MICHIGAN OHIO UNIVERSITY TRANSPORTATION CENTER
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TRAFFIC SIMULATION IN REGIONAL MODELING:
APPLICATION TO THE INTERSTATE INFRASTRUCTURE NEAR THE TOLEDO SEA PORT

FINAL REPORT

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DISCLAIMERS

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ABSTRACT

A small team of university-based transportation system experts and simulation experts has been assembled to develop, test, and apply an approach to assessing road infrastructure capacity using micro traffic simulation supported by publically available data in partnership with personnel of the Toledo Sea Port, the Toledo Metropolitan Area Council of Governments, and the Ohio Department of Transportation. Application activities previously focused on the arterial road infrastructure connecting the Toledo Sea Port to the interstate highway system via Interstate 280 and now focus on capacity on Interstate 75 in Toledo near Anthony Wayne Trail and Nebraska Avenue. Data was gathered from the Toledo Metropolitan Area Council of Governments and the Ohio Department of Transportation. A micro traffic simulation model was developed using the commercial software product AIMSUN. Simulation experiments were conducted to assess traffic bottlenecks caused by a construction project to add one additional lane in each direction to I-75. The road infrastructure was seen to have sufficient capacity to support the construction activity without traffic delays.

Table of Contents

List of Tables

List of Figures

I. Action Plan for Research

The action plan was designed to help the research team meet its fundamental goal of assessing the adequacy of the capacity of the road infrastructure supporting the construction activity adding one lane in each direction to I-75 near Anthony Wayne Trail and Nebraska Avenue in Toledo, Ohio. Meeting this objective involved the following.

1. Systematically acquire publically available relevant data relevant from TMACOG and the Ohio Department of Transportation (ODOT).
2. In addition, acquire map information describing the road infrastructure from public sources such as Google Earth, Bing Maps and Microsoft Map Point.
3. Develop a micro traffic simulation model of the road infrastructure using the AIMSUN traffic simulation software.
4. Design and conduct simulation experiments to assess the adequacy of the capacity of the road infrastructure during the construction activity.

II. Introduction

A small team of university-based transportation system experts and simulation experts has been assembled to develop, test, and apply an approach to assessing road infrastructure capacity. This team is supported by funding provided by the MIOH-UTC through the U.S. Department of Transportation (USDOT) with matching funds supplied by Grand Valley State University (GVSU). This report covers the period: September 2011 through June 2012.

The team has been working in the following areas:

1. Gathering and using publicly available data concerning road infrastructure and the traffic that uses such infrastructure.
2. Micro traffic simulation to assess the adequacy of the capacity of the traffic infrastructure.

As a proof of concept of the procedures and methods we have developed, the above have been applied to a capacity assessment of the road infrastructure supporting the Toledo Seaport, focusing on the arterial roads between the port and the interstate highway system. Now, this work is extended to assess the adequacy of freeway capacity during a lane addition construction project.

The effort has been led by faculty in the GVSU School of Engineering (SOE), Professor Charles Standridge, as well as the WSU Department of Civil and Environmental Engineering (CEE), Professor Emeritus Snehamay Khasnabis. Students from School of Computing and Information Systems (SCIS) at GVSU, particularly M. Qureshi and S. Kesireddy, have ably assisted. Support for our work has been provided by TMACOG, Mr. Warren Henry, as well as ODOT, particularly the staff of District 2, Mr. Todd Audet.

III. Objective

The team has established that its primary research objective is to assess the adequacy of the capacity of I-75 near Anthony Wayne Trail and Nebraska Avenue during a construction project to add one lane in each direction. The team has addressed this objective through the development and application of a micro traffic simulation model developed in AIMSUN.

IV. Scope

The construction project is proposed in three phases. Two of these phases result in the restriction of traffic on I-75 to one lane in each during construction. More specifically traffic is restricted to one lane starting at the bridge at Nebraska Ave to 1500 feet on either side of the bridge. This section of I-75 has a posted speed of 65 mph, and has two lanes in each direction with shoulders. The roadway has enough capacity to accommodate current traffic demand. During the proposed construction, this section may be effectively reduced to a one lane facility. Assessing the impact of this construction is the object of this pilot study.

V. Methodology

A micro-traffic simulation model of the traffic network shown in Figure 1 was developed using AIMSUN. This area is about 2 miles south on I-75 from the exit to the Toledo Seaport. Data sources included TMACOG and ODOT for Lucas County using the following websites.

http://www.tmacog.org/Transportation/Transportation.htm
http://www.dot.state.oh.us/Pages/Home.aspx
http://www.dot.state.oh.us/districts/D02/Pages/default.aspx
http://www.odotonline.org/techservapps/traffmonit/countinformation/default.htm
(time of day distribution)

There is one entrance / exit (201 as shown in Figure 1) to consider in each direction. Data showed the traffic count preceding the exit and the traffic count after the exit. The difference is the net volume increase due to the exit and entrance activity, which could be negative.

AIMSUN requires that the net volume increase consist of two components: The traffic exiting and the traffic entering. The available data allowed only for the computation of the net volume increase as a single value. To determine the each of the two components it was necessary to assume the percent of traffic exiting at 201, which was set to 20%. We believe this assumption will have little effect on the results since the net traffic volume is correct. Additional simulation experiments can be conducted to test the validity of this assumption.

In addition, AIMSUN requires that the percent of trucks and cars in the traffic flow be specified as trucks take more space on the roadway than cars. It was assumed that the traffic was distributed as 85% cars and 15% trucks. Additional simulation experiments can be conducted to test the validity of this assumption by varying the percentage of trucks and cars.

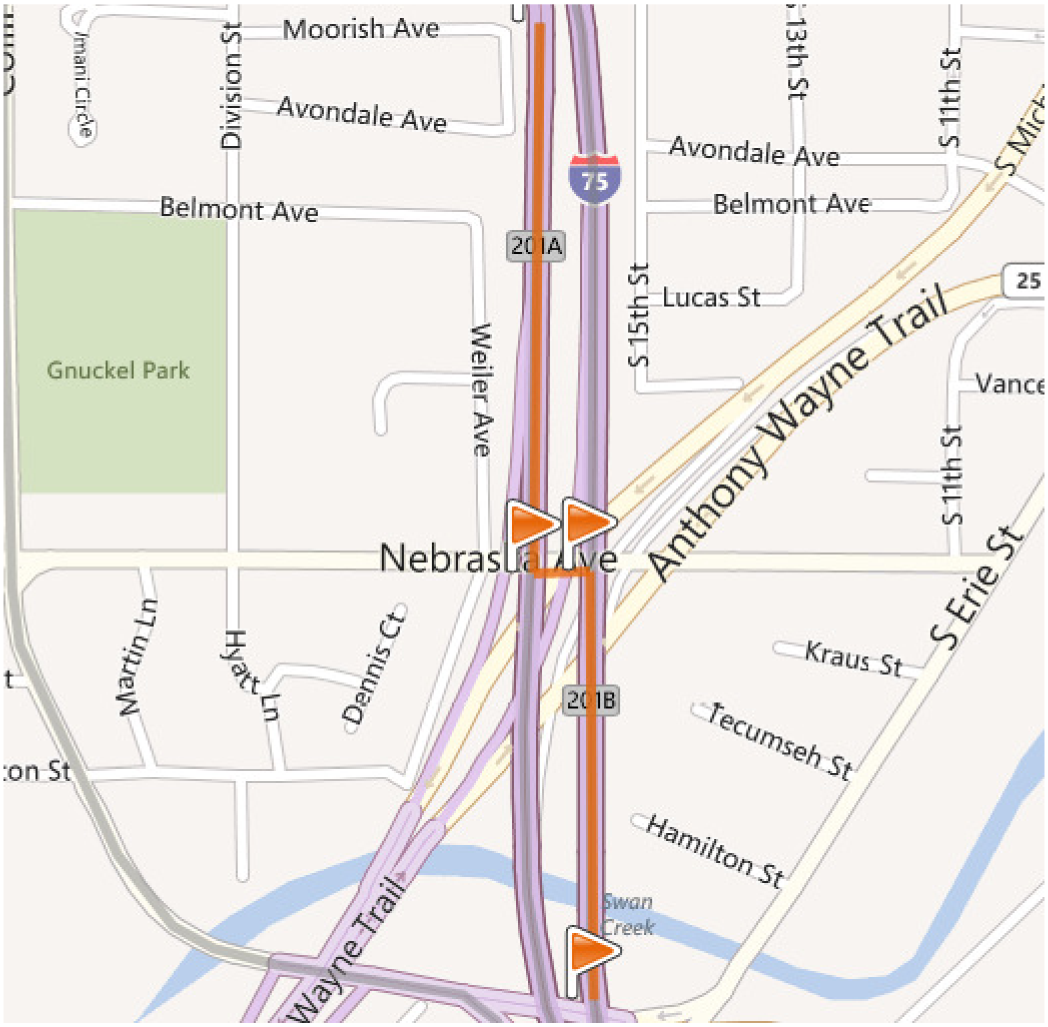

Figure 1. Map of Construction Zone on I-75

VI. Discussion of Results

Simulation experiments were run with all lanes open in each direction and with one lane open in each direction for a 16-hour period. The distribution of traffic over the 16-hour period was determined using traffic counts for a nearby road.

Selected quantities resulting from the simulation experiments may be defined as follows.

- Hours (input): Total simulation hours.
- Inside (output): Total numbers of vehicles within the network at any point in the simulation. We defined a value exceeding 1% of the Gone Out value as excessive, indicating a lack of capacity.
- Gone Out (output): Total number of vehicles exited from the network.
- Total (output): Total numbers of vehicles entering the network, equal to the sum of Inside and Gone Out.

The following tables contain the simulation results by time of day with I-75 at normal capacity and with traffic reduced to one lane.

Table 1. Results with No Closed Lanes

15-Minute Interval End-Time	Inside	Gone Out	Total
7:15:00	4	612	616
7:30:00	2	580	582
7:45:00	7	592	599
8:00:00	1	584	585
8:15:00	10	603	613
8:30:00	3	584	587
8:45:00	13	590	603
9:00:00	2	598	600
9:15:00	8	550	558
9:30:00	10	615	625
9:45:00	9	582	591
10:00:00	8	570	578
10:15:00	6	540	546
10:30:00	8	580	588
10:45:00	8	592	600
11:00:00	10	601	611
11:15:00	9	654	663
11:30:00	8	577	585
11:45:00	6	576	582
12:00:00	5	621	626
12:15:00	12	550	562
12:30:00	6	649	655
12:45:00	3	564	567
13:00:00	7	561	568
13:15:00	2	601	603
13:30:00	9	573	582
13:45:00	1	569	570
14:00:00	9	539	548
14:15:00	9	576	585
14:30:00	2	559	561
14:45:00	7	583	590
15:00:00	3	609	612
15:15:00	10	562	572
15:30:00	6	608	614
15:45:00	4	567	571
16:00:00	6	599	605
16:15:00	6	601	607
16:30:00	7	588	595

15-Minute Interval End-Time	Inside	Gone Out	Total
16:45:00	3	557	560
17:00:00	6	602	608
17:15:00	5	600	605
17:30:00	4	538	542
17:45:00	3	544	547
18:00:00	5	572	577
18:15:00	6	510	516
18:30:00	7	626	633
18:45:00	4	578	582
19:00:00	4	541	545
19:15:00	9	605	614
19:30:00	7	597	604
19:45:00	6	574	580
20:00:00	6	579	585
20:15:00	4	633	637
20:30:00	3	580	583
20:45:00	9	578	587
21:00:00	4	642	646
21:15:00	9	615	624
21:30:00	5	593	598
21:45:00	4	612	616
22:00:00	5	570	575
22:15:00	5	566	571
22:30:00	6	601	607
22:45:00	6	562	568
23:00:00	6	574	580

The table shows no traffic congestion as the number of vehicles in the network at the end of each 15 minute interval is small relative (less than 1%) to the total number of vehicles traveling the network.

Table 2. Results with One Lane Closed in Each Direction

15-Minute Interval End-Time	Inside	Gone Out	Total
7:15:00	14	564	574
7:30:00	13	567	580
7:45:00	5	602	607
8:00:00	12	604	616
8:15:00	2	617	619
8:30:00	19	604	623
8:45:00	9	509	518
9:00:00	5	603	608
9:15:00	7	569	576
9:30:00	9	597	606
9:45:00	2	562	564
10:00:00	8	545	553
10:15:00	4	580	584
10:30:00	1	589	590
10:45:00	7	561	568
11:00:00	1	561	562
11:15:00	7	593	600
11:30:00	7	526	533
11:45:00	5	582	587
12:00:00	5	590	595
12:15:00	15	571	586
12:30:00	2	602	604
12:45:00	10	545	555
13:00:00	5	550	555
13:15:00	5	581	586
13:30:00	9	583	592
13:45:00	3	578	581
14:00:00	15	581	596
14:15:00	7	560	567
14:30:00	1	559	560
14:45:00	15	588	603
15:00:00	3	596	599
15:15:00	7	588	595
15:30:00	3	579	582
15:45:00	1	590	591
16:00:00	18	582	600
16:15:00	9	597	606
16:30:00	7	592	599

15-Minute Interval End-Time	Inside	Gone Out	Total
16:45:00	7	565	572
17:00:00	5	592	597
17:15:00	5	604	609
17:30:00	12	602	614
17:45:00	1	616	617
18:00:00	3	576	579
18:15:00	2	579	581
18:30:00	10	576	586
18:45:00	2	601	603
19:00:00	1	609	610
19:15:00	1	545	546
19:30:00	10	619	629
19:45:00	5	567	572
20:00:00	6	632	638
20:15:00	3	595	598
20:30:00	5	626	631
20:45:00	8	606	614
21:00:00	5	598	603
21:15:00	3	586	589
21:30:00	2	560	562
21:45:00	3	571	574
22:00:00	1	575	576
22:15:00	1	557	558
22:30:00	10	577	587
22:45:00	2	558	560
23:00:00	18	621	639

The table shows no traffic congestion as the number of vehicles in the network at the end of each 15 minute interval is small (less than 1%) relative to the total number of vehicles traveling the network.

VII. Conclusions

The results of the micro traffic simulation indicate that the construction project will not cause congestion on I-75.

VIII. Recommendations for Future Research

Assessing for potential congestion by changing the traffic volume or time of day distribution would be of interest. In addition, additional simulation experiments varying the percentage of trucks and cars in the traffic flow as well as the percent of cars exiting at 201 could be performed to assess the sensitive of the results to these values.

IX. Recommendations for Implementation

The simulation results support proceeding with the construction project as planned.

X. List of Acronyms, Abbreviations, and Symbols

CEE	Civil and Environmental Engineering
GVSU	Grand Valley State University
MIOH-UTC	Michigan Ohio University Transportation Center
ODOT	Ohio Department of Transportation
SCIS	School of Computing and Information Systems
SOE	School of Engineering
TMACOG	Toledo Metropolitan Area Council of Governments
USDOT	United States Department of Transportation
WSU	Wayne State University

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