Accident Analysis and Prevention 44 (2012) 140–148

Contents lists available at ScienceDirect

Accident Analysis and Prevention

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

Sustainable road safety: A new (?) neighbourhood road pattern that saves VRU lives

Vicky Feng Wei, Gord Lovegrove*

School of Engineering, Faculty of Applied Science, Kelowna, BC, University of British Columbia, Okanagan, Okanagan, 3333 University Way, Canada V1V 1V7

ARTICLE INFO

Article history:
Received 14 June 2010
Received in revised form
15 November 2010
Accepted 1 December 2010

Keywords:
Vulnerable road users
Collision prediction models
Road safety
Bicycling
Road patterns
Fused grid
3 way offset
Sustainable
Community design

ABSTRACT

Both the UN (2007) and World Health Organizations (2004) have declared the enormous social and economic burden imposed on society by injuries due to road collisions as a major global problem. While the road safety problem is not new, this prominent global declaration sends an important signal of frustration regarding progress to date on reducing road collisions. It is clear that governments, communities, businesses and the public must discover ways of reducing this burden, especially as it relates to vulnerable road users (VRUs), typically meaning pedestrian and bicyclist road users. Recent comparisons of global VRU collisions statistics suggest that, in addition to mixed land use density, the layout of neighbourhood roads plays a vital role in the encouragement of walkable, safe and quiet, yet accessible and sustainable communities.

The purpose of this paper was to:

(1) Review the literature concerning sustainable neighbourhood land use and transportation network patterns, increased VRU volumes, and road safety;
(2) Present empirical research results on road safety related to VRU volumes; and
(3) Present emerging research regarding more sustainable land use and transportation patterns, increased VRU volumes, and road safety.

The Dutch Sustainable Road Safety (SRS) Program has produced a number of innovative land use and transportation initiatives for vehicular road users as well as non-vehicular VRUs. Following from the Dutch initiatives, these new 3-way offset, and fused grid neighbourhood patterns appear to not only have positive effects in encouraging mode split (i.e. increasing walking and bicycling, and transit), slowing traffic, and reducing energy consumption and GHG emissions; but also, to hold potential to improve road safety.

To test the road safety hypothesis, UBCO researchers evaluated the level of road safety relative to five neighbourhood patterns – grid, culs-de-sac, and Dutch Sustainable Road Safety (SRS) (or limited access), 3-way offset, and fused grid networks. Analysis using standard transportation planning methodology revealed that they would maintain both mobility and accessibility. Analysis using standard road safety analysis methodology further revealed that these 3-way offset, and fused grid patterns would significantly improve road safety levels by as much as 60% compared to prevalent patterns (i.e. grid and culs-de-sac).

It is important to note that these results ignore the road safety effects of providing convenient off-road trails along trip desire lines to shift mode choice from auto to non-auto VRU modes. Subject to further research, it is intuitive that shifting trips from auto to pedestrian/bike modes will lead to reduced auto collisions. Hence, these initial results should be considered as conservative estimates, subject to further research. In before and after studies to date, researchers have shown that increasing bicycle use does not lead to a commensurate increase in bicycle collisions, but no predictive relationship has been found in the literature. Therefore, the next steps in this research are to develop collision prediction models that provide insight on VRU mode split and overall road safety.

* Corresponding author. Tel.: +011 250 807 8717.
E-mail address: gord.lovegrove@ubc.ca (G. Lovegrove).

0001-4575/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.aap.2010.12.005

1. Introduction

Road collisions are both a social and economic burden on societies worldwide. According to 2004 World Health Organization and 2007 United Nations reports on road safety, injuries due to road crashes are the 11th leading cause of death in the world. Projections indicate that road crashes will be the 3rd leading cause of death by 2020 unless there is new commitment to prevention (WHO, 2010; UN, 2007; Gaspers, 2004). While it is understood that most of the road collisions leading to these morbid road safety records can be attributed to failures in at least one of the three road system components – driver, vehicle and road – a larger dynamic needs to be considered, namely that leading to our auto-dominated culture.

No one can deny the natural appeal of driving versus taking more sustainable modes (walk, bike, bus, pool) – speed, mobility, convenience. Until recently, it had generally been an accepted axiom that a country's automobile dependence was proportional to its economic status. However, the European continent defies this axiom. Despite being among the most affluent in the world, European countries proudly promote and predominantly use more sustainable transportation (TDTM, 1995; Schafer, 2000; Kenworthy and Laube, 1999; Newman and Kenworthy, 1999; Osberg and Stiles, 1998). North America has experienced significantly less use of sustainable transportation modes than Europe. Table 1 (Kenworthy and Laube, 1999) was derived from a comprehensive global review of urban areas carried out in 1990, and shows a summary comparison of transport mode split among Europe, developed Asia and North America. On review, land use patterns would appear to be the dominate influence on travel distance and mode, backing up conclusions of earlier researchers such as Buchanan (1963).

Moreover, since the turn of the 20th century, the two most prevalent neighbourhood land use patterns built in North America include low density, single land use superimposed on: (1) traditional neighbourhood layouts (grid networks) popularized in the early 1900s, and, (2) conventional suburban layouts (loops and culs-de-sacs) developed after 1950 (see Fig. 1). This contrasts with much denser, walkable, mixed land uses and non-linear 'village' road networks across most of Europe. European researchers found in before/after studies that neighbourhood land use patterns have a dominant influence on travel choices, with those that result in more travel for foot, bike, and/or bus, and less travel by automobiles leading to reduced frequency and severity of road collisions (TDTM, 1995; Buchanan, 1963). For example, the Dutch Sustainable Road Safety (SRS) Program explored a limited access neighbourhood layout (shown in Fig. 1). Hence, European road network patterns have lead to much less automobile use than the sprawling North American patterns.

Research on ways to improve road safety in North America is now turning its focus onto an integrated approach to land use and transportation planning that will proactively improve not only road safety, but also community sustainability. Specifically, two road network patterns – 3-way offset and fused grid – are newly developed based on the Dutch SRS network. The 3-way offset pattern developed by Lovegrove (2007) contains a large proportion of 3-way intersections (see Fig. 1). The fused grid network (see Fig. 2), developed by Canada Mortgage and Housing Corporation (CMHC) combines traditional grid and conventional suburban layouts. These two new road patterns were designed to promote more sustainable land use and transport patterns – increased walking, biking and transit – than the conventional road patterns. Bicycling has been a relatively dormant commute mode in North America since the advent of automobiles, but, judging from European success, holds much potential to benefit from an integrated sustainable land use and transportation approach. Moreover, bicycling is generally one of the most efficient modes of transport for trips less than 3 km (TDTM, 1995), from the travel time, utility, speed and energy use perspectives. Across North America, approximately 40% of all trips are less than 3 km in distance (Schafer, 2000). With the right conditions, therefore, it may be possible to significantly raise bicycle use in North America via more sustainable, integrated land use and transportation planning and design, while reducing auto use and improving road safety. However, in order to change from past practises that have lead to our auto dominated culture and embrace more sustainable community development patterns, decision makers require improved information, including more reliable proactive predictions of the road safety benefits – economic, social, as well as environmental – during community planning stages. This improved information would then lead to and be framed in terms of supporting policies and other programs aimed at increasing bicycle use and more sustainable communities, very similar to what has been successful across Europe, for example (TDTM, 1995; CROW, 2000). The foundation of this improved information rests in more reliable empirical tools that allow community planners and engineers to evaluate the level of road safety of increased bicycling and walking, and decreased auto use.

The objectives of this paper are to:

(1) Review the literature concerning sustainable neighbourhood land use and transportation network patterns, increased VRU volumes, and road safety;
(2) Present empirical research results on road safety related to VRU volumes; and,
(3) Present emerging research regarding more sustainable land use and transportation patterns, increased VRU volumes, and road safety.

Table 1
1990 comparison of commute mode split by geographic region (Kenworthy and Laube, 1999).

	European	Canadian	US	Asia
Urban density (persons/ha)	50	28	14	153
Vehicle use (VKT/capita)	5026	7761	12,336	2950
Vehicle ownership (/1000)	392	524	604	123
GRP/capita ($US)	31,721	22,572	26,822	21,331
Avg journey to work (km)	10.0	11.0	15.0	10.0
% bicycling and walking	18.4	6.2	4.6	20.3
% using transit	38.8	19.7	9.0	59.6
% driving	42.8	74.1	86.3	20.1

2. Previous research

Generally, the literature reveals that different development patterns, specifically at a neighbourhood network level, contribute to and/or are meant to address problems related to one or more area, such as traffic calming, mobility, accessibility and/or safety. Moreover, conventional patterns in North America have mainly addressed vehicular movement and ignored VRU travel modes. Our research interest was to find studies road network pattern(s) that encourage more of a balance between vehicular and VRU trip making, as well as facilitating safer neighbourhoods that are well connected to community facilities.

From a historical perspective, the grid pattern is not friendly for cyclists and pedestrians, as its connectivity promotes good vehicle accessibility (VTPT, 2010). However, high accessibility has typically meant high auto volumes and decreased biking, walking, and transit use. While this network worked well for all modes in the early 1900s, when auto ownership and use were much lower, as the motor vehicle use and volumes increased, alternate off-road VRU facilities in most cases were not provided. Many grid pattern neighbourhoods were retrofitted with traffic calming and sidewalks,