**PARKme System**

**Timing Analysis**

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1.0 OVERVIEW

1.1 General Model

1.1.1 Definition

The PARKme system is designed to direct a user entering a facility to the closest parking lot with available parking spaces. This could be implemented in one of two current scenarios. The first is as an electronic sign directing them to the closest lot to there current location. The second is the user accessing data specific to them that would direct them to the parking lot nearest to a pre-defined final location at the facility.

1.1.2 Goals

One of the main goals of the PARKme system is to show an improvement in the time it takes to find a parking space once entering a facility. This is defined as an improvement over how long it would take the user to find a parking space if they were not using the PARKme system.

1.1.3 Assumptions

This model will make a number of assumptions to define the scope of the problem. Time will be noted to represent the total time passed in finding a parking lot with an available parking space. Time will begin once the user enters the perimeter of the facility. Time will cease when the user arrives at a parking lot with a available parking space. Time will be advanced by the time it takes the user to travel to the current parking lot. This could be traveling either from the facility perimeter or from the previous full parking lot. Time will also be advanced by the time it takes to search the current lot. This could be either the time it takes to determine that no free spaces are available in this lot or the time to find and park in the free space.

1.1.4 PED Versus Electronic Sign Instantiations

This model will not differentiate between these two variants. The CPN model will model both of these variants. This model will product data on the time it takes the user to find a parking place without the use of the PARKme system. the time the user takes to find a parking place without the PARKme system. This model will assume that if either variant were in place the user would go straight to the first available parking lot with free parking spaces. Thus the time it takes to go from the perimeter to this first lot will be the time compared against.

1.1.5 Current GMU Parking Statistics

This model will also use data provided by the Director of Parking at George Mason University in Fairfax Virginia. The campus parking director provided current time for finding a parking space on campus. These times will also be compared against the times produced by our model.

1.2 The Model

1.2.1 The Modeling Language

This model will be modeled using Mathworks Matlab. It will be a non-graphical model. Data output will be included to use in statistical comparisons.

1.2.2 Monte Carlo Model

The model will run as a Monte Carlo simulation.

1.2.3 Model Parameters

The model will let the user define the number of Monte Carlo runs to perform. The number of parking lots available will also be a user-controlled parameter. The model will not model the number of individual parking spaces in a parking lot. Instead the model will assign a percentage that each lot is full. This means in which this percentage is calculates is set by the users as either a constant for all the lots or to be randomly generated for each lot. The default values will be to randomly determine each lot to be between 10 and 90 percent full. Also the time it takes to drive to the current lot and the time spent searching that lot will be combined. This travel time can also be set by the user to either be a constant value or randomly generated. The randomly generated value will be the default and will generate times between three and six minutes. The internal values for the times to travel between each lot and the percentages of each lot being full will not be displayed unless the users chooses to do so. Also for larger Monte Carlo runs the time and number of lots searched will not be displayed for each run unless chosen by the user. For single runs this data will always be presented. The model will produce full statistical data on the time searched and number of lots search for each Monte Carlo run.

1.2.4 Cases Presented

This model will produce statistics on three scenarios. A completely random case will be run where the percentage of each lot being full and the times to travel between lots are both random. Also a worst case scenario will be models where the percentage of a of each lot being full will be set to 90 percent and the time spent traveling between lots will be set at five minutes. Finally a best-case scenario will be modeled. In order to isolate the percentage of a lot being full as the control factor the time traveling between lots will again be five minutes. The percentage of each lot being full will be set to be 10 percent.

2.0 PRESENTED DATA

2.1 Without the PARKme System (Our Model)

2.1.1 Random With Five Monte Carlo Runs

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Number of Monte Carlo Runs: 5

Run Number 1 Search Time 47 Minutes Lots Searched 10

Run Number 2 Search Time 8 Minutes Lots Searched 2

Run Number 3 Search Time 4 Minutes Lots Searched 1

Run Number 4 Search Time 9 Minutes Lots Searched 2

Run Number 5 Search Time 5 Minutes Lots Searched 1

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Minimum Time: 4 minutes

Maximum Time: 47 minutes

Mean Time: 14.60 minutes

Mode Time: 4 minutes

Mode Occurrences: 1

Median Time: 8 minutes

Time Variance: 332.30

Time Standard Deviation: 18.23

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Minimum Number of Lots Searched: 1

Maximum Number of Lots Searched: 10

Mean Number of Lots Searched: 3.20

Mode Number of Lots Searched: 1

Mode Occurrences: 2

Median Number of Lots Searched: 2

Number of Lots Searched Variance: 14.70

Number of Lots Searched Standard Deviation: 3.83

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2.1.2 Random With 100 Monte Carlo Runs

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Number of Monte Carlo Runs: 100

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Minimum Time: 3 minutes

Maximum Time: 53 minutes

Mean Time: 10.20 minutes

Mode Time: 6 minutes

Mode Occurrences: 15

Median Time: 7 minutes

Time Variance: 78.71

Time Standard Deviation: 8.87

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Minimum Number of Lots Searched: 1

Maximum Number of Lots Searched: 10

Mean Number of Lots Searched: 2.27

Mode Number of Lots Searched: 1

Mode Occurrences: 47

Median Number of Lots Searched: 2

Number of Lots Searched Variance: 3.61

Number of Lots Searched Standard Deviation: 1.90

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2.1.3 Best Case

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Number of Monte Carlo Runs: 100

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Minimum Time: 5 minutes

Maximum Time: 25 minutes

Mean Time: 5.95 minutes

Mode Time: 5 minutes

Mode Occurrences: 85

Median Time: 5 minutes

Time Variance: 7.42

Time Standard Deviation: 2.72

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Minimum Number of Lots Searched: 1

Maximum Number of Lots Searched: 5

Mean Number of Lots Searched: 1.19

Mode Number of Lots Searched: 1

Mode Occurrences: 85

Median Number of Lots Searched: 1

Number of Lots Searched Variance: 0.30

Number of Lots Searched Standard Deviation: 0.54

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2.1.4 Worst Case

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Number of Monte Carlo Runs: 100

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Minimum Time: 5 minutes

Maximum Time: 50 minutes

Mean Time: 35.50 minutes

Mode Time: 50 minutes

Mode Occurrences: 42

Median Time: 40 minutes

Time Variance: 239.65

Time Standard Deviation: 15.48

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Minimum Number of Lots Searched: 1

Maximum Number of Lots Searched: 10

Mean Number of Lots Searched: 7.10

Mode Number of Lots Searched: 10

Mode Occurrences: 42

Median Number of Lots Searched: 8

Number of Lots Searched Variance: 9.59

Number of Lots Searched Standard Deviation: 3.10

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2.2 With the PARKme System

Using the PARKme system will always produce the best results. If the PED variant is implemented the user knows which lot closest to there desired location has available parking and goes straight there. If electronic signs are implemented the user is directed straight to the closest lot with available parking. The time to find a free parking space is reduced down to the time to travel from the facility perimeter and search for the free space. Thus for the random model this would always be between three and six minutes. For the constant model this would always be five minute.

2.3 Current Parking Statistics for GMU

This is the result of a recent campus wide survey.

Survey provided by GMU Director of Parking.

Parking lot status includes all parking lots.

This includes residence parking and a West Campus overflow lot.

The East main campus lots were noted to be full by 1100 daily.

The GMU survey had extreme results and capped the maximum time at 40 minutes.

Peak Hour Parking

Tuesday/Thursday Peak: 93% Full

Monday/Wednesday/Friday: 85 – 90% Full

Average Time Spent Looking for a Parking Space.

32 % : 5 Minutes

24 %: 10 Minutes

19 %: 20 Minutes

10 %: 30 Minutes

15 %: Greater Than 30 Minutes

Means Tim: 16.5 minutes

Standard Deviation: 12.20409

3.0 ANALYSIS RESULTS

* The GMU data reflects that during peak hours the inner campus lots are full and the outer overflow lots are at 85 % full
* To compare our data with the data provided from GMU it could be noted that the worst case of 90% is an acceptable model.
* The GMU data shows an average of 16.5 minutes spent looking for a parking space.
* The GMU shows a worst case of over 40 minutes spent looking for a parking space.
* The GMU Data reflects that approximately 25% of the users did spend over 30 minutes each day looking for a parking space.
* Our worst-case model also reflects over 30 minutes spent looking for a free parking space.
* Our model worst case also reflects over seven lots searched before a parking lot with available spaces is found.
* Using the PARKme system a parking lot with available spaces could have been found in 3 to 6 minutes.
* Compared to the current GMU times this is a saving of over 10 minutes for the average case and 30 minutes for the GMU worst case.