

Evidence-Based Approach to Train Design

How an evidence-based approach can help resolve potential conflict on train projects

When designing a new train, people will inevitably disagree. With so many stakeholder groups involved, from passenger representatives, operating crew and drivers to manufacturers and special interest groups, each with their own requirements, it's no surprise that tensions sometimes flare. And if disputes do arise that are left unresolved, they can lead to strained relationships, delayed projects, and spiralling costs.

The good news? It doesn't have to be that way. Designing a train is a team effort. Everyone involved wants the same thing: the best train possible. The challenge lies in how each group defines 'best'. One person's idea of comfort might be another's ergonomic nightmare. And when requirements are vague, like 'seats shall be comfortable for two hours' or 'screens must be free from glare', it's easy for interpretations to diverge.

Individual stakeholders often represent much larger groups, and they take that responsibility seriously. When the details are fuzzy, it's natural for people to lean toward cautious, sometimes overly constrained interpretations. However, while these intentions are commendable, they can have unintended consequences. A minor design tweak to please one group might unintentionally create a significant problem for another.

That's why DCA takes an evidence-based approach to avoid unnecessary disputes and resolve the unavoidable ones swiftly, openly and fairly.

Four simple steps to getting (and staying) aligned:

1. Clarify what the requirement means – ambiguity is the root of many disputes, so DCA works with stakeholders to agree on precisely what a requirement is asking for. Then the company defines clear, measurable, and testable targets that remove the subjectivity when trying to determine whether a particular requirement has been met.

2. Make sure the criteria are fair and grounded – once DCA has pinned down the quantified requirement, it sets objective pass/fail thresholds. These criteria must be clear and understandable to everyone, supported by solid reasoning and practical considerations.
3. Communicate clearly, and keep it simple – DCA focuses on explaining its methods and the resulting outcomes in a way that's easy to understand, so everyone from engineers to end users can see what's being proposed and why.
4. Test quickly, iterate faster – DCA has developed rapid-assessment tools ranging from Excel models to custom software and physical rigs to explore questions like: 'What if the seat angle were changed by one degree?' or 'Would this panel still comply if it were a darker colour?' Fast, iterative testing quickly provides the definitive answers to such open-ended questions that are needed to reach a speedier consensus.

Tools that help everyone see eye to eye

To support this evidence-based approach and deliver on Step 4, DCA uses a suite of bespoke tools and techniques that bring clarity to complexity.

Customisable Mannequins

Most people involved in the train design process will be familiar with the idea of designing around a 5th and 95th percentile mannequin. However, the importance of customising these for specific markets and situations is often missed. DCA has developed custom-built 3D mannequins that can be parametrically tailored to the train's specific passenger population. Furthermore, the company can realistically adjust their dimensions (e.g. hip breadth) based on whether they are standing or sitting. These customisable mannequins help DCA assess fit, reach, and usability for the particular target user population in both 2D drawings and 3D/VR environments. Because they are tailor-made for a specific population and application, they can also be used to address

contractual clauses, demonstrating that the proposed design solution meets the specified needs of the intended user groups.

These custom-built mannequins can be used to explore how specific combinations of body measurements (e.g. shorter stature with a large belly) can shape access and the ability to complete specific tasks – ensuring that naturalistic body types are considered early in the design process.

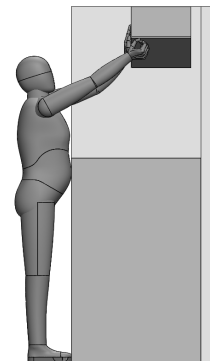


Figure 1

'DCA takes an evidence-based approach to avoid unnecessary disputes and resolve the unavoidable ones swiftly, openly and fairly'

Immersive Virtual Reality

VR is playing an increasingly important role in the stakeholder engagement process. It lets stakeholders experience the proposed space and design features early in the development process. However, when used in an unstructured way to solicit subjective responses from users, there is the risk that the design is not comprehensively assessed, and no clear audit trail is left. However, when used as part of a structured review process, interactive elements within the VR model that respond when they are looked at or touched, combined with postural tracking, turn subjective impressions into actionable insights.

For example, DCA has used an interactive VR model of a train driver's desk in combination with its in-house developed posture tracking software to ensure that the target user group could address all the most frequently used controls and screens without over-reaching, discomfort, or risk of long-term health issues.

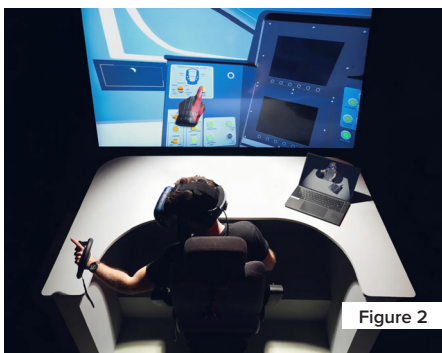


Figure 2

Glare assessment techniques

The visibility of the displays within the driver's cab has always been important, but as the industry makes the shift to in-cab signalling (ERTMS), this is now of paramount importance. Without appropriate mitigations, glare from internal and external light sources can adversely affect the visibility of safety-critical information. DCA has developed a structured and repeatable process for practically assessing in-cab glare.



Figure 3

This proven approach has been applied successfully to both mock-ups and production cabs. However, there is a considerable advantage to be gained by assessing the design in the mock-up stage, as such early assessment before the

design is frozen typically permits more radical changes to be adopted – desk panel angles can be adjusted, cowling designs can be modified, and screen positions can be adjusted. The options available for mitigation following assessment of a production cab are normally far more limited, such as the application of films and the introduction of blinds or shades.

Advanced seat comfort analysis

DCA has enhanced existing seat comfort assessment frameworks (e.g. GMGN2696, EuroSpec) to predict how designs, on paper, will perform under physical testing, allowing designs to be evaluated as a conceptual design stage. With its mechanical test rigs and comfort pressure mats, DCA can apply and evaluate known loads in predictable ways to replicate specific sitting arrangements – allowing for direct comfort comparisons between different seating concepts under equivalent sitting scenarios, making the process more repeatable and easier to assess at early design stages.

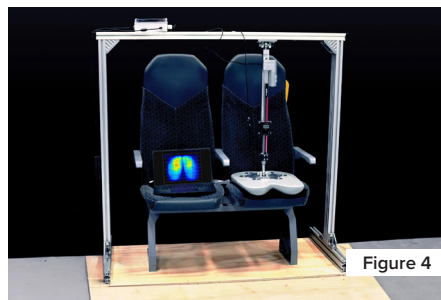


Figure 4

Ergonomic and task assessments

Whether it's routine tasks like refilling a coffee machine in the café bar or emergency procedures, DCA uses manual handling assessment techniques and computerised motion tracking technologies to evaluate posture and usability throughout the task. These techniques allow the company to quantify the ergonomic risks associated with a particular task and the ergonomic and efficiency benefits of one solution concept over another.

These approaches allow DCA to focus its attention on the tasks that pose the most significant risk. By testing with an appropriate range of users, the company can ensure that the diversity of the operator population is considered. The approach can be applied using simple special wooden mock-ups and repeated with final mock-ups.

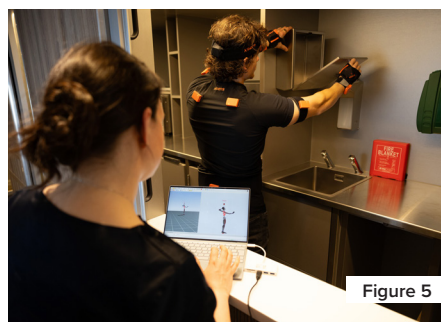


Figure 5

Summary

Disagreements are natural, especially in projects as complex as the delivery of a new train design. But with a structured, evidence-driven process, most conflicts can be avoided and the rest solved before they derail progress.


By providing quantified evidence and prioritising clarity, fairness, simplicity, and speed, DCA helps everyone pull in the same direction. Furthermore, by using these predictive tools to assess the design earlier in the process, before the first units have been manufactured, proposed changes become far more viable and less costly to implement, and therefore less contentious. The result? Smarter decisions, stronger relationships, and better trains for everyone. 

Figure 1 – Examples of DCA's custom mannequin – a short female with a large belly
Immersive Virtual Reality

Figure 2 – VR review of a train cab with posture detection and interactive cab elements
<https://www.dca-design.com/news/hybrid-reality-delivers-human-factors-insights>

Figure 3 – Glare review of a cab mock-up
<https://www.dca-design.com/news/putting-rollingstock-glare-in-the-spotlight>

Figure 4 – Seat comfort test using pressure mats and repeatable loads
<https://www.dca-design.com/news/feeling-is-believing>

Figure 5 – Physical review of a wide range of tasks in a train catering facility mock-up to identify potential hazard

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