Spatial Analysis for Sustainable Pedestrian Safety

Investigating the geography of pedestrian safety in New York City

By Matthew Roe

Forward & Acknowledgements

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Executive Summary

Introduction: This report describes a GIS-driven investigation into the geography of pedestrian safety, especially related to seniors, and the causes of pedestrian-vehicular crashes in New York City. Particular attention is paid to pedestrians over the age of 65, who comprise 40% of pedestrian deaths in New York City. It reports on existing and emerging tools used to improve pedestrian safety in New York City, and describes several NYCDOT programs and projects that have been guided by this research, including the *Safe Streets for Seniors* program. This work and associated research are intended to lay the groundwork for broader pedestrian safety planning in New York City and to point the way to further research.

Background: New York City is an FHWA Focus City for pedestrian safety, but has the lowest pedestrian fatality rate of any large city in the United States. Having presided over a reduction in pedestrian fatalities and the fatality rate by roughly 50% since 1990, NYCDOT has adopted the goal of reducing pedestrian fatalities another 50% by 2030. However, total pedestrian injuries fell by only half the rate that fatalities fell. Many of the most easily-identified locations (the 'low-hanging fruit') have been targeted for safety countermeasures since 1990; it is recognized that further opportunities for pedestrian safety treatments will be more difficult to identify and may involve more operational tradeoffs than earlier treatments. Finally, a guiding principle of this work is that safety measures, like all street design, should enhance rather than limit pedestrian mobility. Therefore, a need exists for techniques to identify *environmentally, fiscally* and *operationally sustainable* pedestrian safety measures – targeted, cost-effective measures that support walking and other priority modes.

This report focuses on the question of where to target these rapidly-implemented measures. It illustrates the applicability of several geospatial and analytical tools (found in off-the-shelf GIS software) to the problem of prioritizing safety improvements, using pedestrian crashes in New York City as the primary input.

Methodology: Several investigations through GIS revealed important conclusions about the geography of pedestrian safety in New York City. All investigations used data from the NYSDMV crash database.

The project had three distinct sets of tasks: conversion of data into a GIS format; crash data analysis; and planning and design of safety treatments in priority areas, notably within the Safe Streets for Seniors project.

Several major GIS tools and database-querying techniques were used to support policy decisions about safety resource allocation. These are 1) Spatial analysis, most usefully Kernel Density analysis, which was used at the planning stages of the Safe Streets for Seniors project 2) crash factor analysis and related investigations; and 3) enhancing data accessibility to project managers. The methodology and findings of specific investigations are listed below.

Senior Pedestrian Crash Density: Maps of the density of all senior pedestrian severe injuries and fatalities in New York City, over a five-year period, were produced using the kernel density technique. 'Hotspots' with high concentrations of crashes were identified, including several neighborhoods that had not previously been identified as problematic. While other techniques were applied to the senior pedestrian crash data, kernel density analysis provided the most consistent and applicable criteria. 2) The above procedure led to the identification of 25 high-priority areas for the "Safe Streets for Seniors" program. Five of these areas were investigated together with NYCDOT staff, and implementations were designed. Treatments include the installation of pedestrian refuge islands and neckdowns; leading pedestrian intervals; and (universally within the designated areas) pedestrian "Don't Walk" clearance phases timed for a 3 foot per second walking speed, the average for pedestrians over 65.

Other findings of this analysis include the identification of several factors related to crash density. These include neighborhood types (CBDs and NORCs), land use types (intermodal transit stations; retail and warehousing uses; parks) and street types (multilane streets without refuge islands; bridge, tunnel and highway entrances/exits)

Time-series Analysis of Crash Density: An analysis was conducted of the change in pedestrian crashes from the 1992-1996 period to the 2002-2006 period using the kernel density technique. A 'snapshot' of the density of pedestrian crashes (weighted for severity) was mapped. Then, the quantity of increase or decrease in the severity of pedestrian crashes was mapped. NYCDOT project boundaries were overlaid on these maps. Pedestrian crashes in New York City were found to have decreased in severity and frequency from the mid-1990s to the mid-2000s, but these changes were not evenly distributed across New York City. The CBD and nearby neighborhoods had the highest crash density in the both periods, but experienced sustained and consistent improvements at nearly all streets and intersections. Low-density residential and commercial areas did not experience consistent improvements, except at the locations of major NYCDOT safety implementations, e.g. Queens Boulevard. This trend is consistent with year-on-year changes in pedestrian fatalities by borough.

Severity Profiles and *Contributing Factors to Crash Severity:* The notion of a 'severity profile' was developed by measuring the likelihood of a fatality or severe injury once a crash has occurred. Since the probability of a pedestrian fatality increases with vehicle speed, it was hypothesized that more severe crashes will occur at mid-block crossings than at intersections, at signalized intersections, and when pedestrians cross against signals. For Manhattan pedestrian crashes over a three-year period, it was found that there was no difference in the fatality rate at mid-block vs. intersection crashes, and a measurable but statistically insignificant difference between signalized and stop-controlled locations. However, pedestrians struck while crossing against a signal were more than four times more likely to die than those struck while crossing with a signal (2.6% vs. 0.6%).

Pedestrian exposure and injury rate: The above findings prompted a more focused investigation of pedestrian exposure and crash rate in the Canal Street area, which had by far the highest density of pedestrian crashes citywide across all investigations. Using short sample counts of with-signal and against-signal pedestrian crossings, applied to longer counts conducted during the Canal Area Transportation Study, it was determined that turning vehicles during the 'walk' phase present nearly the same threat to pedestrians, per crossing, as through-moving vehicles during the 'don't walk' phase. It may even be safer in some cases to cross illegally than legally. These findings prompted investigations of pedestrian attitudes and behavior, including pilot surveys of pedestrians. These surveys, though conducted in numbers without statistical significance, highlight several gaps between engineering definition or assumptions and pedestrian understanding. Specifically, only 20% of pedestrian identified the flashing "don't walk" (clearance) phase as indicating that they should continue crossing if already in the crosswalk.

Display and mapping: Techniques were developed, and data made available, for displaying and analyzing crash data on a project-by-project basis. Experiments were conducted with using Google Earth to display crash data, but the size of the datasets proved burdensome to existing network capabilities. However, mapping through ArcGIS produced useful results for the Safe Streets for Seniors program, the annual "Top 20 Pedestrian Crash Locations" investigations, and the Congested Corridors program, among others.