UTC Spotlight

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Research Helps City Improve Crash-Prone Bike Lane

Dozens of cyclists have crashed on a slice of railroad tracks in Knoxville, Tennessee. Researchers at the Southeastern Transportation Center at the University of Tennessee, Knoxville (UTK), developed a cost-effective solution.

Prof. Chris Cherry research team, University of Tennessee, Knoxville

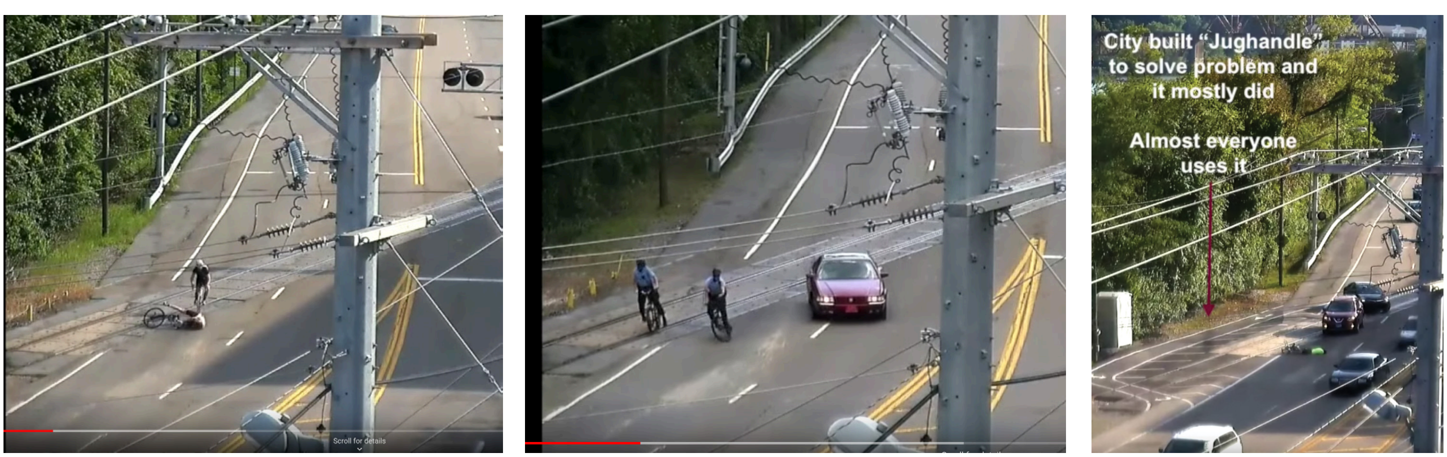
Biker unsuccessfully navigates rail crossing.

According to a recent study published in the *Journal of Transport & Health*, Professor Chris Cherry, with Ziwen Ling and Nirbesh Dhakal, found that most of these accidents occur when cyclists cross railroad tracks at an angle that causes a bike tire to become stuck in the gap between the rails. These UTK researchers happened to have a clear view of the accidents occurring almost daily, and they decided to understand why it happens so frequently. From the vantage point of a window in UTK's John D. Tickle Engineering Building, Cherry, Ling, and Dhakal recorded a brutal compilation of bike crashes using a window-mounted camera that logged more than 50 accidents at the railroad crossing, involving paths on both sides of the street, in just two months in 2014.

Knoxville Tennessee is not the only metro area where this happens. Many cities throughout the world have been making efforts to improve cycling infrastructure. As more people choose to cycle, safety challenges become apparent around infrastructure that was not designed with cyclists in mind. Most research on cyclist safety focuses on crashes involving cars or trucks, pedestrians, or riding under the influence. Only a few studies address single-bicycle crashes, and fewer still focus on crashes that involve crossing railway tracks, where cyclists lose control as their wheels cross rail flangeways.

As of 2015, there are over 100,000 at-grade rail crossings in the US. In addition, many cities have on-road streetcar and tram tracks with continuous bicycle conflict zones. However, to date there are no empirical analyses or data to assess the mechanics of single bicycle crashes at railroad crossings. Moreover, this problem is under-researched in part because single-bicycle crashes are rarely reported in official road crash statistics with enough detail to inform policy or design. A study published recently in Journal of Transport and Health (https://doi.org/10.1016/j.jth.2017.01.004), *Factors Influencing Single-Bicycle Crashes at Skewed Railroad Grade Crossings*, addresses the mechanics of bicycle crashes caused by railway tracks, building statistical models that will integrate the most important factors influencing bicycle crashes on tracks, and suggesting solutions for grade crossings. The results could also be extended to streetcar or other rail crossings. The results of this study were presented as *Avoiding Railroad*

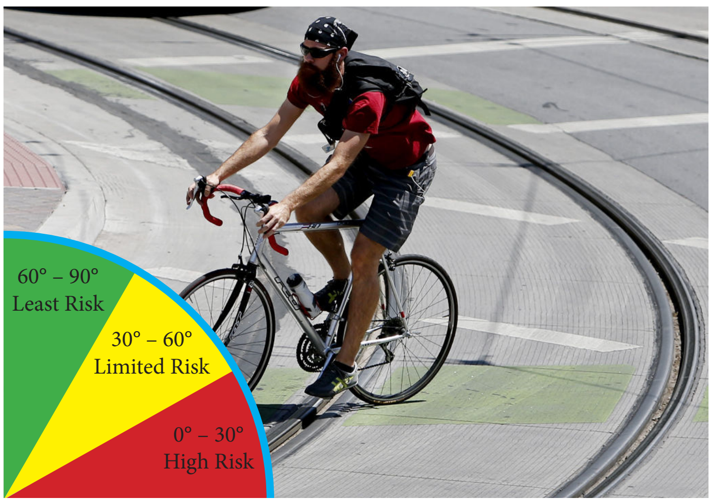
Prof. Chris Cherry research team, University of Tennessee, Knoxville



From their vantage point on the UTK campus, Cherry and his team photographed multiple crashes at a rail crossing when a jughandle crossing is not available or used.

Crossings Hazards to Cyclists at the 6th Annual International Cycling Safety Conference, 21-22 September 2017, Davis, California, USA.

The study used continuous video monitoring of a heavily traveled grade crossing to document more than 2,000 crossings, 32 of which resulted in single-bicycle crashes with enough visibility to dissect the crash scene. A representative random sample of 100 successful crossings was drawn from video data to compare with crashes and assess crash and non-crash factors of riding behaviors, demographics, bicycle characteristics, and environmental characteristics. A binary logistic regression model was built to explore the key factors leading to a successful crossing or a crash.



Mike Christy, Arizona Daily Star, 2015

Which approach angle presents the greatest crash risk?

The study data indicate that the angle of crossing is a critical factor in whether a cyclist crashes. Most transportation design guidance pushes engineers to achieve 90° crossing angles. This is impossible in many settings. In this study, nearly 90% of crashes occurred at angles of less than 30°, whereas 74% of the successful crossing approaches were made at greater than 30°. Still, nearly one quarter of crossings at less than the critical 30° threshold were successful. According the binary logistic model, group riders, women, road bikes with narrow tires, and wet and dark roadway conditions all contribute to higher crash rates. Crash rates are reduced dramatically at approach angles greater than 30°, and practically non-existent at angles greater than 60°.

Based on these findings, Cherry et al. suggest countermeasures such as jug handle designs that improve the crossing angle for cyclists. If 90° angles are difficult or impossible to build, any crossing angle greater than 30° is highly effective at reducing crashes; providing crossing angles greater than 60° would effectively eliminate them. Design guidance should not limit crossing angles to greater than a 60° approach when larger angles are not feasible.

When the crossing used in this study was redesigned, it was not feasible to construct its approach at a 90° angle. Responding to the problem, the City of Knoxville did construct a jug handle design with tangent angles of 57°, with a possible minimum angle of 37° (inside-to-outside of bike lane). This design has largely eliminated crashes except in cases where cyclists traverse the hashmarks and cross at low angles.

After reviewing both successful and unsuccessful crossings in their bone-bruising footage, the UT researchers concluded that a 90° crossing angle is not necessary to significantly reduce crash rates —a lesser, "bronze standard" of 60° is still extremely effective. "We need to make infrastructure that is safe for all users, inexperienced and experienced cyclists alike. The main thing we learned is that after a 60° angle crossing—that is, the bike crosses the tracks at 60°—we didn't see any crashes," says Cherry. "And really, we only saw a couple of minor crashes between the 30° and 60° mark. So if any agency can squeeze in a 30° crossing, they can probably do pretty well to solve a lot of the problems."

That is what the city of Knoxville eventually did. After pondering a 90° crossing that would cost several hundred thousand dollars, partly due to the route being near a river and needing retaining walls, the city and the railroad company settled on a cheaper, roughly 60° jug handle detour on the side of the street where people were tumbling into traffic. "The total cost was $5,000 for all of that, which is unbelievable, really," Cherry says. "This has been years in the making, with probably hundreds of crashes there, and it took $5,000 worth of in-house crew time and materials."

About This Project

This project was supported by the Southeastern Transportation Center, the City of Knoxville and the Knoxville Regional Transportation Planning Organization. The authors thank Jon Livengood and Kelley Segars, respectively, for their support. The authors also thank Wade M. Lawhorn and Dominic Stone for their help on data collection. Chris Cherry is professor of Civil and Environmental Engineering at the University of Tennessee, Knoxville (UTK). His research focus is on urban investments in bicycle and pedestrian safety, which are often difficult to prioritize in traditional highway safety funding mechanisms.