Four-Lane to Three-Lane Conversions

tech transfer summary

Converting a four-lane, undivided urban roadway to three lanes with a continuous left-turn lane can be a cost-effective safety improvement on many roadways where widening is not an option.

Objective

Assess whether converting an undivided urban roadway from four lanes to three lanes (one through lane in each direction and a two-way, continuous left-turn lane) results in a safety benefit on Iowa roads.

Problem Statement

Anecdotal evidence from various sources in Iowa suggested that conversions of undivided, four-lane roadways to three lanes had a safety benefit. Previous research conducted by Huang et al., who evaluated 12 conversion sites and 25 comparison sites in Washington and California, showed less benefit. Their research showed an average crash frequency that was only 6 percent lower on the conversion sites versus the comparison sites. They also found that crash rates did not change from before to after, that crash severities were not affected, and that crash types did not change significantly.

The Iowa Department of Transportation's Office of Traffic and Safety (TAS) funded two independent effectiveness evaluations to find out if there really is a significant safety benefit.

Research Description

Two independent effectiveness evaluations were conducted. The first, conducted by CTRE, used a classical before-and-after study with "yoked-pair" control sites. The second used a Bayesian before-and-after analysis and was conducted by Iowa State University's Department of Statistics in cooperation with TAS.

Both studies started with the same 15 conversion sites and 15 comparison (unconverted) sites. The conversion and comparison sites had traffic volumes ranging from 2,000 to 17,400 annual daily traffic (ADT) from 1982–2004 and were mostly located in smaller urbanized areas (ranging in population from 1,169 to 198,682 according to the 2000 Census). Table 1 lists the study sites, including average annual daily traffic (AADT), population, length of the study segment, and brief description of the land use within the study corridor.

The classical study examined 10 years of annual data (crashes, crash types, and volumes) with comparisons to annual crash trends both citywide and to similar, unconverted roadways (i.e., "yoked pair" control sites). The Bayesian study used monthly crash data and estimated volumes obtained from TAS for the 30 sites over 23 years (1982–2004).

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ABOUT THIS T2 SUMMARY
This document summarizes two projects sponsored by the Iowa DOT, one conducted by CTRE and one by Iowa State University's Department of Statistics.

SPONSORS
Iowa Department of Transportation, Office of Traffic and Safety

MORE INFORMATION
www.ctre.iastate.edu/research/4laneto3lane.htm

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Table 1. Description of conversion sites

City	AADT	Population	Length	Land use
Storm Lake	7,333	10,076	1.41	Primarily commercial and industrial
Clear Lake	12,000	8,161	1.51	Mostly strip commercial, with some residential remnants
Mason City	7,100	29,172	1.78	Primarily agricultural and industrial
Osceola	6,100	4,659	2.04	Residential, strip commercial, and downtown
Manchester	11,200	5,257	0.35	Downtown commercial
Iowa Falls	10,422	5,193	1.23	Industrial, with some residential street access at one end
Rock Rapids	4,532	2,573	0.35	Downtown commercial and office
Glenwood	6,313	5,358	1.09	Strip commercial, residential, and transition between two
Des Moines	13,767	198,682	1.19	Mixed residential and commercial
Council Bluffs	10,900	58,268	0.20	Residential (few drives) and open space
Blue Grass	2,218	1,169	0.72	Residential with commercial and industrial
Sioux Center	9,231	6,002	1.52	Single-residential through downtown commercial
Indianola	13,069	12,998	1.57	Strip commercial with some residential
Lawton	9,233	697	0.64	Residential, access to side streets only
Sioux City	10,650	85,013	0.77	Residential, access to side streets or alleys only

(AADT and population data from year 2000)

Key Findings

- The two study methods produced similar results. The classical study found a 21 percent reduction in total crash frequency and 29 percent reduction in total crash rate, when compared to the overall city crashes. The Bayesian study observed that, despite the fact that both converted and comparison sites experienced reductions, the converted sites' experience was greater, resulting in a 25 percent reduction in crash density and a 19 percent reduction in crash rate.
- When compared to crashes citywide, major injury crashes at the converted sites were reduced by 11 percent, minor injury crashes by 30 percent, and possible injury crashes by 31 percent.

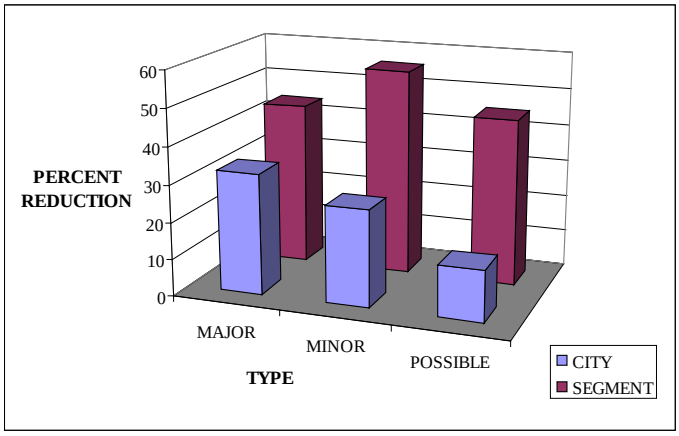

Figure 1. Before and after comparison of injury crashes

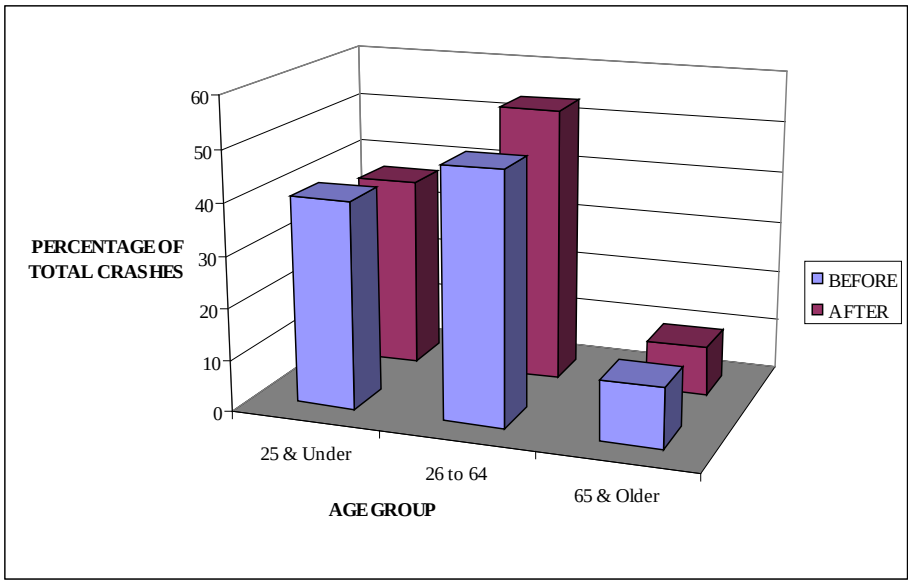

Figure 2. Driver involvement by age for all sites, in percent

Implementation Benefits

- Potential for a 25 percent reduction in crash frequency per mile and a 19 percent reduction in crash rate.
- A 34 percent reduction in the number of all injury crashes and lower severity of the crashes that do occur.
- Less involvement of age groups that are traditionally at risk—drivers 25 and under and 65 and older.
- A significant reduction in the number of crash types related to left turns and stopped traffic.

Figure 3. Study site in Osceola after conversion

Conversion Guidelines

- Determine the feasibility of converting a four-lane undivided roadway to a three-lane roadway on a case-by-case basis.
- From an operational point of view, a conversion is feasible when bi-directional peak-hour volumes are less than 1,500 vehicles per hour (vph), which is equivalent to about 15,000 vehicles per day. For volumes over 1,750 vph, the feasibility should be considered even more closely.
- Follow the feasibility determination factors in the CTRE report "Guidelines for the Conversion of 4-lane Undivided Roadways to 3-lane 2-way Left-turn Lane Facilities" available on the web: http://www.ctre.iastate.edu/reports/4to3lane.pdf.
- If a three-lane conversion is feasible, consider it along with other alternatives within a detailed engineering study.

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Why the Iowa Results Differ

Results of the Iowa studies differ from a previous study by Huang, et al., which indicated little reduction in crash rate or density after conversion. Following are reasons that may explain this:

- The "raw" data from the Bayesian study suggest that the effect of conversion in Iowa roads was much more dramatic than in the roads Huang considered.
- Although Huang began with 12 conversion sites and 25 comparison sites, the numbers were reduced to eight and 14, respectively, for the crash rate analysis due to unavailability of data.
- Huang used just three years of data for both the before and after period whereas the Bayesian analysis used 23 years of data.
- The Iowa sites were all located in smaller cities, and a number of these cities had no possible diversion route or comparison "untreated" site.
- The ADT range of the Iowa sites was 2,200 to about 13,700. The range in the Huang study was about 10,000 to 16,000.

Figure 4. US 18 in Clear Lake after conversion