Transportation + Street Trees: Effect of the Urban Design Industry's Roadside Landscape Improvement Standards on Driver and Pedestrian Performance

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Purpose

The purpose of the research is to examine the effect of industry standard urban design treatments for streetscaping of Main Streets on traffic accident rates and the pedestrian's perception of accessibility and safety. Existing research (Rosenblatt, Bahar) has indicated that the use of roadside landscaping is reducing vehicular traffic accident rates both in terms of frequency and severity. This paper identifies the next research steps being developed at Texas A&M University which will create better understanding of the impact of specific streetscape design treatment on pedestrian safety and accessibility. These standards will be evaluated for the effect on bicycle, pedestrian and wheelchair performance within the treated corridors.

Existing Research and Strategic Needs

Mainstreets projects, pedestrian corridor improvements and scenic highway landscapes are all subject to a set of official design guidelines housed in the American Association of State Highway and Transportation Officials (AASHTO). Members of AASHTO conduct extensive amounts of investigation and research to develop design guidelines that are then employed by all state highway organizations across the United States. Closer examination of the standards being applied in the design of the urban design corridor enhanced our understanding of how we should manipulate the standards to determine thresholds.

Concurrent to identifying and selecting the landscape and urban design standards currently in use in the public rights-of-way, we are also investigating the nature of the multi-modal corridor of the boulevard. We call it multi-modal because it includes, rightly or wrongly, commuters, recreational users, health enthusiasts, skateboarders, tricycles, wheelchairs, children, elderly, shoppers, etc. Understanding the realm that all these users would share is important to understanding the impact of streetscape elements. In fact, it is during this part of the research that the clues to the underpinning challenge emerge.

For example, the AASHTO guidelines look at the overriding necessity to consider pedestrians: "Because of the demands of vehicular traffic in congested urban areas, it is often extremely difficult to make adequate provisions for pedestrians. Yet this must be done, because pedestrians are the lifeblood of our urban areas, especially in the downtown and other retail areas (AASHTO 1995).

While addressing the pedestrian within the road has been the traditional realm of architects, landscape architects, and planners responding to their clients' and local community needs, this has not traditionally been the focus of AASHTO guidelines. As its membership and history reveals, AASHTO has focused on the highway –moving more vehicles through safely in a shorter period of time. As a result, the pedestrian oriented and roadside landscape standards have been developed in response to the needs of the motorized traffic. It is likely that a different set of standards and guidelines are employed when developing a realm for the range of pedestrian and non-motorized uses of the boulevards. The transportation experience which results, depending on which guidelines you use to govern your design, are summed up poetically by Czech writer, Milan Kundera: "A road is a tribute to space. Every stretch of road has meaning in itself and invites us to stop. A highway is the triumphant devaluation of space, which thanks to it has been reduced to a mere obstacle to human movement and a waste of time. In the world of highways, a beautiful landscape means: an island of beauty connected by a long line with other islands of beauty. In the world of roads and paths, beauty is continuous and constantly changing; it tells us at every step: 'Stop!' (Kundera 1991)."

To evaluate the standards that we will be testing, we conducted a review of the concept of the pedestrian's needs carried in human factors, anthropology, engineering and urban design references. We assigned ourselves the task of constructing a habitat and we seek to understand the behaviour of the animal, its eating and sleeping habits, recreational and health needs and mating patterns. Considering only the spatial needs of the pedestrian as such a genus, the anthropologist Edward Hall called for a perspective on man's spatial needs in the 1960's as follows: "If one looks at human beings in the way that the early slave traders did, conceiving of their space requirements simply in terms of the limits of the body, one pays very little attention to the effects of crowding. If, however, one sees man surrounded by a series of invisible bubbles which have measurable dimensions, architecture can be seen in a new light (Hall 1966)."

And in Hall's work we find clues to how we will be structuring the experiment as it relates to adjusting standards to increase pedestrian safety: "When stress increases, sensitivity to crowding rises – people get more on edge – so that more and more space is required as less and less is available (Hall 1966)."

Urban designer Unterman's classic Accommodating the Pedestrian, presents guidelines for pedestrians based on pedestrians viewing cones as part of their spatial requirements, suggesting that "New fences, retaining walls and buildings should ideally be set back from the sidewalk by 3 to 5 feet to compensate for this lost traveling space. Since people walk to the left or right of persons in front of them, 30 inches wide allows for this offset. For planning purposes, this author recommends a three-foot capacity. This width allows for the offset space of pedestrians and more correctly approximate the amount of space needed to accommodate more than one pedestrian (Untermann 1984)." Together, Unterman's guideline would suggest a width consideration much greater than the basic consideration of the AASHTO guideline.

The AASHTO guidelines present a different view of the minimum dimensions for the pedestrian: "The physical dimensions of the human body are reflected in the design of pedestrian facilities. For the design of sidewalks, stairs, refuge areas, or transitloading areas, knowledge of the width and depth of the body or the effective body area is most useful. Studies have shown that nearly all adult males have a shoulder width less than 525 mm and a depth of less than 330 mm. For design purposes, the area of a body is approximated by an ellipse 600 mm wide and 450 mm deep (AASHTO 1995)." This is a 150% difference between one standard and another.

The importance of existing pedestrian research to our experiments is that the parameters can be tested in controlled environments and guidelines can be examined against each other.

Street trees are another standard used throughout main streets and similar urban design improvements, guidelines for which are similarly contradictory. However, Rosenblatt/Bahar's research in Toronto revealed an unusual correlation between the introduction of landscape improvements and traffic accident rates on 5 case studies. Their results showed decrease in accident frequency and severity on all mid-block cases during an ambient condition of rising frequencies and severities. In other words, trees appear to be saving lives, so cost-effectively, that in some instances, their research showed the cost of the landscape installation paid for itself in savings from reduced accident rates using WTP.

However, in the National Cooperative highway Research Program Project 17-18(3), AASHTO consultants identified crashes with trees as one of the top 6 emphasis areas for the September 2000 Strategic Highway Plan. According to this document, “Trees are the objects most commonly struck in run-off-road collisions, and tree impacts are generally quite severe. Collisions with trees represent on the major types of traffic fatalities. A complicating factor in addressing fatal tree crashes is the widespread interest and indeed promotion of tree-planting and preservation associated with highways. This area of the strategic plan is one of the few that appears to represent a significant conflict with other priorities of AASHTO and the public, i.e., ‘context sensitive design’ (NCHRP 2000).”

Whether practitioners are involved in community design projects (Smartgrowth), new urbanism, context sensitive design, Tea 21, Scenic Highway or Main Streets programs, they will be confronted with standards that will govern their approval process. Although the existing power structure of the Highway and Roads Departments is slowly shifting to accommodate the changing demands of the public for quality neighborhoods and streets, quantitative rationale is required to convince engineers, politicians, lawyers, lay-people and accountants who predominate these decision-making processes.

The intention of the research is to provide the profession with quantitative rationale around the application of certain design guidelines to assure maximization of safety and accessibility for multi-modal corridor conditions (bicyclist, wheelchair, pedestrians) subjected to standard urban design treatment. Pedestrian comfort and accessibility is explored considering different types of sidewalk and boulevard conditions including commuting pedestrian, recreational pedestrian, meditation and health-oriented walkers, shoppers. We will begin to explore the nature of standard landscape treatment on behavior of pedestrians and bicyclists sharing the same transportation corridor.

Hypothesis

The first hypothesis is that standard landscape/urban design treatments influence accident rate severity and frequency of automobile drivers. Dependent variables are reaction time and speed, which are traditional indicators of accident rates.

The second hypothesis is that the same standard landscape treatments influence the full scope of sidewalk use. We will measure perception of accessibility for various types of common sidewalk activity. We will also investigate peoples’ perception of safety and levels of stress by physiological response (skin conductance, blood pressure, etc.). We will also measure walking speed and comfort levels for all types of users in response to congestion, sidewalk widths, and landscape treatments. Multi-modal use of the sidewalk/boulevard area will be measured including wheelchairs and various types of pedestrians such as the commuting pedestrian, the recreational pedestrian, and the exerciser to determine variations in spatial needs.

Methodology

To assure that streetscape standards which increase safety are used, we will identify landscape factors that enhance driver behavior through the use of the Texas Transportation Institute’s (TTI) virtual simulator. Corridors will be created virtually, drive throughs will be performed by subjects, responses to events will be monitored through psychophysiographic measuring devices, eye-tracking, etc.

The simulator at TTI uses “tiles” of images can be combined into various transportation corridor configurations as shown in Figure 1. This facilitates emulation of a variety of design conditions both mid-block and at intersections.

The "post" landscape treatment standards can be applied graphically to the same visual base corridor. Drivers can "drive" through the landscape in a full-size car which is inside the simulator. 3-D images allow the designer to test various configurations to assure that the simulation reflects the standards as shown in Figure 2. Tiles are available to facilitate testing suburban, rural and urban conditions and can be linked together in

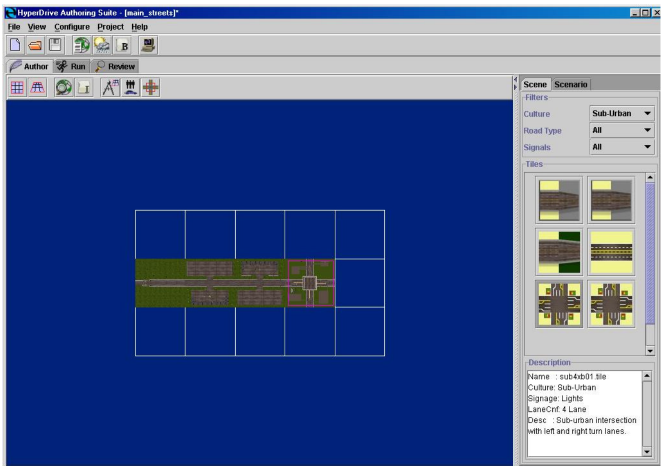

Figure 1. Simulator graphic "tiles" available to create scenarios.

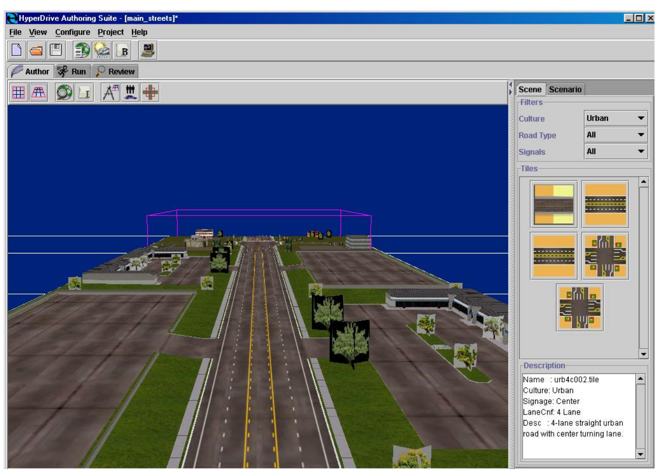

Figure 2. 3-D simulation to facilitate design

any combination to achieve a variety of roadside conditions, which are projected on large screens around the driver in the car. The pc is used to operate the simulation from a remote station.

The subject sits in the car and is asked to drive through a simulated landscape, responding to incidents during the course of his ride and answering a survey at the end of the test. He/she then drives through the same corridor, this time treated with standard landscape treatment, responding to the same or similar incidents and answering a survey at the end of the test. Standard landscape treatments will include street trees, planters/verticals, brick, and hard and soft surface pavement designs. The drive through scenarios are fairly easy to design, like a lego set assembly, and the sensation in the car is that you are actually driving through the landscape.

Determining the effect of the same treatment on pedestrians, wheelchair operators and bicyclists using the same industry standards will be measured through the use of the simulator and through the use of before-after imagery stills that depict standard streetscape treatment associated with Main Streets projects as in Figures 3, 4 and 5. In Figure 3, the standard suburban road includes 2-lane, each way with a central median area painted off. The existing grass boulevard is a boon for the neighborhood, providing some buffer between the travelway of the vehicles and the pedestrian facility. The sidewalk is a standard five foot width, concrete surface, dipping at driveway intersections to accommodate egress of cars.

Figure 4 shows the grass boulevard on the side has been used as a base for boulevard street tree planting. The painted central median has been demolished and a raised grass median has been installed with trees. The image represents the condition at maturity.

In Figure 5, the same road is depicted as in Figure 3, but this time standard includes typical planter box installation on central median with shrubbery. Often, this higher end maintenance solution is appropriate in areas where neighbors will take on maintenance costs, such as in CBD areas.

Using the physiological measuring devices of skin conductance, heart rate and eye tracking devices, the subject's reactions to changes in roadside and boulevard conditions as he/she operates either a bicycle machine or a treadmill will be evaluated in terms of response to events and quantified to determine the level of safety and accessibility achieved through each of the streetscape standards improvements.

All user groups will be tested. Car drivers will be tested using curbside and median treatment to identify which features provide maximum safety benefit. Boulevard users will be tested using curbside treatment only. Number of people will be distributed amongst commuter pedestrian, recreational, exerciser and wheelchair. In the following example, the control variable will be constant congestion level in all cells. We are testing how do various landscape treatments modify perception of accessibility and safety. The tentative study cells for the experiment at this point shown in Table 1.

Figure 3. Pre landscape treatment condition for Road X. ©

Figure 4. Post landscape treatment condition for typical suburban road shown in Figure 3. ©

Figure 5. Same road as depicted in figure 4 but standard includes typical planter box installation on central median ©

Main Results

There is enough evidence in the literature and in practice to indicate that the use of standard streetscape treatments (roadside landscaping, central median enhancements, street trees) in small communities across the United States and Canada is becoming as pervasive as engineering or architectural standards, especially since the funding opportunities created by Scenic highways legislation and TEA-21 have emerged. Unfortunately, designers do not have enough awareness of the effect of "streetscape" industry standards on driver and pedestrian safety and the application of the standards is lacking guidelines that address these issues. With FHWA releasing its new sidewalk and trail design guidelines, it is important to examine the multi-modal response to sidewalk, streetscape and urban design standards so that trade-offs within the curb lane and boulevard area do not compromise accessibility and safety of all users.

We expect to find that landscape treatment reduces accident rates both in terms of severity and frequency and that some treatments are more effective on driver speed and reaction time than other standard treatments. We expect that safer environments are created as a result of implementing landscape and urban design treatment than would exist if no treatment were implemented.

We also expect results that indicate that application of standard landscape treatments are increasing multi-modal user perception of accessibility and sidewalk activities. We expect that post-landscape treatment will result in improved walking speeds and comfort levels for all types of users.

Table 1. Study cells for experiment.

# of people	30	30	30	30	30
CSW Width/standard condition	Trees curbside	Planters curbside	Grass curbside	asphalt curbside	Colored brick
1.5 metres					
2.5 metres					
3.0 metres					
3.5 metres					
5.0 metres					
# of drivers	30	30	30	30	30
	Trees curbside	Planters curbside	Grass curbside	asphalt curbside	Colored brick
Median with trees					
Median with planters					
Median with trees and grass					
Median with grass					
Concrete raised median					
No median					

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