Recovery from Railway Incidents

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Research Problem

When railway incidents occur, transport operators often struggle to get back to normal, and passengers complain of a lack of information.

Is this because the railway staff themselves lack information?

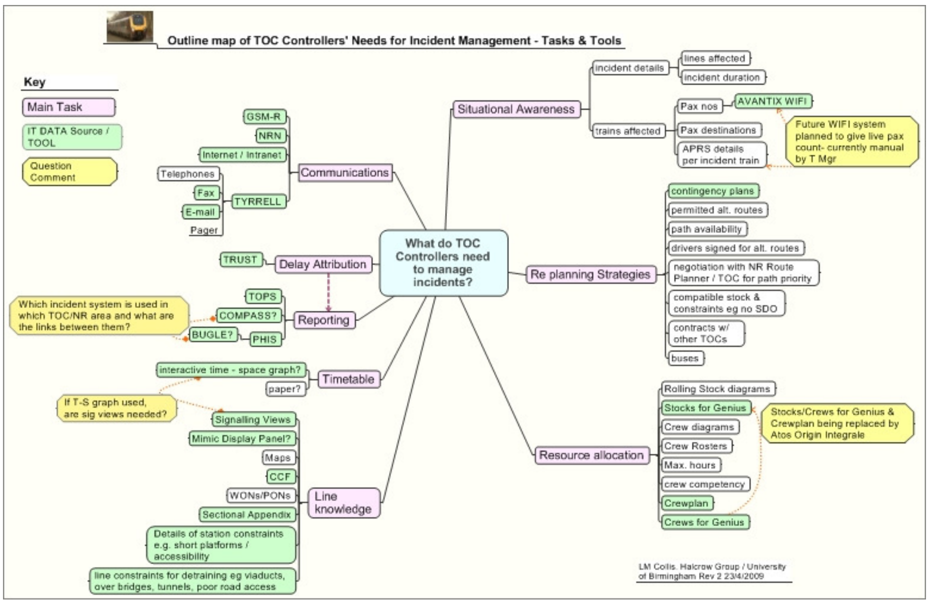
Are there fundamental and unresolved organisational and human factors issues affecting railways' resilience to crises?

The challenges of recovery and resilience to incidents are worse for high speed rail services, due to:

- the speed of the trains themselves, so there is less time to resolve problems;
- the rapidity with which the effects of incidents can spread; and
- because of the complex interfaces of international services.

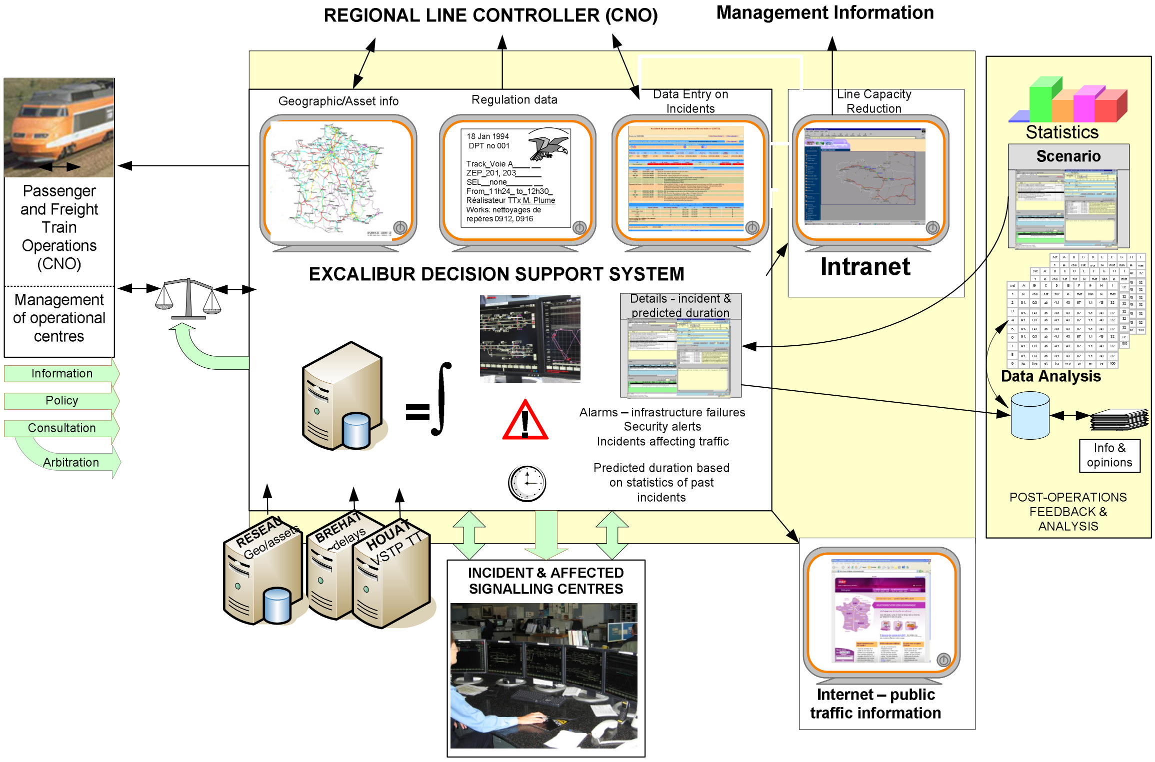
Lynne's Research focuses on:

- The need for information. Many transport operators have a selection of decision support tools but these are not integrated and each provides only a partial picture of the situation. Lynne's work with UK train operators has highlighted a number of needs for incident management – in terms of both information and the tools they use.



Train Operators' Needs for Incident Management

- Other operators, such as French railways, have created an integrated, statistically based decision support tool, called Excalibur, which is mainly used for incident tracking by their National Operations Centre. This uses data on past incident durations to predict the likely, best case and worst case incident duration, for a given incident type, line type and time.



Excalibur Decision Support Model

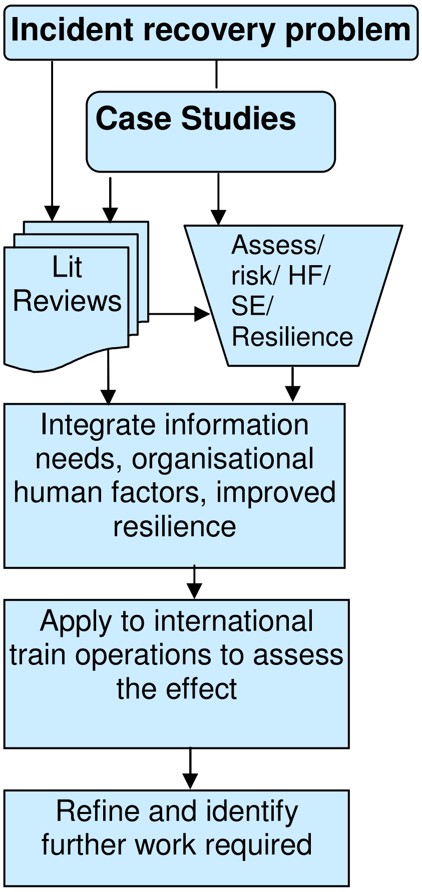
Does the population of a model such as Excalibur rely on a labour-intensive, centralised railway such as SNCF, or are there lessons to be learned that could assist with providing better incident support on other railways?

- Organisation human factors and their impact on recovery from incidents, using systems, risk based and resilience engineering techniques to evaluate organisations' readiness. Case studies such as the Eurostar incidents of 18-19 December 2009 are a rich source of material for analysis.

Methodology

Identification of the problem has been undertaken through case studies and through literature review.

Literature study in the domains of resilience engineering and cognitive task design has also assisted Lynne in determining the operators' and organisational requirements for incident readiness.



Assessment of organisations' resilience to crises has been undertaken using a risk based assessment of each railway operators' resilience for both its own incidents and its impact as an interfacing organisation.

Further assessment will be undertaken to determine the effectiveness of improved, integrated information sources and decision support tools.

This will be applied to international train operations to assess the usefulness – international train operations are currently changing rapidly as the regulations concerning open access by new train operating companies are evolving.

	Eurotunnel	Risks: ET Incidents	Risks: Interface	Comments
AIM	Robust organisation, interfacing without problems, able to learn from experience, understand incidents and anticipate & correct changing adaptive capacity			
	Resilience built into system design including avoidance of wrong side failures, graceful degradation and avoidance of false positives	6	5	Wrong side failures generally avoided but false +ve fire alarms frequent, no graceful degradation in crossover door failures
Avoidance	Redundancy and diversity built into infrastructure sub-systems;	4	5	Interface procedures exist with NR CTRL. Are interface procedures with SNCF available to CNO? Traction problems
	Robust maintenance processes	3	4	Traction problems. Control Systems failures
	Robust competence/training processes	6	5	•Human error contributed to delays in rescuing passengers in 1st major fire. •Incident management human factors on 18/12/09
Ability to route trains around a failure	Bi-directional signalling;	2	3	TVM430 signalling generally robust, but some delays experienced at interfaces (Eurostar 2010a)
	Alternative routes available;	5	5	Limited alternative routes available using different tunnel intervals but breakdowns in opposing tunnels block route completely.
	Rolling stock authorised for alternative routes; or infrastructure designed to facilitate this	4	4	Severe limitations of flexibility for routing round failures on main line interfaces; restrictions on use of tunnel rolling stock
	Drivers passed for the alternative routes, or pilots available; Ease of access for this.	4	4	Only ET rescue drivers passed for main line interfaces; severe constraints on access
Rescue	Availability of rescue trains and crew;	5	5	Only 2.5 ET rescue Krupps available. Eurostar to provide rescue locos. Delays experienced (Eurostar 2010a)
	Availability of evacuation trains and crew;	2	2	Shuttle trains and crew available
Preparedness for evacuation	Robust emergency plans,	3	5	Internal plan (App E), plus interface arrangements in Network Statement, but inadequate coordination with Eurostar (Eurostar 2010a)
	practiced evacuation and emergency exercises,	4	5	Regular Rescue Worker Drills but over-reliance on these and no behavioural tests
	agreed interface protocol	3	5	Coordination with Eurostar lacking - no knowledge of incident phone numbers (Eurostar 2010a)
	communications means	5	5	Lack of GSM leaky feeder in tunnel prevented Eurostar supporting train crew
	Decision support tools support incident response	4	4	Internal system but may not be adequate for incident modes - no assessment possible to date
		4	4.4	
		40.00	44.00	

	Eurostar	Risks: Eurostar Incidents	Risks: Interfaces	Comments
AIM	Robust organisation, able to learn from experience, understand incidents and anticipate changing adaptive capacity			
	Resilience built into system design including avoidance of wrong side failures, graceful degradation and avoidance of false positives	5	5	Sudden failures, no graceful degradation and systems not resilient to weather extremes (Eurostar 2010a)
Avoidance	Redundancy and diversity built into train sub-systems;	5	5	In theory train can be split, 2 TVM chains back up pantograph, but single points of failure exist (ibid)
	Robust maintenance processes	5	5	Poor winterisation, poor appreciation of degradation of resilience
	Robust competence/training processes	5	5	differences in competency - French TM2 is driver with English - no customer training required; failures in evac training
Ability to route trains around a failure	Able to change ends easily to take advantage of bi-directional signalling;	5	5	Failures in application of procedures (Eurostar 2010a) led to loss of lights on 9047
	Alternative routes available;	4	5	Alt. routes available in theory in France; in SE England not possible due to lack of OLE
	Rolling stock authorised for alternative routes;	5	5	Eurostars no longer able to use 3rd rail routes in UK (shoegear removed. Rolling stock limited in UK due to power/EMC
	Drivers passed for the alternative routes, or pilots available	5	5	Eurostars driver knowledge not maintained for classic routes (pilot availability poor)
Rescue	Availability of rescue trains and crew;	5	5	poor availability - delays on 19 Dec 2009 and in previous LGV incidents poor SNCF availability
	Availability of evacuation trains and crew;	5	5	slow/poor availability (Eurostar 2010a; Haydock 2008)
Preparedness for evacuation	Robust emergency plans,	5	5	Eurostar criticised by Independent Review (Eurostar 2010a) as none of their interfacing organisation were aware of their emergency
	practiced evacuation and emergency exercises,	5	5	Only evacuation exercises have been to prove infrastructure. No behavioural tests. Staff criticised for ill preparedness (ibid)
	Agreed interface protocol	5	5	none of their interfacing organisation were aware of Eurostar's emergency structure/contact numbers
	Communications means	5	5	no means of contacting staff in Tunnel; poor links with ET
	Decision support tools support incident response	5	5	no visibility for Belgium; no integration and poor utilisation of other tools
		4.9	5.0	
		49.33	50.00	

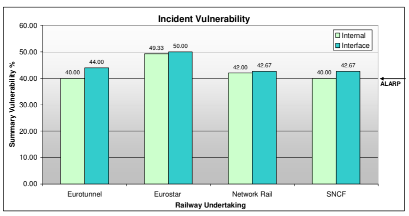
	Network Rail (Main Lines)	NR Incidents	Interfaces	Comments
AIM	Robust organisation, able to learn from experience, understand incidents and anticipate changing adaptive capacity			
	Resilience built into system design including avoidance of wrong side failures, graceful degradation and avoidance of false positives	5	5	Maintenance overruns & system failures have led to severe delays
Avoidance	Redundancy and diversity built into infrastructure sub-systems;	5	5	Little back up for IECCs; infrastructure failures often lead to delays
	Robust maintenance processes	5	5	Widespread use of contractors with varying success
	Robust competence/training processes	4	4	High staff turnover
Ability to route trains around a failure	Bi-directional signalling;	5	5	Patchy
	Alternative routes available;	3	3	generally good
	Infrastructure designed to permit rolling stock authorisation for alternative routes;	5	5	restricted loading gauge and systems prevent open access
	Ease of access for Drivers to be passed for the alternative routes, or pilots available.	4	4	Economic factors by TOCs driving factor here
Rescue	Availability of rescue trains and crew;	4	4	not NR's responsibility but would organise via TOCs
	Availability of evacuation trains and crew;	3	3	would be organised via TOCs
Preparedness for evacuation	Robust emergency plans,	2	2	Mandated by Railway Group Standard, which mandates TOC equivalents & publicly available
	practiced evacuation and emergency exercises,	5	5	not practiced regularly and with all TOCs
	agreed interface protocol	4	5	NR Control protocol published but would have same difficulty with Eurostar incident numbers
	communications means	4	4	GSM-R being rolled out + much of network accessible by mobile phone
	Decision support tools support incident response	5	5	
		4.2	4.3	
		42.00	42.67	

	SNCF (High Speed)	SNCF Infra Incidents	Interfaces	Comments
AIM	Robust organisation, able to learn from experience, understand incidents and anticipate changing adaptive capacity			
	Resilience built into system design including avoidance of wrong side failures, graceful degradation and avoidance of false positives	5	5	Frequent strikes; poor response to incidents has led to severe delays
Avoidance	Redundancy and diversity built into infrastructure sub-systems;	4	5	Interface issues particularly across borders
	Robust maintenance processes	4	4	Old-fashioned management approach still persists
	Robust competence/training processes	3	3	
Ability to route trains around a failure	Bi-directional signalling;	3	3	
	Alternative routes available;	3	3	
	Infrastructure designed to permit rolling stock authorisation for alternative routes;	4	4	Processes exist
	Ease of access for Drivers to be passed for the alternative routes, or pilots available;	4	4	Economic factors by TOCs driving factor here
Rescue	Availability of rescue trains and crew;	5	5	Poor availability demonstrated from previous incidents (Haydock 2008)
	Availability of evacuation trains and crew	5	5	Poor availability demonstrated from previous incidents (Haydock 2008)
Preparedness for evacuation	Robust emergency plans,	4	5	Internally governed by CNO; would have similar problems with Eurostar
	practiced evacuation and emergency exercises,	5	5	poor response to many evacuations; regions organise rescue worker drills only
	agreed interface protocol	4	4	poor communication with Channel Tunnel; better with Belgium/Germany
	communications means	4	5	Better countryside mobile phone coverage; no GSM-R yet
	Decision support tools support incident response	3	4	Excalibur designed to support incidents but little used outside CNO
		4.0	4.3	
		40.00	42.67	

		Severity of Potential Harm or Loss: 5 Multiple fatalities	4 Single fatalities	3 Multiple major injuries	2 Major injury/ major loss[1]	1 Minor injury/loss
5	Daily-monthly	10	9	8	7	6
4	Monthy-yearly	9	8	7	6	5
3	1 to 10 yearly	8	7	6	5	4
2	10 to 100 yearly	7	6	5	4	3
1	> 100 yearly	6	5	4	3	2

Notes
Major loss defined as infrastructure closure or services stopped for >24h
0 = not applicable

2	ALARP region
5	Reduce Risk
8	Unacceptable risk



Risk Based Resilience Assessment

Programme

Milestone	Actual / Planned Date
Part time (40%) PhD started	December 2009
Visits to SNCF and Eurostar	Jan – March 2009
Visits to UK Train operators	April- May 2009
Research – train operation literature	2009-2010
Literature research – human factors and resilience engineering literature	2010
Assessment	2010-2011
Further research into decision support tools	2011-2012
Application to international railway operators and refinement of research	2012
Thesis write up	2012-2013

Author background

Lynne graduated with an MSc. (Eng.) in Railway Systems Engineering from the University in Sheffield in 2001.

She is a Chartered Engineer, employed as a Principal Systems and Human Factors Engineer by Halcrow Group Ltd.

She has 28 years experience in control systems engineering, systems assurance and human factors, including 10 years' work on the Channel Tunnel Rail Link project and 6 years with Eurotunnel. During her time there, she led the section of the Eurotunnel Inquiry into the Channel Tunnel fire of 18 Nov. 1996 which dealt with adequacy and compliance with procedures.

Publications

Collis L.M. 2010, "**Building Control Systems Operators Can Trust–Human-Centred Design"** Lecture on the Ergonomics module of the MSc. (Eng.) in Rail Systems Engineering and Integration, University of Birmingham

Collis L.M. 2009, "**Building Railway Control Centres – Human-Centred Design**" Lecture on the Ergonomics module of the MSc. (Eng.) in Rail Systems Engineering and Integration, University of Birmingham

Collis L.M. 2009, "**The Human-Centred Design Of Railway Control Systems – Channel Tunnel Rail Link Control Systems**" International Conference on Rail Human Factors, Rail Safety & Standards Board, 3-5 March 2009, Lille, France.

Collis L. M. 2008, “**Human Centred Design of Railway Control Systems**”. Lecture on the Ergonomics module of the MSc. (Eng.) in Rail Systems Engineering and Integration, University of Birmingham

Collis L.M., 2007, “**Human Factors Engineering of Interfaces – Connecting Control Centres**”. IET International Conference on Systems Safety, October 2007,London..

Collis L.M., 2005, ‘**Designing Interfaces for Inter-Operability - Connecting Control Centres**’. IEE International Conference on Rail Engineering, March 2005, Hong Kong,

Collis L.M. and Schmid F. 2002, “Human Centred Design for Railway Applications”. In: Noyes J. and Bransby M. ed. ‘**People in control: Human factors in Control Room Design**’. IEE Books, London

Collis L.M. and Robins P. 2001, **Developing Appropriate Automation For Signalling and Train Control On High Speed Railways**. 2nd international IEE People in Control Conference, June 2001, Manchester

Collis L.M. 2000, **Inter-disciplinary Interfaces in Real-Time Control: Protecting Works Across Infrastructure Control Boundaries**’ Thesis (MSc. (Eng.) in Rail Systems Engineering, University of Sheffield

Collis L.M. 1999, **Working with clients on large, multi-discipline projects to deliver effective safety risk assessment’** IIR Conference on Straightforward Approaches to Risk Assessment in Railways, Nov 1999, London

Collis L.M. and Schmid F. 1999 **Human-Centred Design Principles**, IEE People in Control Conference, June 1999, Bath.

Collis L.M. and Schmid F. 1999 **Case Studies on Human Centred Design for Railways**, IEE People in Control Conference, as above

Collis L.M. 1998 **Making sense of Remote Condition Monitoring for operations and incident management**. IEE seminar on Remote Condition Monitoring for Railways, Nov 1998, London