Key User Factors in a New Style Two-Person Train Cab

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ABSTRACT

The introduction of a new train to Transport for Wales (TfW) was initially faced with reluctance and resistance from key stakeholders. Consistent with previous train driver projects, TfW elected to adopt an ergonomics approach to identify, clarify and resolve issues of acceptance, safety and performance. The reasons for this were to address cab design issues, and to inform the design and delivery of a training programme intended to facilitate a cultural shift in drivers' ways of working and those who support them. The ergonomics investigative work embraced consultations, literature review, measurements and observations of cab users, and was conducted alongside, and in harmony with, engineering reviews. This integrated approach led to a successful resolution to the concerns of stakeholders, resulting in accepted changes to working practices and deployment of the train.

KEYWORDS

Cab, Driver, Instructor, Train, Triangulation

Introduction

The introduction of new rolling stock as part of a major transformation of Transport for Wales (TfW), the Stadler FLIRT fleet, with its progressive cab design, required user acceptance. As a matter of prudency, founded on a legacy of considering human factors, the introduction of this new train model prompted an assessment of factors that could influence the acceptability, safety and performance of train drivers and those who instruct and monitor them.

Figure 1. The Stadler FLIRT Cab.

The successful design and provision of a training programme to enable experienced and new drivers to operate the new train was vital his work. This programme necessitated engagement with various stakeholders because of the 'TfW Social Partnership' agreement of using collaborative methods to bring about a cultural shift in drivers' ways of working. Key stakeholders were Trade Unions and Health and Safety Representatives.

It was clear in the early stages of the training design project that there was resistance to the new cab design, principally because of two key design features new to the cab users:

- The driver seat was centralised in the cab, not positioned on the left-hand side as the drivers were used to.
- The second-person (fold-down) seat was positioned on the left-side of the driver rather than the more familiar, right-hand side

The design of the new cab was considered unacceptable by Trade Union partners, and without their buy-in, bringing about the transformation of TfW's network, through the introduction of new rolling stock, would be nigh-on impossible. Furthermore, the introduction of considerable new technology in the cab, added to the seating and cab layout concerns which resulted in many drivers being apprehensive and unwilling to undertake training.

The Stadler FLIRT trains with this cab design had already successfully entered service with another UK TOC, although the evidence for this deployment available to TfW was largely anecdotal, and certainly did not address the issues highlighted by TfW's Social Partners. It was, therefore, agreed that an evidence-based approach was paramount. This further validated the application of triangulation.

In this instance, the data and information to be used in the triangulation were collected through, literature review, observation of users, consultation with users, and measurement of cab layout. These were all within the context of stakeholder engagement, including liaison with personnel from the project team, engineering, operations, safety and unions.

The programme involved three main stages:

Stage 1: Assessment of acceptance factors for the primary and secondary users. This was conducted on a static train in the depot while the users simulated the tasks they would perform in reality. This was followed by consideration of the same factors with the test train on the move (without public passengers).

Stage 2: Several factors identified worthy of further assessment were subsequently investigated.

Stage 3: Following a review of the findings, it was decided by the project team to more closely review the potential impact of distraction to drivers resulting from the cab design and its use.

The Approach

Consistent with previous train driver projects with TfW, this work adopted the aforementioned triangulated approach (Denzin, 2007). Triangulation is an accepted method used in situations where subjectivity plays a significant role. By considering the same factors from different perspectives, triangulation seeks to clarify agreements, yielding greater confidence in findings. Triangulation was considered especially important in this project, because the real-world constraints of the operating company (TfW) and the circumstances of the work (e.g. constraints on availability of trains and track time), meant that only a limited number of trains, instructors and drivers would be involved in work of this nature.

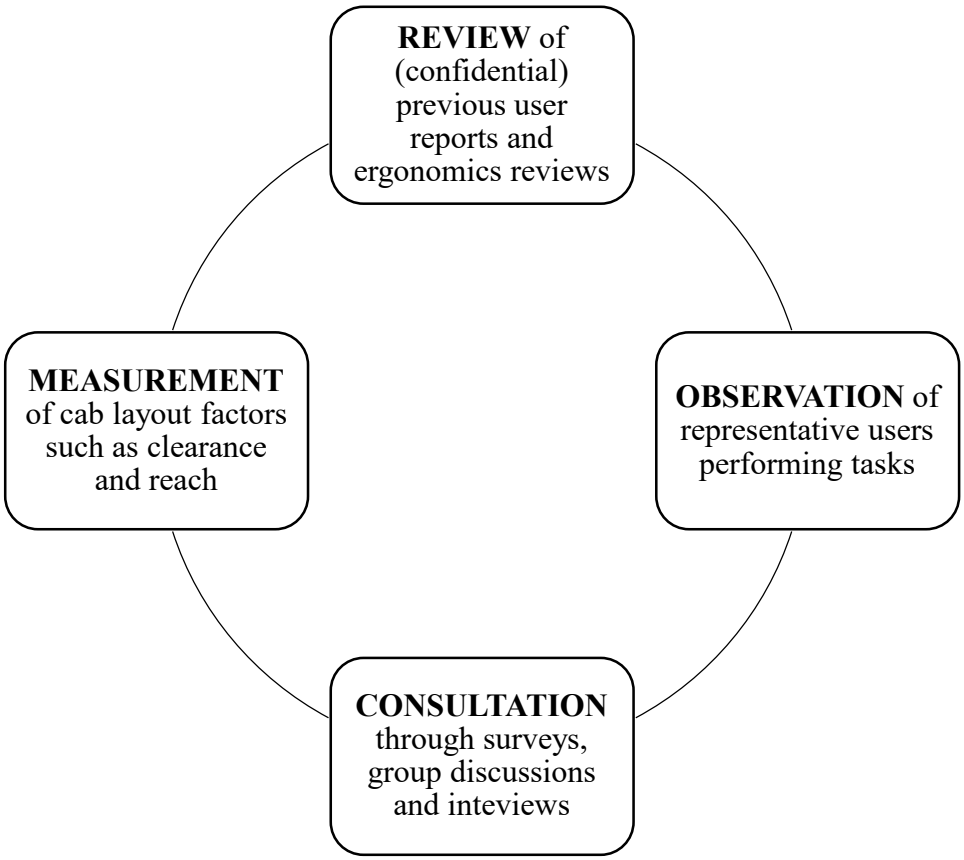

Figure 2. Data And Information Sources Used for Triangulation in This Work.

Stage 1: Assessment of Acceptance Factors

The cab acceptance factors considered included (in alphabetical order); access and egress, clearances and reaches, comfort of the seats, ease of setting up the seats, position and clearance for lower limbs, sense of security/stability, viewing provision, and working space and position.

User participation was core to the ergonomics work (Hitchcock et al. 2016), so with the intention of providing a realistic and pragmatic representation of users in the 'acceptability trials' (observation and consultation) the participants comprised (self-reported):

- Age category range: (25-34) to (55 or over).
- Gender: 3 female,9 male.
- Stature range: between 5%ile and 85%ile UK working age adult (Open Ergonomics, 2020).
- Weight range: between 5%ile and 85%ile UK working age adult.

The trials took place, either on a static train in the depot or on a moving train (without passengers). In both cases, participants were asked to simulate and/or actually perform the full range of tasks they might normally be engaged in (e.g. *"…look at what you might need to look at, reach for what you might need to reach, press what you might need to press…"*).

The participants were observed in action and at the end of each trial, all users completed a survey (feedback form), which chiefly asked them to rate the factors on a 7-point, bi-polar scale. For illustration, Figure 3 presents two summary charts of these ratings.

'Driver Seat' refers to the central seat of the primary user (the Train Driver). 'Second Seat' refers to the other seat in the cab, used by the secondary users, typically instructors (the user type given focus in this work).

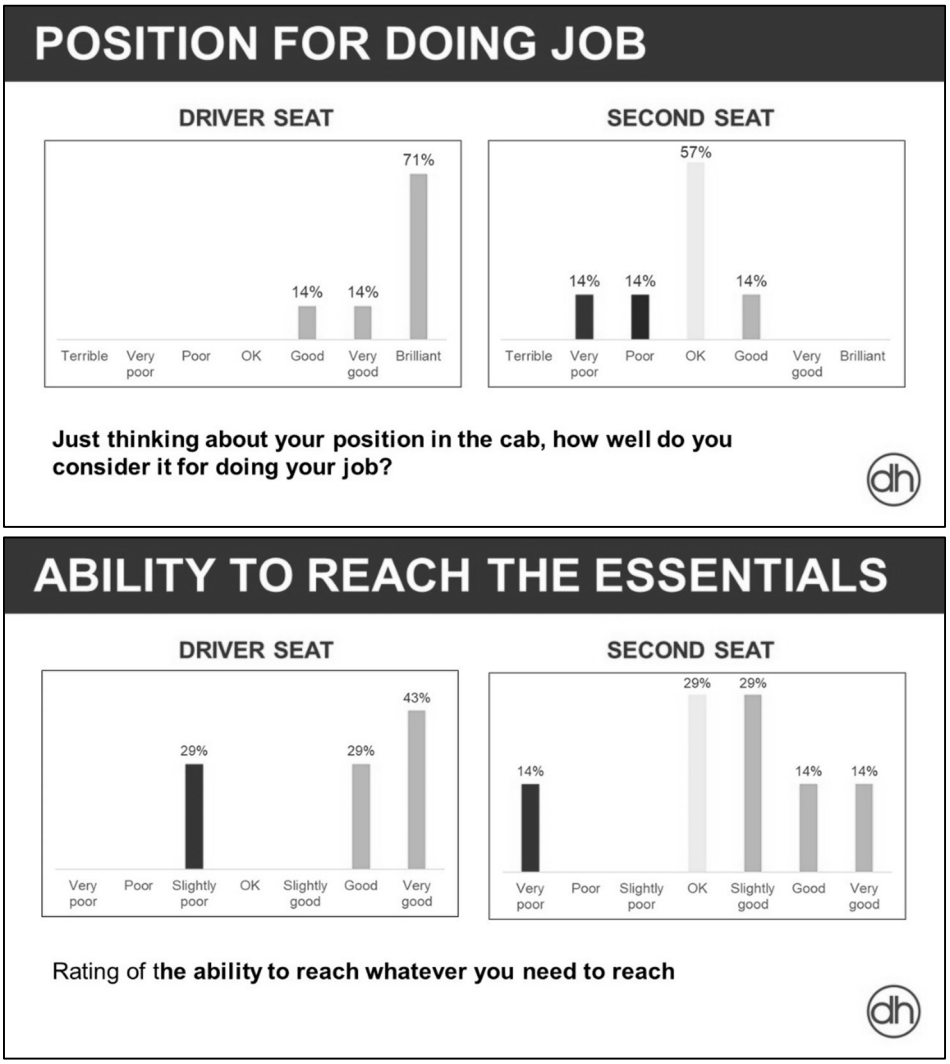

Figure 3. Illustrative Charts of The Acceptability Trials Survey Feedback.

Headline findings of this first stage of the ergonomics input were:

- Overall, 70% of the factors considered were rated ‘OK’ or ‘Better’ in the user feedback survey.
- The primary user driver seat received a very good assessment for its design, comfort and position. This, alongside other clearance and reach factors were in agreement with the anthropometric assessment using the Railway Safety and Standards Board MAT tool.
- The secondary user (e.g. instructor) seat received a less favourable acceptability assessment, principally due to its close proximity to the driver seat. This rendered it important to risk assess access and egress, review position with respect to track signal viewing and monitor comfort factors.

Stage 2: Investigation of Emerging Issues

Although the observations were not analysed in detail (there was no need, given the nature of the factors being considered) it was apparent that they were reflected in the consultation feedback; and were not unexpected given the review of the confidential literature sources. Consequently, three issues emerged as warranting further investigation. All three were considered safety/performance critical for both the primary and secondary users. Importantly their attention demonstrated a growing commitment between the stakeholders to address issues of concern. This unquestionably led to increased iteration of ergonomics application and closer engagement with Social Partners.

Proximity of the Second Seat to the Driver Seat

Even though at the early stage of the ergonomics work there was insufficient evidence to conclude that the two seats were actually too close together to be acceptable, the opportunity was taken to conduct an engineering review of the feasibility of moving or modifying the second person's seat. The review determined that space restrictions made such changes unrealistic:

- On the left-hand side, there was very limited space due to the Power Converter.
- On the right-hand side, there was very limited space due to the main Pneumatic and Electric Control Panels.
- Adding a small perch seat to the right-side of the driver would unacceptably reduce the width of the safety egress throughway to the external door.

Cab Access & Egress

Access and egress issues were raised by the participants in the trials as being potentially problematic, so these were investigated, and the risk assessed through a simulation exercise conducted on a static Stadler FLIRT train using a powered vehicle ensuring the driver's seat had full air supply so that it represented real-in-use conditions. 5 drivers ranging in height and body mass were shown the driver's seat features (the seat has 8 adjustable features) ensuring they were able to set up the seat to their preferred, natural, driving position. Each participant used the driver's seat and in turn occupied the second seat.

It was found that - depending on the driver seat setting - the weight bearing fold-down/flip-up fixed position, second seat was restricted – both for deployment and return. Consequently, the participant drivers were requested to problem solve. Organically, they worked through various methods, before a best practice solution was established. This was captured in a risk assessment which led to a best practice supplementary user guidance document, issued during, and supported in the new fleet training programme materials.

Instructor (Secondary User) Viewing

Although, unlike for drivers, there are no specific standards with which to comply, the ability for an instructor to see the likes of trackside signals is a key aspect of effective training.

To check if this was achievable in the cab, given the centralised driver position, an exercise was conducted in-house in which two people of the design expectation extreme percentiles (5^{th} and 95^{th}) were used to view a target red signal post. It was considered helpful by the project that the exercise followed the same approach used to assess the compliance with industry standards of driver signal sighting.

The exercise was conducted on a static Stadler FLIRT train and recorded viewing measurements from three cab positions:

- Seated in the second seat positioned to the left of the driver.
- Seated on a corresponding movable stool, positioned to the right of the driver.
- Stood in corresponding position on either side of the driver.

The exercise found that the viewing experiences of both percentiles were different during standing and sitting positions:

- The 5^{th} percentile could view more from the standing position rather than sitting.
- The, 95^{th} percentile was able to view more from the sitting position than standing.
- The optimal views for both percentiles were achieved by positioning themselves to the adjacent side of the driver's seat when viewing targets to the opposite side to where they were stood.

Consideration was, therefore, given to, what might be described as, changes in posture which occurred naturally, such as lowering or lifting the head, or changing standing position from the left to the right of the driver and vice-versa. From a performance perspective, these changes were evidently beneficial. Furthermore, such changes were supported by the literature (Buckley et al., 2015, Black et al., 2022) which could be surmised as: 'the best posture is the next posture'.

Stage 3: Consideration of Distraction Concerns

The final 'people aspect' to be reviewed before the fleet could be released into action was to consider the impact on the driver of the secondary cab user moving around the cab or adopting different positions within the cab in order to best perform their duties. In the same vein, the work needed to monitor how the secondary user might be impacted –were they concerned that their movement around, and proximity to, the driver adversely affect the training?

Therefore, to maximise the potential number of user engagements it was decided to conduct this work as part of the programme of training of drivers to use the new cab, and to receive feedback from both the drivers and instructors. This feedback was consolidated with observations to triangulate feedback information. In addition, new trainees (inexperienced drivers) were also observed and consulted but using the Stadler FLIRT simulator rather than an actual live train on tracks. Within the timeframe of the programme, 15 drivers and 6 instructors were observed. In both cases, many participants submitted multiple feedback forms because they received or gave multiple training sessions. A greater sample of drivers were consulted through group discussions and individual interviews.

Table 1. Headline findings of the Distraction Consideration Exercise

Driver Survey Feedback of Occurrences of Distraction	**Instructor Survey Feedback of Perception of Potentially Causing Distraction**	**Comments**
When instructor was sat on second seat, 70% of responses were 'Very Small Distraction' or less.	When instructor was sat on second seat, 75% of responses were 'Very Small Distraction' or less.	The survey findings reflected the information gathered through the other sources of triangulation. The instructors were more sensitive to the possibility of causing distraction than was actually realised; this was anecdotally attributed to their professional practice.
When instructor was stood to left of driver, 91% of responses were 'Very Small Distraction' or less.	When instructor was stood to left of driver, 90% of responses were 'Very Small Distraction' or less.	
When instructor was stood behind driver, 87% of responses were 'Very Small Distraction' or less.	When instructor was stood behind driver, 64% of responses were 'Very Small Distraction' or less.	
When instructor was stood to right of driver, 91% of responses were 'Very Small Distraction' or less.	When instructor was stood to right of driver, 89% of responses were 'Very Small Distraction' or less.	
When instructor was moving around cab, 92% of responses were 'Very Small Distraction' or less.	When instructor was moving around cab, 71% of responses were 'Very Small Distraction' or less.	

These findings supported the preceding work of the benefits to instructor viewing performance and making changes to their posture and movement. Indeed, the instructors reported that working in different positions around the cab enabled them to perform their tasks better and perhaps even reduced the distraction; for example, by being able to see the speedometer rather than repeatedly asking the driver to tell them the speed. In a complementary manner, during group discussions and interviews, drivers indicated that such practice was preferable as it seemed easier to have different controls and displays interactively explained and demonstrated.

Key Conclusions of the Work

Because of the potentially significant safety impact, a primary concern of the acceptance work was the possible cab access and egress limitation – despite receiving generally good feedback. This was further investigated by TfW and a protocol established for efficient and safe access and egress.

Impressive initial feedback from the drivers (for the cab in general and their seat), remained consistent throughout the different ergonomics investigations.

The second seat, initially, received less positive feedback, essentially because of its lack of adjustability, relative 'lack of luxury' compared to the driver seat and its close proximity to the driver seat. Nevertheless, the ratings were reasonable; and furthermore, as the ergonomics investigations progressed, less and less criticisms were aired. Indeed, the feedback moved toward a recognition that it may well represent the best second seat across all of TfW stock.

Instructors reported varying degrees of comfort in the initial work, but this similarly changed as they became used to the benefits of working in different positions. These included being able to change posture and being able to position themselves for instruction for better viewing inside and outside of the cab and not needing to enter driver personal space in order to highlight controls and displays.

Initially instructors appeared to be more concerned that their movements around the cab to change positions might be causing distraction to the driver than the drivers were actually reporting. However, by the conclusion of the ergonomics investigation, it was evident that both user types considered things to be (quote): "*business as usual*" and that distraction from instructors did not present a problem.

Lessons Learned

Perhaps most notably, the experience gained from this work will influence future fleet projects, particularly the use of a thorough, triangulated ergonomics approach.

The results from this work suggest that a new fleet training programme has facilitated a culture shift, which meets the operational requirements to introduce a train into TfW.

In the rail sector, non-technical skills are common in training and development, particularly in operational safety critical roles; this work has highlighted the essential role of ergonomics throughout a project, especially one which focuses on a new working environment.

Throughout the work, high levels of communication between a wide group of stakeholders was maintained and anecdotally was considered beneficial in the adoption ('buy-in') process. For example, presentation sessions were hosted for all TfW Operational Managers so they could understand the rationale behind competency management system enhancement which was developed as training requirements in response to the findings of this work, including:

- Best behavioural practices when two users are in the cab.
- How to set up the seats and their footrest, considering the associated risks.
- Safe access and egress.

What Next?

At the final presentation of this work, it was agreed that the training programme could continue for another three months and that feedback surveys would also continue to be collated to provide more data from a wider pool of users. This could be considered as further recognition of the benefits of ongoing ergonomics contribution throughout a project of this nature.

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