Do Not Block the Box Field Evaluation and Simulation Analysis

Abhilasha Saroj, Nishu Choudhary, Han Gyol Kim, Samuel Harris, Angshuman Guin, Michael Rodgers, and Michael Hunter

Summary

In congestion, when a vehicle enters an intersection without sufficient space to exit on the opposite side, it often leads to the obstruction of vehicle and pedestrian movement on conflicting approaches. The effect of "blocking the box" can potentially lead to gridlock and also poses a safety hazard. "Do Not-Block-The-Box" (DBTB) is a low-cost treatment which seeks to reduce the likelihood of drivers "blocking the box" and thus help alleviate some the above mentioned problems. This study evaluated the operational performance impacts of implementing DBTB treatment in the greater Atlanta area. For the studied sites, the likelihood of a vehicle to block was measured both before and after DBTB installment. The study witnessed both an increase and decrease in blocking rate after implementation of the treatment. However, it was observed that regardless of an increase or decrease in the blocking rate, the aggregated propensities to block were consistently high in both before and after treatment conditions. In addition, there was significant variability in day-to-day blocking opportunities. The study did not find any meaningful impact on blocking behavior.

Project Objectives

The overarching objective of this research is to provide the Georgia Department of Transportation (GDOT) and the Perimeter Community Improvement District (PCID) with an evaluation of the operational performance impacts of implementing a DBTB campaign at selected signalized intersections. The key sub-objectives of the project may be summarized as follows:

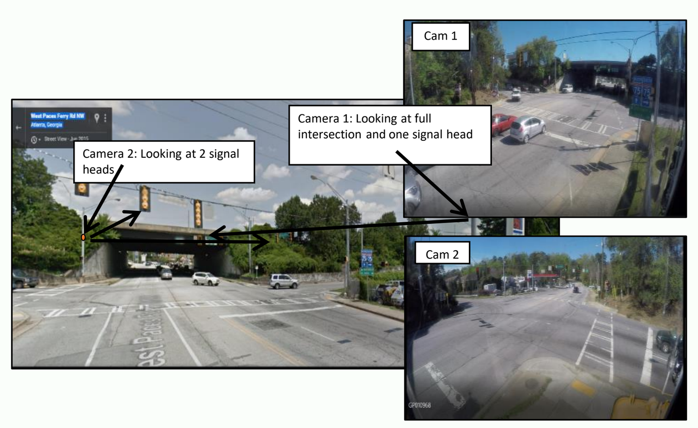
- Determine how variations in conditions among these intersections impact the effectiveness of DBTB
- Provide a review of the existing studies on "Do Not Block the Box" enforcement laws and operational performance analysis
- Perform a before–after analysis of the selected intersections undergoing DBTB implementation to evaluate differences in operational performance
- Aid decision-making regarding future DBTB implementations in Georgia

Field Study: Comparative Before-After Analysis

For this study, a blocking event is considered to occur when a vehicle enters the intersection box, is not able to exit during its given phase, and obstructs conflicting phases with the right-of-way (green indication). Blocking reduces the effective green time and capacity of the obstructed movement. In this document, an approach lane that is blocked is referred to as the *blocked lane* and the approach lane from which the blocking vehicle enters the intersection is referred to as the *block-source lane*.

Video Data Collection

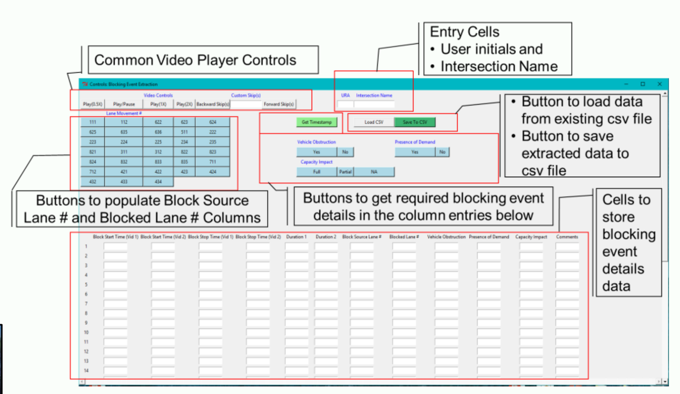
- Intersection video recordings were taken during peak and adjacent off-peak demand conditions, before and after implementation of DBTB signing and marking.
- Multiple cameras were deployed at each site to view traffic signal indications and vehicles on corresponding lanes.
- The video recordings were 7–12 hours long for each of 4–10 days at the study intersections.



W. Paces Ferry Rd. NW at I-75 SB On/Off Ramps

Data Extraction

- A Python ® based video platform called GT-MVP was developed for reliable identification of the signal indications



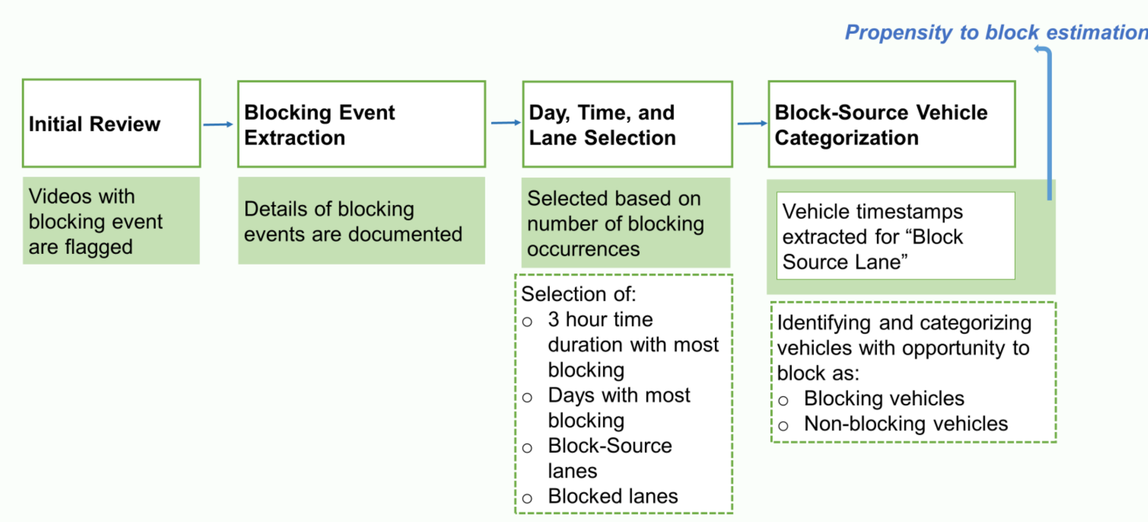
GT-MVP's Blocking Event Data Extraction Window

Methodology To Estimate Propensity To Block

The methodology to estimate vehicle's propensity to block includes four steps:

- Initial Review,
- Blocking Event Data Extraction,
- *Block-Source Lane* Vehicle Categorization Data Extraction, and
- Calculation of Propensity to Block

$$Vehicle's\ Propensity\ to\ block = \frac{\#\ of\ blocking\ vehicles}{\#\ of\ vehicles\ with\ an\ opportunity\ to\ block}$$



Flow Chart of Methodology used to Estimate Propensity to Block

Field Study Comparative Analysis Results

Intersection Name		Total # Hours	Total # of Opportunity	Total # of Blocking	Total # of Non-Blocking	Propensity
Ashford Dunwoody Rd. NE at Ravinia Dr. NE	Before	4	28	20	8	0.71
	After	9	304	184	118	0.61
Peachtree Dunwoody Rd. at Lake Hearn Dr. NE	Before	9	114	77	37	0.68
	After	6.5	44	39	5	0.89
Peachtree Dunwoody Rd. at Abernathy Rd. NE	Before	8	130	112	18	0.86
	After	4	12	1	11	Insufficient Data
Peachtree Dunwoody Rd. at Johnson Ferry Rd.	Before	10.5	219	182	37	0.83
	After	8.75	143	89	54	0.62
W. Paces Ferry Rd. NW at I-75 SB On/Off Ramps	Before	9	85	47	38	0.55
	After	9	33	22	11	0.67
Clairmont Rd. at I-85 SB, near Sam's Club	Before	9	1027	751	276	0.73
	After	9	1088	899	189	0.83

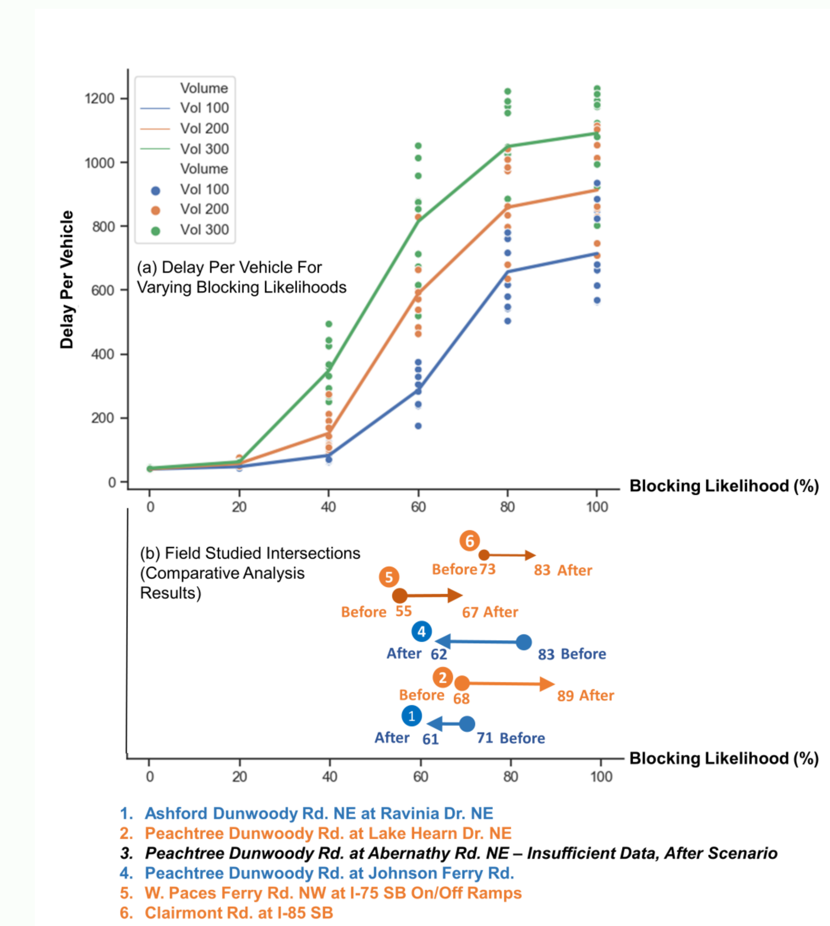
- The change in propensity between before and after conditions was inconsistent
- The aggregated observed propensities were consistently high in both the before and after conditions. The lowest observed aggregate propensity to block was 55% with all other time periods above 60%, and half of the time periods observed had a propensity to block of at least 70%.
- At the same intersection, within the same week there was significant variability in day-to-day blocking opportunities

Simulation Study: Sensitivity Analysis

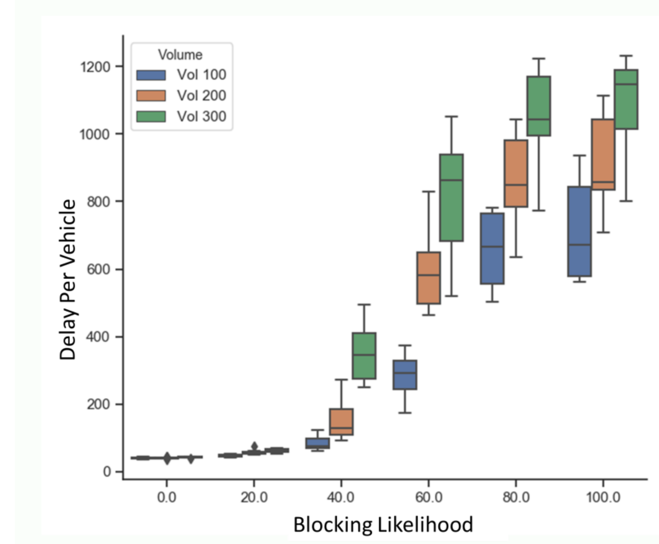
Simulation Experiment Design

- To assess impacts of blocking of the intersection, a microscopic traffic simulation (Vissim) model was developed for an intersection with downstream bottlenecks on the major street creating blocking opportunities.
- Vehicles at the primary intersection on the major street were modeled to exhibit one of two behaviors probabilistically:
  1. a tendency to enter the intersection creating a potential block
  2. a tendency to not enter the intersection when blocking could occur
- To simulate vehicles with a tendency to not enter the intersection when blocking could occur VISSIM's priority rules were used.
- The model parameter to represent a vehicle's probability of entering the intersection when a downstream blocking opportunity exists is referred to as the "Blocking Likelihood".
- Vehicles at the primary intersection are assigned to follow one of the two above-mentioned behaviors using vehicle type, depending on the likelihood input parameter.
- The simulation time period of the model was three hours where the major street volume assigned for the first hour was under capacity, the second hour was over network capacity, and the third hour was under capacity.
- Six blocking likelihood levels (0%, 20%, 40%, 60%, 80%, and 100%) were modeled; Three minor street hourly volumes were modeled (100, 200, and 300);Ten replicates were run for each blocking likelihood and minor street volume combination.

Simulation Results



a) Central tendency showing trend in the delay(s) incurred per minor street vehicles obtained from the simulation experiment.
b) Change observed in the propensity to block values at the field-studied intersections.



Boxplot of delay(s) incurred per vehicle on the minor street for varying blocking likelihood values for different minor street volumes.

- The delay is relatively stable for propensity to block rates up to 20%, then increases rapidly.
- By 40% to 50% the delay likely would be considered as a failing level of service, with extreme delays being experienced at the highest rates of 80% to 100%.

Conclusion

- Simulation results showed that the impact of blocking can be significant. However, the simulation also demonstrated that it is not necessary to reduce blocking to zero percent to limit its impact.
- While the treatments in the current field study did not demonstrate the blocking rate reductions necessary for meaningful operational benefits, the simulation study does highlight the importance for continuing to seek a solution for curbing blocking behavior.

Recommendations

- **Signal timing to reduce blocking opportunities:** Where practical, upstream signal timing should be set to limit downstream vehicle arrivals to that of the downstream intersection processing capacity.
- **Reduction or elimination of free-flow turn movements** during congested periods
- **Limit candidate intersections:** Many of the observed "blocks' had no observed impacts on intersection capacity either because the intersection size allowed conflicting vehicles to easily maneuver or because blocking and blocked vehicles used the same intersection departure lanes. This may have increased the likelihood of disregarding the treatment.
- **Public education:** A public education program on the benefits of not blocking the box may help to decrease the propensity to block and reinforce the need to follow DBTB treatments.
- **Enforcement:** Along with public education, there is likely a need for enforcement. For the given study, none of the intersection DBTB treatments were enforced through citations to drivers that blocked the box. The effectiveness of enforcement in improving the DBTB treatment performance should be explored.

This research is sponsored by the Georgia Department of Transportation under Research Project 13-16 "Enhanced Role of Activity Center Transportation Organizations in Regional Mobility" & 14-43 "Operational Evaluation of DBTB Campaigns in Georgia". Opinions expressed here are those of the authors and not necessarily those of the Georgia Department of Transportation