High-Tech Advances Improve Railroad Safety & Efficiency

ASSOCIATION OF AMERICAN RAILROADS NOVEMBER 2011

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 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 applied or released.

Track and Infrastructure

- **Defect detector cars** are used to 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 reduce fuel costs and extend rail life.
- 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 will 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 hazardous materials accident rate by 90 percent since 1980. Railroads are constantly investigating ways to further enhance tank car safety. For example, the industry committee responsible for establishing tank car design standards has adopted a proposal that will enhance the robustness of tank cars that carry toxic inhalation hazard (TIH) materials. That standard was the basis of a recent U.S. DOT rulemaking on TIH tank cars.

[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. 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. In March 2006, the FRA reported that employee injury rates were 20 percent lower for RCL operations than for conventional switching operations.

Remote control locomotive transmitter

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

- Other new technologies designed to save fuel and reduce emissions include advanced **engine shutdown** and **startup systems** that help keep engine fluids warm and reduce idling; **consist managers** that automatically reduce power on unneeded locomotives; and **"genset" locomotives** that replace conventional yard locomotives in some areas.

Computers and Communication Systems

- Railroads are expanding their use of **advanced communications systems**. For example, the **Integrated Railway Remote Information Service® (InteRRIS®)**, an advanced Internet database with wide potential applicability, was developed at TTCI. An early project using InteRRIS® collects data from wheel impact load detector systems (which identify wheel defects by measuring the force generated by wheels on tracks) and detectors that monitor the undercarriage of rail cars (which identify suspension systems that are not performing properly on curves). InteRRIS® processes the information to produce vehicle condition reports from more than 160 wayside detectors and allows equipment approaching an unsafe condition to be repaired before an accident occurs.

- 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.

- The Rail Safety Improvement Act of 2008 (RSIA) mandates that **positive train control** (PTC) be installed by the end of 2015 on rail main lines used to carry passengers or TIH materials. PTC systems are designed to **automatically stop or slow a train** before certain accidents occur. Specifically, PTC as mandated by Congress must be designed to prevent train-to-train collisions; derailments caused by excessive speed; unauthorized incursions by trains onto sections of track where maintenance activities are taking place; and the movement of a train through a track switch left in the wrong position.

  According to the FRA, the costs to freight railroads to install and maintain PTC over the next 20 years could exceed $13 billion (in today's dollars), but there will be just **$1 in benefits for every $20 spent on PTC**. Railroads are committed to complying with the PTC mandate, but it is an example of well-intended legislation with significant unintended negative consequences. PTC will mean less money is available for other rail projects that enhance capacity, improve service, and improve safety.