

HOW FREIGHT RAILROADS USE AI FOR SAFETY & EFFICIENCY

Key Takeaways

- AI helps freight railroads prevent problems before they happen.
 - AI enables predictive maintenance to keep trains running reliably.
 - AI improves safety, efficiency, and fuel performance across the rail network.
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Freight railroads have used artificial intelligence (AI) for decades to improve safety, reliability, and efficiency across the U.S. freight rail network. Today, AI is integrated into many of the tools and technologies rail employees use every day, supporting safer operations, stronger network performance, and more reliable service for businesses and communities.

In freight rail operations, artificial intelligence helps detect equipment and infrastructure issues early, enable predictive maintenance, optimize fuel efficiency, and enhance inspection processes. By analyzing large volumes of real-time and historical data, AI-enabled systems help railroads identify potential problems before they cause disruptions, improve operational safety, and move goods more efficiently across the United States.

The examples below highlight how freight railroads apply artificial intelligence to support safety, maintenance, and network performance.

- **Trackside Sensors and Wheel Safety:** Trackside sensors capture large amounts of data as trains pass by, including wheel profiles, wheel impact loads, the acoustic signatures of bearings, and the temperatures of bearings and wheels. To guard against wheel failures, AI learns the early signs of what wheel failures look like and flags potential problems before they happen, helping railroads address issues proactively and reduce safety risks.
- **Onboard Monitoring and Predictive Maintenance:** Onboard sensors stream engine and performance data to teams in centralized locations. AI compares this real-time data to records from past failures to predict maintenance needs before locomotives break down. This predictive approach helps reduce delays, improve reliability, and keep trains operating safely.
- **Drone Inspections and Infrastructure Monitoring:** AI analyzes drone imagery to help inspectors get a closer look at cracks or erosion on bridges. It also helps survey track areas for problems such as standing water from blocked culverts or storm damage. These tools help railroads identify infrastructure issues earlier and prioritize repairs more efficiently.
- **Energy Management Systems for Engineers:** Locomotive engineers use onboard energy management systems that incorporate AI. These systems recommend more efficient throttle and braking strategies in real time based on terrain, train makeup, and speed. This helps improve fuel efficiency and further [reduce emissions](#).

- **Automated Railcar Inspection Portals:** High-definition, 360-degree cameras scan railcars as trains pass through inspection portals at speed. AI learns what damaged wheels and components look like and automatically flags potential defects so they can be inspected and fixed. This allows railroads to inspect equipment quickly while maintaining safe, ongoing operations.

HOW CLASS I FREIGHT RAILROADS ARE USING ARTIFICIAL INTELLIGENCE

- **Wayside Sensors:** AI algorithms sift through more than 35 million readings from [BNSF's wayside detectors](#) each day, allowing the railroad to predict maintenance needs in advance. This lowers the likelihood of breakdowns and service interruptions, enhancing fluidity and safety for our customers.
- **Digital Twins:** As Norfolk Southern trains move freight across the country, onboard imaging systems, IoT sensors, and artificial intelligence continuously inspect and inventory track infrastructure, capturing data on rail manufacturer, age, size, and condition. This information powers a [real-time digital twin](#)—a virtual model of the railroad's network—that enables remote monitoring, earlier detection of potential issues, and proactive safety improvements. By combining historical performance data, AI, and predictive analytics, the company can also simulate freight flows and yard operations to anticipate bottlenecks, improve scheduling, and strengthen overall network reliability.
- **Drones:** More than 250 Union Pacific employees are [certified drone operators](#), supporting the railroad's use of drones, data analytics, and artificial intelligence to improve safety and operational performance. Drones survey bridges, track, and other infrastructure quickly and safely, while AI and predictive analytics analyze large datasets to strengthen planning, anticipate maintenance needs, and help the railroad respond more effectively to changing conditions across its network.
- **Edge Computing:** CSX uses AI and [edge computing](#) to drive operational improvements. Edge computing enables real-time detection and decision-making, enhancing safety, reliability, and efficiency across railroad operations. The Innovation X program fosters employee-driven ideas to apply technology for continuous improvement in safety, customer service, and data access for employees.
- **Train Inspection Portals:** Canadian National operates [automated inspection portals](#) that use machine vision — a form of artificial intelligence — to capture panoramic, high-resolution images of trains moving at track speed. These systems analyze equipment condition in real time and help identify defects early, improving safety while reducing the need for manual inspections and minimizing operational disruptions.
- **Thermal Sensors:** One of CPKC's latest innovations is [Optical AEI technology](#), built entirely in-house by its engineers. This advanced system combines optical imaging, artificial intelligence, and thermal sensing to monitor railcars and train components in real time, improving equipment identification accuracy and helping detect potential defects early. It represents another step forward in safer, smarter rail operations.