Optomechanical Challenge

Objectives
Students will:
- Define Optomechanical and apply this knowledge to the design challenge
- Identify Optomechanical devices that we use every day and in space exploration
- Design and create an optomechanical device using recycled materials

Suggested Grade Level
6th-12th

Timeline
60-90 minutes

Standards
NGSS Standards
- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
- HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- 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.

21st Century Essential Skills
- Learning Skills (critical thinking, analysis, creativity, collaboration, communication)
- Literacy Skills (information, media, technology)
- Life Skills (flexibility, leadership, initiative, productivity, social, listening, global awareness)

Created: November/2020

Background

Optomechanical design is combination of optical and mechanical engineering. It is the action of integrating optical devices (i.e. cameras, lens and sensors) and attaching it to a mechanical device (i.e. contain, extend, support). This specialized branch of engineering can range from common everyday use, like using a tripod with a camera, to complex imaging detectors, like on the James Webb Space Telescope.

In this design challenge, students will be just like real engineers and scientists. They will be researching, designing, creating and testing their optomechanical device. They will need to assess the operational and environmental factors that will affect their final outcome.

Vocabulary

Optical, mechanical

Materials

- Assortment of recycled materials (i.e. cardboard, plastic containers, bottles)
- Assortment of craft supplies (i.e. popsicle sticks, pipe cleaners, string)
- Tape or glue
- Scissors

Lesson

1. Introduce lesson by asking students, "What does Optical mean? What does mechanical mean? What do you think it means when we put the two together, optomechanical?"
2. Have students identify some optomechanical devices (i.e. tripods, selfie sticks). Ask students, "Does this only apply to cameras? What about sensors?" Have students think broader, like telescopes, space telescopes and satellites.
3. Research different optomechanical applications. Have students brainstorm ideas for a NEW, or a modification to, optomechanical device.
4. Divide class into groups of three or four students. Their mission is to design and create a model of an optomechanical device. They must have the following:
    a. Determine what type of optical component it will have (i.e. camera, lens, sensor)
    b. Determine what type of mechanical component it will have (i.e. contain, extend, support)
    c. Draw out (by hand or 3D image) a model
    d. Junk engineer the model
    e. Write a description of your device to be used as a sales pitch for a major corporation
5. Allow time for students to design, create, and deliver their product. Optional: contact an engineering firm to be a judge or provide expertise in this field.

Extension Activities

- Explore the optical side of optomechanical engineering. Research how the lens in telescopes allow us to see far away.
- Explore the mechanical side of optomechanical engineering. Research how the moving parts in a planetarium work.
- Visit http://www.discoverspace.org/ for more innovative ideas and resources.

Created: November/2020

Resources

(n.d.). Retrieved November 10, 2020, from https://spie.org/news/optomechanical-design-in-five-easy-lessons?SSO=1