Reconstructing Reality

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Lindsay Lorimer, Matthew Cairnes, and Charles Fox

Abstract:

Events that involve dramatic losses are frequently unwitnessed or unreliably witnessed. Over the past 30 years, tools and techniques have evolved to provide accurate, reliable insight into these unwitnessed events. Singularly, these data collection approaches only provide a slice of the information available. By combining modern data capture methods (i.e., laser scanning and photogrammetry) with commonly found material, like security camera footage or first responder photos, scientists and engineers can accurately recreate an event. Using this data, Virtual Reality (VR) applications and 3D animations allow all stakeholders to experience the viewpoint of a witness, or the driver's view of an accident. Fact finders can witness the reconstruction firsthand. When tasked with reconstructing reality it is important to understand how data capture technologies are visualized and ultimately rendered in VR applications and in 3D animations. Understanding of how these highly influential tools are utilized and how each element contributes to a quality visualization can accelerate investigations and lead to highly credible visualization tools, like 3D animations used to aid expert testimony.

Introduction:

Ever since Buzz Lightyear said, "To infinity and beyond!" in Pixar's Toy Story, people have become comfortable viewing 3D animations as a storytelling medium. 3D animations have also proven their value as teaching tools, helping fact finders understand complex concepts associated with accidents in a wide range of fields. From aviation accidents to construction delays, animated visual tools have delivered understanding in a universal way, free of engineering and scientific jargon.

In the past 15 years several factors, including the availability of sophisticated data collection tools, have transformed 3D animation from a teaching aid to an investigative tool. In the recent past, 3D models were created by human modelers hand sculpting models of buildings, cars, trucks, and people from a handful of measurements and photographs. Now, objects and scenes are scanned with laser scanners and drones, providing millions of measurements called a point cloud, that can be meshed (think connect the dots) automatically to form a dimensionally accurate 3D model that can be used in an animation. The method has evolved from an artistic rendering to a highly accurate depiction of space and time.

If we think of a loss as Alpha and the trial Omega, in many cases 3D animation tools are important from Alpha to Omega.

What if you could have a 1:1 scale world where you could test scenarios to figure out what really happened? It could serve as a sandbox where you could test and reconstruct reality. The answer to this incredible "what if" is you can. That is exactly what legal teams are doing. Many are efficiently and reliably using 3D digital environments as part of their investigation process; And here is why:

Three-dimensional environments can accurately define spaces, critical to reconstructing the scene of an accident. Adding the 4^{th} dimension, time, captures vehicle movement, human motion, and things like machine operation. Other components that can layer into a virtual world include elements like lighting and weather that affect conspicuity, all contributing to a 3D replica of a real space and time involving an event.

In the beginning, you do not need to know what you are going to make. Beginning with the end in mind is important, but openness to what you will learn along the way is critical. In most cases, a team developing a 3D environment is working backwards from an end point that is known (e.g., a crash site). Figuring out what happened that caused the endpoint is the goal. A healthy dose of intuition is helpful to start the process, then the data tends to guide the team.

A commitment to finished, trial-ready animation is not necessary because there are many points along the way that are potentially actionable. In the past, it was difficult to deliver something of value before a finalized rendering of an animation. The rendered movie was an expensive first draft that happened late in the litigation timeline and was the earliest actionable deliverable much of the litigation team, subject matter experts included, would see. Today, tools for peering into 3D worlds as they are developing have dramatically improved our ability to share glimpses into the under-construction phase. We can interact with point clouds (data from laser scanners and drone missions) in VR, allowing investigators to walk around in the data from an accident scene. As the digital accident scene moves from raw data to a curated 3D scene stakeholders can look over the animator's shoulder using screen sharing tools we all learned to leverage during the pandemic. Finally, when the element of time is added and movement becomes part of the investigation, real-time visualization tools like VR play an important role in engaging the litigation team in the investigation and the production process.

From Alpha to Omega, you should think in four dimensions (3D space plus time). Accurately establishing space and time are crucial to reconstructing reality. The geometry where an event occurs often constrains the collection of all possibilities imagined into a significantly smaller set of likely scenarios. When the element of time is added this geometrically constrained set is reduced even more. Collecting all the data necessary to have confidence in the dimensions and the timing of events informs what must be captured or discovered as the matter proceeds from alpha to omega.

Elements needed to reliably reconstructing reality:

Tom Petty famously asserted that "The Waiting is the Hardest Part." But that was so '80s. Getting started is the hardest part. Fortunately, when reconstructing reality is your goal, the path is prescriptive. While each matter is unique, the place to start is collecting the data that defines the 3D space where the event of interest occurred. Specific questions that need to be answered usually exist in the context of a well-made 3D space, and other questions will emerge as you layer in specialized data types onto the 3D data. To be clear, when we assemble different forms of data with the foundation of 3D space the information gleaned either moves us closer to providing an explanation or drives questions that we may be able to answer via simulation or testing. Either way, it helps the team reduce uncertainty.

The following list outlines the type of data that informs the construction of a model suitable for reconstructing an event digitally. Reviewing this list, you will notice that geometric data capture approaches are connected to the scale of the space or object to be captured. United States Geological Survey (USGS) data will usually suffice for a mountain range, traditional survey data is useful for 5 miles of railroad track, drone photographs and laser scan data are great for capturing a roadway intersection, and cars involved in a collision can be captured by a laser scan. Finally, small parts like vehicle or aircraft components can be geometrically characterized with the latest hand scanners that collect millions of points from the surface of a part at $1/1000^{th}$ of an inch accuracy.

- Scene Geometry – typically captured with a survey tool
    - USGS terrain data
    - Survey data (total station)
    - Point clouds from a drone flight
    - Point clouds from a laser scanner
        - FARO Focus, Leica RTC360, etc.
        - Other specialty scanners
- Object Geometry (vehicles, industrial machines, etc.) – typically captured with a scanner
    - Point clouds from a laser scanner
        - FARO Focus, Leica RTC360, etc.
        - Hand Scanners
        - Digital Microscopes
    - Point clouds from photogrammetry
- Discovered motion data
    - Video footage of the event
        - Security cameras
        - Dashcams
        - Witness videos recorded on smartphones.
    - Photo sequences
        - Photos of an event taken at different times (e.g., Automatic Teller Machine (ATM) photos)
- Simulated motion data
    - Vehicles Motion
        - HVE – vehicle crash simulation software
        - PC-Crash – collision reconstruction software
    - Human Motion
        - Human motion capture systems (MOCAP, MOtion CAPture)
        - Computer-based tools (e.g., MADYMO, MAthematical DYnamic MOdeling)
- Conspicuity data
    - Line of sight analysis
    - Calibrated photography for lighting analysis/simulation
    - Weather condition simulation

There are questions that can be asked once the 3D model and additional associated data come together to form an animation. Perhaps a hypothetical will help explain. Let's say I have a client who was the driver of a vehicle that struck a pedestrian in a crosswalk at an intersection in Smallville, Utah. The driver was turning left and claims to not have seen the pedestrian until the very last second before striking her. Let's also say we have the following pieces of data:

- A laser scan of the intersection which provides the complete geometry of the scene
- A laser scan of the vehicle that struck the pedestrian
- A detailed scan of the interior of the vehicle with the seat adjusted to the position this driver was using at the time of the accident
- Biometric information on the pedestrian so we can create a 3D model of her

- The time of day and the fact that it was sunny and clear, so we can position the sun properly relative to the scene
- Security camera footage from a convenience store that captured video of the car striking the pedestrian

Using the scan data (captured weeks after the accident) and photos taken at the time of the accident, we can create geometry of the scene that accurately places all the static objects (buildings, signs, road markings, traffic lights, trees, etc.). The car model and the pedestrian model can then be added to the scene as separate, movable objects. Through a process called camera matching the security camera footage can be aligned to the 3D scene model to overlay the vehicle and pedestrian motion that happened during the accident as captured by the security camera. This video matching technique informs how we move the car 3D model and the pedestrian 3D model to reconstruct their movements and point of contact as accurately as possible. We can then orient the viewer in the car at the eye point of our client/driver and explore why the driver did not see the pedestrian. Was the sun in their eyes when they made the left turn? Did something in the car (like the A-pillar) block their view of the pedestrian? We can also look at the same event from witness viewpoints, and the pedestrian's point of view. Speeds of the vehicle and pedestrian can also be extracted using this approach.

Discoveries made by experiencing the left turn virtually, perhaps watching it repeatedly in VR which allows us to move our head around like a driver, may create more questions that we can answer with more testing. What if we had more information on how the sun reflects off the windshield of the subject vehicle? Perhaps we can gather that information with additional testing.

This approach helps narrow possibilities from all things that we can imagine to conclusions driven by evidence-based facts.

Additionally, it is doubly efficient because the byproduct is a 3D animation; A demonstrative that can be used to resolve the matter. The visual aids rendered from this process are often powerful communication tools. Showing an event from a witness's point of view or the driver's seat can substantiate or refute testimony.

Figure 1: An engineer using Virtual Reality to explore an accident scene.

Virtual Reality is a method for experiencing a reconstruction in real-time and at a 1:1 scale with the environment (Figure 1). While it is still rare for jurors to don a head mounted display, VR is frequently used during the construction phase of a 3D model and in some cases immediately prior to rendering an animation for mediation or a trial. VR allows us to explore camera views without rendering draft animations. It's more efficient than rendering and editing movies, and in several cases, we have extracted head motion data from experts in VR to direct camera motion in an animation that will be shown on a screen in the courtroom. It is only a matter of time before VR headsets regularly make their way onto fact finders.

From Alpha to Omega, what should legal teams think about when reconstructing reality?

- What can I capture?
    - Scene scan/photos
    - Subject equipment scan/photos
    - Vehicle scan/photos

- What can I discover?
    - First responder photographs/video
    - Security camera footage
    - Dashcam footage
    - Bodycam videos
- What can I know from a client's in-house expertise?
    - Testing data
    - Exemplar information from tear downs (inspection preparation)
    - (Computer Aided Design) CAD data
- How do I synthesize all this information?
    - Decide on complexity of scene model necessary, capture the appropriate data, and build the scene
    - Layer in motion data from simulation, testing, video, deposition testimony, and other information sources that inform motion
    - Consider exploring stories that don't make sense (e.g., if the rider's testimony is they were going the speed limit, the motorcycle misses the truck it collided with entirely)
- Iterate in the model. VR is a powerful tool for interacting with a model. This interaction usually happens at two stages. First, when the geometry is completed; It's valuable to interact with the space where an event happened to explore being there and how people may interact with a machine. Second, is when the motion work is complete. At this stage you can don a head mounted display and sit in the driver's seat of a bus approaching an intersection where a crash occurs, or ride in the pilot seat of an airplane approaching a mid-air collision. After experiencing what the data tells us about an event multiple times, the way forward often becomes clear.
- Leave time to explore and actively utilize 3D environments during the litigation process.
    - Don't wait until the last minute because missed opportunities may be costly
    - Exploration and iteration inform new lines of investigation and discovery
- Consider how to use products from this process as a demonstrative aid or demonstrative evidence.
    - Should VR be used with the fact finders, or will a rendered animation deliver the message clearly?

Examples

Landscaping Site Accident

A worker on a residential landscaping project was crushed between a powered concrete buggy and the tailgate of a dump truck, resulting in injury. The worker was loading slabs of concrete from a sidewalk demolition into a skid loader that was parked in the street. The skid loader was parked behind a dump truck so it could load the slabs of concrete from the sidewalk demolition into the truck. In one cycle of unloading the concrete, the operator backed the powered buggy away from the skid loader and his upper back encountered the tailgate of the dump truck. He was unable to stop the reversing buggy and the force of his body pushing onto the handlebar of the concrete buggy depressed the safety release handle in the powered position. The buggy continued to move causing significant injuries to the operator.

How do we know this? The thin thread of information that allowed us to confidently reconstruct the accident space was two first responder photos taken shortly after the accident happened. One of the photos is shown in Figure 2.

Figure 2: Accident photo of skid loader.

Our team was engaged in the matter many weeks after the accident happened and the dump truck and concrete buggy were no longer at the accident side. High quality laser scans were captured at the accident location, but the truck and concrete buggy were scanned at a different location remote from the accident site. A 3D model of the skid loader was available as well as biometric data for the injured worker, so we had all the elements we needed to reconstruct the accident scene. The critical missing detail was the exact positions of the skid loader and the dump truck. These two vehicles defined the space the operator and the concrete buggy were maneuvering within. Fortunately, first responders took two critical photos, one allowing us to place the skid loader and the other allowing our team to define the position of the dump truck. This accurately established the 3D space where the accident occurred, a space too small to safely operate the concrete buggy (Figure 3).

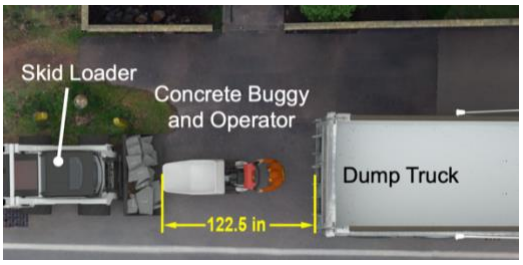

Figure 3: Scene reconstructed from scan and photos.

Not only was the 3D model valuable for creating measurements and a visual depiction of the accident space, but it also provided detailed dimensions necessary for building a physical model in which we could test the allegation that the safety stop on the drive for the buggy was defective or malfunctioning. Live surrogate testing helped us show that as the worker came in contact with the back of the dump truck, his upper body would have pressed upon the safety bar continually engaging the buggy's drive system (Figure 4).

This iterative process of creating a 3D environment from materials captured and discovered, moving digital objects within that environment, then answering questions with physical testing resulted in an effective explanation for the accident sequence, and a valuable visual tool used to help settle the case.

Figure 4: 3D Reconstruction and Physical Surrogate Testing

City Bus Accident

A pedestrian crossing in a busy crosswalk at night was killed when she was struck by a city bus passing through the intersection. There was a large amount of video of the event because the bus was equipped with several video cameras capturing video inside and outside of the bus as it approached the intersection, struck the pedestrian, and stopped. When there is so much data it's fair to wonder why the investigators would want to create a digital reconstruction. You can see the accident clearly on the video. And that's part of the problem. The video cameras on the bus were capable of capturing images in low light conditions, unlike the human eye. Because the accident happened at night, the video from the bus did not depict what the driver saw, or his point of view as the bus approached the intersection.

You now understand the stepwise approach to recreating reality. Our first step was to capture the data needed to build an accurate model of the intersection where the accident occurred. Laser scans were captured of the site (shown in Figure 5A). These laser scans were used to create a 3D model of the scene. A team of investigators also conducted a lighting study at the accident intersection. They measured the light produced by streetlights, storefronts, and other vehicles that pass through the intersection. The laser scan data captured all the static light sources at the scene, so our 3D model was programmed to include the illumination from those lights (a rendering is shown in Figure 5B). The video from the bus was also a source for lighting

Figure 5: Laser Scan and 3D Renderings from City Bus Accident

information. It showed us which static lights were functioning and tracked the movement of other vehicle lights associated with this event. In this accident the light from oncoming traffic was an important factor (see Figure 5C).

The bus videos also provided us with the movement of the bus, the motion of other vehicles approaching or moving through the intersection, and the activity of pedestrians including the person struck by the bus. Armed with this detailed information, a visualization technologist can position the light sources of known intensity in the scene, place the vehicles in the scene, adjust their headlight's illumination, and animate the pedestrians moving in the scene.

The final piece of information that proved useful in this case was video captured inside the bus that showed the driver's actions. From that video, a human factors expert provided information about where the driver was looking as the bus approached the intersection and struck the pedestrian. With this information we created a virtual camera at the driver's eyepoint that captured the driver's viewpoint as the

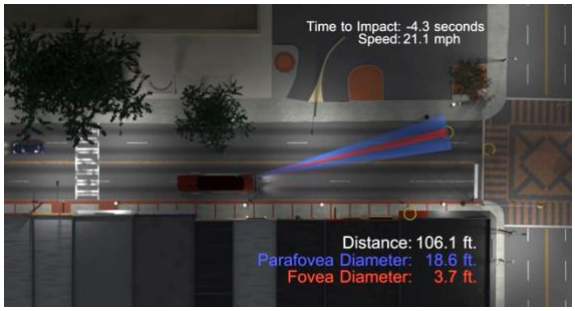

Fig. 6: Driver's View Analysis from City Bus Reconstruction

animated bus passed through the reconstructed environment. An image from that animation is shown in Figure 6).

Conclusion

The advent of rapid data collection technology has unlocked the ability to create digital spaces that serve as frameworks for combining diverse types of data associated with events. The digital sandboxes we create are tools for legal teams and investigators to assemble the known information about a loss and iterate through scenarios. Working in these digital sandboxes accelerates the investigative process in several ways. In one way sandbox sessions generate questions for discovery. What data is available or what questions should be asked in a deposition? The second way is to inform physical testing. Consider eliminating uncertainty around a question by physical testing. For example, can I test how the sun reflects off a specific type of windshield to help evaluate whether a driver could see a pedestrian?

When a team is satisfied that they have discovered, captured, combined, and iterated upon all the information available, they can utilize the finished reconstruction to render images and/or movies to teach parties outside the team. These visualizations are effective tools that have aided in the resolution of many cases and reconstructing reality played a crucial role from alpha to omega.

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Lindsay has extensive experience defending class actions and both individual & commercial product liability lawsuits involving a broad range of products including fire and security, consumer, food, pharmaceuticals and medical devices, recreational, construction and industrial machinery, motor vehicles, building materials and juvenile products. Lindsay assists several global companies with national coordination and management of their litigation matters. Lindsay also advises on product launches and market entry due diligence, regulatory challenges and enforcement, regulatory compliance, risk management issues and product recalls. Consistently recognized for her expertise in numerous directories, Lindsay is listed as a leading lawyer in the *International Who's Who Legal for Product Liability Defence*, *Chambers Canada*, and as a litigation star in *Benchmark Litigation: Canada*. The 2022 WWL Product Liability Defence Report observes that "Lindsay Lorimer with McMillan is hailed by peers as "one of the best in the product liability field" as well as "excellent client relations". She received the Client Choice Award for Product Liability Defence from Lexology in 2022. Lindsay is the Co-Chair of the Gender Parity Initiative and a member of the Board of Directors at McMillan. She is an active member of IADC and DRI.

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EDUCATION

UNIVERSITY OF NORTH CAROLINA (2022)
KEENAN- FLAGLER BUSINESS SCHOOL EXECUTIVE LEADERSHIP PROGRAM

BROWN UNIVERSITY, AB 1983 (*History and International Relations*)
Varsity Football Manager, 1979 - 1982

CASE WESTERN RESERVE UNIVERSITY SCHOOL OF LAW, JD *cum laude* 1986
Journal of International Law, *Associate,* 1983 – 1984
Law Review, *Associate,* 1984 – 1985; *Research Editor*, 1985 – 1986

PROFESSIONAL EXPERIENCE

Textron Inc., Providence, Rhode Island
Associate General Counsel – Litigation, 2008-Present

Manage non-aviation products liability claims for Textron and its business units. Retain and supervise outside law firms and internal litigation support teams of engineers, insurance and finance personnel. Perform other legal duties as required including managing commercial litigation and class actions.

2023 Textron Legal Enterprise Diversity Advocate Award Winner

GALLAGHER, CALLAHAN & GARTRELL, CONCORD, NEW HAMPSHIRE
Director, June 2008 – Present

Diverse commercial, complex and traditional litigation practice defending the interests of businesses, individuals and insurers in all state and federal courts, and State agencies including representation before the Department of Labor, Department of Employment Security, Public Employee Relations Board, Department of Safety and Department of Environmental Services; general corporate and municipal representation; risk management training. Special focus on Products Liability, Trucking and Commercial Litigation.

RANSMEIER & SPELLMAN P.C., CONCORD, NEW HAMPSHIRE

Associate, 1986 - 1994

Director, 1994 – May 2008 (Executive Committee, Secretary 1998 – 2001; Executive Committee, Treasurer 2002 – 2006)

Admitted: New Hampshire Supreme Court; Rhode Island Supreme Court; United States District Court for the District of New Hampshire; First Circuit Court of Appeals; United States Supreme Court

Honors: SuperLawyer – Products Liability Defense 2007 - 2016
Best Lawyers
Personal Injury Defense 2012-16
Municipal Litigation 2013-16
Construction Litigation 2013-16
Construction Lawyer of the Year 2015
Labor & Employment Litigation 2013-16

Reported Appellate Decisions: Cole v. Hobson, 143 N.H. 14 (1998)
Lower Village Hydroelectric Associates v. City of Claremont, 147 N.H. 73 (2001)
Kalil v. Dummer, 159 N.H. 725 (2010)

Representative Client List While in Private Practice:

ABD Services – Recreational Products Claims
Advance Auto Parts -- Employment
Bobcat Corp. – Products Liability
CNA – Architects & Engineers, Bad Faith, Coverage
Cascade Designs Inc. and MSR – Products Liability
Chubb Insurance Company -- Employment
The Hartford – Employment Liability
Irving Oil Corporation – General Liability, Employment
Joe Brigham Inc. – Aviation and General Liability/Corporate matters
Kenseal Corporation – Products Liability
Karl Storz Endoscopy USA – Products Liability
Landstar Inway, Inc. – Transportation and General Liability
Lloyds of London – Construction Claims
Lorillard Tobacco Company – Local Counsel for Products Liability, Anti-Trust
McDonald's Corporation – Products Liability, General Liability
National Indemnity Company – Trucking, Products and General Liability
New Hampshire Property Liability Trust – Civil Rights, General Liability
R.J. Reynolds Tobacco Co. – Local Counsel for Products Liability, Anti-Trust
Raleigh America, Inc. – Products Liability

REI – Products Liability
REM Ltd – Products Liability, Complex Claims
Regis Corp. – Personal Injury
State of New Hampshire – Special Counsel
Suburban Propane – Products Liability, Explosion
Textron Inc. – General Business and Products Liability Litigation
Travelers Insurance – General Insurance Defense, D&O, Specialty Risk
Underwriters at Lloyds – Appraiser Professional Liability

Representative Trials to Verdict

Auger v. Conlogue – Personal Injury, dog bite – NH Superior Court
Boston Maine Railroad v. Sprague Energy – Railroad Right of Way Litigation – NH Superior Court
Brown v. Town of Northfield – Wrongful Discharge – NH Superior Court
Hammell v. City of Concord – Civil Rights Brutality – USDC
Kalika v. Boston Maine Railroad – Railroad Right of Way Litigation – NH Superior Court
Kempf v. City of Concord – Civil Rights Brutality -- USDC
Leclerc v. Nelson Communications – Breach of Contract – NH Superior Court
Lombardi v. Town of Sunapee—Personal Injury (double hip replacement from bike accident) – NH Superior Court
Noel v. City of Concord – Civil Rights Brutality -- USDC
PPG v. Town of Derry – Property taking and conspiracy – NH Superior Court
Reid v. Walgreen and State of New Hampshire -- Civil Rights Prison Brutality -- USDC
Sackett v. Davis – Personal Injury, motorcycle accident – NH Superior Court
Salvas v. JRM Associates – Property Damage – NH Superior Court
Smith v. O'Charley's Inc. – Personal Injury, slip/fall – NH Superior Court
Sprague v. Snader Transporting – Personal Injury, trucking – NH Superior Court
Viens v. Balcolm Brothers – Personal Injury, alleged brain injury – NH Superior Court
Volak v. N.O.W. Construction – Property Damage – NH Superior Court
Whittier v. Irving Oil Corporation – Property Damage – NH Superior Court

SIGNIFICANT CURRENT PROFESSIONAL ACTIVITIES

DRI *THE VOICE OF THE DEFENSE BAR*, 1996 – Present
President, 2010 - 2011
Executive Committee 2007-2102
Senior Advisor 2012-Present
Northeast Regional Director, 2004-2007
New Hampshire State Representative, 2000 – 2004
Chair, Membership Committee, 2005 – 2007 (*Vice Chair* 2004 – 2005; *Member* 2002-2004)
Chair, Law Practice Management Committee 2003-2005

Marketing Co-Chair, 2004 Annual Meeting
Winner, 2002 Community Service Award
Recipient, 2003 State Leadership Award
Recipient, 2005 Committee Leadership Award
Recipient, 2007 Service Award

Substantive Law Committees: Corporate Counsel, Products Liability; Commercial Litigation; Fire and Casualty; Governmental Liability; Trucking; Employment, Law Practice Management; Diversity;Women in the Law

INTERNATIONAL ASSOCIATION OF DEFENSE COUNSEL, 2002 – Present
New Hampshire State Membership Chair, 2005 -- 2009

FEDERATION OF DEFENSE AND CORPORATE COUNSEL, 2011 – Present
Chair, Products Liability Section, 2016 -- 2018
Dean, Litigation Management College 2016 – 2017
Secretary Treasurer, Foundation of the FDCC 2022 - Present

AMERICAN BOARD OF TRIAL ADVOCATES, 2014 – 2016
NH PRESIDENT, 2016

ASSOCIATION OF DEFENSE TRIAL ATTORNEYS, *Associate Member* 2007 - 2008

LAWYERS FOR CIVIL JUSTICE, *Board Member* 2009-2012

AMERICAN CIVIL BAR ROUNDTABLE, *Member* 2009-2012

NATIONAL FOUNDATION FOR JUDICIAL EXCELLENCE,
Member, 2004-2013
Board of Directors, 2010 - 2013

NATIONAL JUDICIAL COLLEGE
Board of Visitors, 2010 - 2013

TRI-STATE DEFENSE LAWYERS ASSOCIATION, 1990 – 2017

USLAW NETWORK, 2005 – 2015

NEW HAMPSHIRE BAR ASSOCIATION, 1986 – Present
Federal Practice Section, 2000 – 2017
Rules of Evidence Committee, 2013-2016

DANIEL WEBSTER INN OF COURT, 1993 – 2002
President, 1998 – 2000

SIGNIFICANT LEGAL EDUCATION COURSES TAUGHT

- *Constitutional and Civil Rights Supreme Court Update*, New Hampshire Department of Justice, July 1997
- *Electronic Discovery*, New Hampshire Federal Practice Section, September 2001
- *Electronic Discovery*, Federal Practice Institute, December 2002
- *Developing Deposition Skills*, National Institute for Trial Advocacy (NITA) New England Deposition Program, 2003, 2005, 2006
- *Special Considerations for Law Enforcement Employment Practices*, Primex^3 Law Enforcement Symposium, November 4, 2003
- *Electronic Case Filing Best Practices Seminar*, U.S. District Court for the District of New Hampshire, March 24, 2004
- *Satellite Trial Academy*, IADC, Boston, MA (2006)
- *NH Bar Association Insurance Program*, Concord, NH (2011)
- *iPad for Litigators*, United States District Court, Concord, NH, January 24, 2013
- *Attorney Conducted Voir Dire*, Federal Practice Section, Concord, NH, February 7, 2013
- *Litigation Management College*, Federation of Defense and Corporate Counsel, Emory University, June 2013-2017
    - *Preserving the Record for Appeal* 2014-2017
    - *Evidence 101* 2016
    - *Technological Innovations for Adjusters and their Attorneys, 2017*
- *Trial Academy*, International Association of Defense Counsel, Stanford University, July 2013
- *It's All About the Love - Leadership and Law Firm Ethics*
    - Idaho Association of Defense Counsel, McCall, ID, September 14, 2013
    - Defense Trial Counsel of West Virginia, Charleston, WV, April, 2014
    - Tri-State Defense Lawyers Association, Portsmouth, NH, September 2014
    - South Carolina Defense Trial Attorneys, Pinehurst, NC, November 2014
- *Rise of the Machines-Technological Disruption in Law Practice*, Federation of Defense and Corporate Counsel Annual Meeting, Banff, Alberta, 2015
- *Voir Dire*, Texas Association of Defense Counsel Annual Meeting, New York, New York, September 18 2015
- *Fantastic Voyage: The New Biotech/Human Interface and Resulting Legal Challenges*, Federation of Defense and Corporate Counsel Winter Meeting, San Diego, CA, 2016
- *Silent Advocacy: It's Not What You Say, It's How That You Say It*, International Association of Defense Counsel Annual Meeting, Southampton, Bermuda 2016
- *Using the Construction Statute of Repose by Products Manufacturers*, DRI Products Liability Conference, Las Vegas, 2017
- *Autonomous Vehicles*, Federation of Defense and Corporate Counsel Winter Meeting, Charleston, SC, 2017
- *Contractual Risk Transfer – the Changing World of Indemnification and Insurance in Construction Contracts*, Federation of Defense and Corporate Counsel Summer Meeting, Montreux, Switzerland, 2017
- *In Advance of the Crisis: An Ounce of Prevention and Preparation*, Federation of Defense and Corporate Counsel Summer Meeting, Montreux, Switzerland, 2017

SIGNIFICANT LEGAL PUBLICATIONS

- *Products Liability Defenses: A State by State Compendium: New Hampshire*, The DRI Defense Library Series (2004, revised 2007)
- *Laying the Groundwork for a Daubert Challenge to a Design and Warnings Expert*, IADC Products Liability Newsletter (December 2005)
- First Circuit Editor, *Daubert On-Line*, DRI (2006 – 2010)
- *Duty to Warn: A State by State Compendium: New Hampshire*, The DRI Defense Library Series (2008)
- *Comment*, "Preserving Our Collapsing Judicial Function: DRI Officers Speak Out," The Metropolitan and Corporate Counsel (April 2008)
- *RSA 358-A: Real Estate Transactions*, A Practical Guide to Understanding RSA 358-A in New Hampshire, MCLE New England (2014)
- *Ethical Considerations for Sharing Documents in the Cloud*, IADC Business Litigation Committee Newsletter (September 2015)
- *Insurance Issues in Construction* Projects, A Practical Guide to Construction Law and Litigation in New Hampshire, MCLE New England (2016)

SIGNIFICANT COMMUNITY ACTIVITIES

HOPKINTON SCHOOL DISTRICT, Board of Education, 2012 -- 2017

CONCORD HOSPITAL HUMAN INVESTIGATION COMMITTEE, 2003 – 2013

ST. ANDREW'S CHURCH, *Youth Committee Member*, 2002 – 2006
Vestry, 2004--2006

UNITED WAY OF MERRIMACK COUNTY, Board of Directors, 2000 – 2005

PERSONAL DATA

- Leisure Activities: outdoor recreation, reading, running, and raising strong daughters
- Eagle Scout 1978.
- Married with 2 children

Revised 12/2022

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Dr. Fox oversees technologists providing field data collection, visualization, lab services, and facilities and artifact management across all Engineering Systems Inc. (ESi) offices. His team works with in-house consultants and ESi clients to recover and store artifacts, assist in analyzing materials in ESi laboratories, collect and visualize data, and create demonstrative aids and exhibits. Technologists at ESi assist experts in all phases of high-stakes litigation. Technologists at ESi are constantly innovating to integrate a growing variety of data capture technologies with a wide array of visualization tools to connect ESi experts and legal teams with critical concepts that flow from accurate depictions of often unseen events.

Dr. Fox leverages his 28 years of experience in the litigation industry to lead a technology team that is second-to-none. With an academic background in neuroscience, Dr. Fox provides insight into how visual teaching tools can be used most effectively to teach difficult-to-understand concepts. His scientific training informs an information convergence strategy that marries all forms of data collection with outcomes that drive decision making at the team level.

Before joining ESi, Dr. Fox served as Vice President at Demonstratives, Inc. for 14 years. At DI, he led the Life Sciences Group - a team that focused on biotechnical, pharmaceutical, and biomedical litigation services. These services included production of 3D animations, 2D animations, and PowerPoint presentations. He led program development in cases involving high tech patents and trade secrets. The Life Sciences Group developed sophisticated methods for visualizing macromolecules and animating the processes behind much of today's biosciences industry.

Areas of Specialization

The Effectiveness of Visuals
3D Animations
VR Applications
Real-Time Visualization
Demonstratives Aids and Exhibits
PowerPoint Presentations
Litigation Graphics

Education

Postdoctoral Fellow, Mental Health Research Institute, University of Michigan, 1991-1995

Ph.D., Molecular Cellular and Developmental Biology, Iowa State University, 1991

B.S., Zoology, Iowa State University, 1987

Professional Awards

National Institute of Drug Abuse
National Research Service Award, 1994 – 1995

University of Michigan
Endocrinology and Metabolism Postdoctoral Fellow, 1993 – 1994

University of Michigan
Pharmaceutical Manufacturers Association Postdoctoral Fellow, 1991 – 1993

Positions Held

Engineering Systems Inc., Ames, Iowa

Senior Director of Technology, 2021 – Present
Director, Visualization Practice Group, 2015 – 2021
Senior Managing Consultant, 2015 – Present
Senior Consultant, 2014 – 2015

Demonstratives Inc., Ames, Iowa

Vice President, 2001 – 2014

Engineering Animation Inc., Ames, Iowa

Director of Biotechnical Litigation Services, 1999 – 2000
Director of Production, Interactive Division, 1997 – 1999
Project Manager, Interactive Division, 1995 – 1997

University of Michigan, Ann Arbor, Michigan

Post-Doctoral Fellow, Mental Health Research Institute, 1991 – 1995

Presentations

2020 Webinar "Data at a Distance: The Art of Remote Inspections" DRI Webinar Series, April 9th, 2020, and 10 other legal industry events in 2020.

"Virtual Reality in Litigation" 2020 DRI Products Liability, New Orleans, LA, February 6, 2020

"Seeing the Unwitnessed Hand and Power Tool Accident," 2019 DRI Products Liability, Austin, TX, February 6, 2019

"Virtual vs Reality: Navigating the Matrix of Your Case," 2019 DRI Products Liability, Austin, TX, February 6, 2019

"The Use of VR Technology in Accident Analysis and Reconstruction," 2019 DRI Products Liability, Austin, TX, February 6, 2019

"The Use of Virtual Reality Technology in Aviation Cases," SMU Air Law Symposium, Irving, TX, March 28, 2019

"A Picture is Worth 1000 Words: Seeing the Unwitnessed Facts in Accidents," PLP&D 2017 Fall Workshop, Rosemont, IL, October 12, 2017

"A Picture is Worth 1000 Words," Children's Products Panel Counsel Meeting, Las Vegas, NV, February 7, 2017

"A Picture if Worth 1000 Words: Demonstrative Exhibits in Litigation," XXVIIIth Annual International Occupational Ergonomics and Safety Conference, Chicago, IL, June 9-10, 2016

"Commercial Hand Fed Chipper Winch Line Accident Reconstruction Analysis," 27th Annual Occupational Ergonomics and Safety Conference, 2015

"Visualization: The Science of Seeing the Facts," Georgia Defense Lawyers Association, 2015

Publications

Fox, Charles A., McAlpine, Melissa L., and Owens, Kevin G. "Virtual Reality: Put Your Best Foot Forward," DRI, For the Defense, Product Liability, April 2020, pp. 58-65.

Fox, Charles A., Kenner, Matthew T., Lueck, Jay K., Morris, Steven L., and Winn, Robert C., "The Use of Virtual Reality Technology in Aviation Accident Analysis and Reconstruction," SMU Air Law Symposium, Dallas, TX, March 27-29, 2019.

Fox, Charles A., Kenner, Matthew T., Lueck, Jay K., Morris, Steven L., and Winn, Robert C., "Aviation Accident Reconstruction Using Virtual Reality and Other New Technologies", DRI Meeting Publication, February 2019.

Fox, Charles A. "When A Picture is Worth More than 1000 Words", MDLA The Quarterly, Fall 2019, pp. 8-11.

Brickman, Dennis B., Roberts, Julius M., and **Fox, Charles A**., "Automatic Sliding Door Sensor Safety Analysis," Proceedings of the XXVIIIth Annual International Occupational Ergonomics and Safety Conference, Chicago, IL, June 9-10, 2016, pp. 29-35.

Brickman, Dennis B., Novak, Gary J., **Fox, Charles A**., Lueck, Jay K., and Karlins, Scott A., "Shelving Cart Design and Manufacturing Safety Analysis," Proceedings of the XXVIIIth Annual International Occupational Ergonomics and Safety Conference, Chicago, IL, June 9-10, 2016, pp. 17-22.

Brickman, Dennis B., Bajzek, Thomas J., Knox, Erick H., **Fox, Charles A.,** Lueck, Jay K., and Petersen, John M., "Beach Rental Elevator Child Entrapment Safety Analysis," Proceedings of the XXVIIIth Annual International Occupational Ergonomics and Safety Conference, Chicago, IL, June 9-10, 2016, pp. 23-28.

Edwards, Dale B., Brickman, Dennis B., **Fox, Charles A**., and Brewster, Rodney A., "Failure Analysis of a Plastic Toy Helicopter," Proceedings of the Society of Plastics Engineers Annual Technical Conference, Indianapolis, IN, May 23-25, 2016, pp. 1017-1025.

Brickman, Dennis B., Knox, Erick H., **Fox, Charles A**., and Stage, James D., "Commercial HandFed Chipper Winch Line Accident Reconstruction Analysis," Proceedings of The XXVIIth Annual International Occupational Ergonomics and Safety Conference, Nashville, TN, May 28-29, 2015, pp. 25-30.

Dr. Fox has authored 19 scientific papers in the field of molecular neurobiology.

Dr. Fox has authored two book chapters:

"Interaction Between Dopamine and Opioid Systems in the Dorsal and Ventral Striatum of the Rat," **C.A. Fox**, E.J. Curran, A. Mansour, H. Akil, S.J. Watson, Cellular and Molecular Mechanisms of the Stratum (1996)

"Biochemical Anatomy: Insights into the Cell Biology and Pharmacology of Neurotransmitter Systems in the Brain," **C.A. Fox**, A. Mansour, D.T. Chalmers, J.H. Meador-Woodruff, S.J. Watson, Textbook of Psychopharmacology, pp. 45-63 (1995)