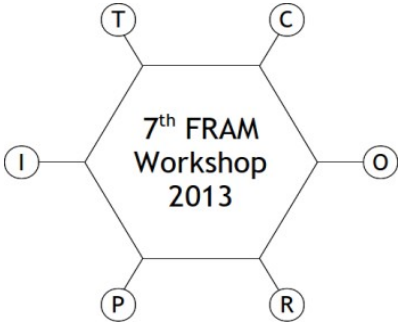


7th FRAM Workshop

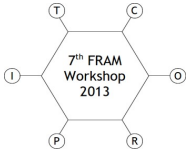
Modelling Complex Socio-Technical Systems

11-13 September 2013, Munich

FRAM Case

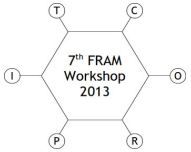
The Hatfield (UK) rail accident

17 October 2000



The purpose of this exercise.

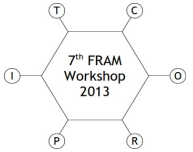
1. Identify relevant functions derived from the description of events
2. Identify relevant functions derived from the everyday “normal” operations and organisational context.
3. Develop the instantiations of the model previously built considered necessary to identify the sources of variability and its aggregation.
4. Conclude on the consequences or recommendation towards the improvement of system safety and efficiency.
5. Compare outcome of the exercise against conclusions and recommendations produced by official investigation by the Office of Rail Regulation (ORR), in order to identify potential benefits and challenges in the use of FRAM.



The facts…

About the events

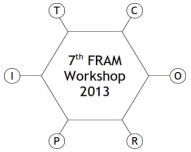
- On Tuesday 17 October 2000, a train travelling from London Kings Cross to Leeds derailed south of the station of Hatfield (approximately 35 Km north of London)
- The train (from GNER) was travelling at a speed of approximately 185 kph (normal line speed) and carrying 170 passenger and 12 staff members
- The immediate technical causes were the **fracture and subsequent fragmentation of a rail** and, as a result of the derailment
- Four passengers were killed and over seventy people suffered injuries, including four seriously injured
- The months following the accident were marked by **serious train traffic disruptions**, not only on that route but also on adjacent ones
- Railtrack (the private owner of the rail infrastructure) revealed itself **incapable of recovering normal operations**
- The lack of responsiveness by Railtrack led to a government intervention and eventually in 2002, to the decision of **revoking Railtrack's license over the rail infrastructure**



The facts...

About the rails

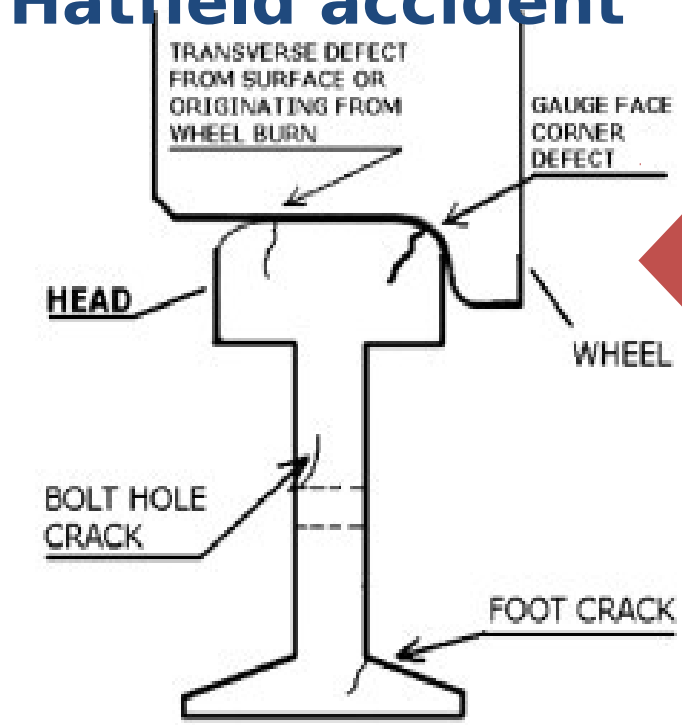
- The derailment occurred on plain line following the catastrophic failure and disintegration of the high rail at a curve
- The initial rail failure may have been a transverse fatigue crack at 59.2 metres north of the road bridge
- Following the initial rail failure, many more failures occurred as a reaction to the stresses induced in the unsupported rail
- Several of these secondary failures occurred at locations where there were shallower transverse fatigue cracks



In hindsight...

- Hatfield derailment has proven to be the culmination of a progressive **loss of control over safety and maintenance requirements**
- Earlier fatal accidents at Southall in 1997 and Ladbroke Grove in 1999 had already flagged **evidence of serious shortfalls, to which there was poor response**
- The aspects were considered relevant for this exercise:
  - Difficulties in managing track inspections (in particular for problems such as gauge corner cracking), planning and scheduling of maintenance and of temporary speed restrictions as a safety measure
  - The **privatisation process was early on strongly criticised for its complexity**, partly due to the number of companies into which the industry was broken into (more than 20 different companies)
  - The infrastructure manager (itself a private corporation) **relied entirely on outsourced engineering contractors** to respond to maintenance needs (Balfour Beatty in the Hatfield area)

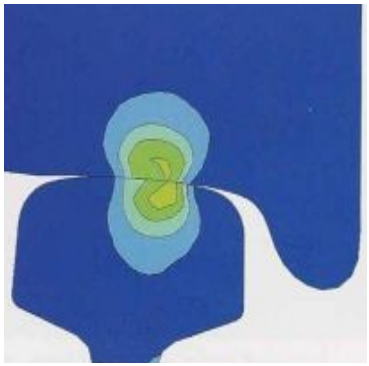
Rail maintenance and the Hatfield accident



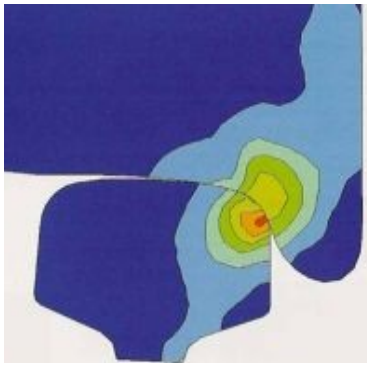
The gauge corner refers to the inside angle of the railhead, from which the distance between rails is measured

Gage corner cracks

- Where trains meet a rail curve, in addition to vertical forces, they also exert lateral forces on the rail, particularly on the one outside the curve in the area of the gauge corner
- One of the most common failures in rails and frequent maintenance demand
- Engineering standards enforce the periodical inspection of rails and whenever necessary, maintenance crews carry out rail grinding, which prevents surface cracks from appearing or developing any further into the structure of the rail

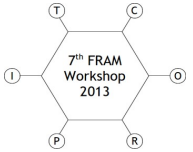


Contact stresses on straight track



Contact stresses on curves

Rail maintenance and the Hatfield accident



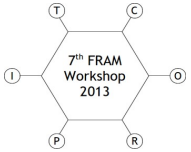
Temporary speed restrictions (TSRs)

- Whenever inspection work identifies the need for maintenance interventions and until such intervention is planned and scheduled, maintenance crews may request the placement of a TSR at the location, aiming to prevent further damages to the railhead or train wheels (ensure safety of the line)
- while maintenance crews may consider the implementation of TSR a necessary safety measure, rail operations tend to challenge such decisions, as they may cause train delays and incur on increased costs

critical ETTOing in rail systems:

- **Train traffic:** As train traffic increases, both the ware-out of rails and their maintenance needs are expected to equally increase
- **Maintenance work requirements:** Gauge corner cracking constitutes a significant risk for rail systems against which, a great deal of preventive maintenance work is carried out, mainly as rail inspections and grinding
- **Maintenance response capability:** Whenever maintenance crews are unable to respond to the work needed TSRs may be applied, as a way to ensure safety of the line whilst awaiting an adequate maintenance intervention

Rail maintenance and the Hatfield accident

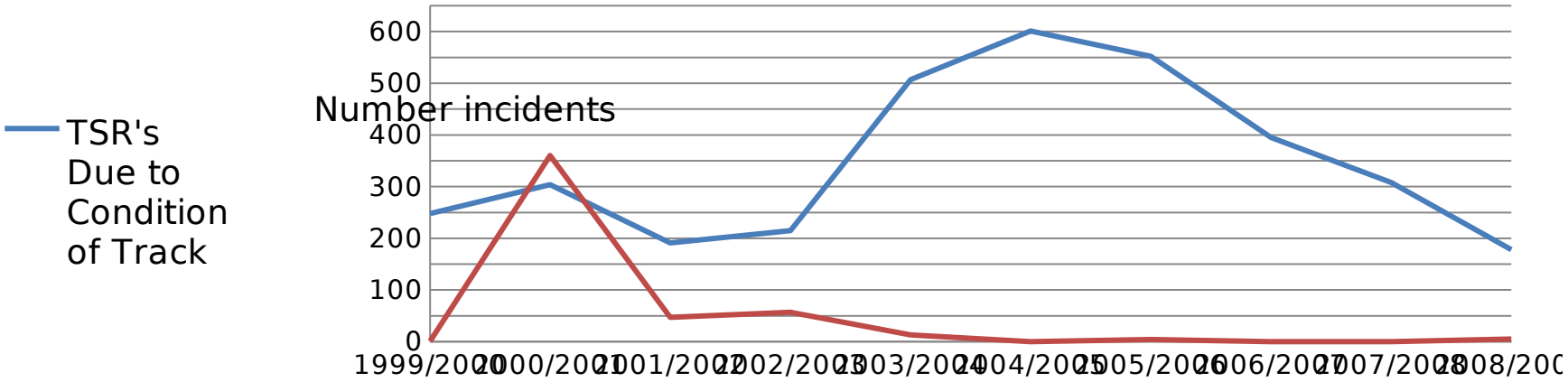


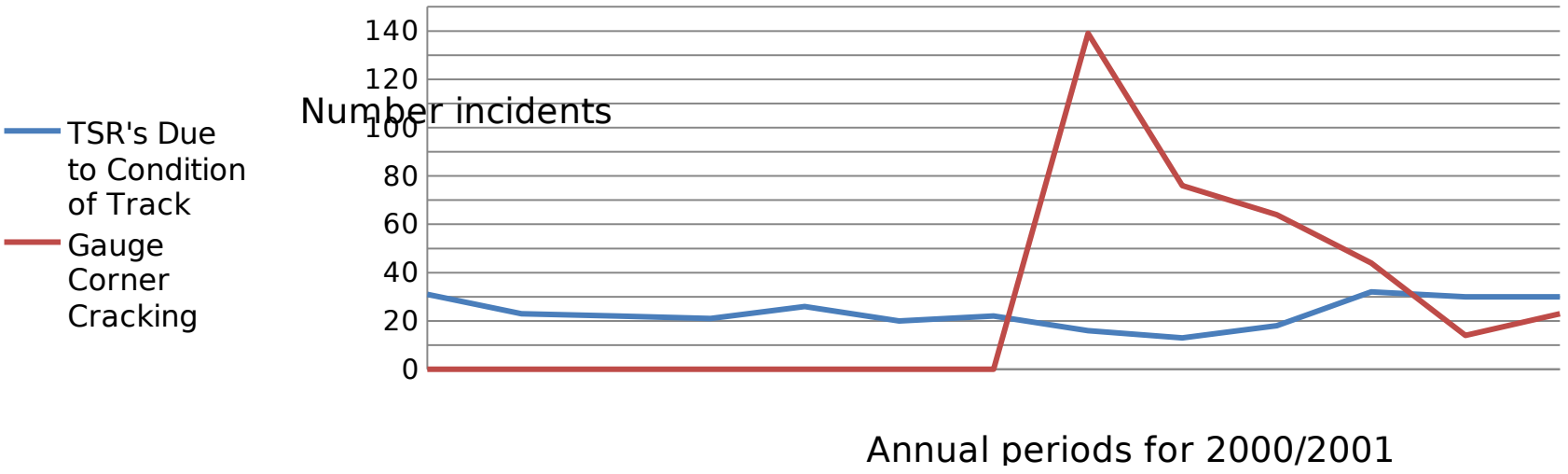
In summary...

- Balfour Beatty, as the maintenance contractor, was required to carry out all necessary track inspections, through which any need for rail grinding or renewal work would be identified and the need for a TSR to maintain safety of the line would also be determined
- Such requirements should be passed on to Railtrack which would then be responsible for a (formal) decision upon the intervention recommended by its contractors or any other deemed appropriate, and planning such intervention
- Not only Balfour Beatty failed to realise the urgency of intervention at Hatfield, but also, Railtrack may have preferred a maintenance intervention (i.e. rail grinding) or if necessary, a rail replacement, and avoid the costs of placing a TSR (as the costs with such measures were likely to register a significant increase)

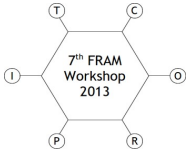
Asset performance data

Evolution of TSR and gauge corner cracks in the area of Hatfield, per year and per period in year 2000/2001 (Asset incident database -- Network Rail)





The rail industry



HM Government
Treasury / Dept. for Transport
- Nomination of regulators (secretary of State for Transport)
- Approval of financial and operational goals

Strategic Rail Authority
Industry operational management
- Awarding passenger rail franchises
- Monitor compliance with franchise contracts
- Manage subsidising contracts between state and passenger and freight operators

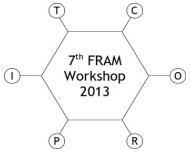
Rail Regulator
Economic authority
- Pricing of access to rail network (track, stations…)
- Allocation of rail capacity
- Efficiency levels to be achieved by industry members (operations, maintenance, renewals and enhancements…)
- Issuing and monitoring of operating licenses
- Development of industry codes for timetable, rolling stock and rail assets, among others

HM Safety Inspectorate
Safety authority
- Compliance with Health & Safety at Work Act
- Accident investigation
- Safety recommendations

Train Operating Companies (TOCs)
GNER…
- Train services
- Train drivers
- Rolling stock maintenance

Railtrack
Owner and manager of rail infrastructure
- Rail assets oversight and management (tracks, points, signalling and electrification)
- Operations management and control
- Station management

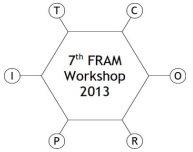
Engineering contractors
Balfour Beatty / Jarvis
- Rail assets maintenance and renewals
- Track inspection and patrolling



Group exercise (this is a workshop...)

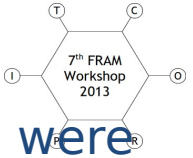
- Proposed set of functions
- Foreground functions and the description of their 6 parameters
- Phenotypes and output of foreground functions
- Review instantiation
- Conclusions

The conclusions of the ORR investigation board



- Post privatisation there was an increase in passenger and freight traffic, which put great strains on a 'stretched, ageing and fragile' infrastructure that had suffered years of under investment
- This brought unforeseen difficulties for Railtrack as it managed the rail infrastructure
- Fragmentation of the industry was a further consequence, particularly following Railtrack's move to the private sector and the decision to contract out the rail maintenance work
- The Board considered that this arrangement proved to be unsuccessful with Railtrack failing to control the contractors, losing control of the condition of the track (its main asset), the quality of the maintenance, and also losing control over its costs
- Network Rail is now showing the health and safety leadership role that is properly their responsibility
- An example of this is the decision by Network Rail to bring maintenance contracts in-house, using better project planning and gaining an improved understanding of the condition of their infrastructure
- This has resulted in better management of costs and a more strategic approach is in place for dealing with infrastructure maintenance
- As a result, the **incidence of broken rail has decreased considerably**

Within this FRAM of mind...



To FRAM or not to FRAM? (is that the question?)

- Critical safety and operational decision making processes were extremely complex and involved many interfaces (i.e. reporting on asset condition by Balfour Beatty and asset management decision making by Railtrack)
  - ? Data and investigation reports show some indication of this but what can FRAM provide us any further?
  - ? what actual elements in the system were uncoordinated (having accurate data on asset status when having to make decisions on whether to maintain, place a TSR or renew...)?
- The system had recovered (more or less) normal operation after 2 previous and similar events but this particular one proven to exceed its ability to recover
  - ? would FRAM be able to show us what changed?
  - ? too complex?...
- Other previous serious accidents had provided important indication of operation beyond or close to system capacities
  - ? If used prospectively rather than retrospectively, could have FRAM supported adjustments of system performance in view of preventing Hatfield?
  - ? What other recommendations (on what subjects, issues...) could have FRAM provided in the aftermath of Hatfield, beyond those of the investigation board