Reducing the damage caused by freight train derailments

Every year there are a number of derailments on our railways; most not getting any media coverage. This is no surprise as a train carrying stone that falls off is not very newsworthy particularly if it occurs, as many do, on a freight only line. However, if a freight train derails on the mainline we do tend to hear about the ensuing chaos, particularly if it delays commuters on their way home. Such derailments do tend to cause significant damage to infrastructure and signalling, causing delays to the wider network. Some method of reducing the severity of freight train derailments would be beneficial, not just to the operator of the train and Network Rail, but also to the wider railway industry and railway users. This paper presents an idea for this.

Derailment statistics

A review of RAIB reports show that there are a number of derailments every year that do significant damage to the infrastructure but the magnitude of the damage is potentially avoidable.

Table 1 shows derailments since 2005 where, with the exception of two cases, the driver has been unaware of the derailment and the train has been stopped usually when the signaller sees the disruption on their panel, or by splitting of the brake pipe.

Table 1 List of freight derailments where the driver was unaware 2005-2017

Date	Location	Type of train	Wagon position	Speed (mph)	Train stopped by	Track damaged (m)
18/10/2005	Hatherley	Steel	14	60	Signaller	6435
18/01/2006	York	Steel	15	27	Signaller	250
21/01/2006	Waterside	Coal	16	10	Drag from derailed wagons	3800
06/02/2006	Carlisle	Engineering	28	15	Brake application	Unknown
28/06/2006	Maltby North	Coal	1	17	Brake application	80
08/09/2006	Washwood Heath	Container	13	15	Signaller	200
20/11/2006	Greenford East Curve	Engineering	4	13	Brake application	150
10/05/2007	King Edward Bridge	Coal	23	16	Brake application	850
14/06/2007	Cromore, Northern ireland	Engineering	1	49	Driver	400
22/06/2007	Ely Dock Jcn	Aggregate	15	16	Brake application	460
10/08/2007	Duddeston Jcn	Container	7	15	Brake application	200
25/01/2008	Santon, Foreign Ore Branch Jcn	Coal	10	25	Driver	1700
25/03/2008	Moor Street	Steel	16	15	Brake application	90
12/06/2008	Marks Tey	Container	10	77	Brake application	2400
25/08/2009	Wigan North western	Container	12	7.5	Brake application	30
26/08/2011	Bordesley Jcn	Aggregate	27	11	Brake application	100
28/01/2012	Reading west	Container	24	25	Signaller	5
07/07/2012	Shrewsbury	Coal	16	14	Signaller	65
21/01/2013	Castle Donnington	Departmental	18	47	Brake application	1600
27/08/2013	Stoke Lane Level Crossing	Fuel	26	53	Brake application	800
15/10/2013	Primrose Hill / Camden Road	Container	5	17	Brake application	1000
15/10/2013	Gloucester	Container	28	69	Signaller	7000
02/04/2014	Angerstein Jcn	Aggregate	9	5	Brake application	160
02/10/2014	Porthkerry	Coal	20	16.5	Drag from derailed wagons	Unknown
23/10/2014	Heworth	Cement	10	51	Signaller	2250
13/11/2014	Ashburys, Manchester	Aggregate	17	6	Brake application	Unknown
23/03/2015	Washwood Heath West Jcn	Container	10	15	Signaller	100
30/06/2015	Langworth	Fuel	11	46	Brake application	400
20/03/2017	East Somerset Junction	Aggregate	24	20	Brake application	79

Compiling this table showed that the type of wagon, contents, prime mover, train speed, or position in the consist of derailment initiation, has no predictable impact on the amount of damage caused. It was also clear that the impact can be significant, despite the fact that most derailments occur at relatively low speed, as shown in Table 2.

Table 2 Summary of damage statistics

	Minimum	Median	Maximum	Mean	Mode
Derailed wagon no	1	15	28	15	10
Train speed (mph)	5	16.5	77	27	15
Track damage (m)	5	325	7000	1177	200

The challenge

The challenge is whether the severity, and therefore disruption, caused by derailments of freight trains can be limited by alerting the driver of the derailment before the damage causes the train to be stopped by other means? We think it can be.

We considered that equipment could be placed on the wagons themselves, similar to the Perpetuum equipment to send a short distance (Bluetooth or Wi-Fi) alarm, should the equipment show unusual accelerations. We also considered that equipment could be placed in the tail lamps on the rear vehicle of a freight train which could carry out acoustic and accelerometer measuring and alert on unusual activity in the same manner.

However, both those systems require additional equipment in the locomotive and both rely on an isolated power source and communications equipment which would require health monitoring.

We therefore considered systems which were locomotive based and so could be relatively self-contained. As previously suggested, acoustic monitoring could be utilised but it could be argued that the derailment of say, the rear wagon of a “jumbo train” may not be acoustically detectable from a locomotive at speed.

The all seeing-eye

Following previous involvement in the development of machine vision systems for monitoring of wheel treads and brake blocks, it is proposed, that automated CCTV could be used to monitor the behaviour of the wagons of a train and send an alert on the detection of unusual behaviour.

Due to the constricted loading gauge of the GB rail network, wagons tend to be manufactured to the maximum possible size, which does provide some challenges in providing a clear view of the wagons of the train. However, we believe this can be overcome.

Our proposal

The use of forward facing CCTV (FFCCTV) has become standard on passenger trains over recent years and has been demonstrated as most useful in determining incidents, particularly involving trespass and track workers. Our solution would be to fit all freight locomotives with FFCCTV in the form of two cameras at each end, one on each side of the cab at cant rail level. These would be fitted with infrared capability to enable continuous vision even in tunnels and during the hours of darkness.

The FFCCTV at both ends of the locomotive would record the usual visual output for the purposes of reactive post-incident review. The FFCCTV at the rear of the locomotive would be actively monitoring the state of the train and would alert on unusual activity via a resettable indicator on the driver's desk. A future development may be the displaying of the CCTV image on the driver's console following an alarm to enable the driver to review the severity of the situation.

Figure 1 Positioning of FFCCTV camera

The CCTV cameras would be set to view down each side of the train. The use of two cameras would prevent blind spots caused by the curvature of the line and would assist in the determination of the derailment through the visual alignment of the sides of the vehicles.

There are of course difficulties to such a development including how to prevent the CCTV from sending spurious alarms so it is likely that testing on disused or private railways would be required.

However, the benefits of such a system would be:

- fitting of forward facing CCTV to locomotives;
- prevention of the severe damage to the infrastructure;
- reduction in the disruption and delays caused to the wider industry, particularly passengers, by severe derailments;
- reduction in the delay penalties paid out by the freight companies; and
- driver's eye view film in 3D for training purposes.

IPEX Consulting is a bespoke consultancy providing trains systems commercial engineering solutions across the global railway industry.

Chris Hoskin is an Associate Director with IPEX Consulting. He has 19 years' experience in the UK, Europe, Asia Pacific, and North America, having developed a career specialising in rolling stock while having a deep understanding of the rail industry systems interactions. He specialises in procurement, development of standards, both national and local, strategic planning and due diligence, and the development and use of remote condition monitoring equipment.

Contact: c.hoskin@ipexconsulting.com ☏ 07970 287 834