Bad actors aren't always bad

Consistently and reliably identifying poorly-performing freight car suspension components is just one challenging aspect of wheel/rail interaction, as discussed at a recent industry seminar.

By Bob Tuzik, President, Talus Associates LLC, for *Railway Age*

The fundamental aspects of wheel/rail interaction haven't changed from year to year. Balancing vehicle behavior with track integrity and friction management remain the mainstays of an optimized wheel/rail system. But the increasing use of wayside and onboard vehicle/track monitoring systems has provided a new vantage point that is enabling railroads to more clearly see the impact that vehicle and track behavior have on each other.

An international gathering of railroaders, researchers, and suppliers at Interface Journal and Advanced Rail Management's 11th Annual Wheel/Rail Interaction Seminar looked at what railroads are doing to cull the worst-acting vehicles from the fleet before they damage the infrastructure, and to identify vehicle and track conditions—some of which may be "in spec"—that may lead to disaster. Speakers at this year's seminar focused on the use of technology to manage wheel/rail interaction. They also examined economic issues, including the lingering question of "who benefits/who pays?" for preemptive maintenance measures, particularly as they relate to private car owners.

As part of their mandate to reduce the stress state, the major North American railways have begun planning maintenance based on performance characteristics, rather than on time- and mileage-based maintenance intervals. "We want to identify cars that are behaving badly—those that are generating excessive lateral or vertical loads—before they damage the track, and identify small problems before they turn into big ones," said Scott Cummings, senior engineer at TTCI.

While railroads and private car owners agree that removing bad-actor cars and high impact wheels is good for all, there is disagreement over the 90-kip (dropping to 80-kip) alarm levels at which impact detectors are set and the consistency of the readings, which can vary depending on the operating speed, lading, and detector location. Another point of contention is that flat or out-of-round wheels that generate high impact loads are often the result of operating practices—poor train handling or failure to release hand brakes. Railroads and private car owners (more than 60% of the North American fleet) are interested in preventive efforts that will generate the biggest bang for the buck. Whose buck, however, remains an issue.

Vehicle/track measurement systems

Vehicle performance, as measured by hotbox, wheel impact load (WILD), acoustic bearing, and truck performance (TPD) detectors, represents the yardstick by which good and bad actors are judged. Identifying flat or out-of-round wheels by the vertical impact loads measured by WILD systems is fairly straightforward. Failed or failing bearings can be identified by their temperature readings or acoustic signatures. Judging truck performance, which is characterized by axle angle of attack along with lateral and vertical force measurements, is more difficult, however. And identifying the cause(s) of poor truck performance adds further complexity. A warped truck, for example, generates high lateral forces in curves and excessive truck rotational resistance, TTCI's Cummings said. The latter also can be due to extremely dry centerbowls or improperly set up CCSBs. Because of variability in equipment, some cars simply perform better (or worse) than others.

TTCI identified the bad-actor trucks beyond the 99th percentile at one test site. Of the cars that were inspected and torn down, 60% had obvious defects, such as broken springs, worn wedges, and damaged side bearings—the types of defects that are billable under AAR interchange rules. Another 20% alarmed on safety limits, such as high L/V ratios. The remaining 20% had no obvious defects. But when put back into service, they showed repeated poor performance. This is because trucks may perform differently each time they pass a TPD, depending on factors such as the wheel/rail coefficient of friction or the dynamic activity of the vehicle, which is related to speed, lading, and truck warp position. A truck that is warped on one pass may be knocked square by a switch on the next. This performance "elasticity" is more prominent for the worst-of-worst than for the best-of-best acting trucks. "While good actors are always good, bad actors are sometimes bad, sometimes good," Cummings said. This has made it difficult to draw trend lines and make predictions about when trucks are in need of repair.

Norfolk Southern incorporated several wayside measuring systems to identify and quantify the effects of hunting—a phenomenon that wears friction components in trucks, contributes to track degradation and damages lading. NS installed a Salient Systems WILD system, a Wayside Inspection Devices' Truck/Bogie Optical Geometry Inspection (T/BOGI) laser/camera-based system, and a proof-of-concept system from Lynxrail and TTCI that uses wheel proximity sensors to identify hunting motions. Through these tests, NS found that while hunting tends to increase with speed, particularly within the 35-to 50-mph range, there are periods during which vehicles that have become excited may dampen back down. Empty cars are more prone to hunting than loaded cars. Worn trucks are more likely to hunt than new or well-maintained trucks. Friction conditions also play a role.

Friction management

NS has tested various lubrication and top-of-rail friction management systems over the years. Friction modification, with proper wheel/rail profile designs, has been shown to significantly reduce lateral loading on the high and low rails in curves. TOR friction management also has shown to reduce rolling resistance and energy consumption. NS conducted tests of three locomotive-mounted TOR systems on a 100-mile section of the Belews Creek Coal Line between Virginia and North Carolina. A Leader™ energy-monitoring system mounted on the locomotives showed that while both energy requirements and lateral loads were reduced, the benefits may not accrue at the same time.

While the use of TOR friction modifiers significantly reduces lateral loads under loaded cars on ascending grades (braking on descending grades tends to burn off the material negating the potential benefits), fuel consumption is not affected, said NS Research Engineer Kevin Conn. "The greatest potential for fuel savings is on level grade."

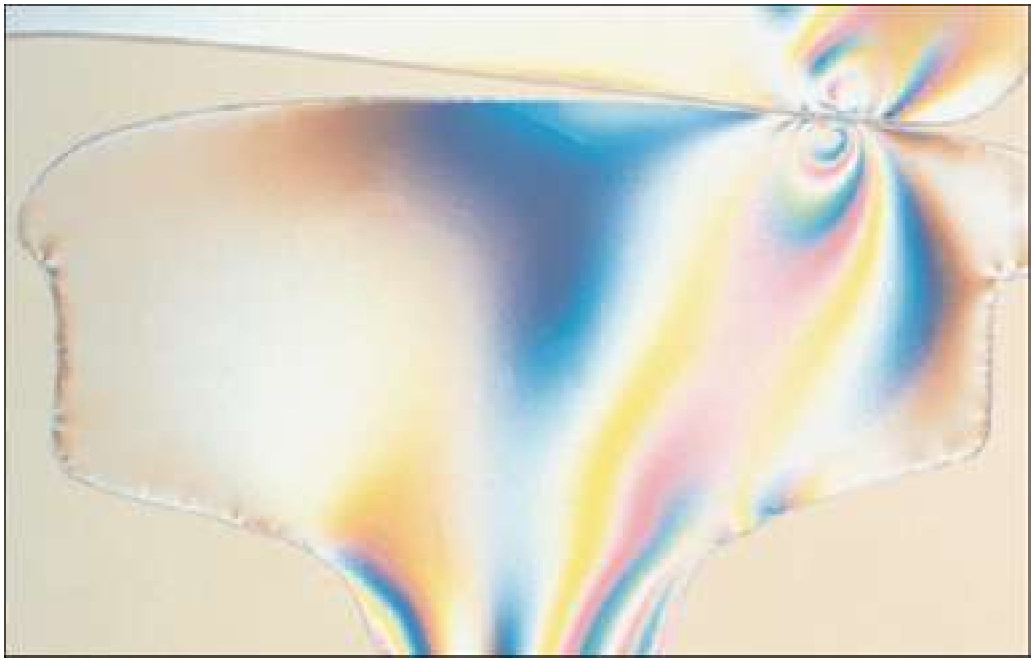
TOR friction management techniques of another sort are applied to deal with seasonal low adhesion issues—a phenomenon in which autumn leaves collecting on rails cause adhesion levels to drop precipitously, leading to operating issues, such as station overruns, and such maintenance issues as slid flat wheels. While the potential for seasonal low adhesion exists wherever there are falling leaves, it is most prevalent in the UK, where commuter trains operate with faster acceleration and shorter stopping distances than in North America.

British railways have developed a water jetting system that sprays water at 15,000 psi to remove leaf deposits that leave a hard, Teflon-like surface when they dry on the top of rail. A custom two-car train cleans the running surface of the rail, then applies sandite, a paste with sand particles suspended in it, to improve adhesion. A UK-based Adhesion Working Group has fostered the development of a laser-based system to clean rail.

Wheel/rail profile management

Friction and wheel/rail profile management have never been more important on North American railroads than they are today with the move to 286K cars. "We're seeing vertical and lateral load conditions that didn't exist 15 to 20 years ago," said Gary Wolf, president of Rail Sciences, Inc. Thus, it's essential to better understand how profile management can reduce contact stresses, extend asset life, and reduce derailments. Wheel climb potential can be mitigated by controlling the contact angle between the wheel and rail. "It takes a high L/V to initiate wheel climb when new wheels and well-maintained rail provide an 80- to 85-degree contact angle," Wolf said. But as that contact angle wears to within the 65- to 70-degree range, the L/V force required to initiate wheel climb decreases. "Rail profile grinding and proper maintenance of rail cant, which can also affect gauge-face angle, can help limit wheel climb potential."

Wheel profile design and maintenance represent the other half of the wheel/rail equation. Mismatched or poorly maintained wheel and rail profiles can lead to high stresses that can cause rolling contact fatigue, said Rob Caldwell, Senior Engineer at the National Research Council of Canada's Centre for Surface Transportation Technology (CSTT).



ERIC MAGEL, NRC

Wheel/rail profile management can reduce contact stresses and extend the asset life of wheel, rail, and other vehicle/track components. This graphic shows typical wheel/rail stress distribution patterns, specifically, how stresses move through both.

Several years ago, Canadian railways experienced a high "infant mortality" rate on AAR1B-design wheels, which developed shelling within 25,000 miles of operation during winter months. The CSTT developed a modified Heumann antishelling (ASW) profile for coal service on the Quebec Cartier Mining railway that was later adopted for use on CN and CP Rail unit coal and grain trains. The ASW profile incorporates additional metal in the flange root area with a slight roll off of the 1:20 tread taper to improve steering and slow the development of tread hollowing. "During their first winter of operation, shelling was reduced by 60% on wheels with the ASW profiles compared to wheels with the AAR1B," Caldwell said.

Cracked wheels represent another area of concern. "There are about 2,000 wheel failures a year, caused by some combination of tread, flange, and rim crack defects," said Brian Smith, Principal Investigator at TTCI. With associated annual costs estimated at about $21 million, there is a need to detect defects before they cause derailments. TTCI developed a prototype Dynamic Detection Station that uses a combination of laser and ultrasonic technology to identify these defects. The system is expected to be rolled out later this year.