Brazilian Journal of Analytical Chemistry
2022, Volume 9, Issue 34, pp 10-12
doi: 10.30744/brjac.2179-3425.point-of-view-mvoandrade

POINT OF VIEW

Forensic Analysis of Artworks
More than a (Complex) Analytical Issue

Marcus Vinicius de Oliveira Andrade

Forensic Expert at Brazilian Federal Police, Belo Horizonte, MG, Brazil

In 2008, Nicolas Eastaugh, founder and chief researcher at Art Discovery, a renowned London company for the analysis and research of artwork, discovered the presence of the white titanium (titanium dioxide) pigment in a painting attributed to the Dutch naturalized expressionist artist Heinrich Capendonk. The work had reached a record value of EUR 2.4 million at an auction in 2006. However, in 1915, the year in which the work was supposed to have been created, white titanium was not even available for use as a pigment, which would happen about 20 to 30 years later. The analytical result achieved by Eastaught revealed one of the biggest schemes of artwork forgeries ever discovered. The forger, Wolfgang Beltracchi, made a fortune, (under)estimated at EUR 30 million, built over 25 years acting in the art market. There are several cases of counterfeiting schemes involving artwork, large fortunes, renowned galleries, museums, collectors, specialists, and masterpieces. Cases like the one revealed by Eastaugh's analyses or the millionaire counterfeit scheme involving the century-old North American Knoedler Gallery [1] are illustrative examples of how the art market is vulnerable to this kind of crime.

The International Monetary Fund (IMF) and the United Nations Office on Drugs and Crime (UNODC) estimated the total annual trade in art and antiques in 2018 at around USD 70 billion, of which about USD 6 billion may have been due to illegal transactions related to theft, counterfeiting, smuggling, and organized crime. Still according to those institutions, half of that amount involved financial crimes and money laundering [2]. In Brazil, within the scope of the *Lava Jato* Operation, the Federal Police seized 842 pieces of art and historical and cultural heritage, including paintings from different historical periods, sculptures, and other pieces, which add up to an estimated value of over BRL 33 million [3]. All the pieces were related to investigations involving money laundering in cases of active and passive corruption.

As other forms of money laundering resulting from various crimes have been curtailed by world authorities through specific legislation, the art market world has become increasingly attractive to crime. This scenario, combined with the great financial relevance of the legitimate art market, caused a very considerable increase in the demand for works by renowned authors and, as a direct consequence, a proportional increase in the number of forgeries and adulterations. As a result, the quality of counterfeits has also experienced a great improvement, requiring a proportional gain in technology and expertise in forensic analysis and authentication fields [4]. Similarly, the high speculation in prices of artworks also increased the interest in new and advanced analytical techniques for determining authenticity, authorship, origin, and materials used by the authors [5].

The refinement of counterfeiting and adulteration techniques has demanded a multidisciplinary and technological approach to the authentication process, and, at this point, we are faced with a considerable degree of complexity in the already difficult process of authenticating works of art. The authorship or authenticity determination of a painting is unavoidably based on a triangle formed by three disciplines: art history, preservation sciences, and materials sciences [1,6]. The voices of our benches and equipment are unlikely to be able, on their own, to unequivocally conclude the authenticity of a work of art. Likewise, the

Cite: Andrade, M. V. O. Forensic Analysis of Artworks: More than a (Complex) Analytical Issue. *Braz. J. Anal. Chem.,* 2022, *9* (34), pp 10-12. doi: http://dx.doi.org/10.30744/brjac.2179-3425.point-of-view-mvoandrade

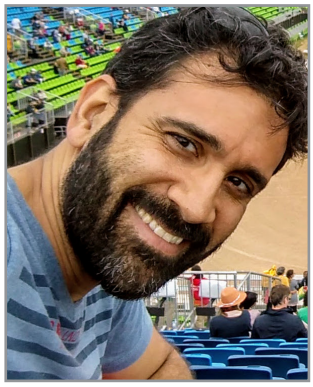
most trained eyes of a professional connoisseur are no longer able to face the most astute counterfeiters. The best results of authenticity studies will always be achieved when these three distinct disciplines come together and complement each other in the search for comprehensive, technical, and artistic knowledge about the work. In addition to the historical study of the piece, the physical–chemical characterization of materials and components or elementary and multispectral imaging become powerful tools for fraud detection and even characterization and individualization of the authentic piece [6].

The simplest techniques, generally used for initial documentation, to the more complex, analytical resources are used to extract the greatest amount of information from the different parts that make up a painting. In its diverse and complex layers, from the support to the final coating, paintings are composed of multilayers of heterogeneous mixtures of varied organic and inorganic compounds. A thorough investigation of this scenario always requires the use of advanced and combined techniques to better understand each case, depending on their nature [7]. The analysis of the painting surface by a stereo-microscope will reveal genuine – or artificially produced – craquelure or brushwork patterns compatible with the artistic style proposed by the author of the work. Likewise, the UV fluorescence properties of the painting may differentiate between old and new additions of paint to the piece. However, it is in the deepest layers of an artwork that the most sophisticated analytical techniques contribute most incisively. X-ray radiography and infrared reflectography, coupled with ultra-sensitive charge-coupled devices (CCD), began to detect underdrawings that were invisible to the previously available methods. Several works have demonstrated the usefulness of tools such as synchrotron radiation, microimaging by X-ray fluorescence (XRF), and Raman or Fourier-transform infrared (FTIR) spectroscopies, combined with the versatility of portable spectrometric identification techniques, where pigment particles less than 1 micrometer in diameter can be analyzed. Even the power of pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS) to identify novel synthetic organic polymers, which greatly assists in the analyses of pigments, coatings, binders, and other painting components, can, in many cases, reveal anachronisms present in the counterfeits. Other techniques such as laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS), isotope-ratio mass spectrometry (IRMS), and accelerator mass spectrometry (AMS) allow for the determination of isotopic ratios of heavy and light elements, which are decisive to determining the geographical origin of some pigments and the age of a painting canvas or its wooden frame. Such techniques used in association with multivariate analysis tools, artificial intelligence, and machine learning help achieve increasingly conclusive results, requiring less time and effort from the entire team of researchers [1]. Each of the analytical techniques, evaluated for their versatility, resolution power, type of information generated, portability, and employment, have the potential for greater use in combined and multimodal work. This approach makes the description of the artwork much more precise and richer in details since it individualizes not only its components, support, and coating materials, but also the context in which they were used. The wisdom in better bringing together the analytical resources available and performing the analyses required by each case determines the success of a forensic examination of a forgery or the authenticity of a work of art [8].

It is not hard to see that it is unlikely that a single company or laboratory, whether public, private, academic, or not, will own all the technological resources to exhaust such an analysis. Furthermore, it is not uncommon for crimes involving works of art to be transnational. All this leads us to the last step of our range of complexity: laboratories, museums, forensic, and research institutes involved in examining the authenticity of artworks should operate on secure and integrated networks, generating data that is widely shared between partner institutions. Several institutes in the world already work in this way, such as INTERPOL, the INTERNATIONAL COUNCIL OF MUSEUMS (ICOM) [9], the Federal Bureau of Investigation (FBI), UNODC, and the Integrated Platform for the European Research Infrastructure on Cultural Heritage (Iperion CH). This has proven to be one of the most effective ways to curb this type of crime, which, sneakily, erodes our history and cultural heritage [10].

REFERENCES

1. Ragai, J. *The Scientist and The Forger – Probing a turbulent art world*, 2nd Ed., Vol. 1. World Scientific Publishing Europe Ltd, New Jersey, **2018**.
2. Mashberg, T. "The Art of Money Laundering: The loosely regulated art market is rife with opportunities for washing illicit cash" *International Monetary Fund e-Library*, **2019**. Available at: https://www.elibrary.imf.org/view/journals/022/0056/003/article-A009-en.xml [Accessed April 12, 2021].
3. Polícia Federal, Ministério da Justiça e Segurança Pública do Brasil. "Operação Lava Jato." Available at: www.pf.gov.br/imprensa/ [Accessed April 12, 2021].
4. Hwang, S.; Song, H.; Cho, S. W.; Kim, C. E.; Kim, C. S.; Kim, K. *PLoS ONE*, **2017**, *12* (2) (http://dx.doi.org/10.1371/journal.pone.0171354).
5. López-Ramírez, M. R.; Navas, N.; Rodríguez-Simón, L. R.; Otero, J. C.; Manzano, E. *Anal. Methods*, **2015**, *7* (4), pp 1499–1508 (http://dx.doi.org/10.1039/c4ay02365j).
6. Schossler, P.; de Figueiredo Júnior, J. C. D. A.; Fortes, I.; Cruz Souza, L. A. *Sci. Justice*, **2014**, *54* (6), pp 465–469 (http://dx.doi.org/10.1016/j.scijus.2014.06.013).
7. Rodriguéz-Simón, L. R.; Navas, N.; Manzano, E. *Is the painting authentic? A multi-method approach to investigate the provenance and the authenticity of two 20th century canvas paintings with the signature of 'Picasso'*. In: International Conference of Education, Research and Innovation Proceedings (ICERI), Nov. **2009**, pp 3782–3793.
8. Radvan, R.; Ratoiu, L.; Cortea, I. M.; Chelmus, A.; Angheluta, L.; Marinescu, D. *Multi-step Approach for Characterization of Artworks Based on Hyperspectral Imaging and Complementary Techniques*. 11th International Conference on Developments in eSystems Engineering (DeSE), **2018**, pp 117-122 (http://dx.doi.org/10.1109/DeSE.2018.00025).
9. International Council of Museums, "Object ID - ICOM." Available at: https://icom.museum/en/resources/standards-guidelines/objectid/ [Accessed Feb. 10, 2021].
10. United Nations Office on Drugs and Crime. *Acting together against destruction and trafficking of cultural property by terrorist and organized crime groups protecting cultural heritage an imperative for humanity*, **2016**. Available at: https://www.unodc.org/documents/publications/SRIUN_Protecting_Cultural_Heritage_2016.09.12_LR.pdf [Accessed April 18, 2021].



Marcus V. O. Andrade is a senior forensic expert and holds his M.Sc. (2003) in pharmaceutical sciences from the Federal University of Minas Gerais. Since 2003, he has worked for the Brazilian Federal Police, where he has performed in several areas, such as forensic chemistry, bombs and explosives, crime scene investigations, counterfeiting artworks, and environmental crimes. In the last few years, he coordinated forensic responses to complex crimes, such as the dam collapse in Mariana (2015) and Brumadinho (2019). His work in forensic sciences includes contributing to the development of important partnerships between the Federal Police and Universities, such as the Network of Forensic Sciences of Minas Gerais, the National Network of Forensic Isotopes, and the Integrated Network of Forensic Laboratories in Works of Art and Historical and Cultural Heritage. He is also a member of the board of directors of the Brazilian Academy of Forensic Sciences.