# Learning from a Train Derailment

Kevin Payne
London Underground

Abstract

This paper discusses wider engineering lessons that may be drawn from the investigation of a train derailment that occurred on the Northern Line of London Underground on 19 October 2003 at Camden Town. It summarises the accident investigation process followed and the main findings and discusses: the management of "legacy" systems; maintaining the links between design intent and maintenance practice; the concept of insidious criticality; and the use of standards to control interactions.

## 1 Introduction

This paper briefly describes the investigation into a passenger train derailment and some of the key findings of the investigation into its causes, and discusses some wider lessons that may be drawn from both the investigation findings and the investigation processes used.

## 2 The derailment

At 10:01hrs, on Sunday 19th October 2003, a northbound train derailed on the approach to Platform 3 at Camden Town station on the Northern Line of London Underground while travelling at approximately 20mph. Seven people attended hospital as a result; two of the injuries were serious, one a broken femur and the other a head injury.

The derailment occurred as the train traversed a junction in a tube tunnel. The track sustained damage, the rear two cars of the train were damaged, severe damage occurred to line-side cabling and some slight damage occurred to the iron lining of the tunnel.

## 3 The investigation into the derailment

The investigation into the derailment was conducted in accordance with the relevant London Underground procedures and the main steps are summarised in Figures 1 and 2. The practices and processes used have been compared with various models of good practice, the comparison is being reported in-full elsewhere[1], but some aspects are discussed later in this paper.

## 4 The main findings of the accident investigation

The derailment occurred as the leading axle of the rear car of a six car train traversed the switchblade of a set of facing points. The points were correctly set

and locked. It was established that the train had been travelling at a speed consistent with the designated limit, and had been driven in accordance with recommended practice. Although the track and its lubrication displayed a number of unusual features, there was no apparent fault that could explain the derailment; likewise, there was no immediately apparent fault on the train.

It was found that the design of the point switchblade was such that it predisposed wheels to derail when:

1. the switchblade formed part of a facing point; **and**
2. that the track leading into the point was curved below a critical radius in the same direction as the turnout; **and**
3. that the switchblade had not experienced significant amounts of wear; **and**
4. that high levels of friction existed between the wheels and the rails.

All of these conditions existed at the derailment site. Conditions (1) and (2) were functions of the design configuration of the track and, as such, had existed since 1986. Conditions (3) and (4) were set-up the night prior to the derailment, when the left-hand switchblade was renewed. It was found that the design weakness n the switchblade had existed since it was adopted as an industry standard item in 1968, but had never before manifested itself by causing a derailment on a "main line".

One key question that the investigation attempted to answer was: why had the particular wheel, as opposed to any other, derailed? Twelve trains of the same kind, and five cars of the train that derailed, had passed over the site without incident since the switchblade had been replaced. When the bogie that first derailed was examined after the accident, it was found to be more prone to wheel unloading (a reduction in downward forces on the wheels) than was expected. Subsequent analysis showed that the way that the suspension had been set-up reduced the margin of tolerance that prevented serious wheel unloading. There was still a good margin of tolerance to cope with the normal range of track conditions, but possibly not enough to cope with the conditions at the site of the derailment. The Northern Line trains were, at the time, approximately five years old and it had recently become necessary to re-profile the wheels on some cars to compensate for wear. This re-profiling had reduced the diameter of the wheels, so shims had been fitted above the primary suspension to re-set ride height and level. It was found that the procedures governing suspension shimming could lead to vehicles being set-up in a way not envisaged by the designers. It was found that eighteen cars had been set-up in a way not intended by the designers and that the vehicle that derailed was furthest from the designed condition.

The Final Report of the investigation is available from the internet[2] and provides more detail of the above and of a number of other matters that came to light during the investigation.