Adopt, Adapt, and Improve: Assessment of a new driver display in rail

Karl Bridges[a], Anjum Naweed[b], Jan Rose[b], Kyle Wilson[a], Soren Low[c]

[a]*HFEx Ltd, Auckland, NEW ZEALAND*
[b]*Appleton Institute, Central Queensland University, Adelaide, AUSTRALIA*
[c]*KiwiRail Ltd., Auckland, NEW ZEALAND*

1. **Scope:**

This project evaluated the impact of a new enhanced information display intended as a cognitive aid on the operating performance of Locomotive Engineers (i.e. Train Drivers) within a large New Zealand freight rail network. The display previewed the upcoming route and presented information capable of optimising the performance of the locomotive. It did not exert any direct influence over the train and therefore did not take any decision-making capacity away from the driver.

The addition of this technology represented a step-change for the organisation and a considerable investment for furthering safety and performance by improving the situation awareness of train drivers. Improving situation awareness is likely to lead to improved decision-making and hence performance and safety (Endsley, 1999) However, given the impact on ways of working for the train driver, and on the development of the organisation, acquiring insight into the cognitive, organisational and/or physical ergonomics impact of the technology was critical and attracted the need for a human factors assessment.

2. **Project Organization:**

Ensuring the scientific integrity of the work was paramount but as with most projects of this nature delivery of findings was time-critical. The project was managed locally by Human Factors Professionals at HFEx Ltd, supported remotely by academic scientists at Central Queensland University, and overseen by key stakeholders at KiwiRail.

3. **Project phases:**

The project was broadly subdivided into six phases:

(1) Preliminary research (literature review, risk assessment, stakeholder liaison, implementation strategy)
(2) Familiarisation (access to device and vendor, user review, preliminary rail journeys and interviews)
(3) Early systems analysis and mapping (identify high-risk periods during driving, ascertain resilience of Locomotive Engineer, understand impact of variability)
(4) Data collection (cab observations, repeated user trials with 3 x Locomotive Engineers, think-aloud commentary [see Walker, 2005])
(5) Analysis (baseline comparison, task analysis (as per Rose & Bearman, 2012), verbal protocol)
(6) Findings and recommendations.

4. **Conclusions:**

Train drivers have many goals including minimising wear and tear, optimising fuel usage, optimising on-time running, and most importantly, safety. The train-driving task as it currently stands requires a high level of route knowledge, attention to the outside environment, and monitoring of in-cab displays. The information display examined here provided drivers with the profile of the track and optimal speeds along the route. This was intended to assist the driver in reducing fuel consumption whilst maintaining on-time running. The track profile on the display also assists drivers with their route knowledge. With the aim of assessing the display in terms of benefits and potential for distraction, the team employed a data collection strategy that used various technologies. These included Go-Pro cameras, voice recorders, and peripheral display recorder hardware to capture and triangulate a complete snapshot of operator performance. In terms of research tractability, the sum of this process was remarkable, but it was not always reliable, as we saw under low light conditions, or with very noisy cab environments. For this reason, in-cab work was *supported* by technology but fundamentally *directed* by a participative process. The drivers communicated with the researchers using the think-aloud technique, and the researchers recorded their own observations for retrospective analysis.

During the project, questions were raised from both the display design and physical ergonomics perspective such as physical location of display. These included: should the display provide an overall user-performance metric at the end of a shift? How should Locomotive Engineers respond to information in the display when going through Temporary Speed Restrictions? Was it an “advisory” aid, or perhaps more of an “instructional” one, and what were the implications of this distinction on the worker? Was the positioning of the display optimal from both a cognitive and physical perspective? Over the course of the project, answers to some of these questions were found.

As a prototype for initial trials, the display did not always operate according to expectations. Whilst this was very useful from the perspective of capturing its failure modes, it also showed us that Locomotive Engineers were remarkably resourceful, and for the most part, demonstrated good resilience in how they used the information provided by the display under uncertain conditions.

A number of key lessons were learned over the course of this project. First and foremost, to construct a research project with some flexibility. The project phases outlined in this abstract were the product of an iterative experience. Initially, for example, the scope contained research with simulators, and the display was not always operational for every trial. Second, technology is great but it can only take you so far. This applied not only to the Locomotive Engineers who had to adapt to the display and fluctuate between using it when it was operational and returning to their usual driving when it was not operational, but also to the project team who had to manage installation and trouble-shooting of the technology they used for data collection and at times manage without it.

This case study is intended to extend learning from practical experiences, and provide feedback to researchers on the applicability of methods and techniques used in an operational environment. Overall, the composite of measures used in this case study resulted in rich data that provided the end user with valuable information about the impact of the display and its potential negative effects. This information assisted the rail organisation to discuss some of the issues with the provider of the technology and so not only provided valuable knowledge for researchers but had a practical application in industry.

References

Endsley, M.R. 1999. Situation awareness and human error: Designing to support human performance. *Proceedings of the High Consequence Systems Surety Conference, Albuquerque.*

Rose, J.A., & Bearman, C. 2012. Making effective use of task analysis to identify human factors issues in new rail technology. *Applied Ergonomics, 43,* 614–624.

Walker, G. 2005. Verbal Protocol Analysis. In N.A. Stanton, A. Hedge, K. Brookhuis, E. Salas, & H.W. Hendrick (Eds.), *Handbook of Human Factors Methods,* pp. 301–309. Boca Raton: CRC Press.