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ATTRIBUTION AND ATTRIBUTIVE ANALYSIS OF ARTWORKS: A PRACTICAL, THEORETICAL, AND LEGAL GUIDE FOR MUSEUM RESEARCH STAFF

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Abstract. This article develops a practical, theoretical, methodological, and legal framework for the attribution and attributive analysis of artworks in museum collections. It preserves the core professional focus of museum attribution while reorganizing it into an IMRAD research structure and strengthening the relationship between connoisseurship, provenance research, technical examination, digital humanities, and museum documentation. The study is intended primarily for new and practicing research staff in museum art departments. Classical approaches associated with Giovanni Morelli, Heinrich Wölfflin, and Erwin Panofsky are considered alongside infrared and ultraviolet imaging, radiography, microscopy, spectroscopy, X-ray fluorescence, digital image analysis, and carefully bounded applications of artificial intelligence. Particular attention is given to provenance, evidentiary hierarchy, legal due diligence, and the scientific passport of a museum object. The legal context is discussed with reference to the Law of the Republic of Uzbekistan "On Museums," the ICOM Code of Ethics for Museums, and the UNESCO 1970 Convention. As a principal result, a five-stage integrated attribution protocol is proposed: preliminary documentation and provenance screening; visual-stylistic and iconographic analysis; technical and material examination; digital/computational assistance; and collegial synthesis with formal documentation. An illustrative training case based on a Fergana Valley painting is used to demonstrate how a museum researcher should distinguish hypotheses from verified evidence.

Keywords: museum, attribution, attributive analysis, art history, authorship, authentication, provenance, iconography, technical examination, scientific passport, ICOM, digital humanities, artificial intelligence, Fergana painting.

Attribution is one of the most responsible areas of museum research because it connects an object's visible artistic characteristics with questions of authorship, date, place of production, artistic school, authenticity, provenance, legal status, and scholarly significance. In museum practice, an attribution is not merely a label attached to an object. It is a reasoned scientific conclusion that influences inventory records, conservation decisions, exhibition narratives, publication, insurance, loans, and the interpretation of cultural heritage. For this reason, a museum researcher must distinguish between a working hypothesis, a probable attribution, and a conclusion supported by convergent evidence. The source text on which this article is based correctly places the museum researcher at the centre of a multidisciplinary process involving collection custodians, conservators, exhibition specialists, archivists, chemists, historians, and information-technology specialists. Contemporary attribution has become more demanding because the global circulation of art, sophisticated restoration, deliberate forgery, incomplete provenance, and the rapid development of digital image analysis can all complicate judgement. The researcher therefore needs both the visual literacy of traditional art history and the evidentiary discipline of conservation science and museum documentation.

Technical examination has significantly expanded the evidentiary base of attribution. Infrared reflectography can reveal underdrawing and compositional changes; ultraviolet examination may help identify varnish, retouching, or later interventions; radiography can disclose underlying structures and changes; microscopy can characterize surface and stratigraphy; and spectroscopic or elemental

techniques can help identify pigments and materials. Recent heritage-science literature also emphasizes that portable X-ray fluorescence and other non-destructive methods are powerful only when their limitations, sampling context, and need for multi-technique interpretation are understood. Material evidence is therefore diagnostic, not automatically dispositive. Digital humanities and artificial intelligence add a further layer. Computational systems can compare visual features, brushwork, edge patterns, surface topography, or large image corpora. However, model performance depends on the training data, the question posed, image quality, and the representativeness of reference works. A 2023 study on a restricted set of Raphael paintings reported high validation performance for a machine-learning classifier, but the authors explicitly framed the system as one component of a broader authentication protocol that must also include provenance, material studies, iconography, condition, and connoisseurship. This caution is fundamental for museum practice: an algorithm can support expert reasoning, but it cannot replace documentary and material evidence.

The study is methodological and practice-oriented. It draws on the conceptual structure of the original museum lecture, classical art-historical methods, museum ethics, provenance research, and contemporary conservation science. The principal methods used were comparative analysis, conceptual clarification, normative-legal analysis, methodological synthesis, and process modelling. The objective was not to authenticate a specific artwork experimentally, but to design a scientifically defensible procedure that can guide museum staff when they investigate objects whose authorship, chronology, or provenance is uncertain. For terminological clarity, attribution is defined here as the scholarly process of assigning, with an explicitly stated degree of confidence, an artwork to an artist, workshop, school, place, and period. Attributive analysis is the wider evidentiary process through which such a conclusion is tested. Provenance refers to the documented chain of ownership, custody, exhibition, transfer, or collection history. Iconography identifies represented subjects, attributes, figures, motifs, and conventional meanings, whereas iconology interprets those elements in relation to broader cultural, intellectual, and historical contexts. Pentimenti are changes made by the artist during the process of creation that may become visible through examination or imaging. A scientific passport is the museum record that consolidates the object's identification, dimensions, technique, condition, attribution, provenance, research history, exhibitions, bibliography, and decisions of authorized museum bodies. Evidence was grouped into five interrelated domains: documentary/provenance evidence; visual-stylistic evidence; iconographic/contextual evidence; technical-material evidence; and computational/digital evidence. The key methodological principle was triangulation. A high-confidence attribution should emerge from agreement among independent forms of evidence, while contradictions should be recorded rather than suppressed. The researcher should also document negative evidence, such as a pigment unavailable in the proposed period, an exhibition label inconsistent with the ownership history, or a computational result that conflicts with material data. The methodological framework further distinguishes evidence from inference. Evidence is an observable or documented fact: for example, a dated archival catalogue, a verified collector's label, a pigment composition, a visible inscription, or a documented exhibition record. Inference is the researcher's interpretation of how such facts relate to authorship or date. This distinction is especially important when dealing with erased signatures, workshop production, replicas, later copies, and heavily restored works.

The principal result of the study is an integrated five-stage protocol for museum attribution. The protocol retains the practical content of the original lecture but gives each stage a clearer evidentiary function and decision rule.

Stage 1 is preliminary documentation and provenance screening. Before stylistic comparison begins, the researcher records the object's current inventory data, title, dimensions, support, technique, inscriptions, labels, stamps, condition, acquisition history, and existing catalogue references. A

provenance chronology is then constructed, with gaps clearly marked. This stage helps identify legal and documentary risks early and prevents later visual enthusiasm from overshadowing due diligence.

Stage 2 is visual-stylistic and iconographic analysis. The researcher examines composition, drawing, colour, modelling, brushwork, spatial construction, anatomy, costume, motifs, recurring details, and relationships to securely attributed works. Morellian attention to minor details, Wölfflinian formal categories, and Panofskian levels of interpretation may be used as structured analytical lenses. Comparisons should be made with documented originals rather than low-quality reproductions wherever possible, and similarities should be balanced against differences.

Stage 3 is technical and material examination. The choice of method depends on the research question and object condition. Infrared imaging may reveal underdrawing; ultraviolet-induced fluorescence can help map varnish and retouching; radiography may show structural changes or earlier compositions; microscopy can examine craquelure, fibres, ground layers, and paint stratigraphy; XRF, Raman spectroscopy, Fourier-transform infrared spectroscopy, or related techniques may identify inorganic or molecular components. Findings must be interpreted historically. The presence of a modern material in a supposedly early work can be strong negative evidence, whereas the presence of historically plausible materials is supportive but does not prove authorship.

Stage 4 is digital and computational assistance. High-resolution scanning, image registration, multispectral comparison, 3D macro-topography, database searching, and machine learning may reveal patterns not readily visible to the eye. The original text referred to “AI stroke analysis” as if it could identify authorship with a fixed 98% accuracy. That statement requires qualification. Some controlled studies have reported high classification performance under restricted experimental conditions, but accuracy is not a universal constant and cannot be transferred automatically to an unknown museum painting. Computational results should therefore be reported with the model, dataset, confidence, validation conditions, and limitations.

Stage 5 is collegial synthesis and documentation. All evidence is brought together in an attribution dossier. The researcher states the proposed author or school, date range, place, degree of confidence, supporting evidence, contradictory evidence, unresolved questions, and recommended next steps. Where institutional procedures require it, the conclusion should be reviewed by the relevant acquisition/fund commission, scientific-methodological council, or expert group. The final attribution and its basis should then be entered into the scientific passport and other collection records without erasing the history of previous attributions.

Table 1. Integrated attribution protocol for museum research staff

Stage	Primary question	Main evidence and tools	Research output	Key caution
1. Documentation and provenance	What is known about the object and its custody history?	Inventory data, labels, archives, catalogues, acquisition files, provenance chronology	Baseline dossier and provenance gaps	Do not infer ownership history from style alone
2. Visual-stylistic and iconographic analysis	How does the work relate to an artist, workshop, school, period, and subject tradition?	Morellian details, Wölfflinian formal comparison, Panofskian analysis, secure comparanda	Working attribution hypothesis	Similarity is not proof; compare differences as well

Stage	Primary question	Main evidence and tools	Research output	Key caution
3. Technical-material examination	Are support, pigments, layers, and construction consistent with the proposed date and authorship?	IR, UV, X-radiography, microscopy, XRF, Raman/FTIR and other justified methods	Material chronology and evidence of alteration	Plausible materials support but do not prove authorship
4. Digital/computational assistance	Can digital analysis reveal additional patterns or improve comparison?	High-resolution imaging, image registration, 3D topography, databases, ML/AI tools	Quantified or visual computational evidence	Report dataset, model, uncertainty, and limitations
5. Synthesis and museum documentation	Do independent evidence streams converge?	Expert discussion, evidentiary matrix, scientific council/commission review, passport	Attributed record with confidence and rationale	Record uncertainty and prior attributions; avoid false certainty

A second result is a more precise approach to the scientific passport. The passport should not contain only the latest conclusion; it should preserve the object's research history. At minimum, it should include the inventory number, standardized title, author or attribution formula, proposed date and place, materials and technique, dimensions with and without frame when relevant, inscriptions and marks, condition, restoration history, provenance, acquisition information, exhibition history, bibliography, photographic/technical imaging references, expert decisions, and the date and authorship of each attribution update. When a conclusion remains provisional, expressions such as "attributed to," "workshop of," "circle of," "school of," "after," or "formerly attributed to" should be used consistently and defined institutionally.

In the training exercise, the museum receives an unsigned oil painting on canvas, approximately 60 × 80 cm, depicting a Fergana teahouse scene. The initial visual hypothesis compares the palette, geometric organization, figures, and decorative motifs with documented works connected to the Central Asian avant-garde and artists active in the region during the 1920s–1930s. Morellian analysis may focus on recurring forms of hands, facial profiles, vessels, furniture, and drapery. At this point, the correct conclusion is not "the details match a particular painter 100%," but "selected features justify further comparison with a defined reference corpus." The second phase of the exercise applies imaging and technical examination. If infrared imaging reveals underdrawing or pentimenti, those features are documented and compared with securely attributed works. If an inscription becomes visible beneath later layers, its physical relationship to the paint stratigraphy must be established before it is accepted as evidence. An inscription that appears through imaging is not automatically an original signature; it may be later, transferred, restored, or unrelated to authorship. Likewise, pigment or support data are interpreted chronologically rather than treated as a direct "fingerprint" of the artist.

The third phase reconstructs provenance. Museum archives, exhibition catalogues, acquisition books, collector correspondence, photographs, stamps, and labels are searched for a chain linking the painting to a historical collection or exhibition. If an archival entry is found, the researcher must demonstrate that it refers to the same physical object, not merely a work with a similar title. Only after documentary, stylistic, technical, and contextual evidence converge should the museum formulate a

stronger attribution. If key evidence remains absent, the object should retain a qualified attribution and the gaps should be listed in the scientific passport.

The integrated protocol demonstrates that attribution is best understood as an argument built from different kinds of evidence rather than as an act of expert recognition. Traditional connoisseurship remains indispensable because it identifies meaningful visual relationships and generates testable hypotheses. Yet its conclusions become more robust when they are examined against provenance, scientific analysis, and historical documentation. Conversely, technical science cannot replace art history: chemical compatibility can show that a work could have been made in a period, but it normally cannot establish who painted it. The legal and ethical dimension is equally important. The ICOM Code of Ethics stresses due diligence and the need to establish valid title and provenance before acquisition. The UNESCO 1970 Convention addresses illicit import, export, and transfer of ownership of cultural property. These principles matter directly to attribution because provenance gaps may signal not only scholarly uncertainty but also legal and ethical risk. A museum should therefore avoid treating attribution as separate from acquisition history.

Digital tools are particularly useful when they improve reproducibility, visualization, and comparison. High-resolution images allow researchers to revisit observations; multispectral and 3D data can reveal features invisible in normal light; databases can connect dispersed archival and visual material; and machine learning can rank or cluster similarities. Nevertheless, computational systems are vulnerable to biased or incomplete training data, overfitting, image-processing artifacts, and domain shift. Current research in computational art attribution increasingly emphasizes expert-led, interpretable, and multimodal systems rather than autonomous algorithmic verdicts. For museum staff in Uzbekistan and the Fergana Valley, the protocol is also relevant to local art-historical research. Regional museum collections contain works whose documentation may have been created under different administrative systems and whose titles, artist names, or dates may have changed over time.

Professional training is another important implication. New museum researchers should learn terminology, visual analysis, archive work, collections documentation, legal norms, basic conservation science, and the logic of uncertainty. They do not need to become chemists or machine-learning engineers, but they must know what questions each specialist method can answer, what it cannot answer, and how to request and interpret expert reports. Collegiality is therefore not optional; it is a methodological condition of responsible attribution. The study has limitations. It is a methodological paper and does not report new laboratory analysis of a specific object. The illustrative Fergana case is intentionally framed as a training scenario because the source material does not provide sufficient verifiable documentation to support the strong historical claims originally attached to it. Future research should apply the proposed protocol to museum objects with accession identifiers, documented provenance, reproducible technical data, and published comparative images. Such case studies would allow the framework to be tested and refined in real collection practice.

Attribution and attributive analysis are core scholarly responsibilities of museum research staff. Their purpose is not simply to attach a famous name to an object, but to establish the most defensible identification possible while preserving the evidence, uncertainties, and research history on which that identification depends. A scientifically responsible attribution therefore combines visual-stylistic analysis, iconography and iconology, provenance, technical examination, digital assistance, and legal-ethical due diligence.

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