Lesson Plan:

Shake it up with Seismographs
The Design Challenge
You are a team of engineers who have been given the challenge of designing a reliable seismograph to record earthquake activity in your classroom. Your machine must be able to record motion visually on a scale of your own design. The design needs to record the intensity of a simulated classroom earthquake which will be created by dropping a ball from three heights: .5 meter, 1 meter, and 1.5 meters.
Defining the Challenge: Criteria & Constraints

Criteria

• Must be able to record motion visually on a scale of your own design
• Needs to record the intensity of a simulated classroom earthquake which will be created by dropping a ball from three heights: .5 meter, 1 meter, and 1.5 meters.

Constraints

• Use only the materials provided.
• Teams may trade unlimited materials
Materials – Trading/Table of Possibilities

- String
- Wire
- Paper
- Pencil/pen/marker
- Paperclips
- Cardboard
- Posterboard
Materials – Trading/Table of Possibilities

- Foil
- Rubber bands
- Modeling clay

Testing Materials

- Table/Desk
- Pan/tray
- Rubber Ball

continued on next page
Testing Materials and Process

Testing Material

- Tennis Ball
- Ladder or stool (from which to drop ball to simulate earthquake)
- String cut to .5 meter, 1 meter, and 1.5 meters pieces

Testing Process

Test each team's seismograph by placing the design on top of a small table. Simulate an earthquake by dropping a small rubber ball on the table from three different heights (.5 meter, 1 meter, and 1.5 meters).
Testing Materials and Process

Testing Process

We recommend standing on a secure ladder and measuring with lengths of string the point from which the ball will drop to ensure a consistent and fair test. (Note: you may wish to consider using different size balls as well -- tennis ball for example.)

Teams should record the following observations for each drop height:

- Measurement of quake in your scale:
  - .5 meter
  - 1 meter
  - 1.5 meter
Testing Materials and Process

- Physical observations (what did you notice about your design during the test…what worked, what didn't?)
  - .5 meter
  - 1 meter
  - 1.5 meter
Consider...

- Before you get started building, consider discussing what a seismograph is. Also consider discussing the Richter Scale. Refer to the Background Concepts section of the lesson plan.
Reflect & Debrief
Reflection

• Did you succeed in creating a seismograph that could record on a scale the earthquake simulation for all three quakes?
• Did you need to request additional materials while building your seismograph?
• Do you think that engineers have to adapt their original plans during the manufacturing process of products? Why might they?
• If you were to adapt your classroom seismograph to one that would actually record a real earthquake, what modifications would you need to make?
Reflection

• If you had to do it all over again, how would your planned design change? Why?
• What designs or methods did you see other teams try that you thought worked well?
• Do you think you would have been able to complete this project easier if you were working alone? Explain…
Engineering Design Process
Learn about the engineering design process (EDP). The process engineers use to solve problems.

(Video 1:47)
Engineering Design Process

• Divide into teams
• Review the challenge and criteria & constraints
• Brainstorm possible solutions (sketch while you brainstorm!)
• Choose best solution and build a prototype
• Test then redesign until solution is optimized
• Reflect as a team and debrief as a class
Productive Failure

• The engineering design process involves productive failure: test, fail, redesign. Iterate again and again until you have the best possible solution.

• It is important to document iterations to keep track of each redesign. Use the engineering notebook to sketch ideas, document iterations and any measurement and/or calculations.

• It’s also important to showcase the fact that there can be multiple solutions to the same problem. There’s no one “right” solution.
Vocabulary
Vocabulary

• Criteria: Conditions that the design must satisfy like its overall size, etc.
• Earthquake: a sudden and violent shaking of the ground, as a result of movements within the earth's crust or volcanic action
• Engineers: Inventors and problem-solvers of the world. Twenty-five major specialties are recognized in engineering (see infographic).
• Engineering Design Process: Process engineers use to solve problems.
• Engineering Habits of Mind (EHM): Six unique ways that engineers think.
• Intensity: Strength of earthquake movement.
Vocabulary

• Iteration: Test & redesign is one iteration. Repeat (multiple iterations).

• Prototype: A working model of the solution to be tested.

• Richter Scale: Magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the strength of earthquakes.

• Seismic waves: Allow seismologists to map the interior of the Earth, and locate and measure the strength of these earthquakes.

• Seismograph: Instruments that measure and record motions of the ground, including those of seismic waves generated by earthquakes, nuclear explosions, and other seismic sources.
Dig Deeper
Dig Deeper into the Topic

Internet Connections

- USGS Earthquake Hazards Program Learning Resources
  (https://earthquake.usgs.gov/learn/topics/)
- USGS Global Seismographic Network
  (https://earthquake.usgs.gov/monitoring/)

Recommended Reading

- Earthquakes by Bruce Bolt (ISBN: 0716775484)
Dig Deeper into the Topic

• Introduction to Seismology by Peter M. Shearer (ISBN: 0521708427)

Writing Activity

• Write an essay or a paragraph exploring why civil engineers might need to evaluate the seismic activity of a particular building site?
• Write an essay or a paragraph on how existing seismologic technology might have reduced death rates from the 1960 earthquake in Chile.
Engineering Fields
What is Engineering?

Learn about engineering and how engineers are creative problem solvers and innovators who work to make the world a better place. (Video 3:43)

Source: TeachEngineering YouTube Channel - http://www.youtube.com/watch?v=H9VDkvgGmVo
Related Engineering Fields

• There are several types of engineering fields that are involved with the engineering and design of seismographs. Here are just some of the related engineering fields.
  • Mechanical Engineering
  • Electrical Engineering

• Download the Engineering Fields Infographic

How will YOU change the world?
Engineering Habits of Mind (EHM) is about how engineers think everyday. The Core Engineering Mind is about making things that work and making them work better.

Source: https://online-journals.org/index.php/i-jep/article/view/5366
Engineering Habits of Mind Checklist

- Systems thinking
- Problem-finding
- Visualising
- Improving
- Creative problem-solving
- Adapting
Learning Habits of Mind Checklist

- Open-mindedness
- Resilience
- Resourcefulness
- Collaboration
- Reflection
- Ethical Consideration
- Curiosity
Greatest Engineering Achievements of the 20th Century

Welcome!
How many of the 20th century's greatest engineering achievements will you use today? A car? Computer? Telephone? Explore our list of the top 20 achievements and learn how engineering shaped a century and changed the world.

1. Electrification
2. Automobile
3. Airplane
4. Water Supply and Distribution
5. Electronics
6. Radio and Television
7. Agricultural Mechanization
8. Computers
9. Telephone
10. Air Conditioning and Refrigeration

11. Highways
12. Spacecraft
13. Internet
14. Imaging
15. Household Appliances
16. Health Technologies
17. Petroleum and Petrochemical Technologies
18. Laser and Fiber Optics
19. Nuclear Technologies
20. High-performance Materials

Source: http://www.greatachievements.org/
Learn more about how engineers make the world a better place

Provide energy from fusion

Human-engineered fusion has been demonstrated on a small scale. The challenge is to scale up the process to commercial proportions, in an efficient, economical, and environmentally benign way.
For more engineering lesson plans and resources like games, engineering careers, and STEM opportunities visit IEEE’s TryEngineering.org.