**Introduction to Traffic Simulation**

13th Street is one of the more commonly traveled streets in Omaha. Heading south on 13th Street leads directly to the zoo and I-80, whereas heading north will lead toward Downtown and the Old Market. Both directions on 13th Street lead to heavily populated parts of the city, or lead to common routes for commuting, such as the Interstate.

For this analysis, the intersection of 13th and Martha was used to record and analyze different traffic pattern simulations. With average traffic totaling over 25,000 vehicles a day, most of this traffic is happening on 13th Street going north and south. As seen in the image below, 13th Street itself has four lanes of traffic due to the increased volume, while Martha Street has only two lanes (one north and one south) to help handle the daily traffic of people moving east and west through Omaha. Traffic lights are used for control at this intersection.

A picture containing tree, day

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**Assumptions and Other Factors**

While the simulation is very nice, it is dealing with a human matter. A machine can do a great job of trying to predict outcomes, but traffic is still a human activity, and humans can be hard to predict.

There are assumptions to be made, and other human factors not taken into account when running through the simulation. For assumptions in the simulation, we are making an educated guess on things such as the amount of time lights are green, the amount of time it takes each traveler to depart once green, having an even number of lanes each way, and that travelers are heading in one direction without turning. In the initial simulation, there is an assumption that heading E/W, the light will remain green for 60 seconds, and for N/S, the light will remain green for 30 seconds, and it takes 2 seconds for a commuter to depart once the light switches to green. We also assume that all directions of the intersection have the same control unit, such as a stoplight. If 13th Street has a stoplight, then we have to automatically assume that there is a stoplight on Martha Street as well. There are certain human elements that are not accounted for as well, such as potential construction that takes place on this street, and the willingness of travelers to choose other routes during peak hours. For the simulation, however, we must make these assumptions. As discussed in the next section, traffic wait times are not bad at this area. Still, it is interesting to see if there may be a way to reduce the overall time that travelers spend waiting as they commute through this intersection in all directions.

**As-Is Simulation Traveler Analysis**

When data for 13th and Martha is ran through the simulation, there are revelations that can be discovered. Using Python visualization tools, we are able to see the total number of travelers per hour after the simulation is ran. Figure 2.1 refers to this. The simulation data reveals that the common “rush hour” times (7-8am and 4-5pm) are the busiest times of the day for the intersection of 13th and Martha, nearing close to 2,000 travelers per hour at the maximum. This makes sense due to the fact that the interstate is so close, and there are many highly populated communities, such as Little Bohemia and Little Italy, in this area. It can be assumed that most of this traffic is happening on 13th Street (N/S), and a further breakdown of the direction that travelers are heading further confirms this theory, as seen in Figure 2.2 below.

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Breaking down the average wait time per direction in Figure 2.4, similar to Figure 2.2, shows which direction that is being traveled that is causing the wait. This can be further analyzed to decide where inefficiencies lie, and if these inefficiencies can be resolved to help move the travelers along with less wait time. Some solutions for these inefficiencies can be to add more lanes or change to a stop sign, which will be explored further, but first, it is important to try and find where the inefficiency lies.

Figure 2.4 confirms that the average wait time traveling E/W on Martha Street has a wait time of around 6-7 seconds, where the wait time traveling N/S on 13th Street hovers at more than 20 seconds. The lower wait time going E/W is bringing the average down. Because 13th Street is the more-traveled street, and there are significantly higher wait times heading E/W, it would be reasonable to explore options where 13th Street can be more efficient. These are explored in the following section.

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**Simulation for Efficiencies**

From the data gathered above, it seems that 13th Street could potentially be adjusted so that the flow of traffic is easier going through, bringing wait times down. Since Martha Street is far less traveled and has a far shorter wait time, the most worthwhile and effective strategy would try to find ways to help traffic as they travel along 13th Street. With the assumptions made in the simulation, there are a couple of different options that could be explored. The following simulations will look at increasing/decreasing the amount of time the light is green on 13th Street and adding a lane to 13th Street. A stop sign cannot be used in this simulation because it is assumed that a traffic light will be used for all intersections with more than two lanes.

**Changing the length of time the light remains green on 13th Street:** Interestingly, if the amount of time the light is green heading E/W is changed from 60 seconds to 75 seconds, this actually causes the average wait time to increase for all directions. An educated guess for why this could be happening is that having longer green lights allows more cars to stack together as they flow through 13th Street, causing inefficiencies while the light turns to red as more cars line together. This is displayed in Figure 3.1 below.

Using the same logic, if the amount of time that the light is green were decreased from 60 seconds to 30 seconds, we actually see more efficiency when traveling on 13th Street. Wait time on Martha Street (N/S) would increase, but the average wait time for commuters on 13th Street would decrease dramatically. It would be almost an even wait for travelers in all directions, as seen in Figure 3.2. Travelers on Martha Street would have to wait longer than travelers on 13th Street, which does not sound as bad considering there are vastly more travelers on 13th Street and that the average wait time goes down for travelers heading N/S greater than it goes up for travelers heading E/W.

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**Increasing the amount of lanes on 13th Street:** Assuming the green lights at the intersection going E/W on Martha Street are set at 60 seconds, as in the initial assumption for the simulation, it is curious to see how adding more lanes to 13th Street will help with traffic, and whether this is more beneficial than the duration of green lights as described above. Figure 3.3 shows the results of increasing the amount of lanes on 13th Street from four to six, with the green light remaining at 60 seconds. As shown, adding this extra lane actually does nothing to the average wait time heading in all directions when all else remains equal from the initial simulation. Figure 3.3 is exactly the same as Figure 2.4, meaning that adding a lane would not help with the flow of traffic heading in any direction. All else remaining equal and knowing that increased lanes did not help with wait times from the initial simulation, this means that mathematically if we had a six-lane road and decreased the green light time from 60 seconds to 30 seconds, then this would produce the same results as Figure 3.2. Adding lanes to 13th Street does not help in any situation when it comes to wait times.

In Figure 3.4, adding a lane to Martha Street is explored. Adding a lane to this less-traveled road yields the same results as increasing the lanes on 13th Street: There is no difference when lanes are added. It seems that the current assumptions on the lanes in our initial simulation are the most efficient, since adding more would do absolutely nothing for the cause.

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**Recommendation and Conclusion**

After analyzing these traffic patterns on 13th and Martha and trying different simulation scenarios, it seems that the efficiency of travel can be increased at an extremely minimal cost. As mentioned above, there is no need for new lanes in the assumptions that we have made. Adding a lane would cost $3 to $5 million and thousands more to maintain each year, but based off the analysis, this would be a complete waste of money and would not help traffic in the slightest. A stop sign cannot be put in place of the stoplights since 13th Street currently has four lanes. Even with these four lanes, the wait time is more than 20 seconds when the green light going N/S is set at 60 seconds. It would be logical to assume that if adding a lane would not help these times, then decreasing a lane would not help either.

From the analysis, the best solution is the cheapest: Decrease the amount of time the light is green going through 13th Street. It almost seems paradoxical, since spending less time going being able to go through the light would seemingly result in greater lines and thus a longer wait each time, but the opposite is true. There is such a high volume of traffic going through that the cars lump and stick together the longer the light is green, and making it green for a shorter time will space out the cars in the lanes so that there is more movement between lights.

This solution requires no money, just a program change to the light. Adding and decreasing lanes is incredibly expensive and would bear no fruit. A stop sign is not safely possible. The only thing that would help with the flow is to be able to spread out the traffic by decreasing the amount of time the light is green, and this brings the average down from over 20 seconds of waiting to just around 8-9 seconds of waiting. While Martha Street would see increased waiting times due to the decreased green light time on 13th Street, this would be a maximum of 4 seconds difference.

It should be noted that the initial assumption is that the intersection heading E/W is green for 30 seconds, while N/S is 60 seconds. This is just an assumption, but with this assumption, we can see that shifting the time helps dramatically. The city of Omaha could increase effiency and not spend a single nickle if they decreased the green light time, with the presumption that our initial assumptions are correct.

Also to note is that if we go with our initial assumptions, the maximum wait time is greater than 60 seconds. Rougly 6,000 travelers wait more than 20 seconds on 13th Street, with 700 waiting more than 50 seconds, occuring primarily in the “rush hours”. Decreasing the light time will still have around 6,000 travelers wait more than 20 seconds, but the amount of travelers waiting more than 60 seconds will decrease to around 250, bringing the average down.