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Task #1 - First Interim Report: Simulation Modeling of Toll Plaza Traffic at Midpoint and Cape Coral Bridges for November 1997

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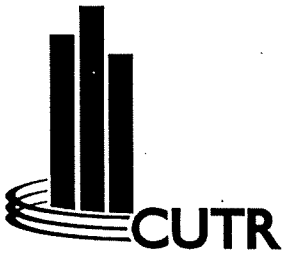
(CUTR Account No. 21-17-271-L.0.)



by
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for the
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Introduction

The Lee County DOT is planning to open the Midpoint bridge in October 1997, and it is to be equipped with an ETC system upon opening to traffic. Additionally, traffic volumes served by present bridge facilities in Lee County will experience significant changes due to the opening of Midpoint Bridge. It is expected that some traffic handled by Cape Coral bridge will shift to Midpoint bridge along with a large shift from other non-tolled bridges.

This report examines the potential impact of non availability of electronic toll collection (ETC) systems on traffic on two toll bridge plazas in Lee County (Midpoint bridge and Cape Coral bridge) along with the predicted change in traffic volumes. To accomplish this, computer simulation models developed previously (Technical Memorandum #3, CUTR Project No. 21-17-227-L0) for each of the toll plazas and their approaches have been modified to reflect the changes in the traffic volumes and toll payment options. These models have been developed to examine all aspects of the toll collection processes. These simulation models have used several possible arrangements of the vehicle users, vehicle arrival rates, and traffic volumes.

Methodology

Traffic Data Collection

To simulate the traffic conditions expected due to the opening of Midpoint bridge, new traffic data have been compiled and computed. The data used in the simulation modeling has been compiled and calculated from various yearly, daily, and hourly statistics kept by the Lee County DOT. Data obtained from Lee County DOT included:

- The predicted daily volumes of traffic on Cape Coral and Midpoint bridge facilities for the year 1997.

- Hourly traffic counts on Cape Coral bridge for December 1996.[1]
- Percentage of vehicles that use coin drop stickers and unlimited pass stickers.

Initial traffic calculations were done by averaging the monthly traffic data of March and July. When Lee County DOT provided the traffic data for the month of December, the previously calculated statistics were scrutinized by CUTR project team to verify any discrepancies. It was observed that there are no significant differences between the statistics calculated by averaging and the ones calculated with new traffic data. Data calculated by the project team included:

- The typical daily traffic in November by using monthly traffic factors.
- Percentage of vehicles traveling in peak hours over the Cape Coral and Midpoint Bridges.
- Number of vehicles traveling in each direction in peak hours over the Cape Coral and Midpoint Bridges.
- Percentage of vehicles that use coin drop stickers and unlimited pass stickers, automatic coin machines, and manned booths.

The daily traffic expected during November 1997 has been calculated by scaling the predicted daily traffic for the year 1997 with a standard monthly factor. The traffic figures used by NationsBanc Capital Markets, Inc. indicated that Cape Coral bridge and Midpoint bridge will experience a daily traffic of 37,936 vpd and 26,885 vpd respectively during the year 1998.[2] They include 10,000 vpd from Cape Coral bridge and another 16,885 from free bridges and new trips. By applying a monthly factor of 99%, the predicted traffic during November has been computed as:

- Predicted traffic volume on Cape Coral Bridge during November 1997 is

  $0.99 \times 37{,}936 = 37{,}557$ vpd.

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[1] Due to technical problems, the December data has been used instead of November data.

[2] 1998 Predicted traffic volumes have been used in order to reflect the impact of Midpoint bridge on other facilities.

- Predicted traffic volume on Midpoint Bridge during November 1997 is

  0.99 **x** 26,885 = 26,616 vpd.

The percentage of vehicles traveling in a peak hour and the percentage of vehicles traveling in peak direction during the peak hour have been computed using hourly traffic data provided by the Lee County DOT. In December 1996, Cape Coral bridge handled a daily traffic of 47,068 vpd on average and the hourly traffic count distribution showed that approximately 3,691 vehicles travel during morning peak hour (7-8) and 4,432 vehicles use the Cape Coral facility during evening peak hour (4-5). It was also found that approximately 80% of the traffic travels in peak direction during the morning peak hour and approximately 70% of the traffic travel in peak direction during the evening peak hour.

- percentage of vehicles traveling in the morning peak hour = $\frac{3,691}{47,068}$ **x** 100 = 7.7%
- percentage of vehicles traveling in the evening peak hour = $\frac{4432}{47,068}$ **x** 100 = 9.0%
- number of vehicles traveling in peak direction in the morning peak hour

  = 37,557 **x** 7.7% **x** 80% = 2,313 vph

- number of vehicles traveling in peak direction in the evening peak hour

  = 37,557 **x** 9.0% **x** 70% = 2,366 vph

By using the same percentages for Midpoint Bridge, the vehicles traveling in peak direction during a peak hour have been computed as:

- number of vehicles traveling in peak direction in the morning peak hour

  = 26,616 **x** 7.7% **x** 80% = 1,640 vph

- number of vehicles traveling in peak direction in the evening peak hour

  = 26,616 **x** 9.0% **x** 70% = 1,676 vph

Since the objective of this study is to examine the effect of non-ETC facilities on the traffic, other vehicle types modeled here include vehicles using unlimited pass stickers, vehicles using coin drop stickers, vehicles with correct change, and vehicles needing change or receipts or exempted. Based on data collected in the past and experience, Cape Coral bridge has been modeled for one set of toll payment options. Keeping in mind the uncertain number of vehicles that would be equipped with unlimited pass stickers and coin drop stickers by the opening of the new bridge, Midpoint bridge has been modeled with two different sets of vehicles using different toll payment options. They are as shown in Table 1 and Table 2.

Table 1: Percentage users with various toll payment options on Cape Coral bridge

Payment Option	**Percentage**
Vehicles using unlimited pass stickers	18.80%
Vehicles using coin drop stickers	31.30%
Vehicles with correct change	20.00%
Vehicles needing change	29.90%

For Midpoint bridge, it is predicted that out of the total volume of 26,900 vpd, 10,000 vpd will shift from Cape Coral bridge and another 16,900 vpd will come from other free bridges. Since the number of users coming from free bridges that would have stickers is not known, two scenarios have been modeled with different proportions of toll payment options. These two scenarios have been explained in Table 2.

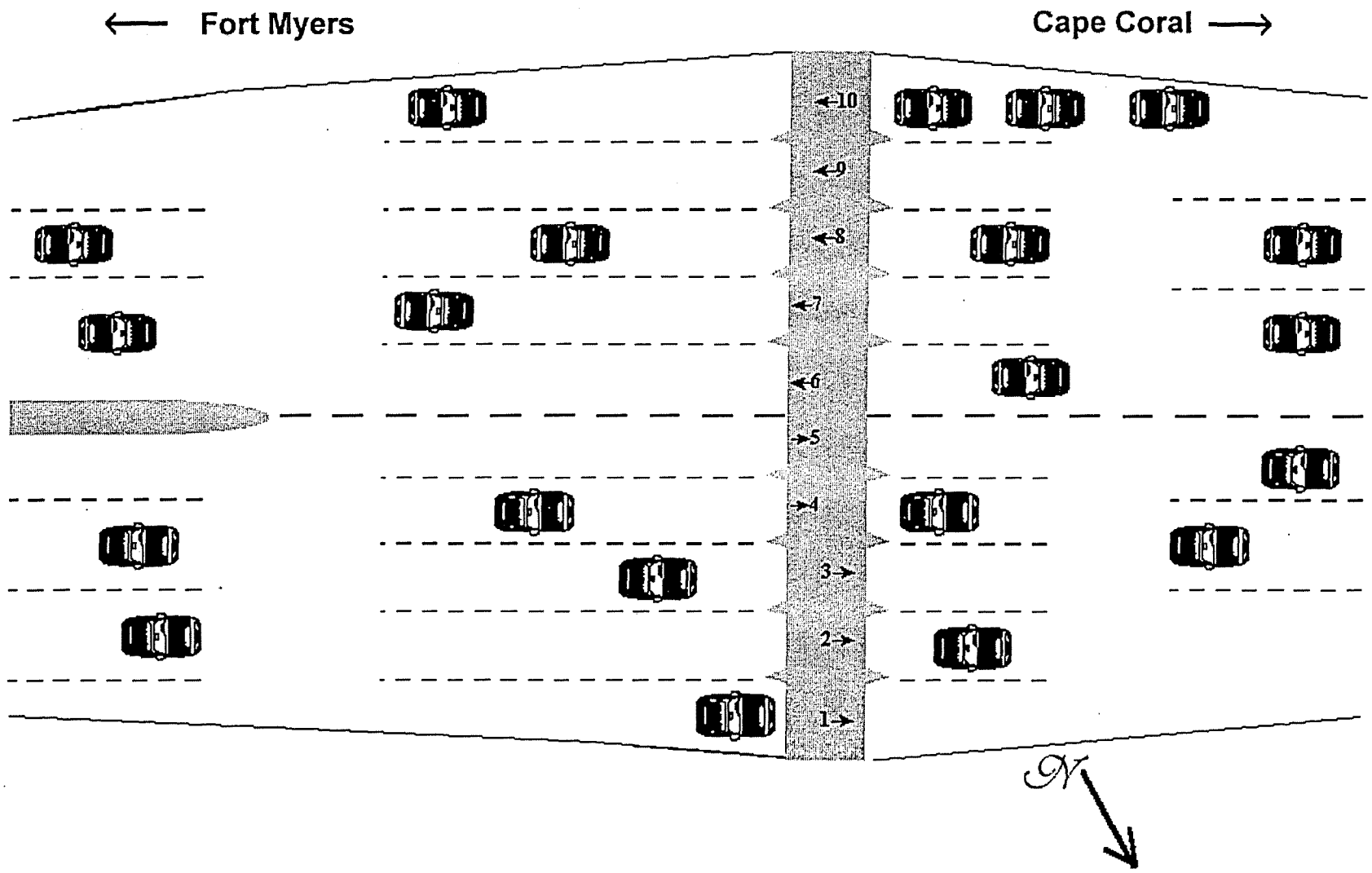
Table 2: Percentage users with various toll payment options on Midpoint bridge

Expected Users	Traffic Volume	
	Scenario 1	**Scenario 2**
Users shifting from Cape Coral bridge	10,000	10,000
• Unlimited pass stickers	1,880	1,880
• Coin drop stickers	3,130	3,130
• Needing change	2,000	2,000
• With exact change	2,990	2,990
Users expected from free bridges and new trips	16,990	16,900
• Unlimited pass stickers	2,000	500
• Coin drop stickers	3,000	1,000
• Needing change	4,500	8,500
• With exact change	7,400	6,900
Totals (%)		
• Users	26,900 (100%)	26,900 (100%)
• Unlimited pass stickers	3,880 (14.40%)	2,380 (8.80%)
• Coin drop stickers	6,130 (22.80%)	4,130 (15.40%)
• Needing change	6,500 (24.20%)	10,500 (39.00%)
• With exact change	10,390 (38.60%)	9,890 (36.80%)

Lane Configuration

This section describes the arrangement of various lanes on the two toll bridges modeled in this study. The Cape Coral Bridge has four bridge lanes (BRLN) and 10 approach lanes (APLN) (five in each direction) leading to toll collection booths where as the Midpoint Bridge has 12 approach lanes (six in each direction) leading to toll collection booths. Both the facilities have been modeled with one exclusive manual lane (without AVI), one manual lane with AVI, and the rest of the lanes with ACM

Cape Coral Toll Bridge Plaza



and AVI users. In Cape Coral Bridge, the approach lanes 1 and 10 are exclusive manual lanes, the approach lanes 2 and 9 allow the passage of both manual and AVI equipped vehicles, and the rest of the lanes are equipped with AVI and ACMs. Similarly, for Midpoint Bridge, the right most and left most approach lanes are for manual toll collection, the approach lanes 2 and 11 are reserved for manual and AVI equipped vehicles and the rest of the lanes are shared by ACM and AVI users.

Model Runs

To calculate the impact of not having ETC facilities on the two toll plaza facilities, it was necessary to run the models with different combinations of traffic, toll payment options, and vehicle arrivals. The statistics obtained here are for peak hour traffic only. Models have also been run by considering five different vehicle arrival rates and the final results are computed by averaging these five different streams.

Model Run Results

This section summarizes the results from the models created. The results presented in **Table 3**, **Figures 1, 2, & 3** explain the queue lengths and transaction times experienced by vehicles generated over a peak hour. As explained earlier, the vehicles have been generated with five different arrival patterns, and their output statistics have been averaged to ensure random results. Simulation results indicated that for Cape Coral facility and scenario 1 of Midpoint bridge, lane 2 has smaller queues though it allows both manual and AVI users. This may be due to the passage of a relatively smaller number of manual users through the lane 2. A brief explanation of the table setup is as follows:

Scenarios (Midpoint Bridge):

- Scenario 1 and Scenario 2 corresponds to two different combinations of vehicle types using the toll plaza (for exact definition see page 5)

Lane arrangements:

- Lane 1 is an exclusive manual lane.
- Lane 2 is for both AVI and users paying manually

- Lanes 3,4,5, and 6 (Midpoint Bridge only) are for ACM and AVI vehicles.

Table 3: Simulation Model Run Results

	Cape Coral Bridge	Midpoint Bridge (Scenario 1)	Midpoint Bridge (Scenario 2)
Average Number of Vehicles in the Queue	23.68	8.82	19.23
Average Time spent by a Vehicle at:			
The Plaza	36.14	19.08	41.52
Lane 1	40.81	22.78	73.31
Lane 2	25.44	16.59	70.29
Lane 3	38.60	14.84	14.51
Lane 4	37.85	18.16	17.75
Lane 5	39.33	22.67	22.35
Lane 6	N/A	23.00	22.56
Longest Queue in any lane at any time	5 (in lane #4)	3 (in lane #3)	12 (in lane #1)

Figure 1: Time spent by a vehicle at Cape Coral Toll Plaza

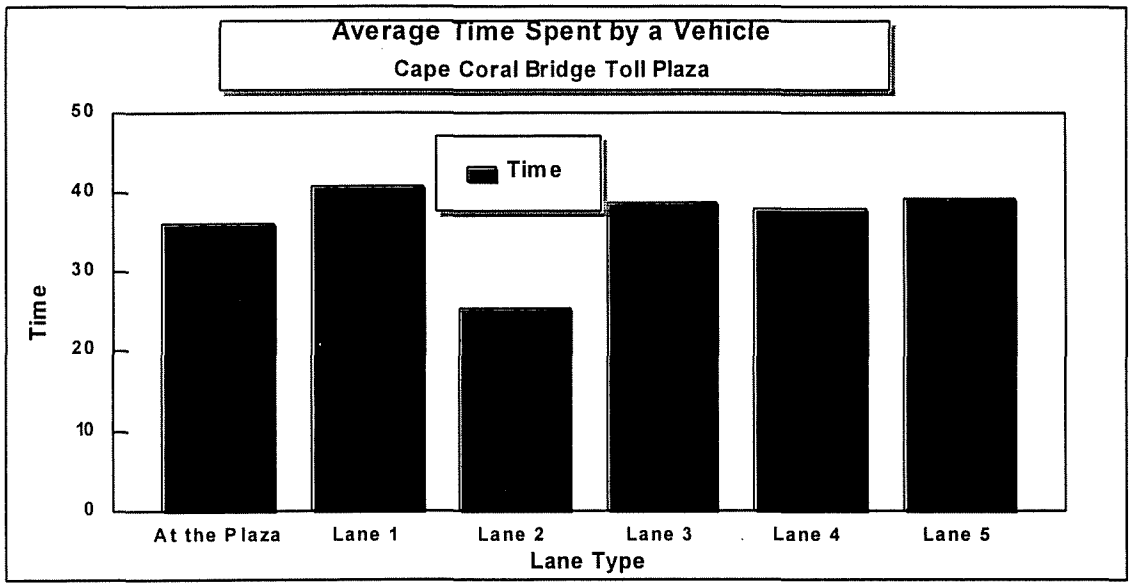


Figure 2: Time spent by a vehicle at Midpoint toll plaza (Scenario 1)

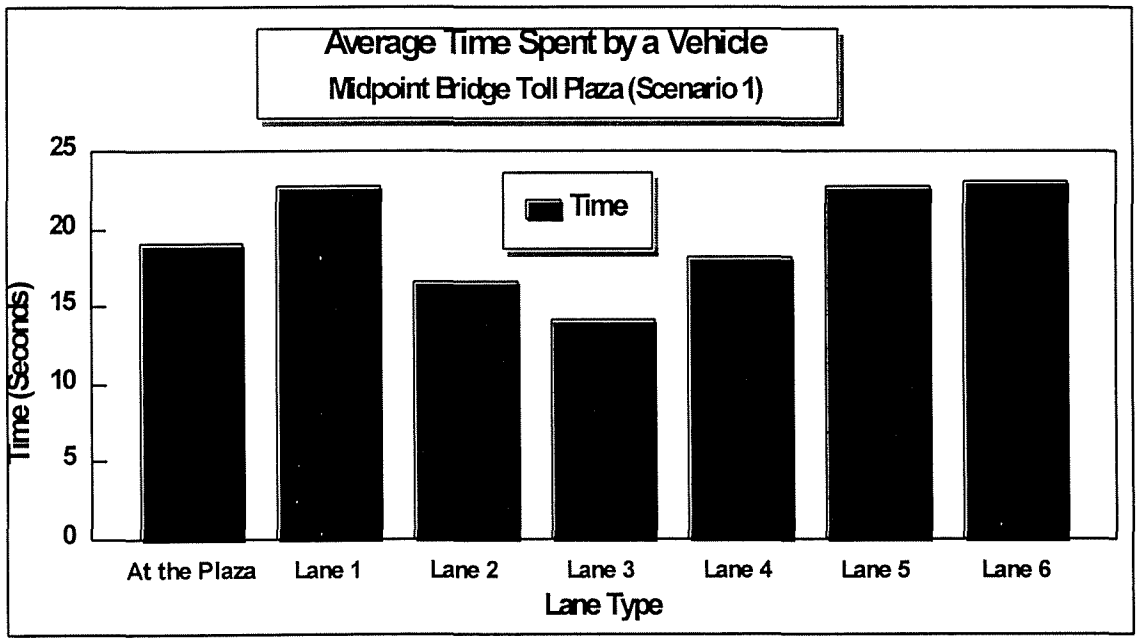
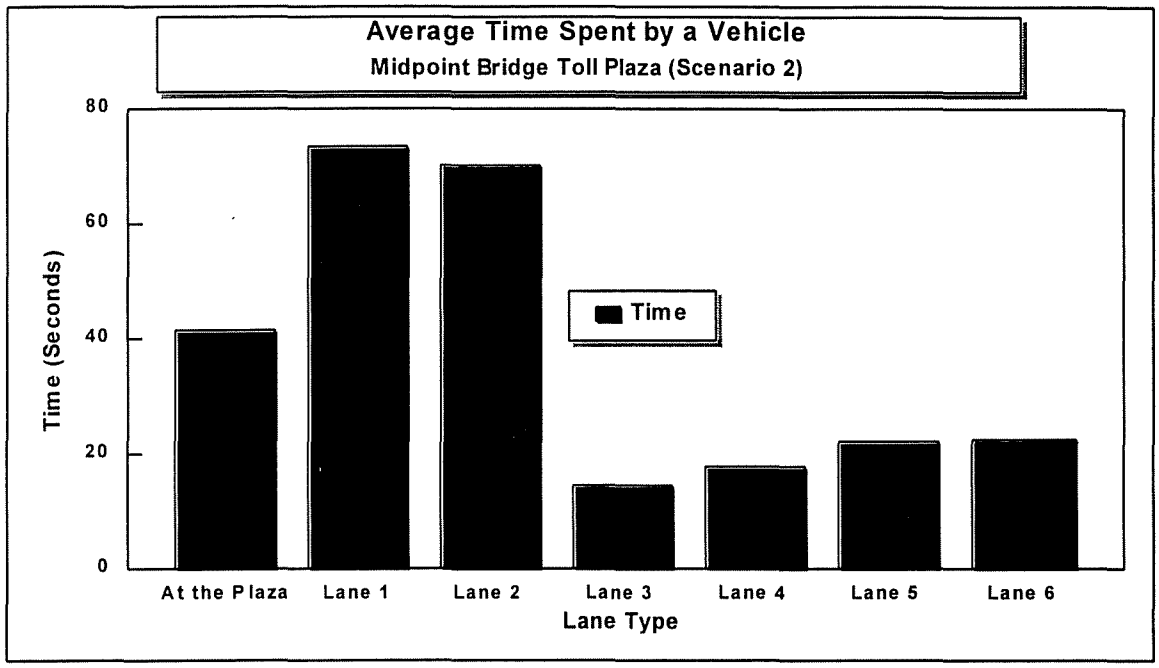


Figure 3: Time spent by a vehicle at Midpoint toll plaza (Scenario 2)



Conclusions

Based on the simulation modeling performed, the following conclusions can be drawn:

- The non availability of ETC services **is not likely** to pose significant problems on the newly constructed Midpoint Bridge. However, one key issue that may pose serious problems is the proportion of the vehicles using stickers (37% vs 24%) and those using manned lanes (63% vs 76%).

- In the two scenarios modeled for Midpoint Bridge with two different percentages of sticker users, the results are observed to be significantly different. According to the predicted traffic volumes, a large number (16,900) of users that are presently served by several free bridges are expected to shift to Midpoint Bridge. Therefore the proportion of sticker users

is unknown and will obviously have considerable impact on the expected queue lengths, transaction times, and delays.

- Simulation results show that good traffic conditions will exist (delays of less than 20 seconds per vehicle) if more than 35% of free bridge users have stickers. With this arrangement, it is found that the single exclusive manual lane will not cause any traffic problems. However, Midpoint models run assuming that only about 24% of users will have stickers (scenario 2) have resulted in average wait time at the plaza of 41 seconds.

- The non availability of ETC facilities is also expected to cause no problems at the Cape Coral Bridge toll plaza. With an average queue length of 24 vehicles during peak hour and an average transaction time of 41 seconds in the single manual lane, it is be anticipated that traffic at the plaza will improve over current conditions due to the reduction in traffic volume by 10,000 vpd due to the opening of the Midpoint Bridge.