

Review

Virtual Reconstruction as Scientific Evidence in Criminal Proceedings

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Abstract

Background: Recent technological advances, such as 3D laser scanning, digital photogrammetry and virtual autopsy, have significantly reshaped the acquisition and interpretation of scientific evidence in criminal proceedings. These tools enable highly detailed visualizations that can enhance factual understanding while also introducing potential cognitive biases for judges. This study aims to assess the legal, epistemological and forensic implications of 3D virtual reconstruction as evidence, examining its admissibility, scientific robustness, and associated risks within contemporary criminal trials. **Methods:** An interdisciplinary methodology was applied, integrating criminal procedural law, forensic medicine, digital forensics and legal epistemology. The study includes doctrinal analysis, a review of the literature from the last decade, Italian and comparative case law, and evaluation of European forensic guidelines (particularly ENFSI). Direct observation of laboratory practices and technical assessment of reconstruction tools were conducted to evaluate scientific validity, repeatability, traceability and transparency. **Results:** The findings reveal that 3D reconstruction provides high metric accuracy, durable digital preservation of the crime scene and improved communication of complex dynamics to the court. It allows experts to test alternative hypotheses, reducing ambiguity in technical explanations. Nevertheless, several critical issues emerged: the persuasive power of highly realistic imagery, dependence on non-transparent software processes, potential vulnerabilities in the chain of custody for digital data, and the absence of a unified Italian regulatory framework governing digital scientific evidence. **Conclusions:** 3D virtual reconstruction constitutes a powerful but epistemologically complex form of scientific evidence. Its probative value depends on transparent methodology, verifiability and strict compliance with adversarial safeguards. The study underscores the need for national technical standards, clear admissibility criteria and specialized training for legal professionals. A coherent regulatory framework is essential to ensure that digital technologies enhance, rather than distort, the pursuit of truth in criminal justice.



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1. Introduction

The relationship between science and law has long been marked by profound epistemological tension. While legal reasoning is oriented toward certainty and the need to reach definitive conclusions, scientific inquiry is inherently grounded in doubt, provisional

hypotheses, and continuous revision. This divergence becomes particularly evident in criminal proceedings, where the judicial obligation to issue a clear and unequivocal verdict clashes with the probabilistic and evolving nature of technical-scientific knowledge. As several scholars have noted, the courtroom becomes one of the most critical arenas in which these two rationalities must coexist and interact [1–4].

In recent years, this tension has been intensified by the progressive incorporation of digital and virtual technologies into forensic practice. Tools such as 3D laser scanners, advanced photogrammetry software, and artificial intelligence systems for crime-scene analysis have reshaped the very landscape of evidentiary reconstruction [5–8]. Their use challenges traditional conceptions of procedural truth, which have historically been rooted in verbal testimony and documentary evidence. The judicial process must now confront three-dimensional, immersive visualizations that present factual scenarios with unprecedented immediacy and persuasive power [9].

Unlike traditional textual or photographic evidence, digital scientific reconstructions do not merely *describe* an event, they *show* it. Their visual impact can elicit emotional and cognitive responses capable of influencing judicial perception and, consequently, the assessment of guilt or innocence. This potential shift in how evidence is understood underscores the necessity for the judiciary to develop reliable standards for evaluating such material. Without robust methodological safeguards, visual suggestion may risk taking precedence over logical and probative reasoning, thereby undermining the guarantees of a fair trial.

Virtual crime-scene reconstruction represents a natural evolution of traditional forensic documentation techniques. By integrating 3D laser scanning, digital photogrammetry, three-dimensional modelling, and augmented reality, it is now possible to produce metrically accurate and highly detailed representations of the physical environment in which a criminal event unfolded [10]. These technologies not only preserve evidence digitally but also allow for dynamic simulations of different reconstruction hypotheses, providing experts with a more rigorous and objective basis for their analyses. However, some reconstructions also carry an associated error.

Yet, in the legal domain, the central question is not the sophistication or technical potential of these tools. Rather, the focus lies on their epistemological and procedural reliability [11]. Scientific evidence, according to well-established legal doctrine and jurisprudence, must be grounded in a recognized experimental method, validated by the relevant scientific community, and replicable under controlled conditions. In the absence of these criteria, virtual reconstructions risk being regarded merely as illustrative aids without autonomous evidentiary weight. Their probative value would thus be significantly diminished.

This study seeks to address these challenges by pursuing four main objectives:

- To analyze the legal foundations governing the use of virtual reconstructions in criminal proceedings, with particular reference to Articles 189–190 of the Italian Code of Criminal Procedure and the overarching principles of the fair trial;
- To explore the epistemological implications associated with the introduction of digital technologies into the formation and evaluation of evidence;
- To examine Italian and comparative case law concerning the admissibility, methodological scrutiny, and evidentiary weight of 3D reconstructions;
- To identify the ethical and professional issues that arise from employing immersive visual representations within courtroom settings.

The aim of the study is to assess whether 3D crime-scene reconstruction can be considered a scientifically reliable form of evidence and effectively used in Italian criminal proceedings. In particular, the research examines whether this tool meets the criteria

of repeatability, verifiability, and criteria for falsifiability, as well as the guarantees of a fair trial.

2. Materials and Methods

The analysis undertaken in this study adopts an inherently interdisciplinary perspective, reflecting the composite nature of virtual crime-scene reconstruction, which sits at the crossroads of multiple scientific and legal domains. Criminal procedure provides the framework for defining the admissibility and evidentiary weight of digital reconstructions, while forensic medicine and the broader forensic sciences contribute the methodological foundations necessary to validate their technical reliability. Digital forensics plays an equally essential role, providing tools for managing, preserving, and processing digital data, and ensuring that virtual models remain authentic while the chain of custody is meticulously maintained. Finally, legal epistemology offers the conceptual lens through which the nature of evidentiary reasoning, the construction of procedural truth, and the epistemic status of digital visualizations can be properly understood.

It should be specified that the present study does not involve experimental activity or the autonomous production of original three-dimensional reconstructions. Rather, it is primarily configured as a critical last decade review of legal, forensic and technical literature, combined with doctrinal analysis and case-law examination. A literature research was conducted using the keywords “3D technologies,” “forensic science,” and “scientific evidence,” focusing on publications from the last ten years. The search was performed on Scopus and PubMed, in order to identify the most recent developments and applications of 3D technologies within the forensic science field.

The inclusion criteria were: (1) articles published in peer-reviewed scientific journals, (2) publications written in English, and (3) studies addressing the application or evaluation of 3D technologies in forensic science, including forensic medicine, forensic anthropology, forensic odontology, crime-scene reconstruction, and forensic imaging; (4) studies published between January 2016 and December 2025; (5) studies evaluating technologies such as 3D scanning, photogrammetry, 3D printing, virtual reconstruction, or computer-assisted 3D modelling; and (6) articles with full-text availability.

Exclusion criteria included: (1) conference abstracts, editorials, letters, and book chapters; (2) studies not directly related to forensic applications; (3) articles focused exclusively on non-forensic medical or industrial uses of 3D technologies; (4) duplicate publications; and (5) studies lacking sufficient methodological details or outcome data.

Articles that were not directly related to forensic applications of 3D technologies were excluded from the review.

The initial search yielded 52 results. Titles and abstracts were screened to assess their relevance to the research topic. After applying the inclusion and exclusion criteria and reviewing the full texts, a total of 18 articles were selected and included in the final analysis. In addition, a hand search of the reference lists of the selected articles was performed to ensure the completeness of the information and to minimize the risk of overlooking additional relevant publications related to the topic.

Moreover, in order to contextualize the operational dimension of the technologies discussed in scientific sources, a non-participatory observational activity was carried out at the Department of the Forensic Police in Rome-Italy. This observational component made it possible to examine, in their ordinary application, the main tools and workflows used in digital crime-scene reconstruction, without any direct acquisition, processing, or experimental validation of data by the author.

Consequently, the assessment of the scientific reliability of the technologies considered in this study is grounded in published protocols, international guidelines, and peer-reviewed literature rather than in original experimental results.

To capture the complexity of this intersection, the methodology integrates several complementary approaches. First, doctrinal analysis and review of judicial decisions, particularly recent developments in evidentiary law and the jurisprudence of the European Court of Human Rights, provide the normative foundation for assessing digital evidence. This is combined with non-participatory direct observation of 3D reconstruction practices currently employed in leading Italian forensic laboratories, including those operated by LABANOF [12] and the Forensic Police [13]. A comparative dimension further enriches the study, drawing on the experience of common law jurisdictions such as the United States and the United Kingdom, where digital simulations and virtual reconstructions have long been admitted as demonstrative tools in court. Finally, a technical examination of the software most commonly used for digital modelling, simulation, and visualization, ranging from photogrammetry and laser scanning platforms to rendering programmes and virtual autopsy technologies, allows for a critical assessment of the scientific soundness of these methods. Therefore, the study adopted a triangulation approach integrating legal analysis, forensic technical assessment and observational evidence. Legal doctrine, case law and European forensic standards were first analyzed to identify the normative and epistemological requirements for the admissibility and reliability of digital evidence (while acknowledging the existence of alternative interpretations and the evolving nature of the relevant case law). These requirements were then used as analytical criteria for evaluating 3D reconstruction technologies and laboratory practices. Finally, findings from the technical assessment and direct observation were compared with the legal framework to identify areas of convergence, strengths and regulatory gaps.

The aim of the study is to assess whether 3D crime-scene reconstruction can be considered a scientifically reliable form of evidence and effectively used in Italian criminal proceedings. In particular, the research examines whether this tool meets the criteria of repeatability, verifiability, and falsifiability, as well as the guarantees of a fair trial.

This inquiry draws on a wide range of normative and jurisprudential sources. The analysis considers Articles 189 and 190 of the Italian Code of Criminal Procedure, which regulate atypical evidence and set the parameters for the evaluation of scientific proof, as well as Article 111 of the Italian Constitution, which enshrines the principles of adversarial proceedings and due process. At the supranational level, Article 6 of the European Convention on Human Rights provides the broader framework of fair-trial guarantees applicable to all forms of evidence. Additional guidance is drawn from European technical standards and recommendations in the field of digital and computer forensics, including ENFSI guidelines and other sectoral protocols [14].

The case-law corpus examined includes decisions of the Italian Court of Cassation that have addressed the admissibility and probative value of 3D reconstructions, together with judgments on simulations used in the investigation of traffic collisions, homicides, and impact dynamics. Comparative reference is also made to the Daubert standard developed in the United States, which constitutes a well-established benchmark for assessing the scientific validity of expert testimony and technical evidence [15].

From a technological standpoint, the study considers the principal tools currently employed in virtual reconstructions. Among these, 3D laser scanners play a crucial role, using structured-light technology to capture millions of spatial data points and generate highly accurate point clouds that allow for exhaustive and precise documentation of the scene. Digital photogrammetry, relying on multiple photographs processed through correlation algorithms, offers an alternative and particularly versatile method for reconstructing

objects, bodies, or surfaces that are difficult to scan directly. Modelling and rendering software, such as RealityCapture, 3D Studio Max. (see Figure 1), enables data cleaning, post-processing, and the creation of dynamic simulations. In parallel, virtual autopsy systems integrate high-resolution CT and MRI imaging with three-dimensional modelling of the human body, allowing for the non-invasive analysis of internal injuries and providing both technical advantages and ethical benefits.

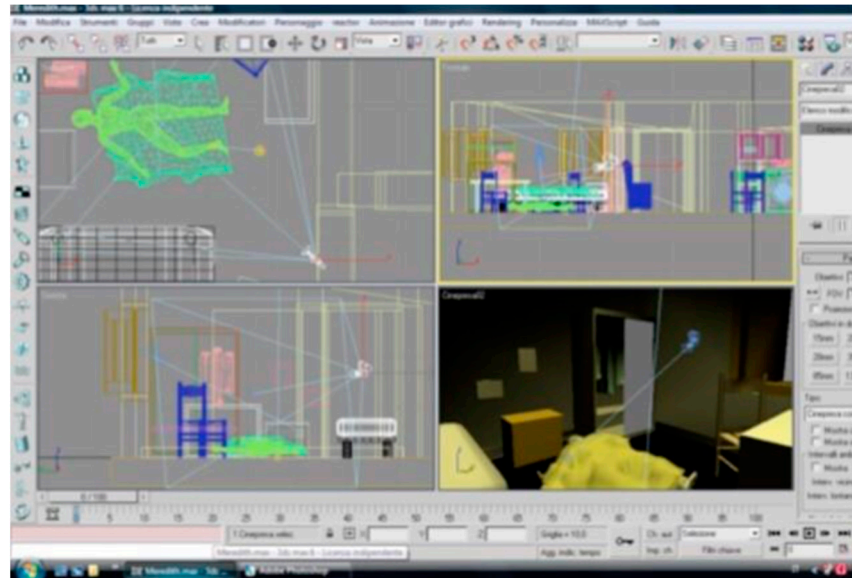


Figure 1. Reconstruction of the scene obtained using 3D representation software (3D Studio Max ver. 6).

To assess the scientific nature of digital reconstructions, the study applies three principal analytical criteria. The first concerns scientific validity: techniques must be grounded in recognized and peer-reviewed methodologies, consistent with ENFSI protocols, ISO standards, and established forensic literature. The second criterion is repeatability and verifiability, requiring that digital models be open to independent scrutiny through access to original data, the possibility of replicating measurements, and full traceability of all modifications. The third relates to the transparency of the workflow: every stage of the reconstruction process, from data acquisition to modelling choices and simulation hypotheses, must be thoroughly documented. Without such transparency, digital evidence risks losing both credibility and probative integrity.

3. Results

3.1. Practical Applications of Virtual Reconstruction

The analysis reveals that three-dimensional reconstruction is now employed across a wide range of forensic and judicial contexts. In cases of homicide and assault, 3D modelling is used to reconstruct the relative positions of individuals, determine shooting angles, analyze bullet trajectories, and study weapon dynamics. These reconstructions offer a more nuanced and accurate interpretation of the sequence of events, often clarifying elements that traditional documentation techniques may leave ambiguous [16].

In the field of road traffic collisions, virtual models make it possible to reconstruct collision dynamics with high precision, enabling experts to estimate vehicle speeds, trajectories, and the spatial positioning of those involved at the moment of impact [17,18].

Virtual autopsies represent another significant application. Through post-mortem CT imaging, investigators can identify bony fractures without resorting to dissection, reconstruct bullet trajectories within the body, and compare alternative reconstruction

hypotheses with a greater degree of objectivity than is typically achievable through conventional autopsy procedures [19–21].

From a technical perspective, the main advantage lies in the non-destructive and repeatable nature of the examination. Unlike traditional dissection, which irreversibly alters the body, virtual autopsy allows for the digital preservation of the cadaver and enables repeated re-analysis over time. Moreover, as previously noted, it allows for highly precise 3D reconstruction of bony fractures, bullet trajectories, and internal injuries, thereby reducing the risk of information loss associated with manual intervention or tissue decomposition [22,23].

From an ethical perspective, the most evident benefit concerns respect for bodily integrity. Virtual autopsy avoids or significantly reduces invasive dissection, which may be relevant for cultural, religious, or family-related sensitivities [24]. Furthermore, it limits bodily exposure and physical manipulation, thereby reducing the psychological impact on operators and better preserving the dignity of the deceased. In some cases, it may also reduce the number of unnecessary invasive autopsies when radiological data are already sufficiently informative [25,26].

From an epistemological standpoint, it enhances the possibility of verification and hypothesis comparison: different experts can re-examine the same raw data, making the process more controllable and potentially more transparent than direct observation, which is partly non-reproducible.

In summary, the advantage of virtual autopsy lies in its ability to improve the quality, reproducibility, and transparency of forensic analysis (technical dimension), while simultaneously reducing invasiveness and enhancing respect for the body (ethical dimension).

Moreover, in complex crime scenarios such as explosions, fires, or structural collapses, 3D reconstruction allows for a comprehensive and integrated visualization of the event (Figure 2). This holistic view facilitates interpretation by providing judges and investigators with a clearer understanding of spatial relationships and causative mechanisms that would otherwise be difficult to conceptualize [27].



Figure 2. Example of 3D scene modelling.

3.2. Advantages Identified

Several key advantages emerge from the use of virtual reconstruction.

First, metric precision and digital preservation ensure that the crime scene can be revisited and re-examined long after the physical evidence has degraded or disappeared. The permanence and accuracy of digital documentation overcome the intrinsic volatility of traditional evidentiary materials [28,29].

Second, visual communication significantly enhances judicial comprehension. The ability to present dynamic, three-dimensional representations of complex events helps to bridge the cognitive and linguistic gap that often separates technical experts from judges, making the evaluative process more transparent and accessible [30,31].

Third, the possibility of comparing multiple hypotheses represents a major benefit. Modern software allows experts to model and test alternative scenarios, such as different bullet trajectories or collision dynamics, thus supporting a more rigorous and intellectually honest form of evidentiary reasoning.

3.3. Forensic Issue

From a forensic perspective, several studies have observed that close-range photogrammetry and optical surface scanning represent mature and scientifically grounded tools for post-mortem documentation [32–35]. The production of high-resolution, metrically accurate, life-size three-dimensional surface models enables comprehensive preservation of the external condition of the body, allowing subsequent measurements, re-evaluations, and expert assessments without further manipulation of the remains. This feature significantly strengthens evidentiary preservation and aligns with the principles of repeatability and independent verification that characterize reliable forensic methodologies.

However, the probative robustness of such digital reconstructions does not depend solely on their technical accuracy. The post-processing phase, as image alignment, mesh generation, and data cleaning, introduces elements of discretionary human intervention that may affect transparency and reproducibility if not properly documented. Moreover, as in many other areas involving the application of emerging technologies to medical and forensic science [36], known technical limitations persist, such as difficulties in scanning reflective or hair-covered surfaces [37], which necessitate a methodologically cautious approach. Therefore, while these technologies constitute highly valuable forensic documentation tools, their integration into criminal proceedings requires standardized acquisition protocols, full traceability of raw data, and clear documentation of the entire workflow [38,39]. In the absence of such safeguards, 3D reconstructions risk being perceived not as fully autonomous scientific evidence, but rather as demonstrative aids possessing persuasive force that may exceed their methodological transparency [40].

Other authors have investigated that, in addition to documenting the external condition of the body, three-dimensional photogrammetry and virtual visualization offer significant advantages in the assessment of injuries and damage [41,42]. Traditional forensic photography, still widely used today, especially in the evaluation of biological damage, inherently reduces three-dimensional structures to a two-dimensional plane, resulting in potential loss of spatial information and approximations in estimating lesion dimensions [43]. In contrast, 3D models allow precise and repeatable measurements of lesion size, surface area, and morphological characteristics, supporting more objective evaluations of both biological and aesthetic damage [44,45]. Moreover, such models can be examined and analyzed even after healing or decomposition, enabling subsequent expert assessments, including those performed by other consultants, and facilitating independent verification [46]. Immersive visualization in virtual reality further enhances the understanding of lesion morphology, although measurement accuracy is slightly lower than that obtained with dedicated photogrammetric software [47,48]. Overall, the integration of 3D photogrammetry and virtual visualization strengthens both technical documentation and the evidentiary quality of forensic analyses, particularly in evaluating injury severity, quantifying damage, and preparing medico-legal reports [49].

4. Discussion

3D virtual reconstruction introduces a profound transformation in the way criminal proceedings acquire, preserve, and interpret scientific evidence. Unlike traditional forms of documentation, which describe or depict events in a static manner, virtual reconstruction shows the event through highly immersive and dynamic models. This shift brings a new evidentiary language into the courtroom, one that is neither purely verbal nor simply documentary, as with conventional photography, but instead visual, spatial, and immersive, endowed with strong evocative and persuasive potential [50–52].

The use of virtual reconstruction thus combines three distinct dimensions:

- Scientific rigour, derived from advanced acquisition tools and precise data collection;
- Simulation capacity, allowing experts to reproduce and test alternative dynamics;
- Perceptual impact, which may significantly influence the cognitive processes of judges and factfinders.

Given this hybrid nature, virtual reconstruction cannot be assimilated either to traditional forms of evidence or to a mere illustrative aid. It requires its own evaluative framework and methodological safeguards.

Although virtual reconstruction originates from real and measurable data, it is inevitably shaped by a series of interpretative operations, algorithmic processing, geometric interpolation, modelling choices, and even manual corrections. This raises a fundamental epistemological question: does the reconstruction directly represent the data, or does it present an interpretation of the data?

According to authoritative legal doctrine, virtual reconstruction should be classified as interpretative scientific evidence, analogous to ballistic analysis or forensic pathology. It is based on empirical data but structured through technical hypotheses and inferential reasoning [53].

This interpretative nature exposes judges to the so-called “realism fallacy,” whereby visually detailed content is perceived as more truthful or accurate simply because it appears realistic. Yet aesthetic realism does not guarantee scientific validity. For this reason, the assessment of virtual reconstruction must rely on methodological transparency rather than the persuasive quality of the images produced.

From a legal standpoint, virtual reconstruction qualifies as atypical evidence under Article 189 of the Italian Code of Criminal Procedure. It is admissible insofar as it respects adversarial principles, is relevant to the case, and demonstrates sufficient scientific reliability. Italian courts generally accept 3D reconstructions when they are produced by qualified experts, accompanied by comprehensive methodological explanations, supported by original raw data, and not relied upon as the sole incriminating element.

For example, in a homicide case involving a firearm, the reconstruction may be used and admitted to clarify the shooting dynamics. In practice, a forensic ballistics expert digitally reconstructs the scene by indicating the positions of the victim and the defendant, as well as the possible bullet trajectories, based on objective data such as crime-scene measurements, cartridge case analysis, and autopsy reports.

The reconstruction is considered admissible only if the way it was constructed is clearly explained, the methodology is transparent and reproducible, the underlying data are available and verifiable, and it can also be independently reviewed by the defence.

Furthermore, research in cognitive psychology underscores the potential dangers of immersive visuals. Realistic images tend to be perceived as more credible, are more easily retained in memory, and produce an immersive effect that may reduce critical distance [50,54].

Therefore, the main critical issues are represented by: (a) the risk of visual suggestion, whereby high graphic realism may lead judges to overestimate the reliability of the recon-

struction, attributing to it a degree of veracity that is not fully supported by the underlying data; (b) dependence on software, as many elaborations rely on “black box” algorithms that are not fully accessible or externally verifiable, raising concerns regarding transparency and controllability of the reconstruction process [27,28]; (c) chain-of-custody problems, since altered, insufficiently documented, or inadequately protected files may expose digital evidence to risks of both accidental and intentional manipulation; and (d) the lack of Italian regulatory standards, as the Italian legal system still lacks a comprehensive framework governing digital evidence and 3D reconstructions, resulting in interpretative uncertainty and potential inconsistencies in judicial practice.

This is particularly problematic in criminal trials, where judges may be influenced by graphic quality rather than scientific substance, reconstructions may appear definitive even when hypothetical, and simulations may embed interpretative assumptions that are not explicitly disclosed.

To mitigate these risks, it is essential to distinguish between different types of reconstructions:

- Descriptive reconstructions, which faithfully document the spatial context;
- Demonstrative reconstructions, which visually support a technical explanation;
- Scenic or immersive reconstructions, which recreate the event in a highly realistic, narrative-like format.

Only the first two categories carry legitimate evidentiary value, whereas the third raises significant concerns regarding undue influence and potential bias.

The probative value of any virtual reconstruction depends on the transparency of its methodological workflow. Experts must provide access to raw data (such as point clouds, photographs, CT or MRI files), specify the software and versions employed, document data-cleaning procedures, articulate the reconstruction hypotheses adopted, and indicate margins of uncertainty. Without such documentation, the reconstruction cannot be independently verified and consequently loses scientific credibility.

Comparative legal systems offer useful guidance regarding the admissibility and evaluation of virtual reconstructions. In particular, they emphasize the need for methodological transparency, disclosure of the underlying data and software tools, documentation of all processing steps, assessment of error rates, and the possibility of independent review by opposing parties. These safeguards are intended to ensure that digital reconstructions remain scientifically reliable, reproducible, and compatible with the requirements of due process and adversarial proceedings [55–78].

In the United States, the Daubert standard requires that the potential for falsifiability should be known (and preferably, found to be absent or very low), and that the error rate is known (should be absent or very low), that the methodology be accepted within the scientific community, and that it have undergone peer review. 3D reconstructions are admitted as demonstrative evidence only when they satisfy these criteria [79,80]. Likewise, other jurisdictions require digital reconstructions to be comprehensively documented and capable of independent verification before they can be admitted as evidence in court.

In the United Kingdom, the Criminal Procedure Rules mandate that digital scientific evidence be produced by qualified experts, supported by a clear methodological explanation, and free from prejudicial bias [81].

Across Europe, ENFSI guidelines emphasize proper digital acquisition, rigorous documentation, and stringent chain-of-custody protocols.

Italy aligns with these principles but still lacks a specific normative framework regulating digital and 3D evidence. This regulatory vacuum results in heterogeneous judicial practices and interpretative inconsistencies. There is a clear need for national legislation to establish minimum standards for 3D acquisition, documentation requirements, criteria for admissibility, and mandatory training for judges, lawyers, and experts [34]. Such reforms

would promote uniformity, strengthen defence rights, reduce the risk of manipulation, and enhance the probative value of virtual reconstructions within criminal proceedings.

In fact, in the forensic medical field, the use of 3D photogrammetry and virtual reality would significantly improve the documentation and assessment of injuries compared to traditional photography. Their use would allow for more precise, repeatable, and verifiable measurements, support the objective quantification of biological and aesthetic damage, and enable subsequent reviews by other experts. Although slight differences in accuracy may exist between VR systems and dedicated software, these technologies could enhance transparency, reproducibility, and the evidentiary robustness of forensic medical analyses [82–84].

5. Conclusions

Virtual reconstruction represents one of the most significant transformations in the landscape of contemporary criminal evidence. It introduces a new mode of observing and analyzing events, combining technologically sophisticated data acquisition with highly impactful visual communication. This dual dimension, scientific and perceptual, reshapes traditional evidentiary paradigms and challenges long-standing assumptions about how facts are established in court.

The findings of this study indicate that 3D reconstruction possesses considerable probative potential. It enhances the clarity of expert explanations, facilitates dialogue between technical specialists and judges, and enables more transparent evaluation of competing hypotheses. At the same time, its use entails substantial risks: susceptibility to visual suggestion, reliance on opaque or proprietary software, and dependence on operator expertise. These vulnerabilities highlight the need for dedicated and coherent regulation, an area in which Italy continues to exhibit notable gaps.

More broadly, virtual reconstruction compels the legal system to reconsider several foundational concepts. It raises questions about the very meaning of procedural truth in an era where immersive simulations coexist with traditional testimony and documentary evidence. It reshapes the role of judges, who must now engage with highly technical materials and assess their reliability through appropriate methodological criteria. It also necessitates renewed attention to adversarial safeguards in digital contexts and prompts a re-evaluation of what qualifies as “scientific” evidence, shifting the focus from the persuasiveness of the visual outcome to the soundness of the underlying method.

Addressing these challenges requires legislative intervention. Italy urgently needs a comprehensive regulatory framework capable of governing the acquisition, processing, and use of 3D reconstructions in criminal proceedings. Such a framework should include:

- Technical standards, encompassing recognized protocols for 3D acquisition, certified or verifiable software systems, and mandatory documentation to ensure reproducibility;
- Interdisciplinary training, enabling judges, lawyers, and experts to acquire basic scientific literacy and competently evaluate digital evidence;
- Transparent admissibility criteria, ideally aligned with standards similar to the Daubert factors, to ensure methodological reliability;
- Harmonization with European guidelines, promoting stable adherence to ENFSI recommendations and fostering cross-jurisdictional consistency;
- Safeguards against visual suggestions, such as methodological warnings, explicit annotation of hypothetical elements, and cautious use of fully immersive or narrative-style reconstructions.

Virtual reconstruction is poised to become increasingly prevalent in criminal trials. Its future effectiveness will depend on the legal system’s capacity to maximize its scientific value, minimize distortive cognitive effects, and integrate it within a clear, transparent,

and methodologically rigorous regulatory framework. Only under these conditions can technological innovation genuinely serve the pursuit of justice.

6. Limitations

The present study presents some intrinsic limitations, particularly related to the nature of literature review and the omission of emerging critical issues. The assessment of the scientific reliability of 3D reconstructions is based exclusively on secondary sources without the production of original data or autonomous experimental analysis, which exposes it to risks of incompleteness: the available literature may not capture recent evolutions or unresolved controversies, such as discrepancies between theoretical protocols and practical applications. The study does not address emerging critical issues such as cybersecurity vulnerabilities in data acquisition. Such omissions suggest the need for future integrations with empirical analyses and interdisciplinary perspectives on digital security.

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References

1. Accredia. Accredia—L'Ente Italiano di Accreditamento. Available online: <https://accredia.it/> (accessed on 4 March 2026).
2. Catálogo Coletivo—Coleção. Available online: http://biblioteca2.senado.gov.br:8991/F/?func=item-global&doc_library=SEN01&doc_number=000515296 (accessed on 4 March 2026).
3. Capraro, L. Primi casi “clinici” in tema di prova neuroscientifica. *Process. Penale Giust. Riv. Dottrina Giurisprud.* **2012**, 95–103.
4. Giupponi, L. Scienza in Rete. Il Giudice, l'Esperto e il Paradosso della Prova Scientifica. 2013. Available online: <https://www.scienzainrete.it/contenuto/articolo/lisa-giupponi/giudice-lesperto-e-paradosso-della-prova-scientifica/marzo-2013-0> (accessed on 4 March 2026).
5. Cunha, R.R.; Arrabal, C.T.; Dantas, M.M.; Bassaneli, H.R. Laser scanner and drone photogrammetry: A statistical comparison between 3-dimensional models and its impacts on outdoor crime scene registration. *Forensic Sci. Int.* **2022**, 330, 111100. [[CrossRef](#)] [[PubMed](#)]
6. Marinelli, S.; De Paola, L.; Stark, M.; Montanari Vergallo, G. Artificial Intelligence in the Service of Medicine: Current Solutions and Future Perspectives, Opportunities, and Challenges. *Clin. Ter.* **2025**, 176, 77–82. [[CrossRef](#)] [[PubMed](#)]
7. Srivastava, A.; Sharma, V.; Krishan, K. Forensic applications of 3D printing—A review of literature, case studies and future implications. *Forensic Sci. Med. Pathol.* **2025**, 21, 1843–1854. [[CrossRef](#)] [[PubMed](#)]
8. Böven, J.; Boos, J.; Steuwe, A.; Morawitz, J.; Sawicki, L.M.; Caspers, J.; Küppers, L.; Hartung, B.; Thomas, C.; Antoch, G.; et al. Diagnostic value and forensic relevance of a novel photorealistic 3D reconstruction technique in post-mortem CT. *Br. J. Radiol.* **2020**, 93, 20200204. [[CrossRef](#)] [[PubMed](#)] [[PubMed Central](#)]
9. Kamnik, R.; Nekrep Perc, M.; Topolšek, D. Using the scanners and drone for comparison of point cloud accuracy at traffic accident analysis. *Accid. Anal. Prev.* **2020**, 135, 105391. [[CrossRef](#)] [[PubMed](#)]
10. Fedorova, A.S. Three-dimensional scanning of the objects of forensic medical expertise. *Sud. Med. Ekspert.* **2019**, 62, 43–45. [[CrossRef](#)] [[PubMed](#)]
11. Berezowski, V.; Mallett, X.; Moffat, I. Geomatic techniques in forensic science: A review. *Sci. Justice J. Forensic Sci. Soc.* **2020**, 60, 99–107. [[CrossRef](#)] [[PubMed](#)]
12. LABANOF. Available online: <https://www.labanof.unimi.it/> (accessed on 4 March 2026).
13. Polizia di Stato. La Polizia Scientifica. Available online: <https://www.poliziadistato.it/articolo/23433> (accessed on 4 March 2026).

14. ENFSI. 20 September 2016. Available online: <https://enfsi.eu/> (accessed on 4 March 2026).
15. Ismail, I.; Akram Zainol Ariffin, K. The admissibility of digital evidence from open-source forensic tools: Development of a framework for legal acceptance. *PLoS ONE* **2025**, *20*, e0331683. [[CrossRef](#)] [[PubMed](#)] [[PubMed Central](#)]
16. Ebert, L.C.; Nguyen, T.T.; Breitbeck, R.; Braun, M.; Thali, M.J.; Ross, S. The forensic holodeck: An immersive display for forensic crime scene reconstructions. *Forensic Sci. Med. Pathol.* **2014**, *10*, 623–626. [[CrossRef](#)] [[PubMed](#)]
17. Sun, J.; Wang, T.; Li, Z.D.; Shao, Y.; Zhang, Z.Y.; Feng, H.; Zou, D.H.; Chen, Y.J. Reconstruction of Vehicle-human Crash Accident and Injury Analysis Based on 3D Laser Scanning, Multi-rigid-body Reconstruction and Optimized Genetic Algorithm. *Fa Yi Xue Za Zhi* **2017**, *33*, 575–580. [[CrossRef](#)] [[PubMed](#)]
18. Zhang, X.; Li, S.D.; Yu, Y.G.; Zhang, F.; Zou, C.B.; Zou, Z.L.; Miao, Q.F.; Zhang, M.T.; Tang, L.J.; Li, D.R. Analysis of Driver-Passenger Relationship and Restoration of Accident Process Based on 3D Laser Scanning Technology. *Fa Yi Xue Za Zhi* **2020**, *36*, 69–71. [[CrossRef](#)] [[PubMed](#)]
19. Ebert, L.C.; Franckenberg, S.; Sieberth, T.; Schweitzer, W.; Thali, M.; Ford, J.; Decker, S. A review of visualization techniques of post-mortem computed tomography data for forensic death investigations. *Int. J. Leg. Med.* **2021**, *135*, 1855–1867. [[CrossRef](#)] [[PubMed](#)] [[PubMed Central](#)]
20. Edwards, H.; Shelmerdine, S.C.; Arthurs, O.J. Forensic post-mortem CT in children. *Clin. Radiol.* **2023**, *78*, 839–847. [[CrossRef](#)] [[PubMed](#)]
21. Joseph, T.I.; Girish, K.L.; Sathyan, P.; Kiran, M.S.; Vidya, S. Virtopsy: An integration of forensic science and imageology. *J. Forensic Dent. Sci.* **2017**, *9*, 111–114. [[PubMed](#)] [[PubMed Central](#)]
22. Zaami, S.; Napoletano, G.; Marinelli, E.; Sablone, S.; De Paola, L.; Introna, F. Post-COVID-19 Era Forensics: Hospital Autopsies, New Methodologies, and Medicolegal Perspectives. *Forensic Sci.* **2025**, *5*, 8. [[CrossRef](#)]
23. Alfsen, G.C.; Gulczyński, J.; Kholová, I.; Latten, B.; Martinez, J.; Metzger, M.; Michaud, K.; Pontinha, C.M.; Rakislova, N.; Rotman, S.; et al. Code of practice for medical autopsies: A minimum standard position paper for pathology departments performing medical (hospital) autopsies in adults. *Virchows Arch. Int. J. Pathol.* **2022**, *480*, 509–517. [[CrossRef](#)] [[PubMed](#)] [[PubMed Central](#)]
24. Yadukul, S.; Parmar, P.; Mada, P.; Reddy, D. Medico-legal autopsies after sunset: Ethical issues. *Indian J. Med. Ethics* **2023**, *8*, 224–225. [[CrossRef](#)] [[PubMed](#)]
25. Groß, D.; Wilhelmy, S. Clinical autopsies from a medical ethics perspective. *Pathologe* **2017**, *38*, 396–401. [[CrossRef](#)] [[PubMed](#)]
26. Delannoy, Y.; Becart-Robert, A.; Houssaye, C.; Pollard, J.; Cornez, R.; Tournel, G.; Gosset, D.; Hedouin, V. Body's integumentary restoration after autopsy: Legislative, technical and ethical issues. *Presse Med.* **2013**, *42*, 145–150. [[CrossRef](#)] [[PubMed](#)]
27. Wang, J.; Li, Z.; Hu, W.; Shao, Y.; Wang, L.; Wu, R.; Ma, K.; Zou, D.; Chen, Y. Virtual reality and integrated crime scene scanning for immersive and heterogeneous crime scene reconstruction. *Forensic Sci. Int.* **2019**, *303*, 109943. [[CrossRef](#)] [[PubMed](#)]
28. Sevillano Oriola, L.; Armentano Oller, N.; Martínez-Abadías, N. Virtual anthropology: Forensic applications to cranial skeletal remains from the Spanish Civil War. *Forensic Sci. Int.* **2022**, *341*, 111504. [[CrossRef](#)] [[PubMed](#)]
29. Piraianu, A.I.; Fulga, A.; Musat, C.L.; Ciobotaru, O.R.; Poalelungi, D.G.; Stamate, E.; Ciobotaru, O.; Fulga, I. Enhancing the Evidence with Algorithms: How Artificial Intelligence Is Transforming Forensic Medicine. *Diagnostics* **2023**, *13*, 2992. [[CrossRef](#)] [[PubMed](#)] [[PubMed Central](#)]
30. Godinho, R.M.; O'Higgins, P.; Gonçalves, C. Assessing the reliability of virtual reconstruction of mandibles. *Am. J. Phys. Anthropol.* **2020**, *172*, 723–734. [[CrossRef](#)] [[PubMed](#)]
31. Sieberth, T.; Dobay, A.; Affolter, R.; Ebert, L.C. Applying virtual reality in forensics—A virtual scene walkthrough. *Forensic Sci. Med. Pathol.* **2019**, *15*, 41–47. [[CrossRef](#)] [[PubMed](#)]
32. Urbanová, P.; Hejna, P.; Jurda, M. Testing photogrammetry-based techniques for three-dimensional surface documentation in forensic pathology. *Forensic Sci. Int.* **2015**, *250*, 77–86. [[CrossRef](#)] [[PubMed](#)]
33. Urbanová, P.; Jurda, M.; Vojtíšek, T.; Krajsa, J. Using drone-mounted cameras for on-site body documentation: 3D mapping and active survey. *Forensic Sci. Int.* **2017**, *281*, 52–62. [[CrossRef](#)] [[PubMed](#)]
34. Kottner, S.; Ebert, L.C.; Ampanozi, G.; Braun, M.; Thali, M.J.; Gascho, D. VirtoScan—A mobile, low-cost photogrammetry setup for fast post-mortem 3D full-body documentations in X-ray computed tomography and autopsy suites. *Forensic Sci. Med. Pathol.* **2017**, *13*, 34–43. [[CrossRef](#)] [[PubMed](#)]
35. Fukuda, H.; Nakazawa, T.; Shinjo, S.; Kominato, Y.; Tokue, H. Forensic Reconstruction of a Fatal Stair-Related Fall Using Postmortem CT, Photogrammetry, and Virtual Reality: A Case Report. *Cureus* **2025**, *17*, e81580. [[CrossRef](#)] [[PubMed](#)] [[PubMed Central](#)]
36. Napoletano, G.; Putrino, A.; Marinelli, E.; Zaami, S.; De Paola, L. Dental Identification System in Public Health: Innovations and Ethical Challenges: A Narrative Review. *Healthcare* **2024**, *12*, 1828. [[CrossRef](#)] [[PubMed](#)] [[PubMed Central](#)]
37. Carew, R.M.; Morgan, R.M.; Rando, C. A Preliminary Investigation into the Accuracy of 3D Modeling and 3D Printing in Forensic Anthropology Evidence Reconstruction. *J. Forensic Sci.* **2019**, *64*, 342–352. [[CrossRef](#)] [[PubMed](#)] [[PubMed Central](#)]
38. Chango, X.; Flor-Unda, O.; Gil-Jiménez, P.; Gómez-Moreno, H. Technology in Forensic Sciences: Innovation and Precision. *Technologies* **2024**, *12*, 120. [[CrossRef](#)]

39. Sieberth, T.; Meindl, M.; Sagmeister, B.; Franckenberg, S.; Ptacek, W. Cost-effective 3D documentation device in forensic medicine. *Forensic Sci. Int.* **2024**, *357*, 112005. [CrossRef] [PubMed]
40. Villa, C.; Lynnerup, N.; Jacobsen, C. A Virtual, 3D Multimodal Approach to Victim and Crime Scene Reconstruction. *Diagnostics* **2023**, *13*, 2764. [CrossRef] [PubMed] [PubMed Central]
41. Koller, S.; Ebert, L.C.; Martinez, R.M.; Sieberth, T. Using virtual reality for forensic examinations of injuries. *Forensic Sci. Int.* **2019**, *295*, 30–35. [CrossRef] [PubMed]
42. Piraino, M.; Beltrame, B.; Nigliaccio, S.; Fontana, D.; Argo, A.; D'Anna, T.; Zerbo, S.; Albano, G.D.; Messina, P.; Scardina, G.A. From evidence to proof: Case series application of 3d reconstructions in forensic analysis of dog bite injuries. *Leg. Med.* **2025**, *78*, 102718. [CrossRef] [PubMed]
43. Baier, W.; Warnett, J.M.; Payne, M.; Williams, M.A. Introducing 3D Printed Models as Demonstrative Evidence at Criminal Trials. *J. Forensic Sci.* **2018**, *63*, 1298–1302. [CrossRef] [PubMed]
44. Massini, F.; Ebert, L.; Ampanozi, G.; Franckenberg, S.; Benz, L.; Sieberth, T. Comparison of superficial wound documentation using 2D forensic photography, 3D photogrammetry, Botscan© and VR with real-life examination. *Forensic Sci. Med. Pathol.* **2021**, *17*, 422–430. [CrossRef] [PubMed] [PubMed Central]
45. Simon, G.; Tóth, D.; Heckmann, V.; Poór, V.S. Application of 3D printing in assessment and demonstration of stab injuries. *Int. J. Leg. Med.* **2022**, *136*, 1431–1442. [CrossRef] [PubMed] [PubMed Central]
46. Maksymowicz, K.; Kuzan, A.; Tunikowski, W. 3D reconstruction of events: Search for a spatial correlation between injuries and the geometry of the body discovery site. *Forensic Sci. Int.* **2024**, *357*, 111970. [CrossRef] [PubMed]
47. Sieberth, T.; Ebert, L.C.; Gentile, S.; Fliss, B. Clinical forensic height measurements on injured people using a multi camera device for 3D documentation. *Forensic Sci. Med. Pathol.* **2020**, *16*, 586–594. [CrossRef] [PubMed] [PubMed Central]
48. Luchowski, L.; Pojda, D.; Tomaka, A.A.; Skabek, K.; Kowalski, P. Multimodal Imagery in Forensic Incident Scene Documentation. *Sensors* **2021**, *21*, 1407. [CrossRef] [PubMed] [PubMed Central]
49. Jani, G.; Johnson, A. Virtual reality and its transformation in forensic education and research practices. *J. Vis. Commun. Med.* **2022**, *45*, 18–25. [CrossRef] [PubMed]
50. Vergallo, G.M.; Marinelli, S.; Napoletano, G.; De Paola, L.; Treglia, M.; Zaami, S.; Frati, P. 20 Years Since the Enactment of Italian Law No. 40/2004 on Medically Assisted Procreation: How It Has Changed and How It Could Change. *Int. J. Environ. Res. Public Health* **2025**, *22*, 296. [CrossRef] [PubMed] [PubMed Central]
51. Reichherzer, C.; Cunningham, A.; Walsh, J.; Kohler, M.; Billinghamurst, M.; Thomas, B.H. Narrative and Spatial Memory for Jury Viewings in a Reconstructed Virtual Environment. *IEEE Trans. Vis. Comput. Graph.* **2018**, *24*, 2917–2926. [CrossRef] [PubMed]
52. Porzionato, A.; Guidolin, D.; Emmi, A.; Boscolo-Berto, R.; Sarasin, G.; Rambaldo, A.; Macchi, V.; De Caro, R. High-quality Digital 3D Reconstruction of Microscopic Findings in Forensic Pathology: The Terminal Pathway of a Heart Stab Wound. *J. Forensic Sci.* **2020**, *65*, 2155–2159. [CrossRef] [PubMed]
53. Manuale delle Investigazioni Sulla Scena del Crimine. Available online: <https://www.giappichelli.it/manuale-delle-investigazioni-sulla-scena-del-crimine-9788892141117> (accessed on 4 March 2026).
54. Bombari, D.; Schmid Mast, M.; Canadas, E.; Bachmann, M. Studying social interactions through immersive virtual environment technology: Virtues, pitfalls, and future challenges. *Front. Psychol.* **2015**, *6*, 869. [CrossRef] [PubMed] [PubMed Central]
55. DECRETO LEGISLATIVO 28 Luglio 1989, n. 271—Normattiva. Available online: <https://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:decreto.legislativo:1989-07-28;271!vig=> (accessed on 4 March 2026).
56. LEGGE 15 Febbraio 1961, n. 83—Normattiva. Available online: <https://www.normattiva.it/uri-res/N2Ls?!vig=urn:nir:stato:legge:1961-02-15;83> (accessed on 4 March 2026).
57. La Costituzione—Articolo 27 | Senato della Repubblica. Available online: <https://www.senato.it/istituzione/la-costituzione/parte-i/titolo-i/articolo-27> (accessed on 4 March 2026).
58. La Costituzione—Articolo 111 | Senato della Repubblica. Available online: <https://www.senato.it/istituzione/la-costituzione/parte-ii/titolo-iv/sezione-ii/articolo-111> (accessed on 4 March 2026).
59. La Costituzione—Articolo 55 | Senato della Repubblica. Available online: <https://www.senato.it/istituzione/la-costituzione/parte-ii/titolo-i/sezione-i/articolo-55> (accessed on 4 March 2026).
60. La Costituzione—Articolo 134 | Senato della Repubblica. Available online: <https://www.senato.it/istituzione/la-costituzione/parte-ii/titolo-vi/sezione-i/articolo-134> (accessed on 4 March 2026).
61. Art. 189 Codice di Procedura Penale. Available online: <https://app.toga.cloud/codici/codice-di-procedura-penale/3/27779/art-189-prove-non-disciplinate-dalla-legge> (accessed on 4 March 2026).
62. Art. 190 Codice di Procedura Penale. Available online: <https://app.toga.cloud/codici/codice-di-procedura-penale/3/27780/art-190-diritto-alla-prova> (accessed on 4 March 2026).
63. Art. 190-Bis Codice di Procedura Penale. Available online: <https://app.toga.cloud/codici/codice-di-procedura-penale/3/27781/art-190-bis-requisiti-della-prova-in-casi-particolari> (accessed on 4 March 2026).

64. Art. 191 Codice di Procedura Penale. Available online: <https://app.toga.cloud/codici/codice-di-procedura-penale/3/27782/art-191-prove-illegittimamente-acquisite> (accessed on 4 March 2026).
65. Art. 192 Codice di Procedura Penale. Available online: <https://app.toga.cloud/codici/codice-di-procedura-penale/3/27783/art-192-valutazione-della-prova> (accessed on 4 March 2026).
66. Art. 233 Codice di Procedura Penale. Available online: <https://app.toga.cloud/codici/codice-di-procedura-penale/3/27826/art-233-consulenza-tecnica-fuori-dei-casi-di-perizia> (accessed on 4 March 2026).
67. Art. 360 Codice di Procedura Penale. Available online: <https://app.toga.cloud/codici/codice-di-procedura-penale/3/27969/art-360-accertamenti-tecnici-non-ripetibili> (accessed on 4 March 2026).
68. Art. 391-Novies Codice di Procedura Penale. Available online: <https://app.toga.cloud/codici/codice-di-procedura-penale/3/28011/art-391-novies-attivita-investigativa-preventiva> (accessed on 4 March 2026).
69. Art. 391-Sexies Codice di Procedura Penale. Available online: <https://app.toga.cloud/codici/codice-di-procedura-penale/3/28008/art-391-sexies-accesso-ai-luoghi-e-documentazione> (accessed on 4 March 2026).
70. Articolo 46—Tutela Diplomatica e Consolare | European Union Agency for Fundamental Rights. 2015. Available online: <https://fra.europa.eu/it/eu-charter/article/46-tutela-diplomatica-e-consolare> (accessed on 4 March 2026).
71. Pacini Editore: Codice di Procedura Penale—TITOLO I—DISPOSIZIONI GENERALI. Available online: <https://pacinieditore.xligo.com/documento/it/documentazione/stato/codice.procedura.penale/art187/comma1?v=2026-03-02> (accessed on 4 March 2026).
72. LII/Legal Information Institute. Rule 102. Purpose. Available online: https://www.law.cornell.edu/rules/fre/rule_102 (accessed on 4 March 2026).
73. LII/Legal Information Institute. Rule 401. Test for Relevant Evidence. Available online: https://www.law.cornell.edu/rules/fre/rule_401 (accessed on 4 March 2026).
74. LII/Legal Information Institute. Rule 402. General Admissibility of Relevant Evidence. Available online: https://www.law.cornell.edu/rules/fre/rule_402 (accessed on 4 March 2026).
75. LII/Legal Information Institute. Rule 403. Excluding Relevant Evidence for Prejudice, Confusion, Waste of Time, or Other Reasons. Available online: https://www.law.cornell.edu/rules/fre/rule_403 (accessed on 4 March 2026).
76. LII/Legal Information Institute. Rule 702. Testimony by Expert Witnesses. Available online: https://www.law.cornell.edu/rules/fre/rule_702 (accessed on 4 March 2026).
77. LII/Legal Information Institute. Rule 703. Bases of an Expert. Available online: https://www.law.cornell.edu/rules/fre/rule_703 (accessed on 4 March 2026).
78. Canzio, d.G. *Prova Scientifica, Ricerca Della "Verità" e Decisione Giudiziaria nel Processo Penale*; Giuffrè Francis Lefebvre: Milan, Italy, 2005.
79. Mnookin, J. Science, justice, and evidence. *Science* **2023**, 382, 741. [[CrossRef](#)] [[PubMed](#)]
80. Murrie, D.C.; Gardner, B.O.; Kelley, S.; Dror, I.E. Perceptions and estimates of error rates in forensic science: A survey of forensic analysts. *Forensic Sci. Int.* **2019**, 302, 109887. [[CrossRef](#)] [[PubMed](#)]
81. Pretty, I.A. The barriers to achieving an evidence base for bitemark analysis. *Forensic Sci. Int.* **2006**, 159, S110–S120. [[CrossRef](#)] [[PubMed](#)]
82. Carew, R.M.; Errickson, D. An Overview of 3D Printing in Forensic Science: The Tangible Third-Dimension. *J. Forensic Sci.* **2020**, 65, 1752–1760. [[CrossRef](#)] [[PubMed](#)]
83. Feola, A.; Mizio, G.D.; Sala, F.L.; Giordano, C.; Pietra, B.D. Crime scene investigation and dynamic reconstruction: Importance of synergic collaboration between forensic pathology and digital reconstruction for work-related fatalities. *Soud. Lek.* **2021**, 57, 2–5. [[PubMed](#)]
84. Carew, R.M.; French, J.; Morgan, R.M. 3D forensic science: A new field integrating 3D imaging and 3D printing in crime reconstruction. *Forensic Sci. Int. Synerg.* **2021**, 3, 100205. [[CrossRef](#)] [[PubMed](#)] [[PubMed Central](#)]

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