

ENGINEERING INCLUSION THROUGH TACTILE INNOVATION: CO-DESIGNING ACCESSIBLE URBAN MODELS FOR DISABLED USERS IN LAMBETH

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ABSTRACT

Many citizens are marginalised from making decisions that affect their lives, including urban planning, with disabled users often excluded due to how spatial information is presented. For example, infrastructure decisions are often made without adequate consultation with disabled users, with a reliance on non-inclusive tools such as visual maps and plans. This project, delivered in partnership with MP Smarter Travel (MPST) and ASU-London, undertook this work to aid disabled citizens in engaging with urban planning in the London Borough of Lambeth. Working with an Accessibility Working Group (AWG), a diverse team of visually impaired, neurodivergent, and mobility-impaired residents, the project developed a system of interchangeable, tactile models that translate complex street and transport designs into accessible, tangible forms. Through an iterative co-design process, AWG members became collaborators and shaped refinements in texture, colour contrast, feasibility, and ergonomics, producing a robust “kit-like” co-design tool that enables users to physically build and critique real-world proposals. Using 3D printing, laser cutting, and embedded magnets, the models aimed to balance detail, portability, and durability for project consultation. Key outcomes include empowering disabled people to actively implement change, creating a reusable model adaptable to user intentions, and demonstrating co-creation as essential for inclusive understanding and evaluation of urban design.

Keywords: Co-design, visual disability, accessibility

1 INTRODUCTION

Urban planning processes have been developed to engage a range of stakeholders in upcoming projects. This includes changes to current infrastructure, such as modifications to road layouts, as well as larger new infrastructure developments [1]. Typically, ‘users’ have been a key stakeholder whose concerns and opinions on the changes have been influential in the urban planning process. However, disabled users have often been under-represented or excluded from engaging with this process [2].

This collaborative project helps to address the critical issue of disability discrimination in urban planning and development. The project collaborated with Lambeth Council, MP Smarter Travel (MPST) and an Accessibility Working Group (AWG). MPST works to promote active travel and community engagement in a range of councils. This project aimed to bring about significant changes across the borough to ensure that urban transport systems and infrastructure are inclusive and accessible to all, with a particular focus towards active travel. The AWG has, for the past 2 years, played a pivotal role in this endeavour, providing feedback on all aspects of accessibility throughout various site projects and policy meetings; however, co-design processes have, until recently in the AWG, been somewhat limited by the lack of accessible mapping tools. By working closely with the AWG, this project gained a deeper understanding of the challenges faced by disabled individuals and aimed to collaboratively design a tool to enable the co-design of urban infrastructure projects with the AWG.

This paper shows the progress made towards the co-design of a tool for advocating for accessible transport systems that cater to the needs of disabled citizens and the challenges still faced.

2 BACKGROUNDS

2.1 Co-design

The co-design process in this paper operates on two levels: first, AWG members were active co-designers in the development of the tool itself; second, the resulting tool (a reconfigurable, modular map) is designed to be used by those same communities to express and co-design how they want future infrastructure in Lambeth to look and function. This concept deviates from consultation design, in giving the users the ability to make design decisions rather than only giving feedback. This process offers benefits such as richer insights into user needs, deeper understanding of user knowledge and experience and earlier validation of designs [3]. In particular, co-design can be particularly beneficial when designing for users with disabilities, ensuring users' needs are incorporated into the design process.

Co-design aims to bring the voices of relevant stakeholders into the design process, and case studies across a range of sectors, from healthcare to urban infrastructure, have shown how to use co-design principles in the development of products [4]. Co-design has an ethos of empowerment for the stakeholders, using their lived experience to inform the design process. In theory, this process is well aligned for users who experience impairment; however, this can act as a barrier to involvement in the design process. Disabled users can often struggle to engage with traditional co-design tools that rely on discussions and or visual tools. Research has shown the creation of tactile tools, enabling users to overcome these limitations and create meaningful connections between users and designers [5]

2.2 Urban Planning Consultation

Urban planning within the UK follows a series of government and council documents to advise planners and developers on requirements. The Manual for Streets [6] is a UK government document with guidance for designing, constructing, and maintaining residential and lightly trafficked streets. This highlights key fundamentals, including that (i) roads are designed for motor vehicles to move from A to B and (ii) streets are designed for communities to thrive in. This was highlighted in the following extract: "Streets make up the greater part of the public realm. Better-designed streets, therefore, contribute significantly to the quality of the built environment and play a key role in the creation of sustainable, inclusive, mixed communities". There is particular emphasis on the point that "Inclusive design places people at the heart of the design process". This is further detailed in subsequent documents [8], outlining inclusive street design principles through the use of user hierarchy, placing pedestrians at the top priority in urban planning design. This ensures an inclusive environment that recognises the needs of all.

Research publications have extensively explored how disabled people interact with urban planning and travel. For example, the review of Park *et al.* [8] underscored the challenges faced by disabled individuals in navigating urban environments, including physical barriers and a lack of accessible infrastructure. Ulahannan *et al.* [9] highlighted the importance of inclusive design principles that prioritise the needs of disabled users, ensuring that urban spaces are accessible and user-friendly for everyone and that inclusive design principles are essential for creating environments that cater to the diverse needs of all individuals.

Despite the emphasis on inclusive design principles, many studies [10] reveal that disabled individuals frequently feel that they are not being heard and that they are isolated from decision-making and planning. This results in those users having to put up with inconsiderate design features when traversing the urban environment. This literature underscores the need for a more inclusive approach to urban planning that actively involves disabled individuals in the decision-making process.

3 INDUSTRY PROJECT AND AIMS

This project was undertaken as part of a final year individual project over a 6-month period. The industrial partner, MP Smarter Travel, is a transport consulting firm based in Southwark, London, and played a pivotal role in facilitating the project between the student and the AWG. The purpose of the AWG is to bring together members from various backgrounds, ranging from vision and mobility disabilities to members with neurological disabilities, to consult on and co-design urban redevelopment projects. The group has a particular focus on active travel, including walking, wheeling (such as wheelchairs and mobility scooters), cycling, and other forms of non-motorised transportation. Active travel has gained significant attention in recent years [6] and is promoted for its numerous benefits, including improved public health, reduced traffic congestion, and reduced environmental impact. Research highlights street layout being critical to the promotion of active travel [11].

AWG meetings are comprised of 9 members, with sessions ranging from 2 to 3 hours. Meetings may include in-person site visits to conduct walkthroughs or workshops discussing potential changes and covering policy-based issues and early project proposals. All meetings were used to allow AWG members to express their feelings about a project and enable changes to be discussed. A total of 6 meetings were attended for this project.

At the start of this project, the team at MP Smarter Travel relied on rudimentary card models, as shown in Figure 1, to show members of the AWG how the area changes were being proposed. In the field of spatial awareness and mapping, various tools have been developed to increase inclusivity, such as smartphone-based applications [12] and tangible maps that utilise tactile clues to facilitate comprehension, collaborative editing, and discussion [13]. This form of co-design is central to the AWG's ethos. It shifts the dynamic from council and stakeholders merely "informing" or "consulting" members toward a partnership, wherein AWG members wield greater agency. By actively shaping design decisions, they improve outcomes for both disabled and non-disabled users.

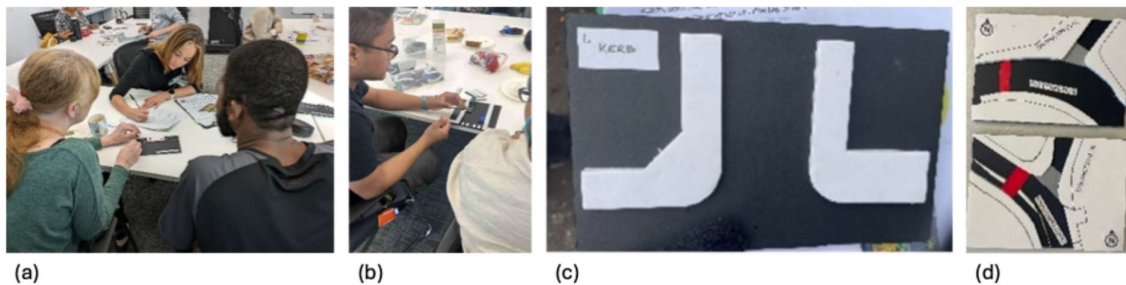


Figure 1. shows (a & b) the AWG meetings and different iterations of the initial cardboard prototype used at the start of the project. (c) example of kerb layout, (d) example of changes to road layouts

4 PROJECT METHODOLOGY

Before beginning the co-design process, the student spent the first two weeks attending meetings, building an understanding of the style of projects and the users of the AWG. The user interactions with the current solutions were observed with discussions around how members of the AWG worked and interacted with the information and area models being present. The following reflection was given: *"These first few weeks were insightful as they allowed me to build a good working relationship with member of the AWG, as I got to understand their background and what they would like to see in an urban redevelopment project"*. Following this, the co-design process with members of the AWG was started to improve the cardboard models. The prototype developed was a simple T-Junction as shown in Figure 2. The main purpose of this initial, lo-fi prototype was to understand how the AWG reacted to this new, more tactile model and to understand what they wanted from the models in the future. Feedback from members included: *"It feels like a T-Junction, and it is very easy to understand"*, and *"This texture feels more realistic compared to the previous models and feels more like a pavement."*

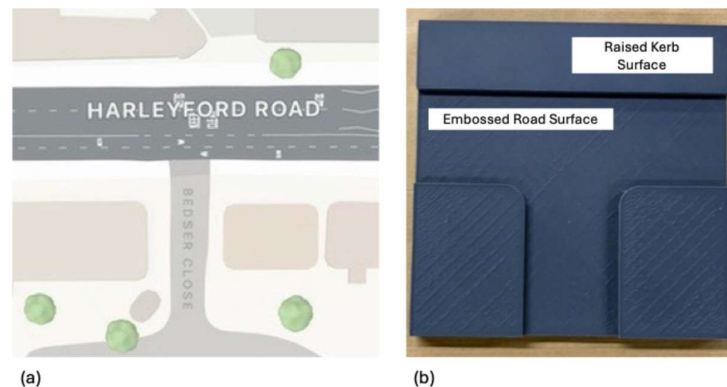


Figure 2. (a) Road layout of T-Junction via map, (b) the initial prototype of a T-Junction

Following this, subsequent sessions of the AWG were used to further co-design a solution. Members identified using different textures, colours and markings to identify different features such as roads, pavements and crossings. Figure 3 shows the next version of the prototype, incorporating this into the model. A more complex road layout was used, with the Oval site being selected. This aided the design process as members had already been familiar with the site due to previous site visits.

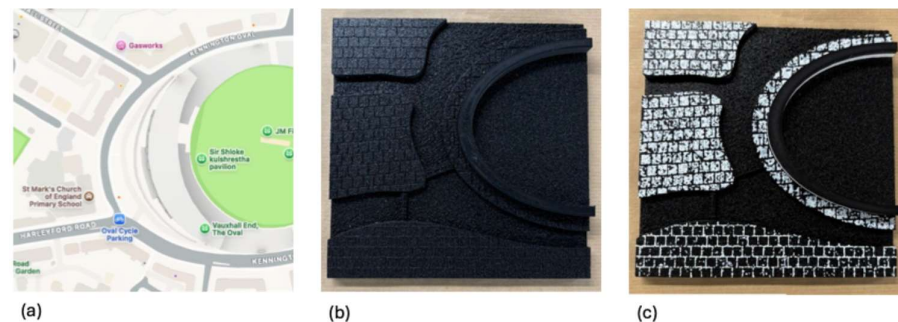


Figure 3. shows (a) a Maps screenshot of Oval London, (b) the first prototype including textures and (c) the second iteration based on AWG member feedback

Following the production of these prototypes, further discussions with members were conducted, feedback of which included: “Liked the different textures”, and “They were different, and they were more realistic in regard to the texture.”

This feedback proved that the process of co-designed development was heading in the correct direction. Once the positive feedback was collected, the AWG gave working feedback on where the model could be improved. The main consensus, particularly from the visually impaired users, was “More colour contrast and should include visual clues for roads like yellow lines and zebra crossings”. The visually impaired users found it easier to discern spatial information from models when the colour contrast was significant, such as black/white; therefore, moving forward, the models had a significant colour contrast. The improved Kennington Oval section can be seen in Figure 3 (c). Following this feedback, the next step was turning the model from a “one-off” static model to a more texture-refined and interchangeable model. This facilitates further dialogue and co-design with the members of the AWG.

4.1 Model Refinement

Discussions with AWG members allowed the designers to model a range of different surface textures to represent a range of urban landscapes such as concrete, asphalt and man-hole covers. A range of depths of textures was presented, with feedback from the group agreeing on the use of a 2 mm raised texture.

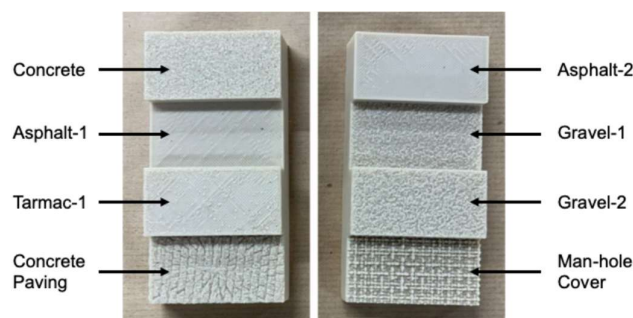


Figure 4. Example 3D printed textures of common urban landscape surfaces

The next phase of the project was making the models interchangeable to help facilitate co-design and a two-way collaborative process. A demonstration prototype model showcased how an interchangeable model using magnetic pieces could be used to replicate real-world sites. This was presented to AWG members and the staff of MPST. Both groups approved of this interchangeable model method, with the staff saying, “It resembles Lego” and that it would be great going forward to have a reusable and interchangeable “kit-like” model. This corresponds with the ‘Lego serious play’ movement, which was a useful inspiration for the kit [14].

Ultimately, the project culminated in the development of two sizes of the final prototype, featuring pieces of pavement, crossings, parking bays and other urban features. Figure 5 shows an example of the movable objects and possible scenarios. The baseplates came in two sizes; the smaller size was sized to the original card models used in the meetings for similarity, whilst the larger baseplate is sized to an A4 piece of paper, meaning that more detail could be included for larger layouts.

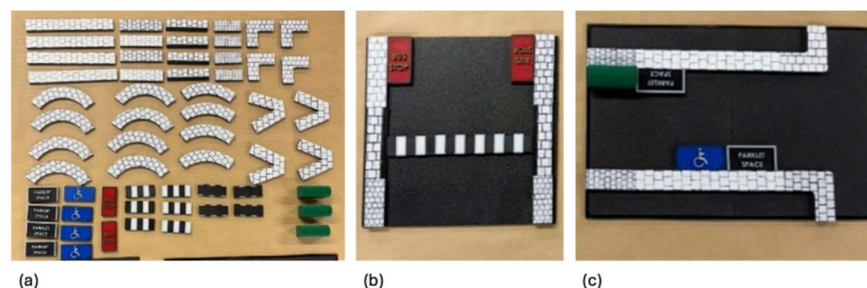


Figure 5. The final prototype with (a) showing a range of individual magnetic pieces, (b) showing a zebra crossing with bus stops, and (c) showing a road with parking

The final prototype proved successful with the AWG and MPST. The AWG liked the ability to move pieces around and could easily recognise different features such as junctions and crossings. Some members of the AWG said that “*Something like a Key*” would help recognise certain pieces which should be implemented in future development of this project.

The impact of this project has been substantial. The 3D tactile models provided the AWG with a more accessible and understandable way to engage with urban planning and road design. The iterative co-design process ensured that the models were tailored to the needs of the users, resulting in a tool that is both practical and user centred. This project has not only improved the AWG's ability to provide essential feedback but also has given MPST a reusable and interchangeable tool that can be used to discuss complex and in-depth projects in the future.

5 RESULTS AND REFLECTION

The project achieved significant progress in making urban planning and development a more inclusive process. The members of the AWG at the beginning of this project were passive listeners to the various projects and redevelopments that were presented to them. The prototype tool turned the members of the AWG into active designers and developers, enabling them to fully understand projects and enact their design changes. As an additional positive, the MPST staff had a tool that they could repeatedly use for various sites due to the projects continually changing to different sites across the borough.

The main limitation of the design is the lack of exposure to a range of scenarios, which would have given further feedback on the prototype. This would enable further co-design and co-creation with the AWG group to ensure the balance between customisability and accuracy could be improved.

5.1 Student Reflection

As a student, this was the first time I faced real-world clients in a design context. I learned the importance of building a good working relationship with co-designers, understanding their needs and viewpoints, to create an impactful design. An example of this was experienced when one member of the AWG refused to engage in the co-design processes, with their opinions set in stone from the start of the session. The members' central argument was that existing infrastructure (pavements and roads) was already broken and should be repaired before any new projects were funded. This created a repetitive loop in discussions and significant disruption within the session. To engage this member, a change of approach was needed, moving from a passive observation to an active, fact-based mediation. In this session, delicate communication was needed both from the design team and MPST with this member to ensure they did not feel opinions were not being forced upon them. An intervention method I used during this was to use facts and statistics rather than emotive language to engage the member.

This project allowed me to theory of co-design and turn passive listeners into active contributors in practice with the AWG. The diversity within the AWG required me to develop my own style in interacting and co-designing with the AWG. Examples of this include building personal relationships with the members and adapting the session and content to best engage members in the process.

The project provided valuable insight into real-world stakeholders; in particular, it taught me the complexities of managing a range of stakeholder opinions and requirements. This causes significant resistance in the design processes, something which is rarely experienced during academic projects. I learned that a successful project requires work, empathy and negotiation with resistant stakeholders to co-design relevant and meaningful designs. The impact of this project is significant as the AWG has a prototype that can be easily used and adapted to suit various site locations and scenarios.

6 CONCLUSIONS

This project represents a significant step forward in supporting visually impaired and other disabled members of the AWG. The 3D printed, tactile models have proven to be an invaluable resource, facilitating better comprehension and interaction with urban planning elements. However, it is important to recognise that this project is only the beginning. It serves as the foundation for enabling people with disabilities to make more impactful changes in their environment. Ensuring that their voices are integrated into the decision-making process is essential for creating inclusive and equitable urban spaces. Furthermore, this project has the potential to serve as an example for other UK boroughs. By adopting tactile maps that are co-designed, other boroughs across the country can create meaningful changes in urban environments that are inclusive and accessible to all.

REFERENCES

- [1] Norton P. and Hughes M. Public consultation and community involvement in planning: A twenty-first century guide. Routledge, 2017.
- [2] Transport for All (2024). Accessibility Review of the PTAL Index. [online] Available at: <https://www.transportforall.org.uk/wp-content/uploads/2024/11/Public-transport-accessibility-level-review.pdf>
- [3] Steen M., Manschot M. and De Koning N. (2011). Benefits of co-design in service design projects. *International Journal of Design*, 5(2), 53-60.
- [4] Watchorn V., Tucker R., Hitch D. and Frawley P. (2024). Co-design in the context of universal design: An Australian case study exploring the role of people with disabilities in the design of public buildings. *The Design Journal*, 27(1), 68-88. <https://doi.org/10.1080/14606925.2023.2264652>
- [5] Labattaglia O., Reay S. and Nakarada-Kordic I. (2023). Co-designing accessible co-design. *Design for Health*, 7(3), 366-382. <https://doi.org/10.1080/24735132.2023.2265239>
- [6] Department for Transport, Manual for Streets. Available <https://assets.publishing.service.gov.uk/media/5a7e0035ed915d74e6223743/pdfmanforstreets.pdf> [Accessed on 2026, 28th February] (2007)
- [7] Chartered Institution of Highways & Transportation. Manual for Streets 2 Wider Application of the Principles. Available: <https://www.ciht.org.uk/media/9351/manual-for-streets-2.pdf>. [Accessed on 2026, 28th February] (2010)
- [8] Park K., Esfahani H. N., Novack V. L., Sheen J., Hadayeghi H., Song Z. and Christensen K. Impacts of disability on daily travel behaviour: A systematic review. *Transport reviews*, 2023 43(2), pp.178-203.
- [9] Ulahannan A., Birrell S. and Herriotts P. Inclusive streetscapes: Embedding disabled people's lived experience into street accessibility. *Wellbeing, Space and Society*, 2025, 8, p.100261.
- [10] Stafford L., Vanik L. and Bates L. K. Disability Justice and Urban Planning. *Planning Theory & Practice*, 2022, 23(1), pp.101-142.
- [11] Active Travel England, Annual Report and Accounts 2022/23, p 9-15
- [12] Guerreiro J., Sato D., Ahmetovic D., Ohn-Bar E., Kitani K. M. and Asakawa C. Virtual navigation for blind people: Transferring route knowledge to the real-World. *International Journal of Human-Computer Studies*, 2020, 135, p.102369.
- [13] Ducasse J., Macé M. J. M. and Jouffrais C. From open geographical data to tangible maps: improving the accessibility of maps for visually impaired people. In *GeoVIS'15-ISPRS Geospatial Week (GeoVIS 2015)* (pp. pp-517).
- [14] Garde J. and van der Voort M. Could LEGO® Serious Play® be a useful technique for product co - design? in Lloyd, P. and Bohemia, E. (eds.), *Future Focused Thinking - DRS International Conference 2016*, 27 - 30 June, Brighton, United Kingdom.