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Stop and Go

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Lesson Focus

Lesson focuses on how engineers have developed and improved traffic management over time by engineering and re-engineering the traffic light. Students work in teams to design a new traffic light system to meet the needs of a potential client. They must devise a system or technical enhancement to accommodate a busy bicycle lane and roadway that intersects a hospital emergency room entrance. As a team they devise their planned improvements, draw a design of the improved traffic signal, develop a written and verbal presentation to the client, present their designs to the class, provide feedback on other team's designs, and share observations about re-engineering.

Lesson Synopsis

The "Stop and Go" lesson explores how traffic signals have changed over time and been re-engineered as new technology and new features were needed by the population. Students work in teams to develop an enhancement to the current traffic signal to meet the needs of a client. They develop their proposal on paper, research what the new enhancements might cost to manufacture, and present their re-engineered traffic signal plan to the client (class).

Age Levels

8-18.

Objectives

- Learn about traffic engineering.
- Learn about engineering design and redesign.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- traffic engineering
- engineering design
- teamwork

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Lesson Activities

Students explore how engineers redesigned or re-engineered the traffic signal over time to enhance its functionality. They work in teams to develop a proposal to a prospective client for a new enhancement to the traffic signal that accommodates both a bicycle lane and the entrance to a hospital emergency entrance for ambulances. They consider patenting options, how the new design might impact costs, and present their ideas to the client (class).

Resources/Materials

- Teacher Resource Documents (attached)
- Student Resource Sheet (attached)
- Student Worksheet (attached)

Alignment to Curriculum Frameworks

See curriculum alignment sheet at end of lesson.

Internet Connections

- TryEngineering (www.tryengineering.org)
- The History and Evaluation of Traffic Lights (https://www.scienceabc.com/innovation/ready-steady-go-the-evolution-of-traffic-lights.html)
- Institution of Transportation Engineers (www.ite.org)
- International Municipal Signal Association (www.imsasafety.org)

Recommended Reading

- Principles of Highway Engineering and Traffic Analysis (ISBN: 978-0470290750)
- Traffic Engineering (ISBN: 978-0136135739)

Optional Writing Activity

- Write an essay or a paragraph about what driving might be like without traffic signals.

Optional Extension Activity

- Have students build a working model of their traffic system using lights, switches, wiring, and other sensors.

For Teachers:
Teacher Resource

Lesson Goal
The "Stop and Go" lesson focuses on how engineers have developed and improved traffic management over time by engineering and re-engineering the traffic light. Students work in teams to design a new traffic light system to meet the needs of a potential client. They must devise a system or technical enhancement to accommodate a busy bicycle lane and roadway that intersects a hospital emergency room entrance. As a team they devise their planned improvements, draw a design of the improved traffic signal, develop a written and verbal presentation to the client, present their designs to the class, provide feedback on other team's designs, and share observations about re-engineering.

Lesson Objectives
- Learn about traffic engineering.
- Learn about engineering design and redesign.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

Materials
- Student Resource Sheets
- Student Worksheets
- Student Team Materials: paper, pen, pencil; access to the internet is optional though helpful.

Procedure
1. Show students the student reference sheets. These may be read in class or provided as reading material for the prior night's homework.
2. To introduce the lesson, consider asking the students what driving would be like without traffic signals. Ask them to observe those in their town and consider how they work, and to see if any of the ones in their town have enhancements such as special signals for bicycle lanes or joggers.
3. Teams of 3-4 students will consider their challenge, conduct research into traffic control and traffic lights, and develop a plan to present to the potential client.
4. Teams will develop a drawn and written description of their plan for a re-engineered traffic light, and an estimate of how the new light might impact the cost of one light.
5. Teams present their ideas to the client (class) and complete a reflection sheet.

Time Needed
One to two 45 minute sessions.

Student Resource:
History of Traffic Lights

◆ What is a Traffic Light?

Traffic lights, which may also be known as stoplights, traffic lamps, traffic signals, or semaphores, are signaling devices positioned at road intersections, pedestrian crossings and other locations to control competing flows of traffic. Traffic lights have been installed in most cities around the world. They assign the right of way to road users by the use of lights in standard colors (red - amber/yellow - green), using a universal color code and a precise sequence. Usually, the red light contains some orange in its hue, and the green light contains some blue, to provide some support for people with red-green color blindness.

◆ Traffic Engineers

Traffic engineering is a branch of civil engineering that uses engineering techniques and develops mechanisms that achieve the safe and efficient movement of people and goods on roadways. It focuses mainly on research and construction of the infrastructure necessary for safe and efficient traffic flow, such as road geometry, sidewalks and crosswalks, segregated cycle facilities, shared lane marking, traffic signs, road surface markings and traffic lights. Typical traffic engineering projects involve designing traffic control device installations and modifications, including traffic signals, signs, and pavement markings. However, traffic engineers also consider traffic safety by investigating locations with high crash rates and developing countermeasures to reduce crashes. Traffic flow management can be short-term (preparing construction traffic control plans, including detour plans for pedestrian and vehicular traffic) or long-term (estimating the impacts of proposed commercial developments on traffic patterns). Increasingly, traffic problems are being addressed by developing systems for intelligent transportation systems, often in conjunction with other engineering disciplines, such as computer engineering and electrical engineering.

◆ Traffic Light History

The earliest known traffic signal dates to London in 1868, well before automobiles clogged the streets. The signal was a revolving lantern that flashed red lights (for stop) and green lights (for caution) which was illuminated by gas and operated by hand. The design was a bit flawed as the light exploded in 1869, injuring the policeman-operator. As early as 1912 in Salt Lake City, Utah, a policeman named Lester Wire invented the first red-green electric traffic light. In 1914, the American Traffic Signal Company installed a traffic signal system on the corner of East 105th Street and Euclid Avenue in Cleveland, Ohio. It had two colors, red and green, and a buzzer, to provide a warning for color changes. The first four-way, three-color traffic light was created in Detroit, Michigan in 1920.

Student Worksheet:
Traffic Light Innovation and Costs

◆ Traffic Light Innovation

Over the years many different adaptations of traffic lights have been engineered to meet societal challenges. For example, pedestrian lights with timers were developed to provide walkers with a number representing the number of seconds they have to cross the street before automobile traffic will be allowed to pass. Also, automatic control of interconnected traffic lights was introduced in 1922.

Some cities have dual lights, such as the one to the right with a separate light for bicycle or bus lanes. This one in Warrington, United Kingdom, also shows a red and amber combination seen in a number of European countries to represent slowing down. Another innovation incorporated into this traffic light is a reflective white border around the edge that improves the visibility of the signal, especially at night.

Another area of innovation is related to the light source. Traditionally, incandescent and halogen bulbs were used. But, because of the low efficiency of light output, newer designed incorporate LED arrays that consume less power, have increased light output, last significantly longer, and in the event of an individual LED failure, still operate although with a reduced light output.

Red Light Cameras have also been incorporated into traffic lights. These take photos of the license plate of any car that goes through the light. The photos are used by police to keep track of those not obeying traffic rules, and to send them a violation fee!

There are also portable LED traffic lights that have been designed on a wheeled base so they can be easily transported to wherever there is a temporary need for a traffic light -- such as at a construction site, or during a parade or road race.

In 2001 Bharat Electronics Limited in India engineered a traffic light that uses solar cells, countdown timers, LED displays, programmable logic controllers and a dual power supply. The solar cells are efficient and generate enough power daily to run the system for three days.

And..in China new LED strips change from green to yellow to red, using one light instead of three. The strip is fully illuminated at the start of each signal, then shrinks in size to show how much time is left before the color changes.

Student Resource: All About Patents

What is a Patent?

A patent for an invention is the grant of a property right to the inventor, issued by a country's Patent and Trademark Office. The procedure for granting patents, the requirements placed on the patentee, and the extent of the exclusive rights vary widely between countries according to national laws and international agreements. In the United States, the term of a new patent is 20 years from the date on which the application for the patent was filed or, in special cases, from the date an earlier related application was filed, subject to the payment of maintenance fees. *Utility patents* protect useful processes, machines, articles of manufacture, and compositions of matter. Some examples: fiber optics, computer hardware, medications. *Design patents* guard the unauthorized use of new, original, and ornamental designs for articles of manufacture. The look of a specific athletic shoe or a bicycle helmet are protected by design patents. *Plant patents* are the way we protect invented or discovered asexually reproduced plant varieties. Hybrid tea roses, Silver Queen corn, and Better Boy tomatoes are all types of plant patents.

Famous Patents

Safety Pin: The patent for the "safety pin" was issued on April 10, 1849 to Walter Hunt, of New York. Hunt's pin was made from one piece of wire, which was coiled into a spring at one end and a separate clasp and point at the other end, allowing the point of the wire to be forced by the spring into the clasp.

Dishwasher: A patent for the first practical dish washing machine was issued December 28, 1886 to Josephine Garis Cochran of Shelbyville, Illinois. She was wealthy, entertained often, and wanted a machine that could wash dishes quickly, and without breaking them. When she couldn't find one, she built it herself.

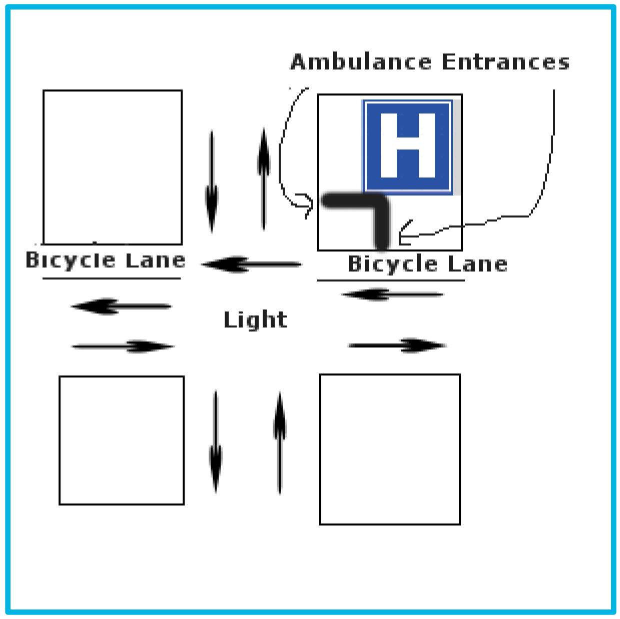
How to Register a Patent

Each country, or sometimes a region has its own patent procedures. For example, in Europe, there is the European Patent Office; in the United States, the U.S. Patent and Trademark Office manages the patent process. Wherever you are, you have to design your product on paper or on a computer and specifically show why your design is different from others. On the left is one of the first drawings of the Coca Cola bottle, and on the right, is a copy of the patent design. You also need to check to see if someone else has already invented what you think you did! Try searching for a trademark at www.uspto.gov/patents.

Student Worksheet:

◆ **Engineering Teamwork and Planning**

You are part of a team of engineers given the challenge of developing an proposal to meet the needs of a potential client. The downtown area of BusyCity has a particularly busy intersection that includes two roads with heavy traffic, a bicycle lane, cross walks, and also the ambulance entrance to a hospital emergency room. Too often, ambulances have to wait for the lights to change which delays transporting a patient for quick care. Also, bicycles are often unable to cross the intersection because they have to wait for cars to let them go. The town would like you to develop a plan to technically enhance the simple "green, yellow, red" traffic light to help alleviate the problems the ambulances and bicycles encounter.



As a team, consider the challenge and agree on a system to adapt the traffic signal to meet the challenge.

◆ **Research Phase**

Read the materials provided to you by your teacher. If you have access to the internet, you can also research ideas online, then work as a team to develop a plan. Your plan will be both written and presented to the client (your class), and you may choose to use presentation software such as PowerPoint, or create posters, or paper handouts.

◆ **Design Phase**

On a separate piece of paper draw a detailed diagram showing how what changes you would engineer into the traffic light. Be specific and include a list of parts or materials you might need to purchase if you were to build a prototype of the traffic light. Make an educated guess as to how the revisions might increase or decrease the cost of manufacturing a traffic light.

◆ **Presentation Phase**

Present your ideas, drawings, and proposed new traffic light to the class, the complete the reflection sheet.

Student Worksheet:

◆ Reflection

Complete the reflection questions below:

1. What was the most interesting proposed change to the traffic light that was developed in your class presentations? Why?

2. Do you think that your design would increase or decrease the cost of manufacturing a traffic signal? Why?

3. Do you think your new traffic light would have a market if manufactured? Who would buy it, and why?

4. Do you think that you could raise funds to pay for manufacturing? How would you go about raising funds?

5. Do you think that many engineers reinvent products or systems based on new technology or current needs? Can you provide an example of a product or system that has been re-engineered many times?

6. Did you think that working as a team made this project easier or harder? Why?

For Teachers:
Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:

- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (http://www.nextgenscience.org/)
- International Technology Education Association's Standards for Technological Literacy (http://www.iteea.org/TAA/PDFs/xstnd.pdf)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (http://www.nctm.org/standards/content.aspx?id=16909)
- U.S. Common Core State Standards for Mathematics (http://www.corestandards.org/Math)
- Computer Science Teachers Association K-12 Computer Science Standards (http://csta.acm.org/Curriculum/sub/K12Standards.html)

◆**National Science Education Standards Grades K-4 (ages 4-9)**

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design
- Understanding about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Science and technology in local challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Science as a human endeavor

◆**National Science Education Standards Grades 5-8 (ages 10-14)**

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

CONTENT STANDARD E: Science and Technology

As a result of activities in grades 5-8, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Populations, resources, and environments
- Risks and benefits
- Science and technology in society

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Science as a human endeavor
- Nature of science
- History of science

For Teachers:
Alignment to Curriculum Frameworks

◆**National Science Education Standards Grades 9-12 (ages 14-18)**

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop
- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of
- Personal and community health
- Science and technology in local, national, and global challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of
- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspectives

◆**Next Generation Science Standards Grades 2-5 (Ages 8-11)**

Engineering Design

Students who demonstrate understanding can:
- 3-5-ETS1-1.Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2.Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

◆**Next Generation Science Standards Grades 6-8 (Ages 11-14)**

Engineering Design

Students who demonstrate understanding can:
- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

◆**Next Generation Science Standards Grades 9-12 (Ages 14-18)**

Engineering Design

Students who demonstrate understanding can:
- 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.

For Teachers:
Alignment to Curriculum Frameworks

◆Standards for Technological Literacy - All Ages

The Nature of Technology

- Standard 1: Students will develop an understanding of the characteristics and scope of technology.
- Standard 2: Students will develop an understanding of the core concepts of technology.

Technology and Society

- Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 5: Students will develop an understanding of the effects of technology on the environment.
- Standard 6: Students will develop an understanding of the role of society in the development and use of technology.
- Standard 7: Students will develop an understanding of the influence of technology on history.

Design

- Standard 8: Students will develop an understanding of the attributes of design.
- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities for a Technological World

- Standard 11: Students will develop abilities to apply the design process.
- Standard 13: Students will develop abilities to assess the impact of products and systems.