HOF in Train Protection Systems: A Case Study from Irish Rail

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- PhD in human factors aspects of automated signalling systems
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Case Study – Irish Rail Train Protection System

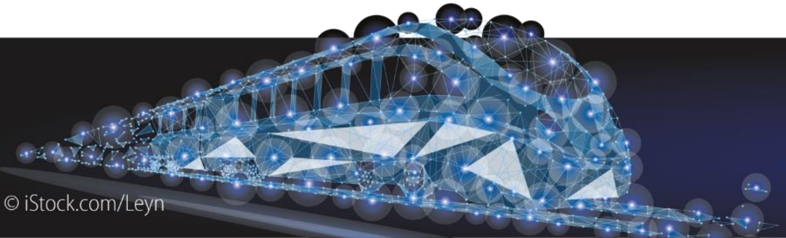
- Overview of case study
- Examples of HOF automation issues in the project
- Key approaches for integrating HOF

Background of IÉHS

- IÉ Hybrid System (IÉHS)
  - Class B system
  - Combines the functionality of existing ATP and driver warning systems with balise-based protection for movement authority and train speed
  - Initially started as an obsolescence project for existing systems
- It aims to protect against:
  - SPADs (through train stop and overspeed supervision)
  - Overspeeds through PSRs
  - Overspeeds through TSRs
  - Bufferstop collisions
- It supervises rather than replaces the driver
  - The driver is still primarily responsible for observing and responding to signals and for braking for stations, taking account of adhesion, the timetable, trackside hazards, etc.

IÉHS Project

- Project is led by the Infrastructure Manager
  - Main discipline is signalling
- Primary end users work for the Railway Undertaking
  - Drivers will have most of the interactions with the system
  - Largely invisible to signallers
  - Some interaction in maintenance and programming of balises for track/signalling engineers
- Result is that RU has been kept aware of project progress, but had relatively little input into shaping user requirements

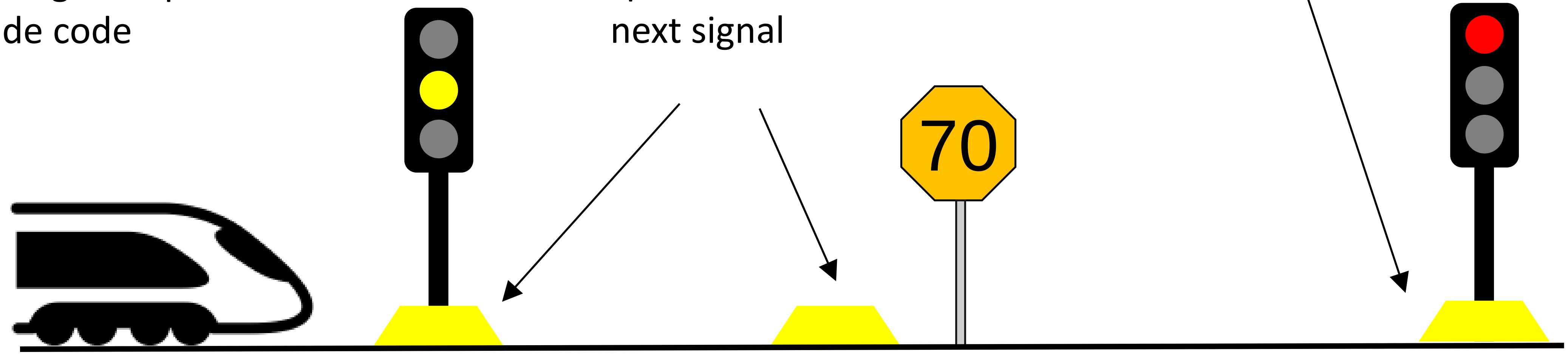


How does IÉHS work

In CAWS/ATP areas, IÉHS onboard detects signal aspect from trackside code

Balises also give information on the line-speed and distance to the next signal

In non-CAWS/ATP areas, TPS onboard detects signal aspect from balise positioned at signal

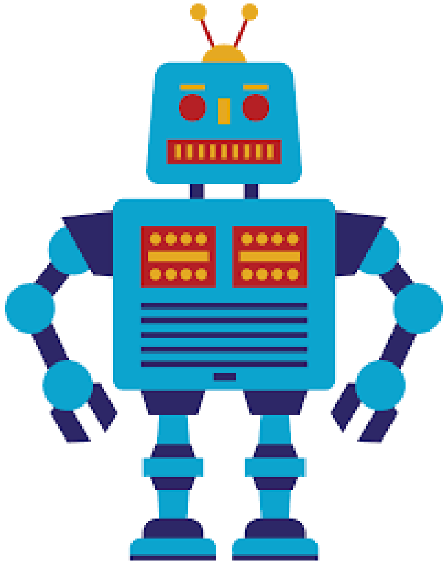


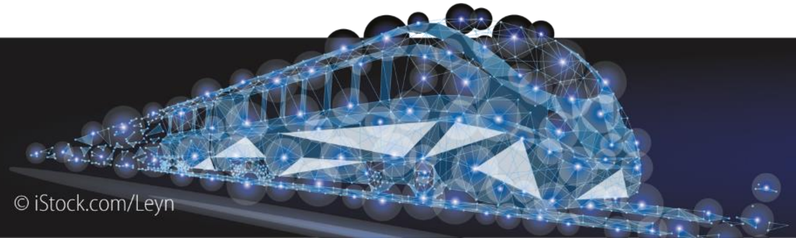
Train is equipped with:

- Pick up coil to detect track code in ATP/CAWS areas
- Balise antenna to receive information from balises

Some ‘classic’ issues with automation

- Mode awareness
  - Automation which operates differently in different modes
  - Undermines user situation awareness
- Feedback and interaction
  - How to understand what the automation is doing
  - And how to make it do what needs to be done
- Screens where there were no screens before
- Business change
  - Although automation may be specified to fit into the existing system seamlessly, in practice this is rarely the case
- Reliability, de-skilling, monitoring role
  - Not expected to be issues due to the nature of the system





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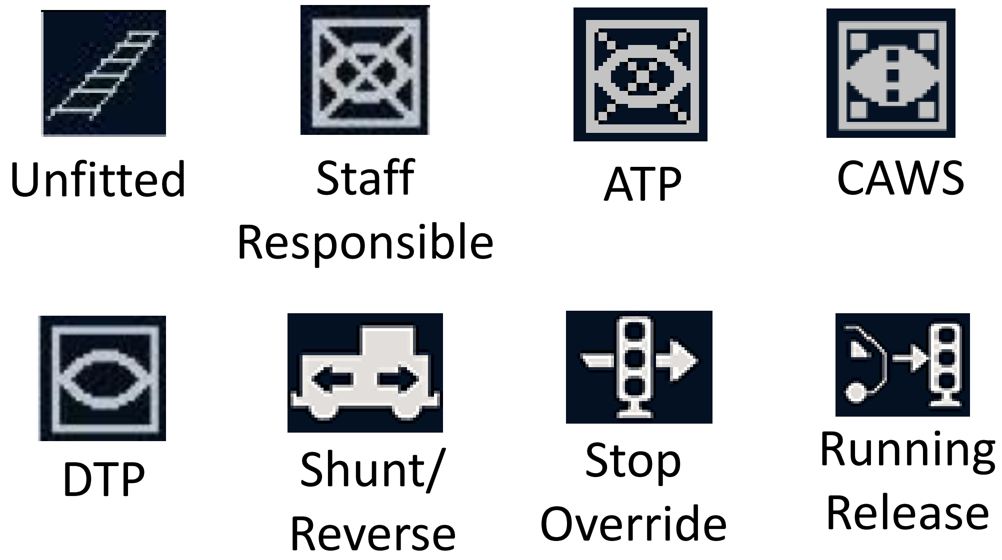
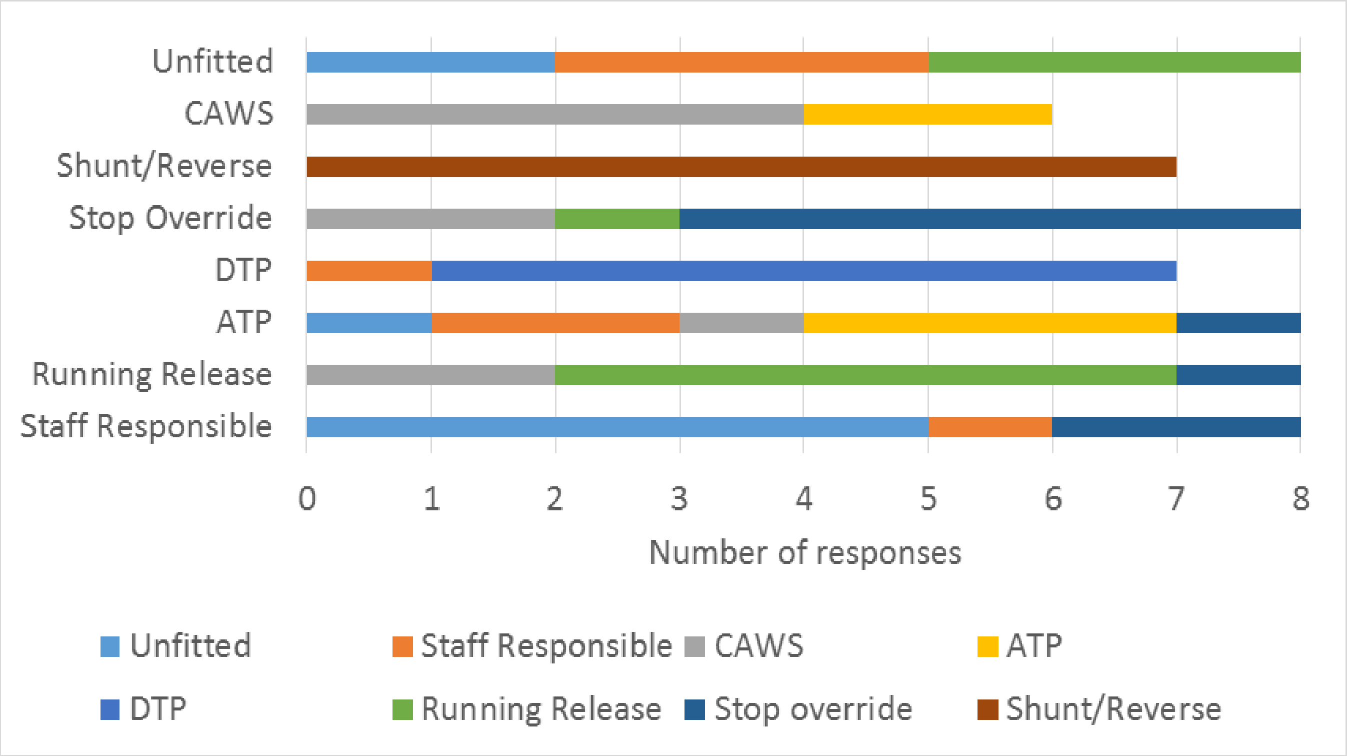
Mode awareness

- Mode proliferation
  - The IEHS system includes 17 different operational modes, which were all individually described in the user manual
  - A review of these identified that, from the driver perspective, the train operated in the same way
  - Modes were reduced to 8, with 3 of these only applying during migration (i.e. as the network is fitted)
    - Five modes in the final system
- Mode transition
  - Acknowledgement only of less safe modes
  - Minimise transitions during migration
    - Current plan has maximum of 4 transitions in one passenger journey
    - For all current passengers routes, the average maximum during the migrations phases is 2.47

Feedback and interaction

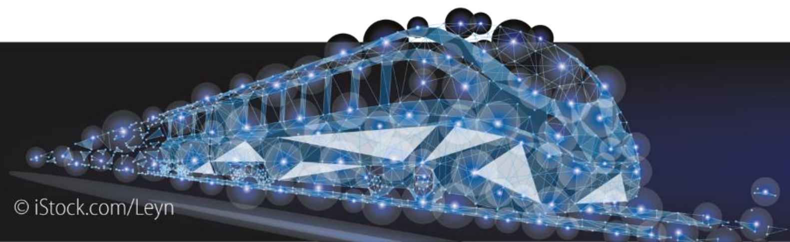


- Apart from Shunt/Reverse, the icons are not intuitive
- Creates a need for a reference tool in cab, particularly for rarely used icons



Other issues with interaction:

- No way to exit keyboard if it is mistakenly selected
- No feedback from buttons that are disabled in some modes
- System displays speeds in kmph, network operates in mph

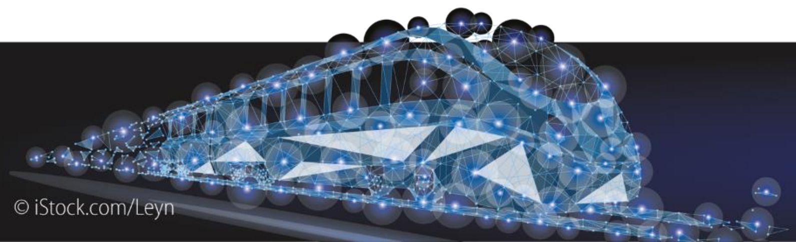


Screens where there were no screens before

Business change

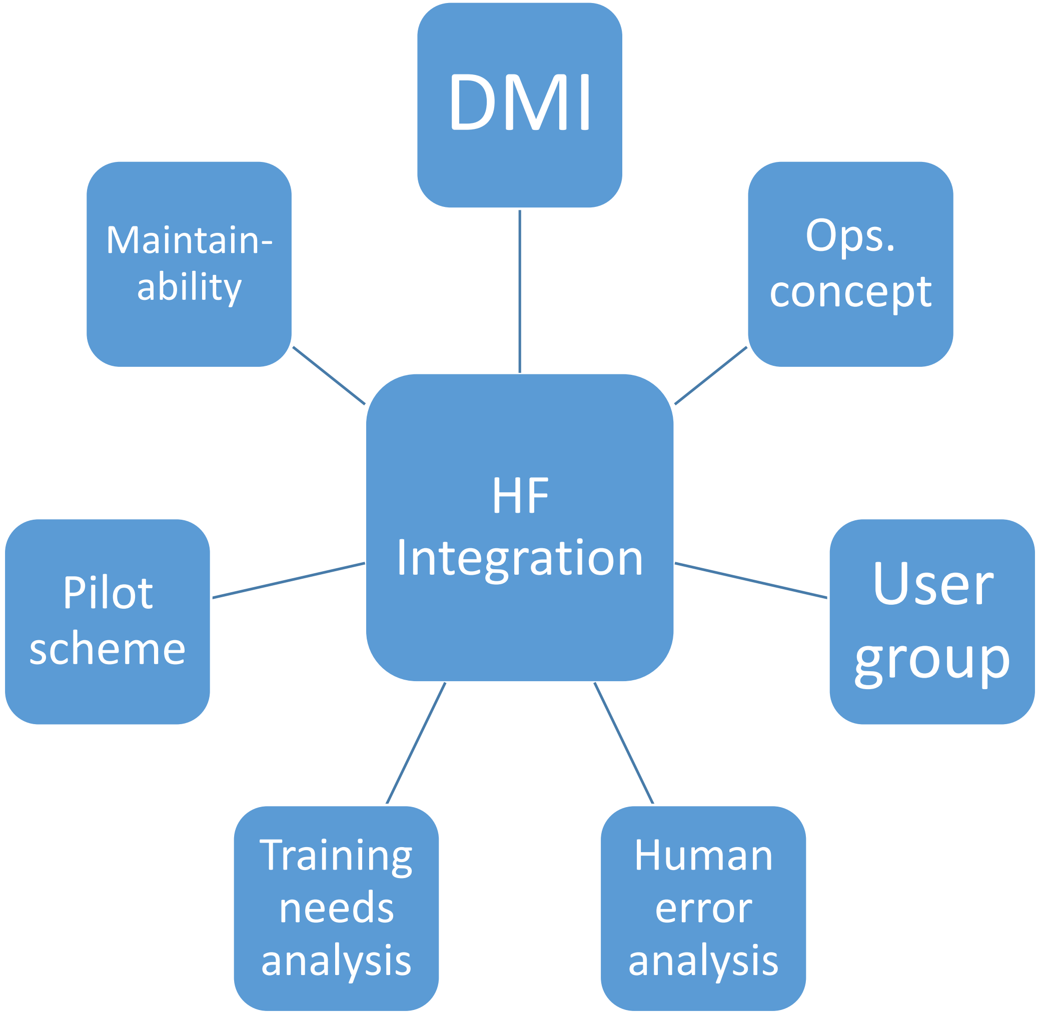
- First implementation was described as a like-for-like replacement of existing technology on two fleets
- Training needs analysis revealed that this was not the case
  - No aspect of using the system was unchanged
  - Some changes were minor (e.g. double confirmation of selecting a function instead of single)
  - Some were more major (e.g. entirely new brake test procedure, requirement to enter train formation and check brake isolations)
- Some procedures are not possible in the current system
  - E.g. temporary block working
  - Incomplete consideration of operational requirements
  - Lack of flexibility in automation programming

TPS Procedure	Same as existing ATP	Modified compared to existing ATP	Entirely new	Discrete task	Performed under time pressure	Safety critical
3.1 Power on		✓		✓		
3.2 Autotest		✓		✓		
3.3/4.1 Driver ATP test			✓	✓		
4.2 Data entry			✓	✓		
4.3/4.4/5.3 Shunting mode			✓		✓	✓
4.5/4.6/5.4 Reverse mode			✓		✓	✓
4.10 DRA (override)		✓			✓	✓
4.11 Running release		✓			✓	✓
4.14 Change cab		✓		✓	✓	
5.1 Cab selected		✓		✓		
5.2 Staff responsible			✓		✓	✓
5.5 ATP mode		✓			✓	✓



How can HOF help?

- Applying HF methods as part of the project development
- Identify issues early, suggest suitable mitigations
- Main approaches:
  - Maintaining HF Issues Log
  - Facilitating User Group
  - Task/scenario analysis
  - Human error analysis
  - Training needs analysis



User group

- Composition
  - 1 driver and 1 driver assessor from each district
  - Chief driver
  - Rules manager
  - Trainer
- User group meetings 2-3 hours
- Every 4-6 weeks
- Currently running remotely
- Most drivers have seen the system on a test train
  - Arranging familiarisation for those who have not

- Future additions
  - Signaller
  - Permanent way staff
  - Signalling staff

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User group discussions

- Issues on the user group agenda
  - Agree DMI icons, messages and sounds
    - User group requested reference book for icons
    - Highlighted that two different brake icons and sounds are not necessary
  - Agree acknowledgement of mode changes
    - Originally, driver had to acknowledge almost all mode changes
    - Proposed to acknowledge only changes to LESS safe modes; therefore, acknowledging a change means that the driver must increase their vigilance
  - Agree track signage designs
  - Retention of Driver Reminder Appliance
  - Position of transition balises
- User group runs in parallel with an Operations Stakeholder Group

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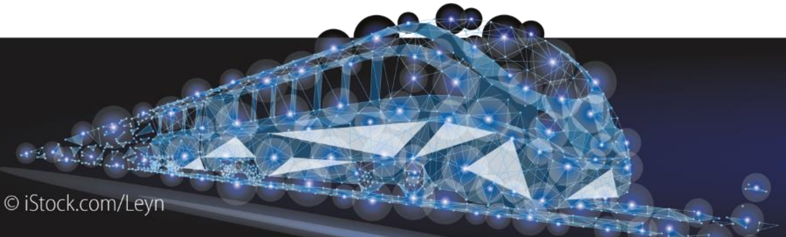
HF Issues Log

- Currently tracking 86 HF related issues
  - From the minor, e.g. providing a sticker against the DMI to explain icon meanings
  - To the major, e.g. DMI reliability
- HF Issues log is shared with the technical development working group to explore and identify solutions to the issues
- Many of the issues are referred to the User Group for discussion
- The final issue log will provide assurance that HF issues have been considered and closed out through the project



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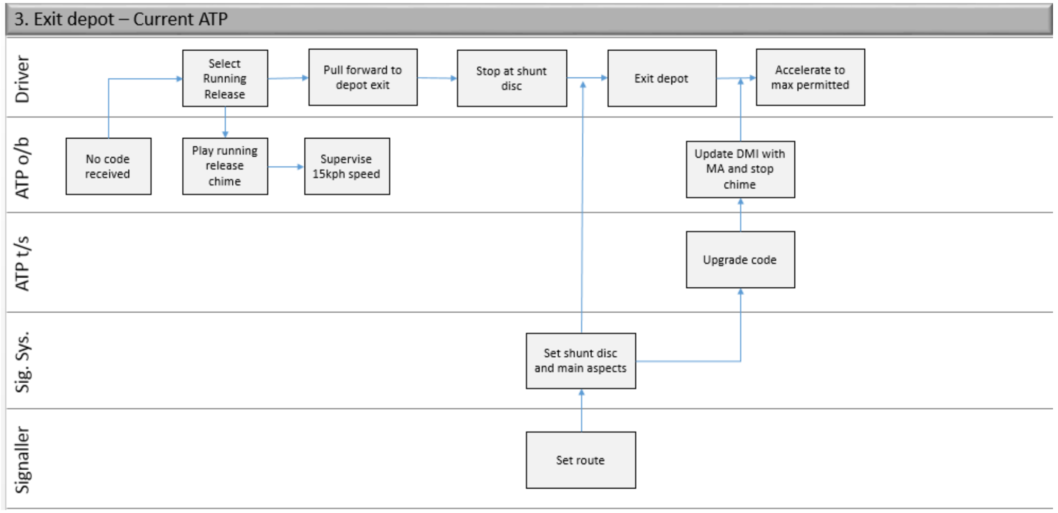
Scenario analysis

- Swim-lane diagrams of current process developed
- Based on procedure documents and two DILO workshops
- Started by HF, completed by safety project team members
- Highlighted several areas for new system requirements (e.g. entering and exiting depots, temporary block working) and/or changes to operating procedures (e.g. new procedures to pass a signal at danger)
- Used as the basis for a human error analysis



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Conclusions

- Although an IM project, much of the impact for end users is on the RU
- HF helps to bridge the gap between the system as imagined by the engineers and the system as experienced by the users
  - Many potential issues have been identified and mitigated early, e.g.
    - Identifying the actual level of training required
    - Distinguishing between technical modes and operational modes
    - Improving the DMI
    - Driving a migration plan that minimises mode transitions

Q & A

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