Searching for a hot one

Railroads record a tremendous amount of data on wayside fault detectors, but don't always take a holistic approach in examining the information. Integrated detection systems can change that.

By Tom Judge, Engineering Editor

For decades, railroads have relied on wayside detection units to warn of such things as hot bearings, hot wheels, and dragging equipment. Canadian National and Union Pacific are taking an integrated look at the data collected by these systems to improve safety and efficiency as well as predict inspection and maintenance of rolling stock. Representatives of the two railroads as well as the Transportation Technology Center, Inc., presented technical papers on the subject at the 2003 International Heavy Haul Association Specialist Technical Session in Dallas.

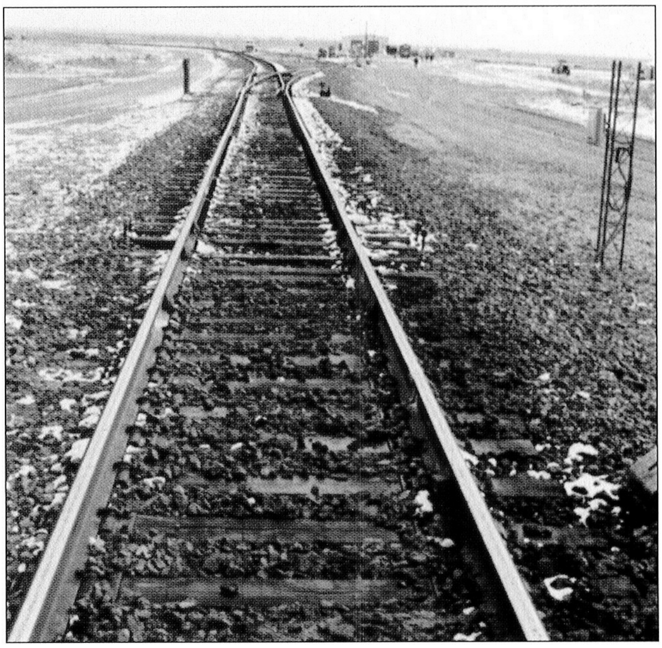
William G. Blevins, chief mechanical and electrical engineer for CN, and Richard Morgan and Chris Pinney, TTCI engineers, discussed how TTCI analyzed and documented the benefits of CN's use of integrated wayside detection systems to significantly reduce journal burn-offs.

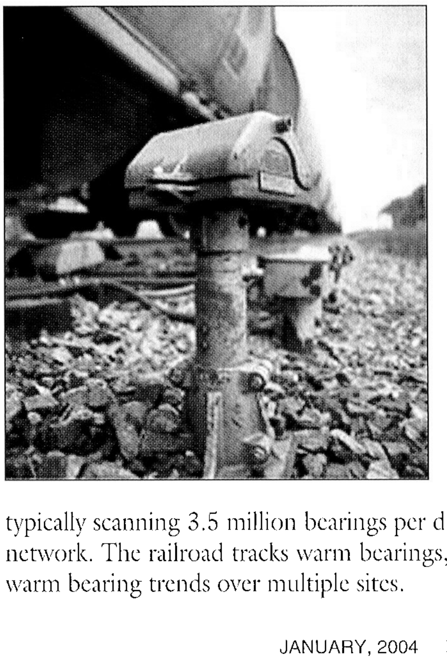
The hot bearing detector network on CN began to take shape in the 1960s as the technology began to take hold on North American railroads. Today, there are 452 wayside inspection system sites in Canada incorporating 452 hot bearing and dragging equipment detectors, while 324 sites have hot wheel detectors.

All CN sites are linked to its Rail Traffic Control Centre in Edmonton, Alta. Mechanical Department staff monitors these sites 24/7 with the help of central computer trend and pattern analyzers. A "hot" bearing can be declared from the RTC office with additional criteria not installed at the local HBD site. The traditional paper chart tapes have been replaced by computer displays. The staff uses these displays triggered by "warm" bearing and "warm" wheels trending thresholds at about half that of traditional field alarm levels. Central "hot" analysis and "warm" trending was unique to CN in North America until mid-2002.

While developing the expertise on tracking warm wheels in the mid-1990s, mechanical and C&S staff began to take notice of all the detected signals coming from the detector network. They observed that many bearings destined to become future hot alarms in the field showed distinct warming tendencies at prior HBD sites. By 1997, the staff was able to predict future hot alarms based on prior warm readings. In the second quarter of that year, CN formalized this new predictive bearing detection technique and began preventive car setouts.

Since April 1997, CN staff has tracked hot bearing detectors, typically scanning 3.5 million bearings per day on CN's Canadian network. The railroad tracks warm bearings, looking for repeated warm bearing trends over multiple sites.





CN and UP are among the railroads using such wayside detectors as HBDs (pictured here at TTCI's FAST). TTCI is presently determining the feasibility of tracking warm bearings. Data analysis techniques used on a burn-off test showed promise toward providing an early warning of bearing deterioration and failure.

"There is a benefit to having close spacing to build trend data," Blevins said. "The staff requests a preventive setout with three to four repeated warm readings at sequential or close HBD sites. The action taken is proportional to the magnitude of the warm reading and any known car history. When needed, the staff uses nearby AEI scanners to identify both alarmed and warm cars at HBDs. A crosscheck with the train crew ensures the correct car is inspected."

Bearing teardowns continue to confirm that a significant number of these predictive setout bearings have internal defects. "CN accepts the fact that some setouts are 'false' because the overall benefit has been extraordinary," Blevins noted. "CN has experienced a dramatic reduction in burned-off journals in the past five years. In addition, the number of hot bearing detector alarms per axle scanned has dropped by one-third during the period 1992-2002. The service reliability and safety benefits of the predictive process are evident. CN has not seen a significant rise in total cars setout with this policy."

TTCI developments

As part of the AAR's Wayside Detection Program, TTCI is presently determining the feasibility of tracking warm bearings. Data analyzed from CN's HBD network suggest that a prediction can be made, within limits, on how bearings may behave in service. Mechanical officers use real-time data analysis of bearing temperature along with AEI readers to track warm bearings at HBD sites.

As part of the program, TTCI conducted a burn-off test. Results indicated that warm bearing trends might be detected early in the deterioration process of a defective bearing. Data analysis techniques used on the test showed promise toward providing an early warning of bearing deterioration and failure.

In an effort to reduce the number of undetected (and burned-off) failed bearings on the UP, an action team visited CN's detector network monitoring station at the Edmonton RTC in May 2002. Having seen the benefits of bearing trend analysis, UP reviewed its capability to emulate this approach.

In 2002, 400 of UP's 1,200 HBDs had communications capabilities with the Harriman Dispatching Center in Omaha, Neb. Almost all of these "communicating" HBDs are on UP's original Omaha-Los Angeles-Portland, Ore., Overland Route, and on the former Chicago & North Western Omaha-Chicago route. The remaining 800 or so of UP's system HBDs are stand-alone machines on other routes.

During May-June, 2002, UP programmed a data acquisition detection algorithm and display system to find bearings in early failure mode using trend analysis between HBD sites. In July 2002, the new system was initiated, and predictive failed bearings were set out immediately. About two dozen of these were forwarded to the Rail Sciences, Inc., lab in Omaha for teardown analysis. There was a 100% correlation of these predictive bearings to serious internal damage that was destined for destructive failure. Cars with multiple symptoms and/or repeat events are candidates for further preventive action.

To capitalize on this, detected events and symptoms must be associated with a specific car number; it's possible that a computer could be programmed to deduce a car number. CN is completing a new project to automatically attach a car number to every HBD/HWD/DED axle number. Using computer logic, the trains/cars will be tracked over subdivisions using AEI at the beginning and end sites only. For sites between AEI scanners, the computer will logically determine the car ID based upon train axle counts, time of arrival, and direction. This "virtual AEI Scanner" project creates a powerful tool to provide a car number to every symptom, however minor they seem. This will lead to further diagnostic processes to find associated failure mode events.

UP: Predictive inspection

"Heavy-haul North American railroads must maximize line capacity to meet business goals," said Mike Iden, general director car and locomotive engineering for UP. "Historically, wayside detectors have been installed as preventive devices to protect the track structure from damage imposed by aberrant rolling stock, e.g., wheel flat spots and overheated roller bearings. With few exceptions, wayside detection devices have never been installed or managed in a coordinated manner reflective of the interconnected relationship between rolling stock defects. Rolling stock maintenance continues to be reactive and failure-based. A comprehensive program of integrating wayside detection technologies with predictive rolling stock maintenance will achieve significant increases in operating efficiency, reduce derailment risks, and improve asset utilization. The integrated wayside detector network will feed all car (and locomotive) data collected at the many different sites into one composite data system. This will enable a railroad to correlate increasing wheel impacts from Wheel Impact Load Detector sites, for example, with increases in roller bearing temperatures from HBD sites or with increases in acoustic emissions or noise from Acoustic Bearing Detector sites."

A move from the current reactive car maintenance system to a predictive system —through wayside detector technology—will allow railroads and car owners to improve asset utilization and reduce rolling stock capital expenditures.

"In turn," said Iden, "each car and locomotive must exist in the information system as a discrete vehicle health record. The health record for a particular freight car will contain all recent detector data gathered for that car. The health record also creates the basis for generating repair task or work orders for the preventive or predictive repair or replacement components."

Railroads need to move from the current reactive car maintenance system to a more predictive system, Iden said. "By converting to predictive freight car repair and maintenance, railroads and car owners will achieve improvements in utilization of both rolling stock and repair facilities. Availability of freight cars will improve, reducing the capital expenditures required for rolling stock."

According to Iden, there are several new wayside detection technologies needed, among which are "machine vision" packages to perform higher-accuracy inspections now done primarily by sight and gauge, and advanced axle inspection technologies for both wayside and wheel shop application to monitor axles for cracks. Machine vision is the use of digitized images, either still or video, which are then analyzed using computer algorithms. The Beckman Institute at the University of Illinois at Urbana-Champaign is currently undertaking an AAR-sponsored program to develop machine vision packages for freight car inspection.