RESEARCH OBJECTIVES
Document the full range of driver behaviors at single-lane roundabouts and quantitatively describe how these behaviors vary with traffic volume in order to improve simulation models.

MOTIVATION
Driver behavior at roundabouts is generally modeled using gap acceptance methods; this assumes that a driver enters the roundabout only when there is a sufficient gap in the circulating traffic for that driver to enter safely. In reality this is not always the case, yet current models of roundabout operations do not reflect these non-compliant behaviors. Because there is a lack of rigidly defined priority and traffic control rules at roundabouts, driver behavior types are subject to a wider range of behaviors than are observed at conventional stop- and signal-controlled intersections.

The fundamental issue with roundabout operations is that some drivers either: 1) stop for no reason when there are sufficient gaps or no other vehicles present; 2) enter into gaps that are neither sufficient nor safe; or 3) yield to entering vehicles while circulating.

DATA / METHODS
Approximately 10 hours of video were collected on one approach at each of five single-lane roundabouts in Maine, New Hampshire, Vermont, and New York. Each roundabout approach was selected so that there would be similar geometries in order to control for as many variables as possible. Videos were only collected on fair weather days when pavement conditions were dry. Multiple days of video were collected at each roundabout during peak and off-peak hours to obtain data under several flow regimes. The camera was oriented so that the brake lights of the circulating vehicles could be clearly seen.

Video processing required two steps using a timestamp-based keystroke command script: the first step was to obtain circulating, entering, and exiting turning movement volumes. The second step was to obtain stop- and slow-hindered events for circulating and entering vehicles. These events correspond with priority taking, priority surrendering, and priority abstaining behavior.

SIGNIFICANT FINDING #1: NON-COMPLIANT BEHAVIORS EXIST AT ROUNDABOUTS, SOME OF WHICH OCCUR QUITE FREQUENTLY

SIGNIFICANT FINDING #2: THE PERCENTAGE OF ENTERING VEHICLES EXHIBITING PRIORITY TAKING INCREASES AS CIRCULATING VOLUME INCREASES

SIGNIFICANT FINDING #3: PRIORITY ABSTAINING STILL OCCURS EVEN WHEN THERE ARE NO OTHER VEHICLES PRESENT AT THE ROUNDABOUT

SIGNIFICANT FINDING #4: PRIORITY ABSTAINING BEHAVIOR APPEARS TO DIMINISH WITH TIME SINCE CONSTRUCTION, BUT PRIORITY TAKING DOES NOT

DISCUSSION
There are five main issues with using strictly gap-acceptance-based methodologies for driver behavior at roundabouts:

1) using “lags” in gap acceptance analyses will always artificially lower critical gap values thus making it appear, on aggregate, that people are more aggressive than they really are;
2) priority taking causes an immediate alteration of the gap into which the vehicles enters. This means that the data we use to calibrate and validate gap acceptance models is erroneous;
3) for priority abstaining, there is no “gap” to measure accepted or rejected;
4) using an accepted/rejected framework, there is no information regarding the utilization of space by the entering vehicle (e.g., the gap was accepted but there was impedance to the follow-up vehicle); and
5) gap acceptance models describe vehicle interactions in a reactive manner – describing only the behavior of entering vehicles based on how they react to major stream gaps. In reality, priority rules are less strict and the relationship between major stream and minor stream is much more interactive.

CONTRIBUTIONS
This research adds the knowledge and understanding of roundabout operations and entry driver behavior by using observations of real-world driver interactions at roundabouts. This represents timely research with regard to the ways in which driver behavior type and frequency change under prevailing traffic conditions. Further, current modeling methods do not appropriately account for driver behaviors that do not conform with gap acceptance frameworks or the offline-priority rule (i.e., yield-at-entering) at roundabouts. These findings provide the foundation for a new cellular automata model that will explicitly account for these behaviors for in traffic simulation.

Acknowledgments
The authors would like to acknowledge the US Department of Transportation’s University Transportation Centers program and the UVM Transportation Research Center for funding.

THAT’S NOT HOW YOU’RE SUPPOSED TO DRIVE THROUGH A ROUNDABOUT!!
NON-COMPLIANT DRIVER BEHAVIORS AT SINGLE-LANE ROUNDABOUTS
Nathan P. Betz | Doctoral Candidate, College of Engineering and Mathematical Sciences | nathan.betz@uvm.edu
Dr. Lisa Aultman-Hall | Professor, School of Engineering and Transportation Research Center | lisa.aultman-hall@uvm.edu

DATA / METHODS
Approximately 10 hours of video were collected on one approach at each of five single-lane roundabouts in Maine, New Hampshire, Vermont, and New York. Each roundabout approach was selected so that there would be similar geometries in order to control for as many variables as possible. Videos were only collected on fair weather days when pavement conditions were dry. Multiple days of video were collected at each roundabout during peak and off-peak hours to obtain data under several flow regimes. The camera was oriented so that the brake lights of the circulating vehicles could be clearly seen.

Video processing required two steps using a timestamp-based keystroke command script: the first step was to obtain circulating, entering, and exiting turning movement volumes. The second step was to obtain stop- and slow-hindered events for circulating and entering vehicles. These events correspond with priority taking, priority surrendering, and priority abstaining behavior.

SIGNIFICANT FINDING #1: NON-COMPLIANT BEHAVIORS EXIST AT ROUNDABOUTS, SOME OF WHICH OCCUR QUITE FREQUENTLY

SIGNIFICANT FINDING #2: THE PERCENTAGE OF ENTERING VEHICLES EXHIBITING PRIORITY TAKING INCREASES AS CIRCULATING VOLUME INCREASES

SIGNIFICANT FINDING #3: PRIORITY ABSTAINING STILL OCCURS EVEN WHEN THERE ARE NO OTHER VEHICLES PRESENT AT THE ROUNDABOUT

SIGNIFICANT FINDING #4: PRIORITY ABSTAINING BEHAVIOR APPEARS TO DIMINISH WITH TIME SINCE CONSTRUCTION, BUT PRIORITY TAKING DOES NOT

DISCUSSION
There are five main issues with using strictly gap-acceptance-based methodologies for driver behavior at roundabouts:

1) using “lags” in gap acceptance analyses will always artificially lower critical gap values thus making it appear, on aggregate, that people are more aggressive than they really are;
2) priority taking causes an immediate alteration of the gap into which the vehicles enters. This means that the data we use to calibrate and validate gap acceptance models is erroneous;
3) for priority abstaining, there is no “gap” to measure accepted or rejected;
4) using an accepted/rejected framework, there is no information regarding the utilization of space by the entering vehicle (e.g., the gap was accepted but there was impedance to the follow-up vehicle); and
5) gap acceptance models describe vehicle interactions in a reactive manner – describing only the behavior of entering vehicles based on how they react to major stream gaps. In reality, priority rules are less strict and the relationship between major stream and minor stream is much more interactive.

CONTRIBUTIONS
This research adds the knowledge and understanding of roundabout operations and entry driver behavior by using observations of real-world driver interactions at roundabouts. This represents timely research with regard to the ways in which driver behavior type and frequency change under prevailing traffic conditions. Further, current modeling methods do not appropriately account for driver behaviors that do not conform with gap acceptance frameworks or the offline-priority rule (i.e., yield-at-entering) at roundabouts. These findings provide the foundation for a new cellular automata model that will explicitly account for these behaviors for in traffic simulation.

Acknowledgments
The authors would like to acknowledge the US Department of Transportation’s University Transportation Centers program and the UVM Transportation Research Center for funding.