TOYOTA UNDER THE HOOD: THE SCIENCE BEHIND SAFE DRIVING

VIRTUAL FIELD TRIP ACTIVITY

Invention, Innovation, Inspiration

Overview

Follow the engineering process to create an innovative solution to an automobile design problem. In this activity, students explore the role of nature in improving automobile safety and efficiency. Students research the application of biomimicry for inspiring innovation and then form teams to apply lessons from nature to automobile design. In their design teams, students choose a particular design parameter, such as safety, reliability, fuel efficiency, performance (handling, power-to-weight ratio, etc.) and follow the engineering design process to create an innovative solution to a design problem. As part of their solution, teams will specify how their invention would integrate into an existing production line, or whether their design would be part of a pure concept vehicle. Teams present their design to the class.

Next Generation Science Standards

- **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.

Objectives

Students will:

- Identify engineering aspects of automobile safety and efficiency
- Define the concept and goal of biomimicry as an engineering discipline
- Analyze specific automobile safety and efficiency problems
- Design an innovative solution to an automobile safety and efficiency problem using nature-inspired design
- Describe and illustrate a design solution in a presentation to peers

Optional Resources

- Argument Driven Inquiry
- The Science Behind Safe Driving
- University of Michigan Engineering: Biomimetic
- Science 360 (NSF) Assembly Line of the Future
- Science 360 (NSF): Worker Robots
- Smithsonian: How Butterfly Wings Inspire Innovation
- Virginia Tech: Biomimetic Underwater Vehicles
- MIT: Autonomous Vehicles and Urban Mobility
- NASA: Engineering Design Process

Procedure

1. Divide students into Group A and Group B.
2. Divide Group A into teams and have those students do online research to identify key engineering aspects of automobile safety and efficiency. Divide Group B into teams and have students do online research to learn about the concept of nature-inspired design (i.e., the basic principles of biomimicry).
3. Create new teams by regrouping students so that each group has at least one Group A "expert" and at least one Group B "expert."

   Team Challenge: Have students work in their new teams to apply nature-inspired design to automobile design and brainstorm a specific innovative solution to an automobile design problem. Encourage students to bring the expertise they gained from their initial small group research.
4. Allow time for each team to present their designs to the class and explain the role of biomimicry in their designs.

Instructional Options

- To engage students in discussion of automobile safety, explore The Science Behind Safe Driving interactive.
- Be sure that students understand that different terms may be applied to nature-inspired design, including biomimicry (most widely used), biomimetics and bionics. (Students can use each of these words as search terms during their research.)
- Encourage students to consider various media for their presentations including digital slides, posters, web pages, or even a skit.
- Consider using the Argument-Driven Inquiry method (http://www.argumentdriveninquiry.com/) as the pedagogic basis for this activity.
- If needed, ensure that students understand that fuel consumption depends on numerous interacting variables, including engine-specific technology, energy loss (due to wind resistance, tire drag, etc.) and driver behavior.
- If needed, address the potential misconception that the fuel economy of electric vehicles is zero, and can be calculated in mileage equivalent based on the cost of operation.
- Depending on students' prior experience and knowledge you may wish to assign a particular design parameter (e.g., safety, reliability, fuel efficiency, performance, handling, power-to-weight ratio, etc.) for the team design challenge.
- If needed, review the engineering design process. Some steps may be impractical in a class-setting (such as testing a prototype), so encourage students to adapt. Ensure that students understand the main principle of the engineering design process is iteration and improvement of successive designs.