



Lesson 2: Modeling Traffic Solutions - Designing & Modeling (Days 3-6)

Subject Areas: Environmental Science

Grade Levels: 11-12

Time Required: ~200 minutes (4 days @ 50 minutes/day)

Group Size: 2-4

Cost: \$0

Materials: 2 large sheets of paper per group, computer/device with internet access and [PTV Vissim trial](#) software installed

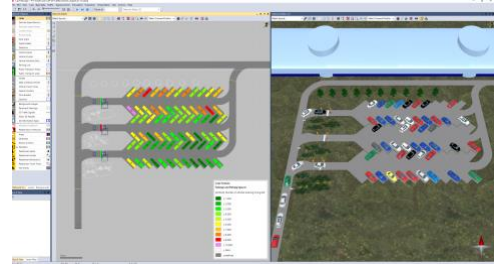


Image 1: PTV Vissim Software

Summary:

The goal of this block of time is for each group to design a solution to a traffic problem and then use a model to collect data on their design. Students should have identified a traffic problem area during the first 2 days of this unit. Next, students will develop the criteria for success or goals of their proposed solution, for example, the goal is to decrease travel time, or to increase pedestrian safety. Students will also develop a list of constraints that will apply during the design process.

Engineering Connection:

Designing solutions is at the core of engineering. Students will first identify a problem, and after gathering information and data, they will propose a solution(s). Finally they will need to test their solution(s) using a model.

Keywords:

Engineering Design, traffic, urban sprawl, real-world problem

Educational Standards:

NGSS:

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

North Dakota Science Standards:

Performance Standard HS-ET1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Performance Standard HS-ET1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Performance Standard HS-ET1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Prerequisite Knowledge:

Urban vs rural areas, basic computer skills, traffic principles, experience using road networks, map skills

Learning Objectives:

After this lesson students should be able to:

- Use a model to collect data on a proposed solution
- Evaluate a solution to a complex problem

Introduction/Motivation:

Traffic can be frustrating. Solutions are often complex and expensive, even for seemingly small projects. Now that the class has identified an area of concern, they will be tasked with designing a solution. Solutions could include different traffic signs, additional lanes/roads, dedicated turning lanes, pedestrian bridges, or any other solution students can think of. The goals of the project can be modified to fit your particular needs.

DAY 3: (50 minutes) Defining Success Criteria & Brainstorming

Introduction:

For the purposes of this example I will use a traffic situation that is well known in my school. We have a single parking lot for students with only 2, small exits. Before and after school the traffic can back up for several city blocks and it is a constant point of frustration for students and families. I will be using this scenario for the rest of this lesson plan but your scenario could be very different depending on your school and community.

Prepare before class by having 2 large, clean sheets of paper for each group. With students working in their groups, use the first sheet of paper and ask each group to define the problem from the previous lesson(s). After a minute or two, ask one group to share with the whole class.

Next, ask each group to come up with a list of **success criteria** that will be used to evaluate their solutions. They should brainstorm a list on the same sheet of paper at their table. Example criteria could include:

- Reduced drive times
- Reduced pedestrian conflicts
- Shorter lines at an intersection
- Improved traffic flow
- Increased traffic volume
- Reduced number of stops
- Increased number of cars through each light cycle
- Reduced accidents
- Increased speed
- Cost of the project
- Length of construction
- Longevity (how long the solution will last)

After about 5 minutes of brainstorming, create a class list on the board. Lead a whole group discussion about the criteria with the purpose of narrowing it to 1-3 for this project. I recommend choosing 1 or 2 criteria for measurement. Be sure that you can collect data for that criterion.

Note: Some criteria are more difficult to evaluate. It will also depend on whether or not you're using the simulation software or inviting local experts to evaluate your projects.

Save this list for future lessons. If possible, post this list in the classroom or make copies for each group for easy reference as they continue the design process.

Review the Engineering and Design Process from lesson 1 (https://docs.google.com/presentation/d/1v2opED383DBvAkZuLWds_08K48Fcc3iNVjaWI2qYU64/edit?usp=sharing). Ask/remind students where the class is in the process. Students should understand that they have identified the problem, done research, and are entering the imagining, planning and creating stages.

Using the second large sheet of paper, ask each group to brainstorm possible design solutions to the traffic problem. This could include any and all solutions. This is the imagining and planning stage of the engineering design process so students should generate multiple solutions. They should be practical but do not discourage outside of the box thinking. Work with individual groups as they work on their brainstorming.

The format is up to each group. They could choose to draw a picture, explain in words, use Google Maps with drawing software or any other way to represent their ideas. Allow ample time for student creativity. Ask questions to help groups generate ideas and discussions.

Keep the large sheets of paper with the students' solutions for the next lesson. They will build a model using their ideas.

DAY 4: (50 minutes) Building a Model

Distribute the large sheets of paper back to each group. Ask them to review their work and add anything else they think might be useful. Allow 5 minutes for revision.

Next, each group will need to narrow their list of solutions down to one solution they want to model. Post and review the list of **success criteria** generated on Day 3. Instruct each group to narrow their ideas to one design they think meets the criteria. This will be the design for their model.

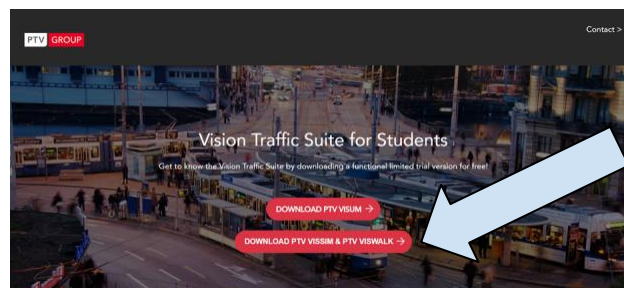
Ensure all groups have selected an appropriate solution before moving on to build the model.

Transition to building the model. For alternative modeling activities see the end of the lesson.

Using the VISSIM software, lead students through the basics of the program. If all groups are using the same traffic network, consider creating a base model in the VISSIM software and allowing students to download it. Once equipped with the base model, groups can modify that to create their own solution. This will save time and frustration.

Another option is to invite local experts to the classroom to help students use the VISSIM software.

Using VISSIM Software: [Download Here](#)



VISSIM software is a powerful tool that will require teachers to be familiar with certain functions before the lesson. This plan will outline basic features of the software and provide additional resources for more advanced features. It will be up to teachers to determine how to best use the software for students' models.

Guide students through the software to create a road network that will represent their solutions.

Alternative Modeling Activities

Instead of using the VISSIM software to model the road network, teachers may choose to create different models:

- **Poster Models** - groups create a scaled drawing of their proposed road network solution using a large poster board. These poster boards could be evaluated by classmates, other teachers, administrators, city officials, or engineers.
- **Modified Google Maps** - using Google maps, groups could use editing software to create a model of their proposed road network solution. Groups could draw on top of the map or superimpose their design using other mapping software. These modified maps could be evaluated by classmates, other teachers, administrators, city officials, or engineers.

DAY 5 & 6: (100 minutes) Building a Model

Groups continue to build and refine their model traffic networks. Regular progress monitoring and feedback should be given throughout the design process. Teachers should help groups that are struggling and connect them with appropriate support.

Once the models are completed, they must be tested and evaluated for their effectiveness. Depending on the success criteria selected on Day 3, this will determine the set-up in the software. VISSIM contains numerous tools to test the effectiveness of a road network. One particularly useful tool is the **Average Vehicle Delay**.

Modifications:

Extensions:

- Groups that finish early could be challenged in many ways using the VISSIM traffic modeling software:
 - Increase the amount of data collected for the road network
 - Increase the complexity
 - Create a model for unique situations (traffic after a sporting event or concert, traffic on a Sunday vs a day during the week, etc)
 - Modify the volume of vehicles on the road network
 - Change the composition of vehicles (ex. more trucks and less cars)
 - Introduce Autonomous Vehicles to the road network (see additional resources below)

Additional resources:

- VISSIM Training Tools:
 - General Overview Videos: <https://company.ptvgroup.com/en-us/getting-to-know-ptv-vissim>
 - Parking Lot Video: <https://www.youtube.com/watch?v=nqOdfk3m9Sc>
 - Getting Started Manual: <http://www.dot.ga.gov/PartnerSmart/DesignSoftware/TrafficSoftware/Getting%20Started%20VISSIM%206.pdf>
 - Vissim Resource Library: <https://company.ptvgroup.com/en-us/resources/resource-library>

Images:

Image 1 Source - <https://www.ptvgroup.com/en/solutions/products/ptv-vissim/release-highlights/>

Credit: PTV Group - Vissim Software

Subject Area:

Environmental Science, Grades 11-12

Contributors:

Josh Rogers, Davies High School

Acknowledgements:

This curriculum was developed under National Science Foundation RET grant # 1953102. However, these contents do not necessarily represent the policies of the National Science Foundation, and you should not assume endorsement by the federal government.