Accident Analysis and Prevention 37 (2005) 235–244

ACCIDENT ANALYSIS & PREVENTION

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A systems analysis of the Ladbroke Grove rail crash☆

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Received in revised form 16 August 2004; accepted 16 August 2004

Abstract

On 5 October 1999, near London Paddington Station, two trains collided on a main line near Ladbroke Grove. The immediate "human error" that preceded this crash was a Signal Passed At Danger (SPAD). Thirty-one people lost their lives and many more were injured.

The crash prompted an extensive multi-disciplinary investigation and hearing to identify the factors that contributed to the Signal Passed At Danger event. This included the involvement of psychologists to consider the human factors "responsible" for the crash and the broader system context, including the operational and organizational environment that may have contributed.

This paper summarizes the key factors identified in relation to this crash within a system analysis framework. This framework considers multiple sources of influence upon the driver in relation to the committed Signal Passed At Danger. These influences include direct factors attributable to the driver and the immediate circumstances of the event, as well as indirect, or latent, factors within the operational procedures and the management of the organization. This systemic combination of factors, not an isolated case of human error, conspired to propagate the events that resulted in the Signal Passed At Danger event and subsequent crash.

This particular case demonstrates that train crashes cannot be distilled to a single causal factor. Rather, such crashes result from a system failure in which unpredicted interactions between direct and indirect influences coincide at an inopportune instant.

Keywords: Train safety; SPAD; Error; Crash investigation; Systems

Imagine a single nipped-off second hung between one moment and the next — a time-dot in which train, carriages, everything is flung outside the world's hard limits of mass and space and rises up weightless, torn from its proper place.
An excerpt from a poem about the tragedy of the fatal train crash at Ladbroke Grove in London near Paddington station by Poet Laureate Andrew Motion. (Motion, 1999)

1. Rail safety

As expressed in the preceding excerpt from a commemorative poem, fatal train crashes, as in other transportation systems, are traumatic and significantly impact society. Historically, the fatal train crash rate has been fairly stable in the United States and Britain. For example, in the USA between 1993 and 2003, the annual crash rate has shown only minor fluctuations, between 3.5 and 4.3 fatal crashes per 1.6 million train kilometers (1 million miles), with no significant downward trend (FRA, 2002). For the same period, train accident fatalities in the UK fluctuated between 1 and 33 (the year of Ladbroke Grove) with an average of 10 fatalities in train accidents per year (HSE, 2003a,b). Again, there is no evidence of a downward trend. This may suggest that while current safety programs have stabilized the crash risk for rail transportation they have not been able to produce a sufficient impetus to dramatically reduce crash rates.

☆ Complete documentation from both the joint agency investigation and public hearing for this crash are available from the official Web site for the British Health and Safety Executive: http://www.hse.gov.uk/railways/ladbrokegrove.htm. Additional information is also available from the national media http://www.guardian.co.uk/traincrash/0,2759,180785,00.html and rail enthusiast Web site archives http://danger-ahead.railfan.net/reports/rep99/paddington991005.html.

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doi:10.1016/j.aap.2004.08.001

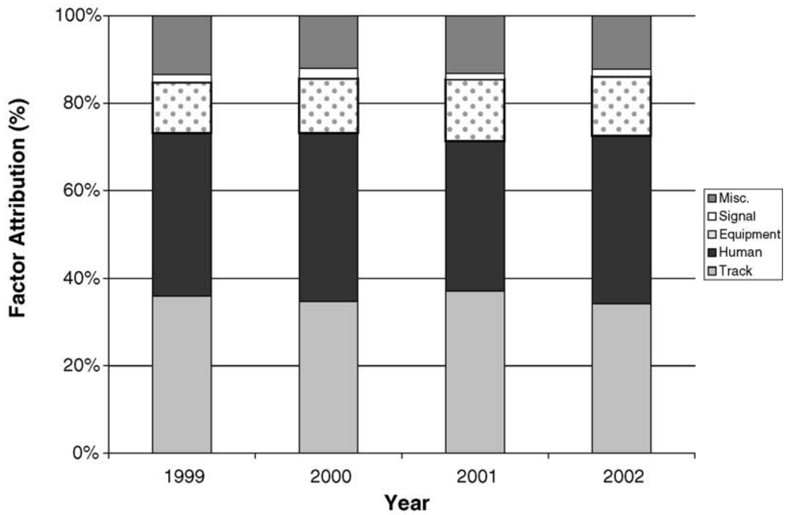

Fig. 1. Relative assignments of factor types for U.S. train crashes expressed as a percentage of the annual number of crashes with a cited factor (FRA, 2002).

To achieve a step function increase in safety within any transportation mode, it is necessary to view safety from a system perspective and to consider the interaction of all types of crash factors within an integrated framework that defines the crash process. Only in this way will comprehensive safety interventions be discerned and implemented to effectively reduce crash risk within the system.

It is clear from Fig. 1 that human error, together with track problems, represent the largest categories of causes of U.S. train crashes between 1999 and 2002. An analysis of primary cause of train incidents in the UK for 2002/03, also gives staff error as a contributory cause of 32 of the 69 collisions occurring on Network Rail within this year.

However, there are several fundamental issues with this simplistic formulation of causal factors that limit our ability to understand and prevent future train crashes. First, this formulation may exclude consideration of other types of factors that may have influenced the sequence of events that precipitated the crash. These may include latent factors that reside as “pathogens” within the organizational structures, policies, and procedures of the rail company and governing agencies. These factors, in turn, may influence the propagation of other factors that can have a more immediate influence on the sequence of events resulting in a crash (Reason, 1990, 1997).

This formulation also ignores the interaction among factors in determining the crash sequence, when, in fact, any factor alone may be necessary but not sufficient without the context of other factors. Moreover, the actual temporal sequence of different factors may not be apparent; therefore, a single factor may be attributed to the crash only because it was mistakenly interpreted as the nearest factor to the crash event. Finally, the interpretation of crashes in terms of independent factors can be biased toward the identification of the human operator as the root cause in an otherwise complex system (Rasmussen, 1990). The attribution of “human error” is often no more than a post-hoc rationalization biased by hindsight. This causal factor is descriptive only, and, therefore, does not provide an explanation of the process that gave rise to a context in which the actions of the human made sense at that moment.

2. Systems perspective

A systems-based analysis is an alternative perspective that can be adopted to interpret the factors that contributed to a crash. This approach considers a broad range of hierarchical factors, including those close to the crash event that may have had a direct influence, as well as latent factors within the organization and a broader context that may have propagated weaknesses in the system — weaknesses that either fostered other risk factors or limited defenses to prevent crash sequences (Reason, 1990, 1997). This approach also considers how the system contributed to the human condition that resulted in the decisions and behavior of those persons deemed “responsible” for the crash. Focusing on the behavior itself without understanding the perspective of the human interacting within the system during the crash sequence ignores those attributes of the system that foster unsafe conditions: “The point of a human error investigation is to understand why actions and assessments that are now controversial made sense to the people at the time.” (Dekker, 2002). This approach has been successfully adopted in the analysis of previous railway accidents involving Signals Passed At Danger (SPAD). For example, as early as 1988, Van der Flier and Schoonan investigated the situational, as well as the personal factors underlying stop signal abuse. They identified that a number of (black) spots accounted for a relatively high number of SPAD incidents. They also found that frequent mention was made of hazardous signals that were situated behind a bend. The immediate cause of these incidents was that signals were overlooked or not anticipated. Smiley (1990) reports an investigation of the ergonomic issues responsible for the Hinton Train Disaster in Canada in 1986. In the case of the Hinton