



A Zytek Communications Corporation White Paper

A Dynamic Congestion-Based Policy for Restricting Turns in Vehicle Intersections
or
The No Hinder Turn

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or

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Abstract

This paper introduces a policy for vehicle intersections whereby vehicle turns are allowed only to the extent that such a maneuver does not cause a hindrance to other vehicles traveling in the same direction that are not turning. A hindrance may be defined in a variety of ways based on whether other vehicles are substantially impeded in their progress. In this way, such a “no hinder” turn restriction is dynamic and dependent on actual traffic conditions and allows for more efficient movement of traffic in both heavily congested and light driving conditions. A no hinder turn restriction may be combined with or may replace other types of turn restrictions and may be utilized for both left and right turns and for streets with single or multiple lanes.

Introduction

At grade intersections of streets and roads carrying vehicle traffic, such as are common in most cities in the industrialized world, impose inherent limitations on traffic flow. In particular, vehicles turning at such intersections impose constraints on the efficient flow of traffic. In regions where left-hand drive vehicles are utilized, it is common to impose left turn restrictions to increase traffic efficiency. This is principally due to the fact that it is a common driving rule that left turning vehicles must yield to oncoming traffic and therefore when traffic is flowing in both directions, a left turning vehicle will block vehicles behind it that are not turning left.

Recognizing the inefficiency of blocking a lane of traffic for a single vehicle, a left turn restriction forces drivers wanting to turn left to make other arrangements. For example, if a driver desires to go left but left turns are prohibited they may be forced to make three right turns to accomplish their desired route. Although this imposes additional driving on the vehicle going left, in many cases it will yield an overall increase in efficiency if a small percentage of vehicles desire to turn and especially when congestion is heavy.

An improvement on the all or nothing approach, another common policy is to prohibit left turns only at certain times and for certain categories of vehicles and to allow left turns at other times. These time-based left turn restrictions tend to be based on congested commute time, i.e. “rush hour”, and are an attempt to balance the inefficiency of a left turning vehicle blocking other vehicles with the desire to allow people to travel in the most direct route. Unfortunately, time based turn restrictions are imperfect solutions. Sometimes they will permit a left turn when doing so greatly reduces the safe and efficient flow of traffic and sometimes they prohibit a left turn when such a prohibition would not affect traffic flow.

In particular, time based turn restrictions are based on a static *a priori* notion of when traffic will be heavy. In certain cases there may be very light traffic during a time when left turns are prohibited. For example if a holiday falls on a weekday, there may be no appreciable commute traffic during that day. In such a case, vehicles may be unnecessarily restricted from turning when doing so would not impact traffic flow and would allow them to take a more direct route. Conversely, there may be times when traffic is very heavy outside of the prohibited times. In such cases, vehicles being permitted to turn left may significantly impact the flow of traffic by blocking many vehicles from crossing the intersection. In such a case traffic efficiency may be greatly reduced and safety may be impacted.

In this whitepaper we introduce an improvement on the all or nothing turn restriction and on the time-based turn restriction in what could be called a “no hinder” turn restriction. The no hinder turn is a dynamic, congestion based policy for restricting turns that is based on driver evaluation and cooperation. Basically, a driver is permitted to make a no hinder turn if doing so does not cause a hindrance to other vehicles traveling in the same direction, and is prohibited otherwise. For example, if a driver desires to turn left and if doing so would dictate a wait for oncoming traffic, and if a vehicle behind is not turning left, then such a left turn is prohibited and the vehicle must continue through the intersection.

It can be appreciated that there are a number of ways in which a “hindrance” can be defined in sufficiently precise terms that it would be understandable to the general public and enforceable through traffic citations and courts.

Examples

Figure 1 illustrates a scenario of an at grade intersection of two perpendicular streets, each with three lanes in each direction. In the scenario depicted in Figure 1, two lanes in each direction carry traffic and the curb lane is set aside for parking, buses, right turns and/or an additional lane during commute hours. Alternatively, other numbers of lanes with or without a special curb lane can be utilized. Figure 1 illustrates two northbound lanes, two southbound lanes, two westbound lanes and two eastbound lanes each with traffic. In the scenario illustrated in Figure 1, vehicles in the westbound lanes and vehicles in the eastbound lanes are currently waiting, such as directed by a red traffic light. Conversely the northbound and southbound lanes are currently flowing, such as directed by a green traffic light. The vehicles in Figure 1 are depicted as solid for cars that are currently stopped and are depicted as hollow for vehicles that are currently moving.

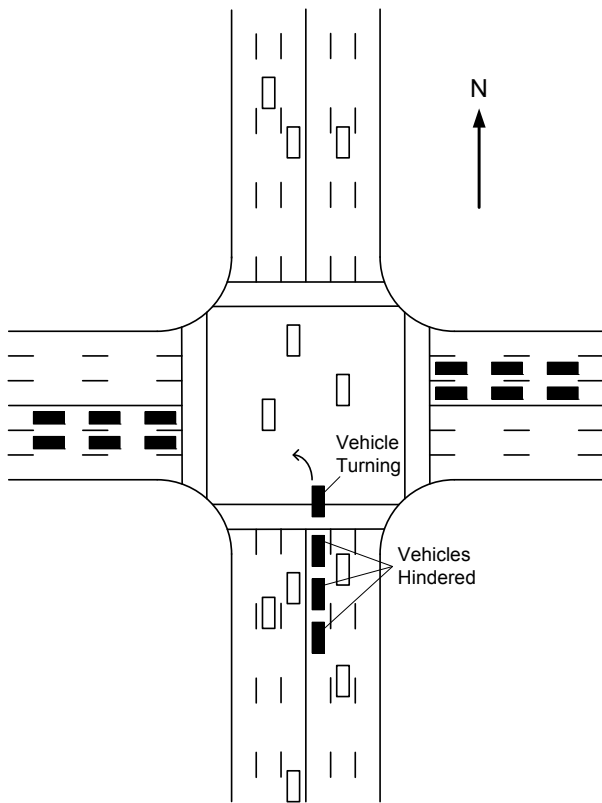


Figure 1

In the scenario of Figure 1, a vehicle desires to turn left into westbound lanes. However, because of oncoming traffic, the vehicle is not able to turn left immediately and must wait. Consequently vehicles behind it, which desire to continue

northbound, must also wait. Thus, three vehicles are being impeded in their progress northbound by the turning vehicle.

Under a no hinder turn restriction, the turning vehicle would be prohibited from making this turn. Note that other vehicles are able to move northbound unhindered in the right lane. Thus, the two northbound lanes have been essentially reduced to a single northbound lane. The hindered vehicles must either merge to the right to pass or they must wait until the turning vehicle is able to turn left. Figure 1 illustrates an example of a left turn causing a hindrance. Figure 1 also depicts pedestrian walkways. In the case of the turning vehicle, in addition to having to wait for oncoming traffic, it may also have to wait for pedestrian traffic in the west crosswalk. Note that the scenario of Figure 1 could also apply in cases where eastbound and westbound lanes consist of a single lane in each direction and there is a stop sign for those vehicles.

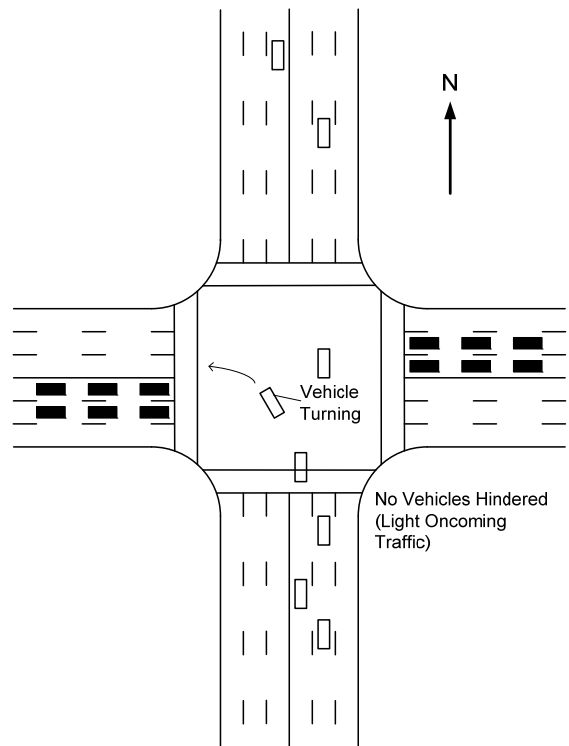


Figure 2

Figure 2 illustrates a different scenario in an intersection of a design similar to that depicted in Figure 1. As for Figure 1, westbound vehicles and eastbound vehicles are waiting. Unlike Figure 1, in the scenario depicted in Figure 2, there is minimal southbound traffic. This allows the turning vehicle to turn left from the northbound lanes onto the westbound lanes without delay. Consequently vehicles behind the turning vehicle are able to continue northbound without hindrance. Vehicles in the right lane also continue northbound without hindrance, allowing for both lanes to utilize the intersection. Under a no hinder turn restriction, the turning vehicle would

be permitted to make such a left turn. Unlike time-based turn restrictions, the turning vehicle is allowed to make such a turn based on current traffic conditions regardless of the time or day. In particular, note that even during relatively congested traffic, there may be gaps in the oncoming traffic that would permit a vehicle to make an opportunistic left turn depending on the dynamic conditions. Figure 2 also depicts pedestrian walkways and it is assumed that the turning vehicle is able to turn left additionally because there are no pedestrians in the west crosswalk.

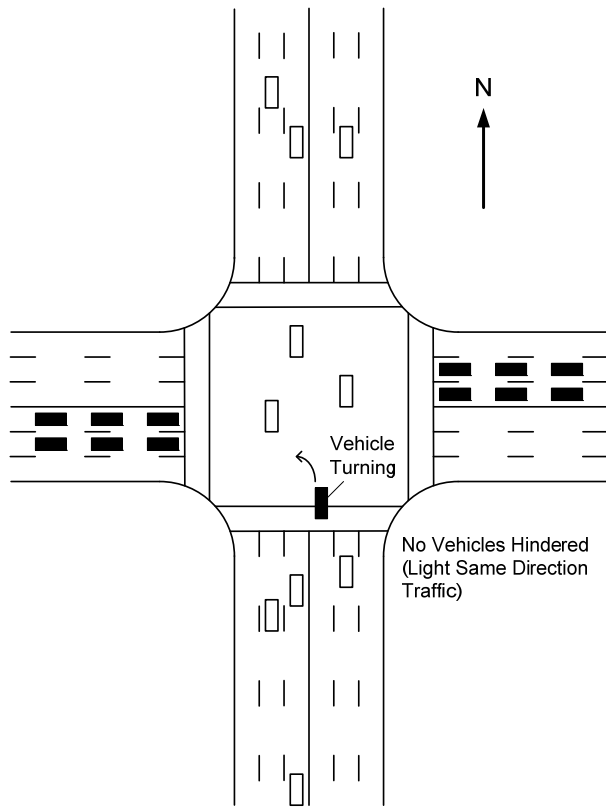


Figure 3

Figure 3 illustrates a third scenario at an intersection of a design similar to those depicted in Figures 1 and 2. As for Figures 1 and 2, westbound vehicles and eastbound vehicles are waiting. Also as for Figure 1, there is heavy southbound traffic and a vehicle desires to turn left and must therefore wait for this southbound traffic. However, unlike Figure 1, there are no vehicles waiting behind the turning vehicle due to light northbound traffic. Northbound vehicles are traveling northbound in the right lane and are not hindered by the turning vehicle. Under a no hinder turn restriction, the turning vehicle is permitted to make such a left turn. Unlike time-based turn restrictions, the turning vehicle is allowed to make such a turn based on current traffic conditions regardless of the time or day. In particular, note that even during relatively congested times a vehicle may have no traffic behind it and may be able to make a turn without causing a hindrance.

Figure 3 also depicts pedestrian walkways and the turning vehicle may also have to wait due to pedestrians in the west crosswalk.

Signage

A proposed sign depicting a no hinder left turn is illustrated in Figure 4. A no left turn symbol is supplemented with text indicating an exception to the left turn restriction.



Figure 4

This graphic solidifies the concept that left turns are restricted and this will be considered to be the default condition. In the case that a driver does not understand the exception, they would normally revert to understanding it as a left turn prohibition.

Definitions

In practice, specific guidelines for what constitutes a hindrance could be established based on a number of factors to allow ease of implementation, enforcement and public understanding. Fundamentally, a hindrance is based on whether other vehicles are substantially impeded in their progress. Specific guidelines might include rules such as:

1. A hindrance may be defined based on the amount of time another vehicle must wait for a turning vehicle, such as a wait of longer than two seconds or five seconds.
2. A hindrance may be defined such that no hindrance is recognized if there is no opposing traffic and no pedestrians, and the vehicle turning is able to do so immediately.

3. A hindrance may be defined based on whether there exists an empty lane to the right; in other words it might not be considered a hindrance if a vehicle behind, even if forced to wait, could easily change lanes to go around the vehicle turning.

4. A hindrance may be defined to allow for multiple vehicles to turn left; in other words it might not be a hindrance if the vehicle behind also wants to turn left.

In some cases, it may be desirable to combine a no hinder left turn with other turn restrictions. For example, it may be desirable that left turns are fully allowed (even with hindrance) at certain times but must be no hinder turns at other times. Alternatively, it may be desirable that turns are completely prohibited during certain times and allowed as no hinder turns at other times. Of course it would also be possible to combine all three cases into a single intersection but creating understandable signage might become a challenge in that case.

In some cases, a no hinder turn can be combined with a traffic light in which an arrow allows a protected turn for a certain period of time at the beginning of a sequencing phase. For example, some intersections have a green arrow allowing a left turn protected from oncoming traffic for a few seconds and once the green arrow goes out, the turn reverts to a traditional left turn yield. In such cases, the turn could revert to a no hinder left turn after the green arrow goes out.

Note that no hinder turn can be utilized for right turns instead of or in addition to left turns. This might be particularly important where there is no curb lane for right turns and vehicles must frequently wait for pedestrians in a crosswalk. However, it should be noted that in general right turn hindrances are less significant for the efficient flow of traffic than left turn hindrances. It is also the case that in regions where right-hand drive vehicles are utilized, all of the discussion above with respect to left turns would apply equally to right turns.

Finally, it should be noted that no hinder turns can be utilized such that vehicles in certain categories are excluded (e.g. buses, bicycles, commercial vehicles, high occupancy vehicles, etc.), and there could be combinations where no hinder restrictions apply to certain categories and not others.

Conclusions

In this white paper we have introduced the “no hinder” turn restriction. The no hinder turn is a policy for vehicle intersections whereby vehicle turns are allowed only to the extent that such a maneuver does not cause a hindrance to other vehicles traveling in the same direction that are not turning. The no hinder turn restriction is dynamic, dependent on actual traffic conditions and based on driver evaluation and cooperation. The no hinder turn allows for more efficient movement of traffic in both heavily congested and light driving conditions.