High-Tech Advances Improve Railroad Safety & Efficiency

Summary

Freight railroads have dramatically improved safety and efficiency through the use of new technologies and operational innovations. Many of these advancements were developed or refined at the finest rail research facility in the world: the **Transportation Technology Center, Inc**. (TTCI) in Pueblo, Colorado. TTCI is a wholly owned subsidiary of the Association of American Railroads. Many of these improvements are designed to identify problems involving freight cars, locomotives, track, and cargo before damage, traffic delays, or accidents occur. Some of these high-tech advances are described below.

Freight Car and Locomotive Wheels

- **Wayside detectors** identify defects on passing rail cars — including overheated bearings and damaged wheels, dragging hoses, deteriorating bearings, cracked wheels, and excessively high and wide loads — before structural failure or other damage occurs. Some of the newest wayside detectors use **machine vision** and **digitized images** to perform high accuracy inspections of car safety features (such as handholds, ladders, and uncoupling levers) and car underframes. Following tests at TTCI, one railroad recently installed a system that uses **ultrasonic probes** to inspect wheels of moving trains.

- **Wheel profile monitors** use lasers and optics to capture images of wheels. The images show if wheel tread or flanges are worn and, consequently, when the wheels need to be removed from service.

- Trackside **acoustic detector systems** use "acoustic signatures" to evaluate the sound of internal wheel bearings to identify those nearing failure. These systems supplement or replace existing systems that **measure the heat bearings generate** in order to identify those in the process of failing.

- Wheels constructed with stronger **micro-alloy metals** that resist damage and can handle heavier service loads are being developed.

- Wheel **temperature detectors**, using infrared technology, scan locomotives and freight cars on passing trains to determine if their brakes are properly set or are applied when they should not be.

Track and Infrastructure

- **Defect detector vehicles** detect internal flaws in rails. The AAR and the Federal Railroad Administration (FRA) fund a Rail Defect Test Facility at TTCI that tests new methods for detecting rail flaws. A prototype of the world's first **laser-based rail inspection system** is being developed and tested at TTCI. In addition, a new in-motion

ultrasonic rail joint inspection system developed at TTCI is being tested on a major railroad.

- **Improved metallurgy** and **improved fastening systems** have enhanced track stability, reducing the risk of track failure that can lead to derailments.

- Advanced **track geometry cars** use sophisticated electronic and optical instruments to inspect track alignment, gauge, curvature, and other track conditions. TTCI has developed an on-board computer system that provides even more sophisticated analyses of track geometry and predicts the response of freight cars to track geometry deviations. This information helps railroads determine when track needs maintenance.

- **Ground-penetrating radar** and **terrain conductivity sensors** are being developed that will help identify problems below the ground (such as excessive water penetration and deteriorated ballast) that hinder track stability.

- Improved **rail lubrication** techniques, including the use of high-tech "friction modifiers," are being introduced to extend rail life and reduce fuel costs.

- Much of the track research underway is related to **heavy-axle load** (HAL) service, which entails the use of heavier and often longer trains. HAL-related applications dealing with rail steels, bridges, welding, and specialized track components are being examined.

- New systems — including remote monitoring capabilities — are being developed and tested to ascertain the **structural health of bridges**.

Locomotives and Freight Cars

- Because a relatively small percentage of freight cars cause an inordinately high percentage of track damage and have a higher than usual propensity to derail, TTCI is working on ways to use **truck performance detectors** and **hunting detectors**[1] to identify poorly performing freight cars.

- **Nondestructive inspection techniques** that use fluorescent magnetic particles to identify defects in rail car castings and coupling systems are being developed.

- **Tank car enhancements** have helped railroads reduce the rail hazmat accident rate by 80 percent since 2000. Railroads are constantly investigating ways to further enhance tank car safety.

- Thousands of **new state-of-the-art locomotives** are now operating on U.S. railroads. These new locomotives are more reliable, stronger, more fuel efficient, and less polluting than the locomotives they replace. They can have 20 or more **microprocessors** to monitor critical functions and performance.

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[1] In terms of rail cars, "truck" refers to the complete four-wheel assembly that supports the car body. "Hunting" is an instability, more prevalent at higher speeds, that causes a rail car to weave down a track, usually with the flange of the wheel striking the rail.

- Some railroads are using **remote control locomotive technology** (RCL) to improve safety and efficiency. With this technology, rail personnel on the ground can operate and control locomotives in rail yards with a hand-held transmitter that sends signals to a microprocessor aboard a locomotive.

- Other new technologies that save fuel and reduce emissions include **engine shutdown** and **startup systems** that keep engine fluids warm and reduce idling and **locomotive consist managers** that automatically reduce power on unneeded locomotives.

Computers and Communication Systems

- The rail industry has begun the **Asset Health Strategic Initiative** (AHSI), a multiyear program that identifies and addresses industry-level issues that can be addressed with information technology solutions and processes that will enable **more reliable service and cost-effective operations** through **more effective asset health management**. The overarching goal is to provide a view of the health of rolling stock available to all stakeholders, particularly to the railroads on which the cars and locomotives are operating. The program builds on existing industry defect detection systems and capabilities — such as equipment databases, component identification, car repair procedures, and detector alerts — to develop a common foundation for solutions aimed at reducing mechanical service interruptions, improving the quality of railcar inspections, and increasing rail yard and repair shop efficiency.

- Advanced **computer modeling software** is being used in a huge variety of rail applications, from automating rail grinding schedules and demand forecasting to construction sequencing and operations simulation.

- Since October 2014, emergency responders have been able to use a web-based app developed by railroads called **AskRail** that allows emergency responders to input the identification number of a particular rail car and immediately determine if the car is loaded or empty, if loaded the product it contains, the hazard class and other information about the product, how to contact the handling railroad, and other key information.

Operational Safety

- Railroads are developing and installing **positive train control** (PTC) on main lines used to carry passengers or TIH materials. PTC systems are designed to **automatically stop or slow a train** before certain accidents occur. As mandated by Congress, PTC is designed to prevent train-to-train collisions, derailments caused by excessive speed, unauthorized incursions by trains onto sections of track where maintenance activities are underway, and the movement of a train through a track switch left in the wrong position.

- Several years ago, the rail industry and several federal agencies jointly developed the **Rail Corridor Risk Management System** (RCRMS), a sophisticated routing model designed to help railroads analyze and identify the overall safest and most secure routes for transporting highly hazardous materials. The model uses a minimum of 27 risk factors — including hazmat volume, population density along the route, trip length, emergency response capability, and availability of alternate routes — to assess the overall safety and security of rail routes. Major U.S. railroads are now using the RCRMS for trains carrying large amounts of flammable liquids and security-sensitive hazardous materials.