

## Chapter X **DRAFT IN PROGRESS**

### **Reported Design Processes For Accessibility In Rail Transport Design**

---

R. Herriott, S. Cook

#### **X.1 Introduction**

This paper sets out to find out what methods are used in the rail sector to achieve accessibility goals and to examine the extent these methods deviate from user-centred and inclusive design norms. Inclusive design (ID) stresses the deployment of diverse design methods to determine user requirements with the aim of maximising accessibility in products and services. A review of ID literature has mainly developed in the arena of product design and design for assistive technology. Accessibility is a fundamental requirement in public transport (PT) yet there exists little research on design for accessibility or ID in this area. How is accessibility and the needs of users accounted for in rail transport design? This paper analyses interviews with rolling stock producers, operators and design consultancies. These were conducted to determine if ID design methods are used explicitly and the extent to which the methods used conform to ID processes (if at all). The research found that for some actors the industry standards were held to be a sufficient guarantee of achieving accessibility goals. For others specific design methods were also required to ensure the requirement of accessibility had been reached. **REVIEWSEE COMMENTS**

#### **X.2 Background**

Accessibility is essential if public transport is to achieve the goal of serving the entire population. There are provisions in the UK's Equality Act relating to accessible public service vehicles (buses and coaches) and to rail vehicles (HM Government UK, 2010). The European Union has drafted the Technical Specification of Interoperability – Persons of Reduced Mobility (TSI –PRM), which specifies standards for visual equipment, boarding aids, tactile signage among other features. In this context, ID would appear to be well-suited to meeting

the requirement of accessibility in public transport: it is user-driven (British Standards Institute, 2005). But there exists little research related to ID and public transport, particularly rail, despite the accepted necessity of accessibility in that context (Tennoy & Lieren, 2008). This point is returned to in the literature review.

The value of accessible public transport design can be explained as follows: “Mobility declines with increasing age, reflecting the onset of physical or mental infirmity, affordability of travel for those on retirement incomes, and the mal-design of the transport infrastructure and operational arrangements.” (Metz, 2003). Exclusion from public transport diminishes quality of life (Social Exclusion Unit, 2003, p3). The problems encountered are not merely physical but also psychological (Hirsch and Thompson, 2011, p.2). Not all public transport is equally unsatisfactory. “In terms of convenience and ease of use, taxis and minicabs are rated the most highly, with rail services the worst” (Miller *et al* 2006, p.31). Rail warrants a special investigation as to why this is still the case. Barriers in public transport exist. But they do not do so just because “that’s the way it is”. It is so because the designers and manufacturers have made it so. This paper sets out to find out what methods are used in the rail sector to achieve accessibility goals and to examine the extent these methods deviate from user-centred and inclusive design norms.

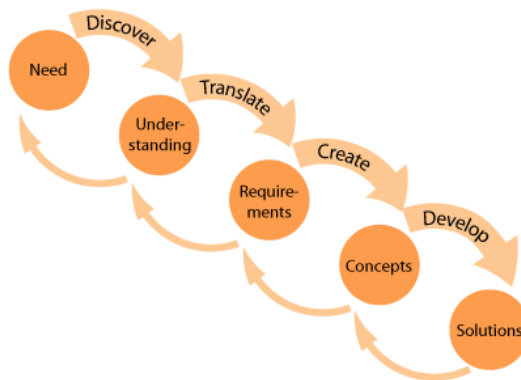
## X.2 Literature review

There appears to be a lack of research in the area of design for public transport as it concerns passengers’ needs. Such material as exists is scattered around related areas and not easily accessed. The material found can be divided into three groups. One relates to passenger ergonomics but does not focus on accessibility (e.g Wilson *et al* 2004; Davis *et al* 2005; Lauren *et al* 2005 Hirsch and Thompson 2011). A second relates to accessibility in transport but does not cover rail vehicles (e.g. Baird, 2009, Azmin-Fouladi 2007; Kaneko *et al* 2009). A third, smaller group is concerned with inclusive design in travel but rather than describing cases or practice, makes recommendations for how to improve the accessibility of the designs (e.g Langdon *et al*, 2009). Marshall *et al* most closely approaches the theme in the theme in an innovative 2009 project. The work describes a system for providing usable ergonomic data for designers and a means for using the data to validate designs. However, the project concerns data rather than actual users and when applied serves as a proxy for user validation. Mackie

Another way to summarise the literature is that surveys and ethnographic work have been done with rail users but not on matters of accessibility and not with express regard to elderly in and disabled rail users. Methods for assessment have been proposed but for air-line travel. Recommendations exist for how to get designers to think more about accessibility but this is not the same as examples of practice. This paper thus addresses a gap in the knowledge concerning design for accessibility in rail transport.

## X.2 Methods

Designers at nine rail manufacturing firms, operators and design consultancies were interviewed (August 2010 -February 2012). Participants were asked to describe what steps they took, if any, to ensure their products were accessible for PRMs. All interviewees were asked for consent and informed of the purpose of the interview. The interviews were recorded and transcribed. The transcripts were sent to the interviewees for review and approval. Most of the interviews were conducted by telephone. Additional information was provided by e-mail. The protocol for the interviews loosely follows Christmann (2009) who recommends “a strongly structured guideline which is similar to a standardised questionnaire, the only difference being that it includes more open questions than the latter” (p.164).



**Figure 2. EDC design process**

The question sequence was based on an assumption concerning the ordering of a design process as described by the Engineering Design Centre, Cambridge (see Fig. 2). The first question was about the firm’s planned design process. Subsequent questions related to the steps of the reported design process and how users were involved (or not) in those steps. The questionnaire is available at [inclusivelydesigned.wordpress.com](http://inclusivelydesigned.wordpress.com).

## X.2 Results

### X.X.X Light Rail Operator Scandinavia

The industrial design co-ordinator was interviewed about a new section of an urban rail system. The design process is embodied in a master document. Initial user-feedback leads to a technical specification, described as a “check list”. This process is an evolution of the previous one. Formal documentation is generated for each element (e.g carriages, ticket machines etc), its problems and grounds for resolution or closure. This forms the cross-checking stage of the specification with the users. Initial ideation was by the operator and then by an outside agency. The

operator's ideation used Post-It note brainstorming following a year of study tours. The process document formalises the translation, concept development and validation steps through repeated feedback to interested parties including users. The requirements translation does not seem to be explicitly user-centred. The interview did not indicate a lower level of user involvement after concept selection than before. Concept selection is done using a forum with representatives from disability organisations. Development and validation is not explicitly user-centred. Instead the documentation is used to refer back to the user-requirements.

### **X.X.X Heavy Rail Operator Scandinavia**

The subject was the former head of design. The planned design process required concept design created in-house and then executed by an external consultancy. There was a strong emphasis on user-centred design. The firm used workshops, ethnographic observation, video-ethnography and consultation with the representatives of disability interest groups. Ideation was not explicitly described. Wherever possible standard solutions should be used (in theory obviating the need for ideation). Translation of the specification into requirements was done in consultation with interest groups. The users' role during concept development was not explicitly described. For development and validation the firm took a recently-completed commuter train as a starting point; disabled-user interest groups were consulted on the design at the mock-up stage, during specification drafting and during model development.

### **X.X.X Rolling Stock Builder "A"**

The subject was the chief vehicle architect. To incorporate the needs of PRMs, this multinational firm makes reference to legislation and standards "the key thing" but the organisation is "very active in writing those standards in the first place". Stakeholders are involved primarily before projects become active ones. The firm's design process consisted of concept phase, a requirement description, a detailed concept phase, development phase which is "preliminary design" and then detailed design phase. Ideation occurs during the concept phase but no further description of what this entailed was forthcoming during the interview. The subject attributed the interior design to "their internal design direction" and also to research and "development in materials and manufacturing methodologies". The translation of the specification into requirements is "through standards and legislation". Virtual modelling is used to test concepts with user-groups in the initial stage of the project. Development did not focus on user groups' feedback. CAD models were preferred to physical ones for reasons of cost-saving.

### **X.X.X Rolling Stock Builder "B"**

The interview subject of this multinational firm chiefly referred to regulations and standards regarding elderly and disabled users' needs. Any additional requirements were provided by the operators. Concerning the planned design process and

ideation stage, “B” has “no special design process for the elderly and disabled. It's part of the normal design”. The requirements are turned into finished designs using a process of sub-sections to handle specific areas. Translation of the specification, concept creation, development and validation were all described as being as per “normal design” process. Users could be accommodated in the design process if the customer requested it.

### **X.X.X Design Consultancy “X”**

“X” is a French firm which designs high speed, regional and local trains plus product and graphic design. The interview subject was the design director. The planned design process was not fully described. The subject put a strong emphasis on direct observation in the field to see how users behaved. However, the answer focused on cultural differences rather than those related to age and disability. User data was also provided by the client. No data was provided on ideation or the translation of the specification into designs. When asked if users were consulted about concept design, the subject responded that consumer product design had a more rigorous approach than PT, where “experience and proven solutions” and the “opinions from top management” mattered more. Development and validation involved full-sized mock ups. The subject viewed the cost of these as being negligible in proportion to a contract’s total cost.

### **X.X.X Design Consultancy “Y”**

“Y” is based in the Midlands, UK and do interior design, urban light rail and renovations of heavy rail carriages in Europe and Asia. The interview subject was a senior designer. The response relating to the design process indicated that their custom was not to work to a prescribed model. When asked how the needs of PRMs were incorporated into the design process, the subject said there was “no differentiation” between the needs of different groups. To find out about the users, “Y” works with user groups and studies the user profiles created by their clients. Focus groups, interviews and personas were also stated methods deployed by the firm. The firm consults with the Royal National Institute of the Blind and an ergonomic specialist. Video ethnography was also cited, specifically with regard to parent-child groups, chiefly to work around the problem of communicating with younger children. The subject responded the brief was where the most important work was done in terms of ideas. It was not made clear if ideation was done as part of the creation of the brief or whether the brief only guided ideation. About whether users were involved in validating concepts the subject seemed to suggest that the firm’s previous experience and the client’s view were more important. No clear information was yielded concerning translation. Partial full-size models were made but no information was provided on user-testing of these models.

### **X.X.X Design Consultancy “Z”**

This London-based firm works in transport, product and packaging design. The interview subject was the firm’s director. The firm has a planned design process: “We adopt the same approach for each of our projects, regardless of the specific industry...a framework of development milestones...”. Asked whether the process corresponded to the waterfall model of ID, the answer was “Broadly speaking, yes...Every project follows rigorous steps of research, understanding, technical requirements, fine tuning and testing et cetera...”. For the EU market, “Z” uses an independent adviser (a specialist ergonomist) to incorporate the needs of PRMs into the design process. This person was “part of the project team” . The firm also invites disabled persons to address designers on their travel needs. The firm also works “with partners who specialise in qualitative research, ethnographic observation and semiotics” and they “observe in situ”. Modelling is done using CAD and hard-models. Full-size mock-ups are used to test users’ responses and the ergonomic aspects. This modelling merges with the validation process in that modelling allows for checking at various stages before final validation.

### **X.X.X Design Consultancy “C”**

“C” is a small consultancy run by the subject. The firm has worked for several decades with a regional PT provider in southern Germany. The planned design process was described as “systematic” starting with a problem analysis, definition of constraints and user investigations. Then follows ideation and consultation with the client (both transport provider and producer). The requirements are defined. Via CAD and hard model mock-up, the design proceeds to testing. The subject’s response regarding the incorporation of PRMs into the design process referred to user interviews and to industrial standards. The user interviews focused on critical areas. Disability groups are consulted during the design process. Additionally, the subject cited his own experience of being more than 70 years old as informing his goals. Users are invited to test proposals when the design has reached the full-size, mock-up stage. Development and validation are carried out in part at the same time. The subject provided no information on ideation, translation or the role of users at the concept stage. The implication is that user involvement is loaded at the beginning and end phases of the process.

### **X.X.X Design Consultancy “D”**

“D” is a large south German consultancy . Its clients are manufacturers and operators. The subject was a senior partner. Discussing their design process the respondent described the order in which the elements of the train are determined, from principle cross-section to local detail. Answering orally, the respondent alluded to a generic design process rather than a specific in-house ideal of such a process. The firm views the needs of PRMs as one of many parameters to be considered. Directly and indirectly, the subject suggested that it was through their client’s relationships with special interest groups that their needs were accounted

for: “The first and best method is to learn from the experience of the operators of trains”. In two listed cases “D” met with users in the existing trains and in mock-ups at the 1:1 modelling stage. The translation process did not typically involve users. If there was user involvement at this stage, it was through contact between the operator and user groups. The subject said that the firm did not typically consult users in between ideation and the building of mock-ups. Development and validation were merged. Users were consulted on specific matters e.g. toilet layout and grab-handles.

## X.2 Analysis of results

Overall, one can conclude that most participants’ design processes differ markedly from the EDC model. The mapping of PT design processes to the inclusive design process is at best partial. Most of the reported methods and strategies that are cited are common to both mainstream industrial design and inclusive design. The main exception to this was Consultancy Z. Although the involvement of users and surrogates was not explicit in the description of the later stages of their process, it was implicit through the integration of experts in the design process, consultation with interest groups and the empathic methods used. In contrast, Consultancy Y said that “...inclusivity is such an important motivation behind what we do it isn’t differentiated, it’s part of the whole technics of the whole process...”. The interview however, did not seem to back up this claim to the extent the statement suggested.

The table below shows the “user-involvement score” of each respondent. Direct user-involvement is where users are present in person during development. The table was arrived at by counting instances where users were directly involved in the design process. It is not possible to guarantee that a higher user-involvement score means better design. It would be difficult to devise an objective weighting scale but there is some value in being able to see instances of user-involvement.

The Scandinavian light rail operator and heavy rail operator have similar scores with different design outcomes: the light rail system is flat floored throughout while the new heavy rail train is not. Both operators have higher direct-user involvement scores than either the design agencies or the producers. Indirect involvement includes user-data provided by clients and input from standards and legislation. Qualitative differences moderate this description. For example, Consultancy Z scores 2 for indirect involvement, as does Manufacturer A. But for Consultancy Z the indirect user-involvement means having an internally-placed advisor working on the project all the way through. For Manufacturer A it means reference to the legislation and data provided by the client. The case of Consultancy C is interesting and ambiguous. The designer, as an older person, can directly empathise with other older people and their needs. However, he is one individual and not entirely representative. However, he does exemplify empathic design in that actually being an older user allows a better insight than when a 27-year old design role-plays the effects of ageing. The designer’s involvement can be counted at each step of his design process but whether it is described as direct or indirect user involvement is open to debate. We have chosen to count it as indirect.

NAME	DIRECT INVOLVEMENT	INDIRECT INVOLVEMENT	USER TESTING	METHODS
Light Rail Operator	5	1	1:1 model	
Heavy Rail Operator	5	n/a	1:1 model	
Builder A	2	6	CAD, detail	
Builder B	0	2	No data	
Consultancy X	2	3	1:1 model	
Consultancy Y	2	2	No data	
Consultancy Z	2	8	1:1 model	
Consultancy C	8	9	1:1 model	
Consultancy D	2	2	1:1 model	

**Table 1.** User-involvement estimates

Direct and indirect user-involvement serve different needs. Standards offer consistency; specialist advisors offer support to the clients unique design needs, for example. Ideally, standards form a minimum level of user input but can't provide the rich information that direct involvement can.

## X.2 Discussion

It has not been feasible to verify the claims made in the interviews. There exists also a gap between the claim that some user requirements have been met and that most or all user requirements have been met. It is not clear how respondents define meeting user requirements.

In brief, none of the firms used a design model directly comparable to the EDC model. The models here are primarily variants on a standard engineering model of design though the consultancies used a more complex process structure. Where user-centred techniques are deployed, it is at the top of the process and then, less often, at the end, during validation. The design consultancies demonstrated a broader use of inclusive design methods. The owner-operators had a higher level of user involvement than the manufacturers.

Why have designers of PT generally not used ID models? It may be that the models were developed initially for product design and reflect tighter consumer-product relationships. Another reason is institutional: the manufacturers are very large firms with a much greater division of labour. A written and oral interview of Rolling Stock Producer "B" revealed very little of its design process other than that, by inference, it has a diffuse design process where no single individual has design authority. The case of the Scandinavian Light Rail operator is an example how it might be done.

There was some difference between the written and oral interview responses. In their verbal response, consultancy D avoided putting a special emphasis on design for disability: this was left to the discretion of the builder or operator. But



the written answer reports that users are involved in consultation, concept approval and prototype-testing. Information on users' needs was found directly through the firm's own research and data provided by the client. This suggests that different responses might have been gained if all the subjects had provided full, written answers. One interpretation is that written responses may reflect the wider view of the corporation. Alternatively, perhaps the perceived formality of written answers might lead the respondent to give more 'officially acceptable' result than would the informal verbal response. We suggest that the verbal answers, though less precise, might be more representative of the firm's actual modes and attitudes, even if they yielded less precise descriptions of activities.

Producer "A" placed a strong emphasis on standards: the respondent did not really get to grips with the need for accessibility and the compromises necessary. The respondent oscillated between the view that it was either a difficult target to attain or that it was also an ordinary, routine requirement. The view that the standards, which they themselves helped to draft, are sufficient should be contrasted with Tyler (2002, cited in Wilson M, 2003) who wrote that it is very easy for a minimum standard of accessibility to become a norm, retarding innovation. Tyler recommends results-based standards in place of process standards or quantitative targets (minimum door widths, for example). This leads the discussion to the case of the Scandinavian heavy rail operator which focussed on deliverables but with mixed results. The operator's process was listed only deliverables (not means). The goal of level access for wheel chair users was attained but the other requirement for diesel propulsion meant the rest of the carriage is inaccessible. User-driven design was not part of the tender which focused on descriptions of a single conception of a finished train at the lowest possible cost.

Two questions arise from the work. Would more junior designers have given different answers? Would a different ordering of the questions produce different results? Future work will involve looking at the design tools rather than the design processes.

## X.2 References

- Azmin-Fouladi, N. (2007) Designing the Inclusive Journey Environment. Proceedings of Include, Helen Hamlyn Centre, RCA, London.
- Barnes, Colin (1991). Disabled People in Britain and Discrimination. Hurst and Company: London. p.63.
- Baird, L., Dong Hua (2009) Inclusive Design for Air Travel. Proceedings of Include 2009, Helen Hamlyn Centre, RCA, London.
- British Standards Institute (2005) British Standard – BS 7000-6:2005 Guide to managing inclusive design.
- Christmann, G (2009) "Expert interview on the telephone: a difficult undertaking" in Bogner, A., Littig, B., and Menz, W (eds) (2009) Interviewing Experts. Palgrave Macmillan, Basingstoke, UK, pp. 157-183.

- Clarkson, J., Coleman, R., Hosking, I and Waller, S., (2007). Inclusive Design Toolkit. Cambridge Engineering and Design Centre. Also available from: [www.inclusivedesigntoolkit.com](http://www.inclusivedesigntoolkit.com)
- Davis, G., Mills, A. (2005) A common system of passenger safety signage. In Wilson, J.R et al (eds) 2005 pp 483-493.
- Evans, G. (2005) Accessibility and User Needs in Transport Design. Proceedings of Include, RCA London. (p1)
- Hirsch, L., Thompson, K. (2011) Tarzan travellers: Australian rail passenger perspectives of the design of handholds in carriages. Proceedings of HFESA 47<sup>th</sup> Annual Conference. Ergonomics Australia – Special edition 11:34. Pp 1-5.
- HM Govt., UK (2010) <http://www.legislation.gov.uk/ukpga/2010/15/part/1>
- Kaneko, Shinzo, Hirai, Y., Elokla, N., et al (2009) Bus for everybody: Nishitetsu Bus case study in Japan. Proceedings of Include 2009, Helen Hamlyn Centre, RCA, London (pp. 1-6)
- Kitchin, R., (1998) Out of Place, Knowing One's Place: space, power and the exclusion of disabled people. Disability & Society, Vol.13, No. 3, 1998, pp. 343-356.
- Langdon P., Waller S., Clarkson J., (2009) Just get a ticket: Inclusive Design In Action. Proceedings of Include 2009. Helen Hamlyn Centre, RCA, London.
- Lauren, J., Rhind, D.J.A., Robinson, K. (2005) Rail Passenger Perception of Risk And Safety and Priorities for Improvement. In Wilson, J.R et al (eds) 2005 pp 473-482.
- Mackie, E (2012) Design for Public Transport. In Tovey, M (ed) Design for Transport. Gower, Aldershot. Chapter 5.
- McGinley, C., & Gheerawo, R., (2007) Improving the konro - kitchen stoves designed to include Japanese elders. In *Proceedings of Include 2007*, Helen Hamlyn Centre, RCA, London
- Metz, D., (2003) Transport policy for an ageing population. Transport Reviews: A Transnational Transdisciplinary Journal, Vol. 23, Issue 4, 2003
- Marshall, R. Portera, J.M., Sims, R., Summerskill, S., Gyi D, Case, K. (2009) The HADRIAN approach to accessible transport. *Work: A Journal of Prevention, Assessment and Rehabilitation*, 33 (3), pp. 335-344
- Miller, P., Gillinson, S., Huber J (2006) Disablist Britain. Demos, London.
- Social Exclusion Unit (2003) Making the Connections: Transport and Social Exclusion Interim findings from the Social Exclusion Unit. HM Stationary Office, London, UK.
- Tennoy, A., Lieren, M. (2008) Accessible Public Transport: A view of Europe today, policy, laws and guidelines. Report 952/2008. Institute of Transport Economics. 2008. Oslo, Norway.
- Tyler, N (ed). (2002). Accessibility and the bus system: from concepts to practice. London: Thomas Telford Publishing.
- Wilson, J.R , Norris, B.J. (2004) Rail human factors, past, present and future. Applied Ergonomics ,Volume 36, Issue 6, November 2005, Pages 649–660
- Wilson, J.R., Norris, B., Clarke, T., (Eds) (2005). Rail Human Factors – Supporting the integrated railways. Ashgate, Aldershot.
- Wilson, M., (2003) An overview of the literature on disability and transport. Disability Rights Commission, London.