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**Modern methods of authentication of criminal goods,  
conservation procedures during the investigation,  
their rescue and reintroduction into the circuit of  
cultural heritage values**

**PHD THESIS ABSTRACT**

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The aim of this work is to develop experimental protocols for the selection and study of artefacts that are part of the cultural heritage, likely to be involved in a wide range of illicit activities. The aim was to identify, recover and preserve them in order to reintroduce them into the museum circuit or in state or private collections. Thus, in addition to scientific investigation, an important role is also attributed to preservation and restoration procedures.

In writing this paper, I have used data and analyses carried out in our laboratory as part of expert authentication or conservation studies of old artefacts, especially paintings and musical instruments (violins), some of which bear the signature or label of great painters or master violin makers. Based on the complex critical analysis that underpinned these studies, a synthesis of the literature on the current state of research in the field of authentication and expertise of works of art has been made.

The choice of the theme was driven by the lack of a unified approach and common standards in terms of expertise in authenticating a work of art worldwide. At present, numerous bodies made up of specialists from different fields are trying to reach a consensus and develop some standards that will be recognized and accepted in the expertise of authentication of works of art, part of the cultural heritage. However, to date, only guidelines and recommendations have been drawn up, which are not binding. Moreover, as the field is very complex, a definition of the expert is necessary, taking into account the expert's training and field of activity, because the role of expert can be assigned to a large number of specialists or connoisseurs of art.

Nowadays, the number of art collectors has increased, so the rise in demand for art objects has also led to an increase in the number of forgeries. The prices paid when auctioning famous works of art have risen fabulously, making counterfeiting a more than profitable activity.

In writing this thesis, four main lines of research were followed.

The first research direction concerns the scientific investigation of works of art as a complex, interdisciplinary discipline. This includes the procedures, methods, specialist means used, differentiated according to the composition of the materials, and the elements under investigation (film, polychrome structures, preparation, support, etc.). In order to be applied to heritage objects, they must meet a number of conditions.

The second line of research concerns the authenticity of an art object and the attributes of authenticity. In this respect, the aim was to define terms such as forgery, copying, reproduction,

counterfeiting, with reference to the field of art. In addition, a classification of experts was made and the notion of authentication expertise was developed.

Another line of research brings to the fore the state of conservation of artefacts, the factors that can influence it and their classification. Deterioration and decay of an artefact start from the moment it is created and subsequently evolve according to ageing/ageing processes and the aggressiveness of environmental factors or agents. As each stage is characterized by specific deterioration and decay, these are often used in archaeometric estimates. Knowledge of the state of preservation allows the development of protocols for the preservation and restoration of the heritage asset under scientific investigation.

The fourth line of action concerns the identification of archaeometric and chemometric features of archaeological value, which are involved in the scientific investigation.

This paper aims to make an analysis of those heritage goods likely to be involved in illicit activities, goods that therefore become criminal goods. Starting from the basic presumption that they are part of the cultural heritage, I will develop ways of authenticating and analyzing them, with a focus on conservation procedures while they are in custody.

The objectives are the following:

- to analyse the current state of research in the field of authentication of heritage assets;
- to establish the steps to be followed in the scientific investigation of movable heritage assets, and the types of analyses that can be carried out in relation to the asset under investigation;
- elaboration of an experimental protocol and the detailing of some physical-structural, chemical or other characteristics to be analysed;
- the use of modern methods and techniques for authentication, dating and conservation, involving related disciplines and experts from different fields;
- the corroboration of the data obtained, with a high degree of novelty, with a view to writing and publishing scientific papers or participating in scientific events;

The topic has an important role in environmental science and the development of this topical field, as it combines knowledge from different disciplines (physics, chemistry, biology, archaeology, materials science and technology, legal sciences, forensic science, etc.) and can contribute to limiting illicit activities with cultural heritage assets.

The book covers 227 pages structured in 7 chapters and includes 142 figures, 34 tables and an appendix.

**A. The theoretical part**, devoted to the study of the literature, extends over two chapters, as follows:

**Chapter I**, entitled **Methods and techniques of scientific investigation of artefacts**, where a description of the modern methods and techniques used in expertise, differentiated according to the composition of the materials and elements under investigation, is carried out. The research directions on which scientific investigation is developed, the types of expertise and the analyses involved in their resolution are presented.

Optical and spectrometric methods used to identify the component materials in a work of art become indispensable in conservation and restoration. However, at present no analysis can pinpoint the source of the work and attribute a work to a particular artist.

The types of analysis that can be carried out on a work of art can be technical, stylistic, historical or scientific.

**Chapter II**, **Authentication and the determination of the state of conservation of artefacts**, explains the meaning of terms used in particular in the case of illicit activities with works of art. The main purposes for which forgeries are made are listed and a classification of artefacts susceptible to illicit activities is made. This chapter defines the concept of authenticity in the case of works of art and classifies experts according to their field of activity. Particular importance is paid to the assessment of the state of conservation in order to make preservation/restoration interventions compatible.

Various factors, both natural and anthropic, contribute to the degradation of materials. For this reason, cultural heritage conservation studies should focus on both the artwork and the environment, with the aim of identifying factors that limit the durability of materials, in a knowledge exchange involving scientists, biologists, conservators and art historians. Some research has shown that the application of inappropriate restoration interventions or the use of products incompatible with the original materials can lead to dangerous choices in the conservation of works of art. Hence the importance of a scientific approach to study the original materials before any restoration operations are carried out and to develop innovative cleaning, restoration and conservation procedures previously tested in the laboratory, in order to suggest to restorers the best method to apply.

**B. The experimental part**, contains the own contributions, the analytical protocol and the experimental research and extends over four chapters, as follows:

**Chapter III, Authentication of an Old Painting by Nicolae Grigorescu**, presents the authentication of a painting by Nicolae Grigorescu. The main objective of the expertise is to establish the authenticity of the painting and to verify by graphoscopic analysis the inscription on the reverse side, by means of artistic-plastic, aesthetic, state of conservation, characteristics of the pictorial surfaces and of the graphics, analysed by UV-VIS and IR reflectography, optical and scanning electron microscopy, X-ray spectrometry and infrared spectrometry.

The dating corresponds to the expertise of art historian Amelia Pavel. It was evaluated on the basis of the archaeometric characteristics obtained by scanning electron microscopy on the microspheres analysed in cross-section, as well as the chemometric ones differentiated on the basis of losses of volatile components, carbonation of weakly basic pigments and hydrolysis, respectively of the coordinative complexes of the traditional metal cations in the pictorial material.

**Chapter IV, Authentication of a painting by Rene Magritte**, brings an oil painting on pressed cardboard by the Belgian Rene Magritte into the study. In addition to establishing the authenticity of the painting, the owner also requested verification of the attribution of the inscription on the verso, signed by the same art historian, Amelia Pavel. The use of SEM-EDX allowed a surface detailing, highlighting the main archaeometric and chemometric features with archaeometric value.

**Chapter V, Establishing archaeometric, artefactometric and chemometric features in old violins**, presents, in chronological order, a series of violins authenticated within our collective, by assessing their state of preservation, determining structural-functional characteristics and examining the interior label, as well as some anamnestic data. Stradivari violins have often been copied, either by violinmakers who were disciples or by other violinmakers who respected the structural-functional characteristics and placed them in models belonging to certain known periods. Thus, many violins with the Stradivari label do not belong to this maker.

**Chapter VI, Authentication of an Antonio Stradivari model violin, 1737**, refers to a 1727-1738 Stradivari model violin, a replica of violins of that period. For authentication, the age patina of the label was studied and the year of manufacture was estimated by assessing the degree of whiteness and the glycolysis rate of the label. Measurements of the whiteness and glycolysis rate of the label are the basic elements in preliminary authentication, confirming the

age of over 280 years. The results were corroborated with other complementary analysis techniques.

The violin was made around 1735-1740. By changing the actual date of manufacture on the label to a date during Stradivarius' heyday, which was 1719-1727, an attempt was made to raise the value of the violin.

**Chapter VII, Authentication of a Stradivari Model Violin, 1723, "Petite Violin"** type presents the authentication of a violin by correlating dimensional, structural-functional data with a series of archaeometric and chemometric characteristics determined by dendrochronological analysis and three modern instrumental techniques (SEM-EDX,  $\mu$ -FTIR Spectroscopy and Dynamic Thermal Derivatography).

The violin is a 1723 Stradivarius model, small (1/2), built by an Italian violinmaker, being a replica of the Stradivarius violins of the period 1721-1729. The leucometric characteristics of the label and the patina inside of the sound box are the basic elements confirming the age of 290 years old. The EDX and  $\mu$ -FT-IR data correlate very well with those obtained by dynamic thermal analysis. They show the presence in the structure of the wood (in the top cover), hydrothermally treated in borax and alum solutions (for hydric, chemical and microbiological/insect-fungal stabilisation, and varnished for aesthetics and climate protection), in addition to cellulose and lignin, of components from the preservation treatment and varnishing.

Scientific investigation of artworks can provide information about authenticity and attribution, as well as insight into artists' techniques. This information not only contributes to the scholarly interpretation of art and artefacts, but also aids in the development and evaluation of conservation programs and treatments and the understanding of the nature and behavior of the materials from which works of art are made.

Another term used when referring to scientific investigation is expertise. As it is a complex technical-scientific and methodological approach, expertise involves a range of analytical methods, with the aim of gaining knowledge of a heritage asset both in terms of its material and artistic technique and in terms of the complex phenomena in which it has been involved over time.

**Keywords:** authentication, scientific investigation, fake, artefact, state of preservation, deterioration, alteration, OM, SEM-EDX,  $\mu$ -FTIR.