Lesson 3: Modeling Traffic Solutions - Analysis and Presenting Results (Days 7- 10)

Image 1: Parking lot

Subject Areas: Environmental Science
Grade Levels: 11-12
Time Required: ~200 minutes (Four 50 minute periods)
Group Size: 2-4
Cost: $0
Materials: Computer/device with internet access and PTV Vissim trial software installed, presentation software (PowerPoint, Google Slides, Prezi, etc), classroom projector

Summary:

Students have designed a solution and will now test that solution and collect data on their model. After collecting data, each group will analyze it to determine if their solution satisfied the success criteria defined in lesson 1. Students will then prepare a presentation to communicate their results. If time allows, groups can engage in the redesign process.

Engineering Connection:

Collecting data for a model is a critical step in the Engineering Design Process. Students will collect data on their models to determine if they were successful. Engineers must use data to drive decisions and this will demonstrate to students that process.

Keywords:

Engineering design, traffic, urban sprawl, road network

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 with using road networks.

Materials:

Computer with presentation software (Google slides, PowerPoint, Prezi, etc)

Learning Objectives:

After this lesson students should be able to:

- Use a model to collect data on a proposed solution
- Evaluate a solution using evidence
- Communicate results of an experiment

Introduction/Motivation:

Modeling is an important part of the engineering and design process. Using software to model complex road networks is one of the only ways you can test proposed roadways. A lot of time and energy has been invested to determine the behavior of cars while traveling through road networks. There are dozens of parameters that can influence a road network. The data collected is used to improve road network designs and predict the capacity of a road network before a single vehicle has driven on a real road.

Of course, engineers could build massive roads that could accommodate thousands of vehicles, but there are limits. Cost, city zoning, noise, aesthetics, wildlife, mass transit, walkability, bike lanes, and many other factors converge on one road network project.

Day 7: (50 minutes)

Groups will now test their model using the traffic software of choice. Set the parameters for the simulation and be sure each group has the correct settings. Things to consider when creating your simulation parameters:

- Vehicle inputs
    - How many vehicles enter the road network
    - Type of vehicles that enter the road network
- Vehicle routes (where the vehicles will go once they enter the network)
- Signal timing (how long each light will stay green, amber and red)
- Length of the simulation (how long will it run)
- Placement of data collection sensors (optional)
    - Queue counters
    - Queue length
    - Nodes (analyze vehicle delay)

Base Model Simulation:
As a class, run the base model simulation using the parameters above. Allow students to write observations using the data collection sheet (see below). Discuss how the solutions should demonstrate improvement from the base model.

Student Model Simulation:
Students will complete the **Data Collection** (see below) as part of their analysis.

Alternative Assessment: (optional)
If an alternative modeling activity is chosen, students will still present their designed solution and demonstrate how it will satisfy the success criteria outlined on Day 2. Once these models have been created, invite experts from your community to evaluate them and give the students feedback. Groups could then redesign their models incorporating the feedback and then present their findings to the class.

DAY 8 & 9: (100 minutes) Preparation for presentation

Groups will create presentations to share their results with the class. The presentation should include the following (see **Presentation Document** below for student friendly version):

- Introduction and Background
    - Explanation of the problem
    - Background information (from their research)
- Proposed solution
    - What was your design?
    - Why did you select this design?
- Results
    - Quantitative
    - Qualitative
- Analysis - did your design (results) solve the problem?
- Impact - would you recommend this solution? Why or why not?

Day 10: (50 Minutes) Student Presentations

Students will present their projects to the class. Each presentation should be approximately 5 minutes in length. Students should have access to the classroom projector or some other way of sharing their presentation with the class. Depending on your class size and period length, this could take more than one class period.

Students listening to the presentation should prepare questions to ask the presenters at the conclusion of the presentation.

Use the “Presentation Rubric” (see below) for Optional assessment would be to invite outside professionals to judge each group's project and award a “best in class” to the winning design.

Images:

Image 1 Source - https://www.flickr.com/photos/kevinkrejci/3251981473
Credit: Kevin Krejci

Subject Area:

Environmental Science, Grades 11-12

Contributors:

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Data Collection **Name:** _____

Record your results here. Use both qualitative and quantitative data.

Qualitative = descriptive observations
Quantitative = numbers and data

BASE MODEL

Qualitative Data:

Quantitative Data:

Description:	Value:	Unit:
Queue Length		
Queue Counter		
Vehicle Delay		

1. How well did the base model work? What problems did you observe?

2. How will your group's design improve the base model?

STUDENT MODEL

Qualitative Data:

Quantitative Data:

Description:	Value:	Unit:
Queue Length		
Queue Counter		
Vehicle Delay		

3. How well did your design work? What problems did you observe?

4. In what ways was your model different from the base model? Be specific and use data to support your answer.

Presentation Document **Name:** _____

Now that you've created a model and tested it, it's time to present your results. Use the following guidelines to create your presentation. Be sure to include all parts listed. See the rubric for more information.

- **Introduction and Background:**
  - Explanation of the problem
  - Background information (from their research)
- **Solution:**
  - What is your proposed solution
  - Why will your design work better than the base model?
- **Results: What were your results**
  - Quantitative
  - Qualitative
- **Analysis: Did your design (results) solve the problem?**
  - Completely solved the problem
  - Partially solved the problem
  - Did not solve the problem
- **Impact:**
  - Would you recommend this solution? Why or why not?
  - What are the strengths and weaknesses of your design?

This is an opportunity to share your design with others. This will also demonstrate your learning over the past few days so be specific and detailed.

Presentation Rubric **Name: _____**

Engineering Design Process				
Category	**4**	**3**	**2**	**1**
Introduction & Background	Accurate information taken from several different sources	Accurate information taken from 2 or fewer sources	Information taken from different sources but not all information is accurate	Information is missing or incomplete. Information is not accurate
Engineering & Design Process	Explanations indicate a clear and accurate understanding of scientific principles	Explanations indicate a relatively accurate understanding of scientific principles	Explanations indicate relatively accurate understanding of scientific principles	Explanations do not illustrate much understanding of scientific principles
Solution (Plan)	Plan is clear and contains detailed explanations for all components	Plan is clear and contains some explanations for some components	Plan is not clear and contains little details or explanations for components	Plan is not clear and is missing some or all of the components
Results (data collection)	Data is detailed and accurate with great detail	Data is detailed and accurate with some detail	Data is incomplete an/or inaccurate	Multiple pieces of data are incomplete/missing or incorrect
Analysis	Complete, detailed analysis of their design and results. Make specific connections between their design and the results	Complete, detailed analysis of the design and results	Analysis is incomplete or is missing specific details	Analysis is incomplete or missing. Analysis is missing major details.
Impact	Detailed evaluation of strengths and weaknesses of their project. Offers insight for further research or testing	Detailed evaluation of strengths and weaknesses of their project.	Evaluation of the impact is incomplete or missing some details	Evaluation of the impact is incomplete or missing major details.
Presentation				
Category	**4**	**3**	**2**	**1**
Preparedness	Student is completely prepared and has obviously rehearsed.	Student seems pretty prepared but might have needed a couple more rehearsals.	The student is somewhat prepared, but it is clear that rehearsal was lacking.	Student does not seem at all prepared to present.
Vocabulary	Uses vocabulary appropriate for the	Uses vocabulary appropriate for the	Uses vocabulary mostly appropriate	Does not use appropriate

	audience and content. Expertly uses a variety of language to convey meaning	audience and content. Uses a variety of language to convey meaning	for the audience and content. May use some terms incorrectly but mistakes are limited	vocabulary for the audience or content. Frequent vocabulary mistakes
Collaboration	Almost always listens to, shares with, and supports the efforts of others in the group. Tries to keep people working well together.	Usually listens to, shares with, and supports the efforts of others in the group. Does not cause "waves" in the group.	Often listens to, shares with, and supports the efforts of others in the group but sometimes is not a good team member.	Rarely listens to, shares with, and supports the efforts of others in the group. Often is not a good team member.

Adapted from http://rubistar.4teachers.org/index.php - ALTEC at University of Kansas