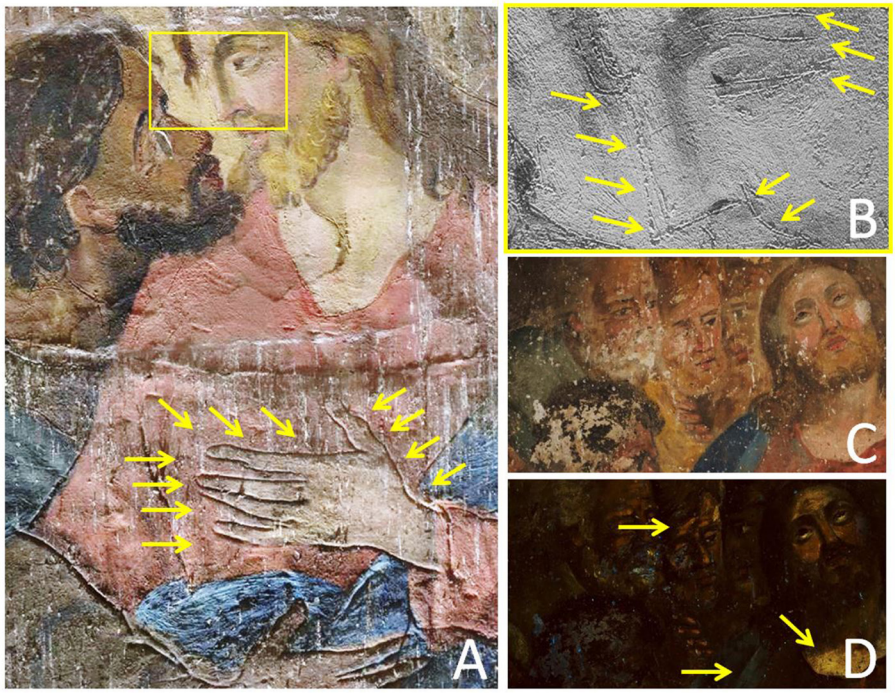

FIGURE 3. Crucifix Chapel, Mother Church, Aci Sant'Antonio (Italy). (A) Raking photo reveals deep incised lines for the hands of Jesus and Judas, suggesting that they were made by the pressure of a pointed tool through a cartoon. (B) Raking photography in the infrared increases the reading of the shallow incisions made with a pointed tool for the faces. (C) Photo of the Last Supper scene. (D) The ultraviolet fluorescence photo reveals an a secco application of the paint using an organic binder, which fluoresces under UV light.

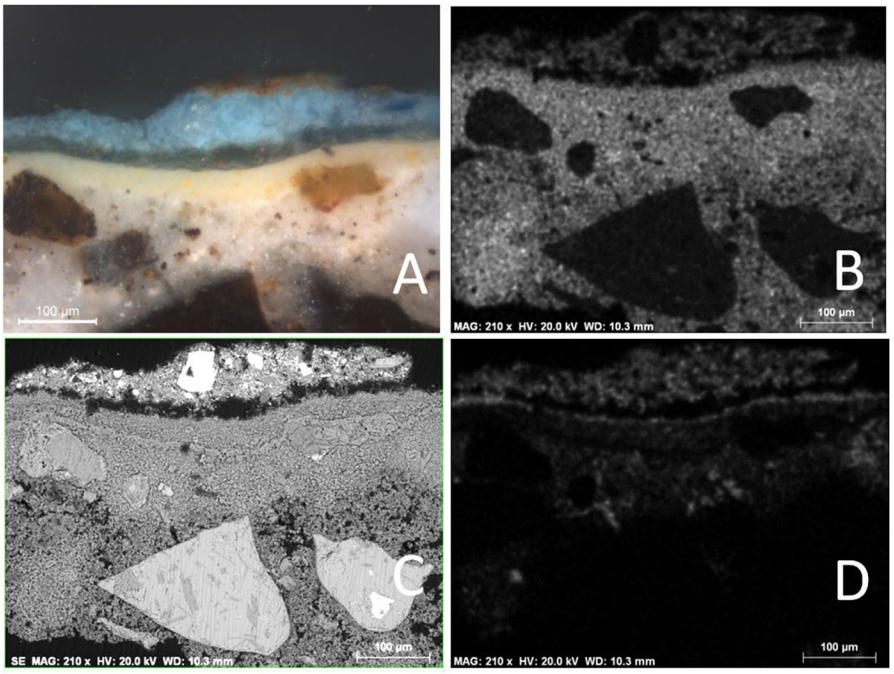

FIGURE 4. (A) Cross section, optical microscope. FT-IR spectroscopy showed that the paint was applied with a protein binder. (B) The a secco method is also suggested by the calcium mapping image, which shows that the pigment was not mixed with the wet plaster. (C) The SEM image of the sample suggests that the mortar was partially or completely dry when the following layers were applied. A thin layer of calcium carbonate precipitation can be observed. (D) The sulfur mapping image shows that a layer of gypsum mixed with yellow ochre was then apparently laid as a ground layer.

This international collaboration has resulted in peer-reviewed publications (Cosentino et al. 2014a; Cosentino et al. 2014b). The data were subsequently used to formulate a conservation intervention strategy that was presented in 2015 to the community of Aci Sant'Antonio at a conference where the project collaborators reported their findings.

Participants greatly benefited from all aspects of this unique research endeavor. International graduate students and scholars were drawn to Italy because of the abundance of cultural heritage objects and locations, which represent a unique opportunity to test their technical methodologies and learn first-hand about traditional western historical art materials. In turn, members of the local community benefited from their expertise and were informed of the significant artistic features present within the discovered cycle. The scientific research effectively engaged the local community, and the conference helped raise funds for the eventual cleaning and conservation of the paintings. This project, then, represents a successful model of the public

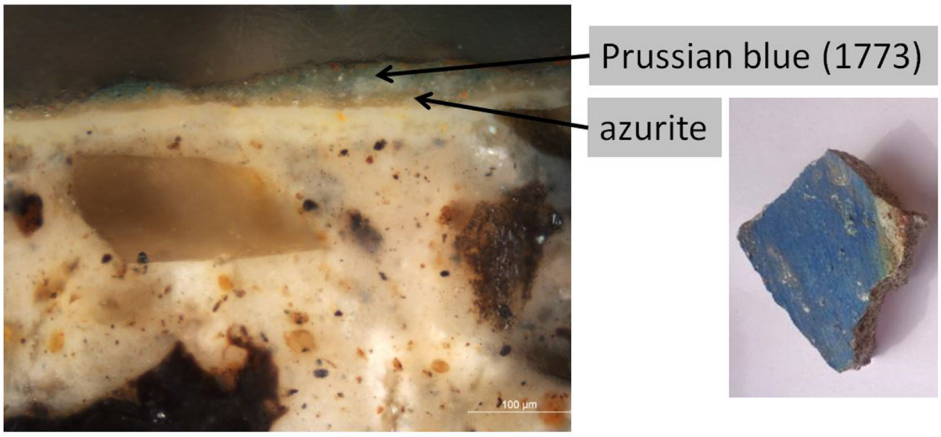

FIGURE 5. Cross section examination of the fragments shows that the scenes were repainted with modern pigments, such as Prussian blue (manufactured from 1773) over older azurite.

communication of science: the active process of scientific inquiry raised local community awareness and appreciation to a level that generated the financial support that was needed to professionally treat and preserve the art object (figure 2).

The local community setting encouraged an explanation of the findings that was straightforward and avoided unnecessary technical jargon. More significantly, in this scientific investigation context, it was TP (technical photography) that led the way. TP proved to be the most cost effective of the methods used and is capable of providing a great deal of information on the painting technique (figure 3). TP is also the most appealing for a non-specialized audience, as the images convey the findings more easily.

The analysis of seven plaster wall fragments revealed that an a secco technique (use of an organic binder rather than the fresco method) was used for the wall paintings (figure 4). The analysis also revealed large areas of repainting using modern pigments applied directly over the original paint layer (figure 5).

Conclusions and Implications for Science Education

Scientific research on the newly discovered wall painting cycle in Aci Sant'Antonio (Italy) illustrates that cultural heritage science methodologies can be used successfully to promote the conservation of art and archaeology, even in poorly funded local communities. The initial findings, detailed visually through technical photography coupled with portable and benchtop spectroscopic methods, proved a successful means to raise awareness of the relevance of science to the community's identity and history, and to the preservation needs of its specific cultural heritage material. The ability of modern scientific methods to provide evidence and increase public knowledge provided the political and financial leverage needed to take action.

Appropriately, the public conference was held in the same church where the mural paintings are located. Here in this setting the local community participated in an integrated learning experience that spanned both science and humanities, providing information about the painting technique and materials used by the original painter and by the others who, centuries later, retouched the paintings. In this specific case the research for this project was achieved without a direct financial contribution from the community. Indeed, the case study was such a compelling educational opportunity that three major foreign universities donated financial resources and provided Ph.D. students to perform the examination. All participants benefited. The conservation scientists worked together as an international team, comparing notes on the data they obtained with complementary equipment. Today the local community better understands the importance of their newly discovered cultural treasure and is justifiably more proud of it. And the results have proven contagious. Soon after the papers were published, CHSOS was contacted by the community of another village in Sicily, which had followed the Crucifix Chapel studies and now desired to replicate the same model to promote the conservation of mural paintings in one of their medieval churches.

The next step for CHSOS will be to integrate the formal and informal learning environments by extending the academic participation in this initiative through a summer school program for undergraduate students. This

project, which will teach rigorous science content "through" the civic challenge of preserving local cultural heritage, will be offered to U.S. college students who are interested in integrating the study of science with art history, archeology, and material culture studies. It will be based on the training programs that CHSOS has offered to professionals and graduate students, and it will be fully hands-on, bringing students to work on selected field projects that conserve Italian art and archaeology while engaging communities in the preservation of their cultural heritage.

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About the Author

Dr. Antonino Cosentino founded CHSOS in 2012. Before directing CHSOS he taught "Scientific Methods for Art Investigation" in Italy and at the Pratt Institute in New York and carried out scientific examinations of important works of art as a researcher for European and American institutions such as the European Mobile Laboratory for Art investigation (MOLAB), the New York's Metropolitan Museum of Art (A.W. Mellon Fellow in Conservation Science) and the University of California San Diego.