Automated Track-Geometry Inspection

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Automated track inspection is a technology relatively new to railroading. For more than a century track inspection was an exclusively visual process. Initially, it depended on the eyes of track walkers who regularly patrolled line segments to detect—and often correct—defects as they developed in track structures. These regular safety checks were supplemented by the inspections made by roadmasters and division engineers as they rode the rear of trains or traversed the lines under their jurisdiction on track cars. Defects and their location were noted manually for subsequent attention by maintenance forces.

Railroads began experimenting with mechanical measurement of track geometry 25 years ago. Generally, a converted passenger car was fitted with measuring devices that required physical contact with the rails being traversed. Data were recorded by pens on paper-strip charts.

In 1966, the Office of High-Speed Ground Transportation, U.S. Department of Commerce, undertook the development of a track-geometry-measuring system that used non-contact sensors and recorded the measurements on magnetic tape to simplify analysis of the data by computer. Four Philadelphia commuter cars without passenger interiors were purchased from the Budd Company for that and other development testing.

The program was transferred to the Federal Railroad Administration (FRA) when the U.S. Department of Transportation was formed in April 1967. Later, the program became a function of the FRA's Office of Research and Development.

The initial instrumentation was installed by Melpar in one pair of cars during the summer of 1967. Early measurements with the test cars were made on the Northeast Corridor tracks to assist in the quality control of track rehabilitation for the Metroliner demonstration. Later, measurements were made on other railroads for the purpose of track maintenance planning. The Denver and Rio Grande Western, as well as the Bessemer and Lake Erie Railroads, participated in developing analytical and evaluative techniques for the data collected. During this period 1967-1975, the instrumentation went through an evolution in design as operational problems were encountered. Also, a new contractor, ENSCO, Incorporated, took over development and operation. As the instrumentation improved so did the capability of data processing. From the beginning, data were recorded on both magnetic tapes and paper charts. The charts were used to monitor measurements to ensure proper operation of the instrumentation and eyeball analysis for defects needing quick remedies. At first, tapes were taken to a data-processing facility. When the FRA track safety standards came into effect in 1973, the computer was programmed to print out deficiencies that exceeded allowable tolerance of the standards. Later, a computer was installed on-board to make printouts available during a measuring run.

By 1974, the track-geometry-measuring capability had been perfected to the extent that the test cars could be used in support of the track inspection responsibilities of the FRA Office of Safety. In August of that year, and as a result of a number of derailments, the Federal Railroad administrator directed that measurements be made on the Penn Central's line between Chicago and Louisville. This line was found to be in an advanced state of deterioration. Analysis of measurements revealed that the standard for the lowest quality of track that permits 10-mile/h speeds was not being met. The administrator ordered the line shut down until emergency repairs were made.

This experience demonstrated the value of automated track inspection, and plans were developed accordingly for a fleet of track-geometry-measuring cars to supplement the work of FRA Office of Safety track inspectors. The first pair of the four test cars that had been utilized to develop the inspection capability was put to increasing

A technician verifies the calibration of the gage-measuring sensor mounted underneath the car.

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The two-car T1/T3 inspection facility is propelled by a locomotive unit belonging to the railroad that is being inspected. It is equipped with high-intensity halogen lights on the roof and lights mounted underneath the coupler.

use until it was fully occupied in track safety inspections. Meanwhile, fabrication of two more sets of instrumentation and data acquisition equipment was begun. One set was installed in the second pair of test cars and the other in an army surplus hospital car. All three sets were in operation by February 1978. In the first full year of operation the cars were used to inspect 52 000 miles of track. In 1979, more than 68 000 miles were inspected. Today, operations are scheduled and overseen by FRA's Office of Safety in cooperation with ENSCO, the successful bidder on a four-year operations and maintenance contract, effective January 1, 1980.

When the track-geometry cars are measuring track, sensors mounted on the running gear generate voltages that are sampled at 1-ft intervals and are fed into the data acquisition system. The system on the two pairs of test cars consists of a multichannel analog to digital converter, mini-computer, magnetic tape drive, real-time data printer/plotter, manual entry devices, and oscillograph. The system, which does not have onboard digital printout capability, processes the signals into six track-geometry parameters. These are (a) profile—surface uniformity of each rail; (b) alignment—line uniformity of each rail; (c) gage—distance between the rails; (d) crosslevel—the amount of elevation of one rail above the other; (e) warp—rate of change of crosslevel; and (f) curvature—angular change in track direction. The measurements are correlated to the track structure by an automatic location detector that detects track structures, such as switches, grade crossings, and motor car sets-offs, and uses manually entered milepost locations.

The oscillograph displays are compared with the condition of the track as viewed from the rear of the survey car by an FRA track inspector and a railroad representative. Each can make notes on his own chart and can see the other's notes. Measurements are made at the posted speed limit for each section of track.

The computer printouts of track safety standards exceptions are made available to the railroads to identify sections of track that require both immediate maintenance at specific locations and long-range maintenance. Analysis of the data stored on magnetic tape provides detailed information on curve-limiting speeds, statistical tabulation of the number of exceptions by mile, and an overall mile-by-mile summary. The printouts are made in multiple copies. At least two copies go to the railroad for their use in locating and correcting defects, the third to the FRA track inspector, the fourth to the regional headquarters, and a final copy to the Office of Safety for microfilming. The railroads identify problems and locations that require remedial action.

The FRA inspector determines where further enforcement activity is indicated and schedules follow-up inspections in those areas. These visual inspections are made to determine (a) if the railroad has taken appropriate remedial action on the geometry defects noted and (b) if the track complies with all other provisions of the track safety standards and the geometry requirements.

An important advantage of the automated track inspection is the ability to measure the track geometry under load. The measurements formerly made by hand-held devices or very light on-track devices failed to reveal conditions such as rails rolling outward under wheel load so that the gage opens to a dangerous width. The cars have, on occasion, detected conditions that required immediate action to prevent derailments but had been missed by measurements of the track in an unloaded state.

The track-geometry cars are a valuable supplement to the visual inspections made by railroad and FRA inspectors. They provide more complete and accurate indications of track-geometry conditions that could be obtained through strictly visual inspection and hand measurement. However, visual inspections are still necessary to confirm indications of the automated equipment, to determine the causes and proper correction of geometry defects, and to detect the numerous types of defects that are not directly related to geometry.

In a survey conducted in 1978 by H.G. Webb, chairman of the Roadmasters Track Committee, 15 railroads reported using track-geometry cars. Seven had converted passenger or business cars, three had purchased commercially produced geometry cars, two were using hyrail equipment, and three had made arrangements for special runs by the FRA cars. Undoubtedly, the use of geometry cars and automated track inspection cars will continue to grow.

The interior of the T3 observation area includes two eight-channel oscillographs. They are being used here by an FRA inspector and a railroad representative.