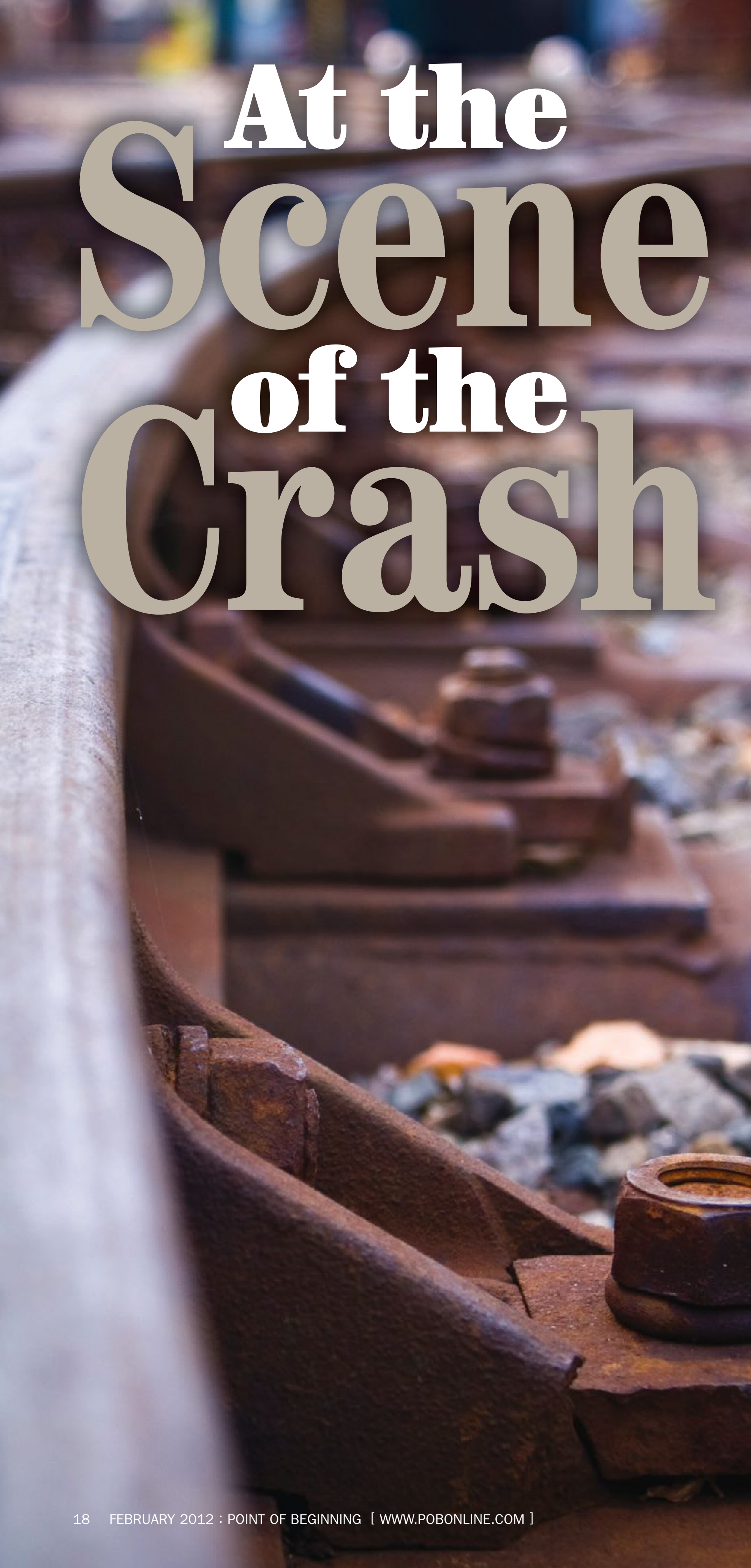
At the Scene of the Crash



By Robert Galvin

Train derailment scenes often resemble a children's game of pick-up sticks, with all of the rail cars in random disarray. While some derailments are clear-cut, the cause of others is a mystery.

Solving these conundrums is a focus of Wolf Technical Services, an Indianapolis-based engineering firm and nationwide leader in accident reconstruction. Wolf has analyzed and reconstructed several hundred train incidents including derailments, railroad/highway grade crossings and pedestrian strikes.

Jim Sobek, a physicist and expert in accident reconstruction at Wolf, says he deals with a minimum of 15 derailments per year on average. Although that may not sound like a big number, consider that many trains are easily a mile long. When there's a derailment, the damage–to cargo, train apparatus, tracks, and real estate–can be catastrophic.

Measuring a derailment scene is a mix of detective work, accident reconstruction skills, and a solid knowledge of physics and how railroads in general operate. "When the experienced investigator comes on scene, he sees an array of hardware lying around just like in auto accidents," Sobek says. "Five to 15 years of experience [of investigating these scenes] tells you what likely happened. Now, you go about looking for the evidence that will confirm or deny your initial thoughts. Once you've got this laid out, you can take the measurements."

Determining the cause of train derailments requires solid sleuthing skills and sound application of measurement and mapping technologies.

Several different tools are used for measuring a scene as complicated as a train derailment. Immediately establishing where everything is in an organized fashion is an application well suited for total stations, Sobek says. The firm uses a Sokkia SET 530R reflectorless total station, which works well to about 400 feet reflectorless. "If you're shooting a large flat surface, then you can actually shoot 1,600 feet reflectorless," says Joe Hubert, a CAD specialist and evidence technician with Wolf.

The total station has an onboard data recorder. "You just click the point data, and while you're shooting the points, you can see that the points are hitting where they need to," Hubert adds.

Photographs are also taken and correlated with survey points for photogrammetry. "The photogrammetry is dependent on the total station, and marrying points mathematically depends on known points from the total station," explains Stuart Nightenhelser, a physicist and crime investigator with the firm. "You can't survey every point. I would set up two, maybe three total stations so I could see most of the major features [of the derailment scene], survey in all the corners you can see from each of those points, and identify them so that you know which are the same corners. These multiple setups are necessary because of the expanse of real estate."

In some cases, the crew uses a helicopter to get a full view of the scene. In other cases, they rely on a series of ground-based panoramic photographs. These are then used with photogrammetry and the total station measurements to map the scene.

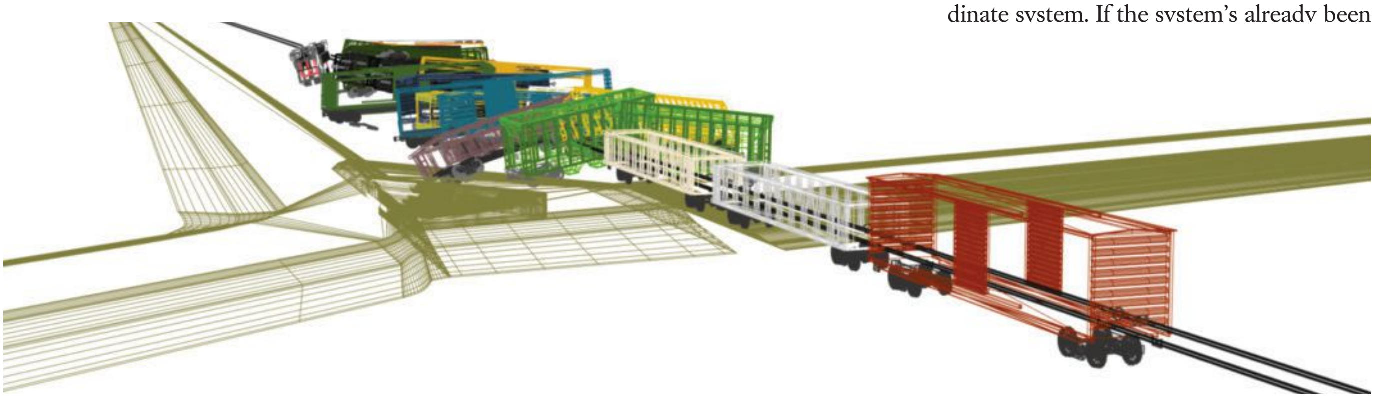
Before pulling out their tools, the crew normally performs a self-check at derailment scenes. Hubert says he typically makes a rough sketch of the scene on paper and then decides what points he wants to capture. "I'll verbalize what I want to shoot with the other person who is with me–this rail, this boxcar, road crossing, signage, trees, utility poles–anything that is important."

Using a total station for scene measuring allows Wolf's derailment experts to apply names to points and to group those points together. For example, one cluster of points can be labeled for a boxcar; another cluster can be identified as a specific rail that was going under the boxcar, and so on. "It's important to label everything correctly," Hubert emphasizes.

He downloads the point data and then imports the data into his diagramming software with ProLINK, a Sokkia software program that facilitates the exchange of data between data collectors and various software packages. "I can see actual point data descriptions," Hubert says. "Then I can export it to a .dxf file and compile it into 3D data so I can open it up in AutoCAD."

A familiar fear among surveyors and reconstructionists is missing key data and possibly never being able to go back to the scene to retrieve it. However, Nightenhelser says modern total stations have eliminated this worry. "Because of the tools that Sokkia's total stations offer, we can download to a laptop right there at the scene, take a look, and make sure we've got a complete data set for all the items we wanted," he says. "Typically, we'll do that even before we've broken down so if we have to go back and get more data, it's still tied into the same coordinate system. If the system's already been

A combination of photogrammetry and total station measurements allows Wolf to accurately map accident scenes.



A Wolf investigator uses a Sokkia SET 530R reflectorless total station to collect detailed data on a train crash.

broken down, we can still go back, set up again, and start taking more data points and just be sure to include some points that were in the original dataset, and then the two datasets can be merged together."

After the derailment scene has been carefully documented, the next step is to create a scaled diagram of the scene. For this phase, scene photographs are a crucial element. "We overlay them [on the diagram]," Sobek says. "Often we will develop a diagram and portray the diagram at exactly the point where the photographer was. And we fade one photo to the next to show we have properly rendered the scene."

Nightenhelser says this process is most effective for court exhibits to either support or deny a claim. "If you put your computer's eye where you're viewing the total station scene from the same point the photo was taken, you can show where evidence is in the 3D space the total station captured and prove or disprove that claim," he says.

Attention to detail is critical when surveying and reconstructing a derailment scene. In one incident, Nightenhelser recalls, a tractor pulling a fertilizer tank across some railroad tracks did not clear the tracks in time before an oncoming train slammed into it. This caused the train to bunch up like an accordion and dump its cargo on both sides of the track. The railroad would like to have claimed that the derailment was caused by the locomotive striking the fertilizer tank, which contained liquid fertilizer weighing 100,000 pounds. However, according to Nightenhaler, the survey showed that the derailment was the result of the train not being made up correctly. When many heavily loaded rail cars are behind empty cars, as was the case with this train, "it becomes fairly easy to squeeze those cars out of line," Nightenhelser explains. "One of the cars came off the tracks and spiraled eight other cars off behind it."

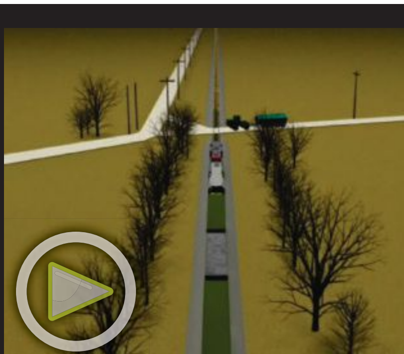
Other common causes of derailments are defects in the track, such as a jointed rail that has undergone movement, or train wheels jumping the rail. "In each case, you'll end up with different evidence, and that evidence will be in different places," Nightenhelser says.

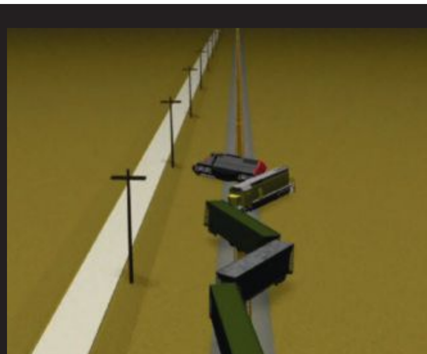
Investigators must understand the nuances of the railroad in order to correctly document a derailment scene. For example, a railcar's makeup begins with wheels or "trucks" on the rails. Then the upper assembly is placed on top of these trucks, and it's all held down by gravity. When a derailment occurs, the whole apparatus topples off the tracks–wheels, springs, trucks and all the cargo. If a set of trucks under a rail car jumps the track, there will be a string of railroad ties with wheels cutting into the ties very deeply, Nightenhelser says.

"If you just take photos of those ties without any surrounding scene context, it can be impossible to figure out where those cut ties were," he explains. "You use a total station to tie things in geometrically. So it's very important to know where the rails with scars on them or ties with cuts in them first appeared, and where it ended up when the event came to rest."

Such details are imperative to understanding the entire derailment process–where it began, how it was triggered, and how the different items that derailed proceeded to final rest. "With this information, you have a complete story that makes sense," he says.

Robert Galvin is a freelance writer who specializes in forensic applications. He can be reached at rsgpr@msn.com. For more information about Wolf, visit www.wolftechnical.com. Additional details about Sokkia equipment and software can be found at www.sokkia.com.





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