Accident Analysis and Prevention 72 (2014) 257–266

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Safe places for pedestrians: Using cognitive work analysis to consider the relationships between the engineering and urban design of footpaths

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ARTICLE INFO

Article history:
Received 23 December 2013
Received in revised form 11 June 2014
Accepted 4 July 2014
Available online 2 August 2014

Keywords:
Safety, Pedestrians
Footpaths
Urban design
Cognitive work analysis

ABSTRACT

Footpaths provide an integral component of our urban environments and have the potential to act as safe places for people and the focus for community life. Despite this, the approach to designing footpaths that are safe while providing this sense of place often occurs in silos. There is often very little consideration given to how designing for sense of place impacts safety and vice versa. The aim of this study was to use a systems analysis and design framework to develop a design template for an 'ideal' footpath system that embodies both safety and sense of place. This was achieved through using the first phase of the Cognitive Work Analysis framework, Work Domain Analysis, to specify a model of footpaths as safe places for pedestrians. This model was subsequently used to assess two existing footpath environments to determine the extent to which they meet the design requirements specified. The findings show instances where the existing footpaths both meet and fail to meet the design requirements specified. Through utilising a systems approach for footpaths, this paper has provided a novel design template that can inform new footpath design efforts or be used to evaluate the extent to which existing footpaths achieve their safety and sense of place requirements.

1. Introduction

There is significant literature, plans and programmes that discuss the known benefits of streets and roads as: safe places for people; the focus for community life; and key elements in delivering quality neighbourhoods (Gehl, 2011; IPWEA, 2010; ITE, 2010; Jacobs, 1961). Through hosting human activity city streets and footpaths have the capacity to keep a city safe and accessible, both physically and psychologically (Appleyard, 1980; Dennis, 2010). While there is recognition of the potential for urban footpaths to be valuable public and pedestrian places, they remain poorly designed and ill-considered extensions of the roadway environment (IPWEA, 2010; SCRC, 2011). Moreover, key aspects of footpath design such as safety, engineering, and sense of place are often pursued in silos with little consideration given to how designing for sense of place impacts safety and vice versa. Footpaths should represent important pieces of transport infrastructure and significant components of the entire transport network (Austroads, 2009; Frackelton et al., 2013). However, the lack of a holistic design approach may be limiting the levels of safety, sense of place, and ultimately pedestrian use. These crucial conduits linking street and urban structure require new knowledge, if they are to emerge as safe places for pedestrians.

This study recognises two main challenges that have inhibited the ability of footpaths to be significant and safe community locations. The first is that they are often dangerous locations; of the 1303 crash-related fatalities occurring in Australia during 2012, 259 were pedestrians (BITRE, 2013). The second is that, regardless of the level of actual safety, the footpath allocation within roadway corridors are often not appealing or indeed hospitable places for pedestrians.

These challenges are, in part, the result of roadway engineering and design standards which prioritise the safe and efficient movement of motor vehicles over all other transport tasks (NJPDT, 2008; TMR, 2013). These standards are rarely expected to consider their contribution to the urban design or the pedestrian quality of roadside environments. Conversely, urban design principles which may support more 'walkable' communities or 'complete' streets often only provide descriptive and illustrative generic guidance (IPWEA, 2010; ITE, 2010; Stevens and Buksh, 2012). What are required

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http://dx.doi.org/10.1016/j.aap.2014.07.007

are context sensitive practical solutions, which seek to establish safe and attractive pedestrian and roadway environments. The identification of design frameworks, which support footpath environments as 'safe places for pedestrians', is essential.

This innovative study brings together the disciplines of Urban Design and Human Factors. A key aspect of this paper is the use of a Human Factors systems analysis and design framework, Cognitive Work Analysis (CWA; Vicente, 1999) to underpin urban design principles in the establishment of safe pedestrian footpaths. The novel theoretical component of the work involves applying and extending sociotechnical systems theory in the urban design context. The aim the study is to demonstrate how the first phase of CWA, Work Domain Analysis (WDA) can bring together into one analysis the often-competing requirements and contexts of the engineering and technical standards of footpaths with their urban design potential. Much of the literature and policy seeks to deal with these issues independently of one another, or in turn, here the issues are considered as interdependent. Specifically, the WDA phase of CWA was used to create a generic model of an 'ideal' pedestrian footpath system that will achieve the 'safe places for pedestrians' concept. It is intended that the WDA be used as a design template that incorporates safety, engineering, and design considerations. The WDA was then used to assess two existing footpath locations on the Sunshine Coast in Queensland, Australia. The purpose of this was to assess the extent to which these current designs achieve the requirements specified in the ideal footpath system design template.

Following a short overview of the WDA method, this paper outlines the domain or footpath context of the study, considering the implications of the roadway task, neighbourhood, and components of the footpath environment. Next, it describes the inputs and the process of building the WDA. Following this, the results of the WDA are outlined, including its application to the two different footpath systems case. Finally the paper discusses the implications of this work for theory and practice and concludes with insights into future research.

1.1. Cognitive work analysis and work domain analysis

CWA is currently a popular systems analysis and design framework used by Human Factors practitioners for the evaluation and redesign of complex sociotechnical systems (e.g., Jenkins et al., 2009; Vicente, 1999). To date CWA has been applied in various areas for systems analysis and design applications (e.g., Ahlstrom, 2005; Bisantz et al., 2003; Cornelissen et al., 2013; Jenkins et al., 2009, 2010; Naikar et al., 2003; Naikar and Sanderson, 2001; Watson and Sanderson, 2007); however, it has not yet been applied in an urban design context. More recently the application of CWA for road design and evaluation purposes has been gaining momentum (e.g., Cornelissen et al., 2013).

It is important to note the CWA framework is concerned with constraints rather than goals, and is based on the notion that making constraints explicit can potentially enhance human performance. To identify and understand these constraints the CWA framework comprises five interrelated phases, this study involved applying the first phase, work domain analysis (WDA).

WDA is used to describe or model the purposive and physical constraints imposed on activity within a particular system. This involves constructing an abstraction hierarchy (AH) of the system in question. The AH represents the system across the following five levels of abstraction:

- *Functional purpose* – The overall purpose(s) or raison d'être of the system and the external constraints on its operation;
- *Values and priority measures* – The criteria that the system uses for measuring progress towards its functional purpose;
- *Generalised functions* – The general functions of the work system that are necessary for achieving the functional purposes;
- *Physical functions* – The functional capabilities and limitations of the physical objects within the system that enable the generalised functions; and
- *Physical objects* – the physical objects within the work system that affords the physical functions.

The output provides a constraints-based model of the system that describes the purposes, values and priorities of the system, the functions that are performed within the system and the physical resources that are used to perform the required functions. WDA therefore addresses what activities can be performed within a particular system, but also how and why they are performed and with what. This approach to describing systems enables WDA to describe what such a system should comprise, what design features are required, and what values and priorities should be met through the design. Especially important for system design efforts is the ability to link different physical objects to required functions since this enables analyses to specify not only what a design requires but also what objects can be introduced in the design to achieve the functions. As such the present study involved using WDA to construct an ideal footpath design template that would support the notion of footpaths as safe places for people.

2. Methodology

2.1. The domain: footpath context

An urban block, corner to corner of approximately 200 m in length, was used as the unit of analysis (Fig. 1). The study was concerned with the function, purpose and objects of a footpath environment bounded by the building line and the kerb. The analysis of crossings and intersections, whereby the pedestrian leaves the footpath, are not largely considered. However the impact of roadway and adjacent built form context on the footpath are of interest.

The WDA model represents a footpath located on an urban arterial or community boulevard within an urban neighbourhood or centre of activity which has an adjacent built form context comprised of mixed use commercial, retail and residential uses.

The establishment of this domain considered three significant aspects of footpath context. First, is the identification of the transport task and roadway context (highway, arterial road, local road, etc.). Second, is an understanding of the type of neighbourhood within which the footpath occurs (rural, sub-urban, urban centre, CBD, etc.) and third, is the context of the adjacent built environment within the corridor (residential, commercial, retail, open space, etc.)

2.1.1. Roadway context for footpaths

This study is concerned with higher order roads that are administered and managed by state governments. As such the functional

Fig. 1. WDA footpath context.