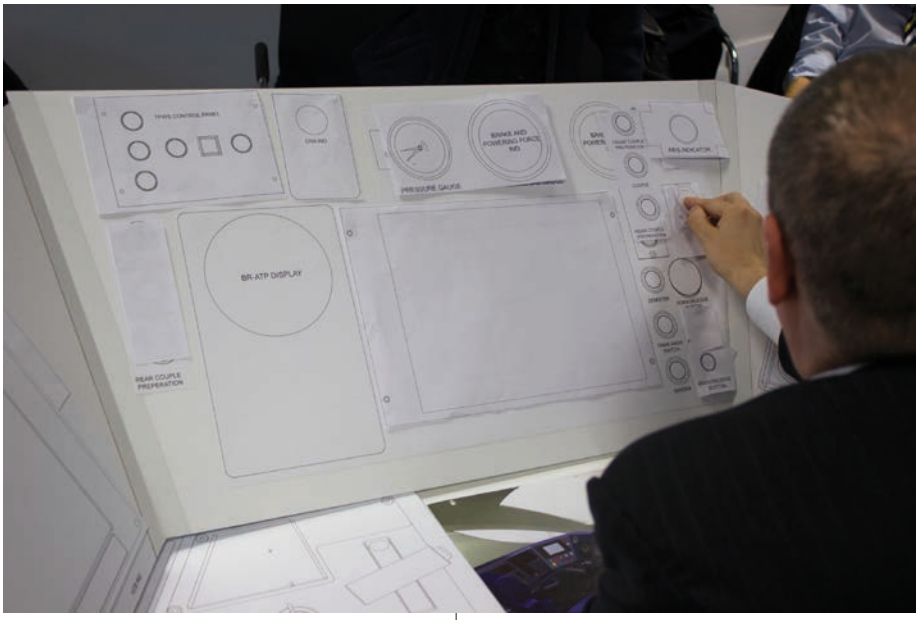
Inclusive design

Dan Jenkins explains the development of the Hitachi Class 800/801 train – part of the Intercity Express Programme

Inclusive design involves designing products so they are capable of being used by as many people as possible, regardless of their size or physical ability. Often very subtle design changes can have a profound impact on the usability of the product for some members of the public, and make the difference between a task being achievable or not. For public transport, inclusive design is of clear importance. For those with very specific mobility requirements, such as wheelchair users, the design can completely remove a barrier to entry. For others, subtle differences in the arrangement and layout of the train can be enough to provide increased independence through the confidence to be able to travel safely and comfortably.

Inclusive design has been at the heart of the design of the new Hitachi Class 800/801train – part of the Intercity Express Programme*. Developing a more inclusive train for passengers involves designing a train that can be used by as wide a range of the population as possible. The design needs to account for reduced mobility (*e.g.* wheelchair users and passengers with difficulty walking) as well as sensory impairments (*e.g.* visually impaired passengers) to ensure the train is not only accessible, but also provides its users with independence. For drivers, an emphasis is placed on optimising task performance. This involves creating a comfortable, controlled environment that allows drivers to remain focused and respond quickly and correctly to unexpected events.



Approach

As with all design projects, the cost of design change increases significantly as the project approaches the final build phase. Accordingly, it was important that opportunities to optimise the design of the class 800/801 train were identified and addressed as early in the design process as possible. The Human Factors work that helped to inform some of that design optimisation can be summarised into seven core stages:

1. a review of all relevant standards and guidelines relating to human requirements and performance (*e.g.* PRM TSI, TSI, LOC & PAS TSI, Group standards, contractual documents) to extract key requirements
2. the development of additional requirements based on analysis of the train user population
3. a desk-based assessment of initial train design using 2D drawings and 3D CAD models
4. the design, build and evaluation of low fidelity mock ups (spatial arrangements based on card and paper)
5. evaluation of full scale ergonomic mock ups (dimensionally accurate low fidelity finish)
6. evaluation of high fidelity full sized model (representative fit and finish)
7. documentation of compliance.

Passenger areas

The passenger areas of a train should be designed so that they provide a safe, accessible and welcoming environment. This includes the saloon areas as well as the more dedicated interior spaces such as the toilets, bike storage and luggage stacks.

At the most basic level, inclusive train

design involves considering the movement about the train. This involves factoring in the door arrangements, the location of handrails and handholds and the spacing of seats. Colour, material and finish (CMF) also has a clear role to play. Contrast between adjacent surfaces is crucial for allowing those with visual impairments to locate doors, and their controls, and safely navigate step thresholds as well as safety critical elements such as handholds and emergency call buttons. The way information is presented is also of clear importance, particularly where the ability to read English text is certainly not guaranteed.

From a practical perspective, the Technical Standard for Persons with Reduced Mobility (PRM TSI) provides useful guidance to ensure that the design meets the requirements of a wide range of the population. Fortuitously for those designing trains, much of this guidance is clearly defined and measurable (*e.g.* toilet door controls shall be between 800-1200m above floor level). Elements of the design that are objectively defined in this manner can be readily assessed using drawings and CAD models.

For other more subjective requirements (*e.g.* ability to wash hands from toilet seat), conclusive demonstration using a drawing is more challenging. These requirements are often better demonstrated with a full- sized mock-up of the train which could be explored by a wide range of users and stakeholders. In the case of the Class 800/801 project, this included a wide range of passenger representatives, such as cyclists groups, passengers with visual impairments, and wheelchair users. Mock-up based assessments (spatial ergonomic mock-up and high fidelity mock-up) were conducted to evaluate all aspects of train usage, including the suitability of the luggage provision and ensuring that bikes could be efficiently moved from the platform to the storage area. Feedback was also sought from staff representatives and unions. Additional evaluations of the mock-up assessed the ease of moving through the train with a catering trolley, and the ease of locating and accessing emergency equipment.

Driver's cab

Inclusive design is also critical for the design of the train cab. While the user population for train drivers differs from that of the general public (*e.g.* there is no requirement to accommodate drivers in a wheelchair), the population remains relatively diverse. From a physical perspective, this involves explicitly designing for drivers ranging from 1514mm tall (just under 5 foot) to 1869mm (6 foot 2 inches).

The layout of a train cab is critically related to driver performance. At a basic physical level, train drivers need to be able to view primary controls and displays alongside a clear external view of the track ahead – regardless of their stature. These controls also need to be within a comfortable reach. On a cognitive level, drivers need to be able to quickly locate the correct control in order to respond to unfolding events. Accordingly, the cab control layout needs to consider frequency of use, functional grouping (*e.g.* all engine controls in one location), left or right hand bias (most the time the left hand will be on the combined power brake controller) and the risk of inadvertent operation.

Early low-fidelity mock-ups, constructed from card with stick on controls, were indispensable in engaging train drivers in the cab design process. Workshops with train drivers allowed cab layouts to be rapidly iterated so that they met user expectations while increasing functional grouping and the sequences of frequent tasks.

Result

Contrary to the beliefs of some, inclusive design is not about designing products for disabled people. Inclusive design is simply good design, as it is design that considers all of its end users. Taking the example of the Universal Access Toilet, the brief was not to design a toilet for disabled users. Rather, the requirement to make the toilet accessible to wheelchair users was considered in addition to other requirements for creating a pleasant and hygienic environment.

The true integration of the inclusive design requirements has been key to the success of this project. By integrating these requirements early it was possible to arrive upon a balanced design without the appearance of bolt on mobility aids.

Some of the personal highlights of the project came from working with passenger representatives. The importance of the work was made clear upon hearing a 15-year old wheel chair user describe how he loved the layout of the universal access toilet as demonstrated in an ergonomic mock-up as, unlike many other toilets he was used to, he would be able to use the toilet alone without the assistance of his parents.

The IEP project

* The Intercity Express Programme (IEP) is an initiative by the Department for Transport that will provide the infrastructure and rolling stock needed to support growth and improvements on the Great Western Main Line and the East Coast Main Line intercity rail routes. Following the electrification of the Great Western Main Line, a fleet of bi-mode Class 800 and electric Class 801 trains will be deployed from 2017, with further fleets of trains to come into passenger service on the East Coast Main Line from 2018.

Dan Jenkins is research lead at DCA Design International
Visit: www.dca-design.com