

**Boston University  
Journal of Science & Technology Law**

**Column**

**Virtual Reality Evidence**

**Gregory P. Joseph, Esq.**

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# Virtual Reality Evidence<sup>†</sup>

Gregory P. Joseph<sup>\*</sup>

## 1. Introduction

"Virtual reality" refers to a category of computer-generated simulations—generally three-dimensional animations—that are designed to place the viewer in a simulated environment that reacts in a visually appropriate fashion to the viewer's actions. The unique aspect of a virtual reality simulation is its interactivity: the simulation responds to the actions of the viewer in a programmed, realistic fashion. While there are no reported decisions discussing the issues raised by admitting virtual reality simulations into evidence, at least one trial court has admitted virtual reality evidence to date,<sup>1</sup> and it is likely that as the technology improves and proliferates, more proffers will be forthcoming. [1]

Analyzing the admissibility of virtual reality proffers is not conceptually taxing. Because virtual reality is a type of computer simulation, the principal foundation issues concern the factual and scientific underpinnings of the proffer. The factual premises, and data input process, may in turn raise hearsay issues. As discussed below in Sections 2 and 3, the necessary foundation for virtual-reality evidence will establish, as with any computer simulation, (1) the admissibility of the underlying scientific theory;

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<sup>\*</sup> B.A., summa cum laude, 1972, University of Minnesota; J.D., cum laude, 1975, University of Minnesota Law School. Mr. Joseph is a partner at Fried, Frank, Harris, Shriver & Jacobson in New York; a member of Advisory Committee on the Federal Rules of Evidence; Vice-Chair of the American Bar Association Section of Litigation; and a fellow of the American College of Trial Lawyers. He is the author of books on evidence, sanctions, and civil RICO. The opinions expressed herein are solely those of the author.

<sup>1</sup> Stephenson v. Honda Motors Ltd. of Am., No. 81067 (Cal. Supp. Ct. Placer Co. June 25, 1992) (unreported), available on the Internet at <http://www.venable.com.litlab/dunn/htm>.

(2) the admissibility of the computer simulation program;<sup>2</sup> (3) the admissibility or utility of the factual predicate; and (4) the soundness of the implementation, that is, the incorporation of the facts and the theory into the program. [2]

The unique quality of virtual reality evidence—its interactivity—may be displayed live or on tape. In other words, the simulation may be shown responding to the actions of a witness, either live at the trial or on videotape. Conceivably, the court could even permit the jury to interact with the simulation. Apart from foundation questions, which largely parallel those raised by any proffer of a simulation, the use of virtual-reality evidence raises a variety of unique evidentiary issues, in particular relevance and prejudice questions under Federal Rules of Evidence ("Rule" or "Rules") 402 and 403.<sup>3</sup> As explored below in Section 4, these issues have a range of potential resolutions. [3]

## 2. *Authentication of Computer-Generated Simulations*

### A. Basic Requirements

The authentication standard governing computer-generated evidence of any sort, including virtual reality evidence, is set forth in Rule 901(a) of the Federal Rules of Evidence: "The requirement of authentication . . . is satisfied by evidence sufficient to support a finding that the matter in question is what its proponent claims."<sup>4</sup> There is a specific illustration of sufficient authentication for computer evidence tucked into Rule 901(b)(9), but it adds nothing of substance, requiring only "evidence . . . showing that the process or system produces an accurate result."<sup>5</sup> [4]

### B. Primary Criteria

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<sup>2</sup> See FED. R. EVID. 702.

<sup>3</sup> FED. R. EVID. 402 provides that "[a]ll relevant evidence is admissible, except as otherwise provided by the Constitution of the United States, by Act of Congress, by these rules, or by any other rules prescribed by the Supreme Court pursuant to statutory authority. Evidence which is not relevant is not admissible." FED. R. EVID. 403 provides that "[a]lthough 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 evidence."

<sup>4</sup> FED. R. EVID. 901(a).

<sup>5</sup> FED. R. EVID. 901(b)(9).

A review of the cases reflects that to assess whether, and how much, detailed computer authentication is needed in any given case, courts rely on the following four criteria: (1) **Completeness of Data:** to the extent that the computer process is dealing with known data, fewer questions are raised than if the computer is performing operations on partial data that are assumed, either in whole or in part (for example, by filling gaps in the data, using various assumptions, before manipulating the data); (2) **Complexity of Manipulation:** simple addition and subtraction, for example, raises fewer questions than complex formulae; (3) **Routineness of Entire Operation:** routineness suggests reliability (key components of routineness are data collection, input/processing (software)/output, and computer hardware); (4) **Verifiability of Results:** can the result be tested or checked? For example, compare a pie chart depicting corporate sales results or inventory (testable) to a sophisticated animation depicting underground pollution contamination or recreating the cause of an aircraft crash (inherently untestable).<sup>6</sup> [5]

The weight a court gives to these variables will vary from case to case, but the implications are straightforward. More complete data, simpler manipulation, more routine processing and more verifiable results all argue against the need for elaborate, computer-specific authentication. If any one of these variables tends in the opposite direction, the court must consider the magnitude of that variance and the strength of the doubt that has been raised as to the exhibit's genuineness. [6]

In any given case, the court may require detailed authentication of input, processing, or output evidence. Not all of these might be challenged in connection with any particular proffer, and each raises separate issues.<sup>7</sup> There are, however, unique issues raised by use of any computer-generated simulation that, like virtual reality, takes the form of an animation. [7]

### C. Simulation Authentication

At its simplest, an animation is merely a sequence of illustrations that, when filmed, videotaped, or computer-generated, creates the illusion that the illustrated objects are in motion. Because animations are drawings, they traditionally have been subjected to the fair-and-accurate-portrayal test; when they have been admitted, it has generally been for illustrative purposes only.<sup>8</sup> [8]

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<sup>6</sup> See generally GREGORY P. JOSEPH, MODERN VISUAL EVIDENCE, §§ 7.01[2]-[4], 7.03[1]-[2], 7.05[1]-[3], 8.03[1]-[2], and 8.05[1]-[2] (Supp. 1996).

<sup>7</sup> For checklists of these issues and further discussion, see *id.* §§ 7.01, 7.03.

<sup>8</sup> See, e.g., *Rockwell Graphic Systems, Inc. v. DEV Indus., Inc.*, No. 84 C 6746, 1992 U.S. Dist. LEXIS 17661 (N.D. Ill. Nov. 10, 1992) (admitting computer-generated animation comparing two printing

#### D. Mathematical Models

Computer-generated animations that are produced from simulation programs are based on mathematical models, and particular attention must be paid to the reliability and trustworthiness of these models. A model is a set of operating assumptions—a mathematical representation of a defined set of facts, or system. To be accurate, it must produce results that are either identical or very similar to those produced by the physical facts (or system) being modeled. In order to do this, the model must contain all the relevant elements and reflect all the relevant interactions that occur in the real world. [9]

#### E. Simulation Models

A simulation model is a computer program that consists of a set of assumptions about precisely what would transpire under certain clearly defined circumstances. If the simulation model works well, the result is to show the probable consequences that are predicted by the theory that underlies the equations. [10]

Because of the difficulty of reflecting all of the complexities of any real-world system in a computer program, various simplification techniques are used. The danger is that the introduction of simplification risks invalidating the simulation that is produced. [11]

Both the scientific theory underlying the simulation and the theory's incorporation into the simulation program must satisfy the test governing scientific or technical evidence, as construed by the Supreme Court in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*<sup>9</sup> More precisely, the mathematical model must appropriately measure the selected factors, those factors must be relevant and inclusive, and the underlying mathematical formulae and simplification techniques must be shown to be apt. The proponent will also have to establish that the mathematical tools were correctly applied, and that the problem—the evidential or usable facts—were appropriately translated into the model. [12]

The uniquely interactive character of virtual reality simulations therefore requires authentication that the underlying theory has been programmed, and the facts in issue input into the program, in such a way that the simulated response is reasonably

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presses). *But see* *Sommervold v. Grevlos*, 518 N.W.2d 733 (S.D. 1994) (excluding computer-generated animation of a collision between two bicyclists).

<sup>9</sup> 509 U.S. 579 (1993). See *FED. R. EVID.* 702; *Robinson v. Missouri Pacific R.R.*, 16 F.3d 1083, 1088-89 (10th Cir. 1994).

identical to the expected real-world response. The incorporation of the facts into the simulation may in turn trigger hearsay concerns, which are discussed below in Section 3. Moreover, as discussed below in Section 4, the actions with which the simulation interacts must also have a basis in the record, by either replicating actions in issue, demonstrating the plausibility of a contention, or attacking credibility. [13]

### 3. *Computer-Generated Hearsay Evidence*

Two components of computer-generated evidence can raise hearsay issues: both the entry of the data into the computer, and any underlying assertions that are so entered, must satisfy a hearsay exception or be exempt in order for the evidence to be admissible. [14]

#### A. *Data Entry*

The act of data entry is an extrajudicial statement (assertive nonverbal conduct) within Federal Rule of Evidence 801(a),<sup>10</sup> as is any underlying declaration, under Rule 801(c), and therefore hearsay.<sup>11</sup> Data entry is usually considered a regularly-conducted activity within Rule 803(6)<sup>12</sup> (or, in appropriate circumstances, a public record under

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<sup>10</sup> FED. R. EVID. 801(a) provides that a "statement" is (1) an oral or written assertion or (2) nonverbal conduct of a person, if it is intended by the person as an assertion."

<sup>11</sup> FED. R. EVID. 801(c) defines hearsay as a "statement, other than the one made by the declarant while testifying at the trial or hearing, offered in evidence to prove the truth of the matter asserted."

<sup>12</sup> FED. R. EVID. 803(6) defines "records of regularly conducted activity" as a memorandum, report, record, or data compilation, in any form, of acts, events, conditions, opinions, or diagnoses, made at or near the time by, or from information transmitted by, a person with knowledge, if kept in the course of a regularly conducted business activity, and if it was the regular practice of that business activity to make the . . . record, . . . all as shown by the testimony of the custodian or other qualified witness.

In appropriate circumstances, data entry falls within the public records exception to the general hearsay exclusion provided by FED. R. EVID. 803(8), which allows the admissions of [r]ecords, reports, statements, or data compilations, in any form, of public offices or agencies, setting forth (A) the activities of the office or agency, or . . . (C) in civil actions and proceedings and against the Government in criminal cases, factual findings resulting from an investigation made pursuant to authority granted by law, unless the sources of information or other circumstances indicate lack of trustworthiness.

Data entry often falls within the present sense exception to the hearsay exclusion, which is defined as a "statement describing or explaining an event or condition made while the declarant was perceiving the event or condition, or immediately thereafter." FED. R. EVID. 803(1).

Rule 803(8)).<sup>13</sup> It also often falls within Rule 803(1)'s present sense impression exception.<sup>14</sup> [15]

The critical question about the data entry function is its accuracy. Although the hearsay rules take trustworthiness into account,<sup>15</sup> this concern is, in substance, one of authenticity.<sup>16</sup> Consequently, as a matter of judicial administration, the accuracy of the data should be addressed as part of the requisite authentication foundation whenever a genuine doubt as to its trustworthiness has been raised. If the foundational evidence establishes that the data have been entered accurately, the hearsay objection to the data entry function should ordinarily be overruled.<sup>17</sup> [16]

Each electronic data entry contained in the computer is, like the hard copy used in the ordinary course of business, a "record" within Federal Rule of Evidence 803(6) or (8). In the terminology of these Rules, each electronic entry is a "data compilation, in any form."<sup>18</sup> Consequently, if each data entry has been shown to conform to Rule 803(6) or 803(8), the computer-generated output satisfies the hearsay exception even if it was not printed out at or near the time of the events recorded (as long as the entries were timely made), was not prepared in the ordinary course (but, for example, for trial), and is not in the usual form (is instead in graphic form). If the data is simply downloaded into a printout, it does not lose its business-record character. To the extent that significant selection, correction and interpretation are involved, however, a court may question the data's reliability and authenticity.<sup>19</sup> [17]

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13 See *supra* note 12 and accompanying text.

14 *Id.*

15 See, e.g., FED. R. EVID. 803(6) and FED. R. EVID. 803(8), which both provide for the admission of evidence "unless the sources of information or the method or circumstances or preparation indicate lack of trustworthiness."

16 See *supra* Section 2.

17 See FED. R. EVID. 803(24)'s catch-all exception, which applies to statements having "equivalent guarantees of trustworthiness" as enumerated Rule 803 exceptions, and that are "more probative" than alternative, reasonably available forms of evidence.

18 See, e.g., *United States v. Catabran*, 836 F.2d 453, 456 (9th Cir. 1988) (admitting general ledger printouts as business records under Rule 803(6)); *United States v. Sanders*, 749 F.2d 195, 198 (5th Cir. 1984) (admitting computer printouts of medical claims as business records under Rule 803(6)).

19 See, e.g., *United States v. Russo*, 480 F.2d 1228, 1239-43 (6th Cir.), *cert. denied*, 414 U.S. 1157 (1973) (discussing the proffor's burden of proof in establishing the reliability and trustworthiness of computer printouts prior to admission as evidence).

## B. Underlying Data

If the underlying data that are entered into the computer are themselves hearsay declarations (for example, witness statements), they in turn must satisfy a hearsay exception under Rule 803 or 804,<sup>20</sup> or be an exemption contained in Rule 801, in order to comply with Rule 805.<sup>21</sup> Alternatively, their use must be permitted even if they are not independently admissible, as under Rule 703.<sup>22</sup> An expert may rely on inadmissible evidence "[i]f of a type reasonably relied upon by experts in the particular field."<sup>23</sup> [18]

### 4. *Potential Uses and Admissibility of Virtual Reality Evidence*

In addition to the issues of authenticity and hearsay that apply to all computer-generated simulations, virtual reality evidence can raise unique issues, depending on its proposed use. The most likely courtroom uses would appear to be either to demonstrate or recreate past conditions or events, or simply to portray them. This could presumably be done either interactively in front of (or with) the trier of fact, or the simulation could be recorded in advance of trial. [19]

## A. Recreations

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<sup>20</sup> FED. R. EVID. 804. Under Rule 804's exceptions to the hearsay rule, hearsay statements are admissible if the declarant is unavailable as a witness and the statement concerns former testimony, or the statement is a statement against interest, a statement made under a belief of impending death, or a statement of personal or family history. Rule 804(b)(5) is a catch-all provision for hearsay that does not fall within a specific exception, but where the statement is probative and bears on a material fact, and where admission of the statement will best serve the interests of justice, it is admitted.

<sup>21</sup> FED. R. EVID. 805 provides that "[h]earsay included within hearsay is not excluded under the hearsay rule if each part of the combined statements conforms with an exception to the hearsay rule provided in these rules."

<sup>22</sup> See FED. R. EVID. 703, which provides that [t]he facts or data in the 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 on by experts in the particular field in forming opinions or inferences upon the subject, the facts or data need not be admissible in evidence.

<sup>23</sup> FED. R. EVID. 703.

Using virtual reality, a witness on the stand could engage in a demonstration purporting to recreate events in issue, with the results being broadcast on a screen to the trier of fact. In-court demonstrations always raise relevancy questions under Rule 402.<sup>24</sup> The burden is on the proponent to satisfy the judge that there is a substantial similarity between the demonstration and what it purports to represent.<sup>25</sup> That standard, in this context, would require the proponent to show substantial similarity in material respects not only between the virtual reality conditions and those at issue, but also the witness's actions on the stand and the events that occurred. Presumably the latter, like the former, would be the subject of foundational testimony and, at the request of the proponent, cross-examination on voir dire. [20]

The recreation might just as easily be videotaped (or transferred to videotape) in advance of trial. This is perhaps more likely to occur, because it would afford counsel greater control over the actions, which might otherwise be inadmissible, and over the results, which might prove untoward. Under either scenario, the evidentiary issues remain essentially the same. [21]

Using virtual reality to recreate conditions and events, whether live or on videotape, there will undoubtedly be differences between the events at issue and those that are simulated or recreated, no matter how careful the witnesses are in their interaction with the simulation. If the court is satisfied that the testimony sufficiently explains the differences, and that the demonstration therefore permits the fact-finder to draw reasonable inferences, the court may allow the demonstration. The unavoidable existence of those differences, however, by definition triggers Rule 403 prejudice concerns,<sup>26</sup> the importance of which are magnified by the potential impact of a virtual-reality in-court recreation on the jury. [22]

There is a general presumption in favor of admitting tests and demonstrations for illustrative purposes, where they may prove helpful to the fact-finder.<sup>27</sup> In the context of a virtual reality simulation, however, this will clash directly with the

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<sup>24</sup> See *supra* note 3 and accompanying text.

<sup>25</sup> See, e.g., *United States v. Wanoskia*, 800 F.2d 235, 238 (10th Cir. 1986) (placing the burden on the profferor of evidence to show that an experiment substantially replicates the conditions of the actual event). In *Wanoskia*, the prosecution physically re-enacted the decedent's death in an attempt to show that the decedent could not have died from a self-inflicted gunshot wound. *Id*; see also *Kehm v. Procter & Gamble Mfg. Co.*, 724 F.2d 613, 624 (8th Cir. 1983) (requiring an expert witness to testify about the similarities between an in-court demonstration and the phenomena it replicates).

<sup>26</sup> See *supra* note 4 and accompanying text.

<sup>27</sup> See, e.g., *Harvey v. Mazal American Partners*, 79 N.Y.2d 218, 223-24 (1992) (allowing demonstrative evidence of a plaintiff's cognitive abilities, which had been severely diminished as a result of the accident at issue).

widespread judicial reluctance to admit recreations or reconstructions without very careful scrutiny.<sup>28</sup> In light of the nascency of virtual reality technology, and its potential impact on the jury, the latter approach would appear the more sound. [23]

## B. Simple Demonstrative Evidence

Virtual reality could also be used to create a fuller, three-dimensional portrayal of the events or conditions at issue. Although there are no reported decisions on this issue, a legal memorandum available on the Internet<sup>29</sup> reports that a California trial court admitted a three-dimensional, virtual reality portrayal of the terrain over which the plaintiff drove her motorcycle. The simulation allowed the jury to view the scene from the motorcycle rider's perspective.<sup>30</sup> While the court's legal analysis is not reported, presumably it consisted of the fair-and-accurate portrayal test, under which computer-generated graphic evidence, like non computer-generated evidence, is admissible if shown to fairly and accurately portray its subject matter.<sup>31</sup> [24]

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<sup>28</sup> See, e.g., *Robinson v. Missouri Pacific R.R. Co.*, 16 F.3d 1083, 1087-88 (10th Cir. 1994) (affirming the admission of a computer-generated animation videotape depicting the collision of a car and train); *Champeau v. Fruehauf Corp.*, 814 F.2d 1271, 1278 (8th Cir. 1987) (affirming the admission of a videotape demonstrating the distance and speed estimates of a collision of a tractor-trailer). In *Champeau*, the videotaped experiment was not a recreation of the accident; rather, it was "used to demonstrate general principles of physics" and to refute a witness's testimony. *Id.* The videotaped experiment was performed at the scene of the accident. *Id.* at 1273.

<sup>29</sup> Located on the Internet at <http://venable.com:80/litlab/DUNN.HTM>. The site is maintained by the law firm of Venable, Baetjer, Howard & Civiletti, LLP. The memorandum was authored by Jeffrey A. Dunn of that firm.

<sup>30</sup> *Stephenson v. Honda Motors Ltd. of Am.*, No. 81067 (Cal. Sup. Ct. Placer Co. June 25, 1992) (unreported case).

<sup>31</sup> See, e.g., *People v. McHugh*, 124 Misc.2d 559, 560, 476 N.Y.S.2d 721, 722 (Supp. 1984) (noting that "[w]hether a diagram is hand drawn or mechanically drawn by means of a computer is of no importance"). In *McHugh*, the criminal defendant sought to introduce as evidence a "computer re-enactment of a fatal car crash." *Id.* See also *Ladeburg v. Ray*, the court affirmed the admission of "diagrams drawn by a computer" where "[t]he expert testified that he used the computer as a drafting tool" on the theory that "[t]he diagrams were merely mechanical drawings made by a computer and the expert who prepared them was available for cross-examination." 508 N.W.2d 694, 695-96 (S.D. 1993). In *Ladeburg*, the defendants sought to introduce computer-drawn diagrams of the accident scene. *Id.*

Any exhibit, including any virtual reality exhibit, is subject to exclusion under such principles as those embodied in Rule 403,<sup>32</sup> Rule 611(a),<sup>33</sup> and where applicable, Rule 1006 (which allows charts, calculations and summaries to represent the contents of voluminous data that are independently admissible and that have previously been made available to adversaries).<sup>34</sup> [25]

### C. Jury Interactivity

To the extent that virtual reality would be introduced for illustrative, rather than substantive, purposes, it would presumably not go to the jury room.<sup>35</sup> Were the jury to have access to virtual reality that members could don and manipulate, that could lead to unregulated juror tests and experiments, which are generally impermissible. Juror test results would constitute "extraneous prejudicial information . . . improperly brought to the jury's attention," within the meaning of Rule 606(b).<sup>36</sup> [26]

Juror access to a virtual reality simulation is problematic because juror actions need not be limited to those in evidence, unless the simulation is specially programmed to disregard irrelevant acts, in which case something less than full interactivity would exist. In the absence of such special, limiting programming, any interactivity, including juror interactivity, raises serious Rule 402<sup>37</sup> relevance issues, as well as prejudicial-effect-versus-probative-value issues under Rule 403, which is an underlying explanation

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<sup>32</sup> See *supra* note 3 and accompanying text.

<sup>33</sup> FED. R. EVID. 611(a) states that "[t]he court shall 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."

<sup>34</sup> FED. R. EVID. 1006 states: "[t]he contents of voluminous writings, recordings, or photographs which cannot conveniently be examined in court may be presented in the form of a chart, summary, or calculation."

<sup>35</sup> See, e.g., *United States v. Wood*, 943 F.2d 1048, 1053-54 (9th Cir. 1991) (stating that charts or summaries when used as pedagogical devices should not be admitted as evidence); *Pierce v. Ramsey Winch Co.*, 753 F.2d 416, 431 (5th Cir. 1985) (stating that charts organizing documents or testimony should not be admitted as evidence).

<sup>36</sup> See, e.g., *Simon v. Kuhlman*, 488 F. Supp. 59 (S.D.N.Y. 1979). In *Simon*, the court held that the jury's unauthorized experiments with a stocking in the jury room may have created a "possibility of prejudices sufficient to constitute a denial of due process" and justify a writ of habeas corpus. *Id.* at 66-67.

<sup>37</sup> See *supra* note 3 and accompanying text.

for the Rule 606(b) ban.<sup>38</sup> It is not inconceivable, however, that the trial court might properly exercise its discretion, in some circumstances, to allow the jury to interact to a limited extent with certain types of virtual reality evidence—perhaps to show that, the conditions having been accurately recreated, one party's version of the events is impossible, or a witness's version of the events is incredible. [27]

## 5. Conclusion

There is nothing novel or radical about harnessing visual technology for courtroom use. Since photography was first admitted as evidence in the mid-19th century,<sup>39</sup> new types of visual evidence have repeatedly been introduced. The challenge is to adapt familiar evidentiary precepts to evolving technologies—in other words, to unfamiliar facts. To assess proffers of virtual reality evidence, established principles governing computer-generated evidence provide the necessary benchmarks, and the sound discretion vested in judges affords the necessary flexibility. [28]

The defining characteristic of virtual reality evidence—its interactivity—raises unique relevance and prejudice issues, in addition to the bundle of foundation questions typically presented by computer simulation evidence. Its potential impact should, and no doubt will, raise the level of judicial scrutiny applied even to typical foundation issues. As virtual reality technology becomes more advanced, and the evidence more familiar, judicial receptivity is likely to increase, as is the potential usefulness of the evidence. [29]

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38 *Id.*

39 *See, e.g., Church v. City of Milwaukee*, 31 Wis. 512, 519-20 (1872) (holding that a photograph of the plaintiff's premises could properly be admitted as evidence).