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Behavioural analysis of interactions between pedestrians and vehicles in street designs with elements of shared space

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ABSTRACT

This paper describes the development and implementation of qualitative behavioural criteria in order to analyse the conduct of pedestrians and vehicles when they are required to interact with each other, with particular interest to street designs with elements of shared space. The new behavioural analysis technique is developed by identifying the fundamental principles that underpin existing traffic analyses, such as traffic conflicts techniques, and adapting those to a qualitative framework that describes the mindset and rationale of road users. The technique is then applied to a case study in London, using video data from periods before and after the redevelopment of the Exhibition Road site from a conventional dual carriageway to a modern design with some elements of shared space. With the main goals being to assess the pedestrians' confidence and the vehicles' tolerance/patience when forced to interact with each other, behavioural trends are related to instantaneous characteristics of the vehicle flow (vehicle approach speed and traffic density). The data produced are used to develop and validate qualitative behavioural relationships for pedestrian–vehicle interactions, as well as location-specific conclusions for the Exhibition Road site.

1. Introduction

Urban street design has traditionally been very closely tied with road safety. The latter has been a concern since the introduction of motorised vehicles, and became paramount with mass motorisation from the 1950s onwards. Of particular importance was the protection of pedestrians, who, being more vulnerable, faced greater risk of suffering injury or death. This was pursued by means of their segregation from vehicular traffic, which, dating back at least to the work of Le Corbusier in the 1930s, relied upon the design and implementation of structures including pedestrian subways and bridges, as well as guardrails and walls separating pedestrian pathways from the road, which in turn was reserved for vehicles. The concept is set out most lucidly in Buchanan's 'Traffic in Towns' report (Buchanan et al., 1963), which served as a street design manual in the UK for many decades.

In recent years, however, there has been a trend away from traffic segregation, driven by developments in architecture and urban planning. Instead, street design and traffic engineering have seen a shift in focus from vehicles to pedestrians as a means of creating a better public realm, mainly by asserting the function of streets as places rather than arteries and designing more to a scale aimed at easier pedestrian movement and lower vehicle speeds. Examples of this approach

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include: the removal of segregating features such as street furniture, signage and kerbs; the introduction of more "informal" (uncontrolled) pedestrian crossing facilities; or the re-engineering of layouts with a single surface and little or no delineation between pedestrian and vehicle areas (Hamilton-Baillie, 2004a, 2004b; Hamilton-Baillie, 2008a, 2008b; Hamilton-Baillie & Jones, 2005).

As part of the trend away from traffic segregation, the concept of "shared space" has emerged in recent years. Shared space is defined by the UK Department for Transport as "a street or place designed to improve pedestrian movement and comfort by reducing the dominance of motor vehicles and enabling all users to share the space rather than follow the clearly defined rules implied by more conventional designs" (UK Department for Transport, 2011). As such, and conversely to popular belief, the term "shared space" is not used to characterise entire streets and places as "shared" or "not shared", particularly given that streetscape design cannot be standardised and needs to be context-sensitive. Instead, shared space is used as an "umbrella" term to collectively refer to a range of streetscape treatments, aiming at creating a more pedestrian-friendly environment. Examples of streets with varying extents of shared space elements can be found around the world and include: the concept of "woonerf" and "home zone" in residential areas in the Netherlands and UK respectively; the "Manual for Streets" approach in the UK (Chartered Institute of Highways, 2010; UK Department for Transport, 2007); and the "Complete Streets" initiative in the USA (LaPlante & McCann, 2011).

The shared space concept has been met with mixed reactions from different road user groups. Opponents of the concept (such as some elderly and disabled road users) have expressed their discomfort towards the idea because they perceive it as less safe (Deichman, Winterberg, & Bredmose, 2008; Hamilton-Baillie, 2008b). Proponents, on the other hand, have suggested that shared space actually contributes to the improvement of road safety, mainly due to the introduction of ambiguity, which makes both drivers and pedestrians more vigilant (Hamilton-Baillie, 2004b). From a traffic engineering perspective, the latter view is a paradox, since shared space introduces a greater degree of vehicle–pedestrian interaction. This highlights the need to analyse the interactions between vehicles and pedestrians from a behavioural perspective. It should be clarified here, though, that this is different from traffic conflicts analysis, a method of which has recently been developed and applied (Kaparias et al., 2010, 2013), as it does not focus on the mechanics of the interaction (i.e. speed, direction, etc.), but on the qualitative behaviour of the road users which may or may not lead to a conflict (or accident) situation.

More specifically, the framework defined by Hydén (1987) and conceptualised by Svensson and Hydén (2006) is followed here, according to which the range of interactions is represented by a pyramid, the height and width of which denote the severity (from "undisturbed passages" to "fatal accidents") and occurrence frequency of interaction events respectively. In an extension of the framework (Svensson, 1998), interactions are further classified in a diamond, as it is argued that the occurrence of the least severe events is rare when road users are undisturbed by other road users. The framework is illustrated in Fig. 1, as fully presented by Laureshyn, Svensson, and Hydén (2010), and the present work focuses on what is defined as "encounters of medium severity", which comprise the majority of road user interactions. In the graphical representation, these cover roughly the "potential conflicts" and the top half part of the "undisturbed passages" slices of the pyramid (Fig. 1a), and the central portion of the diamond (Fig. 1b).

The present paper has two key objectives. The first objective is to present a new qualitative behavioural analysis technique for the vehicle–pedestrian interaction events defined, for use in both conventional and shared space environments. This is expected to complement the work of Laureshyn et al. (2010) by providing a means of conducting behavioural observations in the public realm in a systematic way. The second objective is then to apply the new method on a redeveloped street layout in a before- and after-context and to draw conclusions as to changes in the behaviour of drivers and pedestrians following the redevelopment. The work has been carried out as part of a traffic monitoring programme of the Exhibition Road project, comprising the conversion of the layout of the Exhibition Road site in London's South Kensington area from a conventional dual carriageway to a single surface, featuring a number of elements of shared space.

The paper is structured as follows: Section 2 presents the background of the study through a review of traffic conflicts and behavioural analysis methods. Section 3 describes the new qualitative behavioural analysis method developed for vehicle–pedestrian interactions, while Section 4 deals with its implementation, which includes the description of the test site and the

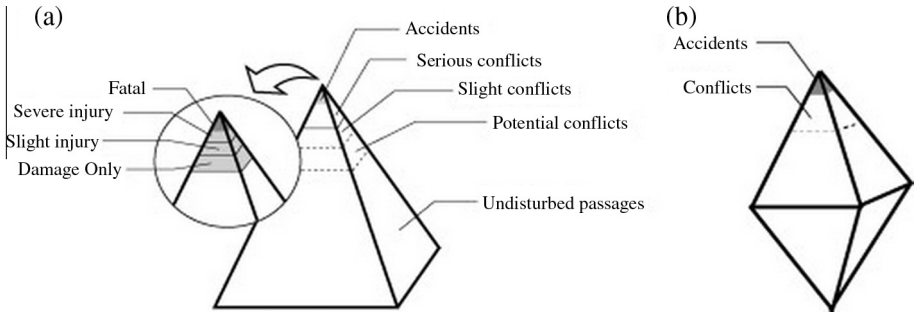

Fig. 1. Conceptual framework of vehicle–pedestrian interactions (Laureshyn et al., 2010): (a) pyramid hierarchy (Hydén, 1987) and (b) diamond representation (Svensson, 1998).