Human system integration in the design of a new high-speed rail system

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SUMMARY

High Speed 2 (HS2) will be a highly automated rail system, which adds greater complexity to a complex socio-technical system, with potential unanticipated consequences. The Human System Integration workstream is at an early stage and the proposed methodology will allow the identification and management of Human Factors risk profiles associated to each function of the HS2 railway throughout the HS2 design lifecycle, as well as for the identified HS2 Operational Scenarios.

KEYWORDS

Rail, Systems Integration, Human System Integration

Introduction

High Speed 2 (HS2) is one of the largest and most complex infrastructure projects ever undertaken in the UK. It requires a bespoke delivery organisation to execute the planning, design and integration of the component parts of the new high-speed railway. HS2 will be a highly automated rail system, which adds greater complexity to a complex socio-technical system, with potential unanticipated consequences. Therefore, it is crucial to consider the human element in Systems Engineering (SE) and Systems Integration (SI).

The HS2 System Engineering Management Plan states:

‘The Ergonomics (Human Factors) capability will ensure that the HS2 railway and its operation is designed based on a full understanding and supporting the capabilities and behaviours of the staff that will operate it and the passengers who will use it. In so doing, this will manage the risk of hazards of operating and maintaining the system to an acceptable level (human reliability); and identify where operators and passengers interact with the system and supports the design to maximise human performance (human performance).’

A Human System Integration (HSI) workstream has been established and details an iterative process throughout the entire HS2 design lifecycle to ensure the design of the HS2 system matches the capabilities of its people, as well as supporting the end state Infrastructure Manager. It places human risks on par with other aspects of system design and integration, and recognises that Human Factors (HF) input needs to be timely and coupled with other elements of the system design and integration processes.

Proposed Methodology

The proposed HSI methodology aims to identify and manage human risks throughout the HS2 design lifecycle. The scope of work will collaboratively progress with other SI workstreams (e.g.

Functional Integration, Capabilities, Testing and Commissioning). The Management of the identified HF risks will be co-ordinated with the wider Ergonomics team and the Safety team.

The initial focus of the HSI work has been to embed Ergonomics within SI, and to collaboratively work with different disciplines (e.g. SI teams, Operations, Safety), to ensure that interdisciplinary end goals and products are understood and aligned. Initial HSI work has been conducted in collaboration with the Functional Integration and Operations teams. The FI team has produced a 'Railway Functional Description Document' which defines the functionality to be delivered by the railway to support the Operational Concept. It provides a summary of how each function is delivered including identification of the railway sub-systems requirements that contribute to achievement of the function.

For each function a 'Detailed Functional Description Document' (DFDD) is produced which provides details of each functionality to help with the detailed design of the software and systems, detailed information flows to ensure the fulfilment of the Function. The DFDDs also include activity diagrams which show a sequence of activities that take place per function, their logical relationship and information flows.

The generation of the DFDDs have involved collaborative inputs and reviews by the FI, SE, Operations, Maintenance, Safety, Security and Ergonomics teams. A HF risk identification framework has been developed and is being tested and validated using the initial completed DFDDs. This framework will be used to identify and demonstrate areas of HF risk prior to contractors coming onboard. The HF risk profiles will be used to identify where HF evidence is required to demonstrate that both the system and the operational rules support the operators. Furthermore, it will provide traceability to identify where the system needs further design solutions to support the operator. The HF risk profiles will be included within the DFDD documents as part of the functional integration activities and engagement with the contractors.

Current HF work also includes supporting the scope of HS2 Operational Scenarios with the Operations, Capabilities, FI and Safety teams. This workstream will expand the functionalities described in the DFDDs into more complex operational scenarios to further elicit HF risks and validate Operational rules. Workshops have also been conducted to elicit Operational lessons learnt from the implementation of automation in other major rail projects.

Impact

Benefits of early Ergonomics input will iteratively mitigate human risk in the HS2 design lifecycle. These include reducing technical design risks by examining the user assumptions placed on operators in System Design. In addition, reducing operational risks by analysing the impact of Systems Design decisions on Operational rules and procedures, as well as supporting users through design solutions, as opposed to training solutions. Furthermore, it allows HS2 to be an informed and prepared client in the Testing and Commissioning phases.

Conclusions

The HSI workstream is at an early stage and the proposed methodology will allow the identification and management of HF risk profiles associated to each function of the HS2 railway, as well as for the identified HS2 Operational Scenarios. This will enable HS2 to be an informed client regarding the identified HF risk areas prior to the contractors coming onboard, and consequently influence the Human Factors Integration plans and Functional Integration activities.