

CHAPTER 5: THE SIMULATION ENVIRONMENT: LEARNING TO SEE A TRAFFIC SIGNAL SYSTEM

This chapter includes information that you will need to prepare for, conduct, and assess each of the seven activities included in Chapter 5 of the student activity book. Figure 1 shows the various files that are available to support your works as you use these activities, including mini-lecture slides, solution files, and student resource files.




















| Chapter 5 The Simulation Environment | Mini-lecture slides | Solution files | Student resource files |
|-----------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| A#25 Reading |  | | |
| A#26 Assessment | | |  |
| A#27 Discovery | | |  |
| A#28 Design |  |  |  |
| A#29 In Practice | | |  |


Figure 1. Support files

Figure 2 shows the kind of work required for each activity, how the activities might be grouped, and the approximate amount of class time required to complete the activity. The figure also identifies whether there is homework involved, a mini-lecture could be presented, student discussion could take place, and group work to do.

| Chapter 5 The Simulation Environment | A#25 Reading | A#26 Assessment | A#27 Discovery | A#28 Design | A#29 In Practice |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| |    |  |  |  |    |
|  | 50 min | 50 min | 50 min | 25 min | 25 min |

 Homework

 Mini-lecture

 Student discussion

 Group work

Figure 2. Activity work

Using Activity #25: Microsimulation Models and the Traffic Control System (Reading)

Overview

Students are asked to complete an introductory reading on simulation models. The reading covers the kinds of models that traffic engineers use, some of the basic concepts upon which most simulation models are based, what data are produced by the models, and why it is important to use simulation models to help visualize the traffic flow and performance.

Options for Use

The reading, defining the terms in the glossary, and answering the critical thinking questions are usually done as homework, to prepare for class discussion. After the students complete this work, the instructor has several options for assessing and clarifying student understanding of the reading during class:

- Quiz to assess their understanding and to hold them accountable for the reading.
- Present mini-lecture summarizing key points from the reading, with active questioning of the students as the lecture material is presented.
- Discussion and synthesis of the answers to the quiz, the glossary definitions, and answers to the critical thinking questions.

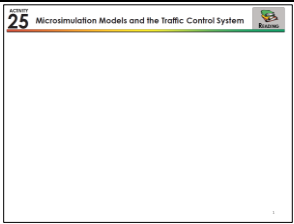
Preparing for the Activity


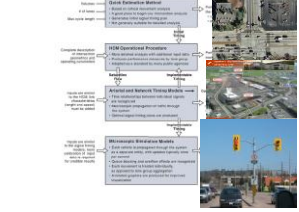
- Decide which of the options you want to do during class.
- Prepare for the class by reviewing Activity #30, including the “Information”, the Glossary definitions, and the Critical Thinking Questions and answers.

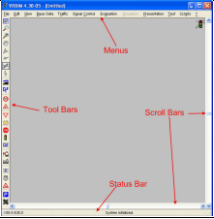

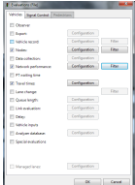

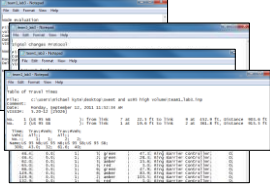
Doing the Activity (Script)

[Slides: slides25.pptx]

The following script can be used along with the PowerPoint slides for this activity. The script and slides can be modified based on your needs and what you decide to emphasize.

| Slide | Text |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | |
| <p>Web sites of the day</p> <ul style="list-style-type: none"> • McTrans <ul style="list-style-type: none"> – Highway Capacity Software – Transyt 7F – CORSIM • Trafficware <ul style="list-style-type: none"> – Synchro – SimTraffic • PTV America <ul style="list-style-type: none"> – VISSIM | <p>Here are three examples of software developers each of which has a set of traffic analysis tools, from macroscopic models to microscopic models.</p> |
| | <p>What is a model? [ask them] It is a “representation of reality that</p> |

| Slide | Text |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <p>allows us to study a system, ask questions about the system and its components and to change conditions or features of the system and to observe how it will behave.” Look at each part of this definition: (1) representation of reality, (2) study system (ask questions), and (3) change components to observe behavior.</p> <p>Why use a model as part of engineering analysis and design? [ask them]. Possible responses:</p> <ul style="list-style-type: none"> • Understand how a system works under a variety of control conditions. • Help select design parameters • Predict how a system will work |
| <div data-bbox="191 709 483 919" style="border: 1px solid black; padding: 5px;"> <ul style="list-style-type: none"> • VISSIM model demonstration • Moscow downtown signal system demonstration </div> | <p>Before we look at some of the specifics of model characteristics, let’s look at a VISSIM simulation/animation and not some of the things that are included:</p> <p>[Videos that are linked on the Vimeo web site] [VISSIM complex intersection]</p> <ul style="list-style-type: none"> • Initial screen: representation geometry, flow, and control. • Driver behavior: car following, lane changing, response to control display • Controller operations: timing processes • Detector operations <p>Some characteristics:</p> <ul style="list-style-type: none"> • Updates states of vehicles and control every tenth of a second (time step) • Some uncertainty in driver responses (stochastic) • Individual vehicle representation (microscopic) • Tracks events and processes (simulation) • Reports performance (evaluation) |
|  | <p>Let’s now develop a scheme by which we can classify models: (See Table 11 in book; write on board or show slide)</p> |
|  | <p>Complexity of problem: level of detail in model, kinds of problems or questions.</p> <ul style="list-style-type: none"> • How many lanes will I need to accommodate traffic projected in five years? (Is what I have now sufficient?) • How much will delay increase if a new hotel or shopping center or office building is constructed? • What signal timing plan will work best with the intersection |

| Slide | Text |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <p>design?</p> <p>[Each question requires a different, and increasing, level of detail?]</p> |
| | <p>When is microsimulation appropriate?</p> <ul style="list-style-type: none"> • When demand exceeds capacity • When you need to see the effect of a specific design element • When you need to know signal timing details • When you need to visualize operations for yourself or others |
|  | <p>This slide shows the basics of the VISSIM “window”.</p> |
|  | <p>This slide shows how we represent network. Here is an intersection showing the geometry, traffic, and control attributes that can be represented in a network. For example, nodes and links represent intersections and streets or approaches.</p> <p>Both visualization and numeric data are important. This slide shows a queue storage problem</p> |
|  | <ul style="list-style-type: none"> • Evaluation files • |
|  | <ul style="list-style-type: none"> • Evaluation file windows |
|  | <ul style="list-style-type: none"> • Example output files |

Solutions

The solutions include:

- Glossary definitions
- Critical thinking questions and answers

- Example student responses

Glossary Definitions

| Term | Definition |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Microsimulation models | Model in which the decisions of individual drivers are modeled, with the performance data being reevaluated in set time increments for the duration of the simulation. |
| Network | Refers to the intersection or series of intersection which are being modeled |
| Performance measures | Used to quantify the performance of an intersection or network of intersections. Typical performance measures include speed, travel time, number of stops, queue length, and average delay. By collecting performance data, the impact of any changes made to the intersection can be analyzed. |
| Traffic analysis tools | Is anything which can be used to measure the performance of an intersection |
| VISSIM | A microsimulation software used to model intersections and collect performance measure data. |

Critical Thinking Questions

1. Why do you think it is important to use a microsimulation model to evaluate the performance of your design network?
 - It is important to use a microsimulation model when the issue being addressed is complex. This includes instances when the demand exceeds the capacity of the intersection, when queues spillback from one intersection to another, when geometric design elements needs to be tested, or to test, refine, and evaluate a timing plan for an intersection.
2. What performance measures do you think are important to evaluate signal timing alternatives that you develop?
 - Delay, queue length, green time utilization, distribution of green times
3. What can you learn from the numerical performance data and the visual observations of the simulation model to help you evaluate your performance of a signal timing alternative?
 - Visual observations could be used to determine if queue lengths are too long, if green time is being poorly utilized, if there are cycle failures, and to verify that the numerical data is reasonable. Numerical data can be used to determine the expected delay, green time distributions, travel times, and other types of quantifiable data.

Some example student responses to question “What is a simulation model?”

- A simulation model that represents individual entity decisions and interactions. In traffic simulation, this type of model will have some sort of algorithm that dictates driver behavior, taking into account vehicle capabilities and attributes.

- Microsimulation model: A computer-based representation of events at an intersection or series of intersections with a high level of detail regarding system operation and performance.
- Microsimulation model- yields high level of detail on system operations and performance when details on signal timing are important to consider.
- Microsimulation Model – In general a model is a representation of reality that allows for the study of a system. Specifically for a microsimulation it requires a high level of data to describe a traffic facility. From this high level of data it then has the potential to produce a high level of data that represents how the traffic facility is likely to operate in the real world.

Using Activity #26: What Do You Know About Simulation Models? (Assessment)

Overview

The purpose of this activity is to introduce the students to another source (FHWA traffic analysis tools guidebooks) about simulation modeling. In combination with the reading from Activity #26, this activity tests students' understanding of simulation models, to learn more about the variety of traffic analysis tools that are available to transportation engineers, and to understand the benefit that simulation tools provide to engineers.

It is important to emphasize to students that both data analysis and visual observation should be used to analyze the performance of an intersection. Rather than just analyzing data, students should use simulation to verify if the data is reasonable. This is because from an engineering perspective, the data is what will be used to evaluate the performance; however, from a user's perspective, visual analysis will be used to analyze the intersection performance.

Options for Use

- Assign as reading for homework
- Lead classroom discussion on key topics
- Conduct quiz to test student understanding of the key topics

Preparing for the Activity

The reading is often done as a homework assignment. Discussion of the key topics from the reading can be done during class.

Doing the Activity (Script)

Lead class discussion on critical thinking questions and answer.

Solutions

Critical Thinking Questions and Answers

1. What are the categories of traffic analysis tools and what are the basic attributes of each category?
 - Sketch planning tools allow for evaluation of specific projects or alternatives without conducting an in depth engineering analysis; they are primarily used to conduct preliminary budget estimates and proposals.
 - Travel demand models are mathematical models that forecast future travel demand based on current condition and future projections of household and employment characteristics; they are developed to determine the benefits and impacts of major highway improvements in metropolitan areas.
 - Analytical/deterministic tools (HCM-based) quickly predict capacity, density, speed, delay, and queuing on a variety of transportation facilities; they are good for analyzing small scale or isolated transportation facilities, but are limited in their ability to analyze network or system effects.
 - Traffic signal optimization tools are designed to develop optimal signal phasing and timing plans for isolated intersection, arterial streets, or signal networks

- Macroscopic simulation models are based on deterministic relationships of flow, speed, and density of the traffic stream; they analyze entire intersection or network rather than individual vehicles; less intensive and less detailed simulation models than microscopic simulation models.
 - Mesoscopic simulation models combine elements of macroscopic and microscopic simulation; they provide less detail than microsimulation models, but are superior to typical planning analysis techniques.
 - Microscopic simulation models model individual vehicles in set time increments (typically less than one seconds) based on car following and lane change theories; they include speeds, accelerations, and other vehicle parameters are stochastically assigned to each vehicle.
2. What is a microsimulation model?
- From "Traffic Analysis Toolbox", Volume II, page 8: "Microscopic simulation models simulate the movement of individual vehicles based on car-following and lane-changing theories. Typically, vehicles enter a transportation network using a statistical distribution of arrivals (a stochastic process) and are tracked through the network over brief time intervals (e.g., 1 second or a fraction of a second). Typically, upon entry, each vehicle is assigned a destination, a vehicle type, and a driver type. In many microscopic simulation models, the traffic operational characteristics of each vehicle are influenced by vertical grade, horizontal curvature, and superelevation, based on relationships developed in prior research. The primary means of calibrating and validating microscopic simulation models are through the adjustment of driver sensitivity factors. Computer time and storage requirements for microscopic models are significant, usually limiting the network size and the number of simulation runs that can be completed."
3. Under what conditions would you use a microsimulation model?
- It is important to use a microsimulation model when the issue being addressed is complex. This includes instances when the demand exceeds the capacity of the intersection, when queues spillback from one intersection to another, when geometric design elements needs to be tested, or to test, refine, and evaluate a timing plan for an intersection.
4. What are the strengths and limitations of the Highway Capacity Manual methodologies?
- Strengths: Quick and reliably predicts if an isolated facility with relatively moderate congestion is operating above or below capacity
 - Limitations: Cannot predict systems effects such as queue spillback, effects of multilane or two lane rural roads where traffic signals or stop signs significantly impact the capacity and operations, the effects of adding or dropping a short through lane at an intersection, large roundabouts, or tight diamond interchanges
 - From "Traffic Analysis Toolbox", Volume II, pages 9-10: "For many applications, HCM is the most widely used and accepted traffic analysis technique in the United States. The HCM procedures are good for analyzing the performance of isolated facilities with relatively moderate congestion problems. These procedures are quick and reliable for predicting

whether or not a facility will be operating above or below capacity, and they have been well tested through significant field validation efforts. However, the HCM procedures are generally limited in their ability to evaluate system effects. Most of the HCM methods and models assume that the operation of one intersection or road segment is not adversely affected by conditions on the adjacent roadway. Long queues at one location that interfere with another location would violate this assumption. The HCM procedures are of limited value in analyzing queues and the effects of the queues. There are also several gaps in the HCM procedures. HCM is a constantly evolving and expanding set of analytical tools and, consequently, there are still many real-world situations for which HCM does not yet have a recommended analytical procedure. The following list identifies some of these gaps: (1) multilane or two-lane rural roads where traffic signals or stop signs significantly impact capacity and/or operations, (2) climbing lanes for trucks, (3) short through-lane is added or dropped at a signal, (4) two-way left-turn lanes, (5) roundabouts of more than a single lane, and (6) tight diamond interchanges."

5. What are the strengths and limitations of simulation?
 - Strengths: Effective in evaluating the dynamic evolution of traffic congestion problems, can evaluate buildup, dissipation, and duration of traffic congestion, can model the variability in driver and vehicle characteristics
 - Limitations: Require significant amounts of input data, error checking, and manipulation of large amounts of calibration parameters, cannot model two way left turn lanes, the impact of driveway access, the impact of on-street parking, and the interferences that can occur due to multimodal transportation
 - From "Traffic Analysis Toolbox", Volume II, page 10: "Simulation tools are effective in evaluating the dynamic evolution of traffic congestion problems on transportation systems. By dividing the analytical period into time slices, a simulation model can evaluate the buildup, dissipation, and duration of traffic congestion. By evaluating systems of facilities, simulation models can evaluate the interference that occurs when congestion builds up at one location and impacts capacity at another location. Also, traffic simulators can model the variability in driver/vehicle characteristics. Simulation tools, however, require a plethora of input data, considerable error checking of the data, and manipulation of a large amount of potential calibration parameters. Simulation models cannot be applied to a specific facility without calibration of those parameters to actual conditions in the field. Calibration can be a complex and time-consuming process. The algorithms of simulation models are mostly developed independently and are not subject to peer review and acceptance in the professional community. There is no national consensus on the appropriateness of a simulation approach. Simulation models, for all their complexity, also have limitations. Commercially available simulation models are not designed to model the following: (1) two-way left-turn lanes, (2) impact of driveway access, (3) impact of on-street parking, commercial vehicle loading, and double parking, and (4) interferences that can occur among bicycles, pedestrians, and vehicles sharing the same roadway."
6. What are the differences in how the Highway Capacity Manual and simulation models report performance measures?

- The HCM is deterministic (static) while microsimulation is stochastic (dynamic). There are differences in the specific definitions of some performance measures.
 - From "Traffic Analysis Toolbox", Volume II, page 11: The HCM methodologies and tool procedures take a static approach to predicting traffic performance; simulation models take a dynamic approach. HCM estimates the average density, speed, or delay over the peak 15 minutes of an hour, while simulation models predict density, speed, and delay for each time slice within the analytical period (which can be longer than an hour). Not only are there differences in approach, there are differences in the definitions of the performance measures produced by simulation models and the HCM tools. Some of the most notable differences include:
 - Simulation models report density for actual vehicles, while HCM reports density in terms of equivalent passenger cars (trucks and other heavy vehicles are counted more than once in the computation of density).
 - Simulation models report vehicle flow in terms of actual vehicles, while HCM reports capacity for freeways and highways in terms of passenger-car equivalents.
 - Simulation models report delay only on the street segment where the vehicles are slowed down, while HCM reports all delays caused by a given bottleneck (regardless of the actual physical location of the vehicles).
 - Simulation models report queues only on the street segment where the vehicles are actually queued, while HCM reports all queued vehicles resulting from a given bottleneck (regardless of the actual physical location of the vehicles).
 - Simulation models do not necessarily report control delay at signalized intersections. The reported values include midblock delays for the vehicles traveling along the link, or only stopped delay at the traffic signal.
7. What is a link/node diagram and what do links and nodes represent?
- A link node diagram is the fundamental way to represent a transportation network for a microsimulation model. Links represent streets and highways, while nodes represent intersections or interchanges.
 - From "Traffic Analysis Toolbox", Volume III, page 35: "The link-node diagram is the blueprint for constructing the microsimulation model. The diagram identifies which streets and highways will be included in the model and how they will be represented. An example link-node diagram is shown in figure 4. This step is critical and the modeler should always prepare a link-node diagram for a project of major complexity."
8. What kinds of driver behavior are modeled in a microsimulation model?
- Driver behaviors which are modeled in a microsimulation model include minimum headway in car following, gap acceptance, response to yellow interval (stop or continue through the intersection), speed, and acceleration
9. What are some of the new features available in the current version of VISSIM?

- In the latest version of VISSIM (5.30), new features include more realistic modeling of drivers searching for parking, improved lane change behaviors, improved compatibility with other programs, and better routing of pedestrians
10. What kind of model would you use to determine the number of lanes needed at a signalized intersection to meet a desired level of service?
- A critical movement analysis should be used because the effect of adding another lane on capacity and level of service could easily be calculated.
11. If a time-scan model is based on scanning time on a regular basis, what is an event scan model based on? For a signalized intersection, list some events of interest that would be the basis for an event scan model.
- An event scan model is based on scanning events on a regular basis. Some events that could be used in an event scan model could be signal changes or the arrival and departure of vehicles.
12. For what kinds of problems or system conditions would you consider using the following models: CMA, HCM, VISSIM?
- CMA: Traffic volumes are known and signal timing parameters need to be estimated; the effects of adding or removing a lane need to be evaluated; capacity and level of service calculations
 - HCM: Simple analysis of intersection performance; average performance values and expected queue lengths
 - VISSIM: Complex issues are present including queue spillback or the effects of an intersection in a network operating over capacity on the performance of the remaining intersections; detailed data is needed; evaluation of alternative intersection designs not covered in HCM
13. Which model would you use to test signal timing strategies for a congested arterial with three closely spaced signals? Why? Justify.
- A microsimulation model should be used because it would allow the effects of changing the signal timing parameters at one intersection on the performance of the other intersections to be observed.

Using Activity #27: The VISSIM Simulation Model – Learning Your Way Around (Discovery)

Overview

This activity introduces students to the basics of VISSIM through watching a short video. The video introduces students to the toolbar, how the ring barrier controller (RBC) operates, how to collect node evaluation information, and how to change simulation speed.

Options for Use

This activity can be done either as a homework assignment or during class.

Preparing for the Activity

- Decide which of the options you will do for this activity.
- Prepare for the class by reviewing the video and the use of VISSIM. As you watch the video note the following:
 - Toolbar: this gives you access to various tools in VISSIM
 - Signal controller data with data base
 - Evaluation data, files
 - Simulation options

Doing the Activity (Script)

You can use all or part of the following notes to guide the students through this activity.

| Slide | Text |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | The purpose of this activity is to introduce you to VISSIM simulation environment and some of its features. You will watch a video (about 4 minutes), explore the VISSIM website, and answer questions. |
| | Ask the students to read the Learning Outcomes, Resources, Deliverable. Have them work in pairs to observe the video. This takes about 5 minutes. Reviewing the web site will take about 10 minutes. |
| | Take 5 minutes to discuss the answers to the Critical Thinking Questions. |

Solutions

Critical Thinking Questions and Answers

1. What are some of the components of the VISSIM model that are accessible through the toolbar?
 - The VISSIM toolbar has many tools on it including; routing decisions, vehicle detectors, data collection points, travel time, change speed sign, stop signs, and signals.
2. What are some of the traffic signal timing parameters that are required to specify the operation of the RBC controller?

- Some timing parameters used in a RMC controller include minimum green time, maximum green time, and vehicle extension.
3. What kinds of evaluation data are produced by VISSIM and which ones might be most important in evaluating a design?
 - VISSIM evaluates many pieces of data the most important for evaluation a design might be delay, travel time, and average vehicle stops. Some lesser important data are emissions or average speed.
 4. Why would you consider various simulation speeds when you run VISSIM?
 - VISSIM allows the user to run at different simulation speeds which may be needed for different reasons. For example if the user wanted to record to the tenth of a second when a vehicle crosses a point they will want to run the simulation at a slow speed. On the other hand, if the user wants to watch the simulation to see if any cycle failures occur at a specific intersection, they will want to run the simulation at a higher speed.

Using Activity #28: Building a Simulation Model Network (Design)

Overview

The purpose of this activity is for students to learn how to build and use a simulation model network. They will use the network created in this activity as the basis for an isolated signalized intersection design project. This activity first focuses on having the students create sketches which will benefit them in the creation of their VISSIM network. Students then take a base network and add signal heads, detectors, and base timing parameters. This is the base network that will be used as a comparison to evaluate the effectiveness of for future timing parameter changes during the design project. Finally, students will collect base case data and summarize it, allowing them to easily compare future changes to their base case.

Options for Use

This activity is best done in a computer lab in which the students can use VISSIM and receive guidance from the instructor in the preparation and testing of this simulation model network. Several VISSIM networks are provided for your use. But you may develop your own networks that reflect your local conditions.

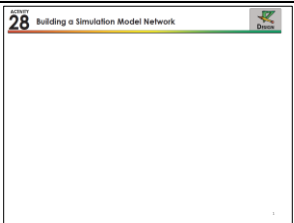
Preparing for the Activity

- Review base VISSIM networks to make sure that they work for your VISSIM installation.
- Review VISSIM tutorial so that you will be prepared to assist students in their work.

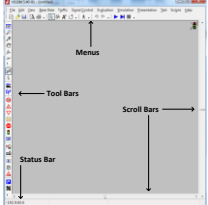
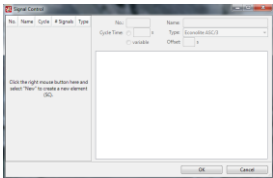

Doing the Activity (Script)

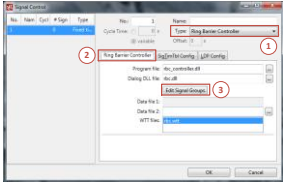
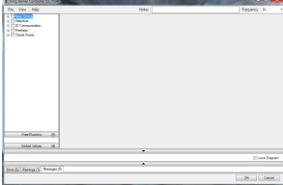
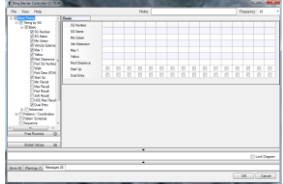
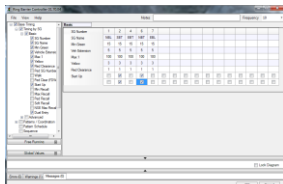
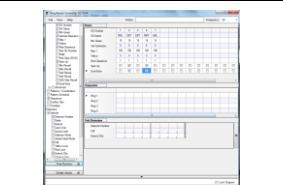
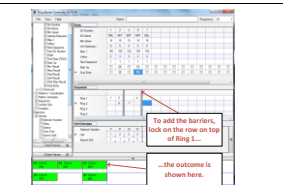

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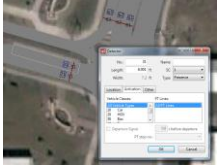
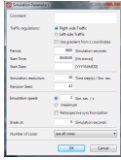
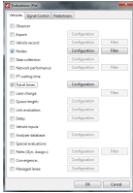
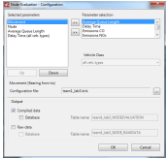
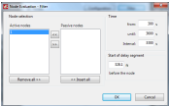
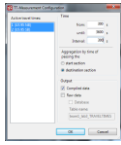
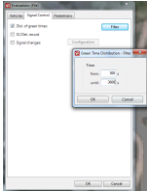
The preparation of their first VISSIM network will be a challenging one for students. It is important that you review both the broader goals of this activity (have a base network with performance indicators that will be used to compare with future design work) and the specific goals (learning how to set up a VISSIM network). Note that they are not building a network from scratch but only adding the signal control components (the detectors, the signal heads, and the signal timing and phasing) to an existing base network.

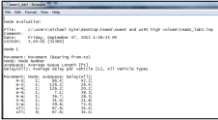
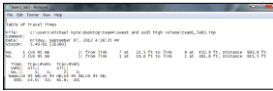

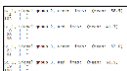

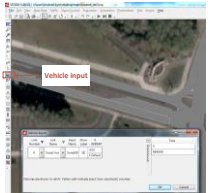
| Slide | Text |
|------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p>Slide 28: Building a Simulation Model Network</p> | <p>The purpose of this activity is for you to build your base VISSIM network. This network will be used as the base case that you will use to compare with future signal timing changes and the results of these changes in the performance of the VISSIM network.</p> <p>The end results are (1) correctly working base network and (2) base case data for comparison with future analysis</p> <p>Note: we are creating a new reality: your simulation ...it is not calibrated to your field conditions. You are given a set of traffic conditions designed to help you learn about specific kinds of traffic</p> |

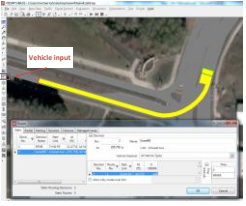



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|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | operations problems. |
| | <p>Ask them to read through the purpose, learning objectives, required resources, and deliverables for this activity. Go over each of these in detail to make sure that the key points are clear.</p> <p>It is particularly important to review the deliverables as this is the first time that they are handling a large amount of data from the several VISSIM output files.</p> |
| [write on board] | <p>Here is a list of the tasks that you will complete as part of this activity:</p> <ul style="list-style-type: none"> • Prepare sketches • Open network and run: what is missing • Add signal control components to network • Evaluation nodes: check and set up • Run and debug as needed (make final run) • Review evaluation data (prepare data tables) • Demonstrate network • Excel summary and Critical Thinking Questions |
| [write on board] | <p>Here are some common problems or issues that students have struggled with in the past:</p> <ul style="list-style-type: none"> • File management issues are important, and need to be clear on the process: download, unzip, copy to a location on hard disk. Backup is critical. You will need to keep track of versions for subsequent activities. • What did you learn by observing the simulation? What problems exist that you need to try to solve or manage? What things can you do to solve the problems? What is your primary goal in developing the timing plan? Look at example video file. • What do the evaluation data tell you? What can you learn from each of the following? <ul style="list-style-type: none"> ○ Delay ○ Queue length ○ Travel time ○ Green interval distribution ○ VISSIM files: kna, rsz, lzv • Importance of looking at and synthesizing data sets and linking to what you see in the simulation. • Excel data management and analysis. • Common VISSIM issues: <ul style="list-style-type: none"> ○ Check carefully that the detectors have been mapped to the correct phases. |

| Slide | Text |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <ul style="list-style-type: none"> ○ Make sure that you add a signal group (phase) number to the signal heads. ○ Be sure that you understand the evaluation data. Read the help file for additional information. |
| [draw on board] | <p>Review task 1: In this task you will make two sketches:</p> <ul style="list-style-type: none"> ● One that includes the lane geometry, the numbered directional movements, the phase numbers that control each movement, stop bar detectors in each lane, and signal heads in each lane. ● Another that is the ring barrier diagram for your intersection assuming leading protected left turns. |
|  | <p>Review task 2: In this task you will download the VISSIM files, unzip them, copy to your hard disk, open the VISSIM file, and run. What is missing? What do you see?</p> |
| | <p>Review task 3: When you realize what is missing from your base network, you will need to add the signal control information.</p> <ol style="list-style-type: none"> 1. Create signal controller group <ul style="list-style-type: none"> ● (phases are signal groups) 2. Data needed for controller data base <ul style="list-style-type: none"> ● Base timing: timing by signal group (phase)-basic and sequence (RBD) ● Detectors (vehicle) 3. Create signal heads 4. Add detectors <p>[the following slides are taken from the VISSIM tutorial file; you may use them as needed]</p> |
|  | <p>“Signal Control” dialog box, before any controller data have been selected.</p> |
|  | <p>“Ring Barrier Controller” is selected as the type of controller.</p> |

| Slide | Text |
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|  | <p>This slide shows three relevant elements of the “Signal Control” dialog box.</p> |
|  | <p>When “Edit Signal Groups” is selected from the previous slide, this slide shows the blank “timing sheets” from the Ring Barrier Controller.</p> |
|  | <p>Here are the basic signal timing data for the Ring Barrier Controller.</p> |
|  | <p>The basic actuated control data have been entered as shown here.</p> |
|  | <p>Data entry areas for the “sequence” of the phases for each ring and the vehicle detector data are shown here.</p> |
|  | <p>Hints on how to enter phase data in ring barrier diagram, and the resulting graphical representation of the ring barrier data.</p> |
|  | <p>This slide shows the “Signal Head” dialog box.</p> |

| Slide | Text |
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|  | <p>This slide shows the “Detector” dialog box.</p> |
|  | <p>This slide shows the “Simulation Parameters” dialog box.</p> |
|  | <p>Review task 4: Set up the evaluation files as noted in the instructions. You need to collect data for delay, queue length, and green times. Note also the simulation time parameters in the instructions.</p> <p>This slide shows the “Evaluation (files)” dialog box in which you can select the types of evaluation files that will be produced.</p> |
|  | <p>This slide shows the “Node Evaluation – Configuration” dialog box, and the parameters that can be selected.</p> |
|  | <p>This slide shows the “Node Evaluation – Filter” dialog box in which students show the time durations for the data collection.</p> |
|  | <p>This slide shows the “Travel Time Measurement Configuration” dialog box.</p> |
|  | <p>This slide shows the “Evaluation (Files)” for signal control data.</p> |
| | <p>Review task 5: Run the network and debug as needed. How do you know it is “working correctly”?</p> <ul style="list-style-type: none"> • Phase operate in sequence and for the expected duration. |

| Slide | Text |
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| | <ul style="list-style-type: none"> • Vehicles respond to the signal displays in an appropriate manner. • There are no conflicts between vehicles from different traffic streams. |
|  | <p>Review task 6: Review and become familiar with the evaluation files. Learn how to import these text files into Excel so that you can manipulate the data easily.</p> <p>[Node evaluation example output file]</p> |
|  | <p>[Travel time example output file]</p> |
|  | <p>[Distribution of signal times example output file]</p> |
|  | <p>[Green times example output file]</p> |
| <p>Review task 7: Demonstrate your working network to your instructor.</p> | |
|  | <p>[Node evaluation setup]</p> |
|  | <p>[Vehicle input]</p> |

| Slide | Text |
|------------------------------------------------------------------------------------|------------------------------------------------|
|  | <p>[Route selection for turning movements]</p> |
|  | <p>[Signal heads and detectors]</p> |
|  | <p>[Priority rules; conflict areas]</p> |
|  | <p>[Priority rules; conflict areas]</p> |

Solutions

[Excel files with example solutions: solutions28x.xlsx]

Included here:

- Notes from the tasks
- Critical thinking questions and answers

Notes from the tasks

Task 2: This network includes the link and node structure, a background photograph, priority rules governing vehicle interactions, vehicle routing decisions, and traffic volumes. What is missing?

- The base network is missing detectors, signal heads, and the signal timing and phasing.

Task 6: Following are notes on student solutions for this task.

- Example table of delay and, queue length are shown below for one team.

| Node | Movement | Average Queue (ft) | Delay (s) |
|------|----------|--------------------|-----------|
| 1 | EBTH | 30.5 | 16.1 |
| 1 | EBRT | 30.5 | 17.3 |
| 1 | EBLT | 19.4 | 31.6 |
| 1 | NBRT | 31 | 25.8 |
| 1 | NBTH | 31 | 25 |
| 1 | NBLT | 12.6 | 32.9 |
| 1 | WBTH | 37.2 | 18.6 |
| 1 | WBRT | 37.2 | 19.5 |
| 1 | WBLT | 13.8 | 33.6 |
| 1 | SBRT | 30 | 22.8 |
| 1 | SBTH | 30 | 21.2 |
| 1 | SBLT | 15.2 | 32.7 |
| 1 | All | 26.5 | 21.5 |
| 0 | All | 26.5 | 21.5 |

Figure 3. Example delay and queue summary

The following table shows a green time distribution example output.

| t SG | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|------|----|---|----|---|----|---|----|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 16 | 0 | 17 | 0 | 10 | 0 | 12 | 0 |
| 5 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| 6 | 6 | 0 | 3 | 0 | 7 | 0 | 3 | 0 |
| 7 | 9 | 0 | 10 | 0 | 11 | 0 | 5 | 0 |
| 8 | 5 | 0 | 0 | 0 | 5 | 0 | 5 | 0 |
| 9 | 1 | 0 | 4 | 3 | 4 | 1 | 7 | 6 |
| 10 | 3 | 1 | 1 | 4 | 4 | 1 | 2 | 6 |
| 11 | 1 | 2 | 0 | 6 | 2 | 0 | 1 | 1 |
| 12 | 0 | 2 | 2 | 3 | 3 | 5 | 2 | 3 |
| 13 | 0 | 1 | 0 | 3 | 2 | 2 | 0 | 8 |
| 14 | 0 | 0 | 0 | 9 | 0 | 1 | 1 | 2 |
| 15 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 5 |
| 16 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 4 |
| 17 | 0 | 4 | 0 | 3 | 0 | 2 | 0 | 0 |
| 18 | 0 | 1 | 0 | 2 | 0 | 2 | 0 | 3 |
| 19 | 0 | 2 | 0 | 1 | 0 | 5 | 0 | 4 |
| 20 | 0 | 2 | 0 | 2 | 0 | 4 | 0 | 1 |

Figure 4. Example green time distribution data

This table shows the average green time for each signal group (phase) and the movement controlled by each.

| Signal Group | Movement | Average Green Time (s) |
|--------------|----------|------------------------|
| 1 | WBLT | 6.1 |
| 2 | EBTH | 23.4 |
| 3 | NBLT | 6.1 |
| 4 | SBTH | 15.9 |
| 5 | EBLT | 7.5 |
| 6 | WBTH | 21 |
| 7 | SBLT | 7.2 |
| 8 | NBTH | 15.3 |

Figure 5. Example Average Green Time Table for Each Phase

- An example distribution plot showing the variation in green times is shown in Figure 6. Green times vary because vehicles arrive randomly at the intersection, causing queue lengths to vary throughout the simulation. Because of this, different amounts of green time are needed to serve each movement.

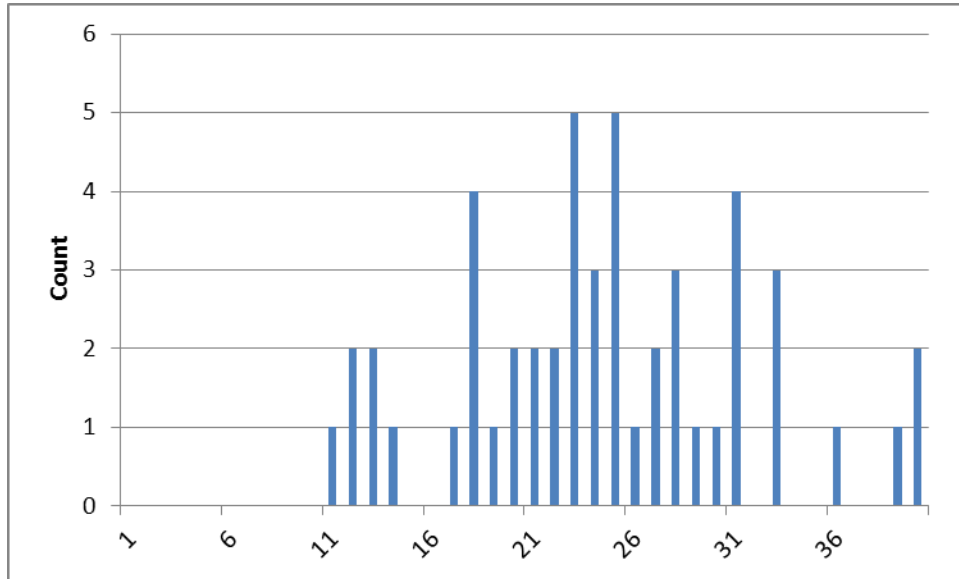


Figure 6. Example Green Duration Histogram for the Eastbound Through Movement

Critical Thinking Questions and Answers

1. Are your observations of the animation consistent with these data?
 - The simulation data and the observations made should agree with each other. If they do not, either the data was collected incorrectly, and the VISSIM network should be checked in detail, or the students made incorrect assumptions about the meaning of their observations.
2. What traffic problems do you observe?
 - Although answers will vary from group to group, typical answers include queues not clearing before the end of green, queues spilling out of a left turn pocket and into a through lane, the queue in the through lane blocking access to the left turn lane, or vehicle extension times that seem to cause the intersection to operate inefficiently.

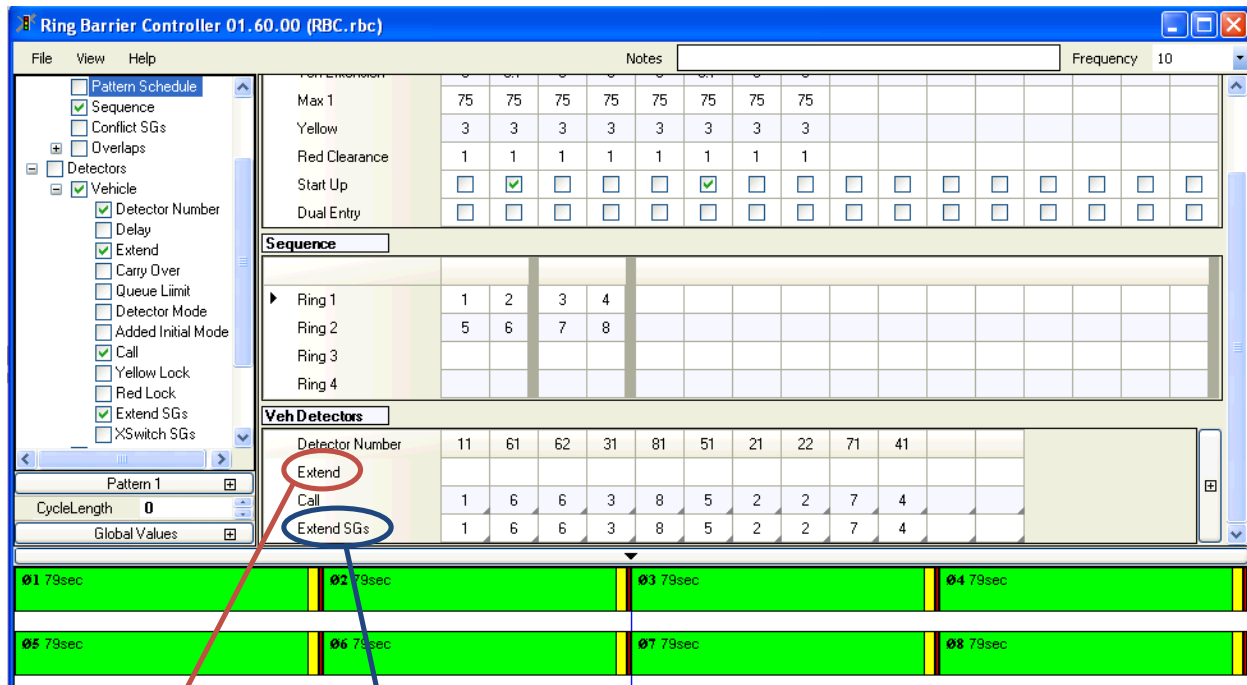
Other Notes

Common VISSIM network issues

- Check carefully that the detectors have been mapped to phases. Detectors on same approach serving same phase can have the same number.
- One of the common problems is that vehicles aren't stopped by the red lights. A common error is that signal heads and detectors need to be upstream of the connector (not touch the connector, but be on the link only).
- The most common error students make is to map detectors or signal heads to the wrong phase. This can be typically be checked by observing the simulation and watching for

detectors which do not seem to be placing calls or signals which do not time with the correct phase.

- Important note on RBC controller: The "Extend" feature on the detector is the extend time, not the phase that will be extended. This should be zero unless I want to use this as another "extend". Rather the "Extend SG" should be set to the phase number! [see following figure]



“Extend” provides the same function as the Passage Time; it should be blank unless you want the detector to have additional “extend” time

“Extend SG” identifies which phase is extended by this detector

- Students sometimes have a problem saving their RBC files. This occurs because they didn't download the zip file, and then unzip it. Emphasize: downloading the zip file, unzipping the folder and placing it on the computer (and not on a thumb drive), and finally the importance of backing up their work regularly (and having multiple copies).
- There is also an issue with their experience in using Excel and some of the tools within Excel for data analysis, including importing text files into Excel, use of the data analysis package that may need to be activated. Some help on these data analysis tasks (and the recognition that all students don't have sufficient experience with Excel) should be part of what I talk about.

Example student questions and things that they said that they learned:

- One thing I learned about traffic yesterday is there are never exact answers.
- What does "leading, protected LT" mean?
- Can VISSIM do right turn on red?
- Dual entry-what does it mean?
- What is a link-node diagram?
- What does the startup phase mean?
- What does dual entry mean?
- We did not know how to delimit data in Excel, so brief instructions on this could be beneficial.
- When entering detectors into the controller, students seemed to have a hard time figuring out how to add more columns, so a short instruction in the VISSIM help section of the book clarifying how to do this would be good (there is a + button to the far right of the detector section of the RBC controller that adds more columns).
- Small adjustments made to the parameters of a movement can have a larger effect down the line, also detector length make a large difference in passage time.
- I learned how an intersection works in a model.
- That the process of analyzing the intersection to better its performance really takes time and patience and a really good understanding of the data
- One thing I learned yesterday is that if the detectors don't work, neither do the signals
- The mean times between each phase are different.
- How a random seed compares to actual volumes for an intersection.
- I learned that it can be difficult to save your data in the right location using VISSIM
- The output data that we transferred from a notepad doc to an excel sheet took a while to understand exactly how that was arranged and what it was telling us
- How to accurately make a ring barrier diagram
- I learned about how to interpret data on VISSIM and how to troubleshoot on the software when the program didn't function right.
- Can vehicles in the right hand lane on sweet ave. turn both right and left?
- I learned the basics of VISSIM and how to set up my own simulations if I want to. I would like to know how to create the intersections
- I would like to learn more about the excel data analysis module. One thing I understand better after yesterday is phase numbering for different cycles.
- The general setting up of the program to suit our purposes (future reference)
- One thing I learned about traffic yesterday is there are never any exact answers.
- VISSIM operation and configuration.
- What type of reports/output data will VISSIM run for use. We experienced a couple, but are there other parameters we can investigate?

Using Activity #29: Traffic Analysis Tools (In Practice)

Overview

The purpose of this activity is to provide the students with guidance on how practitioners think about and use models.

Options for Use

- This activity is often done as homework. The discussion is usually done in class.

Preparing for the Activity

- You should review the reading in the Traffic Signal Timing Manual.

Doing the Activity (Script)

1. Describe the purpose of the “In Practice” activities and how they will be used to review and calibrate the work that they have previously done in each chapter.
2. Invite them to consider the CTQ and their answers.
3. Ask for answers and discussions for selected questions.

Solution

Critical Thinking Questions and Answers

1. How does the description of models from the Traffic Analysis Toolbox compare and contrast with the discussion in the Traffic Signal Timing Manual?

