Human Error Quantification
Railway Action Reliability Assessment

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Aims

• Make a case for the quantification of human performance for safety decision making

• Introduce Railway Action Reliability Assessment
Involvement in Quantification

• CORE-DATA database of human error probabilities – University of Birmingham

• Project team for development of Nuclear Action Reliability Assessment

• Development of Controller Action Reliability Assessment for EUROCONTROL

• Development of Railway Action Reliability Assessment at RSSB
Why quantify human performance?

- Understanding human performance
  - Safety decision making
  - Incident Investigation
- Normalising data
- Better risk quantification
Quantifying a human error

• 299 train driver errors - signals passed at red per year

• Is this good?
  – 1,000 red aspects experienced by drivers on the Network, or
  – 1,000,000 red aspects experienced by drivers on the Network
299 SPADs Per ....

- 1 in 10
- 1 in 100
- 1 in 1,000
- 1 in 10,000
- 1 in 100,000

1E-05

1,000 stop aspects
1,000,000 stop aspects
Actual Estimate
Very best

Always
Safety Decision Making Example

1.
- c ryanair 6 6 3
  - right turn heading 3 0 0
- p right at 3 0 0
  - ryanair 6 6 3

2.
- c jetset 2 5 delta
  - descend to flight level 1 2 0
- p descend flight level 1 2 0
  - jetset 2 5 delta

3.
- c shamrock 2 0 alpha
  - descend flight level 6 0
- p descend flight level 6 0
  - shamrock 2 0 alpha

4.
- c ryanair 4 4 3
  - climb flight level 1 6 0
- p we're cleared flight level
  - 1 6 0
  - ryanair 4 4 3
Air Traffic Control Context

- Critical slips in communication
  - ‘flight level five zero’ say ‘flight level six zero’
- No safety inter-locking for air traffic control
- 1,000s of communications an hour
- Solution: move from voice to electronic communication

- Equivalent to railway operations:
  - Automation of forms
  - i-Pad
  - Automated messages
Communication errors

Electronic data entry errors

- Always
- 1 in 10
- 1 in 100
- 1 in 1,000
- 1 in 10,000
- 1 in 100,000

1E-05

0.00001

0.0001

0.001

0.01

0.1

1
Railway Action Reliability Assessment

- RSSB research project T270 “Enhancement of the HEART human error quantification technique for use in the railway industry”

- Outline some feature of the project

- Present an example and consider how it is applied
RSSB Project Role:
Manage project and undertake technical work:
- Safety data/risk team
- Human Factors
- Operations

Railway Action Reliability Assessment Users: Risk assessors and human factors specialists

External Technical Review: B. Kirwan
How do we quantify human error?

Priority:

1. Incident data/on-train data recorders
2. Simulation
3. Ask those who carry out the task
4. Railway Action Reliability Assessment
HRA Process

1. Problem definition
2. Task analysis
3. Error identification
4. Risk model development
5. Quantification - use of Railway Action Reliability Assessment
6. Impact assessment
7. Error reduction
8. Problem evaluation

Skip steps 1 and 5 for Quantitative Human Reliability Assessment
Generic Quantification Techniques

- Identify task which requires quantification
- Compare the task with the generic tasks listed in the technique
- The generic task will have a probability
- Increase this probability based on negative performance shaping factors
1. Understand the task you want to quantify
2. Identify the **Generic Task Type (GTT)** which best matches your task
3. Identify any **Error Producing Conditions (EPCs)** (performance shaping factors) which will make performance less than optimal
4. Consider overlaps between the selected elements
5. Estimate the strength of the error producing conditions - **Affect**
6. Use the Excel sheet to calculate the human error probability
Project Deliverables

• Technical basis reports: Generic Task Types; Error Producing Conditions; Assessed Proportion of Affect Guidance

• Railway Action Reliability Assessment manual

• Railway Action Reliability Assessment calculation sheet
1. Review HEART GTTs
2. Map GTTs to Rasmussen step-ladder model
3. Map GTTs to a train driver task inventory
4. Identify additional GTTs – gaps from (2) and (3)
5. Identify data available to quantify new GTTs
6. Removal of original GTTs - newer data or not well matched to the driver task inventory
More automated and skill-based

- Well-designed, human centred automation
- Straightforward well-designed tasks
- Increasing potential for confusion between data
- Reduced attention or reduced accuracy through person carrying out the task at a quicker pace

R1. Respond correctly to system command even when there is an automated system providing accurate interpretation of system state.
R2. Completely familiar, well designed, highly practiced task which is routine.
R4. Skill-based tasks (manual, visual or communication) when there is some opportunity for confusion.
R5. Fairly simple task performed rapidly or given insufficient or inadequate attention.
More effortful, rule-based processes and thinking outside procedures

R6. Restore or shift a system to original or new state, following procedures with some checking.
R8. Complex task requiring a high level of understanding and skill.

Increasing complexity of rule-based judgements
Increasing complexity and knowledge-based judgements

0.003
0.07
0.16
Generic Task Types

- 8 in total to chose from
- More automated and skill based processes
  - Perception, memory, action slips
  - 5
- More effortful and rule-based processes
  - Decision error
  - 2
- Thinking outside procedures
  - Decision error
  - 1
- Lower/upper bounds
- Not for violations
GTT Guidance

- Graphs
- Key considerations
- Train driver examples
Ultrasonic Axle Testing
Current task

• Task: Identify an ‘intrusive’ signal when presented on the display

• Carried out throughout a shift. Automated manual and visual activities – waiting for a ‘blip’ which means that there is a crack in the axle
  – GTT R3 ‘Simple response to a dedicated alarm and execution of actions covered in procedures’ - HEP = 0.0004 (1 in 2500)

• Signals are rare
  – EPC – Unfamiliarity – Affect = 17 times worse

• Signals are masked by noise
  – EPC - Low signal-noise ratio – Affect = 10 times worse

• Environment is challenging
  – EPC – Environment – Affect = 4.5 times worse
• Changes to maintenance procedures by Network Rail
• Train driver use of mobile phones
• Level crossing positioning in relation to signals
• RSSB Safety Risk Model/LUL QRA
• European Common Safety Method

• Train dispatch errors for a train operating company
• Wrong side door opening
• Train cab warning system
• Selective door operation
• Train axle inspection
1. Group EPCs in to key areas
2. Review EPCs against other EPC type sets
3. Propose EPCs for addition or removal
4. Review EPC maximum affects
5. Develop supporting information from definition statements
6. Guidance on calculating the assessed proportion of affect
Error Producing Condition Grouping

- Task design
- Interface design
- Competence management
- Procedures
- Person
- Environment

- Guidance
  - Key prompts, definitions, maximum affect guidance, examples from train driver tasks
• EPCs in these areas identified in other techniques
  – Controller Action Reliability Assessment, Nuclear Action Reliability Assessment, Nuclear Approach - SPAR-H

• Approaches dedicated to better capturing these factors
  – Socio-Technical Risk Analysis (Mohaghegh)

• Recognised importance to rail:
  – RSSB Safety Management System Guidance
  – RSSB Safety Culture Toolkit
• Not included as part of Railway Action Reliability Assessment

• Rationale:
  – Data not readily available
  – Outcomes from culture/safety management inadequacies can be identified as EPCs which are more directly related to the task being assessed

• Mitigations:
  – Qualitative assessment encouraged to support quantification
  – Required to be considered as part of wider human reliability assessment process in manual
  – Recommendations for change/improvement should include safety culture and safety management if they can be demonstrated to underpin human performance issues
Summary

• Why choose Railway Action Reliability Assessment?
  – Immediately available
  – In use and reviewed
  – Consistent with other approaches in terms of key steps

• Why not?
  – 1st generation approach
  – Underpinning data not available
  – Overlapping concepts
  – Reliance on assessor opinion

more relevant to rail?
increasing confidence
guidance

guidance
Taking the approach forwards

- Implementation in projects for safety decision making

- Training/application days:
  - RSSB Human Factors and Risk team
  - Stakeholders – LUL, ORR, NR
  - Consultants to the rail industry (date to be confirmed)
Any Questions

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