Modern Freight Railroads Run on Technology

Improving Track, Infrastructure & Equipment Safety

Sustained railroad infrastructure investment, adoption of new inspection technologies, the development of better track components, and advancements in inspection and maintenance practices have decreased two of the leading causes of accidents: track and equipment failures. Proactive maintenance helps keep the rail network safe, which drives better service and reliability. Class I railroads' mainline train accident rate is down 49% since 2000. Additionally, the equipment-caused accident rate is down 21% since 2000 and 2022 marked the lowest-ever rate of track-related accidents.

ATI technologies measure how the track structure performs under the weight of a train. Automated Track Inspection (ATI) systems use lasers and cameras mounted onto locomotives or railcars to inspect track as the train travels across the network. The system tests each foot of track, which detects issues that may not be visible when a track is not occupied. The data from the inspection devices transmits to a centralized location where employees verify and schedule maintenance as necessary.

ATI speeds up safety inspections and safeguards employees. Track inspection vehicles, or "track geometry cars," can measure hundreds of thousands of track miles yearly. The cars travel along the tracks, measuring every inch for track alignment, elevation in curves, gauge (the distance between the two rails) and many other track geometry measurements. For example, an advanced algorithm can analyze track alignment of more than 1,500 curves in track in just a few hours, whereas it would have taken a team of four people 10 months to complete the same task manually.

Ultrasound looks for flaws inside tracks and ties. As a train travels over any track segment, energy is transmitted through the track and into the ground below. This energy can be measured as a series of sound waves, collectively called an acoustic signature. The acoustic signature of a track is different depending on the health of the track. Going further down, ground-penetrating radar looks inside track foundation — known as ballast — to see water damage or deterioration.

Key Takeaway

Technology is the digital infrastructure that powers America's freight rail network, creating a world-class transportation system that moves the economy forward.

Freight railroads use technology every moment of the day to keep employees, communities, infrastructure and equipment safe while improving customer service and decreasing the industry's carbon footprint. Thanks in part to these technologies, the train accident rate is down 28% since 2000, and the last decade was the safest ever.

Driving Research & Innovation

Railroads work with suppliers and industry partners to research and develop innovations to advance safety, service and sustainability further.

- **Railinc** is the leading provider of information technology, related network operations and financial services, and near real-time network data to North America's railroads.
- **MxV Rail's** world-class team of researchers, engineers and other experts develop and test the emerging safety and efficiency technologies that keep railroads on the cutting edge.

Locomotive sensors monitor individual components. While a train is on the move, hundreds of sensors throughout the locomotive continually gather data on the performance of individual components. Sensors transmit the data to analysts using real-time software to identify equipment needing maintenance. Locomotives also have fuel management systems that use sensors that provide engineers with real-time recommendations on how to operate the train to maximize fuel efficiency, but also sense when an engine is getting too hot or when oil is contaminated.

Machine visioning inspects passing trains. Machine visioning technology uses cameras that collect 40,000 images per second of trains as they pass by at up to 60 MPH. This technology reduces inspection times to mere seconds. A series of algorithms then analyze the images to identify any anomalies, allowing railroads to resolve issues faster than they could with manual inspections alone. The technology helps railroads look at many elements simultaneously, providing a comprehensive view of locomotives, trains and their components.

Lasers and scanners measure the wheel profiles of moving trains. Wheel Profile Detectors (WPDs) measure wheel profiles of moving trains using laser and optical scanning devices to take images of the flange, tread and other aspects of the wheel. The WPD data summary aims to get an aggregate view of these measurements. The data summary can be used to analyze wheel trends and determine wheel wear and condition. This data can alert railroads when immediate action must be taken to remove a car from service or if a wheel is worn beyond the FRA and AAR thresholds.

Hot bearing detectors sense overheating bearings. Railroads monitor bearing temperatures using heat-sensing detectors placed at intervals along the right-of-way to notify the engineer if it is necessary to stop a train due to an overheated bearing. Some hot bearing detectors (also known as hot box detectors) transmit bearing temperature data so that bearings that are warmer than average but still safe to operate can be tracked and replaced before they reach the end of their useful life.

Wheel impact load detectors reduce broken rails and wheel and bearing failures. These detectors identify wheels that are heavily pounding on the tracks and cull them out of service if they are reaching the end of their useful life.

Meeting Customer Needs

More than 630 freight railroads daily provide safe and sustainable transportation for thousands of customers across North America's rail network. Advanced software, mobile apps and other programs improve rail operations and customer communication, improving rail's ability to move vast amounts of freight efficiently and cost-effectively.

Like air traffic control systems, dispatch-planning software helps optimize train movement across the network. The software analyzes system-wide train schedules, speed restrictions and crew schedules to help train dispatchers determine the best operating plan for their portion of the rail system. Today, this advanced software can reassess a train management plan every two minutes, allowing dispatchers to respond in near real-time to changing conditions, such as train delays, weather events and unplanned maintenance work.

Customer Application Program Interfaces (APIs) support shipment tracking. Railroads provide their customers with granularized data to support shipment tracking. This information helps rail customers better manage their operations and inventory. Many railroads have developed specialized tools — from API integrated directly into customer platforms to shipment tracking tools — that provide greater transparency for everything from the location of their products on the rail network to rail car availability and ordering.

Addressing Climate Change

As freight demand is expected to rise 30% by 2040, the nation's railroads want to be and must be a part of the solution to climate change. Thanks to targeted investments, technology and evolving operations, railroads are the most fuel-efficient way to move freight over land, with one train three to four times more fuel-efficient than trucks, on average. Since GHG emissions are directly related to fuel consumption, freight railroads have strategically implemented technologies like locomotive fuel management systems and anti-idling systems to drive down GHG emissions and make rail operations even more resilient.

Locomotives: Today's locomotives emit fewer criteria pollutants and GHGs. Advanced computer systems improve fuel efficiency by up to 14% by calculating the most efficient speed, spacing and timing of trains while monitoring locomotive performance. Idling-reduction technologies, such as stop-start systems that shut down a locomotive when not in use and restart it as needed, can reduce unnecessary idle time by 50%.

Yards: Railroads are driving down emissions and reducing community impact with every operational decision in rail yards — from adjusting the small truck "hostlers" that ferry equipment around the yard to developing multiple technologies that speed truck entry from two minutes to about 30 seconds.

Empowering Employees

The rail industry is one of America's safest workplaces, with lower employee injury rates than most other industries. Advanced training centers with simulators and virtual reality enable employees to practice real-life skills in a safe, rigorous and controlled environment, while innovations like remote control locomotives and high-definition cameras allow employees to perform their jobs effectively from a distance where possible, keeping them out of harm's way.

PTC supports locomotive engineers. Life-saving technology called Positive Train Control is fully deployed on lines that carry passengers and high volumes of hazardous materials. PTC monitors train location, speed, track signals and many other inputs to prevent certain train-to-train collisions and derailments caused by human error.

Training simulators prepare employees for real conditions. Many railroads use a combination of field training, on-the-job training and distance learning to create their professional workforce, with some railroads owning dedicated technical training centers. Simulators range from locomotive and power-operated switches to grade crossing simulators. For example, engineers can virtually learn train handling procedures on different track parts. They can also experience how the PTC system initiates by constantly assessing many variables to guarantee the train has the necessary time and space to come to a stop safely where necessary to do so along the route.

Drones and RCL safeguard employees. Regular inspections of railroad bridges by inspectors or drones are vital for trains safely transporting goods across bodies of water. More frequent inspections occur for bridges with more intensive traffic or whose conditions may warrant closer monitoring. Railroads follow an aggressive "safety first" policy and immediately alter or suspend service on any bridge until all concerns are addressed, and repairs are made if necessary.

Railroads use drones to inspect bridges and to take video and pictures of hard-to-reach areas within the bridge. Sonar identifies increased erosion around the piers, which can compromise a bridge's integrity. Sonar sends sound waves that bounce off the bridge piers and the ground surface below the water. Then, based on the nature of the echo, railroads determine whether there are any concerns with the stability of the bridge piers.

Loose or missing fasteners in track or soft spots in ballast could cause more stress on the track structure and lead to signal problems. Railroads use drones most frequently after weather events to look for washouts, downed trees, misaligned track and other conditions caused by weather. Drones can also look at areas of track affected by severe weather. This technology provides trending data because railroads can analyze older snapshots with newer ones.

Remote Control Locomotives (RCL) allow employees in rail yards to control and operate locomotives with hand-held transmitters, which helps reduce incidents where an engineer operating a locomotive could inadvertently injure another worker in the yard due to miscommunication.

Safeguarding Communities

The freight rail industry extends its commitment to safety beyond its yards and tracks and into the communities through which railroads operate. Railways use technology in multiple ways to keep community members safe, from driver and pedestrian safety initiatives to first responder preparedness.

First Responder Training & AskRAil. In 2023, the railroads will train roughly 20,000 first responders in local communities across the country on accident mitigation. In addition, the industry will facilitate the training of 2,000 first responders at the Security and Emergency Response Training Center (SERTC) facility in Colorado, which includes enhanced scenario planning and training at a new facility. The AskRail mobile app — a collaborative effort among the emergency response community and America's freight railroads — provides the nation's first responders with accurate, timely data about what type of hazardous materials a rail car is carrying so they can make an informed decision about how to respond in the event of a rail emergency.

Drivers & Pedestrians. To help keep the public safe near tracks, railroads have worked with federal regulators and private technology companies to develop technological solutions to improve safety around railroad tracks and rights of way. For example, railroads have partnered with Waze to develop a safety feature that alerts app users to upcoming grade crossings and developed smart crossings that know how fast a train is approaching. Thanks to efforts like these, collisions and incidents involving pedestrians, vehicles and trains have declined in recent years.

Protecting The Digital Network

The nation's freight and passenger railroads have worked daily with government agencies and security, law enforcement and intelligence professionals for almost 20 years to monitor the nearly 140,000-mile rail network, understand potential threats and protect physical and digital assets.

Information Sharing. Railroads disseminate, receive and analyze intelligence daily with public and internal law enforcement, Transportation Security Administration, Department of Homeland Security, Federal Bureau of Investigation, and Transport Canada to inform effective security practices, measures and procedures. Railroads also learn from non-rail incidents worldwide to better understand how illicit activities are planned and executed to adjust plans and measures. A dedicated industry alert network circulates timely security information to the nation's freight and passenger railroads almost daily.

Security Training. Railroad employees receive security training augmented by shared intelligence and related security information. Freight railroads and their security partners participate in an annual industry-wide exercise that simulates physical and cyber threats to evaluate preparedness and enhance procedures. Railroads have participated in hundreds of security preparedness exercises with local police, emergency responders, and U.S. and Canadian government departments and agencies. Individual railroads also maintain security training programs and initiatives.