Virtual Reality

Put Your Best Foot Forward

By Charles A. Fox, Melissa L. McAlpine, and Kevin G. Owens

Using virtual reality in your case can enhance your client's position in various crucial ways.

People are extremely good at processing visual information. Images are remembered by most people better than reading or hearing about an event. This is because our brains process pictures differently than words. Images more directly or effectively engage areas of the brain that are involved in storing memories. Cheryl L. Grady, Anthony R. McIntosh, M. Natasha Rajah, & Fergus I. M. Craik, *Neural Correlates of the Episodic Encoding of Pictures and Words*, 95 Proc. Natl. Acad. Sci. USA 2703–08 (1998).

Image memory is an important factor to consider when presenting to fact finders in a trial. However, there are several reasons to leverage effective visualization in a courtroom or mediation. Good graphics can transform complicated or technical facts into understandable, real-world experiences. When complex concepts are made understandable for a fact finder, mental traction is gained, resulting in actionable insights. Then, a juror may see why the case tips in your favor. Accurate 3D visuals can also put the fact finder at the scene of the occurrence.

Finally, images are memorable. Several studies since the 1970s have shown that humans have an amazing ability to recall images. Some have shown that an average juror can recall thousands of images with about a 90 percent accuracy rate. Lionel Standing, Jerry Conezio, & Ralph Norman Haber, *Perception and Memory for Pictures: Single-Trial Learning of 2500 Visual Stimuli*, 19(2) Psychon. Sci. 73–74 (1970); Gesche

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M. Huebner & Karl R. Gegenfurtner, *Conceptual and Visual Features Contribute to Visual Memory for Natural Images*, PLoS ONE 7(6): e37575, at 1–8 (2012). https://doi.org/10.1371/journal.pone.0037575.

Why 3D Instead of Pictures?

In early 1995, Pixar released the trailer for *Toy Story*—a 3D-animated feature film. Until that time, feature-length animation consisted of a series of hand-drawn frames or photographs, which, when viewed at thirty frames per second, created the illusion of motion. The motion relied on the eye and hands of the artist creating the animation and was not rigorously driven by data. Disney animators studied how animals move and became skilled at creating the illusion of a lion's movements, but digital motion capture, paired with computer algorithms to drive a dimensionally accurate lion model's movement, was a thing of the future, enabled by 3D animation. Working in three dimensions in a computer program allowed animators and scientists to break down the elements of a scene and an event so that every aspect of it could be accurately defined.

One of the advantages of 3D visualization involves data consumption. We exist in 3D, so the information we collect about objects and scenes is typically in three dimensions. We measure left, right, up, and down. If we can simply enter this data into a 3D world, we no longer must start with 2D projections like draftsmen of old. Rather, we can simply replicate our measurements in the computer's 3D world and allow the machine to render 2D images to a screen or to a print. Viewing thirty computer-rendered still images per second can create the illusion of motion: a 3D animation.

Until recently, our means of collecting dimensional data was primitive. It involved drawings with lots of measurements on them, and if we were lucky, a 2D CAD file. Now, we exist in a sea of data. Millions of points of 3D data are collected within minutes with a laser scanner. This technology generates a point cloud, capturing surfaces as far as 300 meters away. Each point contains positional information and color associated with that point. When a series of scans are combined, we have a realistic and dimensionally accurate representation of an object or a scene. *See* Figure 1.

Drone-captured and land-based photo arrays also provide 3D data that can be useful for measuring the dimensions of an object or for creating a realistic 3D model. This intentionally collected data provides the foundation for a scientifically accurate 3D space in which we can create an animation or virtual reality application.

Found data is a second class of data that is also important when creating dimensionally accurate scenes or scientifically reliable animations. Found data consists of information collected by devices such as smart phones, wearable devices, security cameras, and event recorders. This data has value on its own, but combined with an accurate three-dimensional scene, a skilled visualization technologist can accurately place objects visible in security camera footage in the 3D scene so that the object in question can be accurately analyzed in context. Cell-phone video may provide information on the speed of a vehicle that when placed in a 3D scene provides critical information in an accident sequence. Even ATM camera stills can be used to determine a complex sequence of events when placed in a 3D-rendered scene. *See* Figure 2.

Virtual reality allows us to step into these scenes. Until recently, we could create accurate 3D spaces and look at them on a computer monitor. Today, we can slip on a head-mounted display (HMD) and navigate a 3D space at 1:1 scale. Viewers gain a new appreciation for the scale of a space, allowing them experience how tight and tricky it is to enter a space, or how easy it is to interact with a device. Rather than looking at calculations, we can engage our innate intuition about how events occur. In addition to interacting with a scaled scene, we can interact with reconstructed events in real time.

Virtual reality, or "VR," is our best view yet into this data-generated 3D world.

Several studies since the 1970s have shown that humans have an amazing ability to recall images. Some have shown that an average juror can recall thousands of images with about a 90 percent accuracy rate.

Using VR, we can view and engage the 3D environment on a human scale, rather than peering at it through a screen, experiencing multiple points of view as we move around within a virtual event.

Figure 1

Laser scan of a residential fire scene

Definitions: Demonstrative Aids, Demonstrative Evidence, and Admissibility

Demonstrative *aids* consist of materials that are made for demonstration in the courtroom. These animations, 3D prints, or other teaching tools are often used to aid expert witnesses when teaching the trier of fact about technical aspects of a case.

Demonstrative *evidence* is far more rare than demonstrative aids and may be animations, 3D prints, or other images or objects that are entered into the record as evidence. To be admitted as evidence, they are held to a higher standard than demonstrative aids.

There are two main advantages to admitting a demonstrative as evidence. First, demonstrative evidence can be reviewed by jurors during deliberations. Demonstrative aids, while helpful for the jury, are typically not allowed in the jury room. Second, because demonstrative evidence is part of the record, it follows the case through the appellate process. In *KSR v. Teleflex,* 550 U.S. 398, 127 S. Ct. 1727, 167 L. Ed. 2d 705 (2007), demonstrative evidence that ESi team members developed followed the case all the way to the United States Supreme Court.

Admissibility Overview

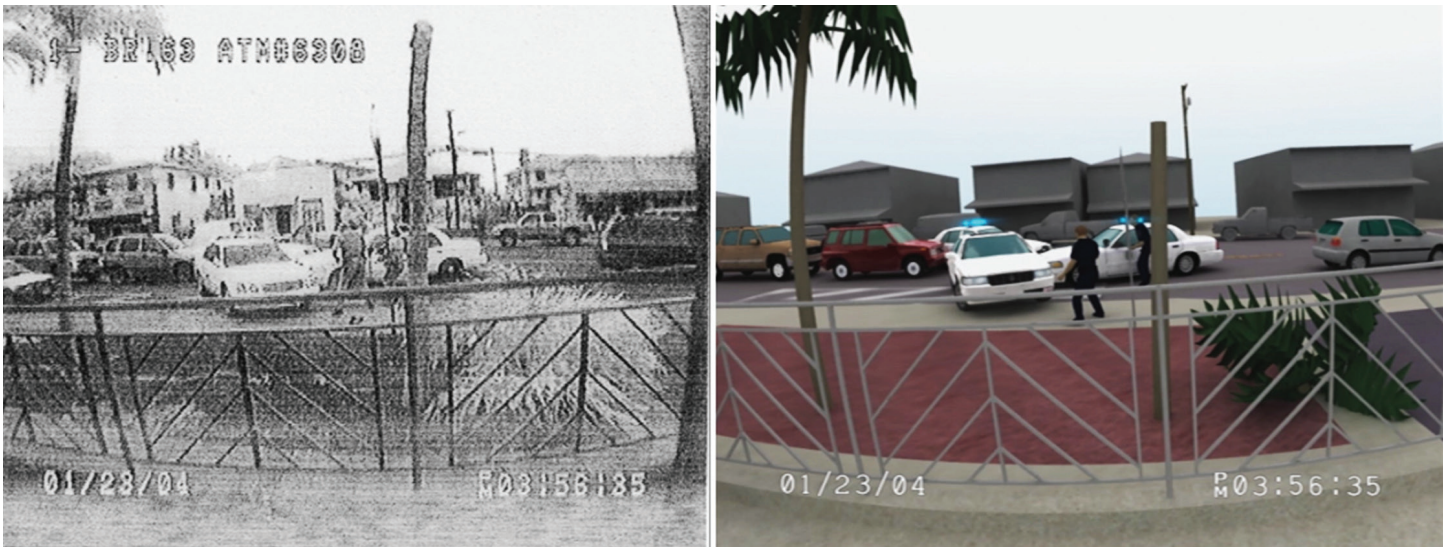
The proponent of demonstrative evidence must satisfy basic tests to meet the requirements for admissibility. In Illinois, for example, it is well established that films and videotapes, when properly authenticated and relevant, are admissible as demonstrative evidence. *See Carney v. Smith*, 240 Ill. App. 3d 650, 608 N.E.2d 379 (1992). Videotapes are admissible on the same basis as still photographs. *Missouri Portland v. United Cement*, 145 Ill. App. 3d 1023, 496 N.E.2d 489 (5th Dist. 1986). To admit a videotape, a competent witness must attest that the videotape accurately depicts what it purports to show, and its probative value must not be substantially outweighed by the danger of unfair prejudice. *Missouri*, 145 Ill. App. 3d at 1029, 496 N.E.2d at 493. Photographs are admissible if, among other things, the photographs enable the jury to apply the testimony of a witness more intelligently to the facts shown. *See Baggett v. Ashland Oil & Refining Co.*, 92 Ill. App. 2d 433, 447, 236 N.E.2d 243, 250 (1968). If a video is relevant, and a proper foundation has been established, it is an abuse of discretion for a court to deny its admission. *See Missouri*, 145 Ill. App. 3d at 1029, 496 N.E.2d at 493.

In Illinois, the courts favor the use of demonstrative evidence to help a jury better understand the issues in a case. *Burke v. Toledo, Peoria & Western R.R. Co.*, 148 Ill. App. 3d 208, 213, 498 N.E.2d 682, 686 (1st Dist. 1986). The overriding considerations in admitting demonstrative evidence are relevancy and fairness. 148 Ill. App.3d at 213, 498 N.E.2d at 686. Illinois courts have long favored the use and admission of demonstrative evidence that clarifies an expert witness's testimony or assists in his or her presentation. *Hubbard v. McDonough Power Equipment*, 83 Ill. App. 3d 272, 404 N.E.2d 311, 319 (5th Dist. 1980).

Likewise, in Illinois, "plats, photographs, drawings and diagrams, which illustrate the subject matter of testimony, may be received into evidence for the purpose of showing a particular situation, explaining the testimony or enabling [the jury] to apply the testimony more intelligently to the facts shown." *O'Brien v. Stefaniak*, 130 Ill. App. 2d 398, 406, 264 N.E.2d 781, 785 (1st Dist. 1970) (quoting *Dept. of Public Works & Bldgs.v. Chicago Title & Trust Co.*, 408 Ill. 41, 95 N.E.2d 903 (1951)). The standards for admitting demonstrative evidence require that the evidence fairly and accurately reflect, and aid the jury's understanding of, the underlying oral testimony. *See Ogg v. City of Springfield*, 121 Ill. App. 3d 25, 38, 458 N.E.2d 1331, 1339–40 (1984).

Although the Illinois courts have not directly addressed the admissibility of computer animations, many other state court jurisdictions have. *See Robinson v.*

Figure 2



The left panel shows an ATM photo. The ATM snapped photographs every 4 seconds and captured several images of the Police disabling a stolen vehicle. The right panel shows a frame from a 3D animation that was created using positional information gained from the ATM camera, matching the virtual camera view with the ATM camera view.

Missouri Pacific R.R. Co., 16 F.3d 1083, 1087 (10th Cir. 1994) (admitting an animation where a simulation of accident illustrated an expert's theory and where trial court issued limiting instruction to the jury not to consider the video as a true recreation); *State v. Harvey*, 649 So.2d 783, 788–89 (La. Ct. App.), *writ denied*, 657 So.2d 1026 (La. 1995) (affirming admission of computer-generated animations where they illustrated an expert's theory); *Commercial Union v. Boston Edison Co.*, 412 Mass. 545, 591 N.E.2d 165, 168 (1992) (admitting a computer model based, in part, on the accuracy of input); *Bray v. Bi-State Development Corp.*, 949 S.W.2d 93, 99 (Mo. Ct. App. 1997) (admitting a computer-generated chart because it was accurate and reflected an expert's testimony); *Kudlacek v. Fiat*, 244 Neb. 822, 509 N.W.2d 603, 617 (1994) (affirming admission of a computer video simulation, in part, based on its conformity to actual dimensions of an automobile, marks on a roadway, the speed, and that angle at which the vehicle left the roadway); *State v. Clark*, 101 Ohio App. 3d 389, 655 N.E.2d 795, 813, *appeal denied*, 72 Ohio St.3d 1548, 650 N.E.2d 1367 (1995) (holding that a computer-generated reconstruction of crime scene was properly admitted, in part, because it was based on the actual dimensions of the crime scene and relied on police calculations); *Deffinbaugh v. Ohio Turnpike Commission*, 67 Ohio App.3d 692, 588 N.E.2d 189, 193–94, *appeal denied*, 55 Ohio St.3d 703, 562 N.E.2d 894 (1990) (holding that computer simulations were properly admitted where they accurately depicted the motion of the vehicle in addition to other previously introduced facts).

People v. McHugh, 124 Misc.2d 559, 476 N.Y.S.2d 721 (N.Y. Sup. Ct. 1984), is the first reported case to address a litigant's use of computer animation at trial. In *McHugh*, the defendant sought to introduce a computer reenactment of his version of an accident. The court held that it was possible for the computer reenactment of the car crash to be introduced at trial, holding that the computer reenactment was "more akin to a chart or diagram than a scientific device." The court further stated:

> Whether a diagram is hand drawn or mechanically drawn by means of a computer is of no importance. What is important is that the presentation be relevant…, that it fairly and accurately reflect the oral testimony offered and that it be an aid to the jury's understanding of the issue.

124 Misc.2d at 560, 476 N.Y.S.2d at 722–23.

In *Mintun v. State of Wyoming*, 966 P.2d 954 (Wyo. 1998), the defendant appealed his conviction for aggravated homicide by vehicle. On appeal, the defendant argued that the court erred in admitting into evidence a computer-generated animation showing the investigating police officers' reconstruction of the accident, arguing that the animation was not properly authenticated because it did not accurately present what the only eyewitness to the occurrence claims to have seen. The computer-generated animation showed the police officers' reconstruction of the accident from three vantage points, including the point at which the eyewitness watched the accident occur. 966 P.2d at 957–58.

The court held that the trial court did not err in admitting the animation. The court found that the animator's testimony as to how the animation was created, combined with the police officer's testimony on the methods used in reconstructing the accident and his intent to show only his reconstruction, not the eyewitness's version, were sufficient to authenticate the animation. 966 P.2d at 958–59.

These cases instruct that the reliability and weight of evidence is chiefly a concern for the trier of fact, while the reliability, methodology, and techniques used to obtain are questions for the court.

The Two-Part Admissibility Test

Federal courts determine the admissibility of demonstrative evidence by reference to Federal Rules of Evidence 401, 402, and 403, and they apply what amounts to a two-step test. Under Rule 402, to be admissible, evidence must be relevant. Rule 401 defines relevance as "the tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence." Rule 403 provides that although relevant, evidence may be excluded "if its probative value is substantially outweighed by a danger of one or more of the following: unfair prejudice, confusing the issues, misleading the jury, undue delay, wasting time, or needlessly presenting cumulative evidence." Fed. R. Evid. 403. In determining whether evidence is admissible under Rules 402 and 403, a trial court is granted broad discretion, and generally an admissibility decision will not be overturned absent a showing of a clear abuse of discretion, or a finding that a court's holding was clearly erroneous. *See, e.g., Strock v. Southern Farm Bureau Casualty Inx. Co.,* 1993 U.S. App Lexis 17431 (4th Cir. 1993).

The United States District Court for the District of Colorado outlined the admissibility standards as they applied to a video animation used by an expert witness to depict and support his conclusions in *Bullock v. Daimler Trucks N. Am., LLC,* 819 F. Supp. 2d 1172 (D. Colo. 2011). There, the plaintiffs' decedent was a passenger riding in a tractor-trailer truck manufactured by the defendant and being driven by another individual, and he was killed when the vehicle crashed. His family brought a negligence and product liability action against the defendant. The defendant sought admission of a modeling analysis prepared using a modeling software known as "MADYMO." *Bullock,* 819 F. Supp. 2d at 1175.The court first noted that "in order for the MADYMO modeling analysis to be admissible, Defendant must lay an adequate foundation for the MADYMO's introduction into evidence. *See* Fed. R. Evid. 901." In barring it, the court found:

> The record is inadequate for the Court to determine how the MADYMO program actually works. *See Novartis Corp. v. Ben Venue Labs., Inc.*, 271 F.3d 1043, 1054 (Fed. Cir. 2001) ("Without knowing the foundations [underlying a computer simulation], a court cannot evaluate whether the simulation is probative…."). Given this, the Court is not in a position to evaluate properly [the expert's] representations that the MADYMO modeling analysis is merely an illustration—an animation—of the expert opinions of Defendant's designated experts….

Id. (alterations in original). The *Bullock* court was clearly troubled by the fact that the record was "unclear to what extent, if any, the MADYMO program, using data provided by the experts, actually generated its own 'opinions' regarding the movements of [decedent and the driver] during the accident in question." *Id.*

Also of significance to a discussion of the potential admissibility of VR, the *Bullock* court highlighted, in its own citations, the distinction between using animations as demonstrative support for an expert's opinions, (i.e., those not admitted as evidence and thus not allowed in the jury room), versus as evidence (i.e., those allowed in the jury room for the jury to use during its deliberations). *Id.* at 1176–77 (citing and quoting *Ortiz v. Yale Materials Handling Corp.,* 2005 WL 2044923 (D. N.J. Aug. 24, 2005) ("While the Federal Rules of Evidence do not have specific provisions governing the admission of computer-generated simulations, reconstruction and animation as substantive evidence, such computer-generated evidence has long been accepted as an appropriate means to communicate complex issues to a lay audience, *so long as the expert's testimony indicates that the processes and calculations underlying the reconstruction or simulation are reliable.*") (emphasis in original), and 57 Am. Jur. Proof of Facts 3d 455, §12 (2005) ("'In order to have a computer animation or simulation admitted into evidence, the proponent of that evidence generally must acquire and have an expert in computer reconstruction or animation testify at trial.'"), and 2 McCormick On Evidence §218 (6th ed. 2009) ("'The computer-generated 'opinion' is determined by the scientific principles that an expert has programmed into the computer. Thus the simulation must be authenticated as an accurate result of a system or process, pursuant to Federal Rule of Evidence 901(b)…. [R]eliability is the 'watchword' in determining the admissibility of computer-generated evidence.'")).

Also of significance to a discussion of the potential admissibility of VR, the Bullock court highlighted, in its own citations, the distinction between using animations as demonstrative support for an expert's opinions, (i.e., those not admitted as evidence and thus not allowed in the jury room), versus as evidence (i.e., those allowed in the jury room for the jury to use during its deliberations).

As with an animation offered as evidence, the proponent of VR as evidence must be prepared to meet a more rigorous test of its admissibility than a court would require for an ordinary photograph or video. The proponent should be prepared to show (1) the qualifications of the expert who prepared it; (2) the capability and reliability of the computer hardware and software used; (3) the calculations and processing of data were done on the basis of principles meeting the standards for scientific evidence under Rule 702; (4) the data used to make the calculations were reliable, relevant, complete, and properly inputted; and (5) the process produced an accurate result.

How does this specifically apply to VR, which is a real-time fleeting experience? On one hand, a VR experience that is static is similar to taking the jurors to the scene of an occurrence or handing them a physical object to examine. However, foundationally, it is similar to a 3D animation, because the data that goes into supporting a VR experience is identical to the data that supports a 3D animation. The only difference is that in a VR experience, the user, not the animator, controls the point of view. One solution is to capture the VR experience of an expert witness as a movie and then have the expert narrate it exactly as she or he would an animation.

VR experiences have yet to be admitted as evidence, but they have been used as demonstrative aids. VR applications have also been developed in the course of investigations to aid experts' explanations of a sequence of events. Movies captured from VR experiences have also been used in the courtroom as demonstrative aids.

Lessons Learned: Effectively Using VR Throughout the Course of a Case

Accurately establishing the geometry of a scene in three-dimensions is critical to a quality analysis. Combining highly accurate data with data that may have some imperfections can be extremely useful when viewed in the context of a high-quality 3D scene. It is a framework to which you can attach details in a spatially meaningful way.

The first step: *collect data to establish geometry of a scene*. Doing this immediately after an incident is best for scene preservation. This data is usually captured using 3D-laser scanners, or via photogrammetry, using a photo array taken from a drone or systematized ground-based photography. While it is best to capture the scene in the resting state of the event, this rarely occurs. By the time a scene is accessible, it is nearly always altered.

Skilled technologists can use photographs and video taken before alteration to reconstruct the scene digitally at the time of the event. Photographs taken at the time of the incident, accident reports, and other information can often be woven into the 3D laser-scanned scene using sophisticated techniques, such as photo matching, to integrate the 2D-photographic information precisely.

Access to found data (i.e., security camera images) can be valuable in reconstructing the exact geometry of an accident scene. Even grainy security camera footage placed in a 3D space may inform specific positions of objects and individuals involved in an event.

VR gives legal teams unprecedented access to collected data. Within twenty-four hours of collecting laser scans of an accident scene or drone-captured photos of an explosion site, 3D data can be viewed in VR. The data may look rough at this point, displayed as a point cloud, but it holds a tremendous amount of information that can be accessed intuitively using VR. Done well, laser scanning can capture an entire scene measured to millimeter accuracy. Laser-scanned VR is pure digital preserva-

tion. It is forever in the state that the scene was at the time of the capture in a visual *and* measurable way. This allows investigators to revisit the scanned scene at any time. It also allows team members that did not visit the site to access it virtually. *See* Figure 3. Not only can VR participants view the scene, investigators can collect measurements in the virtual scene. So, an analysis that may be time limited when on the scene can continue later, virtually.

The virtual space also allows subsequent analysis as new information emerges. For example, after taking the deposition of a witness, investigators can reenter the scene and evaluate witness testimony. Perhaps a statement was made about what the witness was able to see from a particular vantage point. With VR, investigators can go to that point and evaluate what the witness could have seen. Was the witness's view obstructed? Could details recounted be seen at that distance? Many questions can be evaluated in the 3D environment.

Digital surrogates can also provide valuable information. The geometry of a scene often limits the number of ways that an accident victim could have interacted with a device. For example, in an in-home elevator accident, ESi consultants were able to determine the position of a child who was alone in the elevator car when the accident occurred. By positioning a properly scaled digital surrogate, a number of hypotheses could be eliminated or advanced. For example, he couldn't have been lying down, because the elevator car was too small for that position. Once his approximate positioning was determined, his injury pattern was used to fine-tune the digital surrogate's position. This iterative process can reveal not only a starting position, but a sequence of positions during an accident's timeline.

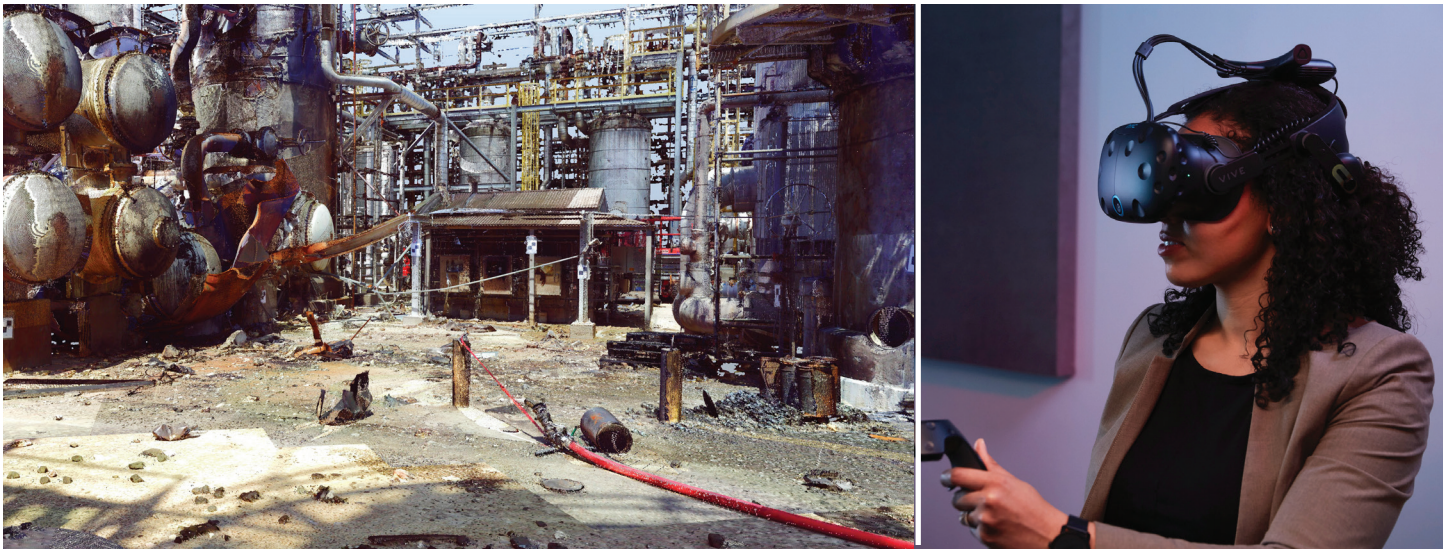
That first immersive look at newly collected 3D data can change the course of your case. First, it generates curated hypotheses of what happened. By eliminating unlikely hypotheses, the team can then focus on logical next steps. Next steps may involve further visualization, or additional investigative steps. Engaging all the stakeholders in details early in the investigation helps avoid lengthy trips down blind alleys. When it comes to further visualization, ask these questions:

- Would it be helpful to add elements not captured in the laser-scanned scene? Perhaps the scan wasn't taken at the time of the accident, so critical elements are missing.
- Do you need to animate components in the scene? If so, the scene must be 3D modeled.
- Are there lighting or atmospheric effects to simulate?
- Are there other conspicuity considerations that you have overlooked?

When these questions have been answered, and the proper associated tasks completed, the second VR experience is next. This typically involves interacting with a dynamic 3D-modeled scene and is more like interacting with the real world. Doors can be opened and closed, buttons can be pushed, and automated process can be simulated. The virtual 3D world can be programmed to behave exactly like the real world.

Getting to the first look in VR is relatively inexpensive. Getting to the second look can be more costly, and the expenses increase in proportion to the complexity of the VR application. Modeling can be a large portion of the cost and will depend on the quality of the laser scanning and the complexity and size of the scene. The level of interactivity is the second most costly component. Decisions about the focus of the visualization experience are critical as the team moves from the first look to the second. However, when good choices are made, the value of the second look is very high. The second look can move the team from eliminating hypotheses to discovering exactly what happened and building a tool to help teach fact finders why our visualization of events is correct. *Convergence* is the key word for this phase of the investigation. By adding motion and interactivity, detail can be added to a witness's viewpoint. Lines of sight can be evaluated over time. The timing of bad decisions may become clear. In VR, participants can experience a scene iteratively, bringing all the facts together into one explanation that ties all the details together.

Figure 3



An engineer interacting with point cloud data in VR.

Then, VR can be used to direct what an animated visual should show. Key stakeholders can "direct" the construction of a teaching visual from within the VR application. For example, a walk-through of a facility simulating a worker's path and what could be seen during that walk can be experienced and tested in VR. The experience can also be recorded so that specific movements and viewpoints can be incorporated into a visualization that may be used on a screen in a mediation or in trial.

Showtime!

In a perfect world, each juror would don a set of VR goggles and view the animation. However, it is impossible to control just what each member of the jury will be looking at and when. This is a major consideration when the VR application captures a specific event in time, or a sequence of events that are important to follow. So, the use of VR in the courtroom must be carefully managed. As a result, it is better to create the final animation with a testifying expert guiding passive viewers through a scene. The fact finders may be guided "live" using a single VR headset that the expert wears and a screen that mirrors that experience for the passive viewers, or a movie can be created from the expert's VR experience before trial, then shown at trial, similar to a conventional animation. The expert then testifies using that animation as an aid.

Deploying VR in a Mediation or Trial Setting

Because there are a number of ways to use VR, from a fully immersive dynamic experience, to viewing a static scene via a spherical photograph or rendered image, weighing pros and cons of using VR "live" in a mediation or trial setting is important. First, should you use it "live" with a head-mounted display, or do you want to create a movie from a VR experience and use that movie in the courtroom? Second, if you take the "live" route, how immersive do you want that experience to be? Figure 4 is a useful summary of pros and cons for the options in each of the two categories, going "live," or going with a "movie," exported or captured from a VR experience.

Figure 4

Options for Going "Live"

1. **A full VR experience with a powerful computer and head-mounted display**

   Pros: This offers the full VR experience with its interactivity, and it supports detailed, elaborate scenes.

   Cons: It presents an IT challenge; it's expensive—the equipment rental and technicians, both; and it could be difficult to support in a courtroom.

2. **A portable VR unit, such as Oculus Quest**

   Pros: This is easy to deploy; it's relatively inexpensive; and it's self-contained and battery powered—requiring no infrastructure.

   Cons: The option only offers a limited VR experience, with some interactivity, and limited scene details.

3. **A Google Cardboard-type experience**

   Pros: This is easy to use, very inexpensive, and works with a smartphone.

   Cons: The experience is limited because it relies on spherical images, offers no interactivity, and can only present a view from a single position within a scene.

Options for Going with a Movie-Style Presentation

1. **Simple screen capture, or live mirroring to a screen**

   Pro: Movie-style can capture and share a VR experience.

   Con: It may be adequate but is limited in resolution and may not provide the quality of images and/or video desired for the courtroom; this is especially true if conspicuity is an issue in the demonstration.

2. **Rendered images and animations**

   Pros: This option is the better solution of these two because the technologists record the head position of the VR user and render a high-resolution version of that user's experience. Capturing the user's movements or viewpoints over time renders a higher-resolution version of that experience, which may eliminate anomalies resulting from inadequate pixel resolution. This preserves conspicuity.

Who Should Participate in VR Experiences?

For stakeholders involved in the litigation process—litigants, counsel, independent witnesses, experts, mediators, triers of fact (jury, judges, arbitrators)—VR can provide an intuitive view of a complex event to enable them to contribute to the development of the case like never before.

Since VR is such a new technology, there is little precedent on admitting VR at trial. We do know that no court has admitted a VR experience into evidence to date. However, VR has been used as a demonstrative aid, and movies created from VR experiences have been used by expert witnesses as demonstrative aids.

There are a number of pitfalls that a legal team should consider when preparing a VR experience for the courtroom. These considerations do not diminish the advantages of using VR in the course of case development, but if the goal is to deliver it in the courtroom, it is important to understand that you will have foundational issues to overcome that are similar to those faced when admitting a 3D animation.

- Avoid presentation of cumulative evidence; if both sides intend on using VR, a court may only allow one side's presentation
- You must have a competent witness with personal knowledge to lay the proper foundation for evidence.

If the opposing side is attempting to admit a VR experience, there may be ways to keep this kind of demonstrative out of a trial.

- Lack of proper foundation: evaluate the foundation for an opponent's VR application. The elements that go into creating a solid VR application are the same as those that form the foundation for a good 3D animation.
- Argue Rule 403 balancing test tips in favor of exclusion: the probative value is outweighed by unfair prejudice, confusion of the issues, misleading the jury, undue delay, wasting time, or needless cumulative evidence

VR has value even in environments where it is unlikely to be admitted because much of the benefit of virtually entering a scene is extracted early on as the case is developing. First, the intuitive nature of immersively entering collected data is extremely valuable. While this environment is static, it is to scale and provides a place to evaluate geometric constraints around, say, fitting people or objects into confined spaces. Virtual testing can be done iteratively and inexpensively. This early experience will inform next steps in the visualization process. Perhaps more detailed VR analysis is necessary. Perhaps you can move on to 3D animation or other visuals based on this initial VR experience. If a 3D-modeled scene is created in a VR environment, that can be used to, for example, iteratively walk a path described by a witness through a scene and ultimately record a walk-through that can be presented as a movie.

Finally, a VR application can be useful to the 3D-animation process even if it will never be used "live" for dispute resolution. Using VR as a tool creates a more thorough, efficient path for 3D-animation production. Using VR allows more iterations than is economically feasible using 3D-animation tools and allows an expert witness to have many more experiences in the virtual environment, directing what ultimately should be visualized in an animation for the courtroom.

Conclusions

Virtual reality is a powerful tool that can be used effectively throughout the course of litigation. In fact, it may be most valuable early in a case when all stakeholders can benefit from a common view of a scene or piece of equipment. Evidence-based VR is the most powerful, robust visual communication technology available today, and it is poised to have a great effect on the litigation industry for years to come.

By leveraging data-driven VR, clients, jurors, and judges gain a deeper level of visual understanding, including perspectives of one or more points of view from an event such as an aviation accident or mechanical failure. An understanding of best practices and the decisions that a legal team must make throughout a case should inform incorporating VR through the case developments. Used properly, it can be a crucial component to success in litigation or dispute resolution. FD