Northeastern University
College of Engineering

STEM Newsletter 26 – (12.7.2020)
Mechanical Engineering

Introduction

What is mechanical engineering? You might picture machines, gears, or things that move in a machine. Mechanical engineering is much more than just that. It is a branch of engineering that combines physics and mathematics to design, manufacture, and maintain mechanical systems. The core areas are mechanics, thermodynamics, fluid dynamics, material science, and electricity.

Let's take a closer look at the core areas!

Mechanics is the study of the motions of physical objects. It is concerned with forces applied to objects that result in the changes of an object's position relative to its environment. Thermodynamics deals with heat, temperature, work, and their relation to energy, and radiation. It is the study of the transfer of energy from one form to another (and from one place to another). It can be said that heat is a form of energy corresponding to a definite amount of mechanical work. Fluids are things like liquids and gases, and fluid dynamics is essentially the study of the movement of fluids. Material science focuses on discovering and designing new materials that can improve our lives. It can range from biomaterials which can help in areas such as dentistry to designing new materials to be used in Computers. Finally, Electricity is the core you will probably be the most familiar with. Electricity is a form of energy that is a result of having charged particles.

Mechanical Engineers can work to improve energy, transportation, health care, space exploration and much, much, more.

Northeastern Connections

Faculty Connection

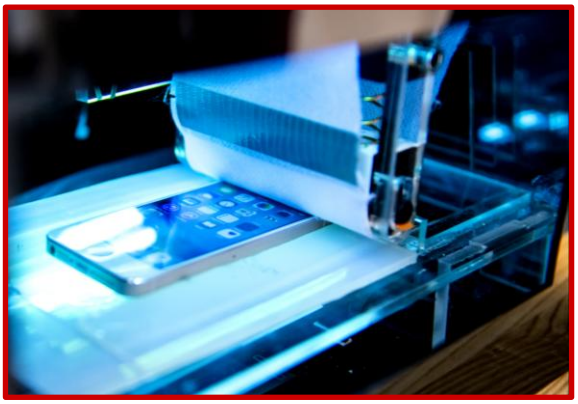
Marilyn Minus is a Professor and Chair for the Department of Mechanical and Industrial Engineering here at Northeastern University. Her research focuses on nanotechnology, the field that is concerned with the use of matter on an atomic, and molecular level for industrial applications. Dr. Minus was awarded the $1.23M AFOSR Grant to develop a new approach for nano-composite materials possessing (try researching more about this!).

Dr. Minus is also a member of the Society for the Advancement of Materials and Process Engineering, the Society of Plastic Engineers, Materials Research Society, as well as the American Chemical Society.

Andrew Gouldstone also works at Northeastern as an Assistant Professor in the Department of Mechanical and Industrial Engineering and is also the Associate Chair for Experiential Innovation. Dr. Gouldstone wrote his PhD dissertation on the mechanical behavior of small volume structures, such as thin film. He also worked on nanoindentation experiments, which is testing how easily a small volume can be indented. Dr. Gouldstone is now interested in areas such as Mechanics of Heterogeneous Systems (Heterogeneous Systems are computer systems that use more than one kind of processor or core) and Respiratory Mechanics (how lungs function by studying pressure and volume). He has also won the National Science Foundation CAREER Award and was the College of Engineering Faculty Fellow in 2014.

Student Connection

Mechanical Engineering knowledge can be used to solve real-world problems. Here at Northeastern, many students have embarked on this mission and have created new solutions to fix these problems. One of these creations was a robot arm. When one person wears the robot arm, the other robotic arm moves in an identical fashion (this one is not connected to the other robotic arm, making the other arm act as a "remote control"). This can potentially allow operations to be performed remotely, such as having a doctor perform a surgery internationally or disabling an explosive device.

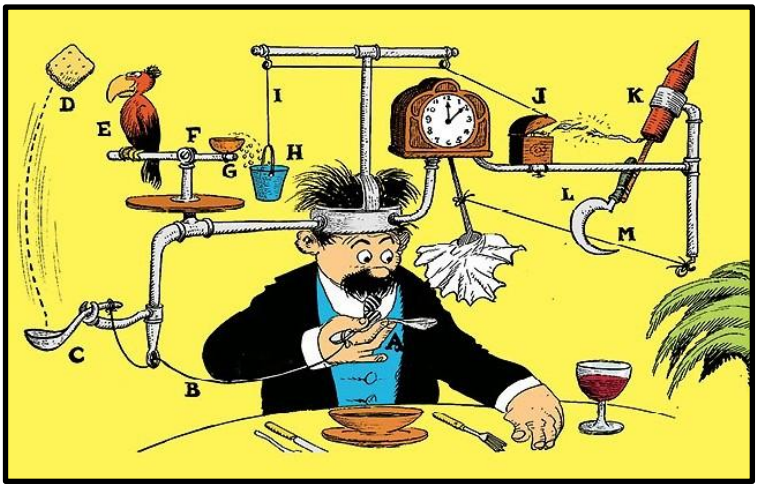


Another creation was made to help clean our phones. Did you know that our phones are ten times dirtier than a toilet seat? We take our phones everywhere, and while we tend to take showers and wash our hands, we never seem to clean our phones. A team of students tested their own phones to confirm the existence of bacterial colonies and created a phone cleaner that essentially removes them. The machine wipes the phone with a microfiber cloth after it is placed in the box that wipes phone surfaces with a microfiber cloth then exposes it to ultraviolet light. "After 10 seconds of exposure to UV-C [ultraviolet light] and wiping, we killed most of the bacteria." said one of the students.

Some other students focused on hygiene, building a machine that can clean dental retainers and aligners. Another group worked on extracting additional oil from oil and gas companies waste. What problem do you want to solve?

Do Now

Rube Goldberg was a cartoonist, engineer, and inventor. He drew machines and gadgets that performed simple tasks in complicated and hilarious ways. His drawings consisted of simple machines that were used to transfer energy and change the directions and magnitudes of the forces. Simple machines use mechanical advantage to do this. Below is an example of one of Goldberg's cartoons where the combination of some simple machines are used to complete the simple task of wiping the man's mouth.



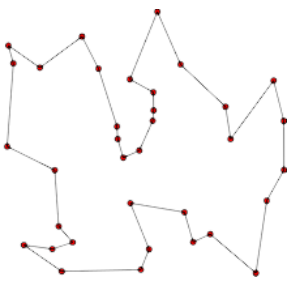
Here are the 6 simple machines with some images and some examples:

Lever: A simple machine that is a beam on a fixed hinge known as a fulcrum. When loads and forces are involved, a lever can rotate and can lift the heavy load because of the force.

Inclined Plane: This is simply a ramp! It is a flat surface that is tilted at an angle and can be used to help raise or lower a load.

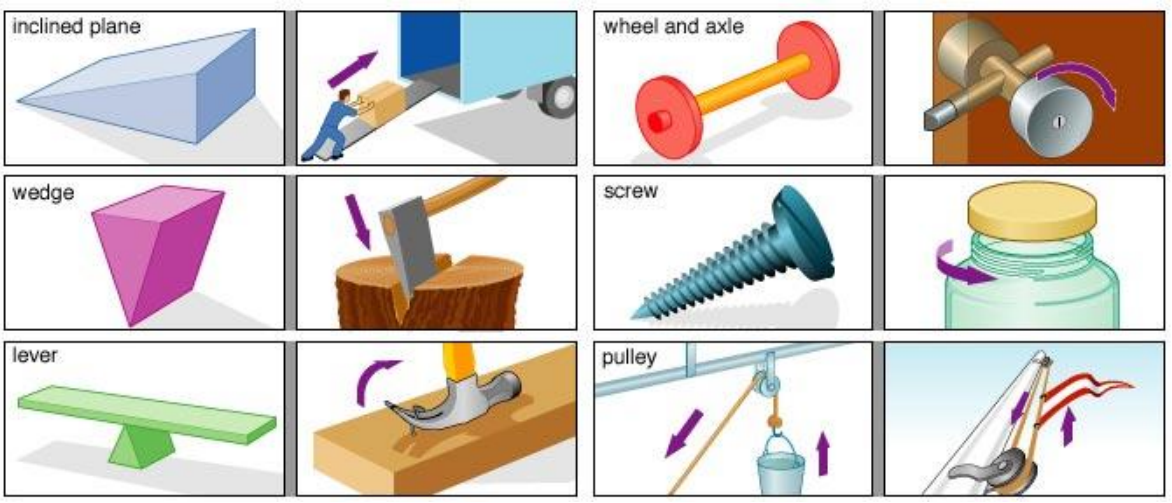
Screw: A screw converts rotational motion to linear motion. Examples are jar lids, screws, and even desk chairs that rotate!

Wedge: A simple machine that is triangularly shaped. It can be seen as a portable inclined plane that is instead used to separate two objects, a portion of an object, or even lift one up.



Wheel and Axle: This machine consists of a wheel attached to an axle and the two rotate together.

Pulley: A pulley consists of a wheel and axle combined with a rope to aid in lifting heavy loads.



Although Rube Goldberg drew many cartoons featuring his inventions, he never actually built any of them. Now that you know more about Goldberg and simple machines watch one of the videos below (or all of them if you'd like to!) of a machine that was inspired by Goldberg. Pay close attention to how energy is being transferred and where the simple machines are being used! Keep a tally of how many you can spot!

OK Go - This Too Shall Pass - Rube Goldberg Machine - Official Video

The Page Turner | Rube Goldberg | Joseph's Machines

World's largest Rube Goldberg machine

Activity

A catapult is a device used to launch a projectile by taking advantage of the energy transfer as it does not require gunpowder, electricity, or anything of that sort. The way a catapult works is that potential energy is stored, then transferred to kinetic energy to move at a rapid speed. To think about potential energy, think about lifting a ball from the ground. When you lift the ball, it has gravitational potential energy, meaning that it has the potential to move because of gravity. Once you drop the ball, the potential energy decreases and the kinetic energy increases

(essentially meaning that the potential energy is converted to kinetic energy). When it comes to catapults, the potential energy comes from the rubber bands you will use in this activity (some catapults use ropes). Once you release the item in the catapult, the potential energy gets transferred to kinetic energy similar to the ball falling.

Source for the activity.

Materials Needed:

You can use any materials you want but here are some suggestions:

- Popsicle sticks
- Rubber bands
- (Plastic) Spoon
- Bottle cap
- Tabe
- Scissors
- Pencil and Paper

Steps:

- Sketch a blueprint of your design using the pencil and paper. Think about how you would go about building this using the materials at hand.
- Aim to make your catapult sturdy and repeatable, it shouldn't break after just one shot!
- Build your catapult!
- Once you test out your catapult, it must be on the ground but don't tape it to the ground.
- Test out your catapult!
- If it doesn't work the way you hoped it would, change your catapult slightly or try an entirely new design.
- If you're really struggling, take a look at this video for some inspiration: Design a Catapult by TeachEngineering

Discussion Questions:

- How well do you think your catapult works? Does it break after you use it? Does it launch objects far away?
- What would you do to improve your design?
- What makes a good catapult?
- What is the best angle for your catapult?

Share Your Results

We'd love to know how the activity and/or the "do now" turned out! What worked and what didn't work? Please share with us something you learned and/or send us pictures! Email us at stem@northeastern.edu.

Related links/Extensions

- Northeastern Mechanical Engineering Creations by Students
- Science buddies for any upcoming science fairs
- Mechanical Engineering Crash Course
- Mechanical Engineering Lesson for Kids
- Mechanical Engineering Activities (Might require a paid subscription)