Lesson #1: Modeling Traffic Solutions - Kick-off Activity & Background (Days 1 & 2)

Image 1: 7 Circle Roundabout

Subject Areas: Environmental Science
Grade Levels: 11-12
Time Required: ~100 minutes (Two 50 minute periods)
Group Size: 2-4
Cost: $0
Materials: Computer with internets access, projector

Summary:

This lesson will get students thinking about how traffic impacts their lives. Students' experiences with traffic will vary, but most experience negative aspects of traffic at some point. Traffic is also something that many people have strong opinions about, one way or the other, which will serve to motivate students to design and test their own solutions.

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

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, map skills,

Learning Objectives:

After this lesson students should be able to:

- Identify how traffic impacts communities and individuals
- Identify and evaluate the causes of traffic congestion
- Collect data on traffic patterns near their school

Pre- Lesson Assessment:

Use the **Pre-lesson Assessment** (see below) prior to the first lesson)

DAY 1: (50 minutes) Hook & Observations

Introduction/Motivation:

Traffic congestion can range from a minor inconvenience to a major obstacle. Most individuals have had an experience with traffic delays in the form of congestion due to road construction, poor road design, or other factors. Drawing from those experiences, most people have daydreamed of a solution that would improve traffic, but how many have actually designed and tested one? This unit gives students the opportunity to do just that. Students will use the engineering and design process to design and test a solution to a real world traffic problem.

Lesson Hook:

Roundabouts, already popular in other parts of the world, are showing up in more and more US cities. Many communities have seen the benefits of using roundabouts but some residents have a difficult time navigating them. Show the following clip of a 7 circle roundabout:

See How an Insane 7-Circle Roundabout Actually Works | WIRED 1 minute 32 seconds
(Link: https://www.youtube.com/watch?v=6OGvj7GZSIo)

After the clip, ask students if they would feel comfortable driving on this particular intersection. Ask students why they think this intersection was built? What problem was it solving and why did they choose to solve it this way?

Next, have students generate a list of the pros and cons for the 7 circle roundabout as discussed in the video. Write the list of pros and cons on the board. As the discussion progresses, students may offer stories about frustrations they have while driving. Make note of these experiences as they may be useful later in the lesson.

Organize students into groups of 2-4. I usually use their lab groups. Working with their groups, ask students to discuss a negative experience with traffic. Each group member should share a story or pet peeve about driving. Ask each student to describe the location and the circumstances of their negative driving experience. Allow 1 minute (5 minutes total) for each group member to share within the group.

Bring the class together and ask for any volunteers to share their experiences. Ask students to look for common themes. Possible questions to ask during discussion include:

- Does anyone else find this situation frustrating?
- What made this experience so bad?
- If you could change anything about the situation, what would it be?
- Is this a huge problem, or just a small inconvenience?
- Is it a safety issue, or just an inconvenience?
- What impact did this have on other drivers, not just yourself?

At this point, hopefully everyone in the class has had an experience with traffic that gets them excited/frustrated. Pose the following question:

- Is there a location that is frustrating in terms of traffic near our school?
    - Help students identify a location that is near the school so that you can collect data.
    - This location can be anywhere, but for data collection it works best if students can directly observe the road network.
    - **Note:** Students may want to talk about driving behaviors. Ask how the road network/layout impacted that behavior. The goal will be to make the road network because we cannot control drivers' behaviors. But we can influence those behaviors by good road network design.

Once a location has been identified, hand out the **Observations Worksheet** (see below). Lead the class to your location and have students complete the observations worksheet. If direct observations cannot be made here is a list of potential alternatives:

- Find videos online of traffic incidents and write observations using the video
- Ask local authorities for data related to an intersection or road in your area
- Invite experts from the city/county/state to share current road designs.

SAFETY: Collecting data near the road is dangerous! Check with your building administration and safety professional before taking students into the field. Always follow all safety procedures. Students should NEVER be on the roadway. All observations should be made from a safe distance.

DAY 2: (50 minutes) Background Information

Begin class with a discussion of their observations from day 1. Hand out the Pre-lesson assessment (see below). Once students have completed it, begin the background notes using the Google Slides presentation linked below.

Slide 14 describes the research step in the design process. The slide asks 2 questions:

- What problem did the 7 circle roundabout solve? Why was it built?
- What information might help us solve the problem?
- Where can we find the information?
- What makes a good road network?
- What makes a bad road network?

After discussing the research questions, allow students ~10 minutes to do some preliminary research in their groups.

- Computers with internet access
- Phones or personal devices
- Library resources (books, databases, periodicals)
- Local experts (students could email a local official and as their research questions)

One student should record a summary of the group's research on a piece of paper. A different group member will then report the group's findings to the whole class at the end of the work session.

Finish the notes (slides 14-17).

Use the **exit ticket** embedded in the slides to assess students' understanding of the Engineering and Design process.

Background Google Slides Presentation:
https://docs.google.com/presentation/d/1v2opED383DBvAkZuLWds_08K48Fcc3iNVjaWl2qYU64/edit?usp=sharing

Additional resources:

- Crash Course Kids: The Engineering Process
  https://www.youtube.com/watch?v=fxJWin195kU
- Crash Course Kids: What's an Engineer?
  https://www.youtube.com/watch?v=owHF9iLyxic

Images:

Image 1 Source - https://www.wired.com/2016/08/brilliant-sorcery-englands-7-circle-magic-roundabout/
Credit: Aarian Marshall - Wired

Subject Area:

Environmental Science, Grades 11-12

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Observations Worksheet **Name:** _____

Record your observations below.

Location:

Drawing of the Road Network: (include labels, directions and a scale. Use arrows to show how traffic moves on the roads)

Written description of the road network (include location, speed limit, number of lanes, direction of traffic, etc)

Observations of traffic flow:

Potential Traffic conflicts:

Pre-Lesson Assessment **Name:** _____

Answer the following questions in complete sentences.

1. What is a road network?

2. Who is in charge of designing/building a road network?

3. What does a traffic engineer think about when designing a road network?

ANSWER KEY
Pre-Lesson Assessment **Name:** _____

Answer the following questions in complete sentences.

4. What is a road network?
   (System of roads used for the movement of people and goods)
5. Who is in charge of designing/building a road network?
   (Traffic Engineer)
6. What does a traffic engineer think about when designing a road network?
   (Answers will vary: safety, efficiency, aesthetics, cost, etc)