



PURPOSE

The purpose of this activity is to give you the opportunity to determine the maximum allowable headway (MAH) for your intersection.

LEARNING OBJECTIVE

- Select an MAH

REQUIRED RESOURCES

- VISSIM input file created in Activity #28
- Phase Termination Analysis Excel template

DELIVERABLE

- Prepare an Excel spreadsheet that includes the phase termination analysis results and data analysis outcomes, as well as the results from Task 5. The Excel worksheet should follow the formatting outlined below:

Tab 1: Title page with activity number and title, authors, and date completed

Tab 2: Raw data from the MER file

Tab 3: Headway data for both lanes

Tab 4: Headway distribution analysis showing frequency data, frequency plot, and cumulative frequency plot for one lane

Tab 5: Data for the phase termination analysis

Tab 6: Phase termination analysis using template including a summary table containing the number of occurrences of each termination type

Tab 7: Summary of phase termination analysis including selection of and justification for the MAH

CRITICAL THINKING QUESTIONS

1. How does increasing the MAH affect the likelihood of a Type 1, Type 2, or Type 3 termination?

2. Describe the differences that you observe in the frequency distributions for queued and non-queued vehicles from your data analysis.

3. What is the result of a phase termination analysis?

4. What is the basis for your selection of the MAH? Use the results from your phase termination analysis in explaining your answer.

INFORMATION

The MAH is the largest headway that you will tolerate in a departing queue before the phase should terminate. The choice of this headway involves balancing two conflicting and competing issues: if the headway that you select is too small, then you run the risk of terminating the phase too soon and not serving all of the vehicles in the queue that formed during red. However, if the headway that you select is too large, then you run the risk of allowing the phase to extend too long, serving not just the initial queue but also vehicles that arrive after the initial queue has cleared. One problem comes in recognizing that some of the headways that you observe after the queue has cleared might be in the same range as those that you observed during the queue clearance. Conversely, a slowly reacting driver in a vehicle that is part of a departing queue will result in a headway that is longer than the normal saturation headway. The choice that you make in the value of the MAH will have some risk of both conditions: A Type 1 termination, or cycle failure, when not all of the initial queue is served or a Type 2 termination, an inefficient extension of the green, resulting in longer delays on the other approaches. While the ideal goal is to achieve a Type 3 termination (when the phase terminates just after the queue has cleared) each time a phase terminates, your challenge is to find a MAH that balances the risks of the Type 1 and Type 2 terminations.

So what is a phase termination analysis? A phase termination analysis is a tool that looks at the headway data generated by a simulation model from a stream of vehicles departing from an intersection and, given a value of the MAH, classifies each phase termination into one of the three types described above. The first part of the analysis involves the stream of headways for the departing vehicles, with the stream separated into vehicles that were a part of the queue (noted by Q) and those that arrived after the queue had cleared (noted by NQ). An example of the headway data are shown in the first two columns of Figure 119. Note that when you collect your headway data in this activity, the passage time will be set to a very high value (5 seconds) so that you can observe a sufficient sample of both queued and non-queued vehicles and their resulting headways departing after the beginning of green. The high passage time provides you with enough vehicles (and resulting headways) to allow you to study different values of MAH and their effects on phase termination.

The next step in the analysis involves superimposing a value for the MAH that determines when the display would change from green to red. The display would continue as “green” as long as the headway in the data stream is less than the MAH, but would change to “red” (for simplicity, we’ve skipped “yellow” here) when a headway exceeded this value. The “Ideal Signal Display”, column 3 in Figure 119, shows the display that would result from the MAH that has been selected: the green would be displayed until a headway occurs that is greater than the MAH. The “Change Occurs” column (column 4) shows when the change from green to red would occur.

The third part of the analysis, the “Termination Outcomes”, determines whether this display change occurs when queued vehicles are still being served (a Type 1 termination) or whether the green would continue to be displayed even when non-queued vehicles would be served (a Type 2 termination). In this example, the two queued vehicles are served, but the first three non-queued vehicles are served as well. The display doesn’t change to red until the sixth headway (7.79 seconds), which is the first headway in this example to exceed the MAH of 3.0 seconds.

In summary, the phase termination analysis subjects the simulated headway data stream to a range of values of the MAH to determine how effective each MAH value would be in serving these vehicles. We know whether each vehicle is a part of the queue or not, and we can determine for a given MAH if a vehicle would be served or not. In addition to the information described above, the phase termination analysis as shown in Figure 119 also provides:

- The Outcome Distribution for the value of the MAH selected; in this example there are three Type 1, five Type 3, and nine Type 2 terminations
- The Percentile is the percentage of vehicles with headways that are less than the MAH (in this example, 98.2%)
- The “Results” summarizes the Percentiles and the number of terminations for each type for four MAH values (ranging from 1.5 seconds to 3.0 seconds)

MAH	Percentile									
3.0	98.2%									
Headway (sec)		Signal Information		Termination Outcomes			Outcome Distribution			
Queued	NonQueued	Ideal Signal Display	Change Occurs	Type 1	Type 3	Type 2	Type 1 Termination			
1.15		Green					3			
1.96		Green					5			
	1.15	Green					9			
	1.3	Green								
	1.91	Green								
	7.79	Red	Change			1				
	8.03	Red								
	5.14	Red								
Results of Phase Termination Analysis										
Headway	1.5	2.0	2.5	3.0						
Percentile	32.0%	76.4%	95.9%	98.2%						
Type 1 Termination	17	14	6	3						
Type 3 Termination	0	1	6	5						
Type 2 Termination	0	2	5	9						

Figure 119. Example phase termination analysis procedure

TASK 1

Initial steps.

- Make a copy of the folder that includes your VISSIM data files from Activity #28. Name this new folder “a36”. Use this VISSIM file as the basis for your analysis and design of the passage time.
- Select one approach on one of the major streets of your intersection for your headway study

- Increase the volume on this link to produce “beginning of green” queue lengths of 10 to 15 vehicles per cycle per lane
- Set the passage time to 5.0 seconds on the approach that you have selected
- Establish “data collection” points just downstream of the signal head for the two lanes on the approach that you selected previously. For instructions on how to add a Data Collector in VISSIM see the VISSIM tutorial.
- Select and configure the “Data Collection” evaluation file. To do this, make sure to check “raw data” in configuration box.

TASK 2

Headway data.

- Run VISSIM
- Open and parse the MER file in tab 2 of your Excel template
- Copy the parsed data to tab 3 of your Excel file. Keep only three columns: CP, t(leave), and tQueue. Delete the other columns. Figure 120 shows the layout of the MER file after it has been opened in Excel and parsed.

Data Collection (Raw Data)											
File: f:\sweet and us95 high volume\team1_lab3.inp											
Comment:											
Date: Monday, May 28, 2012 12:21:31 PM											
VISSIM: 5.30-08 [29295]											
Data Collection Point 1: Link 1 Lane 2 at 143.633 m, Length 0.000 m.											
Data Collection Point 2: Link 1 Lane 1 at 143.610 m, Length 0.000 m.											

Data C.P.	t(enter)	t(leave)	VehNo	Type	Line	v[m/s]	a[m/s ²]	Occ	Pers	tQueue	VehLength[m]
2	16.42	-1	2	100	0	14.3	-0.29	0.08	1	0	4.5
2	-1	16.73	2	100	0	14.2	-0.29	0.03	1	0	4.5
1	66.77	-1	6	100	0	1.4	2.77	0.03	1	42.7	4.5
2	66.82	-1	7	100	0	1.5	2.93	0.08	1	42.6	4.5
1	-1	68.1	6	100	0	5.2	2.6	0	1	42.7	4.5
2	-1	68.13	7	100	0	5.2	2.55	0.03	1	42.6	4.5
1	69.57	-1	8	100	0	6.5	2.86	0.03	1	42.1	4.5
2	69.85	-1	14	100	0	6.9	2.95	0.05	1	30.8	4.5
1	-1	70.18	8	100	0	8.2	2.71	0.08	1	42.1	4.5
2	-1	70.44	14	100	0	8.5	2.82	0.04	1	30.8	4.5
1	71.62	-1	10	100	0	8.6	2.4	0.08	1	38.5	4.5

Keep three columns:

- Data C.P, designating the data collection point or lane
- t(leave), the time that the vehicle leaves the data collection point
- tQueue, the time that the vehicle spends in queue

Figure 120. VISSIM MER file in Excel

- Eliminate all rows in which t(leave) equals “-1” or in which t(leave) is less than 300
- Separate the data into two separate tables, one for each of the two data collection points (lanes 1 and 2)
- Add a new column for each table that identifies whether the vehicle was a part of the queue or not. This can be done by putting a Q or NQ in the cell adjacent to the tQueue data. Figure 121 shows an example of the determination of Q or NQ based on whether tQueue is zero or greater than zero using an Excel logic function.
- In a new column, compute the headway between each vehicle pair as shown in Figure 122

Data C.P.	t(leave)	VehNo	tQueue	Q/NQ
2	300.42	161	11.8	Q
2	301.41	164	10	Q
2	302.87	167	8.9	Q
2	304.76	171	4.5	Q
2	305.97	176	2	Q
2	315.15	184	0	NQ
2	318.14	187	0	NQ
2	324.84	190	0	NQ

If(tQueue>0,"Q","NQ")

Data C.P.	t(leave)	VehNo	tQueue	Q/NQ	Headway
2	300.42	161	11.8	Q	
2	301.41	164	10	Q	1.0
2	302.87	167	8.9	Q	1.5
2	304.76	171	4.5	Q	1.9
2	305.97	176	2	Q	1.2
2	315.15	184	0	NQ	9.2
2	318.14	187	0	NQ	3.0
2	324.84	190	0	NQ	6.7

Figure 121. Example determination whether a vehicle is in a queue or not (Q or NQ)

Figure 122. Example calculation of headway based on the “leave” times of two consecutive vehicles

TASK 3

Headway distribution analysis.

- Using the headway data created in Task 2 for one of the lanes only, create frequency (histogram) and cumulative frequency plots using 0.25 second bins in tab 4 of the Excel template. Figure 123 shows an example of the data used to create the frequency and cumulative frequency plots including (for headway bins from 0.00 to 2.00 seconds) the frequency (number), the percent frequency, the cumulative frequency, and the percent cumulative frequency.

Bin	Frequency	Freq%	CumFreq	CumFreq%
0.00	0	0.000	0	0.000
0.25	0	0.000	0	0.000
0.50	0	0.000	0	0.000
0.75	0	0.000	0	0.000
1.00	0	0.000	0	0.000
1.25	16	0.136	16	0.090
1.50	42	0.356	58	0.328
1.75	36	0.305	94	0.531
2.00	42	0.356	136	0.768

Figure 123. Example frequency and cumulative frequency headway data

- Figure 124 and Figure 125 show the resulting frequency and cumulative frequency plots based on the frequency data shown in Figure 123

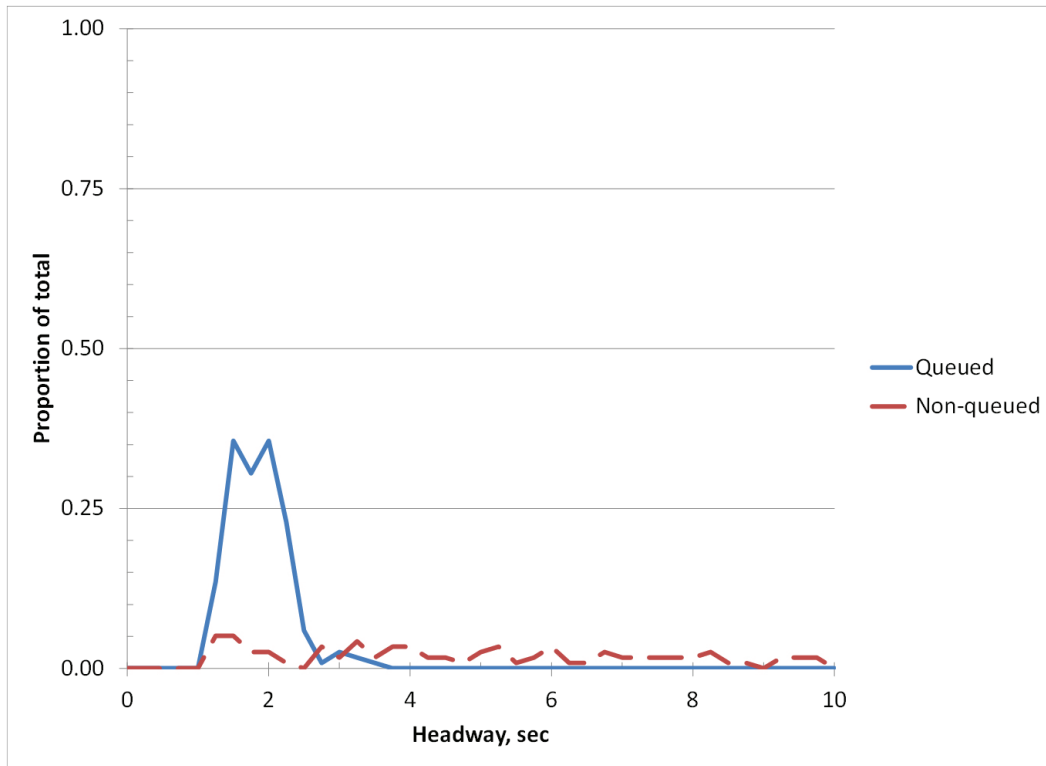


Figure 124. Headway frequency plot for queue and non-queued vehicles

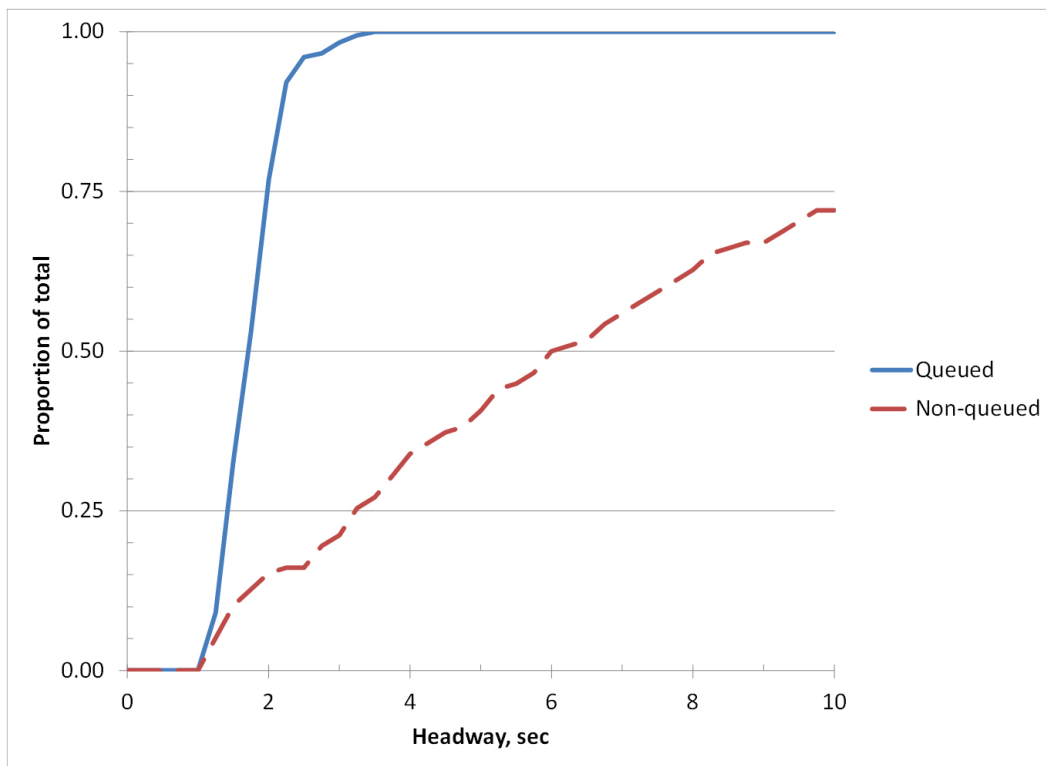


Figure 125 Headway cumulative frequency plot for queued and non-queued vehicles

TASK 4

Phase termination analysis.

- Create the data that you will need for the phases termination analysis in tab 5. Figure 126 shows two columns that have been created that place the queued and non-queued headway in the appropriate columns.

Data C.P.	t(leave)	VehNo	tQueue	Q/NQ	Headway	Headway (sec)	
						Queued	Nonqueued
1	300.18	163	9.6	Q			
1	301.33	165	9.1	Q	1.1	1.15	
1	303.29	169	5	Q	2.0	1.96	
1	304.44	174	0	NQ	1.1		1.15
1	305.74	177	0	NQ	1.3		1.3
1	307.65	179	0	NQ	1.9		1.91
1	315.44	186	0	NQ	7.8		7.79
1	323.47	189	0	NQ	8.0		8.03
1	328.61	193	0	NQ	5.1		5.14

Figure 126. Creation of input data for phase termination analysis

- Copy the headways for the queued and non-queued vehicles into the two input columns in the phase termination analysis spreadsheet template to tab 6 of your Excel template. The data should be pasted as “values.” Figure 127 shows the headway data that have been pasted into the first two columns of the phase termination analysis template. The Signal Information and Termination Outcomes are calculated based on these input data.

Headway (sec)		Signal Information		Termination Outcomes		
Queued	NonQueued	Ideal Signal Display	Change Occurs	Type 1	Type 3	Type 2
1.15		Green				
1.96		Red	Change	1		
	1.15	Red				
	1.3	Red				
	1.91	Red				
	7.79	Red				
	8.03	Red				
	5.14	Red				

Figure 127. Outcomes for phase termination analysis showing type 1 termination

- Use the Phase Termination Analysis template to determine the Termination Outcomes for a range of possible MAH. Enter a value in the MAH cell and record the resulting number of Types 1, 2, and 3 terminations in the “results” section of the template. Each time you enter a new value for the MAH, a new set of outcomes will be calculated. Figure 128 shows the results of a phase termination analysis for four MAH cases, ranging from 1.5 seconds to 3.0 seconds. When the MAH was set to 1.5 seconds, the phase terminated before the queue had cleared for all 17 phases, and only 32 percent of the vehicles would be served. At the other extreme, if the MAH was set to 3.0 seconds, the phase would extend past the time the queue had cleared in 9 of the 17 cases (Type 2 terminations).

MAH	Percentile										
3.0	98.2%										
Headway (sec)		Signal Information		Termination Outcomes			Outcome Distribution				
Queued	NonQueued	Ideal Signal Display	Change Occurs	Type 1	Type 3	Type 2	Type 1 Termination	3	Type 3 Termination	5	
1.15		Green					Type 2 Termination	9			
1.96		Green					Results of Phase Termination Analysis				
	1.15	Green					Headway	1.5	2.0	2.5	3.0
	1.3	Green					Percentile	32.0%	76.4%	95.9%	98.2%
	1.91	Green					Type 1 Termination	17	14	6	3
	7.79	Red	Change			1	Type 3 Termination	0	1	6	5
	8.03	Red					Type 2 Termination	0	2	5	9
	5.14	Red									

Figure 128. Phase termination analysis results for four example maximum allowable headways

TASK 5

Select the MAH.

- Write a goal statement for the selection of the MAH based on your desired balance of type 1 and type 2 terminations
- Select your MAH using your goal statement and the analysis that you have completed as the basis for your selection