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A Better Approach to RAILROAD SAFETY & OPERATION

Train derailments and collisions are rare, but when they happen they can be catastrophic, particularly when the trains are carrying flammable or otherwise dangerous chemicals. In South Carolina on January 6, 2005, a freight train carrying chlorine gas, sodium hydroxide, and cresol was misdirected by an improperly aligned switch onto a track where a local train was parked. The collision derailed both engines and many freight cars, including one loaded with 90 tons of chlorine, which ruptured. The chlorine killed nine people, at least 250 were treated for chlorine exposure, and 5,400 residents were forced to evacuate for nearly two weeks as the site was decontaminated.

In June 2004, a westbound Union Pacific Railroad freight train in Macdona, Texas, struck the midpoint of an eastbound BNSF Railway Company freight train as it was leaving the main line to enter a parallel siding. The derailment caused a car loaded with pressurized, liquefied chlorine to be punctured, creating a cloud of chlorine gas more than a quarter-mile in diameter. Three people died, and damages to rolling stock, track, and signal equipment were estimated at $5.7 million. In July 2013, a train was left unattended, with its brakes not properly set, near a small town in eastern Quebec. It rolled into the town and derailed, spilling petroleum and causing a fire that killed 47 people and destroyed dozens of homes along with most of the lakeside town's downtown core.

Railroad history is peppered with crashes such as these. One analysis in 2013 estimated the cost of train crashes in the United States, including loss of life and injury, at $13 billion per year. Accordingly, the National Transportation Safety Board and the Federal Railroad Administration have taken steps to help reduce crashes and derailments to save the lives of passengers and railroad employees, and also reduce damage to railroad equipment and rails, prevent environmental impacts from fires and spills of hazardous materials, and mitigate the broader economic consequences of railroad crashes.

Early steps in automating train control

Since early in the twentieth century, there has been interest in developing automated systems for controlling train speeds and ensuring that trains are not allowed on rails where they could be on a collision course with other trains. Such systems are designed to monitor train positions and speeds, maintenance sites, weather, and track conditions (such as switch positions) along their routes. These safety controls have been, and are still to a good extent, carried out by railroad personnel according to well-established protocols. Major automated control systems are currently being implemented independently by the railroad companies under governmental pressure, but they are not fully proven and, for some railroads, are incomplete because of their expense.

The first element of an automatic system for train control, put in place by some railroads in the 1920s, was the communication of safe operating speeds directly to the cab of the locomotive. A midtown line of the New York City subway system had the nation's first fully automated train operation, implemented in 1961. But problems remained. On August 20, 1969, two Penn Central commuter trains collided head-on in Darien, Connecticut, killing four people and injuring 43. The National Transportation Safety Board's report on the crash urged the development of a more comprehensive automatic train control system.

In the early 1970s, the Bay Area Rapid Transit (BART) system became the first major newly built system to adopt completely automated control of its trains, with no human operators required. These controls included over-speed protection, assurance of safe separation between trains, and determination of train scheduling. However, shortly after the first units were put into operation, a relatively minor collision forced BART to put operators in all trains to monitor the automatic control system—and at the national level spurred Congress to ask the Office of Technology Assessment to study automated train control technology.

Positive train control enters the scene

In response to a continued stream of train derailments and collisions, Congress, the National Transportation Safety Board, and the Federal Railroad Administration have urged—and funded—railroads to implement positive train control (PTC) systems. The Federal Railroad Administration defines PTC systems as “integrated command, control, communications, and information systems designed to prevent train accidents by controlling train movements with safety, security, precision, and efficiency.” PTCs are meant to control train operation (speed and possible conflicts that could lead to crashes) by automatically monitoring where trains are, how fast they are moving, and (where there’s a safety issue) informing locomotive engineers of the danger, and potentially taking over braking of the train.

There are two basic components of a PTC system. The first is signaling within the locomotive that provides the engineer with information on track status and condition, and the information is continually updated on an in-cab display. These systems are typically designed to automatically apply a train’s brakes if the engineer ignores a signal that the train is in a dangerous situation. They may also show the location of nearby trains and give timely information about conditions and other equipment on the track ahead. Some locomotives also have equipment to inform the engineer of track or signal conditions based on internal system maps and feedback from a central control.

The second component documents each train’s location in the system. This can come either from the Global Positioning System installed in the locomotive or from electronic beacons or transponders placed between the rails of a railway that respond to radio frequency energy broadcast by a module mounted under a passing train. The two-way communications with central controls for the individual train sets are by wire or through radio towers.

Congress passed the Rail Safety Improvement Act of 2008, prompted by a collision between a Metrolink passenger train and a Union Pacific freight train in Chatsworth, California, that claimed 25 lives. The nation’s largest railroads (called Class I railroads), as well as regularly scheduled intercity carriers and commuter rail passenger carriers, were required to submit to the US Secretary of Transportation their individual plans for implementing a PTC system by the end of 2015.

Problems with PTC

Each railroad company is responsible for its own PTC system, and these systems are duplicative and sometimes incompatible. The difficulties include differences in how train location is determined (some use GPS while others use track sensors triggered by passing trains, the latter of which effectively shows the position of stationary trains), and differences in communications (some use radio communications through towers while others have direct wire connections from rail sensors). Moreover, each railroad has its own control hub and means of communication, which could lead to confusion as tracks of one railroad are used by the trains of other railroads. These systems require expensive maintenance and their reliability has not been established.

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The implementation of PTC has been slow, due to the railroads’ reluctance to spend the money required. Some years ago, it was estimated that the Class I railroads would have to invest $5.8 billion to install PTC technology, then spend another $3 billion to $8 billion over the next 20 years to maintain it. The full implementation of PTC is currently in doubt; after an expenditure of around $10 billion, it will cost well over a billion dollars more to complete.

Because of the delays and problems with installed systems, additional preventable crashes have occurred. The failure in 2009 of an automated train control track circuit used by the Washington, DC, Metro system led to a fatal collision of two Metro trains, killing nine people and injuring 80. Another crash—of a train in which PTC had been installed but was not yet operational—occurred on December 18, 2017, when an Amtrak passenger train derailed near DuPont, Washington. Preliminary data from the train’s data recorder showed that it was traveling nearly 50 miles per hour over the speed limit when it derailed. Three people on board the train died, and derailed train cars crushed several automobiles on southbound I-5. Also likely preventable was a crash of a southbound Amtrak passenger train with a stationary CSX Transportation freight train in Cayce, South Carolina, on February 4, 2018, that killed two Amtrak crew members and injured 116 other crew and passengers.

A twenty-first century alternative

PTC systems are being implemented that are complicated, piecemeal, and expensive. In contrast, motorists today are able to take advantage of a unified, real-time, satellite-based navigation system that provides them with similar benefits. This navigation system, accessed through software apps such as Waze or Google Maps (both owned by Google), alerts them to impediments in the road ahead. The information comes from data acquired from other motorists' speeds and the system's ability to directly receive reports of road hazards such as crashes and repair work.

Since railroads regularly use one another's tracks, such a unified system for railroads is both possible and desirable—and would be relatively easy for all North American railroads to adapt. A comprehensive map of the rail network could be substituted for the road network, showing appropriate speed limits on all stretches of track as well as the positions of all switches between rails in the network. This system—let's call it satellite train control (STC)—could be used to warn engineers if they are operating under dangerous conditions. In the event that an engineer does not respond to a warning, a receiver in the locomotive could automatically apply the train's brakes. For trains traveling through tunnels, STC would be augmented by other technologies to sense their location and keep the engineers posted.

As with the highway system, the positions and speeds of all locomotives would be determined within each locomotive using GPS. These data would be regularly sent via satellite to a national central control, as would the positions of all switches in the system and the location of maintenance operations. A computer at the central control would continuously monitor the position, speed, and intended route of all trains to determine the potential for collisions and show where trains are going too fast for conditions.

The advantages of STC over PTC are many. STC would be unified for all railroads across the entire North American railroad system. It would make virtually all communications in the system by satellite, and would use more precise GPS data to determine the positions and speeds of all trains. A central computer would be used to assess whether a train is exceeding speed limits and whether there is a potential for a collision. Because of its simplicity and unity, STC would confer at least as high a level of safety as PTC systems, while bringing greater reliability that would likely result in fewer mishaps.

Cost and timing

There are roughly 27,000 locomotives, thousands of additional train sets without locomotives, and 140,000 miles of track in the United States. For STC, the cost of installing equipment for sending and receiving signals, for navigation, and for computer-based automatic braking would be less than $5,000 per locomotive and per switch, for a total of less than $300 million. Software for adapting the highway navigation system to STC and establishing a central control to warn of collisions should cost less than $100 million. All told, the STC development, hardware, software, and facilities should come in at well under a billion dollars. This is considerably less than the cost of completing the current PTC systems and could be paid by a consortium of railroads.

Because of antitrust considerations, congressional action might be required to permit national cooperation in establishing a unified STC system for all railroad and associated transit systems. If it were to be a North American system, Canadian negotiations would be necessary as well. But STC could be put in place quickly: once all parties decide to act, it should take only one to two years to develop and implement STC.

Such a satellite system could also serve as a basis for a more modern approach to railroad scheduling and management that would reduce costs, ensure more efficient use of the rail network, and improve delivery schedules. It might even permit scheduling that could facilitate just-in-time deliveries to factories. Independent transit systems that do not share rails with the railroads would not have to be included in this system, but they could if they deemed it advantageous.

The savings that would result from reduced human, equipment, and other losses from collisions and derailments, and from improving railroad scheduling and safety, should be sufficient to pay for the STC system. It could also provide new business opportunities for the developers such as Google as well as for railroads. Although much money has already been sunk into PTC, it is not too late to switch gears, especially when switching would save both lives and money. The railroads should proceed with STC, cutting their losses and proceeding with a fresh, modern approach.

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