DELIVERING SAFETY AND RELIABILITY THROUGH INDUSTRY COLLABORATION

SARS LONDON BRANCH/YRP

3RD JUNE 2020

The Safety & Reliability Society is now a Licensed Member of the Engineering Council for direct CEng and IEng Professional Registration
PROGRAMME

• Introduction to YRP / SaRS and our Speakers
• Presentations
• Q&A/Panel session
• SaRS/YRP items
• Feedback form
INTRODUCING SARS

The Safety and Reliability Society is the professional body for safety, reliability and risk management practitioners. We provide our members with a direct path to professional registration for CEng and IEng as well as providing them with opportunities for cross-industry learning, CPD and networking.

We are internationally recognised as the leading body for domain expertise through our branch technical seminars, journal, knowledge base, webinars and membership.
The Young Rail Professionals is the professional association for young people in the railway industry. Our mission is to:

**Promote**

the rail industry as a great place to work.

**Inspire**

the next generation of railway talent.

**Develop**

and connect the future leaders of the industry.
Chair and presenters

John Stringer
Abbott Risk Consulting
Chair

Fotios Zapantis
Safety Intelligence Analyst, RSSB
Presenter

Giulia Lorenzini
Senior Partnership and Grants Manager, RSSB
Presenter
Delivering a reliable railway through industry collaboration and innovation

Presented by Giulia Lorenzini
Senior Partnership and Grants Manager
R&D Programme
Rail as a complex system

Complex systems:

- many diverse, interacting components
- non-linear and non-proportional interactions between the components
- components adapt/ learn in response to change

Image: Eclipse Foundation
A ‘reliable’ complex system

- Whole-system approach
  - Technical sub-systems
  - Interfaces between sub-systems
  - Passengers
  - Human behaviours etc.

- The system as a whole could achieve higher reliability at a lower cost than the sum of its parts
Current Challenges

“The rail industry no longer possesses the same ability or incentive to innovate”

(Keith Williams, February 2019)

- Increased passenger numbers
- Complex timetables
- Restricted maintenance opportunities
- Limited resources
- Lack of a joined-up approach
- Public pressure to deliver

Source: RIA & Network Rail – Unlocking Innovation in the Rail Sector Pulse, Nov 2019
Still a long way to go, but...

Lots already happening:

- Augmented reality
- Thermal and visual imaging equipment
- Digital twin models
- Internet of things
- Graph analysis, Artificial Intelligence and Machine Learning

...more to prove and to achieve!
Towards a reliable railway

INVESTMENT

CULTURE CHANGE & MINDSET

COLLABORATION
Towards a reliable railway
Investment opportunities to stimulate innovation

- RSSB’s R&D competitions and various Research Councils (i.e. EPSRC)’s initiatives and grants
- InnovateUK FOAK SBRI opportunities for rail
- Suppliers innovation and UKRRIN network
- Rail Innovation Network (engagement with tech start ups)
- Catapults (cross-sector fertilisation)
Towards a reliable railway

INVESTMENT  

CULTURE CHANGE & MINDSET

COLLABORATION

Delivering safety and reliability through industry collaboration  
03 June 2020
Mindset: now vs. future
Towards a reliable railway

INVESTMENT

CULTURE CHANGE & MINDSET

COLLABORATION
Collaboration: ‘All aboard!’

- International partners (RTRI, JR East, SNCF, Trenitalia) > knowledge sharing
- Academia (University of Huddersfield; University of Sheffield; ITS Leeds) > specific challenges
- UKRRIN > cross-industry collaboration to support research and innovation
- Duty holders i.e. Train and Freight Operating Companies; ROSCOs; Network Rail etc.
- Small and Medium Enterprises (SMEs) and larger organisations working in rail
- Other industry bodies such as RIA, Rail Alliance, NSAR etc.
- Research Councils (EPSRC) and government bodies (InnovateUK, KTN etc.)
- Professional Institutions
Collaboration: ‘All aboard!’
Collaboration: ‘All aboard!’

DATA

ADHESION

TRAIN DESIGN

ROBOTICS

DECARBONISATION

Collaboration: ‘All aboard!’

ADHESION

TRAIN DESIGN

ROBOTICS

DECARBONISATION
37% passengers satisfied with how well train company deals with delays (Transport Focus, 2018)

Rail users satisfaction at 10-year low

One team one look' at Victoria station saw a 13% increase in passenger satisfaction

14.8m 2017/18
15.6m 2018/19

Delay minutes

20% Trust
37% Distrust
said they trusted or distrusted train travel

Performance is still falling back

Rail news
Delivering safety and reliability through industry collaboration

Summer 2017: Data Sandbox platform was built – powerful example that data from across the industry can be made available...

Oct 2017: £500K ‘call for research’ launched
- 5 projects awarded funding
- Great collaboration from NR + TOCs

2019
- Enhanced Sandbox repository
- April 2019: £1.3m ‘call for research’ launched in collaboration with Network Rail

Purpose / scope:
- Increased understanding of industry data
- Improved consistency of rail performance from reduced dwell time fluctuation
- Improving disruption management through better recovery from reactionary delays

= OPERATIONAL SAVINGS + IMPROVED CUSTOMER EXPERIENCE
£500K for the initial competition (RSSB) and £1.3 million for the second one (RSSB and NR)

Leveraging data
Machine Learning, AI, data analytics techniques...
Case study 1: IntelliDwellTime

Apply Analytics to assist with root cause identification

Quantify Benefits to rank improvement plans

- Staff location
- Door sensors
- TRUST
- OTMR
- Weather
- Train describer
- Passengers

< 3mins: Sub-threshold & suspected to be due to Dwell Issues
1 Million minutes per year, nationally

< 3mins: Sub-threshold so causes unknown
23%

> 3mins: Attributed, so clear focus to determine cause
43%

15 Million Delay Minutes per Year
Case study 2: Rail performance modelling for strategic decision making

Using industry data to help TOCs and Network Rail improve service performance

1. Model the interaction of trains, and the reactionary delays resulting from conflicts
2. Discover the root causes of poor performance by visualizing the complex interacting delays
3. Model interventions designed to remove/reduce the effect of these root causes
4. Quantify the benefits of the improved performance to establish the value for money of interventions.
Conclusions

Innovation strategy

CULTURE CHANGE & MINDSET

Reliability

INVESTMENT

COLLABORATION

DATA
Thank you
Deep Dive into Data Science methods for Rail Safety

Presented by Fotis Zapantis
03 June 2020
Hi, I am Fotis
I work as an Intelligence Analyst at the Risk and Safety Intelligence department at RSSB. I help other Risk and Safety Intelligence Analysts build the intuition they need to identify passenger, public and workforce safety risk from operational incidents
I am also a mentor for the Women in Rail cross-industry mentoring scheme 😊
Data properties and Data sources available

- Confidential Reporting
- CIRAS
- Risk Profiling For Operators
- RPT
- National Incident Reporting online
- NIR
- Precursor model of Train accident risk
- PIM

- SMIS
- Safety Management Intelligence System
- Close Call Database
- CC
- Rolling Stock Database
- R2
- SRM
- Safety Risk Model (v8.5)
Safety Risk Estimation vs Reality (Observed Harm)

High frequency (events/year)
Low consequence (FWI)

- Modelled risk
- Actual harm

Low frequency (events/year)
High consequence (FWI)

1 FWI = 1 fatality or 10 major injuries or 200 Class 1 minor injuries or 1,000 Class 2 shock/trauma events

Fatalities and Weighted Injuries

Note: charts are illustrative and not based on real data
Data Mining Methods (Ancient Methods)

- Classification
- Clustering
- Regression
- Association Rules
- Attribute importance
- Feature selection and extraction
- Anomaly detection
Data is useful when it is Actionable

Data Science will leverage any tools for extracting as much information as the data contains and comprises mathematics (statistics), logic, algorithms and assumptions for uncertainty.

The presence of uncertainty leads to infer rather than deduce solutions and it is statistics that we rely upon to measure the accuracy and reliability of the extracted information.
Fault and Event Tree Analyses for Process Systems Risk Analysis: Uncertainty Handling Formulations

Refaat Ferdous,1 Faisal Khan,2 Rehan Sadiq,2 Paul Amyotte,3 and Brian Veitch1

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Decision Tree</th>
<th>Fuzzy Rule-Based Models</th>
<th>Artificial Neural Networks</th>
<th>Bayesian Networks</th>
<th>Cognitive Maps/Fuzzy Cognitive Maps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network capability</td>
<td>N°</td>
<td>L°</td>
<td>N°</td>
<td>H°</td>
<td>VH°</td>
</tr>
<tr>
<td>Ability to express causality</td>
<td>H°</td>
<td>M°</td>
<td>N°</td>
<td>H°</td>
<td>VH</td>
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<tr>
<td>Formulation transparency</td>
<td>H°</td>
<td>H°</td>
<td>N°</td>
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<td>VH</td>
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<tr>
<td>Ease in model development</td>
<td>H°</td>
<td>M°</td>
<td>M°</td>
<td>VH</td>
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<tr>
<td>Ability to model complex systems</td>
<td>M°</td>
<td>H°</td>
<td>VH°</td>
<td>H°</td>
<td>VH</td>
</tr>
<tr>
<td>Ability to handle qualitative inputs</td>
<td>H°</td>
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<td>N°</td>
<td>VH</td>
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<tr>
<td>Scalability and modularity</td>
<td>VL°</td>
<td>L°</td>
<td>VL°</td>
<td>H°</td>
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<tr>
<td>Data requirements</td>
<td>H°</td>
<td>L°</td>
<td>VH°</td>
<td>M°</td>
<td>L°</td>
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<tr>
<td>Difficulty in modification</td>
<td>VH°</td>
<td>H°</td>
<td>M°</td>
<td>L°</td>
<td>N°</td>
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<tr>
<td>Interpretability of results</td>
<td>VH°</td>
<td>VH°</td>
<td>VH°</td>
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<tr>
<td>Learning/Training capability</td>
<td>H°</td>
<td>M°</td>
<td>VH°</td>
<td>H°</td>
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</tr>
<tr>
<td>Time required for simulation</td>
<td>L°</td>
<td>L°</td>
<td>H°</td>
<td>L°</td>
<td>L°</td>
</tr>
<tr>
<td>Maturity of science</td>
<td>VH°</td>
<td>H°</td>
<td>H°</td>
<td>VH°</td>
<td>M°</td>
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<tr>
<td>Ability to handle dynamic data</td>
<td>L°</td>
<td>H°</td>
<td>H°</td>
<td>H°</td>
<td>M°</td>
</tr>
<tr>
<td>Examples of hybrid models (ability to combine with other approaches)</td>
<td>H°</td>
<td>VH°</td>
<td>VH°</td>
<td>H°</td>
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</tbody>
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Comparison of various risk analysis techniques for Complex Systems (the Theory)
Case Study 1 - Treatment of Disabled Passengers [Text Mining, Graph Inference]

In order to create reproducible workflows we used 

![python](v 3.0) via Orange data mining, an open source tool for data mining and machine learning

POLE (Person, Object, Location, Event) Model

Safety Insights (~1.5K records in SMIS over multiple years):

- The process of booking assistance and the level of experience of assistance staff are a major concern for reduced mobility passengers who often need to find their way to the platform/exit in overcrowded stations or in a short amount of time due to train delays – Hypothetical Action: Provide different ticketing arrangements for disabled passengers e.g. day tickets

- Disabled WC are frequently used by other non-disabled passengers and their general cleanliness is not very well received – Hypothetical Action: Only allow access to the disabled toilet via the disabled persons railcard

- Upper body injuries (shoulder, knee, neck) are more frequently reported as a result of disabled/non-disabled passenger interaction - Hypothetical Action: Possibly segregate disabled and non-disabled passenger flows
Case Study 2 - Trackworker Safety, Network Rail Safety Task Force Programme [DoE]

Recent accidents have sharpened the industry focus on track worker safety, particularly the interface between track workers and moving trains. The Safety Task Force formed in July 2019 to tackle this issue with RSSB providing analysis support from available data: Near Misses recorded in SMIS, Investigation reports, Operational Close Calls in SMIS and Close Calls (Safety Insights ~15K records in multiple systems).

RSSB to work with NR and ISLG to improve the data and metrics for trackworker safety

Environmental attribute correlations

Top 5 attributes with strongest correlation
- Dew point (C): 0.91
- Maximum temperature (C): 0.91
- Temperature (C): 0.89
- Feels like (C): 0.89
- Wind chill (C): 0.89

Environmental Attribute
Maximum temperature (C)
### Success Criteria

**Focus on the business value**

<table>
<thead>
<tr>
<th><strong>Do’s</strong></th>
<th><strong>Don’ts</strong></th>
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</thead>
<tbody>
<tr>
<td>Define the business value in terms of effectiveness, efficiency and risk. Determine which process aspects you want to gain insights.</td>
<td>Don’t be overly fascinated with the possibilities of the technology. There are often multiple ways to get answers for your questions, and sometimes multiple techniques to be combined to get the full picture.</td>
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</tbody>
</table>

**Start small, think big**

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<td>Don’t start with the most important core process of the company. That will come later once the first results have convinced people of the approach.</td>
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**Work hypothesis-driven and in short cycles**

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**Facts don’t Lie:** However, never be careless in handling, preparing and analysing the data. Do not assume that all the information is in your data (often relevant context information needs to be considered to draw the right conclusions).
Common Pitfalls

• Being too fascinated with the technology itself can lead to an inability to show the added value from a business perspective

• An unrealistic image of the data availability, coming from the promise of Big Data, can lead to overblown expectations

• Due to wrong understanding of what data mining can do, the first project is often too ambitious in scope. Too much is being promised and it takes longer than usual before the first results can be shown

Any Questions?
Thank you
Q&A

Panel discussion – 15 minutes

Questions welcome from audience via the on-screen chat facility
SARS ITEMS

Accessing the webinars
Joining SaRS
Next Events
Feedback
Social event
JOINING SARS

If you aren’t a member and have enjoyed this webinar, please join to develop yourself and the Society

We accept membership applications from candidates from all relevant backgrounds – membership is open to everyone from students to experienced professionals

We are delighted to announce that the Safety & Reliability Society is now a Licensed Member of the Engineering Council for direct CEng and IEng Professional Registration

More information available at www.sars.org.uk
NEXT WEBINAR

• Basics of Risk Management – 5. People Placement
  • 17th June at 1300
  • Register via our website www.sars.org.uk
YRP brings together people from all sectors of the industry and we run a packed programme of collaborative networking and development events throughout the year. Membership is free and our events are free or subsidised to ensure they are affordable and accessible to all.

A playlist of our recent webinars is available on our YouTube channel: www.youtube.com/channel/UCSfN7ahABNvsTt9h-ByZRrg or search for “Young Rail Professionals” on www.youtube.com

To sign up to our upcoming events go to our website: www.youngrailpro.com

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th June 2020</td>
<td>Rail Quiz Night</td>
<td>A fun quiz night raising money for charity and breaking the lockdown lull, hosted by Pete Waterman OBE</td>
</tr>
<tr>
<td>18:00 - 19:30</td>
<td>YRP/Railway Benefit Fund</td>
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<tr>
<td>30th June 2020</td>
<td>Andrew Haines talks to the Next Generation of Railway Workers</td>
<td>Network Rail Chief Executive Andrew Haines addresses young railway professionals on his career journey and the challenges and opportunities in the industry</td>
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<tr>
<td>17:00 - 18:00</td>
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<tr>
<td>14th July 2020</td>
<td>Disrupting Disruption - improving the customer experience when things go wrong</td>
<td>A panel of industry leaders discusses how the rail industry handles disruption</td>
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<tr>
<td>18:00 - 19:30</td>
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FEEDBACK

• I am now going to initiate a feedback form
• Please can I ask you to fill it in before you exit the webinar
• The information is vital for us to improve our offering
• Please take two minutes to fill it in and click Submit
• Thank you very much and STAY SAFE
THANK YOU

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