Campus: California State University Los Angeles
Course: CE3700 – Transportation Engineering
Instructor: Mehran Mazari, Ph.D.

Session Topic:
Collect and analyze traffic data at a local intersection that is under stress from left-turning vehicles to determine capacity and level of service (LOS).

Overview: In part 1, students conduct a traffic count at a busy local intersection with a traffic light (signalized) but without a dedicated left-turn lane. In part 2, students analyze the data, evaluate the intersection's capacity and level of service, and apply a growth rate to the traffic data.

Learning Objectives:
Students will be able to:
- Describe what traffic counts and turning movements are and why they are important to collect.
- Determine how different parts of an intersection function.
- Construct a turning movement diagram with field data from a local intersection.
- Describe the concept of level of service and how it impacts transportation engineering.
- Apply a growth rate to current traffic data to project a design forecast.
- Decide if the intersection studied may need improvements now or in the future.

Preparation:
Prior to Meeting 1, complete the following to prepare for the Meeting 1 data collection activity: Review the entire activity.

- Choose a busy signalized intersection near your class location where there is currently no dedicated left-turn lane (if possible, where you think there is an issue with clearing left-turning vehicles; ideally the intersection will have one or two lanes in each direction).
- Obtain a close-up of the intersection from Google maps and make 4 copies (1 copy per team).
- Decide what time of day the traffic count will occur (a higher-volume hour of the day is preferable).
- Recruit 2–4 volunteers to help during the traffic counting.

Gather materials:

For Meeting 1:
- Copies of "Counting Cars" student handout (1 per student and volunteer).
- Copies of the "Traffic Count Field Sheet" student handout (Note: choose the handout that goes with the number of lanes you will be studying) (1 per student).
- Stopwatch or watch to keep track of time (1 per volunteer).
- Clipboards or similar writing surfaces to use in the field (1 per student).
- Pencils with erasers (1 per student and volunteer).
- Safety vests meeting current standards (1 per student and volunteer).
- Optional: Clicker counters for keeping track of traffic (if available) (1 per student).

For Meeting 2:
- Copies of the "Data Crunch" student handout (1 per team).
- Calculator (if students have smartphones, they can use the calculator app on the phone) (1 per student).
- Copy of the "Traffic Count Data Summary" leader sheet.
- Presentation equipment for displaying the "Traffic Count Data Summary" leader sheet, and method for marking student data results on sheet.

*Adopted from ASCE

Prior to Meeting 1

1) Setup Traffic Counting (5 minutes)

- In the team meeting prior to doing this activity, ask students to think about driving or riding around in their city. Does it seem like they breeze through the city on some roads while sitting in traffic forever at others? Are there some places where it's easy to turn left, while others seem nearly impossible, and even dangerous? Tell them these are the types of things that engineers think about all the time. Traffic engineers want to design roadways that are both efficient and safe. They need to understand how much traffic is in a given area and how it moves to be able to efficiently improve roads, highways, subways, trains, or even bicycle paths. One way they learn about traffic loads is through traffic counts.
- Inform students that they will be doing a one-time traffic count to better understand traffic flow and turning movements at an intersection with a traffic light (known as a signalized intersection).
- Explain that traffic is typically traffic counted in several ways: placing pneumatic tubes on a road to collect data from the vehicles that drive over them, using a digital camera to shoot footage that is later reviewed to count vehicles, or sending out people who count traffic manually, similar to what students will be doing.

2) Review Traffic Count Field Work (10 minutes)

- Distribute and review with students the "Counting Cars" student handout.
- Provide a brief introduction about how the traffic count will be conducted during the next meeting.
- Check with your instructor about whether the traffic counting activity is considered a field trip and needs any parental permission; secure permissions as needed.
- Recruit your volunteers, and give each a copy of the "Counting Cars" handout and review the traffic count activity with them. Point out that volunteers will be responsible for keeping track of the time that has been decided to spend out in the field (suggested time is 15–30 minutes).

Review the Field Work (10 minutes)

- Organize students into four teams. If possible, assign at least three students to each team (one student to cover each of the three possible vehicle movements). If more than three students are on a team, students can double up on coverage on traffic movements.
- Pair up volunteers with student teams (two volunteers would have two teams each, four volunteers would have one team each). Distribute the clipboards, pencils, and safety vests to all students and volunteers (and make sure to have a stopwatch or watch to keep track of time). If available, distribute clicker counters to students.
- Distribute copies of the "Traffic Count Field Sheet: One Lane" OR "Traffic Count Field Sheet: Two Lanes" data sheet depending on how many lanes of traffic are in the intersection being studied.
- Distribute copies of the Google map you printed of the intersection you chose. Assign teams to a direction from which to watch vehicles, and have each team mark on the map where they will be stationed during the activity (students will be at either two or four locations at the intersection depending on how many volunteers are helping out):
    - Team A: Northbound vehicles
    - Team B: Eastbound vehicles
    - Team C: Southbound vehicles
    - Team D: Westbound vehicles

- Have each team of students decide within the team who will be counting and recording which of the following vehicle movements:
    - left-hand turn
    - straight through the intersection
    - right-hand turn

- Have each team also review which team members will be responsible for keeping track of whether the final car in queue at the end of the red cycle clears the light during the green phase. (The team member or members who track this vary depending on whether the intersection being studied has one or two lanes of traffic. The “Traffic Count Field Sheet” handout includes specific instructions in accordance with the number of lanes).
- Clear up any questions students might have before heading out to count traffic.

2) Evaluate/Test (50 minutes)

- Visit the intersection site and conduct the traffic count. The count should be performed over a 15- to- 30-minute period for a more effective use of time, and can be scaled up to an hour’s worth of counts. Remind volunteers that they will be responsible for keeping track of time.
- Observers should be positioned where they have a clear view of the traffic, but are away from the edge of the roadway.
- Volunteers should help students if they are having trouble watching or counting the vehicles. If the intersection is very busy and students are having trouble keeping up with counts, estimates are fine. Students can count by two if needed.
- Return to the class space after the traffic count and collect student handouts and safety vests.
- Let students know that at the next meeting they will be sharing and analyzing the data they collected.

Crunch Data (20 minutes)

- Distribute the “Data Crunch” student handout and calculators to each team. Have students fill out the tables on the handout using the data they collected during their field work, and perform the calculations needed on their data.
- Once students have filled out the tables, review the first Turning Movement Sample Diagram on students’ “Data Crunch” handout that shows how engineers report turning movements. Tell students that the numbers in the sample diagram represent **Average Daily Totals** (ADT) for that intersection for one day, which is how traffic engineers typically show intersection turning movements.
- Following the review, have students create their own Turning Movement Diagram using the data they collected for the direction they were watching.

2) Evaluate/Test (50 minutes)

- Once all teams have entered their data, have each team report its results for: the Cycle Data (final average percent loaded)
- the Turning Movement Diagram ADTs for each movement, and the sum of the ADTs for each direction
- Write each teams’ results into the correct table or diagram on your “Traffic Count Data Summary” leader sheet being projected on the overhead.
- Introduce two ways that engineers assess roadway efficiency: Capacity and Level of Service (LOS). Capacity is a measure of how many cars a road can handle, how many trains a railroad can handle, or perhaps how many people a subway system can handle during a given period of time under prevailing conditions. It provides a quantitative measure of a facility, and is usually obtained through field observations. Capacity is usually expressed in terms of vehicles per hour, passenger cars per hour, or persons per hour. Level of service, on the other hand, tries to define the quality of a road’s present traffic situation. It is both a quantitative and a qualitative measure of operational conditions, such as speed and travel time, density of traffic, driver comfort and convenience, and delays. LOS grades range from A through F, with A representing the best range. LOS can be used to quickly analyze the existing condition at the intersection.
- Look at the Cycle Analysis data with students. How well was each road in the intersection able to handle the capacity the day and time they took the data? Were all the cars cleared during each light cycle? How did the four different directions compare in terms of clearing the cars during each light cycle? If there were marked differences in percent loaded across the light cycles, what might account for that? (There may have been heavy vehicles [e.g., trucks, buses, RVs] in some of the

cycles, which would affect the counts because they take up more roadway space and are often not able to keep pace with passenger vehicles, thus at times allowing less traffic to clear. Traffic counts normally take into account heavy vehicles, but were not included in students' field work to simplify the activity).

- Now discuss the level of service for each road in the intersection. Have students look at the average percent loaded numbers for each direction of the intersection they studied during a complete cycle (red to red signal). Then have students use he following LOS criteria below to assign each direction an LOS.
- What levels of service do students determine the intersection to be operating at today based on the direction they watched? The lowest LOS out of the four directions is the intersection's overall LOS. Does it appear that left turns from any direction are impacting the entire intersection's function based on the movement data acquired? Discuss any other observations students had about the intersection during their field work. Did they see any pedestrians or bicyclists using crosswalks? Did that seem to impact traffic flow? In a final analysis, does it appear to students that a dedicated left-turn lane might be needed at any of the intersection's four roadways? Does it appear that a right-turn lane might be needed? Could the signal timing (or length of time for green for each movement) be improved to possibly help the heavier movements?
- Point out to students that they collected data for just a brief period of time at one time of the day during one day of the week, so their observations may not accurately reflect whether a dedicated left-turn lane is needed. Traffic planning decisions are usually based on much more data taken at multiple times of the day and week (and sometimes year), and that accident rates are also taken into consideration when deciding whether to modify roadways or intersections.

3) Forecast (10 minutes)

- What about the future? What if more people move into the area, or a new stadium draws crowds on certain days? Engineers must consider growth factors and their potential impact on how an intersection may be changed.
- What would happen if, projecting out 20 years, the traffic increased by 5% per year? (If you would like, substitute a projected design year and growth rates for your area.) Review the second Turning Movement Sample Diagram on students' "Data Crunch" handout that shows both the original data and also the forecasted data. (Note that the growth projections for the sample data below were 1.25% annually).
- Have students calculate the 5% projected increase for the traffic direction they studied, and add it to their original Turning Movement Diagram that contains the figures from their original traffic count. After they have calculated and added in the forecasted data, have each team report their results for the class. Write each teams' results onto the Turning Movement Diagram on the leader sheet being projected on the overhead.
- Compare results and discuss what this may mean for the future. If the intersection or specific movements aren't failing now, are they likely to fail soon with increased traffic? Do students think an improvement should be made now, or should funds be spent elsewhere?

4) Wrap Up (5 minutes)

- Introduce the next meeting: Students will be designing a dedicated left-turn lane.

EXTENSIONS

- **Learn more about level of service and congestion.** Use parts or all of the "What's Up with All This Traffic?" lesson from TeachEngineering.org to help students discover two ways level of service is determined and the mathematical procedure to derive traffic density using the units of measurement for speed and flow. Find it at
- http://www.teachengineering.org/view_lesson.php?url=collection/usf_/lessons/usf_traffic/usf_traffic_ lesson01.xml - objectives.
- Introduce students to real-world traffic simulations. Traffic engineers create and use traffic simulations to better help plan, design, and operate transportation facilities. Simulations are

created using computer programs that mathematically model traffic flow. Show students some of the following simulations:

- **The** Phantom **Traffic Jam: An Explanation** (2min 35sec) https://www.youtube.com/watch?v=goVjVVaLe10
- Video shows how a phantom traffic jam—one that seems to have no visible cause—occurs on a congested UK highway. Followed by a traffic simulation revealing what happens once the roadway becomes clogged with traffic.
- **Chicago Traffic Microsimulation (1min)** https://www.youtube.com/watch?v=ZQO_gwLMlPQ
- A microsimulation model of Chicago Traffic created by the TRACC center at Argonne National Laboratory.
- **Traffic and Pedestrian Modelling: Los Angeles (1min 17sec)** https://www.youtube.com/watch?v=AygCSbZh60s
- This microsimulation model of LA Live, a downtown Los Angeles destination for entertainment and events; model includes both vehicles and pedestrians.
- **Ask students to look at local intersections without a dedicated left-turn lane during a busy time of day.** Have students evaluate if a dedicated lane is warranted. If so, ask students to list reasons why there is not one. Reason might include: level of service is high even without a dedicated turn lane
- right-of-way issues prevent addition of a turn lane
- although growth or development may have occurred, no one has complained or there has been no significant increase in reported crashes
- no available funding
- **Invite a city engineer to talk about local traffic capacity and level of service.** Ask a city engineer to visit the class to discuss how the city decides when to collect traffic data and how it uses the data to inform planning decisions. Have the engineer also discuss other factors involved with deciding to make any traffic flow changes, such as city policy, community input, and budget.