An Insight into Knott Laboratory with Dr. Ziernicki

Forensic Engineering & Animation Experts

BY RICHARD M. ZIERNICKI, PH.D., P.E.

Founded in 1982, Knott Laboratory provides forensic engineering and computer animation services to comprehensively reconstruct accidents. Our experts have worked on more than 15,000 failure analysis cases nationwide for the legal and insurance industries, as well as for local and national businesses. We assist our clients from initial contact through investigation, analysis, animation production and expert witness testimony. Our expertise includes: vehicle accident reconstruction, product liability, mechanical engineering, computer animation & graphics, fire & explosion investigations and civil & structural engineering.

Learn more from the following interview with the owner, President and CEO of Knott Laboratory, **Richard M. Ziernicki, Ph.D., P.E.**

Dr. Ziernicki, share with me how you got involved in this particular industry.

It was many years ago in 1982 when I started doing this type of work with Knott Laboratory. I just met Dr. Knott, founder of Knott Laboratory and I liked what he was doing so I joined him and here I am.

Since the 80's, you've taken part in over 15,000 cases that require failure analysis, why do some investigations require your services?

Many times when something goes wrong and people get hurt, someone dies, or there are material losses, the industry needs to establish what the cause of the accident was, who is responsible and who is going to cover the expenses of those losses. So that is when they hire us as an independent laboratory to establish what caused that accident and why.

So, we are talking about incidents that are under investigation and your team helps us to better understand what may have happened at that particular juncture?

Yes, that's true. We have a team of sophisticated, experienced engineers and they will go to the accident site and document the scene. We take photographs, videos, measurements and capture high definition scans to document the conditions. Then we come back to the office and analyze what was found. Many times we write a report to outline the findings and opinions. Sometimes testify in deposition; and in some cases, we go to court of law and testify about our findings and opinions.

One of the successful means of doing that and helping expert witnesses is through computer animation. Share with us a little bit how that is used.

Computer animation is a technology that has become quite popular recently. The beginning was in the 80's and, at that time, we were a pioneer in many areas of computer animation, photogrammetry, and 3D interactive animation. The way how an animation can help in a case during court testimony is to illustrate the expert's opinions and sometimes provide scientific evidence of how things are done, how things went wrong, and what happened during the accident. Computer animation is a visual enhancement of expert testimony which is subject to a lot of criteria and scrutiny. Not all animations are allowed to be presented in court. Before the animation is accepted by court of law and before it can be presented in court, there are certain criteria and some challenges that need to be met. After all the challenges are met, then the judge decides whether or not to allow the animation to be presented.

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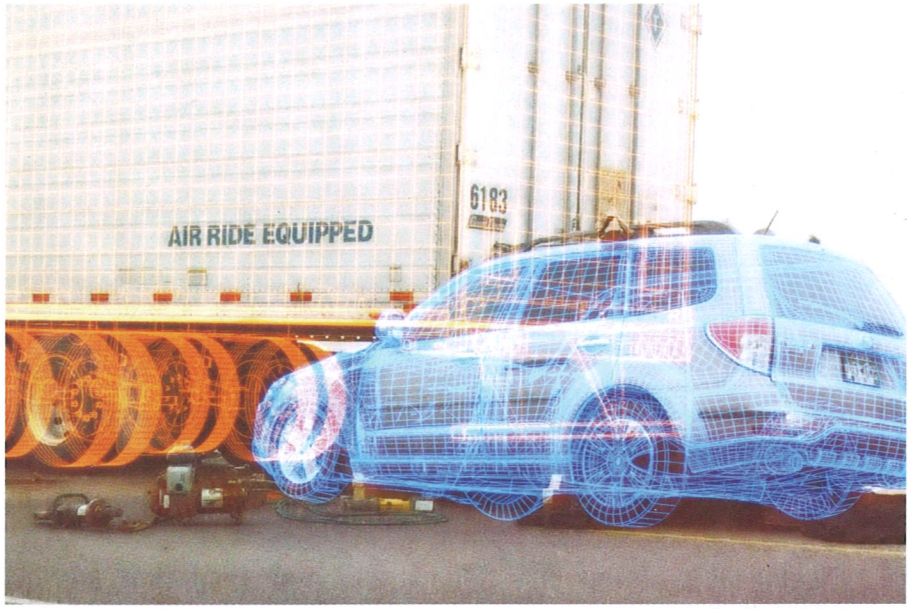
These animations are created really with a scientific accuracy based on a lot of compiling data, we're talking about physical evidence, is that right?

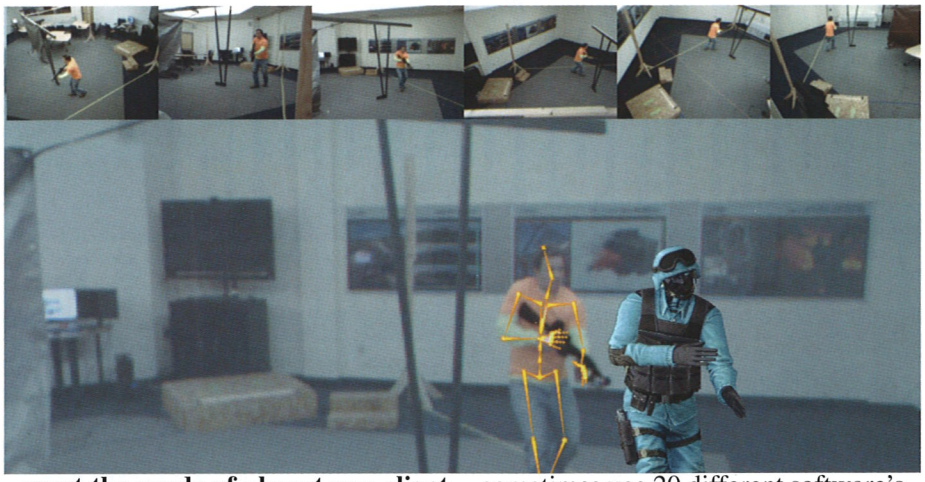
That is right. We are mechanical, structural and civil engineers that rely on engineering evidence. We are relying on evidence like tire marks, debris, scratch patterns, vehicle damage in cases of motor vehicle accidents. So we take all the engineering evidence and use that evidence to provide the foundation for the animation. This foundation and scientific method are one fundamental criteria whether or not that animation is accepted by court. It's not just somebody else's vision of the accident. It is this scientific reliable data which is the foundation and base for the animation. We use sophisticated, validated engineering programs that will find the motion of the vehicles before the accident, during the accident, and after the accident. There is a lot of science into that.



The use of computer animations has been used in a courtroom since the mid 80's, really, since the beginning of the company which you've been at the forefront of. During that time, you've been part of many high profile cases. Share with us just a few of those.

I think the most interesting case I have worked on in the past is the Princes Diana accident reconstruction. The accident which happened in a tunnel in Paris. I was involved in investigating this accident right from the beginning. I was involved in the testing of that accident where we did some very advanced testing on the speedway in Los Angeles. We had the entire speedway for the purpose of that testing. We tried to replicate or reenact the collision between two cars. One car was a Mercedes S-class and the second car was a little Fiat Uno. Although we did not use a Mercedes S-class or Fiat, we used a Lincoln Town Car and a Ford Fiesta to try to duplicate the condition where two cars collided with little damage to the Fiat, or Fiesta in our case. There was some debris of tail lights on the road. We were able after about 7 hours and so many tries, to finally get a case where nobody was injured, but we got a little bit of interaction with those vehicles. Remember, they were moving at quite different speeds. One vehicle was doing about 70 mph and the other vehicle was doing half that speed. To clip those two cars without causing a lot of damage was not that easy. It was a very simple concept but very complicated in a real test. Then we did a crush analysis and created the computer animation of that accident. It was a very interesting project.

You provide a team here of in-house animators and engineers, and your facility itself is over 14,000 square feet and is really set up to



meet the needs of almost any client out there. Share with me a little bit about the facility here.

The facility was designed and built in 1999, so about 16 years ago. I was part of the design process. I had a specific vision how I wanted to design the building. One of those visions was our multimedia room where we meet with clients. We use it for depositions and do some testing here. We have six cameras mounted on the wall and ceiling. Those cameras are used for Motion Capture (MoCap), which is a specific process to track and analyze the motion and movement of humans which is then transferred into an animation.

We use real people, they move, they walk, they run, they fall and the camera is tracking them. We can find out how the joints of the human body move and then we can transfer that motion into virtual space. We apply it to a virtual character that matches the size and description of the person involved in the accident. For example, the virtual character can be dressed in any uniform, military, work uniform or police officer uniform, so we can demonstrate that very realistically in animations.

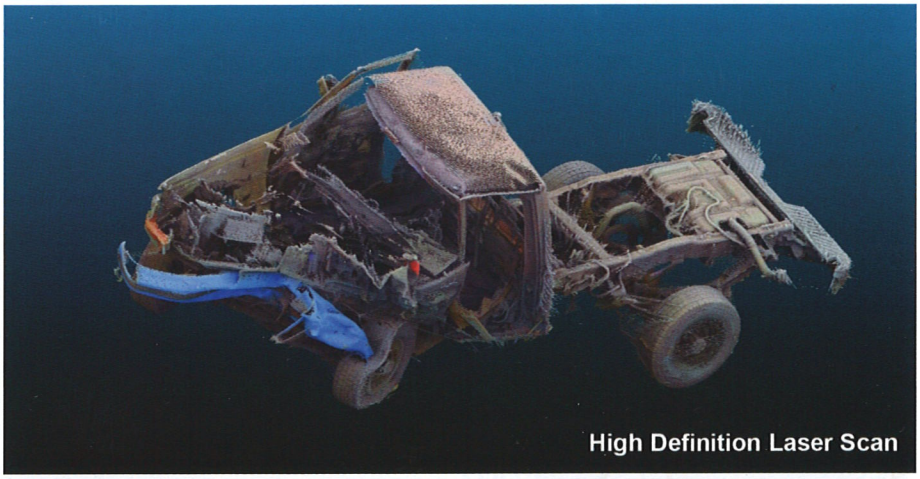
Clients that have 2D renderings, 2D drawings, or photos that need to be realistically created into 3D. Is 3D modeling something that is provided here in house as well?

Yes. Everything we do here on an animation level is in three dimensions or 3D. We use all the latest 3D modeling and animation software and we sometimes use 20 different software's on one project. We always have the newest version of software so that we have the best features available to create the best animations possible. Beyond that, we also write our own programs or scripts that work together with the animation software to perform specialized tasks and analysis customized for the specific needs of the project.

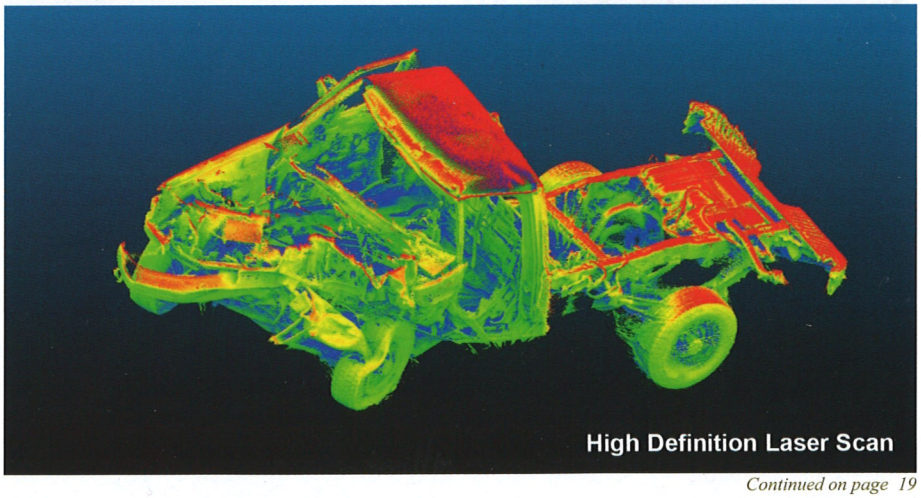
Earlier you mentioned recording data possibly at a scene quickly and accurately. How is the new technology of 3D scanning been able to help in that process?

High Definition 3D laser scanning is phenomenal technology. This technology has been in place for about 5 years for commercial application. It is fantastic technology because, in the past, using the typical method of surveying, you would have a "Total Station", where an individual person has some equipment mounted on a tripod in a construction area. That person is pointing and shooting a laser to capture some points and another person is holding a pole with a reflector. That process is very cumbersome and time consuming. It could take an entire 8 hour day to shoot maybe 800 points. Today's scanner can automatically shoot about 45 million points in approximately 10 minutes.

For example, if you take 4 different scans to document a motor vehicle or document a building, you would have



High Definition Laser Scan



High Definition Laser Scan

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around 200 million points in one hour. Each point has XYZ coordinates so you can go inside virtual space and find out any distance or measurement between two points in that scan out of those millions of points. So it is like a virtual model of the real world in your computer. If you scan this room, you can find out the distance from the tip of your nose to the camera and that

can be found with the accuracy of 1/16 of an inch, very accurate. If you want to know how far it is from point A to point B out of millions of available data points, you will have all that information available and documented forever.

You might say why bother with that when you can take a picture? The problem with the picture is there are no dimensions. You can see the object in the picture but to determine how far is it from point A to point B, you have to use some photogrammetry methods which are convoluted and more complicated. Laser scanning is very useful when a car has crush damage that needs to be measured, or when a bridge or building collapses. You just freeze that moment in time and you come back and measure anything you want.

Speaking about technology, are there any upcoming technologies that you are excited about and believe will be useful in the field of forensic engineering and animation?

Yes, there has been a lot of talk recently and in the past couple of years about drones. We started to experiment how to use this technology to capture data such as aerial photos and video to build very accurate 3D models directly from the imagery. The drone allows us to go and access places we couldn't easily go to before. The technology has developed so rapidly, now you have quadcopters with integrated 4K cameras and are much, much easier to operate safely. I'm very excited about what we can do with this technology.

Technology is a game changer really.

Absolutely. It's very useful.

Some of the animations you are able to provide, are they actually interactive where the person that is testifying or presenting can actually interact with them?

Yes, the classical animation was like a movie, you can play fast forward and rewind, or you can pause, stop and that's it. You only view it in a linear fashion from one perspective.

With an interactive animation without any training or any special instructions, you can move and position the camera to a different location within the 3D virtual scene and view that animation from any point of view you are interested in seeing. It is a phenomenal tool. Now you can say, I'd like to see this accident from a different point of view. You can move the camera 27 feet north and point it wherever you like, and you can see the same motion of those vehicles from that perspective. No special software for the user is required. We use dedicated software to produce the interactive animation, but the user doesn't need any special software.

One of the tools you use in reconstructing accidents is something called photogrammetry. What does this involve and how is it useful?

The photogrammetry process is the process of attaining 3-dimensional information or measurements from photographs. Sometimes, we have photographs taken two years ago by an insurance agent, the car is gone, nothing is available but some photographs from the accident scene showing some skid mark or some debris. Then, two years later, we want to reconstruct the accident. The car is gone, or the roadway may have been modified because

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the tire marks aren't going to stay forever depending on how busy that roadway is. The tire marks might stay for a couple weeks, for a couple of days, or they might stay for 6 months, if there is no heavy traffic. If there is a lot of travel, then the skid marks won't last too long.

If all you have are photographs, then the question is "how can you figure out how long those skid marks are?" Instead of guessing or eye-balling it, there is a technique called photogrammetry by which we can digest and figure out the dimensions of that skid mark. Furthermore, we can find out how much crush we have of that car. By looking at the photographs with the proper software, we can learn the depth of the crush and the location of the crash. We can quantify that damage, which is very useful for engineers to calculate the speed because speed is the result of the engineering analysis, energy balance, and energy calculation, and for that you need to quantify that crash.

Real time simulation was a technique that was used in the Princess Diana case, does that really paint a picture of what happened and how it happened step by step?

Real time simulation has been available since the beginning of the 90's using accident reconstruction software. One of the most popular accident reconstruction software programs used by engineers is "PC Crash" which we have utilized for 22 years. The accident reconstruction programs will take into account the physical properties of the motor vehicle including its weight, size, center of gravity, geometry and inertial properties. In addition, the physics based model can be used to simulate the motion of the vehicle to match certain physical evidence on the roadway. That's why it had become known as simulation software because it will simulate in virtual space, the motion of the vehicle using documented physical evidence collected or obtained from an accident scene, such as gouge marks, tire marks final rest position, and point of impact. This information is analyzed and processed by the computer program which results in a simulation of how the vehicle got from point A to point B matching that physical evidence that

was created during an accident. Matching very precise, within a couple inches. It takes many trials and errors to achieve this precision, but if you are patient, in time, you can get a very good match.

You had mentioned something like photo matching, what about video matching, where you are able to incorporate computer generated objects into a video background. Is that really as close as being the real thing as you can possibly imagine?

Yes, briefly what you said is correct. We can incorporate vehicle motion on top of real video taken of the accident scene. Because we are simulating everything in virtual space, we can take that video and camera properties, and the modeling software will determine the exact location where the camera is taking the video. If the camera is in motion inside the vehicle, it will calculate and determine precisely how that camera is moving in virtual space. One of the ways we bring a vehicle into virtual space is to perform a three dimensional laser scan of the vehicle. With this digitally scanned model of the vehicle, we can integrate the vehicle motion with videos obtained from an accident scene and combine them together for photo-realistic video quality animations.

This really is an industry that has strict criteria and standards when you are talking about evidence used in the courtroom. This is a company that's been up to the challenge and has successfully done so for over 30 years, like you said back when you started. Is it still a fascinating industry for you and are you excited for what the future may hold?

Absolutely. I love what I do and I have tried to pass that love and that fascination with the science of forensic engineering. My engineers are here because they love what we do here, they really enjoy that. Sometimes it's very difficult and stressful type of work. But it's a great reward because we can figure out what went wrong and why, so that's our benefit, that's our work. There are a lot of due dates and requirements we have to meet which are stressful, but as I said, it is fascinating what we can do, how we can do it and how useful that information is for other people, specifically for the legal system, where they need experts to explain to them how things went wrong, why they went wrong. Those are fascinating topics.

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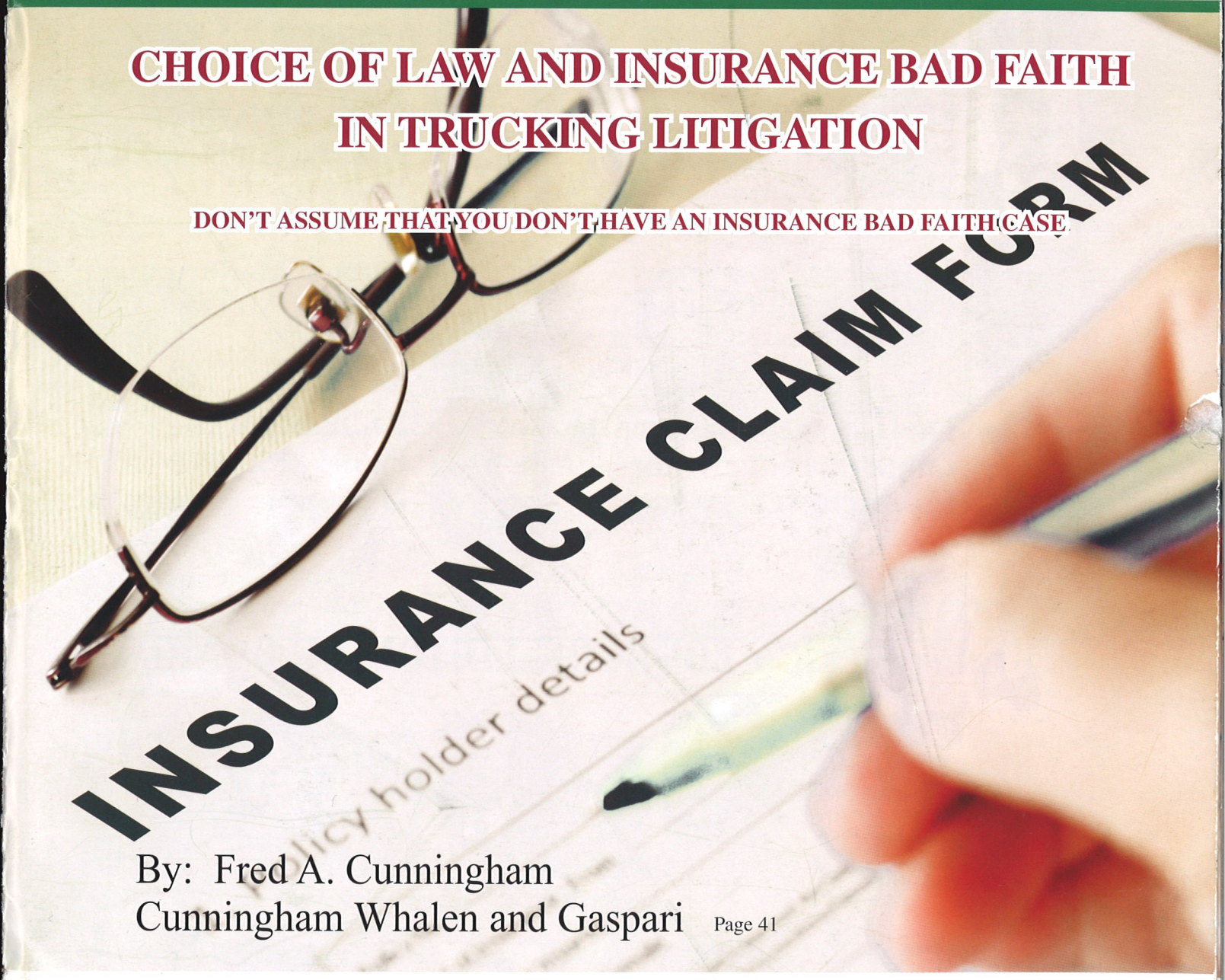

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