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RESEARCH ARTICLE

Continuous Footways for the Future: Embedding Sustainable Transitions into the Design Journey of Active Travel Infrastructure

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Streets are the foundation of a city's urban fabric. As efforts to adapt existing carriageways into multi-modal movement corridors with segregated space for active travel modes and vehicles gather pace, street design will play a critical role in this transition. This research focuses on continuous footways, a design intervention at side roads that gives priority for people walking, over those who are driving. It aims to investigate the processes taking place during the conceptualisation and design of two continuous footways in a contemporary street in Glasgow, and to examine the implications of their design for people using them. A novel methodology is presented to analyse movement behaviour at side roads, captured more broadly within an adapted framework based on socio-technical transition theory (STT). The results indicate that the continuous footways were altered between the initial design and the constructed design due, in part, to the constraining actions of roads engineers who were uncomfortable with the proposed design. Pedestrians are altering their behaviour to some extent at the continuous footways; however, drivers are continuing to behave as if they have priority. Framing the actions of the various design actors within the context of STT illuminates new 'regime-aware' approaches to managing the design governance process during future street regeneration projects.

Keywords: Continuous footways; Pedestrians; Urban design governance; Sustainable transitions

1. Introduction

The extent to which people move around, and how they choose to do so, is heavily influenced by the spatial layout of cities, as well as the proximity of shops and services that can be travelled to sustainably (Leach et al., 2019; Scottish Government, 2023). Streets are the lifeblood of cities, and their design can influence whether people choose to spend time in cities, how they arrive there, and whether they are enabled to move around sustainably, i.e. using active travel modes (Jacobs, 1961; Gehl, 2010; Aldred, Goodman and Woodcock, 2024).

However, many cities have an urban fabric that has systematically prioritised the movement of private vehicles over people using active travel modes (Taylor and Filmer-Sankey, 2002; Hebbert, 2005). Indeed, it has been identified that there is an urgent need to adapt streets to enable a wider (just) transition towards a sustainable way of living in urban areas (Scottish Government, 2019). To achieve this, contemporary urban street design must overcome the hurdle of an established carbon-intense, obesogenic urban form and provide an environment that enables people to travel sustainably using active modes.

Cognisant of this, this research takes a major urban regeneration programme, colloquially known as the 'Avenues' Programme, in Glasgow, Scotland, as a case study for analysing the conceptualisation and design of a contemporary street. The street in question is Sauchiehall Street, a mixed-use high street in Glasgow city centre. The specific focus of the research is the 'continuous footways' introduced at several side road junctions along Sauchiehall Street as part of the Avenues Programme. Continuous footways are a design approach that seeks to reinforce the priority that people crossing a side road have over those driving in and out. Although it was always the case that people crossing side roads had priority once they had stepped onto the road, recent updates to *Highway Code* rule 170 (Driving Standards Agency, 2022) now additionally require drivers to give way to people *waiting* to cross.

Continuous footways can take a variety of forms in the UK, but generally they continue the pavement across side roads, ideally using the same paving material to give visual continuity. They should also include steep ramps to signal to drivers that they should give way to people crossing the side road (Flower and Parkin, 2024). Local Transport Note 1/20 (Department for Transport, 2020) introduced the concept of 'priority by design', where a side road is engineered such that the layout itself communicates the anticipated behaviour for people driving and using active modes. This contrasts with the more ubiquitous 'marked priority', where white lines and signage are used to communicate behavioural intent. Priority by design is novel in the UK, and there is little research thus far into its efficacy. The objective of this research is to address this gap. The side roads forming the focus of this research utilise the essence of design priority; however, they also feature elements of marked priority. This seemingly conflicting approach forms part of the analysis in section 4.

Elsewhere, the concept of design priority at side roads is common in the Netherlands, where it is referred to as 'exit constructions'. Here, it forms part of the Dutch 'Sustainable Safety' strategy, which focuses on reducing driving speed through design and physical interventions in a manner that can vary depending on context but is standardised across all similar side roads (Hummel, 1998; SWOV, 2018). Pedestrian priority and safety therefore arise as a result of this systemic approach, rather than the focus being on trying to promote priority at isolated junctions, as occurs in the UK. In Denmark, there is a more prescriptive continuous footway design used at side roads, rather than a variety of interventions (Living Streets, 2024). In both countries, however, the approaches are used more systematically than in the UK (ibid.).

Introducing the concept of continuous footways is not without its challenges. Embedding the idea of pedestrian priority at side roads within everyday road-user behaviour requires overcoming established behavioural norms, both on the part of those using the road (primarily driving, although sometimes cycling) and those using the footway (primarily walking or wheeling, although cycling where appropriate infrastructure exists). Furthermore, side road infrastructure along mixed-use streets rarely occurs in isolation. Interventions such as continuous footways more often form part of broader regeneration projects. This requires combining the expertise of several professions, including urban designers, engineers and landscape architects; the 'big picture' right through to the minutiae of design details. Urban design governance – the recognition that power is dispersed amongst a range of actors and interests in built environment projects (Carmona, 2013) – must be robust enough within these multi-agent projects to avoid the potential negative implications of 'unknowing' designers having agency over technical designs (Carmona et al., 2003). Continuous footways, it is argued, are more than just another piece of street infrastructure in mixed-use streets. Rather, they are an embodiment of a technical innovation that is aiming to alter everyday behavioural norms, primarily through the medium of design, whilst also ensuring safety for all users and contributing to attractive and healthy streets (Aldred and Sharkey, 2021). As such, interrogation of the design *process*, as well as the finished product, is imperative if continuous footways are to fulfil their intended function.

This research combines a qualitative study of design governance with on-street observation of naturalistic behaviour at two continuous footways to reveal new insights into the nature of the design journey and the impact on the functioning of the side roads. A framework adapted from socio-technical transition theory (STT; Geels, 2002) allows for consideration of the potential of the infrastructure to bring about longer-term behavioural transitions.

The study had three aims. First, to interrogate how new side road infrastructure intended to enable active travel is designed, planned and constructed. Second, to investigate instinctive behaviour at continuous footways, i.e. in the absence of vehicle interactions. Finally, to theorise how the design of future city streets within the context of urban governance and engineering can best enable sustainable transitions.

The following section reviews the brief literature concerning the design of continuous footways and how interaction events are used to measure their safety. However, research tends to focus on the finished product, and there is a lack of research into the design journey. A review of the relevant design governance literature introduces the idea of treating design as a continuum (Carmona, 2014), and this proceeds to the introduction of the theoretical framework used in this research. The mixed methods approach comprising interviews and naturalistic observation is outlined in section 3, followed by the results in section 4. It appears that pedestrians are altering their behaviour somewhat at the continuous footways, but drivers are doing so to a lesser extent. The interviews demonstrate how the beliefs and actions of various designers involved have influenced the design journey. The paper concludes in section 5 with a summary of the findings and implications for practice. The novel, adapted STT framework is presented and used to demonstrate how regimes can act to shape design in different phases of a project, including prior to construction. This has implications for how design training is delivered and sheds light on the importance of identifying whether regimes are being supported or overcome.

2. Background

There has been a notable uptick recently in the production of UK street design guidance focussed on improving streets for people walking, wheeling and cycling. Examples include Local Transport Note 1/20 (Department for Transport, 2020), Cycling by Design (Transport Scotland, 2021) and the Welsh Active Travel Act Guidance (Welsh Government, 2021). Junctions, including side roads, form a particular focus as they are locations where people travelling by active modes are more likely to come into conflict with people driving (Flower and Parkin, 2019). Despite the proliferation of guidance, a recent review by Living Streets (2024) found that side road designs in the UK lack standardisation, and even where design detail is specified, the intent behind the design is not necessarily articulated. The term 'continuous footways' is used loosely to describe a range of so-called 'side road entry treatments', but there is general agreement in the guidance that continuous footways should convey a strong visual indication of priority for people walking and wheeling over approaching and turning vehicular traffic.

The design literature does not always articulate whether side road treatments are intended to cater for people walking or whether they also include people cycling (Living Streets, 2024). Several studies have included cycling at side roads but note that, as the numbers are so small, it is difficult to measure effects (Steer Davies Gleave, SDG, 2018; Flower, Ricci and Parkin, 2021). As such, this research focuses primarily on people walking at side roads ('pedestrians'), and this should also be taken to include people using wheeled mobility aids, such as wheelchairs.

Previous research into continuous footways in the UK has tended to frame them in terms of enhancing safety at side roads. This is most often measured using the yield rate, either that of the driver or the person crossing. A higher driver yield rate suggests that the continuous footway is reinforcing pedestrian priority, and this is generally understood to infer greater safety for people crossing. More recently, yielding behaviour on the part of people walking and wheeling (or cycling) has been further subdivided into 'voluntary' or 'forced' yields, the latter acting as a proxy for safety, or lack thereof (Flower and Parkin, 2024). Conversely, continuous footways have been criticised for potentially introducing ambiguity in terms of priority, leading to a perceived reduction in safety amongst road users (Wood et al., 2006; Flower, Ricci and Parkin, 2021). Flower, Bolado Saenz and Parkin (2023) note that there is a difference between focussing on the driver and pedestrian yield rates, with the former inherently leading to a focus on road safety.

Several studies used crash data as a measure of road safety but concluded that the low rate of actual collisions makes this a poor predictor of future risk (Wood et al. 2006; Cloutier et al., 2017). Instead, Cloutier et al. (2017) suggest using interaction events – where a vehicle and a person crossing coincide at a side road – as a proxy for longer-term safety. Most studies therefore report on yielding rates during interaction events, applying this metric across a variety of junction designs. In a study of seven continuous footways in London, SDG (2018) reported that 78% of drivers yielded to people who were already in the crossing, while only 17% yielded to those who were approaching it. AECOM (2018), conversely, studied the pedestrian perspective, reporting a gradual increase in pedestrian yield rates over a year at a newly installed continuous footway site in Edinburgh: 59% in November 2017, rising to 73% by November 2018. They suggest that this is due to a decline in driver compliance as the design becomes more familiar, leading to what is termed 'forced yields' on the part of pedestrians. Flower, Ricci and Parkin (2021), in a study considering 10 sites across the UK, reported higher driver yielding rate compared to previous studies; however, they still found that nearly 10% of all interaction events resulted in pedestrians yielding, either voluntarily (1.6%) or being forced (8.7%).

Flower, Bolado Saenz and Parkin (2023) compared pedestrian yield rates at crossings with design priority and marked priority. They found that pedestrians did not have to yield during 73.2% of interaction events at junctions with marked priority and 89.7% of events where there was design priority. In contrast, there was a 43.3% 'no yield' rate at the control sites. They conclude that any form of enhancement at a side road improves the priority for pedestrians; however, they also found a greater forced yield rate at design priority junctions. Overall, Flower and Parkin (2024) conclude that a hybrid approach, whereby a junction confers priority by design but with the addition of zebra crossing stripes, is their preferred design in safety terms. They note, however, that this potentially undermines the notion of continuous footway because stripes reintroduce the idea that a road is being crossed.

Most of the studies reviewed here make use of video footage to analyse interaction events. This allows for the collection of many hours of data and means that artificial intelligence can be used to aid the analysis (e.g. Bailey, 2022). Cloutier et al. (2017), however, used naturalistic observation, which enabled them to capture the broader context in which the side roads were situated. Naturalistic observation is frequently used in public life studies to capture instinctive behaviour when the subject is not aware they are being observed (Whyte, 1980; Gehl and Svarre, 2013; Mehta, 2019). The use of in-person observation in side road research, it is argued, enables the researcher to capture more nuanced pedestrian behaviour – slight movements, facial expressions, etc. – and contextual cues which offer a more holistic indication of public life beyond the pure focus on road safety.

Several studies included analysis of interviews with professional informants involved in the design of continuous footways. Flower, Ricci and Parkin (2021) asked interviewees to predict which of ten side road designs would perform best and least well in terms of pedestrian yielding behaviour. Although participants were generally able to identify the best and worst junctions, there was considerable variability across informants. The authors noted differences in opinion amongst the design community and concerns around the legal status of continuous footways. In earlier interviews with key informants, Flower and Parkin (2019) had identified variability in designer compliance with the guidance that existed at the time. They concluded that even if designers understood their own intent, this understanding was not necessarily carried through to road users. In a more recent study, Flower and Parkin (2024) described having to contend with a considerable amount of real-world variation in terms of the design of recently constructed continuous footways, even where designers were technically following the guidance. Focus group participants in this study suggested that more consistency in design at junctions would minimise ambiguity and confusion.

This evidence points to a complex picture where the intent behind the design of continuous footway is perhaps not being reliably articulated by designers, raising the possibility that designers are not even necessarily in agreement about the design intent. To shed light on why this might be happening, urban design theorist Carmona proposes the notion of self-conscious and un-self-conscious design (Carmona et al., 2003). This has at its core the idea that built environment projects will inevitably be shaped by a myriad of individuals beyond 'trained' designers. This can lead to examples of 'unknowing' design, whereby a failure to manage the overarching shape of a design project in the longer term can lead to piecemeal iterations of design that can ultimately undermine the design intent. Carmona also proposes treating design as a *process* – the 'place-shaping continuum' (2014, p.6) – recognising that this design process does not stop when the 'product' is complete. Instead, it will continue as the product is subject to the longer-term process of 'shaping by use' (ibid.).

The studies reviewed here focus primarily on the performance of the 'finished product' but do not consider the design journey, nor how the ultimate design has evolved through the actions of the various professionals involved. Echoing Carmona's work, Flower and Parkin (2019) note the complexity of the interactions involved in side road design: behaviour in the public realm and at junctions is influenced by law and regulation, and by design of infrastructure. In the long term, regulation is influenced by behaviour and the environment. In addition, the way the environment is built for road users is influenced by behaviour and its regulation. Flower and Parkin suggest that whereas individual linkages have been researched, this complete set of interrelations is under-researched. This also suggests the need for an overarching research framework that can capture the longer-term transition as infrastructure continues to both shape, and be shaped by, the behaviour of those using it.

2.1 Socio-technical transitions

STT (Geels, 2002) is a theory developed to describe and understand the long-term movements between socio-technical systems, such as how people interact with street infrastructure. It stems from Geels' proposition that 'technology, of itself, has no power, does nothing. Only in association with human agency, social structures and organisations does technology fulfil functions' (ibid., p.1257). The most widely used iteration of the framework is the multi-level perspective (MLP; Geels, 2002; Geels and Schot, 2007), which suggests that transitions occur across three levels. At the top is the socio-technical landscape, consisting of long-term trends, external to any specific transition but shaping and constraining them. These are relatively stable but will change gradually over time. Examples include economic growth and climate change. Beneath the landscape level are the socio-technical regimes, described by Geels as 'the semi-coherent set of rules carried by different social groups' (2002, p.1260). These are the belief systems, or prevailing practices, that govern behaviour at a given time. Indeed, the framework has at its core the idea that technological innovation on its own has no power, but that it is the social agency surrounding it that enacts change (ibid.). The lower level of the MLP consists of technical 'niches': radical technological innovations (Schot, 1998). Socio-technical change, it is hypothesised, occurs where a niche is suitably protected and can 'break through' to exert pressure on the incumbent regimes surrounding it. Where a niche exerts sufficient pressure, regimes can shift and reform, eventually altering the landscape level and enacting sustainable change.

There does not yet appear to be any existing literature presenting street infrastructure as a 'technical' innovation in its own right. It is argued, however, that infrastructure such as continuous footways is at the cutting edge of technical design (in the UK, at least). Treating these interventions as socio-technical innovations, it is argued, may help to uncover wider lessons on the potential for transition-focused street regeneration. This research therefore frames the continuous footways on Sauchiehall Street as a technical innovation and uses an adapted STT framework to analyse the design journey that shaped how they appear on the street today, as well as how they might shape behaviour on the street in the future.

3. Methods

This is a mixed-methods study combining a longitudinal study of design governance (the 'process' phase) with on-street observation of naturalistic behaviour at side roads (the 'observation' phase) to analyse the impact of their design on behaviour. The process phase comprised a period of document analysis between 2020 and 2021, followed by 17 semi-structured 'elite' interviews with individuals representing different aspects of the Avenues Programme, including Glasgow City Council officers, urban designers and roads engineers. These were carried out virtually between February 2021 and March 2022, on Microsoft Teams (13), by telephone (3) and email (1) due to restrictions imposed by the COVID-19 pandemic. Ethical approval for the collection of interview data was granted by the University of Glasgow College of Social Sciences Research Ethics Committee on 26 November 2020, application no: 400200059. An interview protocol was developed containing several themes and questions based on prompts generated from an early iteration of the updated theoretical framework. However, the interviewer was free to vary the sequence and probe for additional information as the interview went on (Fielding and Thomas, 2008).

The observation phase comprised two data collection periods: October 2021 and January 2022. Ethical approval for the collection of observational data was granted by the University of Glasgow College of Social Sciences Research Ethics Committee on 7 September 2021, application no: 400200221. Side roads were observed to assess 'deviation' behaviour on the part of people walking and driving at three sites. Adapted from research carried out by SDG (2018) and Flower, Ricci and Parkin (2021), the deviation metric was developed to measure how far people walking and driving deviated from a constant trajectory at each side road, i.e. the extent to which they were changing their behaviour on approach. Deviation was defined separately for people driving and walking with corresponding criteria used to categorise the behaviour of each group (**Table 1**). In-person observation was used because this offered the opportunity to capture nuanced behaviour, as well as the broader context surrounding

Table 1: Assessment criteria used to categorise deviation categories for pedestrian and driver behaviour at side roads.

	No deviation	Minimal deviation	Significant deviation	Full deviation
Pedestrians	No glance up/ no change in speed/'oblivious'	Glance up on approach/no change in speed	Slow down on approach/look around/break off conversation	Stop at side road/ full look around/ actively give driver priority
Drivers	No change in speed/ force pedestrians to hurry or retreat/dangerous behaviour (including increase in speed)	Minimal slowing/force change to pedestrian behaviour/overrun corner of footway	Enter slowly/give way to people crossing	Stop regardless of whether pedestrians are waiting or crossing

the behaviour at side roads, which is not possible when using video analysis. Following the precedent set by Whyte (1980), an observational journal was kept alongside the quantitative observation to capture qualitative narration to enrich the data.

It is argued that for continuous footways to function successfully, pedestrians should assert priority whether or not a vehicle is present. People driving should instinctively change their behaviour at the continuous footways regardless of whether someone is crossing, to allow for this possibility. Low pedestrian deviation and greater driver deviation would therefore suggest successfully functioning continuous footways. Rather than only analysing interaction events, as previous studies have done, the behaviour of pedestrians was therefore observed regardless of whether a vehicle was present. Likewise, driver behaviour was recorded even if there was no pedestrian present.

The quantitative data were analysed using descriptive statistics. For the qualitative data, thematic analysis (TA) was applied to first disassemble, then reassemble the data, before interpretation (Yin, 2016). A systematic approach was used to identify themes and code the data, (Creswell and Creswell, 2017). Descriptive codes, a proportion of which used 'latent' or expected themes, were generated to help guide the analysis. A further set of codes were 'emergent', or surprising – identified where participants raised unanticipated themes. Additional in vivo codes were then identified, using participants' words to capture key themes through their own eyes. Hierarchical analysis of these codes was then undertaken to create higher-order themes, which were ultimately carried through to provide the thematic structure for the qualitative analysis.

Triangulation was used to dovetail the findings from each type of data to support the overall interpretation of the data. The use of chronological ordering (Yin, 2009) was particularly useful to chart, e.g. the influence of what was unpublished guidance at the time, such as the *Highway Code* (Driving Standards Agency, 2022), which was nevertheless 'in the pipeline' and therefore impacted the design despite not having been published.

3.1 Data collection sites

Observations took place at three sites (**Figure 1**): two on Sauchiehall Street (Scott Street and Pitt Street) and one control site on Argyle Street (Mitchell Street). Scott Street also features a continuous cycle track across the junction, whereas Pitt Street on the south side has no specific cycling provision (**Figure 2**).

Both streets are one-way for vehicles: northbound on Scott Street and southbound on Pitt Street, so vehicles were turning left and right off the carriageway, respectively, to enter the side roads. Scott Street has a wider splay for vehicles entering the side road, and the presence

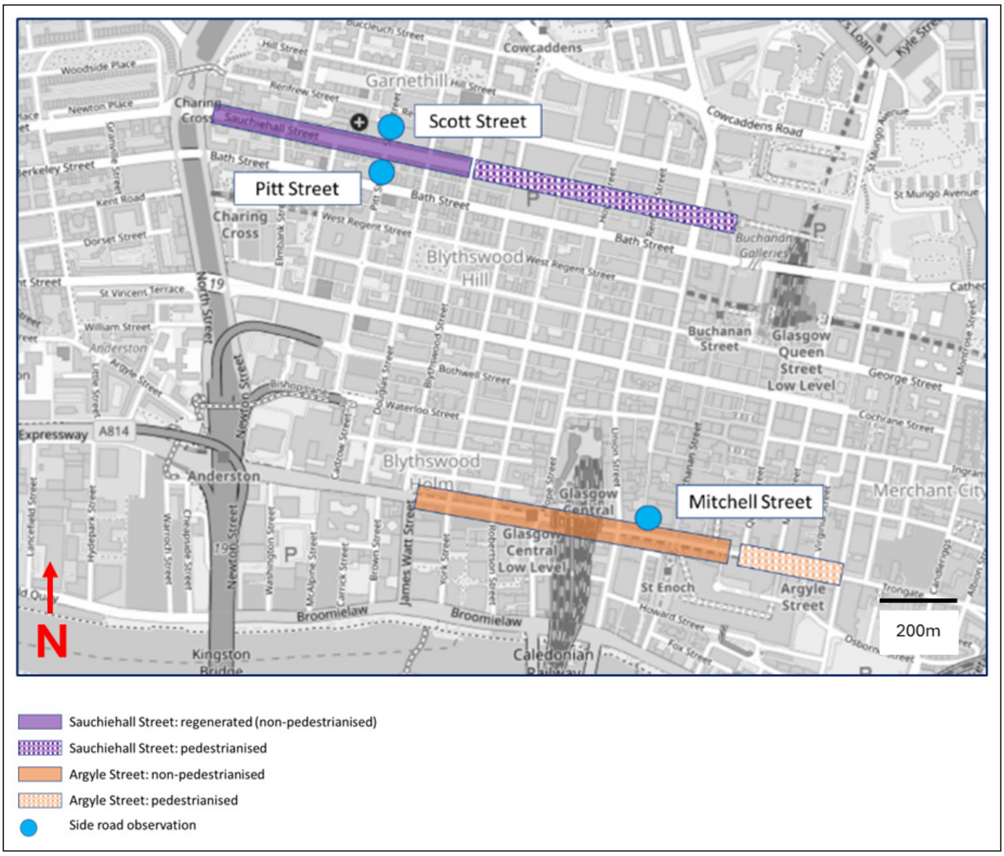

Figure 1: Location of study sites within Glasgow city centre. Map © OpenStreetMap contributors.

Figure 2: Scott Street side road looking westbound with a vehicle turning in (left) and Pitt Street side road looking northwest (right). Images © author.

of the cycle track means that vehicles are required to turn across two separate pieces of infrastructure (footway and cycle track).

Mitchell Street on Argyle Street was selected as a control (**Figure 3**). It is a single lane side road with vehicles travelling one-way towards Argyle Street, i.e. turning out of the junction. The side road presents visually as a traditional crossing with a clear distinction between the granite footway and black tarmac carriageway, although there are no kerbs, so the whole

Figure 3: Mitchell Street side road on Argyle Street looking north, used as a control. Image © Author.

surface is flush. Argyle Street is also a mixed-use street within Glasgow city centre with pedestrianised and non-pedestrianised sections, like Sauchiehall Street.

Observations were dispersed evenly across four time periods: 08:30–09:30, 10:00–11:00, 17:00–18:00 and 19:30–20:30 and the majority of data collection took place on weekdays.

4. Results and discussion

Results from the two phases of the research are presented below, followed by a discussion. The process phase, corresponding to 'design for use', is presented first. This analyses the design journey and sheds light on the process that produced the final design (aim 1). This is followed by the observation phase, relating to 'space in use', which considers how pedestrian and driver behaviour is manifesting at the continuous footways (aim 2). The ensuing discussion considers implications for practice, as well as the potential for longer-term behavioural change (aim 3).

4.1 Process phase

This section presents analysis of the documentary and interview data, interrogating the design journey of the continuous footways on Sauchiehall Street.

4.1.1 Side road design

Figure 4 shows an example of the continuous footways introduced along Sauchiehall Street as part of the Avenues Programme.

Analysis of the pre-construction designs for the side roads indicates that the final design of the continuous footways differed from the original proposed by the urban design consultants who undertook the initial design work. Several interviewees referred to what they considered to be an unhelpful level of ambiguity in the final design, where there is no clear priority for either drivers or active modes (Delivery Manager, interview, 2021; Planning Consultant, interview, 2021; Senior Urban Designer, interview, 2021). The Delivery Manager admitted that the finished design did not look at all how Glasgow City Council (GCC) wanted it to look and suggested that

Figure 4: Continuous footway introduced on Scott Street, Sauchiehall Street, Glasgow, as part of the Avenues Programme. Image © author.

ultimately, the Avenues Team should either have 'done it [the continuous footways]' or 'not done it', rather than settling for ambiguity (Delivery Manager, interview, 2021). This sentiment was seconded by a Councillor who expressed that she suspected there had perhaps been a lack of courage to really commit to the full continuous concept (Councillor, interview, 2021).

Interviews with members of the urban design team offered further insight into the process that had taken place. Having completed the initial strategy development for the Avenues, the urban design consultancy was retained to develop Sauchiehall Street to Royal Institute of British Architects (RIBA) Stage II, the conceptual design stage. GCC then took the project forward from RIBA II to construction, which includes the detailed design stages. These latter stages can include a greater degree of input from related departments, such as Roads. The Lead Designer reiterated that the original design intent for the continuous footway was that 'the cycle lane and the footway were continuous across the side street', adding that there were 'no signifiers of vehicle priority in that space at all when I originally designed it' (Lead Designer, interview, 2021). He went on to describe how retrospective additions to the 'finished' street had undermined this design intent, including double yellow lines, which signify vehicle priority.

The paving was also altered from the intended existing footway material on the rest of the street to a darker grey material at side roads, which the Lead Designer again suggests signifies a road (rather than footway). He describes the result as a compromise between his intention to fragment the vehicle network to give the footway priority and the status quo of vehicle priority (ibid.). The Project Manager at GCC explained that the yellow lines, 'marked priority', were added because of a retrospective safety audit provided by an external consultancy, but that they only recommended this because they're a 'standard sort of consultancy service who don't really know about these kinda schemes'. He added that 'for me that defeats the whole purpose' (Project Manager, interview, 2021).

4.1.2 The spectre of liability

It became apparent during interviews with GCC officers that there was a reluctance to embrace the concept of continuity at the side roads in the absence of engineering standards ratifying the safety of the design. The concept of continuous footway supports *Highway Code* (Driving

Standards Agency, 2022) rules 170 (stating that drivers should give way to people crossing or waiting to cross) and H2 (which defines the hierarchy of road users), whilst conventional side road design does not. However, it should be noted that the updated *Highway Code* had not been published at the time the interviews took place, and despite demonstrating knowledge of the content, interviewees were hesitant to refer to it. Ultimately, it was the job of the roads engineers at GCC to finalise the design of the side roads and instruct the safety auditors afterwards, which placed the control of the design in their hands.

Although seemingly hesitant to refer to the side road design initially, it became clear that the Senior Roads Engineer at GCC was deeply uncomfortable about the concept of continuous footways, perceiving them to be potentially unsafe and stating that it was ‘going to take an awful lot of education, or all parties to behave in the way that you would have to at junctions before these would be safe’ (Senior Roads Engineer, interview, 2021). As the interview unfolded, he shared personal experiences that had led to him being ‘very wary’, explaining that on a previous project ‘there were several accidents. And obviously, with the police getting involved … it’s not a very nice process’ (ibid.). He even went further, referring to his personal experience outside of his professional life: ‘first thing I taught my children was when you get to the kerb, you stop. If you don’t have that kerb, then how do you teach your children to cross a road safely?’ (ibid.).

Interestingly, the Principal Officer, who otherwise presented as a pioneering individual, appeared to support the hesitancy on the part of the roads engineers, responding to the notion that local authorities should just go ahead with continuous footway regardless of design standards with ‘yeah, that’s fine, but there *will be* an accident and then there *will* be a court case. And if a local authority has just gone it alone against what’s written in law, then where do we stand?’ (Principal Officer, interview, 2022). Despite some suggestion by the Delivery Manager, himself a roads engineer, that the concept of liability does not actually exist in the sense that is being described here, it is clearly a spectre that is looming large over the officers charged with designing these sorts of projects. As such, the nature of its reality perhaps does not matter so much as the fact that the notion is held to exist. It appears to be an embedded component within the regimes that constrain the engineering profession, a situation exacerbated by the lack of formal guidance at the time.

4.1.3 The subconscious designer

When asked about the inspiration for the side road design, the Lead Designer pointed to international precedents but described their influence as ‘subconscious’ for him. He noted that his design firm had been applying forward thinking design principles even before design manuals ‘legitimised’ these approaches in the UK. He was not, however, basing the design directly on European examples, hence the use of the term ‘subconscious’ (Lead Designer, interview, 2021). This raises an interesting question as to whether Carmona’s typology of ‘self-conscious’ (knowing) and ‘un-self-conscious’ (unknowing) design (Carmona et al., 2003) might be extended to include the notion of a ‘subconscious designer’, i.e. a type of knowing designer, but one so steeped in practice that consulting design manuals and related guidance (examples of regimes) may not be considered necessary in every instance.

The insight provided by the Senior Roads Engineer above made clear that the changes to the side road design are not simply a result of a lack of awareness of newer designs or an arbitrary failure to follow them. Conversely, the Senior Roads Engineer’s rationale for his decisions demonstrates a heavily ingrained mindset spanning all spheres from personal to professional. This ‘subconscious’ action appears to indicate a clash of regimes: the urban designers and related design professionals were advocating for a design-led, concept-driven street with continuous footways. The roads engineers, however, were operating within a regime that is heavily guided by a perception that the safety offered by the status quo – full vehicle priority at side roads – would be undermined by any significant change to that design.

These findings provide several examples of regime-constrained actions, underpinned by what might be understood as subconscious design. The niche, the newly designed continuous footway, was not sufficiently protected in this case (by design standards or governance) and the incumbent engineering regime acted to re-shape it back towards the established concept of 'side road'. Interestingly, the resulting design is a combination of the intent to provide continuous footway and the actions to revert it back to a 'normal' side road. The niche has established itself but the extent to which it has acted to shape the regime will only be apparent through analysis of longer-term behaviour, both on the part of people using the street, but also those designing future streets.

The following section presents and discusses results from the observation phase – capturing instinctive behaviour at the continuous footways – corresponding to the 'space in use' phase of the STT framework and addressing aim 2.

4.2 Observation phase

Non-intrusive observation of pedestrian behaviour, where those observed are not specifically made aware of the researcher and generally do not know they are taking part in a research study (Webb et al., 1996), was carried out at the continuous footways on Sauchiehall Street and the control site on Argyle Street.

4.2.1 Pedestrian behaviour at side roads

Figure 5 shows the distribution of pedestrian deviation behaviour on each street.

Pedestrians appear to be behaving similarly across all side roads with the majority of those observed demonstrating 'minimal' or 'no deviation' when crossing. This can be interpreted as a positive outcome for Pitt and Scott Street, which are designed intentionally to elicit this behaviour. However, it raises questions as to why this is also the case on Mitchell Street, which is not specifically designed to give people walking priority yet has the highest rate of 'no deviation' behaviour. This may be due to it being narrow, traffic flow exiting onto a one-way street rather than entering from a one-way street (as is the case with both

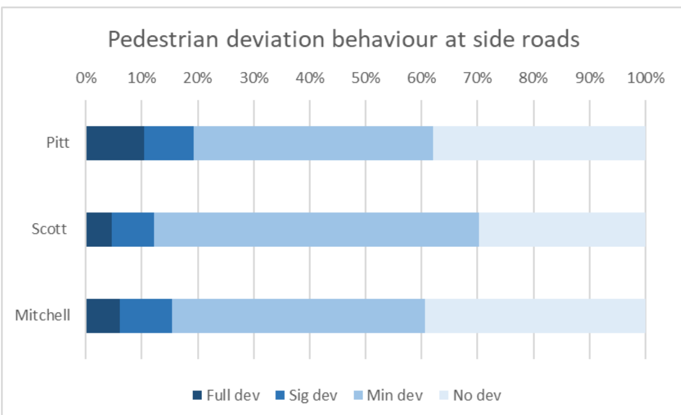

Figure 5: Pedestrian deviation behaviour at side roads as a proportion of total movements on each street. Count based on two 30-minute observations of each street, repeated two times in October and January. Pitt Street $n = 182$, Scott Street $n = 305$ and Mitchell Street $n = 466$.

Sauchiehall Street side roads), and its location on Argyle Street, where other side roads are either signalised or pedestrianised. In addition, whilst it was not possible to record the number of pedestrians crossing at any given time, it was observed anecdotally that a degree of 'herd behaviour' was occurring, where people were more likely to mimic the behaviour of others (whether deviating or not). The greater the flow rate, the more this behaviour may be expected to occur.

Scott Street has a bi-directional cycle track running parallel to the footway (**Figure 4**). This provides a wider buffer between the carriageway and footway, as well as an additional visual cue for both drivers and pedestrians as to the priority of the active travel infrastructure. Pedestrians showed the lowest levels of 'full deviation' behaviour on Scott Street, suggesting that the addition of the cycle track provided some extra encouragement to cross without fully stopping. That said, they also showed slightly lower levels of 'no deviation' behaviour here than Pitt or Mitchell Street. It may be that the cycle track provides an extra buffer from vehicles, offering reassurance; however, it may also act as a potential hazard that pedestrians have to navigate.

Pitt Street has the highest combined rate of 'full' and 'significant' deviation behaviour at just under 20% of people walking. The design of the street, which includes a relatively wide turning radius from Sauchiehall Street and carriageway flush with the crossing, means it is possible for drivers to turn in without slowing down much. The higher deviation rate perhaps reflects people instinctively behaving more cautiously here than on Scott Street, where the cycle track provides an extra buffer.

4.2.2 Driver behaviour at side roads

The majority of driver behaviour on all streets fell within the 'significant' and 'minimal' deviation categories (**Figure 6**). A slightly greater proportion overall fell in the 'full' or 'significant' deviation categories on Scott Street, suggesting that drivers are behaving slightly more courteously here, possibly due to the additional visual cue provided by the cycle track. This was still less than half of all drivers though.

There is no corresponding reduction in the proportion of 'no deviation' behaviour on Scott Street, with rates comparable to Mitchell Street (where a higher rate may be expected due to vehicles turning out, rather than in). Indeed, Scott Street appears to be the street of extremes

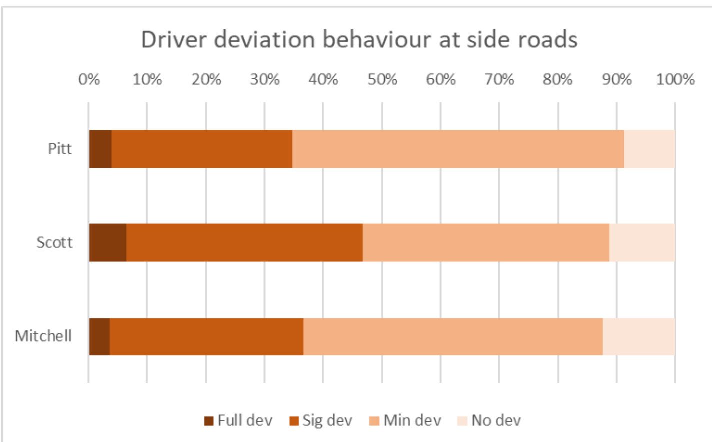

Figure 6: Driver deviation behaviour at side roads as a proportion of total driver movements per street. Count based on two 30-minute observations of each street, repeated two times in October and January. Pitt Street $n = 150$, Scott Street $n = 62$ and Mitchell Street $n = 126$.

with drivers either showing higher rates of 'full deviation' behaviour or higher rates of 'no deviation'. This could be interpreted as drivers reacting to the new infrastructure by either driving more courteously or more dangerously. There could also be an effect of the significant incline up Scott Street (**Figure 7**). Drivers are perhaps turning in faster or more aggressively than usual because they are 'revving up' for the hill.

In terms of assessing how behaviour varied across what are effectively three different designs for side roads, given real-world constraints, Fisher's Exact tests were carried out for pedestrian and driver behaviour. The test returned a *p*-value of 0.0019 for pedestrians, suggesting that pedestrian behaviour is not independent of side road design (taking significance to be $p < 0.05$). This suggests that pedestrians are behaving significantly differently between Scott, Pitt and Mitchell Streets. This could be interpreted as people instinctively reading the designs of the streets and behaving accordingly, whether consciously or subconsciously. The same test, however, returned a *p*-value of 0.4745 for drivers, suggesting that driver behaviour and side road design are independent of each other. This suggests that drivers are behaving regardless of the design of the street and perhaps, therefore, that the designs are instinctively communicating a continuation of the status quo of driver priority, whilst failing to instinctively communicate the intended message of pedestrian priority to drivers.

Recording pedestrian and vehicle movements at a side road separately, rather than focussing only on interaction events, makes it possible to analyse whether people walking are instinctively treating the footways as continuous (without concern for safety), rather than as a road crossing. Likewise, people driving can be observed to ascertain whether they are demonstrating instinctive yielding behaviour. If continuous footways in mixed-use streets are to fulfil their function as enablers of pedestrian priority, people should treat footways as continuous regardless of whether a vehicle is present, rather than defining pedestrian priority merely as a function of the propensity of drivers to yield.

4.2.3 Walking with vs. walking against traffic flow

Sauchiehall and Argyle Streets are both one-way for vehicles in an eastbound direction. People walking eastbound, with the traffic flow, therefore could not see vehicles approaching the side road in the way that people walking westbound could. Approaching vehicles could be *heard* on most occasions; however, it would be difficult to ascertain without

Figure 7: The 'driver's eye' view of the incline turning into Scott Street side road. Image © author.

looking around whether an approaching vehicle was turning into the side road or not. A further category was introduced, therefore, which was 'danger' or 'clear', i.e. could a vehicle be heard approaching (regardless of whether it was turning) or did the street sound clear. Whilst not universally applicable – some individuals were using headphones whilst walking and hearing impairments would not be visible – this measure was applied to control for this effect as far as possible. Observations were also divided into westbound and eastbound.

4.2.3.1 Eastbound vs. westbound

It was hypothesised that individuals walking westbound would be more likely to show 'no' or 'minimal' deviation behaviour on Pitt Street and Scott Street due to being able to see oncoming traffic. Argyle Street is also one-way eastbound, but vehicles are turning out, so it was hypothesised that there should not be a difference between the directions at Mitchell Street. **Figure 8** shows the results of this analysis.

On Pitt Street, higher levels of 'minimal' and 'no' deviation behaviour were indeed observed for people walking westbound, while 'significant' deviation was lower, supporting the hypothesis. However, 'full' deviation behaviour was comparable in both directions. It may be that those individuals who are deviating fully, i.e. stopping and even giving drivers priority, are exhibiting personal tendencies towards risk and that the street design has not acted to override these tendencies. In STT terms, this is perhaps making visible the sort of regimes influencing people's instinctive behaviour at a point where they are interacting with vehicles. The design of the side road 'niche' has been sufficient to disrupt the regimes governing a proportion of people's behaviour, but not all.

On Scott Street, behaviour is more mixed with slightly more people showing 'minimal' deviation behaviour westbound, but more people showing 'no' deviation behaviour eastbound. This supports the theory that this side road is more visually complex and therefore does not communicate as clearly in either direction as Pitt Street. The increased complexity of the design is perhaps diluting or dispersing the pressure that can be exerted on the regime. Mitchell Street, as predicted, shows mixed results across each category, except for 'minimal' deviation behaviour.

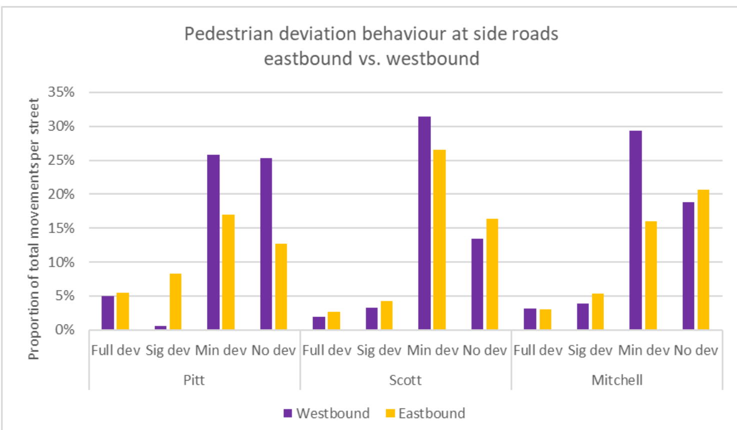

Figure 8: Pedestrian behaviour at side roads by eastbound ($n = 440$) and westbound ($n = 512$) movement as a proportion of total movements per street.

4.2.3.2 'Clear' vs. 'danger'

It was hypothesised that people walking would exhibit higher levels of 'no' and 'minimal' deviation behaviour when the street *sounds* clear, and that this should occur on all three streets. **Figure 9** indicates that this is indeed the case, with higher rates of 'no' and 'minimal' deviation corresponding to clear sounding streets and comparatively higher rates of 'full' and 'significant' deviation in the auditory presence of vehicles.

If the side roads were functioning perfectly, in theory, 100% of people would show 'no' deviation behaviour even in the presence of vehicles approaching. This should also be the case at conventional side road junctions, given that *Highway Code* rules 170 and H2 (Driving Standards Agency, 2022) apply equally to these. That this is occurring slightly more on Scott Street suggests that it is having some visual communication effect in encouraging people to cross regardless of the presence of vehicles. This design, although imperfect, is a significant change to prevailing highways practice in the UK and will take a while to 'bed in', i.e. to exert sufficient pressure on the incumbent regimes to cement behavioural change.

5. Limitations

Naturalistic observation provides useful insight into behaviour, for which hypothetical explanations can be developed; however, it is necessary to use different research techniques to test understanding of *why* these behaviours are occurring. Restrictions following the COVID-19 pandemic prevented the use of intercept interviews in this research; however, these could provide a useful addition to observational methods to elicit a level of self-reported insight as to why behaviour has occurred.

As noted above, Mitchell Street did not prove suitable for use as a control. In selecting it as a control, the wider context of Argyle Street (city centre, commuter route, high footfall, etc.) was deemed the more important element to attempt to control for. However, the layout of Mitchell Street is atypical with flush kerbs, a tight radius, narrow width resulting in limited visibility for all users, and turning-out movements only. The use of a more traditional side road with kerbs and wider visibility would have helped to better contextualise the impact of the designs on Sauchiehall Street, even if this location was outside the city centre.

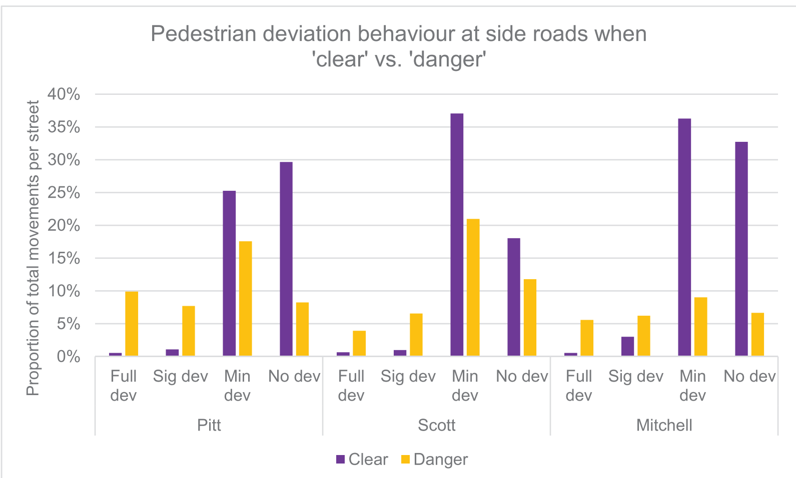

Figure 9: Pedestrian deviation behaviour at side roads when conditions were either 'clear' (no vehicle approaching, $n = 614$) or 'danger' (vehicle approaching, $n = 339$) as a proportion of total movements per street.

6. Conclusion and implications for practice

Analysis revealed that the continuous footways in this study were noticeably altered between design and construction, leading to what was described by interviewees as a compromised final design with an unhelpful degree of ambiguity in terms of how pedestrians and drivers should behave at the side roads. Observations revealed some influence of the new design on pedestrian behaviour, with less deviation at the continuous footway sites. However, driver behaviour did not differ significantly between sites, suggesting the new designs were not communicating clearly to drivers that they do not have priority at side roads.

6.1 Adapting the STT framework

A novel contribution of this research was the adaptation of the STT framework to incorporate the place-shaping continuum (Carmona, 2014). The continuum recognises distinct phases within the life of an urban design project, including 'design for use', which occurs during the conceptualisation and design phase, as well as 'space in use', recognising that streets continue to be shaped through use once they are constructed. Making this adaptation allowed for the identification of different regimes operating within these two phases, as well as different types of niches, shown in **Figure 10**.

Regimes acting to constrain the design and conceptualisation process can be summarised as 'disciplinary regimes', i.e. those embedded within the praxis of each specific discipline, such as engineering. Once constructed, the niches (continuous footways) then continued to exert pressure on these disciplinary regimes, but they also exerted pressure on what are termed 'behavioural regimes', i.e. the behaviours of the people using the street. The identification in this research of the two types of regimes (disciplinary and behavioural) operating in this context, as well as the two categories of niches (conceptual and constructed), forms a conceptual update to STT theory. Furthermore, an additional finding using this framework was that the mere *concept* of continuous footways could already be seen exerting some pressure on the existing disciplinary regimes, even before planning and construction. This points

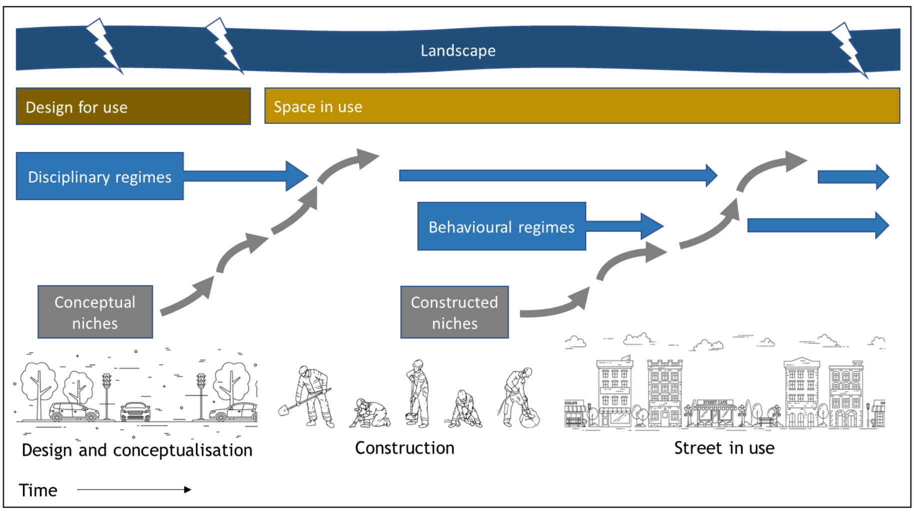

Figure 10: Adapting the STT framework to include the place-shaping continuum (Carmona, 2014) allows for the identification of different regimes operating in the two phases. Conceptual niches, before construction, can be seen exerting pressure on disciplinary regimes.

to the importance of appointing a 'knowing' project manager who can anticipate and manage the implications of potentially conflicting regimes at a sufficiently early stage of a project to avoid challenges later on.

Interviews with project officers suggested that changes to the design occurred primarily due to discomfort on the part of roads engineers, who were able to exert influence over the final design during the latter stages of the project. Analysis suggests these officers acted as 'subconscious' designers, rather than 'unknowing', which is a conceptual update to Carmona's theory (Carmona, 2014). Framing the actions of the roads engineers in the current research as regime-constrained means the issue can be addressed in the future through more holistic (or regime-aware) training, rather than by treating it as a barrier related to an individual, or a profession as a whole (Berry, Davidson and Saman, 2013).

Overall, framing the behaviour of pedestrians and drivers at side roads in terms of regimes makes it possible to analyse a street regeneration project in terms of the systems governing it, and therefore provides a means for linking physical interventions on the street to wider behaviour change. This potentially has useful implications for both theory and practice. Overall, the research concludes that it is important to be clear from the outset about whether an infrastructure project is intended to *support* existing regimes or whether it is intended to *overcome* them, as discussed in more detail below.

6.2 Implications for practice

6.2.1 The design continuity gap

Framing the events of the design process, including the actions of the highways engineers, in STT terms, offers new insight into how similar projects might be managed in the future. This research identified the existence of several 'gaps' inherent in a project of this kind where the concept is developed in-house by a local authority, passed to an external design team who draw up initial designs before passing the designs back to the local authority who can then make further changes, or indeed invite further external input. This potentially produces what has been termed in this research a *design continuity* gap (**Figure 11**), within which there is a *conceptual design gap* where project officers, such as highways engineers, may not be on board with the philosophical intent behind a design (e.g. to change the established priority of people driving and walking at side roads). There is also potentially a *temporal design gap* whereby the urban design consultants relinquish agency over a project when it is taken back 'in-house'. In this case, the *design continuity gap* appeared to have been worsened by a *regulatory design gap*, whereby the design standards that might have provided the Senior Highways Engineer at GCC with a secure basis for accepting the proposed design were not published until after the project had taken place. Despite these being knowingly 'in the pipeline', this was not sufficient for a profession heavily bound by standards and risk mitigation. An awareness amongst project managers from the outset of these potential gaps in future project work may help to mitigate the effects.

6.2.2 Supporting vs. overcoming regimes

This finding that drivers were not reacting as intended to the side road design is particularly noteworthy given the discussion concerning the compromised design of the side roads, which occurred in part due to the apparent influence of regime-constrained behaviour amongst the project team. This illuminates an important point for consideration when installing new infrastructure on a street. The question is whether that infrastructure is intended to support and continue existing regimes (such as installing public benches to enable people to sit) or is required to challenge and change existing regimes (such as continuous footways are designed

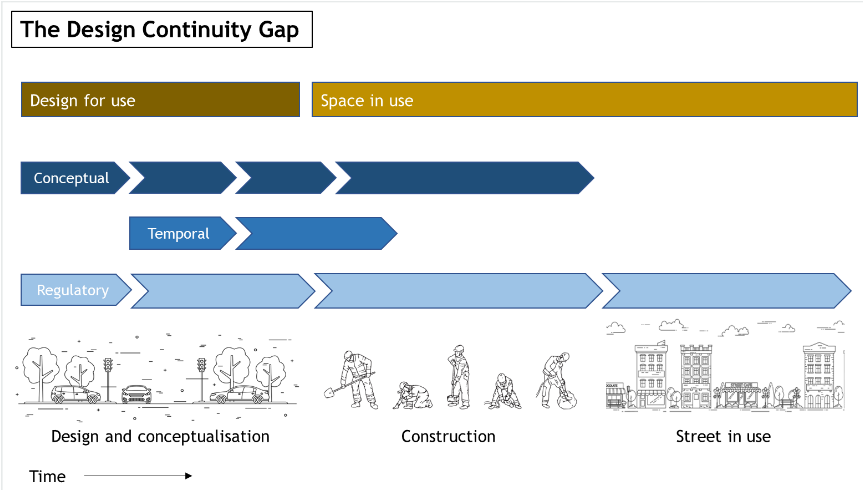

Figure 11: The design continuity gap, comprising a conceptual design gap, temporal design gap and regulatory design gap. Images licensed by author.

to do). This should arguably be identified when designing infrastructure because this will affect whether, and how strongly, the design must exert pressure on the incumbent regime. *Overcoming* a regime will require much more support around an emerging 'niche', and this may be required early in the governance process, even before the commencement of the design or construction work. It is suggested, for instance, that the evaluation of the design and function of side roads is considered in terms of the ability of the design to exert a strong enough pressure on people driving *and* walking, to overcome existing behavioural tendencies.

6.2.3 Regime-aware officer training

An additional recommendation concerns the nature of training offered to local authority officers undertaking street design projects. This research has uncovered the influence of roads engineers over the design of key pieces of infrastructure. When framed through the lens of socio-technical transitions, this issue can be considered as occurring due to the existence of incompatible regimes, i.e. different *types* of knowledge, rather than a lack of knowledge. Current design training tends to try to *provide* knowledge, presuming it is lacking or incorrect. However, it is argued that training might be re-conceptualised to explicitly note these wider regime forces and offer more of a mediation-type approach between officers from different disciplines. This perhaps better respects the various knowledges and encourages, and accompanies, participants on a learning journey, rather than requiring an abrupt change to established thinking. This may also help encourage a new generation of designers to adopt a more holistic view of street regeneration projects as conduits for sustainable transitions, rather than isolated infrastructure projects.

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Competing interests

The author has no competing interests to declare.

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