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High-Tech View: The Use of Immersive Virtual Environments in Jury Trials

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HIGH-TECH VIEW: THE USE OF IMMERSIVE VIRTUAL ENVIRONMENTS IN JURY TRIALS

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> You've got to be careful if you don't know where you're going 'cause you might not get there!
>
> Yogi Berra[1]

I. INTRODUCTION

A trial, at its essence, is a process through which attorneys re-create the image of a real-life event or circumstance and apply to the resulting factual picture certain rules of law. Traditionally, during trial, abstract factual material, such as material relating to state of mind, authority, responsibility, or cause and effect, has been expressed verbally, through witness testimony, rather than visually. Increasingly, however, as technology has progressed, graphic images have played a greater role in communicating this information that was traditionally imparted by words alone.[2]

Much has been written on a variety of legal issues stemming from the advancement of virtual-reality (VR) technology,[3] from the rights of players,

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1. THE YOGI BOOK: "I REALLY DIDN'T SAY EVERYTHING I SAID!" 102 (1998).

2. According to a University of California study, in 1999, 93% of all information generated was generated in digital form on computers, rather than in other media, like paper. *See In re* Bristol-Myers Squibb Sec. Litig., 205 F.R.D. 437, 440 n.2 (D.N.J. 2002).

3. *See, e.g.*, BENJAMIN TYSON DURANSKE, VIRTUAL LAW 4 (2008). "Virtual reality" generally refers to the interface between the user and the computer-based simulated environment. *Id.* The term "virtual reality" was coined by Jaron Lanier. *See* Jaron Lanier, *Virtually There*, SCI. AM., Apr. 2001, at 66, 68.

users, and avatars in virtual worlds,[4] end-user license agreements and terms of service,[5] virtual property and contract rights,[6] intellectual property law and virtual worlds,[7] suing fictitious defendants in virtual worlds,[8] virtual torts,[9] virtual crimes,[10] virtual privacy rights,[11] the taxation of virtual currency,[12] and freedom of expression in virtual reality,[13] to the reliability and authenticity of evidence collected in a virtual world[14] and the authenticity and admissibility of digital evidence.[15] This Article attempts to address a different question: whether immersive-virtual-environment (IVE) technology[16] could be designed for and used during a jury trial.[17]

The benefit of using visual media in a jury trial is that, unlike words in witness testimony, visual media are a richer means of communication, which permit multiple coded items of information to be transmitted and absorbed at one time and result in a direct image being transmitted through associations to a jury.[18] Visual media can furnish an avenue of continual communication by

4. DURANSKE, *supra* note 3, at 23–26.

5. *Id.* at 27–30.

6. *Id.* at 117–37.

7. *Id.* at 139–62.

8. *Id.* at 166–67.

9. *Id.* at 177–79.

10. *Id.* at 197–207.

11. *Id.* at 211–12.

12. *Id.* at 225–40.

13. *See generally* Marc Jonathan Blitz, *The Freedom of 3D Thought: The First Amendment in Virtual Reality*, 30 CARDOZO L. REV. 1141 (2008) (discussing the First Amendment implications of virtual reality).

14. DURANSKE, *supra* note 3, at 52–54.

15. *See* GEORGE L. PAUL, FOUNDATIONS OF DIGITAL EVIDENCE 14–15 (2008).

16. For a primer on the definition and types of IVE technology, see generally Jeremy N. Bailenson et al., *Courtroom Applications of Virtual Environments, Immersive Virtual Environments, and Collaborative Virtual Environments*, 28 LAW & POL'Y 249 (2006).

17. Several commentators have also written about the admissibility of computer-generated animations, which are, in a sense, a type of VR, but which employ fixed, rather than interactive, immersive virtual environments. *See, e.g.*, I. Neel Chatterjee, *Admitting Computer Animations: More Caution and New Approach Are Needed*, 62 DEF. COUNS. J. 36 (1995); Kathlynn G. Fadely, *Use of Computer-Generated Visual Evidence in Aviation Litigation: Interactive Video Comes To Court*, 55 J. AIR L. & COM. 839 (1990); Dean A. Morande, *A Class of Their Own: Model Procedural Rules and Evidentiary Evaluation of Computer-Generated "Animations,"* 61 U. MIAMI L. REV. 1069 (2007).

18. *See generally* ELIZABETH F. LOFTUS & JAMES M. DOYLE, EYEWITNESS TESTIMONY: CIVIL AND CRIMINAL (3d ed. 1997) (discussing jurors' beliefs on eyewitness testimony and factors determining perception); ELIZABETH LOFTUS & KATHERINE KETCHAM, WITNESS FOR THE DEFENSE 14–30 (1991) (documenting the "Magic of the Mind"); EYEWITNESS TESTIMONY: PSYCHOLOGICAL PERSPECTIVES (Gary L. Wells & Elizabeth Loftus eds., 1984) (documenting how word choice and the use of images effect how juries perceive information); Stephen M. Kosslyn et al., *Visual Images Preserve Metric Spatial Information: Evidence from Studies of Image Scanning*, 4 J. EXPERIMENTAL PSYCHOL.: HUM. PERCEPTION & PERFORMANCE 47, 57–59 (1978) (finding that human subjects scanned a mental image of an object in their minds in the same manner and at roughly the same

a party with the jury. Visual media are also infinitely faster, more efficient, and more accurate than merely verbal presentations.[19] Visual media can be far more potent and persuasive than other types of evidence.[20] Studies show that jurors recollect approximately 85% of what they see but only 15% of what they hear.[21]

VR technology, and more specifically IVE, is one such type of visual media. An IVE is an artificial, interactive, computer-created scene or "world" within which a user can immerse herself.[22] IVEs combine high-resolution, stereoscopic projection and three-dimensional computer graphics to create a complete sense of presence in a virtual environment.[23] IVEs consist of immersion in an artificial environment in which the users feel just as perceptually surrounded as they do in "reality."[24] IVEs produce a simulated

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speed that they scanned the original visual object).

19. *See* Robert F. Seltzer, *Evidence and Exhibits at Trial*, *in* PRACTISING LAW INST., PREPARATION & TRIAL OF A TOXIC TORT CASE 1990, at 371, 373 (1990); Robert Seltzer, *Effective Communication: Seeing Is Believing*, *in* PRACTISING LAW INST., PRODUCT LIABILITY OF MANUFACTURERS 1988, at 597, 599 (1988).

20. *See, e.g.*, Scott v. Harris, 550 U.S. 372, 383–86 (2007) (holding that a police officer did not violate the Fourth Amendment when he deliberately rammed his patrol car into that of a fleeing motorist, paralyzing him, during a high-speed chase, and finding that the officer's use of deadly force was justified by the risk that the motorist's driving posed based largely on a video of the chase recorded by a dashboard camera in the officer's car); Dan M. Kahan et al., *Whose Eyes Are You Going to Believe?* Scott v. Harris *and the Perils of Cognitive Illiberalism*, 122 HARV. L. REV. 837, 842 (2009) (finding that video evidence creates a danger of "decisionmaking hubris" in court proceedings). *But see* Maryanne Garry & Matthew P. Gerrie, *When Photographs Create False Memories*, 14 CURRENT DIRECTIONS IN PSYCH. SCI. 321, 322–23 (2005) (arguing that text can be as, if not more, powerful than images because text allows an individual to actively elaborate on details about the words, while images permit an individual to passively absorb details).

Japanese roboticist Mori cautioned in a 1970 essay about the danger of creating human-like robots. Jun'ichiro Seyama & Ruth S. Nagayama, *The Uncanny Valley: Effect of Realism on the Impression of Artificial Human Faces*, 16 PRESENCE: TELEOPERATORS & VIRTUAL ENVIRONMENTS 337, 337 (2007). Mori created a graph that illustrates viewer responses to robots as they become more human-looking. *Id.* at 338. His chart shows that, as robots become more human-looking, there is a point at which "they stop being likeable and instead become eerie, frightening, repulsive—'uncanny.'" Tom Geller, *Overcoming the Uncanny Valley*, 28 IEEE COMPUTER GRAPHICS & APPLICATIONS 11 (2008). At this point, the viewer's sensation becomes uneasy, and the human response dips into "the uncanny valley." *Id.* For an in-depth and thorough analysis of the uncanny valley, see Tom Geller's article on overcoming the valley. *Id.*; *see also* John Mangan, When Fantasy Is Just Too Close for Comfort, Age on the Web, June 10, 2007, http://www.theage.com.au/news/entertainment/when-fantasy-is-just-too-close-for-comfort/2007/06/09/1181089394400.html?page=fullpage (discussing the uncanny valley, animation, and film). Once the robot's appearance becomes perfectly human-looking, the viewer's response increases and is no longer in the uncanny valley. *See* Geller, *supra*, at 12.

21. *See* Seltzer, *Evidence and Exhibits at Trial*, *supra* note 19, at 373; Seltzer, *Effective Communication*, *supra* note 19, at 599.

22. *See* Bailenson et al., *supra* note 16, at 251–53.

23. *See id.*

24. *See id.*

yet interactive reality in real time, which can support spatialized sound and virtual touch.[25] In an IVE, a participant's awareness of physical self is diminished or lost by being surrounded in the engrossing total artificial environment.[26] Common examples of IVEs are certain computer games, training programs such as flight and driving simulators, and immersive and interactive art installations.[27]

One advantage of VR technology is that it enables a litigant, before the jury, to simulate a particular experience, demonstrate and test subjective perspective,[28] and probe the structure and capacity of memory by manipulating assumptions about variables like sequence and spatial relationships.[29] As has been previously documented, VR technology can be designed for use in the courtroom, to re-create crime scenes, impeach the testimony of unreliable witnesses, test assertions, and enhance a jury's understanding of disputed events in computer-based simulated environments.[30] Because IVEs are digital, their data can be stored indefinitely, making it possible for courts to archive VR models to create a database of reusable locations and individuals.[31]

The power of an IVE, however, can be a double-edged sword. On the one hand, an IVE could equip a jury with a better understanding of the material facts at issue. On the other hand, the immersive, interactive, and fluid character of an IVE gives rise to a risk of manipulation or undue influence upon the jury, which may be swept up in the experiential nature of VR.[32] Because VR models project an image of certainty and completeness through

25. *See id.* at 251.

26. *See id.* at 251–53.

27. *See id.* at 251–54.

28. *See id.* at 254–58.

29. *See id.* The user, in this case a juror, enters the IVE by using an "avatar," which is a visual representation of herself that can interact with other users and the environment. DURANSKE, *supra* note 3, at 7.

30. *See supra* note 18 and accompanying text.

31. *See* Bailenson et al., *supra* note 16, at 251.

32. *See id.* at 263–64; *cf.* Lloyd P. Rieber, *Animation, Incidental Learning, and Continuing Motivation*, 83 J. EDUC. PSYCHOL. 318, 326 (1991) (finding that individuals not only remember and learn effectively from computer animation, they also assume information beyond what animations purport to teach). However, it could result instead in the "Christmas tree phenomenon," i.e., jurors will be so dazzled by the "pretty lights" of a new visual technology that they will not adequately consider the other evidence explaining or contradicting it. *See* Neal Feigenson, *Brain Imaging and Courtroom Evidence: On the Admissibility and Persuasiveness of fMRI*, *in* LAW, MIND, AND BRAIN 23, 42 (Michael Freeman & Oliver R. Goodenough eds., 2009).

Some commentators argue that depictions from certain angles can present a biased view of an event because the visual images from multiple perspectives leave less time for analysis of each individual event and present a quality of liveness that may not depict all relevant facets of the accompanying testimony. *See* KENNETH B. HUGHES & BENJAMIN J. CANTOR, PHOTOGRAPHS IN CIVIL LITIGATION 206 (1973).

the clarity of their representations, they can create a distorted aura of reliability for a jury.

The use of an IVE during a jury trial could have profound implications for the manner in which lawyers present facts during trial. An IVE could be a powerful alternative approach to recreating scenes (the configuration of streets, driveways, buildings), episodes or events (appearances, sizes, and shapes), and abstract factual material (trends, relationships) as visual images rather than as strings of spoken or written text.[33] For example, in an IVE, jurors could view a crime scene or the scene of an accident from the perspective of a witness or a party and manipulate the digital assets to test the credibility of that perspective.[34] By using an IVE during cross-examination, an attorney could illustrate for the jury the limitations of a witness's capacity to have observed the events about which he is testifying.

In general, trial courts enjoy a great deal of latitude in admitting demonstrative evidence and controlling the form and manner of its presentation,[35] and the rules of evidence apply to VR evidence in the same way that they apply to other types of evidence. It is the foundation for the admission of VR evidence that may be different.[36] There is little question that a party could introduce a fixed VR simulation in evidence, as demonstrative evidence or an illustrative aide,[37] as long as such party could make the

33. Cognitive-science literature suggests that human beings have the ability to retain no more than a few pieces of information in their short-term memories. *See, e.g.*, George A. Miller, *The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information*, 63 PSYCHOL. REV. 81, 86 (1956). The volume of information that an individual can recall, therefore, is largely a function of the size and content of the individual pieces. *See id.*

34. Bailenson et al., *supra* note 16, at 256–58. Such technology is already being developed. *See, e.g.*, Celeste Biever, Courtrooms Could Host Virtual Crime Scenes, NewScientist, Mar. 10, 2005, http://www.newscientist.com/article.ns?id=dn7130&print=true (describing new software, instant Scene Modeler, that can re-create an interactive, three-dimensional virtual crime scene from a few hundred frames of a scene captured by a special video camera).

35. *See* FED. R. EVID. 611(a) (directing courts to exercise reasonable control over the mode of presentation of evidence to make the presentation effective for the ascertainment of the truth and to avoid needless consumption of time); Meurling v. County Transp. Co., 230 F.2d 167, 168 (2d Cir. 1956); State v. Feaster, 716 A.2d 395, 436 (N.J. 1998).

36. *See generally* PAUL, *supra* note 15.

37. There are two primary conceptual classes of trial demonstrations: (1) demonstrative materials that are admitted as substantive evidence to prove a fact in the case, and (2) illustrative aids to testimony ("chalks"). *See* Morande, *supra* note 17, at 1072–73. Demonstrative exhibits are objects that directly convey relevant information from or of themselves—for example, a crime scene photograph. Illustrative aids are visual representations of a witness's testimony, which do not themselves provide bases for inferences, but merely facilitate the conveying of information by the witness, who is the true source of the information—for example, a witness's illustration of the crime scene drawn to assist the jury in following the witness's testimony about directions, distances, and relative positions. *See id.* Demonstrative or illustrative evidence may be evidence that replicates the original physical evidence, demonstrates some matter material to the case, or illustrates specific aspects of an expert's opinion testimony. *Id.* Demonstrative evidence must satisfy specific tests of

necessary foundational showing of authenticity, relevancy, and reliability prior to its admission into evidence.[38] The more interesting question, and the subject of this Article, is whether the rules of evidence permit either a party or the court itself to employ an IVE during a jury trial—in other words, to permit the jurors to don VR gear and enter an *immersive* simulation of the scene of a crime or accident.[39]

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admissibility (such as relevancy and authenticity), but, once in evidence, it can be directly relied upon by the jury. *See* FED. R. EVID. 104. To use a VR model as demonstrative evidence, a litigant would have to establish its accuracy and trustworthiness. *See* United States v. De Georgia, 420 F.2d 889, 893 n.11 (9th Cir. 1969):

> While . . . it is immaterial that the business record is maintained in a computer rather than in company books, this is on the assumption that: (1) the opposing party is given the same opportunity to inquire into the accuracy of the computer and the input procedures used, as he would have to inquire into the accuracy of written business records, and (2) the trial court, as in the case of challenged business records, requires the party offering the computer information to provide a foundation therefor sufficient to warrant a finding that such information is trustworthy.

Id.; *see also* 14 AM. JUR. 2D PROOF OF FACTS § 17 (1977) ("The most common reason that courts have rejected computerized evidence is that an insufficient foundation was laid to show the accuracy and trustworthiness of the evidence.").

38. *See, e.g.*, Commonwealth v. Serge, 896 A.2d 1170, 1176 (Pa. 2006) (permitting the Commonwealth to present a computer-generated animation as demonstrative evidence to illustrate the expert opinions of its forensic pathologist and crime scene reconstructionist as to how a fatal shooting allegedly occurred as long as the Commonwealth was able to properly authenticate its animated exhibit as a fair and accurate depiction of its experts' reconstruction of the relevant crime and the final version of the videotape animation did not include any inflammatory features that could cause unfair prejudice).

39. There are two ways that a jury could enter an IVE simulating the scene—through a court-appointed expert or through an expert witness retained by one or more of the parties to the case to construct an IVE and testify to sufficient foundation prior to "publishing" the IVE to the jury. Trial courts have the discretion to appoint their own, impartial experts. *See* FED. R. EVID. 614 (permitting the court to call and interrogate witnesses); FED. R. EVID. 706 (codifying the court's inherent authority to appoint expert witnesses of its own selection on its own motion); Reilly v. United States, 863 F.2d 149, 154–56 (1st Cir. 1988) (recognizing that trial courts have the inherent authority to appoint technical advisors to assist them); Danville Tobacco Ass'n v. Bryant-Buckner Assocs., 333 F.2d 202, 208 (4th Cir. 1964) (recognizing the inherent power of a trial court to appoint an expert of its own choosing); Scott *ex rel.* Scott v. Spanjer Bros., 298 F.2d 928, 929–30 (2d Cir. 1962) (same); Commonwealth v. Correa, 648 A.2d 1199, 1201 n.2 (Pa. Super. Ct. 1994) (holding that the trial court had inherent authority to appoint an expert); 3 CHRISTOPHER B. MUELLER & LAIRD C. KIRKPATRICK, FEDERAL EVIDENCE § 367 (2d ed. 1994); CIVIL TRIAL PRACTICE STANDARDS § 6 (2007) (recognizing that trial judges have the inherent authority to appoint expert technical advisors and witnesses) [hereinafter ABA STANDARDS]. Provisions governing the appointment of court experts comparable to those contained in the Federal Rules of Evidence exist in most states. *See, e.g.*, PA. R. EVID. 614 (permitting the court to call and interrogate witnesses); PA. R. EVID. 706 (delineating the procedure that a court must follow if it appoints an expert witness). If the court appoints its own VR expert, it could permit the parties to provide information to its VR expert for use in constructing the IVE. *See* ABA STANDARDS, *supra*, § 6(d) (suggesting guidelines for communication between parties and a court-appointed expert).

The immersive nature of IVEs can seem foreign in the context of the American adversary judicial system. Nonetheless, the use of an IVE during trial is not without precedent; in fact, it is probably inevitable. IVEs fit within the traditional framework of jury trials in two primary and interrelated ways: first, as the next step in technological development of visual media that began with drawings and photographs and has progressed to videotape and computer animations and simulations, and second, as an improved, but functional equivalent, of a jury scene-viewing.

This Article makes both empirical and normative claims about the admissibility of IVE evidence during a jury trial. The empirical claim is that IVE evidence will inevitably enter the American courtroom; the normative one is that this inevitable entrance is a positive development for the jury's search for truth. To the extent that courts have been hesitant to admit VR evidence in jury trials, such hesitance is likely the result of institutional resistance to new technology.[40]

Parts II, III, and IV of this Article explore concerns relating to the accuracy, reliability, and authenticity of, and potential for distortion within, IVEs under the substantial-similarity test that most courts employ in determining whether demonstrative evidence is unduly prejudicial or misleading, the best evidence rule as it relates to digital re-creations of real-life objects, and the traditional methods of authentication, respectively.

Part V explores the foundational requirements for expert testimony and scientific evidence. It argues that, while the digital projections created by an IVE are not perfectly realistic representations of the objects that they seek to re-create, nonetheless, an IVE can be a fair and accurate representation of the scene that it represents, as long as an expert witness could lay the appropriate foundation to show that the IVE was reliable and accurate enough that its probative value would outweigh its inherent risks of distortion. It argues that VR experts need to validate scientifically the consistency and reproducibility of IVE methodology and results and that attorneys seeking to use IVEs during trial must work to fit them within the strictures of the rules of evidence. Specifically, this Part argues that a proponent of expert testimony based upon VR technology, particularly a proponent wanting the jury to enter an IVE, would need to lay the necessary foundation to establish the following: (1) the IVE was relevant to a material dispute in the case (e.g., the vantage point of an eyewitness or a party); (2) the field of IVE generally, and the expert witness's IVE protocols in particular, were generally accepted among the relevant scientific community, presumably computer experts; (3) the expert

40. *See* H.D. Wendorf, *Some Views on Jury Views*, 15 BAYLOR L. REV. 379, 385–87 (1963) (describing the "legalistic inertia" and "anti-newness" that led courts in Texas to resist the institution of the jury view).

witness could demonstrate an ability to produce reliable and accurate IVEs without significant distortion; and (4) the IVE protocols and their accuracy had been scientifically validated and subjected to peer review, and there was some meaningful way to define and measure error within the IVEs created.

Part VI argues that permitting a jury to enter and interact within an IVE is not without precedent in the American legal system. It points out that most American jurisdictions have historically permitted juries to visit the scene of a crime or accident in the middle of trial as part of their factual inquiry, even though the scene that the jury views is no longer in the same state that it was in at the time of the events in question, as long as the scene remains in a substantially similar state as at the time of the alleged crime or accident. This Part notes that, despite clear distortions in the scenes of crimes and accidents that occur between the events at issue and the trial, the common law recognizes that the probative value of an on-site view of the scene outweighs the potential undue prejudice or jury confusion that may result from an imperfect replication of the scene and leaves to argument by the parties the weight that the jury should place on the imperfections.

Part IV also argues that an IVE created to simulate the scene of a crime or accident so that the jury could virtually view it could be a more accurate way to reconstruct the scene than a live jury viewing, since the IVE could simulate the time of day and presence of physical evidence in a way that the actual scene, stripped of much of its material evidence prior to jury viewing, could not. This Part analogizes the use of an IVE to reconstruct a crime scene to the introduction of crime scene photographs into evidence and argues that, if an IVE can re-create a scene that is more accurate than photographs taken at a later time or under different circumstances than those present at the time of the events in question, such evidence is more helpful to a jury than photographic evidence or a live viewing of the scene. It argues that there is no reason why IVE technology should be subjected to any different or more strenuous thresholds for admissibility than any other representational medium.

Part VII discusses the use of expert witnesses and IVEs to reconstruct crime scenes during criminal trials. It argues that, in the context of a criminal case, there are two additional advantages that an IVE re-creation of a crime scene would have over an actual jury viewing or other representational evidence: (1) an IVE could be controlled in a way that could eliminate certain Federal Rule of Evidence (Rule) 403 concerns without diminishing the probative value of the evidence, and (2) the use of an IVE representing the events in question could provide a vehicle for a criminal defendant to introduce evidence of, and permit the jury to test, her version of events without having to waive her Fifth Amendment privilege against self-incrimination.

II. RULE 403 AND THE SUBSTANTIAL-SIMILARITY TEST

Digital projections in an IVE are not perfectly realistic representations of the objects and events that they seek to re-create.[41] VR models are created based upon witnesses' observations of what happened, and those baseline assumptions within the model may or may not be made explicit.[42] Two different VR models built upon two different sets of assumptions about a material fact can produce two different outcomes.[43] VR models can also permit people to view and navigate a scene in ways not possible in the physical world—for example, by "teleporting," flying, or walking through walls.[44]

One concern with using an IVE with a jury would be whether the IVE would be misinterpreted by, or inappropriately persuasive to, lay jurors. This concern arises for at least two reasons. First, VR models can look deceptively like photographs of the scenes that they depict. Media theorists refer to this phenomenon as the appeal of *transparency*.[45] Cognitive and social psychologists refer to it as *naive realism*: the compelling impression that one has unmediated access to objective reality.[46] IVEs may be convincing as evidence because of their ability to induce epistemic confusion—they suggest that the jury is looking directly at the scene of the crime or accident. In other words, IVEs have been remediated to a familiar medium (photography) that jurors are already accustomed to seeing through directly to reality.

Second, IVEs could be uniquely persuasive to jurors because of their status as *scientific* models. An IVE representing the scene of a crime or accident appears as a mechanized, computerized, and, therefore, objective

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41. Bailenson et al., *supra* note 16, at 262. Of course, photographs, long admitted as accurate representations of the objects whose image they capture, are not perfect representations of those images either. *Id.* at 259.

42. *Id.* at 258. There are two philosophies on building IVE models. The first, the "top-down" approach, is to take multiple photographs of a scene from different angles and use software that can "stitch" them together to provide a seamless representation of the scene and calculate depth from algorithms that take into account the distances between objects seen from different angles. The second, the "bottom-up" approach, is to build each object in the virtual scene individually—for example, the car, the tire, the floor of the alley, each bystander.

43. Sometimes it may not be possible to have ground truth of what a scene looked like—for example, if lighting, weather, or traffic patterns are different from day to day.

44. There are ways to "lock" these features and ensure that individuals immersed in the IVE do not deviate from a human perspective by using processes like collision detection (which prohibits virtual individuals in an IVE from walking through physical objects). *See* Bailenson et al., *supra* note 16, at 251 (stating that an IVE can track a person's actual movements).

45. *See* JAY DAVID BOLTER & RICHARD GRUSIN, REMEDIATION: UNDERSTANDING NEW MEDIA (1999).

46. *See* Robert J. Robinson et al., *Actual Versus Assumed Differences in Construal: "Naive Realism" in Intergroup Perception and Conflict*, 68 J. PERSONALITY & SOC. PSYCHOL. 404, 404 (1995).

(i.e., highly reliable) segment of scientific knowledge. In addition, an IVE is a mathematized entity, the visual representation of a series of computerized measurements and computations. The impact of IVEs derives, therefore, from IVEs' similarity to other symbols of scientific truth in society at large.

Another concern with using an IVE with a jury would be whether the medium itself would unfairly distort the message that the witnesses were endeavoring to communicate, by engendering inferences that were not supported by witness testimony because of the assumptions on which the VR models were based. IVE technology, in particular, has the innate power to appeal to a jury's emotional and subconscious processes because of its ability to use symbolic patterns that convey powerfully ingrained psychological messages that are altogether different from the purported purpose of the aid. Psychologists have also documented phenomena such as virtual-source monitoring confusion, in which virtual memories become real.[47] A recent study has shown, for example, that children form false memories very quickly in VR worlds.[48]

These concerns with persuasive distortion increase with the sophistication of the medium in question, particularly in a computerized medium such as IVE technology, because of the increased probability that a jury would lend more credibility to an impressive IVE because of VR's artificial sensation of precision and certainty—for example, by assuming that an IVE was to scale when it was not[49] or drawing conclusions based upon the positioning, path, speed, and reaction times of the objects portrayed.[50] Because of these risks of unfairness and inaccuracy, the most significant evidentiary barrier to the use of an IVE during a jury trial would be the overarching dictate of Rule 403,[51] and the substantial-similarity requirement.[52]

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47. *See* Hunter G. Hoffman et al., *Virtual Reality Monitoring: Phenomenal Characteristics of Real, Virtual, and False Memories*, 4 CYBERPSYCHOL. & BEHAV. 565, 566 (2001).

48. *See generally* Kathryn Y. Segovia & Jeremy N. Bailenson, *Virtually True: Children's Acquisition of False Memories in Virtual Reality*, 12 MEDIA PSYCHOL. 371 (2009), *available at* http://www.informaworld.com/smpp/content~content=a917321633~db=all~jumptype=rss.

49. Much has been written in the VR field on the issue of "distance perception"—the concept that individuals consistently misperceive distances even when they are modeled to scale. *See generally* EDWARD T. HALL, THE HIDDEN DIMENSION (1966). Because of this chronic misperception, some VR experts advocate the need to make virtual distances greater than real distances in order for VR users to accurately perceive the real distances psychologically. *See, e.g.*, Bly v. Arkansas, 593 S.W.2d 450, 456 (1980).

50. *But see Bly*, 593 S.W.2d at 456 (finding no error in the admission into evidence of a crime scene investigator's diagrams and sketches of the scene, even though they were not drawn to scale, reasoning that "[o]bviously, this was of assistance to the witnesses in offering their testimony and probably aided the jury in understanding what the witness was saying") (citations omitted).

51. Rule 403 states: "Although relevant, evidence may be excluded if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury, or by considerations of undue delay, waste of time, or needless presentation of cumulative

The case of *Cartier v. Jackson*[53] exemplifies the concerns that courts often have with demonstrative exhibits that are imperfect representations of material facts. Cartier was a singer-songwriter who alleged that Michael Jackson's song "Dangerous" infringed on the copyright of her earlier song by the same name.[54] Cartier retained a recording engineer to produce comparison tapes, which extracted portions from each version of "Dangerous."[55] The tempo of the excerpts from Jackson's version of the song was slowed on the comparison tapes, and the key of the excerpts was changed to accommodate the slowing.[56] The tape also looped back on themselves musical phrases that were not repeated in the original song and spliced together parts of the choruses that were not adjacent in the originals.[57] Without citing a specific rule of evidence, the district court excluded Cartier's evidence, concluding that the comparison tapes did not "fairly and accurately depict[] the original."[58] Upholding the exclusion of the evidence on appeal, the United States Court of Appeals for the Tenth Circuit interpreted the district court's ruling as a finding that the recordings could have misled the jury under Rule 403 and found that such ruling was not an abuse of discretion because "the changes made to the songs in these recordings were so significant that the tapes no longer represented the songs in question in this case."[59]

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evidence." FED. R. EVID. 403. In any trial, the trial court retains an inherent authority to protect the fairness of the proceedings by preventing unfair prejudice from potentially extraneous influences, particularly under Rule 403, which comprises the power to preclude the presentation of a demonstrative exhibit or illustrative aid that would create a significant risk of unfair prejudice, confusion of the issues, misleading the jury, undue delay, or the needless presentation of cumulative evidence. *See* FED. R. EVID. 403. Most states have evidentiary rules functionally indistinguishable from the federal rule. *See, e.g.*, MD. R. EVID. 5-403; PA. R. EVID. 403; S.C. R. EVID. 403; FLA. STAT. § 90.403 (2009); LA. CODE EVID. ANN. art. 403 (2010).

The court could also exclude an IVE due to related concerns pursuant to Rule 611 (authorizing the court to "exercise reasonable control over the mode and order of interrogating witnesses and presenting evidence so as to (1) make the interrogation and presentation effective for the ascertainment of the truth, (2) avoid needless consumption of time, and (3) protect witnesses from harassment or undue embarrassment").

52. *See, e.g.*, Crispin v. Volkswagenwerk AG, 591 A.2d 966, 974–75 (N.J. Super. Ct. App. Div. 1991) (rejecting a video simulation of a high-speed rear-end automobile collision when the tests were not similar enough because there were too many variables between the tests and the evidence was presented to render the tests probative on any point raised).

53. 59 F.3d 1046 (10th Cir. 1995).

54. *Id.* at 1047.

55. *Id.* at 1049.

56. *Id.*

57. *Id.*

58. *Id.*

59. *Id.*

Most courts deal with the question of fair representation by employing some variation of this substantial-similarity test, which requires that demonstrative exhibits share substantial enough similarity with the items that they seek to represent that they constitute fair and accurate representations of those items.[60] That is what happened in the high-profile case of *Harris v. Texas*.[61] Harris discovered that her husband was having an affair when a private investigator notified her that her husband had checked into a hotel with another woman.[62] Shortly thereafter, Harris and her stepdaughter, Lindsey, drove to the hotel, where they found and vandalized the woman's car.[63] Harris and Lindsey called Harris's husband on his cellular telephone and told him that one of his other children was ill.[64] When her husband and the other woman left the hotel, Harris struck her husband with her car, throwing his body approximately sixty-five feet.[65] When he landed, she circled her car around in the parking lot and ran over him again, killing him.[66] The entire incident was caught on tape by the private investigator that Harris had hired to follow her husband.[67]

At Harris's ensuing murder trial, the crucial disputed issue was how many times Harris had run over her husband.[68] The private investigator's video was of poor quality.[69] The State of Texas called six eyewitnesses who testified that she had driven over her husband's body multiple times while circling in the parking lot.[70] The defense proffered a VR re-creation of Harris's route in the parking lot, made by an expert accident reconstructionist using computer animation, simulation, scene measurements, and the videotape taken by the private investigator.[71] The tape supported the reconstructionist's theory that, given the final resting place of the body and the location of a blood stain next to it, Harris ran over her husband only once by demonstrating that Harris's car never drove over the blood stain.[72] The tape did not use a model or dummy to

60. *See, e.g.*, Ramseyer v. Gen. Motors Corp., 417 F.2d 859, 864 (8th Cir. 1969); Gillam v. J.C. Penney Co., 341 F.2d 457, 460 (7th Cir. 1965); Larson v. Meyer, 161 N.W.2d 165, 167–68 (N.D. 1968); Crecelius v. Gamble-Skogmo, Inc., 13 N.W.2d 627, 631 (Neb. 1944).

61. 152 S.W.3d 786 (Tex. App. 2004).

62. *Id.* at 788–89.

63. *Id.*

64. *Id.* at 789.

65. *Id.*

66. *Id.*

67. *Id.*

68. *Id.* at 789–90.

69. *Id.* at 789.

70. *Id.*

71. *Id.* at 790.

72. *Id.* at 790, 793.

represent the body and had an "X" to indicate the location of the critical blood stain.[73]

The trial court recognized the validity of the field of accident reconstruction and the expert's qualifications and found that the proffered VR exhibit was relevant to the case; the court, however, excluded the video due to concerns with the potential of the inaccurate format of the evidence to mislead and confuse the jury, particularly the omission of a body near the blood stain, and found that the danger of unfair prejudice outweighed the probative value of the exhibit.[74] The trial court permitted Harris to introduce a substantial number of charts and drawings illustrating the defense expert's opinion testimony, including a poster showing the movement of Harris's car as it circled in the parking lot.[75] The jury found Harris guilty of murder, with a special finding that she caused her husband's death in the heat of passion upon adequate provocation.[76] The Texas Court of Appeals upheld the trial court's exclusion of the VR evidence on the ground that whether the VR simulation would have been misleading and confusing to the jury fell within the zone of reasonable disagreement and did not constitutionally impair Harris's opportunity to present a complete defense, requiring the court to leave its admission or exclusion committed to the trial court's discretion.[77]

The Appellate Division of the New Jersey Superior Court reached a similar conclusion in *Rodd v. Raritan Radiologic Associates*,[78] a case involving the Rodds' use of super-magnified computer images of mammograms in a medical malpractice, wrongful death action. To assist the jury in explaining the appearance of a malignancy in a mammogram and to simulate for the jury what the defendants, who treated the decedent, Maria Rodd, saw when they viewed her mammogram films using a magnifying lens, the Rodds' attorney digitally scanned selected portions of Rodd's mammograms into a computer to produce images that were magnified by anywhere between 30 and 150 times the size of the X-rays, which were then projected onto a six-foot-by-eight-foot screen for the jury to view.[79] The Rodds' expert testified that "viewing the computerized images on the large screen from the perspective of the jury was similar to a radiologist viewing a mammogram film on a light box from close observation using a four-times magnifying glass," although he conceded that he examined mammograms

73. *Id.* at 790.
74. *Id.* at 790, 792–23; *see also* TEX. R. EVID. 403.
75. *Harris*, 152 S.W.2d at 794.
76. *Id.* at 788.
77. *Id.* at 794.
78. 860 A.2d 1003 (N.J. Super. Ct. App. Div. 2004).
79. *Id.* at 1006.

with a handheld magnifying glass and did not project them to the size of the demonstrative exhibits offered into evidence.[80]

The defense objected to the use of the super-magnified computer images, in part because of the potential for distortion and confusion engendered by use of the super-magnified images—specifically, that the Rodds "may have created the appearance that the cluster was focal" by compressing the image and "showing only a selective cluster rather than an all-inclusive picture of the calcifications."[81] The trial judge permitted the Rodds to use the large-screen computer projections, over the defense's objection, including in cross-examination of the defense expert, because such projections would aid the jury.[82]

On appeal, the Appellate Division held that the computer imagery displayed to the jury "was unduly influential, potentially confusing, susceptible of being accepted as substantive evidence, and clearly capable of producing an unjust result," thus, warranting a new trial.[83] The court reasoned that the use of computerized images to demonstrate that a cancerous cluster existed and was clearly visible on the mammogram films had the potential to confuse the jurors and distract them from assessing the defendants' action under the correct standard of care, which was to view the mammogram with a 2.5-power magnifying lens.[84] The court explained that the demonstration did more than simply illustrate the Rodds' expert's testimony, but rather provided the jury with "testimonial evidence—independent proof" of what could and should have been seen by the defendants using the standard magnifying glass.[85]

In the case of IVEs, their probative value outweighs their epistemic pitfalls. Even though they may be unduly or improperly persuasive for the reasons discussed *supra*, the dangers that they may pose to a jury's decision making do not compel their per se exclusion from the courtroom. Reliable jury decision making about questions to which IVEs are relevant is best pursued not by excluding IVEs, but rather by admitting them and allowing expert witnesses and lawyers to educate jurors about computer scientists' construction and interpretation of their content.

Courts routinely admit all manners of photographs, conventional, digital,[86] and digitally enhanced,[87] yet all photographs are virtual environments of sorts.

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80. *Id.* at 1006–07.

81. *Id.* at 1007.

82. *Id.*

83. *Id.* at 1012.

84. *Id.* at 1011.

85. *Id.*

86. *See, e.g.*, D.C. CODE § 50-2209.01(b) (2010) ("Recorded images taken by an automated traffic enforcement system are prima facie evidence of an infraction and may be submitted without

Conventional photographs are created when a camera focuses light onto a piece of film using mechanical shutters, creating a negative, which is then developed into a print with chemicals.[88] When an individual uses a camera to take a photograph, she makes all kinds of judgments about lighting, shooting angle, and field of view—judgments that involve inherent distortions.[89]

Digital photographs are created when "[a] digital camera focuses the light onto a semiconductor device that records the information [in binary code (a series of ones and zeros)], which can be read and interpreted by a computer."[90] Once in a digital format, all forms of information—sound, graphics, text, and video—can be stored, accessed, retrieved, manipulated, organized, and sent over the Internet at any time from any location.[91] From the binary code of a digital photograph, a computer creates pixels (the tiny colored dots that make up the larger images).[92] Because the pixels, which are sets of bits that represent a graphic image, can be manipulated, larger images can be easily altered.[93] Digitally enhanced photographs are made by "manipulating the pixels in [a] picture to provide greater clarity."[94] The issue

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authentication.").

87. *See, e.g.*, State v. Swinton, 847 A.2d 921, 943 (Conn. 2004) (admitting enhanced digital photographs of bite marks).

88. PAUL R. RICE, ELECTRONIC EVIDENCE 357 (2d ed. 2008).

89. *See* Tal Golan, *Visual Images in the Courtroom: A Historical Perspective*, 14 PARALLAX 77, 78 (2008). Initially, courts and commentators were resistant to the admission of photographic evidence because of the unique persuasive power of its reality and immediacy. *See id.* at 79; Jennifer L. Mnookin, *The Image of Truth: Photographic Evidence and the Power of Analogy*, 10 YALE J.L. & HUMAN. 1, 41–42 (1998).

90. RICE, *supra* note 88, at 357.

91. *See* MICHAEL R. ARKFELD, INFORMATION TECHNOLOGY PRIMER FOR LEGAL PROFESSIONALS § 1.2(A) (2009).

92. RICE, *supra* note 88, at 357.

93. *Id.*; Michael Cherry, *Reasons to Challenge Digital Evidence and Electronic Photography*, 27 CHAMPION 42, 42–43 (2003); Jill Witkowski, *Can Juries Really Believe What They See? New Foundation Requirements for the Authentication of Digital Images*, 10 WASH. U. J.L. & POL'Y 267, 271 (2002) ("Digital images are easier to manipulate than traditional photographs and digital manipulation is more difficult to detect.").

As one commentator explains:

> [S]hadows could be added to adjacent buildings to make the time of the photograph and the ambient light appear to be different from that which existed when the accident or crime happened; a drawn gun could be placed in the hands of a police officer; an identifying badge could be added to a hat.

RICE, *supra* note 88, at 358.

> Conventional photography can also manipulate a print from a negative, . . . [and c]onventional printing can change appearance by increasing or decreasing contrast, focus, or size. . . . [B]ut the possibilities are miniscule compared to the enhancement options available through digital technology.

Id. at 362.

94. *Id.* at 305. Computer alteration of digital photographs can range from enhancement (e.g.,

of whether an alteration is an enhancement or a distortion also arises with videotapes.[95] Nonetheless, black-and-white, color, digital, and video photographs have all been "successfully integrated into the evidentiary terrain under the illustrative evidence doctrine to be treated merely as graphic expression of human testimony."[96]

Courts also routinely admit all kinds of other visual images produced using more sophisticated technologies: X-rays, computer-generated animations and simulations,[97] digitally enhanced images of latent fingerprints or DNA profiles, and medical-imaging technologies, such as computed tomography (CT scans), positron emission tomography (PET scans), single-photon-emission computed tomography (SPECT scans), and magnetic resonance imaging (MRIs).[98]

Nonetheless, the potential for fraud, even hard-to-detect fraud, does not typically render other forms of visual-image evidence inadmissible.[99] Rather, established evidentiary principles are applied to test the accuracy, reliability, and authenticity of such articles on a case-by-case basis.[100] To the extent that an IVE alters, or varies with, any of the material attributes of the scene, the trial court will merely have to appraise how those variations impact the

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improving sharpness, contrast, and visibility and isolating patterns and colors) to restoration (adding details missing from a photograph based upon a preexisting conception of what the end result should look like) to fraudulent manipulation (transfiguring the image originally recorded by the camera). *Id.* at 362; State v. Hayden, 950 P.2d 1024, 1028 (Wash. Ct. App. 1998).

95. Nooner v. State, 907 S.W.2d 677, 686 (Fla. 1995) (admitting digital photographs of a suspect that had been copied from a videotape and enhanced because the jury had the opportunity to view the original videotape along with the photographs and identify for itself any distortion within the photographs); Dolan v. State, 743 So. 2d 544, 545 (Fla. Dist. Ct. App. 1999); RICE, *supra* note 88, at 362.

96. Golan, *supra* note 89, at 86.

97. The first major case concerning the admissibility of a computer simulation was *Perma Research & Dev. v. Singer Co.*, 542 F.2d 111 (2d Cir. 1976) (upholding the admission of expert testimony based on computer simulations).

98. Golan, *supra* note 89, at 77; *see also* Hose v. Chi. Nw. Transp. Co., 70 F.3d 968, 973–74 (8th Cir. 1995) (allowing into evidence PET and MRI scans); Berry v. CSX Transp., Inc., 709 So. 2d 552, 571 (Fla. Dist. Ct. App. 1998) (reversing trial court's exclusion of SPECT evidence); Green v. K-Mart Corp., 01-675, pp. 16–24 (La. App. 3 Cir. 6/18/03); 849 So. 2d 814, 826–30 (upholding the admission of PET-based testimony to diagnose prior brain trauma).

99. *See, e.g.*, Cowley v. People, 83 N.Y. 464, 478 (N.Y. 1881) (asserting that photographs were not substantively different from the more traditional forms of visual evidence that courts had admitted for centuries).

100. United States v. Salcido, 506 F.3d 729, 733–34 (9th Cir. 2007) (holding that the government is not required to introduce an expert to authenticate child pornography images); United States v. Irving, 452 F.3d 110, 121–22 (2d Cir. 2006) (rejecting a claim that the government must present extrinsic evidence to prove the reality of children depicted in images purported to be child pornography); United States v. Slanina, 359 F.3d 356, 357 (5th Cir. 2004) (holding that extrinsic evidence was not required to prove the reality of children depicted in child-pornography images); United States v. Kimler, 335 F.3d 1132, 1142 (10th Cir. 2003) ("Juries are still capable of distinguishing between real and virtual images . . . .").

balance between the probative value of the IVE and its potential to mislead, confuse, or create unfair prejudice under Rule 403, like with any other proffered exhibit.[101] Concerns with potential distortion should normally be entrusted to the jury as a factor in its resolution of the weight to be given such evidence.[102]

IVEs may produce unsanctioned meanings in jurors' minds, but all images displayed in court are capable of doing this. Implicit meanings are ingrained in all visual representations.[103] In any photograph, there is decreased information when compared to the original image, such as fewer pixels and the conversion of three-dimensional objects into two-dimensional images, which depend upon numerous assumptions about perspectives, distance, and relationships between objects.[104] "[T]he lens used on [any] camera can distort the apparent distance and relationship of things to one another."[105]

Nonetheless, the rules of evidence do not exclude all photographic images. Instead, because the law of evidence recognizes that all visual representations may prompt jurors to find facts or reach judgments for improper reasons, it subjects them (as it does all other evidence) to the balancing test of Rule 403.[106] Some visual representations survive this inquiry; others do not.[107] There is no rationale for treating IVEs specially.

IVEs may, on balance, decrease rather than increase epistemic biases. Photographs lose the z axis (depth), while IVEs preserve it. Because IVEs can capture three-dimensional information about depth and portray images from multiple angles and distances, they are generally a more accurate representation than two-dimensional photographs.[108] Although excluding IVEs may preclude some kinds of distortion, admitting IVEs may rectify other kinds. If an IVE can re-create a scene that is more accurate than photographs taken at a later time or under different circumstances than those present at the

101. *See, e.g.*, Smith v. Kansas City S. R.R. Co., 02-1505, p. 3 (La. App. 3 Cir. 5/28/03); 846 So. 2d 980, 983 (holding that a computer-generated animation of the scene of a railroad crossing was inadmissible because it was based upon inaccurate facts); State v. Stewart, 643 N.W.2d 281, 295 (Minn. 2002) (holding that it was error to admit a computer-generated animation that included the facial expressions of the victim because the facial expressions had no probative value and were unfairly prejudicial).

102. *See* FED. R. EVID. 104(e).

103. *See* Richard K. Sherwin et al., *Law in the Digital Age: How Visual Communication Technologies Are Transforming the Practice, Theory, and Teaching of Law*, 12 B.U. J. SCI. & TECH. L. 227, 245 (2006).

104. *See* RICE, *supra* note 88, at 357–58, 362.

105. *Id.* at 366 n.55.

106. *Id.*

107. *Id.*

108. *See* Bailenson et al., *supra* note 16, at 259.

time of the events in question, then such evidence is more helpful to a jury than photographic evidence or a live viewing of the scene.[109]

The case of *Colley v. Standard Oil Co.*,[110] which addressed the admissibility of photographs that a party had altered to make them better represent the scene at the time of the events in question, illustrates this point. Colley filed a wrongful death action seeking damages for the death of her husband, a train engineer who died from injuries received when his train collided with a Standard Oil truck at a grade crossing.[111] At trial, over Colley's objection, the court permitted Standard Oil to admit photographs of the view to the north of the crossing, the direction in which the truck driver had been looking as he approached.[112] The photographs "had been altered artificially" by eliminating an area of the photograph where a store building had allegedly been obstructing the truck driver's view of approaching traffic.[113] The reason for the alteration was that, between the time of the collision and the time of the trial, the building in question had burned down.[114] Colley objected to the admission of the photographs on the ground that "they did not constitute a true representation of the scene."[115]

On appeal, the United States Court of Appeals for the Fourth Circuit rejected Colley's objection, explaining:

> Here it was only an effort to make the photographs show, as nearly as was possible after the fire, what view of oncoming cars (or trains) there was in that particular direction at the time of the accident. An unaltered photograph would not have shown this and would probably have created a much

109. Courts have held that the availability of audiovisual depictions of the scene is pertinent to the resolution of whether a trial court abused its discretion in denying a request for live scene view. *See, e.g.*, United States v. Crochiere, 129 F.3d 233, 236 (1st Cir. 1997) ("A court generally acts within [its discretion to permit a view] when there is sufficient evidence describing the scene in the form of testimony, diagrams, or photographs."); United States v. Martinez, 763 F.2d 1297, 1305 (11th Cir. 1985) (finding that the district court's decision to deny Martinez's request for a jury viewing of the crime scene was "especially" reasonable because Martinez was afforded, but declined, the court's invitation to offer into evidence a defense-created videotape of the exterior and interior of the scene); United States v. Drougas, 748 F.2d 8, 30–31 (1st Cir. 1984) (finding that the use of photographic exhibits to illustrate the relevant features of the scene rendered a live jury view "cumulative, if not repetitive" and unduly time-consuming); United States v. Gallagher, 620 F.2d 797, 801 (10th Cir. 1980) (holding that the district court did not abuse its discretion in denying Gallagher's request that the jury be permitted to view the truck that he used to escape from the penitentiary because numerous photographs of the truck and its interior were admitted into evidence, which were adequate to show the disputed material facts relating to the truck).

110. 157 F.2d 1007 (4th Cir. 1946).

111. *Id.* at 1008.

112. *Id.* at 1008–09.

113. *Id.* at 1008.

114. *Id.*

115. *Id.*

> more erroneous impression of the scene than could have been obtained from these altered photographs. . . . The assumptions upon which this contention [that the blanked-out area in the photographs was mere theory and not accurate] is based are not borne out in the light of the detailed testimony of the photographer . . . .[116]

As the United States District Court for the District of Minnesota explained in its rationale for admitting digitally enhanced photographs:

> [A]djustments to brightness or contrast, or enlargement of the image, while arguably a manipulation, are in fact no more manipulative than the recording process itself. The image is black and white; the world is not. In the non-digital world, a camera's lens, its aperture, shutter speed, length of exposure, film grain, and development process—all affect the image. Each of these is entirely unremarkable so long as the "image" remains an accurate recording of that which occurred before the camera. If a photographic negative were magnified by lens, and an enlarged image resulted, no one would question the larger picture. Similarly, in the event of a tape recording, no one would comment if the volume were increased to make a recorded conversation more easily heard—again, so long as the volume-increased words were accurately recorded by the recording medium.[117]

Because of the concerns with distortion and manipulation of IVE evidence, courts should ensure that there are rigorous mechanisms for an opposing party to discover and challenge IVE evidence. The rules of criminal procedure provide for pretrial reciprocal discovery of documents and objects (including photographs and "tangible objects"), the results and reports of scientific tests and experiments, and a summary of expert testimony that either party intends to use in its case in chief.[118] The rules of civil procedure are broader and require pretrial reciprocal discovery of data compilations and tangible things, including electronically stored information (ESI), that either party may use to support its claims or defenses and comprehensive reports detailing testimony of any expert that either party may call as a witness.[119]

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116. *Id.* at 1009–10.

117. United States v. Seifert, 351 F. Supp. 2d 926, 928 (D. Minn. 2005).

118. *See* FED. R. CRIM. P. 16(a)–(b).

119. *See* FED. R. CIV. P. 26(a)(1). In 2006, Rule 34 was specifically amended to encompass the discovery of ESI. *See* FED. R. CIV. P. 34(a). The new rule was intended to "cover all current types of computer-based information" and to be "flexible enough to encompass future changes and developments." FED. R. CIV. P. 34(a) advisory committee's notes. Amended Rule 34(a) establishes the right of a party to "test" or "sample" ESI, rather than merely inspect or copy it. FED. R. CIV. P. 34(a). Parties to civil proceedings may also serve upon one another written

While Rule 403 does not expressly list surprise as a ground for exclusion of otherwise probative evidence, courts have found that advance notice (or lack thereof) was an element in deciding whether admission of a proffered exhibit would result in unfair prejudice.[120] In both criminal and civil cases, a court has the discretion to sanction any party who fails to fulfill these discovery requirements, including by compelling disclosure and prohibiting the party from introducing the undisclosed item into evidence.[121] Taken together, these discovery mechanisms should enable a party to detect distortions in another party's (or the court's) IVE evidence and to challenge it, under the extant rules of evidence, if it is not fair and accurate.[122]

III. BEST EVIDENCE

Because an IVE is largely a re-creation of physical evidence based upon out-of-court investigation, the use of IVE technology in the courtroom could also give rise to best evidence rule concerns.[123] The *Seiler v. Lucasfilm, Ltd.*[124] case provides an example. Seiler was a graphic artist who claimed that the Imperial Walkers in the film *The Empire Strikes Back* infringed his copyright on an earlier invention, the "Garthian Striders."[125] At a pretrial evidentiary hearing, Seiler could not produce any originals of the Striders that existed prior to the film.[126] Instead, he sought to rely upon "reconstructions" of the original works that he had deposited with the United States Copyright Office one year after the release of *The Empire Strikes Back*.[127] The district court ruled that the best evidence rule prevented Seiler from introducing

interrogatories, *see* FED. R. CIV. P. 33, requests for production of documents (including drawings, graphs, charts, photographs, and other data compilations), *see* FED. R. CIV. P. 34(a), and admissions to the truth of any relevant matters (including the authenticity of computer data and other electronic information), *see* FED. R. CIV. P. 36(a). The parties may also compel production of ESI in the possession of third parties by use of subpoenas. *See* FED. R. CIV. P. 34(b)–(c), 45(a).

120. *See, e.g.*, Shu-Tao Lin v. McDonnell Douglas Corp., 742 F.2d 45, 48 (2d Cir. 1984).

121. *See* FED. R. CRIM. P. 16(d)(2); FED. R. CIV. P. 37(b)(2), (c)(1).

122. *See* RICE, *supra* note 88, at 399 (arguing that expanded pretrial discovery can justify a lesser foundation for authenticity).

123. *See* FED. R. EVID. 1002 (requiring an original document to prove the contents of a writing, recording, or photograph). *But see* Commonwealth v. Leneski, 846 N.E.2d 1195, 1198–99 (Mass. App. Ct. 2006) ("Videotapes, like photographs, are not subject to the best evidence rule. . . . As with videotapes, we think that digital image evidence is not subject to the best evidence rule, as such images are not writings. . .") (citation omitted). Some commentators have noted the nonsensical nature of a discussion of an "original record" in the context of digital evidence. *See, e.g.*, PAUL, *supra* note 15, at 13–14; RICE, *supra* note 88, at 304.

124. 808 F.2d 1316 (9th Cir. 1986).

125. *Id. at* 1317.

126. *Id.*

127. *Id.* at 1318.

secondary evidence of the Striders.[128] As a result, Seiler had no admissible evidence, and the court granted summary judgment to Lucasfilm.[129]

On appeal, Seiler contended, inter alia, that the best evidence rule did not apply to his works because the rule embraced only the written word.[130] The United States Court of Appeals for the Ninth Circuit rejected Seiler's contention, holding that his reconstructions were "writings" within the meaning of Rule 1001 because they consisted of the "equivalent" of "letters, words, or numbers."[131] The court reasoned: "Seiler's drawings are objective manifestations of the creative mind."[132] The court explained:

> The facts of this case implicate the very concerns that justify the best evidence rule. Seiler alleges infringement by The Empire Strikes Back, but he can produce no documentary evidence of any originals existing before the release of the movie. His secondary evidence does not consist of true copies or exact duplicates but of "reconstructions" made after The Empire Strikes Back. In short, Seiler claims that the movie infringed his originals, yet he has no proof of those originals.
>
> The dangers of fraud in this situation are clear. The rule would ensure that proof of the infringement claim consists of the works alleged to be infringed. Otherwise, "reconstructions" which might have no resemblance to the purported original would suffice as proof for infringement of the original. Furthermore, application of the rule here defers to the rule's special concern for the contents of writings. Seiler's claim depends on the content of the originals, and the rule would exclude reconstituted proof of the originals' content. Under the circumstances here, no "reconstruction" can substitute for the original.[133]

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128. *Id.* at 1317; *see* FED. R. EVID. 1004(1).

129. *Seiler*, 808 F.2d at 1317.

130. *Id.* at 1318–19.

131. *Id.* at 1318–19; *see* FED. R. EVID. 1001(1).

132. *Seiler*, 808 F.2d at 1320.

133. *Id.* at 1319. Because of these hurdles to introducing a VR simulation into evidence, the use of VR technology during trial may fit more comfortably within the framework of traditional illustrative aids to demonstrate testimony—maps, charts, graphs, cardboard cutouts, and the like. Unlike demonstrative exhibits, illustrative aids do not have to be admissible into evidence for an attorney to use them during trial presentation. *See supra* note 37 and accompanying text. Their singular function is to illustrate the testimony of a witness or to demonstrate a point made by counsel in argument. *See id.* Attorneys employ illustrative aides for "pedagogical" ends, not for the truth of their contents. *See id.* The case of *Gomez v. Great Lakes Steel*, 803 F.2d 250 (6th Cir. 1986), is illustrative of this distinction. Great Lakes Steel challenged the admission into evidence of one of Gomez's exhibits, a summary of actual damages. *Id.* at 257. On appeal, the United States Court of

On the other hand, the best evidence rule may provide a justification for admitting a VR simulation into evidence.[134] A "mechanical or electronic recording" or "other form of data compilation" is a writing or recording for the purposes of the best evidence rule.[135] "'Photographs' include still photographs, X-ray films, video tapes, and 'motion pictures.'"[136] As the Advisory Committee Note to Rule 1001 explains:

> Traditionally the rule requiring the original centered upon accumulations of data and expressions affecting legal relations set forth in words and figures. This meant that the rule was one essentially related to writings. Present day

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Appeals for the Sixth Circuit agreed that the challenged exhibit was improperly admitted into evidence. In reaching that conclusion, the court explained:

> Contents of charts or summaries admitted as evidence under Rule 1006 must fairly represent and be taken from underlying documentary proof which is too voluminous for convenient in-court examination, and they must be accurate and nonprejudicial. . . . Such summaries or charts admitted *as evidence* under Rule 1006 are to be distinguished from summaries or charts used as pedagogical devices which organize or aid the jury's examination of testimony or documents which are themselves admitted into evidence. . . . Such pedagogical devices "are more akin to argument than evidence . . . ."

Id. (citations omitted).

Because of this distinction between demonstrative exhibits that are admitted into evidence and aids that are used for illustrative purposes only, the best evidence rule would be inapplicable if a witness only identified an IVE "as a correct representation of events which he saw or of a scene with which he is familiar." FED. R. EVID. 1002 advisory committee's notes. *See also* United States v. Bennett, 363 F.3d 947, 953 (9th Cir. 2004); United States v. Workinger, 90 F.3d 1409, 1415 (9th Cir. 1996) ("[A] tape recording cannot be said to be the best evidence of a conversation when a party seeks to call a participant in or observer of the conversation to testify to it. In that instance, the best evidence rule has no application at all."). The rule would apply, on the other hand, if a witness sought to testify about the contents of an IVE without producing the physical item, particularly if the witness was not privy to the events the IVE depicted. *See* FED. R. EVID. 1002 advisory committee's notes; *Bennett*, 363 F.3d at 953.

This distinction between demonstrative exhibits and illustrative aids is not observed in all jurisdictions. Even the Federal Rules of Evidence do not explicitly address the in-court use of illustrative aids that are not admitted into evidence.

134. The best evidence rule requires the production of an original document rather than a copy. FED. R. EVID. 1002. Specifically, the rule provides that the original of a recording or photograph is required to prove the content thereof. *Id.*; *see also Bennett*, 363 F.3d at 953. Rule 1002 states: "To prove the content of a writing, recording, or photograph, the original writing, recording, or photograph is required, except as otherwise provided in these rules or by Act of Congress." FED. R. EVID. 1002. Under this test, while perfect identity is not required, the admissibility of a demonstrative exhibit again depends upon a foundational showing that there is a substantial similarity between the exhibit and the item that it seeks to re-create. *See* FED. R. EVID. 1001(4), 1002, 1004; *see also Bennett*, 363 F.3d at 953. If an issue were raised as to whether an IVE correctly reflected its contents, such issue would be for the jury to decide, along with all of the other factual disputes in the case, and would not be a ground for exclusion by the court. *See* FED. R. EVID. 1008.

135. FED. R. EVID. 1001(1).

136. FED. R. EVID. 1001(2).

> techniques have expanded methods of storing data, yet the essential form which the information ultimately assumes for usable purposes is words and figures. Hence the considerations underlying the rule dictate its expansion to include computers, photographic systems, and other modern developments.[137]

The recent *Bennett* case demonstrates how an IVE might be not only admissible, but required to be admitted into evidence under the best evidence rule. Drug enforcement agents observed Bennett's boat quickly traveling north along the California coastline off the coast of San Diego, near, but north of, the Mexican border.[138] When the boat reached San Diego Bay, the agents boarded and searched the boat, eventually discovering more than a thousand pounds of hidden marijuana stashed onboard.[139] Bennett was charged with importation of marijuana.[140] It is an element of illegal importation of a controlled substance that the defendant bring the substance into the United States from "any place outside thereof."[141] To prove that Bennett had imported the marijuana found in his boat into the United States from Mexico, the government introduced the testimony of a customs officer who testified, over Bennett's evidentiary objections, that he had discovered a global positioning system (GPS) while searching Bennett's boat and that the "backtrack" feature of the GPS, which graphed the boat's journey that day, revealed that Bennett's boat had traveled from Rosarita, Mexico, to San Diego Bay.[142] On appeal, the United States Court of Appeals for the Ninth Circuit held that the admission of the agent's GPS testimony was improper and reversed Bennett's conviction.[143] The court found that the best evidence rule applied to the agent's GPS testimony because it involved his description of the content of a graphical description of data that the GPS had compiled about the path of Bennett's boat when the agent himself had not observed the boat travel the path depicted by the GPS.[144] The court found that the GPS data

137. FED. R. EVID. 1001 advisory committee's notes. *But see* 6 WEINSTEIN'S FEDERAL EVIDENCE § 1001.03 (Joseph M. McLaughlin ed., 2d ed. 2010).

138. *Bennett*, 363 F.3d at 949.

139. *Id.* at 949–50.

140. *Id.* at 949; 21 U.S.C. § 841(a)(1) (2006).

141. 21 U.S.C. § 952(a) (2006); *Bennett*, 363 F.3d at 952; United States v. Cabaccang, 332 F.3d 622, 625 (9th Cir. 2003) (en banc).

142. *Bennett*, 363 F.3d at 952.

143. *Id.* at 949.

144. *Id.* at 953 (citation omitted); *see also* State v. Springer, 197 S.E.2d 530, 536 (N.C. 1973) (explaining that proponents of computer-generated evidence occasionally flounder on the best evidence rule by presenting oral testimony based on a witness's review of computer data rather than introducing the actual data into evidence).

itself was the best evidence of the boat's travels.[145] By the same token, if an expert witness had access to technology that could generate an immersive model of a crime or accident scene, for instance, the model itself could be the best evidence of the data that it contained, rather than the expert's live testimony.

IV. AUTHENTICITY

All evidence submitted to a court must be authenticated—to wit, proven to be what the proponent claims it is.[146] As commentators have previously noted, "evidence often must be authenticated on several levels, [and s]cience and technology add another level."[147] "The inherent mutability of electronic data" raises questions about the applicability of traditional methods of authentication to IVEs.[148] The authenticity of digital objects cannot be tested by inspection alone.[149] Some commentators suggest that the "unique potential for fraud with electronic evidence has diminished the value" of the traditional circumstantial methods of authentication.[150]

The basic concern of authentication remains the same, however, with any type of physical evidence. As one commentator notes, "While the advent of digital technology has expanded the ways in which documents can be

145. *Bennett*, 363 F.3d at 954.

146. FED. R. EVID. 901(a). For a witness to authenticate an IVE as documentary evidence by recognition, under Rule 901(b)(1), the witness would have to be able to identify and describe the IVE, attest to its genuineness, and provide a rational basis for her recognition of it. See FED. R. EVID. 901(b)(1). Because VR is a comparatively new technology, a proponent of an IVE would likely be required to demonstrate the authenticity of the representations contained therein, unlike the proponent of a more traditional type of visual media.

By contrast, the only foundation that would have to be laid to use an IVE as an illustrative aid to testimony would be that the IVE would assist in presenting a witness's testimony. As a general rule, as long as a witness could testify that the IVE was illustrative of her testimony, it could be used as an illustrative aid. *See supra* note 37 and accompanying text.

147. RICE, *supra* note 88, at 393. In addition to authenticating the IVE as fairly and accurately depicting the scene that it purported to re-create, the process used to generate the IVE would also have to be authenticated by a witness who could describe the process or system used to produce the IVE images and demonstrate that the process or system produced an accurate result. FED. R. EVID. 901(b)(9); People v. Cauley, 32 P.3d 602, 607 (Colo. App. 2001); Sommervold v. Grevlos, 518 N.W.2d 733, 738 (S.D. 1994). By contrast, proponents of photographs are rarely required to make a foundational showing of the accuracy of the discipline of photography prior to admission of a photograph into evidence. *See, e.g.*, Rodd v. Raritan Radiological Assocs., 860 A.2d 1003, 1011–12 (N.J. Super. Ct. App. Div. 2004) (holding that "the use of a computer-generated exhibit requires a more detailed foundation than that for just photographs or photo enlargements" and contrasting the required foundation for computer-generated exhibits with that of photographs or photo enlargements). Such authenticity could be established via deposition, declaration, requests for admission, expert testimony, and metadata (such as embedded file creation and modification dates). DURANSKE, *supra* note 3, at 53.

148. RICE, *supra* note 88, at 335.

149. *See* PAUL, *supra* note 15, at 21–23.

150. RICE, *supra* note 88, at 335.

corrupted or forged, it has also expanded the ways in which they can be authenticated."[151] The language of authenticity rules like Rule 901 establishes a variable benchmark of reliability that depends upon what the proponent of the IVE claimed the proffered evidence was.[152] The proponent would have to be able to establish that the proffered item's purported content was complete, unaltered, and originated from an identifiable source.[153] The proponent would not have to show that the IVE's content was *true*.[154] An item of evidence making an erroneous or even untruthful assertion can unquestionably still be authentic.[155] "Accuracy is not the issue."[156]

Like any photograph, an IVE could be authenticated by testimony from a sponsoring witness with personal knowledge of the scene or incident that it purported to re-create that the IVE accurately reproduced the scene of the crime or accident as the witness remembered it.[157] The mere fact that a witness observed an event reconstructed in an IVE would not change the source of her personal knowledge.

An IVE also might be able to be authenticated through expert testimony about the creation of the IVE, the source of the representations contained in it, and its ability to accurately re-create the events and perceptions as reported.[158] When expert testimony is employed to prove the authenticity of an IVE, authorship and recognition become proxies for the IVE's identity and authenticity.

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151. *Id.*

152. The specific provision in Rule 901(b)(9) governs computer-generated evidence when the accuracy of a particular result of a computer-generated process depends upon the accuracy of the system or process producing it. FED. R. EVID. 901(b)(9).

153. *See* FED. R. EVID. 901(b)(9).

154. *Id.*

155. *See* PAUL, *supra* note 15, at 33.

156. *Id.*

157. *See* FED. R. EVID. 901(b)(1) (permitting authentication through testimony of a witness with knowledge).

158. *See* FED. R. EVID. 901(b)(9) (permitting authentication through evidence of a process or system); State v. Sayles, 662 N.W.2d 1, 8–9 (Iowa 2003) (holding that expert's testimony was sufficient to authenticate computer-generated animated slides as illustrative evidence of shaken-baby syndrome); Commonwealth v. Serge, 896 A.2d 1170, 1180–82 (Pa. 2006) (holding that the testimony of the creator of a computer-generated animation that his program produced an accurate graphic presentation of his opinion was sufficient to establish the authenticity of the animation even though the creator had no firsthand knowledge of the crime, but rather based the reconstruction on the physical evidence, measurements, and other information provided by other witnesses); Commonwealth v. Hardy, 918 A.2d 766, 778 (Pa. 2007) (admitting a computer-generated videotape of shaken-baby syndrome in conjunction with expert's testimony about the cause of the injury and the accuracy of the animation based upon all of the available evidence); Dolan v. Florida,743 So. 2d 544, 546 (Fla. Dist. Ct. App. 1999) ("Where there is testimony as to the nature of the store's video security system, the placement of the film in the camera, how the camera worked, the circumstances of removal of the tape and chain of possession of the tape, such testimony is sufficient authentication of the tape.").

V. EXPERT TESTIMONY AND THE RELIABILITY OF IVE METHODOLOGY

The impediments that a proponent of an IVE would face, under Rule 403, the best evidence rule, or Rule 901, are chiefly matters of foundation, i.e., the admissibility of an IVE turns on whether the proponent could establish its accuracy, reliability, and authenticity.[159] Another potential obstacle to the admissibility of IVE evidence is the barrier posed by the hearsay rule if the VR model is the product of information gathered or generated by humans outside of the courtroom. Computer-generated evidence can be based on out-of-court statements by witnesses not subject to cross-examination and offered, at least in part, to show the truth of those statements. A jury entering an IVE (or even the proponent of the exhibit) likely would not know what components of the IVE were based on information from third-party sources, much less have a way to evaluate the credibility of those sources and their information, and the opposing party has no opportunity to cross-examine those sources.[160]

Because of these foundational hurdles, an IVE often would be used at trial in conjunction with expert opinion testimony establishing the reliability of the IVE methodology.[161] Admission of IVE evidence that could not rest upon the traditional foundations for substantive evidence could be accomplished as either part of the basis for expert opinion testimony,[162] an illustrative aid to

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159. IVEs could also be subject to a hearsay objection. Some of the representations in an IVE model are not based on the personal knowledge of the individual who designed the model. As a consequence, hearsay, and multiple levels of it, could be a problem, given that those representations are being presented to the jury for their truth. *See* FED. R. EVID. 801(c).

160. Of course, these hearsay concerns arise only if the IVE is offered as substantive evidence to prove the truth of the matters asserted therein. *See id.*; Jennifer Robinson Boyle, Note, State v. Pierce*: Will Florida Courts Ride the Wave of the Future and Allow Computer Animations in Criminal Trials?*, 19 NOVA L. REV. 371, 411 (1994):

> Demonstrative evidence does not qualify as hearsay because it is not offered to prove the truth of the matter asserted. Its function is to illustrate expert testimony. It follows that because the computer animation was used solely as demonstrative evidence [to illustrate the witness's testimony], it is not subject to the hearsay rule.

Id.; *see also* James E. Carbine & Lynn McLain, *Proposed Model Rules Governing the Admissibility of Computer-Generated Evidence*, 15 SANTA CLARA COMPUTER & HIGH TECH. L.J. 1, 9–10 (1999) (noting that hearsay concerns are implicated only for "computer-generated evidence . . . offered as substantive evidence").

161. *See, e.g.*, *Serge*, 896 A.2d at 1179–80.

162. For example, a crime or accident scene reconstructionist or a medical examiner could testify about the cause and manner of an accident or a victim's death using an IVE as a visual presentation to illustrate his or her conclusions reached. In *People v. McHugh*, 476 N.Y.S.2d 721 (N.Y. Sup. Ct. 1984), the first reported case to address a litigant's use of a graphic computer animation at trial, a New York trial court admitted a computer reenactment of a fatal car crash to illustrate defense expert testimony that the accident was the result of weather rather than the defendant's intoxication on the theory that the reenactment was "more akin to a chart or diagram than a scientific device" even though it had been "drawn by means of a computer." *Id.* at 722; *see also*

expert testimony,[163] or a stand-alone exhibit introduced through the testimony of an expert involved in creating the IVE.[164]

IVEs are, in a sense, expert environments. The IVE is not just a snapshot of the scene, but rather a computer model created to represent the scene. An expert witness is needed to explain to the inexpert jury the array of sophisticated methodological and interpretive techniques and assumptions that were involved in the creation of the IVE.

Under Rule 702, an expert may assist a jury with testimony "in the form of an opinion *or otherwise*."[165] Traditionally, this "otherwise" has included tools like analogies and visual representations.[166] The factual basis for an expert opinion can also include hearsay, other information relied upon by experts in the field,[167] and hypothetical questions.[168] Rule 703 allows experts

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Livingston v. Isuzu Motors, Ltd., 910 F. Supp. 1473, 1494–95 (D. Mont. 1995) (allowing the introduction of a computer simulation upon which an accident reconstruction expert had based his opinion).

163. As discussed *supra* note 37, illustrative aids are ordinarily held to a less rigorous standard than substantive demonstrative evidence—namely, whether they aid the jury in understanding some fact of consequence in the case. 2 MCCORMICK ON EVIDENCE § 212 (John W. Strong ed., 5th ed. 1999). *See, e.g.*, Carson v. Polley, 689 F.2d 562, 579 (5th Cir. 1982) (explaining that illustrative evidence is admitted solely to help a witness explain his testimony and has no probative value beyond that lent to it by the credibility of the witness whose testimony it illustrates); Hinkle v. Clarksburg, 81 F.3d 416, 424 (4th Cir. 1996); People v. Hood, 62 Cal. Rptr. 2d 137, 140 (Cal. Ct. App. 1997); People v. Cauley, 32 P.3d 602, 607 (Colo. App. 2001); Pierce v. State, 718 So. 2d 806, 808–09 (Fla. Dist. Ct. App. 1997); Cleveland v. Bryant, 512 S.E.2d 360, 362 (Ga. Ct. App. 1999); State v. Sayles, 662 N.W.2d 1, 9 (Iowa 2003); Constans v. Choctaw Transp., Inc., 97-0863, pp. 46–48 (La. App. 4 Cir. 12/23/97); 712 So. 2d 885, 900–01; State v. Harvey, 26,613, pp. 9–12 (La. App. 2 Cir. 1/25/95); 649 So. 2d 783, 788; *Serge*, 896 A.2d at 1179.

Nonetheless, some courts have subjected computer-generated images to the more demanding authentication standard for substantive evidence even when the images are offered solely to illustrate testimony. *See, e.g.*, State v. Swinton, 847 A.2d 921, 945 (Conn. 2004) (recognizing the difficulty of categorically distinguishing substantive and illustrative uses of visual evidence and the persuasive potential of visual images, and instituting a single, demanding authentication standard for all computer-generated evidence).

164. *See* Carbine & McLain, *supra* note 160, at 4 ("In the above example of an air crash, there was no expert witness taking the stand to testify as to how the final moments of Flight 162 looked. The computer itself was the expert.").

165. FED. R. EVID. 702 (emphasis added). The rule states, in pertinent part: "If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise. . . ." *Id.*

166. *See, e.g.*, Perma Research & Dev. v. Singer Co., 542 F.2d 111, 115 (2d Cir. 1976); Lally v. Volkswagen Aktiengesellschaft, 698 N.E.2d 28, 40 (Mass. App. Ct. 1998) (noting without ruling on the issue that "[t]he defendants maintain that the animation was not itself a simulation, but rather, a visual representation of [an expert witness's] testimony concerning the results of one computer simulation program").

167. FED. R. EVID. 703; United States v. Sims, 514 F.2d 147, 149 (9th Cir. 1975); United States v. Williams, 447 F.2d 1285, 1291 (5th Cir. 1971); Jenkins v. United States, 307 F.2d 637, 643 (D.C. Cir. 1962); State v. Oswalt, 463 P.2d 602, 603 (Or. Ct. App. 1970).

to testify without personal knowledge of the underlying facts or data and on the basis of hearsay or other otherwise inadmissible evidence, as long as the out-of-court sources are of a type "reasonably relied upon by experts in the particular field."[169] If an expert witness relies upon outside facts in reaching an opinion, those facts themselves may be admissible.[170] If an expert witness reasonably relied upon an IVE in reaching a conclusion about a material fact at dispute during trial, the IVE itself might be admissible, even if it would not have been admissible as a stand-alone demonstrative exhibit.[171]

The underlying standard for the admissibility of scientific or technical expert evidence in all jurisdictions, whether under the traditional *Frye*[172] general-acceptance standard or the federal Rule 702[173]/*Daubert*[174] standard, is reliability.[175]

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168. *See* Iconco v. Jensen Constr. Co., 622 F.2d 1291, 1301 (8th Cir. 1980) (explaining that a hypothetical question need not include all facts shown by the evidence, but must be "in such a form as not to mislead or confuse the jury"); Daniel D. Blinka, *Ethics, Evidence, and the Modern Adversary Trial*, 19 GEO. J. LEGAL ETHICS 1, 49 (2006).

169. Rule 703 states:

> The facts or data in a particular case upon which an expert bases an opinion or inference may be those perceived by or made known to the expert at or before the hearing. If of a type *reasonably relied upon by experts in the particular field* in forming opinions or inferences upon the subject, the facts or data need not be admissible in evidence.

FED. R. EVID. 703 (emphasis added). *See* United States v. Bonds, 12 F.3d 540, 566 (6th Cir. 1993).

170. FED. R. EVID. 705; United States v. McCollum, 732 F.2d 1419, 1422–23 (9th Cir. 1984).

171. In *Old Chief v. United States*, 519 U.S. 172 (1997), the Supreme Court recognized that the parties have a right to present evidence in the form that they deem best suited to meet jurors' expectations about what proof would be persuasive, even if that evidence is not logically necessary to the jury's verdict. Thus, if IVE-based expert testimony itself were admissible, the proponent of the IVE evidence should be allowed to publish the IVE to the jury to avoid being unfairly prejudiced by having failed to live up to the jury's expectations about what computer-simulated evidence looks like. *See id.* at 189.

172. Frye v. United States, 293 F. 1013, 1014 (D.C. 1923) (holding that, for expert testimony regarding a scientific principle or discovery to be admissible, it "must be sufficiently established to have gained general acceptance in the particular field in which it belongs"). General acceptance exists when a substantial percentage of the applicable scientific community accepts the theory, principles, and methodology underlying scientific testimony because they are grounded in valid scientific principles. *See Bonds*, 12 F.3d at 562; United States v. Baller, 519 F.2d 463, 466 (4th Cir. 1975).

173. FED. R. EVID. 702 (permitting an expert to testify to an opinion based upon scientific, technical, or other specialized knowledge only "if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case").

174. Daubert v. Merrell Dow Pharm., Inc., 509 U.S. 579, 589–90 (1993) (holding that the *Frye* test had been superseded by Rule 702 and charging courts with the responsibility to act as gatekeepers to exclude unreliable expert testimony and ensuring that scientific testimony is "not only relevant, but reliable").

The relevancy requirement stems from Rule 702's requirement that the testimony "assist the trier of fact to understand the evidence or to determine a fact in issue." FED. R. EVID. 702. *Daubert*

The case of *United States v. Downing*[176] illustrates some of the hurdles and possibilities that a party would face when seeking to use an IVE during a jury trial. Downing was charged with mail fraud, wire fraud, and interstate transportation of stolen property arising from a scheme to defraud vendors at national trade shows by pretending to be a member of the clergy with excellent credit references and ordering goods on credit without the intention to pay for them.[177] The government's case against Downing consisted almost entirely of eyewitness testimony of twelve individuals who identified Downing as the fictional Reverend Claymore on the basis of brief interactions that they had with him years earlier.[178] Downing sought to adduce, from a cognitive psychologist with expertise in human perception and memory, testimony concerning the reliability of eyewitness identifications.[179] The district court refused to admit the testimony, based upon the belief that such testimony would not be "helpful[]" to the jury under Rule 702.[180] The United States Court of Appeals reversed the district court.[181] The appeals court held that such testimony was admissible if the reliability of the scientific principles upon which it rested, and therefore the potential of the testimony to aid the jury in reaching an accurate resolution of a disputed issue, outweighed the likelihood that introduction of the testimony would, in some way, overwhelm or mislead the jury.[182] The court also stated that such testimony was admissible if Downing could make a specific proffer that scientific research

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set forth a non-exhaustive checklist for assessing the reliability of scientific testimony: (1) whether the technique or theory can be tested or challenged in some objective manner (rather than a subjective, conclusory approach that cannot reasonably be assessed for reliability); (2) whether the technique or theory has been subject to peer review and publication; (3) the known or potential rate of error of the technique; (4) the existence and maintenance of standards and controls; and (5) whether the technique or theory has been generally accepted in the scientific community. *Daubert*, 509 U.S. at 593–94.

In *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 141 (1999), the Supreme Court clarified that the courts' gatekeeper function applied to all expert testimony, not just scientific testimony, and indicated that the *Daubert* factors could be applicable in assessing the reliability of nonscientific expert testimony. In 2000, Rule 702 was amended to codify *Kumho Tire*'s amplified scope of application. FED. R. EVID. 702 advisory committee's notes.

175. *See* FED. R. EVID. 702; *Daubert*, 509 U.S. at 589; *Frye*, 293 F. at 1014. *But see* Commonwealth v. Serge, 896 A.2d 1170, 1176 n.3 (Pa. 2006) (holding that, because a computer-generated animation was a graphic illustration of an expert's reconstruction, it was not subject to the *Frye* test for admissibility).

176. 753 F.2d 1224 (3d Cir. 1985).

177. *Id.* at 1227.

178. *Id.* at 1227–28.

179. *See id.* at 1228.

180. *Id.* at 1226; *see also* FED. R. EVID. 702.

181. *Downing*, 753 F.2d at 1226.

182. *Id.*

had established that particular features of the eyewitness identifications involved may have impaired the accuracy of the identifications.[183]

To be used during trial in any form (as demonstrative evidence, an illustrative aid to testimony, or as the basis for an expert's opinion about a material issue in the case), an IVE would almost certainly be subject to some type of relevancy and balancing test fundamentally akin to the one spelled out by the court in *Downing*. No matter the specific evidentiary function of an IVE, its proponent would have to be able to make some manner of foundational demonstration that the technology supporting it was reliable and accurate enough to outweigh its inherent dangers of distortion.[184] The court's finding of the systemic and methodological reliability of IVE technology would underlie its ultimate finding of the authenticity and informational integrity of a particular IVE exhibit. In other words, reliability would form the foundation for competency.[185]

In many ways, the potential use of IVE technology in jury trials today is at the same stage of development—both in terms of the raw technology and the legal system's acceptance of the use of IVE technology and expert testimony about it—that the use of DNA analysis for forensic purposes was at a decade or so ago. These days, expert testimony based upon forensic DNA analysis is largely unchallenged and often admitted subject to courts' taking judicial notice of its general reliability as forensic evidence.[186] But this recognition of

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183. *Id.* at 1226, 1242.

184. *See, e.g.*, Rodd v. Raritan Radiological Assocs., 860 A.2d 1003, 1012 (N.J. Super. Ct. App. Div. 2009) (requiring "testimony from a witness who possesses sufficient knowledge of the technology used to create [computer-generated] exhibits" as foundation for their admissibility because of "the reliability problems arising from computer-generated exhibits and the processes by which they are created").

185. When X-rays were first discovered, many courts admitted them into evidence not upon proof of their individual accuracy, but rather upon expert testimony regarding the reliability of the processes that produced them. Tal Golan, *The Emergence of the Silent Witness: The Legal and Medical Reception of X-rays in the USA*, 34 SOC. STUD. SCI. 469, 478 (2004) [hereinafter Golan, *Silent Witness*]. *See, e.g.*, Bruce v. Beall, 41 S.W. 445, 446 (Tenn. 1897) ("New as [the X-ray] process is, experiments made by scientific men, as shown by this record, have demonstrated its power to reveal to the natural eye the entire structure of the human body, and that its various parts can be photographed as its exterior surface has been and now is."). In time, courts took judicial notice of the reliability of X-ray technology. *See* CHARLES C. SCOTT, PHOTOGRAPHIC EVIDENCE: PREPARATION AND PRESENTATION § 791 (1942).

186. *See, e.g.*, United States v. Beasley, 102 F.3d 1440, 1448 (8th Cir. 1996) (holding that the reliability of the Polymerase Chain Reaction method of DNA analysis was sufficiently well established to permit courts to take judicial notice of it in all future cases). Rule 201(b) permits a court to take "judicial notice" of a particular fact when it is "not subject to reasonable dispute in that it is either (1) generally known within the territorial jurisdiction of the trial court or (2) capable of accurate and ready determination by resort to sources whose accuracy cannot reasonably be questioned." FED. R. EVID. 201(b); *see also* United States v. Jakobetz, 955 F.2d 786, 800 (2d Cir. 1992); Turner v. State, 746 So. 2d 355, 362 (Ala. 1998); Moore v. State, 915 S.W.2d 284, 294 (Ark. 1996); State v. Fleming, 698 A.2d 503, 506–07 (Me. 1997); State v. Butterfield, 27 P.3d 1133, 1143

DNA's general reliability and probative value did not happen overnight. Instead, it was the result of two types of serious undertakings: (1) efforts by forensic molecular biologists to scientifically validate the consistency and reproducibility of the methodology and its results, and (2) efforts by attorneys to fit forensic DNA analysis within the strictures of the rules of evidence. The same work now needs to be done by VR experts and attorneys seeking to use IVEs during trial.

The *Bonds* case provides a blueprint for the type of reliability foundation that would have to be laid to admit expert testimony based upon IVE technology. Bonds, a prospective Hell's Angel, was charged with federal firearms offenses along with two other gang members in connection with a shooting murder.[187] The government's theory of the shooting was that Bonds and his co-defendants had mistaken the victim for a member of a rival motorcycle gang whom they had planned to "hit" in retaliation for a shooting of a Hell's Angel the previous year.[188] There were no eyewitnesses to the shooting, but at the scene of the shooting and in the getaway car there was a large quantity of blood which did not match the victim's blood.[189] Bonds had a ricochet wound in his arm, which the government believed to be the source of the unidentified blood at the scene.[190] The FBI eventually matched a sample of Bonds's blood to the blood at the crime scene and in the getaway car through DNA identification.[191] Bonds's defense was mistaken identity.[192]

In the late 1980s and early 1990s, forensic DNA[193] analysis was in its relative infancy.[194] Prior to trial, Bonds challenged the admissibility of the DNA evidence.[195] The magistrate judge "conducted a six-week *Frye* hearing to determine whether the [government's] proposed experts' trial testimony about the DNA evidence was based upon principles generally accepted in the scientific community."[196] The government's experts testified that the FBI's DNA procedures were generally accepted.[197] Bonds challenged the DNA evidence on the ground that the particular methodology that the FBI employed in performing DNA analysis and the results that the FBI reached were

(Utah 2001).

187. United States v. Bonds, 12 F.3d 540, 546–47 (6th Cir. 1993).

188. *Id.*

189. *Id.* at 547.

190. *Id.*

191. *Id.* at 549.

192. *Id.* at 547.

193. "DNA" stands for deoxyribonucleic acid.

194. *See Bonds*, 12 F.3d at 549–50.

195. *Id.* at 551.

196. *Id.* (footnote omitted).

197. *Id.* at 562.

unreliable, arguing that, had the tests been performed differently, using a different database for the calculation of the statistical probabilities of a false match, different materials in performing the test, or a different multiplication rule, the results would have been more accurate and perhaps different.[198] Bonds also challenged the way that the FBI methodology was tested, arguing that the FBI's probability estimate was imprecise and "that the reliability of the results would have been greater had a different method of testing been employed."[199] Bonds argued that the FBI's procedures for making statistical-probability estimates were not generally accepted by population geneticists and molecular biologists.[200] Bonds presented evidence about deficiencies in the accuracy of the match results and the inadequacy of the testing of the results.[201] The defense experts demonstrated that a substantial controversy existed over whether the results produced were reliable and accurate.[202]

At the conclusion of the hearing, the magistrate judge recommended that the district court admit the DNA evidence.[203] In reaching his conclusion, the magistrate judge issued numerous factual findings about the challenged DNA evidence.[204] The judge credited the expert testimony that established that the protocol used was generally accepted by other DNA labs.[205] He found that the FBI was able to produce reliable results without a significant risk of false matches, despite some flaws in the protocol.[206] He found that the defects in the FBI's validation studies "did not affect [the FBI's] ability reliably to make accurate determinations of matches and avoid false positives."[207] He found that the FBI's methods had received ample acceptance outside of the FBI lab.[208] The district court adopted the magistrate judge's report and recommendation and admitted the expert DNA testimony at trial, over Bonds's objection.[209] The court reasoned that it could not examine Bonds's challenges relating to the accuracy of the DNA analysis results, but could only examine whether the government's expert testimony was based on generally accepted theories and procedures.[210]

198. *Id.* at 558.
199. *Id.*
200. *Id.* at 563.
201. *Id.* at 559.
202. *Id.* at 562.
203. *Id.* at 551.
204. *Id.* at 556.
205. *Id.* at 557.
206. *Id.*
207. *Id.* at 558–59.
208. *Id.* at 560.
209. *Id.* at 551.
210. *Id.* at 563.

On appeal, the United States Court of Appeals for the Sixth Circuit upheld the district court's decision to admit the evidence under *Daubert v. Merrell Dow Pharmaceuticals, Inc*.[211] In doing so, the court reasoned that the evidence that Bonds's DNA partially matched the DNA found in the crime scene sample was relevant to whether Bonds was present at the scene on the night of the murder and, therefore, helpful to the jury in determining whether he was guilty of the charges.[212] More importantly, the court found that evidence credited by the district court established that the theory behind matching DNA and calculating false-match probabilities and the particular technique that the FBI lab employed could be tested by comparing the results generated from one set of samples with the results reached after repeating the matching and probability estimate process on control samples, concluding that it was "irrelevant that there are other methods for DNA matching that could also be or have been tested."[213] The court found that the FBI's principles and methodology had been tested by internal proficiency testing, validation studies, and environmental insult studies to determine whether the lab could produce reliable, reproducible results from samples that had been mixed with contaminants or subjected to environmental insults.[214] The court concluded that it was "clear that the FBI's theories, principles, methods, and techniques can be tested and have in fact been tested."[215] The court found that "the theory behind 'matching' DNA itself and the general procedures used to come up with the forensic results clearly have received peer evaluation."[216] While the court was "troubl[ed]" by the FBI's deficiencies in calculating the rate of error and by the lack of external blind proficiency testing, it held that the other *Daubert* factors outweighed its concerns with the error rate because the general acceptance of the methodology in the scientific community implied that "the rate of error is acceptable to the scientific community as well."[217] The court held: "Disputes about specific techniques used or the accuracy of the results generated go to the weight, not the admissibility of the scientific evidence."[218] The court further noted: "[N]either newness nor lack of absolute certainty in a test suffices to render it inadmissible in court. Every useful new development must have its first day in court."[219] The court held that general

211. *Id.* at 554. The Supreme Court issued its opinion in *Daubert* between the trial and appeal in *Bonds*. *See id.* at 554 (citing *Daubert*, 509 U.S. 579 (1993)).

212. *Id.* at 557.

213. *Id.* at 558.

214. *Id.*

215. *Id.* at 559.

216. *Id.* at 560.

217. *Id.*

218. *Id.* at 561.

219. *Id.* (citation omitted).

acceptance encompassed both the theory of DNA profiling and the FBI's methodology for conducting DNA testing.[220] The court explained:

> [W]hile ordinarily the principles and procedures must be accepted by a majority of those in the pertinent scientific community, the absence of a majority does not necessarily rule out general acceptance. The general acceptance test is designed only to uncover whether there is a general agreement of scientists in the field that [these] scientific data [are] not based on a novel theory or procedure that is "mere speculation or conjecture." In some instances, there may be several different theories or procedures used concerning one type of scientific evidence, all of which are generally accepted. None may have the backing of the majority of scientists, yet the theory or procedure can still be generally accepted. And even substantial criticism as to one theory or procedure will not be enough to find that the theory/procedure is not generally accepted. Only when a theory or procedure does not have the acceptance of most of the pertinent scientific community, and in fact a substantial part of the scientific community disfavors the principle or procedure, will it not be generally accepted.[221]

The court held that "the degree of acceptance in the scientific community of the theory of DNA profiling and of the basic procedures used by the lab in this case is sufficient to meet the requirements . . . for general acceptance."[222] The court concluded: "[G]eneral acceptance is required as to the principles and methodology employed. The assessment of the validity and reliability of the conclusions drawn by the expert is a jury question; the judge may only examine whether the principles and methodology are scientifically valid and generally accepted."[223] The court held that "the Government experts' testimony was based on data and facts reasonably relied upon by experts in molecular biology and population genetics."[224]

Following this blueprint, the lesson from *Bonds* is clear. A proponent of expert testimony wanting the jury to enter an IVE and consider its contents as substantive evidence would need to lay the necessary foundation to establish the following: (1) the IVE was relevant to a material dispute in the case (e.g., the vantage point of an eyewitness or a party); (2) the field of IVE generally, and the expert witness's IVE protocols in particular, were generally accepted

220. *Id.* at 562.
221. *Id.* (citation omitted).
222. *Id.*
223. *Id.* at 563.
224. *Id.* at 566.

among the relevant scientific community, presumably VR computer experts; (3) the expert witness had the ability to produce reliable and accurate IVEs without significant distortion; and (4) the IVE protocols and their accuracy had been scientifically validated and subjected to peer review, and there was some meaningful way to define and measure error within the IVEs created.

The case of *State v. Clark*[225] provides an example, in the context of computer-assisted crime scene reconstruction, of how these foundational requirements could be met. Clark was charged with the murder of Tanya Banks, who died of a gunshot wound to the abdomen.[226] Clark's defense was that Banks had accidentally shot herself.[227] A forensic photographer and crime reconstructionist testified for the State about his reconstruction of the bathroom in which Banks was shot, which he generated using computer software that permitted him to rotate his reconstruction and look at it from different positions.[228] For the purpose of reconstruction, the expert made assumptions about the bullet's trajectory and the position of Banks's body at the time of the shooting, based on information contained in the coroner's report, the physical evidence in the bathroom, and Banks's physical dimensions and posture.[229] During his testimony, the expert used blown-up printouts of the computer-generated drawings of the bathroom to explain the results and conclusions of his report to the jury.[230] The expert acknowledged that it was impossible to place Banks and the assailant in their exact positions at the time of the fatal shooting, but concluded that the accident scene was not consistent with a self-inflicted injury.[231]

On appeal, Clark argued that the expert's testimony was not based upon sufficiently reliable grounds, in violation of Ohio's rule of evidence,[232] which was substantially identical to its federal counterpart.[233] The Ohio Eighth District Court of Appeals rejected Clark's argument, holding that the expert's testimony was sufficiently reliable.[234] The court found that "the field of crime scene reconstruction through the use of computer-generated simulations or computer-assisted drafting" had gained general acceptance.[235] Accordingly, the expert testimony would assist the fact finder in the search for the truth,

225. 655 N.E.2d 795 (Ohio Ct. App. 1995).
226. *Id.* at 798–99.
227. *Id.* at 799.
228. *Id.* at 801.
229. *Id.*
230. *Id.*
231. *See id.* at 801–02.
232. *Id.* at 807–08.
233. *See* FED. R. EVID. 702; OHIO R. EVID. 702.
234. *Clark*, 655 N.E.2d at 813.
235. *Id.*

and the danger of unfair prejudice to Clark was prevented by the State's timely disclosure of the expert's report and underlying data and Clark's opportunity to cross-examine the expert at trial.[236]

Similarly, in *Swinton*, the Connecticut Supreme Court upheld the admission of digitally enhanced photographs of bite marks after foundation for their authenticity had been provided by the State's expert in digital image enhancement.[237] The court noted:

> First, [the expert witness] testified that the computer equipment is accepted as standard equipment in the field. He testified that the Lucis program was relied upon by experts in the field of pattern analysis in a forensic setting. He further testified that the program had been used in "fingerprint pattern identification, bloodstain pattern identification, footwear and tire impression identification, and in bite mark identification." Second, it was established that a qualified computer operator produced the enhancement. [The expert witness's] testimony clearly demonstrated that he was well versed in the Lucis program. He was a well trained and highly experienced forensic analyst, and he testified to his qualifications as an expert in the analysis of pattern evidence and the enhancement of that evidence . . . .
>
> Third, the state presented evidence that proper procedures were followed in connection with the input and output of information. During direct examination, [the expert witness] testified accurately, clearly, and consistently regarding the process of the digitization of the image—wherein a photograph is transformed into pixels . . . —and how [he] then had used the Lucis software to select comparable points of contrast and array them into layers. He also testified as to how the Lucis program then diminished certain layers in order to heighten the visual appearance of the bite mark. . . . Importantly, [the expert witness] compared the enhanced photographs with the unenhanced photographs in front of the jury.
>
> Fourth, the state adequately demonstrated that Lucis is a reliable software program.[238]

If experts can attest to an adequate foundation for the reliability of the science on which proffered IVEs are based, courts should address the potential challenges that IVE exhibits create not by excluding those exhibits,

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236. *Id.* at 814.

237. State v. Swinton, 847 A.2d 921, 943–44 (Conn. 2004).

238. *Id.* (footnotes omitted).

but rather by admitting them and educating the jury about the extent of acceptable interpretations. Jurors can be taught to understand what computer scientists already understand: that IVEs are not "snapshots" of the scenes that they represent, but rather highly mediated outputs of computer-science design, and that their probative value depends upon the nature of the mediations (i.e., the validity of the underlying theories, concepts, and principles that guide the translations from underlying data to final visual representation). Jurors can be instructed to interpret IVEs in light of their context within the relevant computer-science discourse.

Despite their epistemic risks, IVEs should not simply be excluded. That jurors may require expert testimony to help them interpret IVEs is not a reason to exclude them. The expert is the interpreter of the IVE. Expert testimony will frame the IVE, from its authentication to the interpretation of its representations. The foundation needed to authenticate the IVE, for example,[239] will prompt jurors to focus on the model's mediated facets, and cross-examination should expose the limitations of the IVE to prove the fact at issue. To presume otherwise is to presume that expert witnesses are unable to set forth the science clearly enough for jurors to comprehend it.[240] When an expert's testimony accompanies an IVE in court, each makes the other more intelligible and persuasive and less misleading or unfairly prejudicial. The expert testimony and the IVE elucidate one another, maximizing the likelihood that the jury's factual findings will be based upon the most reliable science.

VI. JURY VIEW

In addition to the foundational hurdles of establishing the accuracy, reliability, and authenticity of an IVE prior to its admission into evidence or "publication" to the jury, a party (or court) seeking to place a jury in an IVE

239. *See* FED. R. EVID. 901(b)(9) (stating that one form of authentication is "showing that the process or system produces an accurate result").

240. When expert scientific testimony is clearly presented, jurors largely attain a satisfactory level of comprehension and use the testimony appropriately to improve their findings and conclusions. *See, e.g.*, Neil Vidmar & Shari Seidman Diamond, *Juries and Expert Evidence*, 66 BROOK. L. REV. 1121, 1174 (2000). When jurors come to court with preconceived ideas that are incompatible with legal rules, they are more likely to follow the law rather than their preconceptions if those preconceptions are directly identified and addressed. *See generally* Shari Seidman Diamond & Jonathan D. Casper, *Blindfolding the Jury to Verdict Consequences: Damages, Experts, and the Civil Jury*, 26 L. & SOC'Y REV. 513 (1992) (arguing that an active jury is more effective than a passive jury); Vicki L. Smith, *Prototypes in the Courtroom: Lay Representations of Legal Concepts*, 61 J. PERSONALITY & SOC. PSYCHOL. 857, 858 (1991); Vicki L. Smith, *When Prior Knowledge and Law Collide: Helping Jurors Use the Law*, 17 L. & HUM. BEHAV. 507, 507 (1993). It follows, then, that if jurors hold misconceptions about VR, recognizing and addressing those misconceptions through expert testimony reduces the likelihood that they will be driven by their misconceptions of what the images mean in rendering judgment.

as part of its fact-finding inquiry would face a larger and more conceptual hurdle: there has simply never been anything like it done in a jury trial before. Unlike its counterparts in continental Europe, the Anglo-American system of justice is adversarial, not inquisitorial.[241] The presentation of evidence is driven almost entirely by the parties, through their attorneys.[242] The judge is a "referee," and the jury is merely a passive observer.[243] Because of this adversarial structure, the use of IVEs, which would permit jurors sitting in a criminal trial to "enter," interact with, and manipulate a VR model themselves, is perhaps the most difficult use of VR technology to fit within traditional conceptions of the rules of evidence and the role of the jury. In an IVE, jurors would be able to walk around the virtual scene and reach out and touch virtual objects. As they were viewing the virtual scene, their perceptual feedback would be constantly updated.

Nonetheless, permitting trial jurors to enter an IVE is not without precedent. Despite the adversary nature of the criminal justice system, most, if not all, American jurisdictions have a procedure for a unique inquisitorial jury function—the jury view.[244] Juries are often permitted to visit the scenes of crimes and accidents in the middle of trial,[245] subject to the discretion of the trial judge,[246] even when the scenes that the juries view are no longer in the same state that they were in at the time of the events in question.[247]

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241. Peter J. van Koppen & Steven D. Penrod, *Adversarial or Inquisitorial: Comparing Systems*, *in* ADVERSARIAL VERSUS INQUISITORIAL JUSTICE: PSYCHOLOGICAL PERSPECTIVES ON CRIMINAL JUSTICE SYSTEMS 2 (Peter J. van Koppen & Steven D. Penrod eds., 2003).

242. *See id.* at 3.

243. SAUL M. KASSIN & LAWRENCE S. WRIGHTSMAN, THE AMERICAN JURY ON TRIAL: PSYCHOLOGICAL PERSPECTIVES 131, 141 (1988) (explaining that juries are treated as "passive recipients of information" and the judge as a "master of ceremonies").

244. *See* United States v. Passos-Paternina, 918 F.2d 979, 986 (1st Cir. 1990). Federal courts recognize their authority to permit a jury view of places or objects outside of the courtroom as part of their inherent supervisory power over trial. *Id.*

245. *See, e.g.*, Rhonda Cook, *Jurors Stay Silent on Visit to Crime Scene*, ATLANTA J. CONST., May 16, 2009, at A8 (discussing a murder trial jury's visit to the scene where the decedent's body was found). The juries in music producer Phil Spector's two murder trials also toured his home in California, the alleged murder scene. Jury Tours Phil Spector's Los Angeles Home, Telegraph on the Web, Feb. 20, 2009, http://www.telegraph.co.uk/news/newstopics/celebritynews/4701976/Jury-tours-Phil-Spectors-Los-Angeles-home.html.

While historically there was a split among jurisdictions, almost all jurisdictions today consider a jury viewing of a crime scene or other location to constitute the receipt of "evidence." *See, e.g.*, People v. Bush, 10 P. 169, 173–75 (Cal. 1886); 4 JOHN HENRY WIGMORE, EVIDENCE IN TRIALS AT COMMON LAW § 1168 (James H. Chadbourn ed., 1972).

246. United States v. Pettiford, 962 F.2d 74, 76 (1st Cir. 1992); Casias v. United States, 302 F.2d 513, 514 (10th Cir. 1962); Houston Coca-Cola Bottling Co. v. Kelley, 131 F.2d 627, 628 (5th Cir. 1942); Van De Putte v. Cameron County Water Control & Improvement Dist. No. 7, 35 S.W.2d 471, 473 (Tex. Civ. App. 1931) (permitting the jury to view the premises in dispute).

247. *See, e.g.*, Dickson v. Yale Univ., 105 A.2d 463, 464–65 (Conn. 1954) (upholding the trial court's permission allowing the jury to view the premises of an accident that occurred when Dickson

Generally, the scene has been altered through the process of crime scene investigation and preservation, accident reconstruction, or merely the passage of time.[248] It has been cleaned up, and crucial evidence has been removed for laboratory analysis. For example, in a homicide case, the body of the decedent will certainly have been removed so that an autopsy can be performed, biological evidence will have been removed for DNA analysis, the murder weapon will have been removed for ballistics analysis, and so on. Juries generally do not even visit scenes at the same time of day or under the same conditions as when the alleged crime was committed or the accident occurred.[249] Nonetheless, despite these distortions, the common law recognizes that the probative value of an on-site view of the scene outweighs the potential unfair prejudice or jury confusion that may result from an imperfect facsimile of the scene and leaves to argument by the parties the weight that the jury should place on the imperfections.[250] Juries have been permitted to view a scene by going to the scene of the crime or accident and investigating it themselves, if doing so would aid them in reaching a correct result,[251] as long as the scene remains in a substantially similar condition as it

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fell off of a balcony without a guardrail even though the jury could have seen that a guardrail had subsequently been installed).

248. *See generally* Arizona v. Youngblood, 488 U.S. 51 (1988) (holding that the negligent failure of the police to refrigerate the victim's clothing and to perform tests on semen samples during a child molestation investigation did not constitute a denial of due process in the absence of bad faith).

For example, in the infamous O.J. Simpson murder trial, jurors were permitted to view Simpson's home to illustrate testimony regarding his bloody socks that were allegedly recovered there, even though the socks, of course, were no longer at the scene at the time of the viewing. *See* Albert W. Alschuler, *How to Win the Trial of the Century: The Ethics of Lord Brougham and the O.J. Defense Team*, 29 MCGEORGE L. REV. 291, 309–11 (1998). In addition, the jury was permitted to the view the scene after Simpson's attorneys had altered the decor by replacing multiple pictures of white women (including a nude picture of Simpson's white girlfriend) with pictures depicting African-Americans (including a famous Norman Rockwell painting depicting a black schoolgirl being escorted to a recently desegrated school by National Guard troops). *Id.*; George Fisher, *The O.J. Simpson Corpus*, 49 STAN. L. REV. 971, 978 (1997).

249. *See, e.g.*, Rau v. Redwood City Woman's Club, 245 P.2d 12, 17 (Cal. Dist. Ct. App. 1952) ("The mere fact that changes have occurred at the scene of an accident does not necessarily prevent a view of the scene by the jury."); Miller v. Anchor Cas. Co., 45 N.W.2d 705, 708 (Minn. 1951) ("[T]he possibility that a view will aid the jury in understanding the evidence in these actions cannot be precluded merely because some period of time has transpired since the accident occurred.").

250. *See Rau*, 245 P.2d at 17.

251. *See, e.g.*, CAL. PENAL CODE § 1119 (2004); N.Y. CRIM. PROC. LAW § 270.50 (2002) (providing that a court may permit the jury, prior to closing argument, to view or observe the crime scene or any other premises or place involved in the case when doing so would be helpful to the jury in determining any material fact at issue); WASH. CRIM. R. 6.9 (giving a trial court discretion to permit the jury to view the crime scene); MONT. CODE ANN. § 46-16-502 (2009) ("When the court considers it proper that the jury view any place or personal property pertinent to the case, it will order the jury to be conducted in a body . . . to view the place or personal property . . . ."); *see also* People v. King, 534 N.W.2d 534, 538 (Mich. Ct. App. 1995) (stating that a crime scene can be

was in at the time of the alleged crime or accident.[252] A few courts have permitted jury views that were "interactive" in nature.[253]

The purpose of permitting a jury to view the scene is to enable it better to understand and apply the evidence produced in court.[254] As the Appellate Division of the New York Supreme Court has explained:

> It is a well-understood fact that an individual familiar with the locality can better and more accurately understand the testimony of the witnesses describing scenes occurring therein than a stranger who is dependent entirely upon the description given by the witnesses. *A criminal trial is to ascertain the facts . . . .*[255]

If anything, an IVE created to simulate the scene of a crime or accident so that the jury can virtually view it would be a more accurate way to reconstruct the scene as it was at the time of the events in question, since the IVE could simulate the time of day, presence of the physical evidence, and so on, in a way that the actual scene, stripped of much of its material evidence prior to jury viewing, could not.[256] Perhaps the greatest danger presented by a live view of a crime or accident scene is the risk that extraneous, irrelevant, or unfairly prejudicial information would reach the jury, either in the form of communication or comments by one of those present at the scene, or inappropriate sights seen by jurors.[257] Because IVEs can be designed with "gaze-directed" steering techniques and "locked" fields of view, which prevent lateral head movements, they can restrict jurors to a literal "three-

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viewed by the jury as long as it is told of the changes).

252. *See* People v. White, 416 N.Y.S.2d 260, 264 (N.Y. App. Div. 1979) (citation omitted), *rev'd on other grounds by* New York v. White, 421 N.E.2d 825, 827 (1981); *cf.* People v. Postell, 629 N.Y.S.2d 480, 481 (N.Y. App. Div. 1995) (holding that the trial court properly exercised its discretion in permitting the jury to view the crime scene even though a scaffolding had been removed since the murder because "the jury could easily reconstruct the exact scene" and the viewing was "helpful to the jury in assisting it to determine what the eyewitnesses to the crime saw and heard").

253. *See, e.g.*, Newman v. Los Angeles Transit Lines, 262 P.2d 95, 100 (Cal. Dist. Ct. App. 1953) (upholding a trial court's decision to permit a jury view of a streetcar that included a demonstration of the functioning of its door); State v. O'Day, 175 So. 838, 842 (La. 1937) (upholding the trial court's decision to permit witnesses to testify at a jury view of a crime scene); Tarr v. Keller Lumber & Const. Co., 144 S.E. 881, 883 (W. Va. 1928) (upholding the trial court's decision to permit the jury to view a power saw in operation).

254. State v. Gone, 587 P.2d 1291, 1294 (Mont. 1978); State v. Land, 851 P.2d 678, 682 (Wash. 1993).

255. *White*, 416 N.Y.S.2d at 262 (citation omitted).

256. However, this decision would remain discretionary with the trial judge. Thompson v. South Carolina Highway Dep't, 70 S.E.2d 241, 243–44 (S.C. 1952) (upholding a trial court decision that the availability of photographic evidence rendered a jury view undesirable).

257. *See, e.g.*, People v. Stanley, 665 N.E.2d 190, 191 (N.Y. 1996) (finding reversible error after jurors conducted an experiment at the crime scene).

dimensional tour" of the scene, ensuring that each juror gets the exact same optic flow as any other,[258] as opposed to a live scene view, where each juror can look anywhere that she wants in the scene, and not all jurors leave having viewed the same scene.

One of the original rationales for the admissibility of crime scene photographs into evidence was that they were an improved but functional equivalent of a crime scene viewing by the jury.[259] The case of *Mardoff v. State*[260] is an example. Mardoff was convicted of the murder of his wife by stabbing her twenty times in bed.[261] On appeal, Mardoff challenged the introduction into evidence of gruesome photographs of his dead wife, with the weapon still embedded in her body.[262] In the photographs she appeared as she did when she was discovered by the police when they entered the crime scene on the night of the murder: propped up against the wall between the foot of the bed and a bookcase standing nearby.[263] Four of the photographs were taken of the room in which the murder was committed and the body found before the body was moved, and the fifth was taken without any rearrangement of any of the objects in the room except that the body had been lifted from the wall, exposing the hilt of a Chinese dagger protruding from the victim's back, to show how the weapon that caused the death had been plunged into the victim's back and left there.[264] Rejecting Mardoff's challenge, the Florida Supreme Court explained:

> The value of a pictorial representation of the scene of a crime is obvious. From the very nature of the crime of homicide it is not possible for the trial jury to view the premises before physical appearance of the scene is changed by removal of the victim's body. It is common knowledge

258. This "locking" is analogous to the redaction of physical exhibits, often performed by the old-fashioned media of black pen and photocopier.

259. *See Thompson*, 70 S.E.2d at 243. Similarly, courts admitted newly discovered X-rays into evidence relatively quickly based on the rationale that they were a specialized category of conventional photography and, therefore, illustrative aides to medical testimony. *See* Golan, *Silent Witness*, *supra* note 185, at 474–77; W.W. Goodrich, *The Legal Status of the X-Ray*, *in* TRANSACTIONS OF THE MEDICAL SOCIETY OF NEW YORK 235 (1904); Edward C. Halperin, *X-Rays at the Bar, 1896–1910*, 23 INVESTIGATIVE RADIOLOGY 639 (1988); Orlando F. Scott, *Röntgenograms and their Chronological Legal Recognition*, 24 ILL. L. REV. 674, 676 (1930). *See, e.g.*, Miller v. Dumon, 64 P. 804, 805 (Wash. 1901) ("[T]here would seem to be no reason for making a distinction between an X-ray and a common photograph; that is, either is admissible as evidence when verified by proof that it is a true representation of an object which is the subject of inquiry.").

260. 196 So. 625 (Fla. 1940).

261. *Id.* at 626.

262. *Id.*

263. *Id.*

264. *Id.*

> that the descriptions given by witnesses, however conscientious, who have observed the body of a murdered person and the surroundings will vary often to a surprising degree. No better way has so far been devised to show the scene of a homicide than a photograph taken before the body of the deceased and the objects near or around it have been disturbed.
>
> The admissibility of such evidence must be determined by the trial judge after an inquiry as to whether the objects appearing in the picture are in the same position as when the crime was discovered to preclude fabrication of testimony, for a picture of the reconstruction of the crime would be harmful in the same degree that the true representation would be helpful to the jury in comprehending the real conditions of the place where the crime was committed.[265]

This rationale seems equally, if not more, applicable to the use of VR technology to simulate immersive scenes for juries.

The portrayal of scene evidence has followed a somewhat linear progression: live viewing, drawings, black-and-white photographs, color photographs, video recording, and, now, VR simulation. There is no reason why IVE technology should be subjected to any different or more strenuous threshold for admissibility than any other representational medium.[266] As the Florida Supreme Court explained in rejecting a challenge to the then-new technology of color photography:

> We feel that the rule regulating the admissibility of pictures has been settled and that there is no occasion further to pursue it except to the point that it might be varied by the use of prints in color. The argument that there should be a distinction seems to us specious for the accuracy of a print should be enhanced by the natural color of the objects depicted . . . .

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265. *Id.* at 626–27; *see* Adams v. State, 10 So. 106, 107 (Fla. 1891) ("A map, diagram, or picture, whether made by the hand of man or by photography, verified as a correct representation of physical objects about which testimony is offered . . . is admissible in evidence . . . to enable the jury to better understand the case.").

266. *See* Commercial Union Ins. Co. v. Boston Edison Co., 591 N.E.2d 165, 168 (Mass. 1992) ("[W]e treat computer-generated models or simulations like other scientific tests, and condition admissibility on a sufficient showing that: (1) the computer is functioning properly; (2) the input and underlying equations are sufficiently complete and accurate . . . ; and (3) the program is generally accepted by the appropriate community of scientists.").

> Our conclusion is that the test in judging admissibility is one of relevancy and that there is no reason to apply a separate and distinct rule to pictures in color.[267]

VII. THE VIRTUAL CRIME SCENE

In the context of a criminal case, there are two additional advantages that an IVE re-creation of a crime scene would have over a live jury viewing or other representational evidence. First, an IVE could be controlled in a way that could eliminate certain Rule 403 concerns without diminishing the probative value of the evidence. One substantial area of litigation in criminal jury trials has to do with the gruesome details that are often inherent in representational media—autopsy photographs, blood spatter patterns, and ballistics and weapons analysis.[268] An IVE simulating the crime scene could be constructed that would permit a sufficiently, if not more, accurate view of the crime scene and its pertinent details (the position of the body, the location where the weapon was discovered, the fatal wounds) without the blood and guts of video and still photographs.[269]

Second, the use of an IVE representing the events in question, created by a VR expert after consultation with the defense team or review of pretrial discovery materials, might provide a vehicle for a criminal defendant to introduce evidence of her version of events before the jury and permit the jury to test that version of events without the defendant having to waive her Fifth Amendment privilege against self-incrimination. For example, imagine a murder prosecution where the defense is mistaken self-defense. The defendant is claiming that she shot someone in an alley that she believed was attacking her, when in fact the person was in the alley for innocent reasons unrelated to the defendant. The primary issue at trial is the reasonableness of the defendant's mistaken belief. Ordinarily, for the jury to assess whether the

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267. Wilkins v. State, 155 So. 2d 129, 131 (Fla. 1963).

268. A judge may exclude evidence under Rule 403 if "its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury." FED. R. EVID. 403. For a discussion on the impact of gruesome evidence on jury decision making, see David A. Bright & Jane Goodman-Delahunty, *Gruesome Evidence and Emotion: Anger, Blame, and Jury Decision-Making*, 30 LAW & HUM. BEHAV. 183, 184–89 (2006). *See, e.g.*, Brooks v. State, 973 So. 2d 380, 393 (Ala. Crim. App. 2007); Matthews v. State, 99 S.W.3d 403, 405 (Ark. 2003); People v. Hoyos, 162 P.3d 528, 555 (Cal. 2007); State v. Satchwell, 710 A.2d 1348, 1362 (Conn. 1998); State v. Warledo, 190 P.3d 937, 951 (Kan. 2008); Fields v. Commonwealth, 274 S.W.3d 375, 411 (Ky. 2008); State v. Lee, 645 N.W.2d 459, 468 (Minn. 2002); State v. Marshall, 586 A.2d 85, 134 (N.J. 1991); State v. Williams, 565 S.E.2d 609, 653 (N.C. 2002); State v. Craig, 853 N.E.2d 621, 639 (Ohio 2006); Stouffer v. State, 147 P.3d 245, 268 (Okla. Crim. App. 2003); Prible v. State, 175 S.W.3d 724, 733, 735 (Tex. Crim. App. 2005); State v. Calliham, 57 P.3d 220, 231 (Utah 2002).

269. In this sense, the use of an IVE instead of a live scene viewing would be analogous to redacting the gory details from photographs depicting the scenes of crimes or accidents, autopsies, and so on. *See, e.g.*, United States v. Sampson, 486 F.3d 13, 43–44 (1st Cir. 2007).

defendant's mistake was reasonable, the defendant, as a practical matter, would have to take the stand and testify to her recollection and perception of the events for the jury to see the alley through her eyes, placing her credibility at issue and subjecting herself to all of the inherent risks of testimony—being under oath, subject to cross-examination;[270] opening the door to the introduction of highly prejudicial information, like evidence of her prior bad acts, convictions, and inconsistent statements,[271] or evidence that is otherwise inadmissible;[272] or undercutting the jury's ability to apply the presumption of innocence and burden of proof.[273] With an IVE, a VR expert could generate an IVE, taking into account all parties' versions of events, permitting the jury to see the alley through the defendant's eyes without the inherent risks entailed with the waiver of her Fifth Amendment privilege through live

270. *See generally* Jeffrey Bellin, *Improving the Reliability of Criminal Trials Through Legal Rules that Encourage Defendants to Testify*, 76 U. CIN. L. REV. 851, 868–69 (2008) (discussing the value of hearing from the defendant and the way that a criminal defendant's decision to testify exposes her to cross-examination with otherwise inadmissible evidence—"a vigorous rhetorical challenge to any perceived inconsistencies or inaccuracies in the defendant's testimony").

271. *See* FED. R. EVID. 404(b) (prohibiting the introduction of evidence of a defendant's prior bad acts to prove action in conformity therewith); FED. R. EVID. 608(b) (permitting impeachment of a testifying witness with evidence of prior bad acts); FED. R. EVID 609 (permitting impeachment of a testifying witness with evidence of prior convictions); FED. R. EVID 613 (permitting impeachment of a testifying witness with evidence of prior inconsistent statements); *see generally* FED. R. EVID. 609 advisory committee's notes ("[I]n virtually every case in which prior convictions are used to impeach the testifying defendant, the defendant faces a unique risk of prejudice—i.e., the danger that convictions that would be excluded under FED. R. EVID 404 will be misused by a jury as propensity evidence despite their introduction solely for impeachment purposes."); Margaret Meriwether Cordray, *Evidence Rule 806 and the Problem of Impeaching the Nontestifying Declarant*, 56 OHIO ST. L.J. 495, 508 (1995) ("The danger that the jury will misuse evidence of a defendant's prior record is a real one, and the prejudice arising from misuse is substantial."); Alan D. Hornstein, *Between* Rock *and a Hard Place: The Right to Testify and Impeachment by Prior Conviction*, 42 VILL. L. REV. 1, 1–2 (1997) ("Typically, the defendant may keep the jury from learning of prior convictions only by waiving the right to testify."); Gene R. Nichol, Jr., *Prior Crime Impeachment of Criminal Defendants*, 82 W. VA. L. REV. 391, 419 (1980) (noting the impossibility of a jury separating character evidence introduced to impeach a defendant's credibility from its knowledge of the defendant's character as applied to the determination of guilt or innocence). *But see* FED. R. EVID. 806 (permitting the impeachment of the credibility of a nontestifying hearsay declarant in the manner as if the declarant had testified).

272. *See* Michigan v. Harvey, 494 U.S. 344, 351 (1990) (permitting a testifying criminal defendant to be impeached with evidence obtained in violation of the Sixth Amendment right to counsel); United States v. Havens, 446 U.S. 620, 627–28 (1980) (permitting a testifying criminal defendant to be impeached with evidence seized in violation of the Fourth Amendment, even if the defendant's direct-examination testimony did not implicate the illegally seized evidence, as long as the subject was "reasonably suggested by the defendant's direct examination"); Oregon v. Hass, 420 U.S. 714, 721–22 (1975) (permitting a testifying criminal defendant to be impeached with evidence obtained in violation of the Fifth Amendment).

273. Peter W. Tague, *The Fifth Amendment: If an Aid to the Guilty Defendant, an Impediment to the Innocent One*, 78 GEO. L.J. 1, 19 (1989).

testimony.[274] Presumably, this is precisely what the defense in *Harris* was attempting to do with its rejected VR simulation—show the jury what the parking lot looked like from behind the wheel of the Mercedes in a more reliable and less risky way than having Harris testify about what she saw.

VIII. CONCLUSION

In any given trial, there may be legitimate concerns about the reliability and accuracy of employing an IVE to reconstruct the scene of an accident or crime. Some of the essential questions educed by the baseline assumptions underlying the creation and interpretation of IVEs recommend a cautious strategy to their use during jury trials. Assuming, however, that foundational testimony satisfied the ordinary standards for admissibility, the law should not react to the challenges raised by the use of IVEs with juries by categorically excluding them. Instead, courts should allow the use of IVEs (in appropriate cases) while endeavoring to improve jurors' virtual literacy so that their findings of fact and legal judgments will be facilitated by the best available computer technology.

Concerns with distortion and manipulation are not unique to IVEs. Still photographs can be doctored in ways that render the changes undetectable. These types of concerns with IVE models could be addressed through thorough pretrial discovery, particularly of the bases for the construction of the model, under the existing rules of criminal and civil procedure.[275] Some concerns could also be addressed with limiting instructions to the jury,[276] including instructions as to weight that the jury should place on its observations within an IVE. If the different sources of information upon which an IVE model is built are questionable or unreliable, those unreliable sources could be explored by the opponent of the IVE model on cross-examination or even, ultimately, become grounds to challenge the use of an individual IVE model in a particular case,[277] but such concerns do not warrant

274. One non-courtroom example of the possibilities for using VR technology to develop more accurate understandings of past events is the VR simulation "JFK: Reloaded," which uses IVE technology to place participants in the role of Lee Harvey Oswald, John F. Kennedy, Jr.'s assassin, in a mass-participation forensic reconstruction of the events to determine whether Lee Harvey Oswald could have acted alone. Had such technology been available in 1963, Oswald's defense team could have deployed it to advance an alternate theory of the crime.

275. Presumably, an IVE model of crime or accident scene would be constructed primarily with reference to video and photographic recordings, witness statements, and physical evidence.

276. *See, e.g.*, Nunneley v. Edgar Hotel, 225 P.2d 497, 502 (Cal. 1950) (holding that permitting a jury to view the scene of an accident on a hotel roof after substantial changes had been made was not error because the trial court instructed the jury not to consider the changes in reaching its verdict).

277. For example, if an expert computer witness constructed an IVE model, at least in part, on the basis of partisan witness statements, and if changing the contents of the witness statements would

excluding an entire medium from jury trials. Certainly, if a particular IVE model would be of little assistance to a jury and its potential for misuse, delay, or confusion of the issues were great or it were cumulative of other evidence presented, a court would have the discretion to deny its admission under Rule 403.

While the use of an IVE during a jury trial may seem like a foreign invasion into the traditional American adversary judicial system, it can also be viewed as merely another point along a line of technological progression, from scene viewing to photography to video evidence to virtual evidence. Employing an IVE during trial would be no different in substance than the admission of other types of testimonial, photographic, and demonstrative evidence that courts have permitted for decades. Many of the concerns with the use of an IVE during a jury trial (distortion, reliability, authenticity) are the same concerns that were raised when photographic (and later video) evidence of crime and accident scenes first began to be introduced during jury trials. Ultimately, those objections were overcome by comparing and analogizing the photographic evidence to the more traditional practice of the jury viewing the scene. Today, no one doubts the admissibility of a crime scene photograph or video, as long as it is a fair and accurate representation of the scene that it seeks to capture. On the contrary, contemporaneous photographs and videos are often admitted into evidence as more accurate alternatives to a visit to the (subsequently altered) scene by the jury. In the same vein, IVE technology used to re-create a scene is simply an even more advanced and accurate way of helping the jury to weigh and evaluate witness testimony and other evidence. As such, the advantages of its use far exceed the disadvantages.

Much has been written about the epistemic underpinnings of the rules of evidence—to wit, that the central function of a trial is to discover the truth and that accuracy is a measure of the proximity to or likelihood of the truth.[278]

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change the resulting model in a way that benefited the opposing party, such information would certainly affect the weight that the jury would give to the model and the expert's opinion about it. This process would be no different than if a psychiatrist retained by a party in a civil or criminal case gave an expert psychiatric opinion on the basis of information provided directly by the party and an assumption that such information was accurate and truthful.

278. *See, e.g.*, Tehan v. United States *ex rel.* Shott, 382 U.S. 406, 416 (1966) (noting that the "basic purpose of a trial is the determination of truth"); Funk v. United States, 290 U.S. 371, 381 (1933) ("The fundamental basis upon which all rules of evidence must rest—if they are to rest upon reason—is their adaptation to the successful development of the truth."); R. v. Nikolovski, [1996] 3 S.C.R. 1197, 1206 (Can.) (stating that ascertaining the truth is "[t]he ultimate aim of any trial, criminal or civil"); R. v. Levogiannis, [1993] 4 S.C.R. 475, 483 (Can.) (stating that "[t]he goal of the court process is truth seeking"); R. v. Howard, [1989] 1 S.C.R. 1337, 1360 (Can.) (emphasizing "the commitment of courts of justice to the ascertainment of the truth"); ERNEST GELLNER, LEGITIMATION OF BELIEF 27 (1974); H.L. HO, A PHILOSOPHY OF EVIDENCE LAW: JUSTICE IN THE SEARCH FOR TRUTH 63 (2008); LARRY LAUDAN, TRUTH, ERROR, AND CRIMINAL LAW: AN ESSAY

They are why the rules of evidence entertain a strong presumption in favor of the admissibility of relevant evidence.[279] Periodically, the development of a new technology forces the judicial system to rethink those epistemological questions.[280]

Much more than traditional modes of visual media, IVEs have the power to place jurors in the position of the parties and witnesses to the circumstances surrounding a disputed event.[281] At the same time, the use of IVEs would permit courts to "lock in" the scene at the relevant moment in time and remove any unfairly prejudicial items from the jury's perception. Subject to

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IN LEGAL EPISTEMOLOGY 2 (2006); Edmund M. Morgan, *Hearsay Dangers and the Application of the Hearsay Concept*, 62 HARV. L. REV. 177, 184–85 (1948) (suggesting that the court should attempt to get "as close an approximation of the truth as is possible"); Frederick Schauer, *On the Supposed Jury-Dependence of Evidence Law*, 155 U. PA. L. REV. 165, 194 (2006); Alex Stein, *Against "Free Proof,"* 31 ISR. L. REV. 573, 576–77 (1997); Alex Stein, *The Refoundation of Evidence Law*, 9 CAN. J.L. & JURISPRUDENCE 279, 285 (1996); William Twining, *Freedom of Proof and the Reform of Criminal Evidence*, 31 ISR. L. REV. 439, 452 (1997); Wendorf, *supra* note 40, at 387 ("[J]ustice and fairness to litigants insist that jurors be permitted to see the issues for themselves when circumstances make that action feasible."). *But see* LUDOVIC KENNEDY, THE TRIAL OF STEPHEN WARD 251 (1965) ("[L]et no one pretend that our system of justice is a search for truth. It is nothing of the kind. It is a contest between two sides played according to certain rules, and if the truth happens to emerge as the result of the contest, then that is pure windfall."); HENRY SUMNER MAINE, VILLAGE-COMMUNITIES IN THE EAST AND WEST 302 (New York, Henry Holt & Co. 1889) (rejecting the theory that judicial evidence is "a sort of contrivance for the discovery of truth"); FREDERICK POLLOCK, ESSAYS IN THE LAW 275 (1969) (arguing that it is "the greatest of all the fallacies . . . that the business of a court of justice is to discover the truth"); JOHN W. SALMOND, JURISPRUDENCE OR THE THEORY OF THE LAW 458 (1907) (arguing that that the rules of evidence are one of the "last refuges of legal formalism"); Zechariah Chafee, Jr., *A Treatise on the Anglo-American System of Evidence in Trials at Common Law*, 37 HARV. L. REV. 513, 519 (1924) (book review); Edmund M. Morgan, *Suggested Remedy for Obstructions to Expert Testimony by Rules of Evidence*, 10 U. CHI. L. REV. 285, 285 (1943) (rejecting the characterization of a lawsuit as "primarily a proceeding for the discovery of truth"); Robert S. Summers, *Formal Legal Truth and Substantive Truth in Judicial Fact-Finding*, 18 L. & PHIL. 497, 506 (1999) (characterizing the judicial proceeding "less as a search for substantive truth than as a search for a definite winner"); Thomas Weigend, *Is the Criminal Process About Truth? A German Perspective*, 26 HARV. J. L. & PUB. POL.'Y 157, 167 (2003) (arguing that "the jury is not designed to function as a truth-finder" because jurors are irrational).

Other commentators argue that the central objectives of the rules of evidence are legitimacy, fairness, and integrity. *See, e.g.*, H. L. Ho, *Legal Professional Privilege and the Integrity of Legal Representation*, 9 LEGAL ETHICS 163, 168–69 (2006); Jack B. Weinstein, *Some Difficulties in Devising Rules for Determining Truth in Judicial Trials*, 66 COLUM. L REV. 223, 241 (1966).

279. *See, e.g.*, FED. R. EVID. 402; CAL. EVID. CODE § 351 (1995); KAN. CIV. PROC. CODE ANN. § 60-407 (West 2010). One exception to this claim is the rationale behind evidentiary rules that purport to exclude evidence on grounds of unreliability. *See* HO, A PHILOSOPHY OF EVIDENCE LAW, *supra* note 278, at 63.

280. *See* PAUL, *supra* note 15, at 34 ("Digital information objects now compel us to rediscover the concept of authenticity."); *id.* at 48 ("The drafters of Article X [of the Federal Rules of Evidence] gave no thought to the fact that digital files are pure information, and live apart from the world of artifacts. . . .").

281. *See* Bailenson et al., *supra* note 16, at 265–66.

reasonable limitations and the ability of a proponent to establish the necessary foundation for admissibility, the interests of truth are advanced by allowing the parties, or even the court, to employ an IVE during a jury trial.