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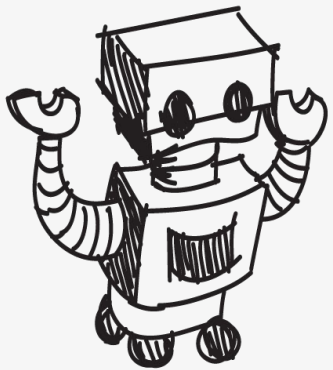
Keysight Lesson: Light Up Name Badge

IEEE

The Design Challenge



The Design Challenge

You have been given the challenge of designing, constructing, and wearing a light up name badge that shows your name.

Criteria

- Three LEDs must be part of your name badge & all must light up
- Use only one coin cell battery
- You must be able to wear your name badge

Constraints

- Use only the material available
- Use a simulation tool to iterate and get the best solution

Materials

- Copper Tape: 1ft - 2ft per student
- LEDs (10mm is best): 3-4 per student (extra if a leg breaks)
- Coin Cell Batteries (3V- CR2023 works): 1-2 per student (2nd for testing more LEDs)
- Index Card: Up to 3-5 per student (extra are for testing, mistakes)
- Table of Possibilities: Items are for for decorating and attaching name badge (pipe cleaners, googly eyes, colored paper, feathers, binder clips, paper clips, Tape/Glue, Scissors, Markers, etc).
- Computers
- PHet Simulations (Circuit Construction Kit: DC)

Phase 1: PhET Simulation Demo

- Students sketch what they think the circuit should look like.
- Invite one student to come up and “make” their circuit in PhET
- Discuss possible pitfalls: wire connections, polarity, etc.
- Together, define a simple circuit and each element (see background concepts).

PhET™ INTERACTIVE SIMULATIONS

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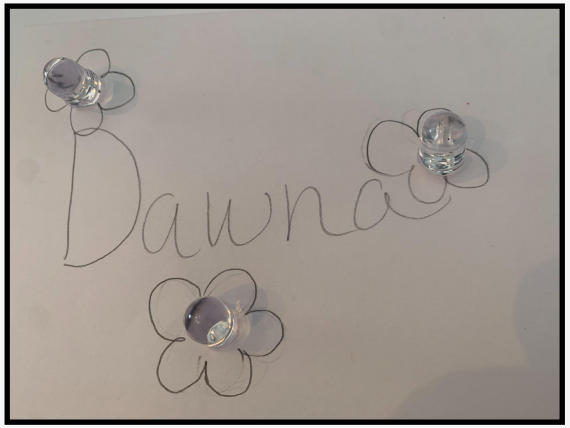
Phase 2: PhET Simulation Challenge

How do you get 3 LEDs to light up with one battery?

- Students work individually or in teams of two to work to get three LEDs to light.
- Test putting the LEDs in series and parallel.
- Debrief: Which type of circuit needed more than one battery to get the LEDs to light brightly?

Phase 3: Construct Your Name Badge

- **Brainstorm ideas for your name badge design**. Look at the materials available on the Table of Possibilities.
  - Where do you want to place your lights? Will the lights be in a specific spot in the design (i.e. dot of an" i" or in the middle of an "o", or in the center of a star or the sun). You may want to have your name on the front and the circuit on the back or you may want the circuit part of your design on the front.



LEDs become the center of the flowers.

Phase 3: Construct Your Name Badge

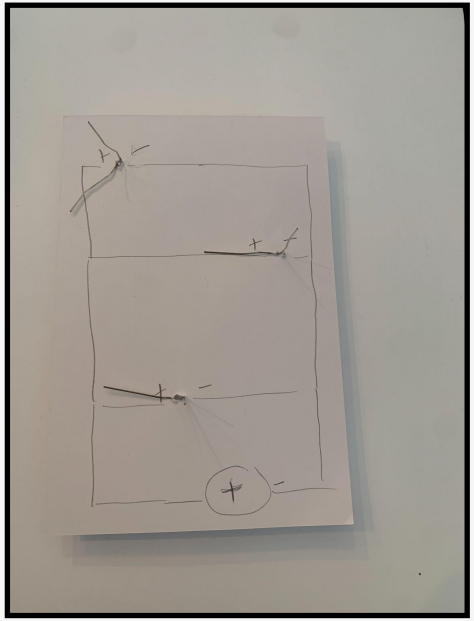
- Your **required materials** include: 3 LEDS, Index Card, Copper Tape and one Battery. Table of possibilities materials used for implementing your name badge design.
- There can be multiple solutions to the same problem. For this challenge. there's no one "right" solution. Designs that work and meet the criteria of lighting up an LED will look very different. **There will be multiple solutions.**

Required Materials

Table of Possibilities

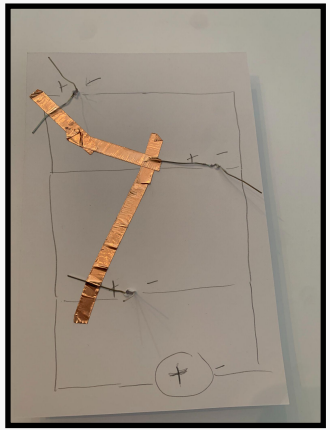
Phase 3: Construct Your Name Badge Cont.

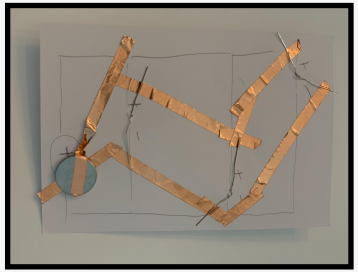
- **Replicate your best circuit from Phet** on your index card. Using pencil, sketch out where the LED's go, battery and wire, your name, etc.
  - Consider…Based on what you learned with the simulation, what would be the best choice for one battery and three LEDs (series or parallel)? Consider starting with that choice.

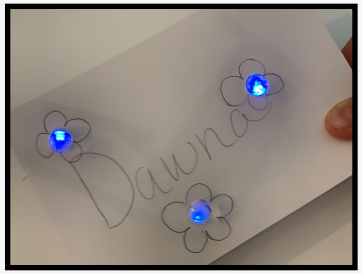


Phase 3: Construct Your Name Badge Cont.

- **Assemble the circuit for your name badge**. Poke the LEDs through and lay down just the long leg of all your LEDs (positive) and tape those down with the copper tape (wire). Next tape down all the short legs of LEDS and then press all the connections down well and close the circuit by pressing hard on the battery (acting as a switch with the negative line going under the battery and the positive line going to the top of the battery).





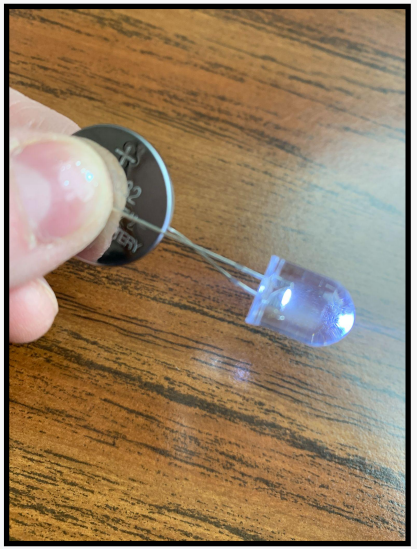


Phase 3: Construct Your Name Badge Cont.

Decorate your badge and design a way to wear it so others can see it (see sample - using pipe cleaners to make it into a necklace).

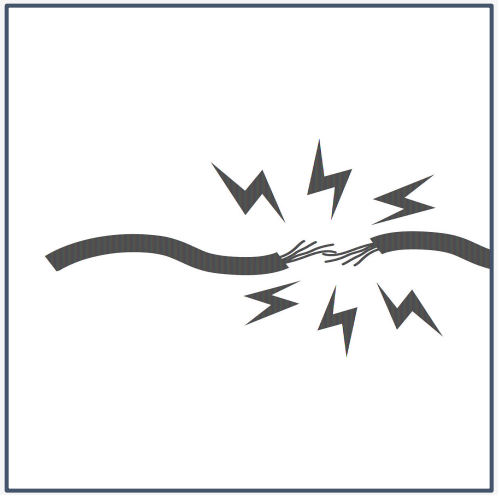
Helpful Hinds

- **Polarity:** Both the LED and coin cell battery have a Positive and Negative end. Notice the positive leg of the LED must connect with the positive side of the coin cell battery and same for the negative side.
- **Test your battery** and LED to ensure your components work prior to assembly. Put the long leg of the LED to the top (+) side of the coin cell battery and the short leg of the LED to the bottoms (-) side of the coin cell battery. How many LEDs can the coin cell battery power in parallel? (add more LEDs to your test).



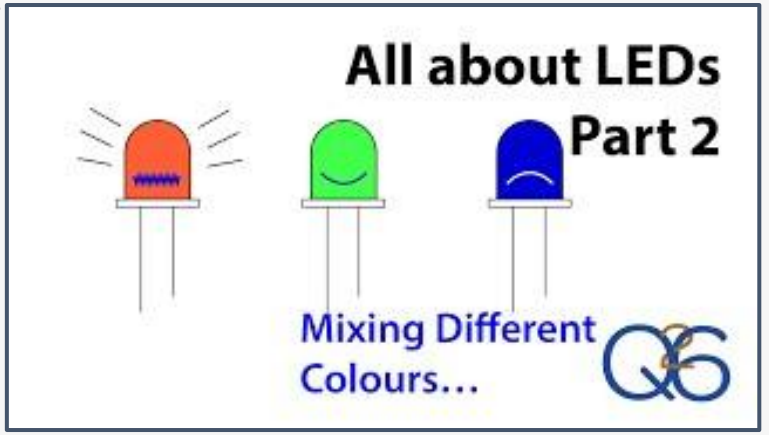
Helpful Hints

- **Shorting a circuit:** Be mindful to not have your copper tape overlap where it shouldn't- resulting in the breaking of the current flow. (i.e. putting copper tape across the circuit, be careful with the coin cell battery as the side of it is also positive.)
- The **copper tape will be your WIRE**. It has adhesive on the back; just peel off the paper.
- To get **good connectivity you need pressure**…make sure to press down on the LED legs and consider adding cooper tape both below and on top of the legs
- Your **coin cell battery (in this circuit) acts like a switch**. When you press on it, it closes the circuit.



Helpful Hints

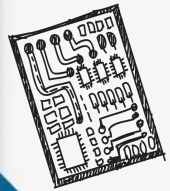
- To **keep your light on, tape down the battery.**
- LED **legs can break off easily**. Be mindful to not bend too sharply.
- **LED colors can be tricky.** To keep it simple use only one color for this project. Each color LED requires a different voltage to light up (for example: Red:1.8V, Yellow: 2.1V, Green: 2.2V, Blue: 3.2V and White: 3.2V). So depending on the combination, it may not work for you to use 3 different color LEDs in this project. To learn more check out this video by Q26: All About LEDs Part 2: Mixing Different Colors



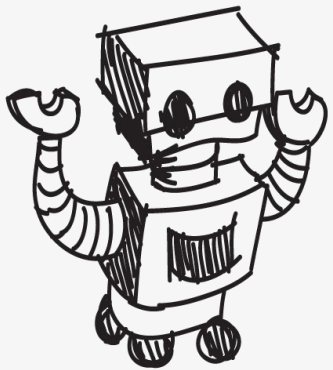
Failure is part of the process

If your light does not light up, don't worry, we expect that. Engineers fail and they try again and again. So troubleshoot and then redesign until you get your best solution. Failure is part of the process! Have fun!

Ready, Set, Let's Engineer!



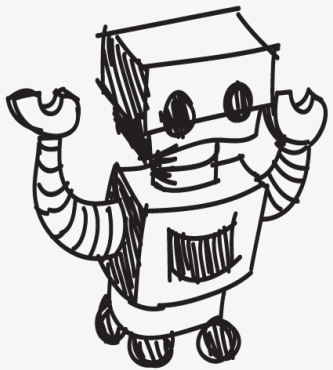
Reflect & Debrief



Reflection

- How does the PhET model you made compare to the actual name badge you created?
- What are the advantages and disadvantages of series vs parallel circuits? Where would you prefer to use one over the other?
- What challenges did you run into in creating your name badge? What other tools or materials might have helped you?

Engineering Design Process



The Engineering Design Process

Learn about the engineering design process (EDP). The process engineers use to solve problems.

(Video 1:47)

Source: TeachEngineering YouTube Channel http://www.youtube.com/watch?v=b0ISWaNoz-c

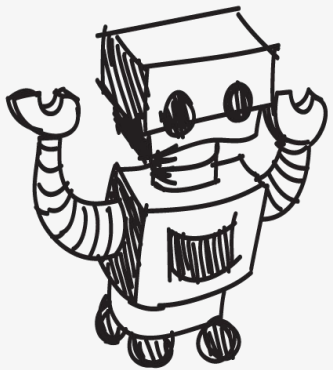
Engineering Design Process

- Divide into teams of two (or up to 4 max)
- 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



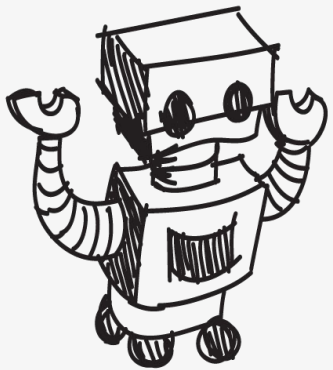
Vocabulary

- **Battery:** Powers the circuit. When the battery is in a closed circuit it will convert chemical energy to electrical energy (electricity) to power the circuit (i.e make current flow and light the LEDs)
- **Current:** Flow of electrical energy (electricity) through a circuit
- **LED:** Type of semiconductor called "Light Emitting Diode" (LED). It will light-up when current is flowing through it. Positive (long) leg is the “anode” and the negative (short) leg is the “cathode”
- **Wire:** Conducts electricity and is used to connect components in a circuit
- **AC:** An alternating current (AC) is an electrical current that regularly reverses direction and changes its value constantly with time
- **DC:** A direct current (DC) is an electric current that flows through in one direction
- **Closed Circuit:** When the switch in the circuit is closed and current can flow

Vocabulary

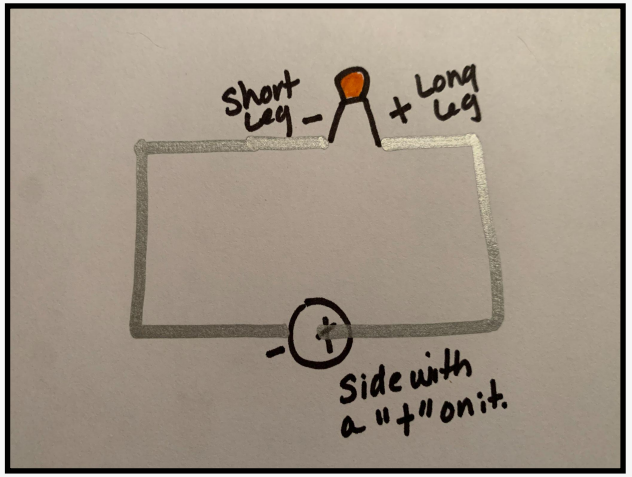
- **Open Circuit:** When the switch in the circuit is open and current can not flow
- **Switch**: A switch in a circuit is used to open or close the circuit. Closing off or opening the flow of current
- **Short Circuit:** When wires that are not supposed to come in contact with each other touch (overlap in someway)
- **Condutor:** Material that allows electricity to flow through it
- **Insulator:** Material that does not allow electricity to flow through it
- **Resistance:** Insulation is measured in resistance. The more insulating a material, the more resistance it has
- **Parallel Circuit:** Allows multiple paths for electricity (current) to flow through
- **Series Circuit:** Allows one path for electricity (current) to flow through

Background Knowledge



Simple Circuit

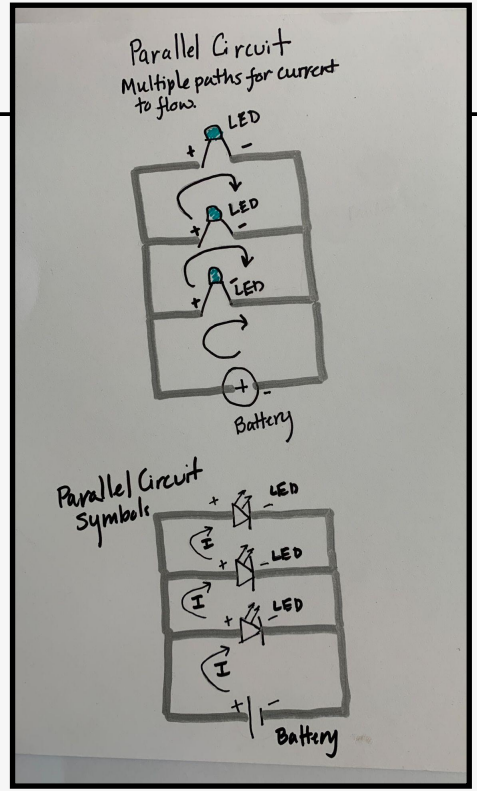
A simple circuit consists of three components: a source of power or electricity (coin cell battery), a path or conductor (wire - copper tape) on which electricity flows (current) and an electrical resistor (LED). This image shows a simple circuit containing one coin cell battery, two pieces of copper tape (wire) and an LED. The flow of electricity (current) is from the positive (+) side of the battery through the LED (lighting it up), and back to the negative (-) side. To make the LED light we must connect the positive leg of the LED to the positive side of the coin cell battery and the negative (short leg) with the bottom of the coin cell battery. (See PPT for a single LED name badge)



Series Circuit & Current

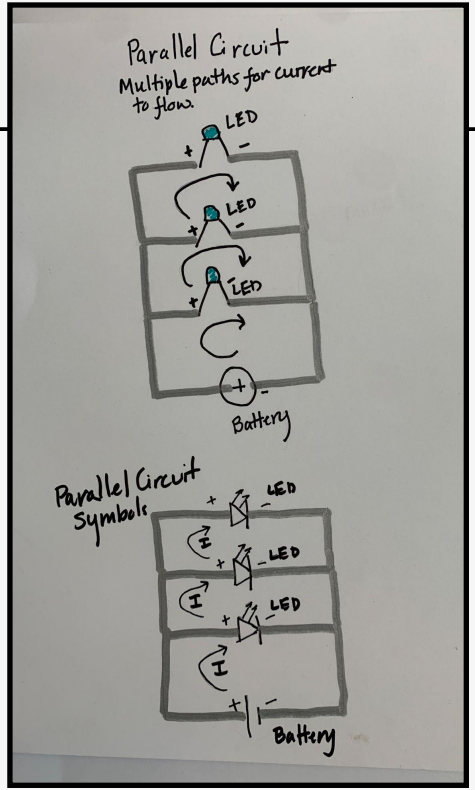
Series Circuit: Components are connected end-to-end in a line forming a single path for the current to flow. Each component in a series circuit shares one node with its nearest neighbor. LEDs are linked in series with the negative leg of the LED connected to the positive leg of the next LED and so on

Current: Current flows from a high voltage (+) to a lower voltage (-) in a circuit. Some amount of current will flow through every path it can take to get to the point of lowest voltage (usually called ground).

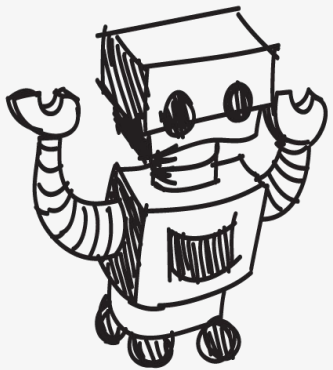


Parallel Circuit

Parallel Circuit: Components are connected across each other's legs- positive to positive and negative to negative**.** There are many paths for current flow, but only one voltage (battery) across all components. Positive legs of LEDs connect to the positive end of the battery and negative legs of LEDs connect to the negative end of the battery.



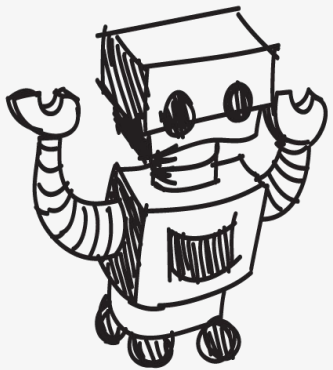
Dig Deeper



Dig Deeper (Extension Activities)

- **Clean Energy:** Discuss the use of LEDs in the world.
  SDG 7: Affordable and Clean Energy
  "About 50% of global residential lighting sales use LED technology. To align with the Net Zero Emissions by 2050 Scenario, progress in this area must be sustained to 2030 to ensure that all countries sell predominantly LED technology and with increasing efficiency." Source: Lighting IEA
  - Why are LEDs part of the clean energy strategy?
  - Do you use LEDs in your home, your school, etc?
  - Develop a plan to convert to LED light where it is not currently being used.
- Dive deeper Into **Conductors and Insulators** on the PHet Simulations (Circuit Construction Kit: DC). Explore the different materials (insulators and conductors) in the simulation.

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)

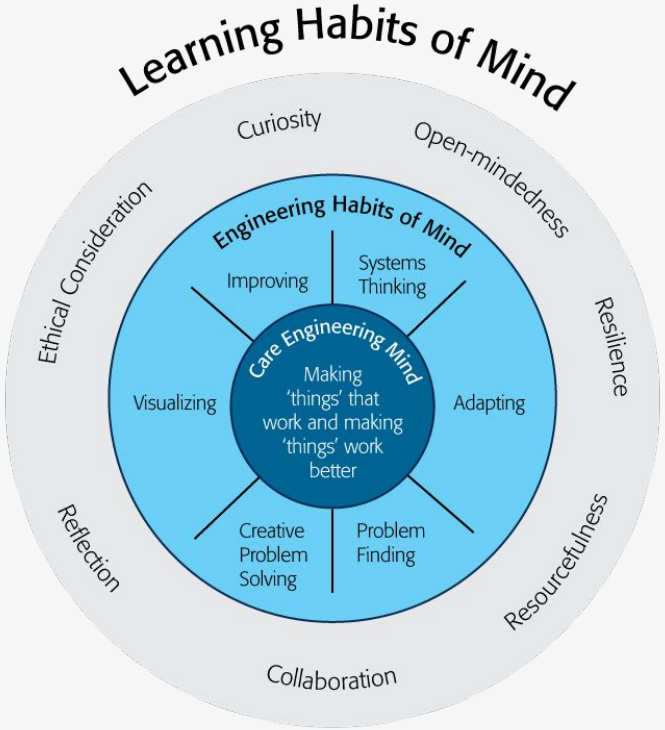
Source: TeachEngineering YouTube Channel - http://www.youtube.com/watch?v=H9VDkvqGmVo

Related Engineering Fields

- There are several types of engineering fields that are involved circuits. Here are just some of the related engineering fields.
  - Computer Engineering
  - Software Engineering
  - Power and Nuclear Engineering

- Download the Engineering Fields Infographic
  How will **YOU** change the world?
  Engineers are the inventors and problem solvers of the world! More than twenty five major specialties are recognized in the field of engineering. **Engineers make the world a better place!**

Engineering Habits of Mind



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)

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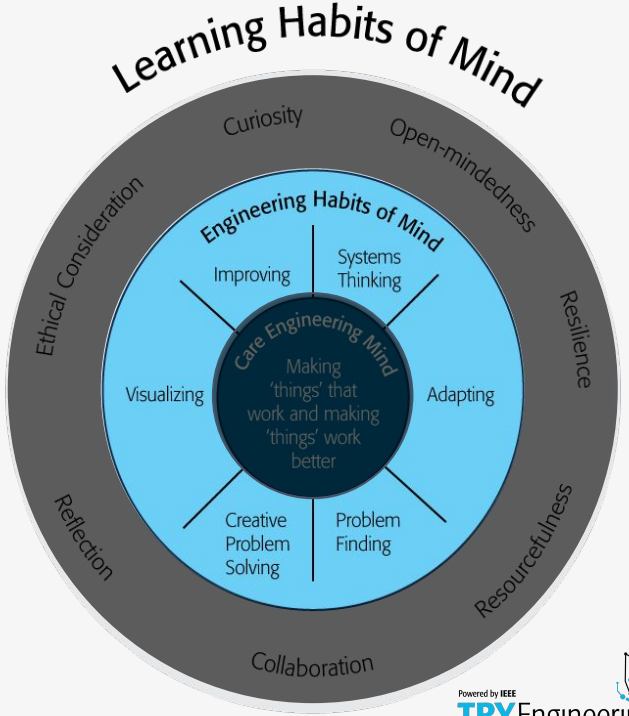
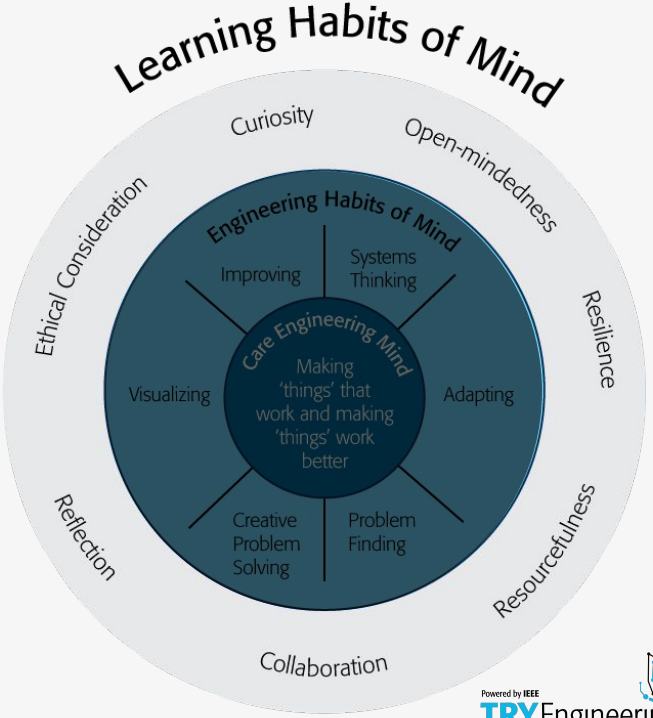
Engineering Habits of Mind Checklist

- ❑ **Systems thinking**
- ❑ **Problem-finding**
- ❑ **Visualising**
- ❑ **Improving**
- ❑ **Creative problem-solving**
- ❑ **Adapting**



Learning Habits of Mind Checklist

- Open-mindedness
- Resilience
- Resourcefulness
- Collaboration
- Reflection
- Ethical Consideration
- Curiosity

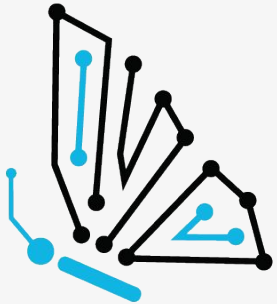


Greatest Engineering Achievements of the 20th Century

Source: http://www.greatachievements.org/

Learn more about how engineers make the world a better place

For more engineering lesson plans and resources like games, engineering careers, and STEM opportunities visit IEEE's TryEngineering.org



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