

# LEMELSON-MIT

*Celebrating invention, inspiring youth*

## Troubleshooting electronics and circuits

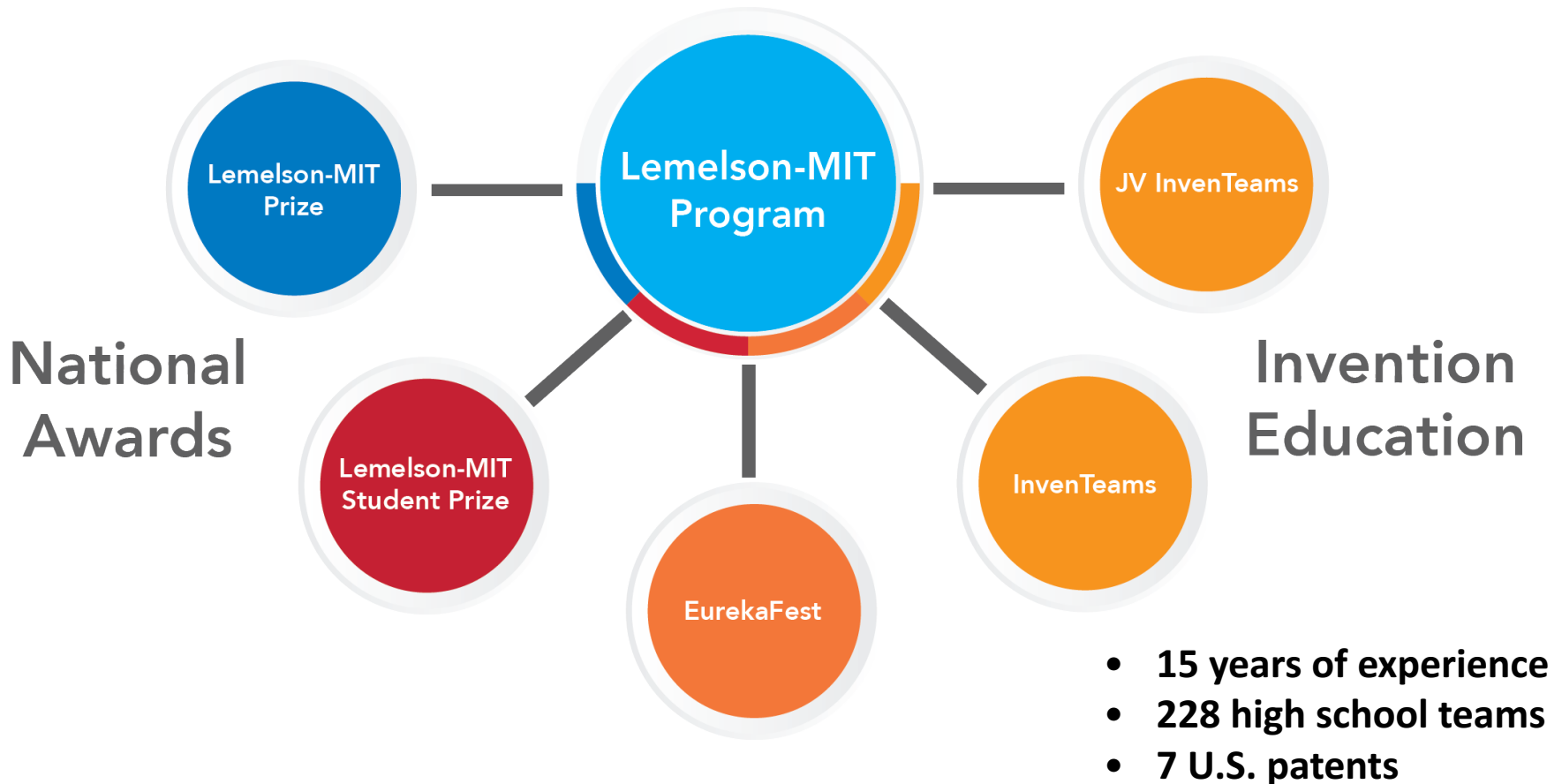
Invention Education  
Webinar Series



Thursday, March 22, 2018

6:30 – 7:00 p.m. ET

# Lemelson-MIT Program Overview



- 15 years of experience
- 228 high school teams
- 7 U.S. patents

# Presenter Doug Scott

- Robotics and Engineering Teacher at Hopkinton High School, MA.
- Technology/Engineering Subject Matter Leader for Grades 6-12 in the Hopkinton Public Schools
- STEM Teacher of the year, Massachusetts, 2014

## Lemelson-MIT InvenTeam Experience

- Natick High School (MA) InvenTeam in 2013
- Received a U.S. patent for their Search and Rescue Remote Operated Robot



**NATICK HIGH SCHOOL INVENTEAM'S PATH TO U.S. PATENT 9,511,833 B2**

Educator Case Study

Invention: Remotely Operated Vehicle (ROV) with submersible for ice search and rescue dive teams

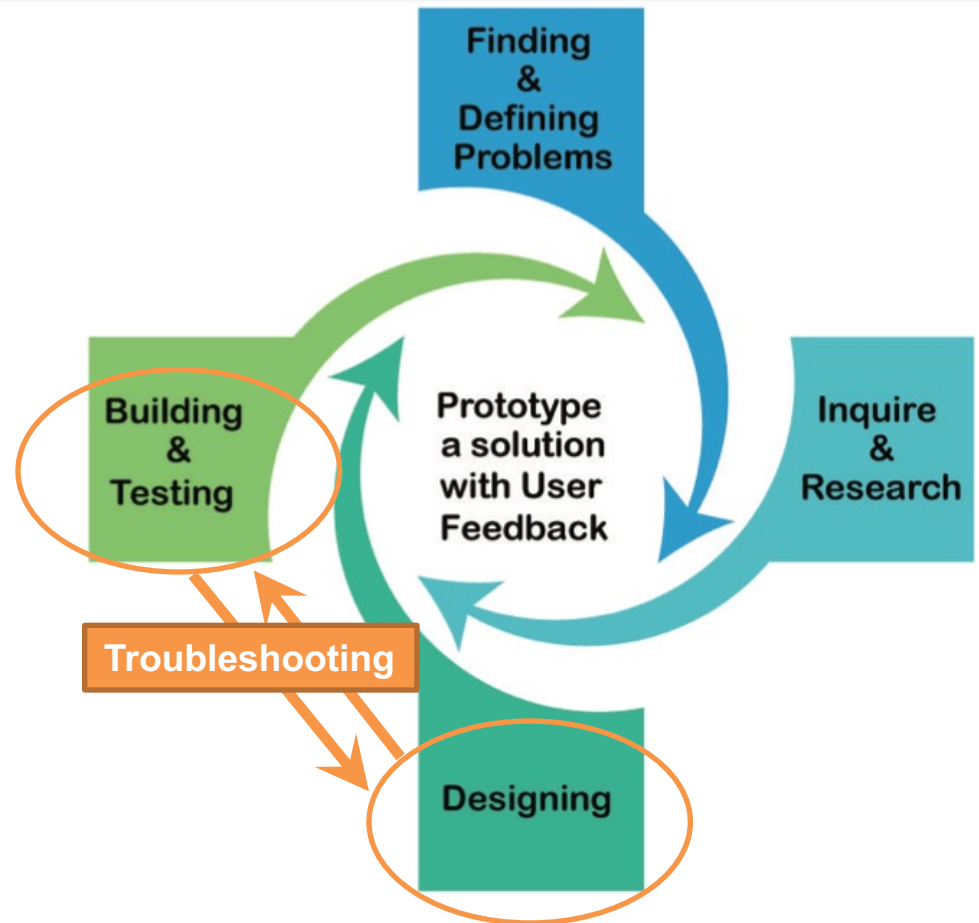
# Troubleshooting Invention Prototypes

## Technical inventions are

- Useful
- Unique
- Reduced to practice

## Troubleshooting is

- different for every situation and every invention project
- come only with experience
- but there are some common problems that can be diagnosed quickly



# Basic Safety Rules for Tool Use



**Wear safety glasses.**

**If you are in doubt about how to use a tool, ask!**

**Have a plan for what you are going to do with the tool.**

**Be mindful of others who might enter into your workspace accidentally.**

**Secure the workpiece.**

**Have a balanced stance while using a tool.**

**Remove all jewelry, watches, and loose clothing before working with machinery.**

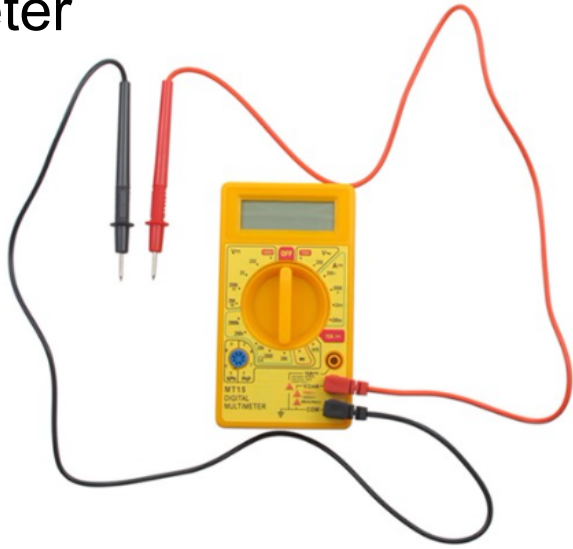
**Pin up long hair and wear closed-toe footwear.**

**Never work when you are tired or unfocused.**

**Leave the workspace cleaner than you found it.**

# Tools working with Batteries and Circuits

Multimeter



Battery tester



Testing batteries and circuits using a multimeter

<https://vimeo.com/album/1897420/video/60032726>

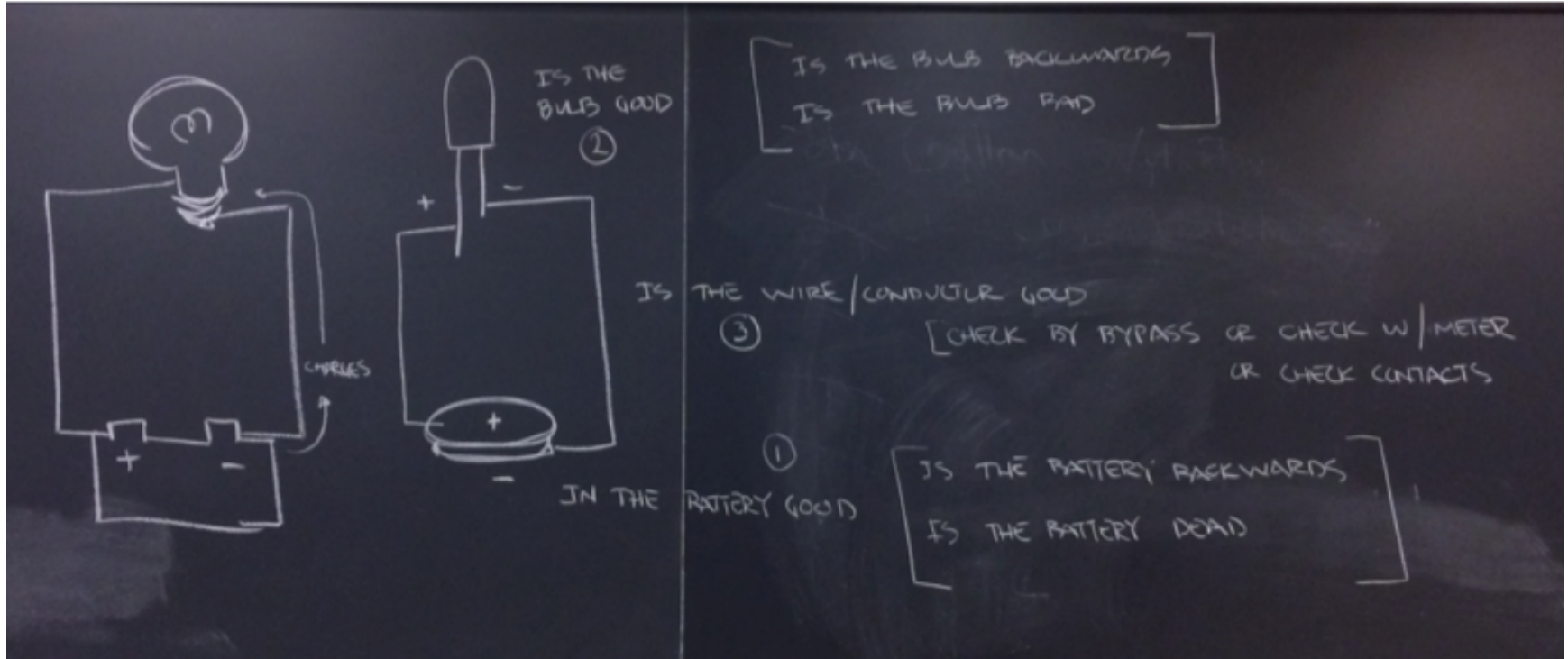
## Do not:

- tilt car batteries!
- cut open batteries!
- allow young children to work with coin cell batteries!
- store 9v batteries loosely. They could cause a fire!!

# Troubleshooting Circuits

## A three-step process:

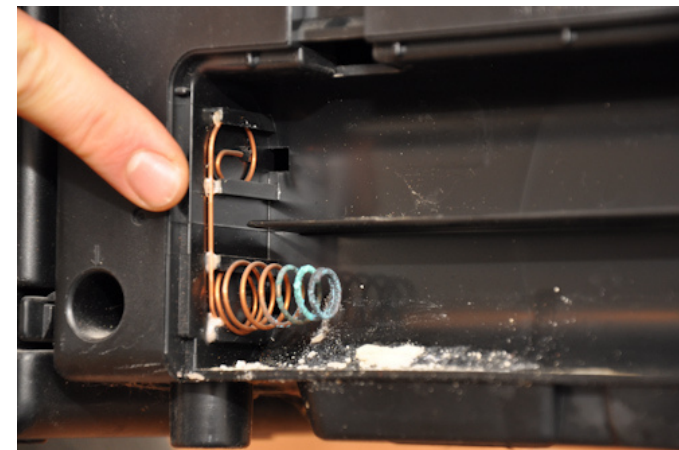
1. Power source: Is the battery good – backwards or dead?
2. Devices: Is the bulb good?
3. Conductor: Is the wire good?





# Working with Power Source

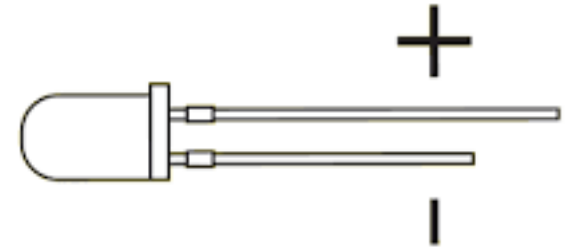
- Is the battery inserted backwards?
- Is the battery dead?
  - ✓ Test it using a battery tester
  - ✓ Test it using a multimeter tester
- SparkFun video on using a multimeter:  
<https://www.youtube.com/watch?v=GpMrVgOaDGY>
- Is the battery fully connected?
  - ✓ Check the contacts for white solid corrosion
  - ✓ Check the ends of battery to ensure that it is not leaking





# Working with LED and light bulbs

- Check the orientation of the LED
  - ✓ Switch the orientation of the LED legs
- Check the LED
  - ✓ Is it good? Test with a coin cell battery—make sure the battery is good.
- Change to a LED light of different color
  - ✓ LEDs of different colors require different power. A red LED typically requires 1.8 volts, but a blue LED needs from 3 to 3.3 volts.
- Check the connections to the LED
  - ✓ Are the right wires firmly connected to the legs?



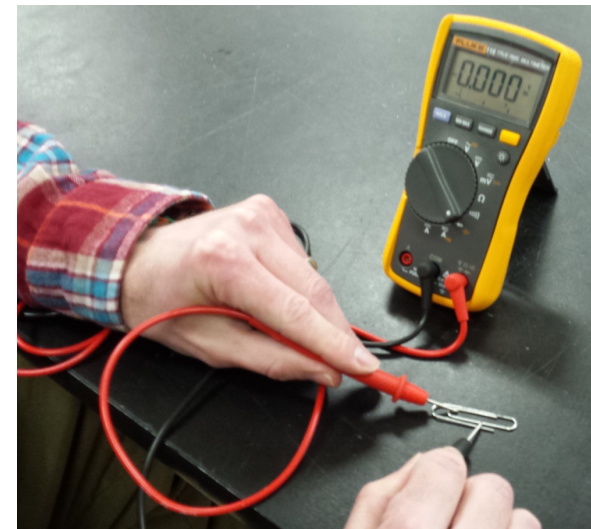
*The legs of LEDs are of different length, the longer leg connects to the positive end, the shorter leg connects to the negative end.*



*LEDs of different colors*

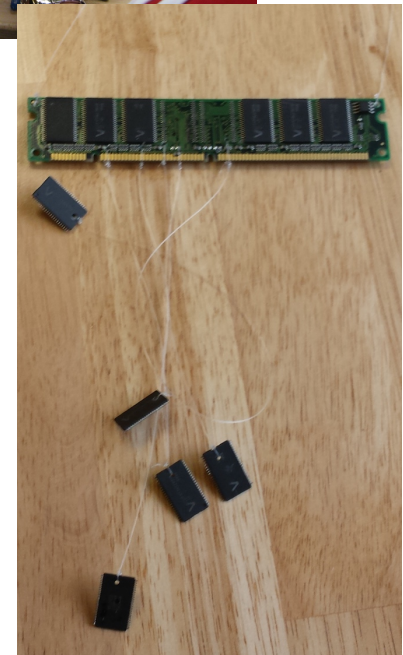
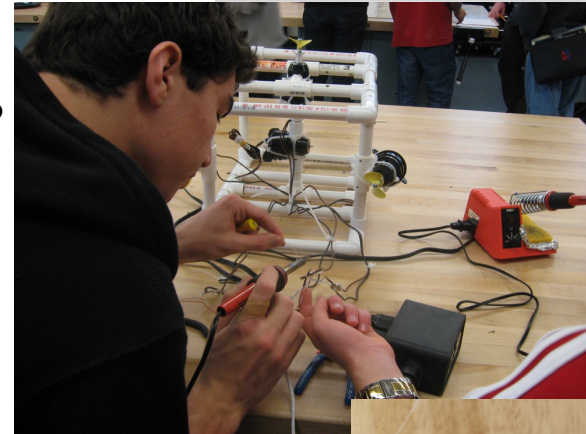
# Working with Copper Tape, Conductive Thread, and Wires

- Check the continuity in the copper tape
  - ✓ Make sure you lay the adhesive side down as one strip. It's not conductive through the adhesive side.
  - ✓ No breaks in the tape! If there's a break in the tape current won't flow to the LED.
  - ✓ Avoid tangled tapes or thread.
- Check the connection between the tape and devices
  - ✓ Put sufficient pressure on the tape that holds the LED legs in place
  - ✓ Use electrical tapes if needed
- Shorts in the circuit?
  - ✓ Use a multimeter to check the circuit



# Working with Electronics, Soldering...

- Is the board good?
  - ✓ Are the ground signals on the board good?
- Are your components the correct values?
  - ✓ Check the values of the resistors
- Are the components soldered correctly?
  - ✓ Is the chip soldered in the right place?
- Are there solder jumpers/shorts on the board?
  - ✓ Check your chips for solder jumpers between pins.
- Are there bad solder joints?
  - ✓ Examine the board for "gray" (as in not shiny) solder joints, as this is usually indicative of an incorrectly soldered pin.
  - ✓ Make sure all solder joints are all nice and shiny, and that the pins of a surface mount device are *actually* touching the pad on the board and not just floating above with solder on them.

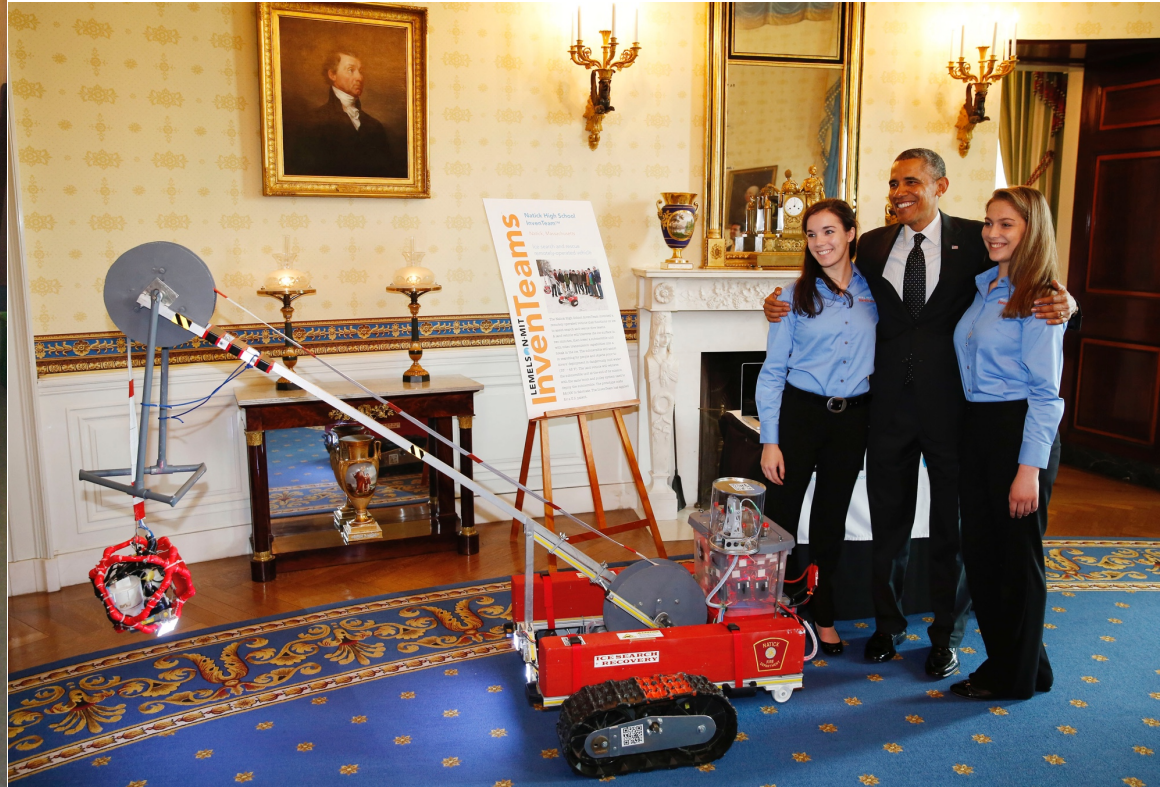


Ram chip that lost chips due to shorted board jumper



# Encouraging Young Inventors to Troubleshoot

Troubleshooting is a learning process!



# Lemelson-MIT Resources

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- Lemelson-MIT Program  
<http://lemelson.mit.edu/>
- InvenTeams National Grants Initiative  
<http://lemelson.mit.edu/inventeams>
- JV InvenTeams Curriculum Materials  
<http://lemelson.mit.edu/jv-inventeams>
- Inventor Archive  
<http://lemelson.mit.edu/search-inventors>

# Other Resources

How to Use a Multimeter from Sparkfun

<https://learn.sparkfun.com/tutorials/how-to-use-a-multimeter>

Don's vimeo channel on batteries and circuits

<https://vimeo.com/album/1897420>

Circuit troubleshooting worksheets from All about Circuits

<https://www.allaboutcircuits.com/worksheets/basic-troubleshooting-strategies/>

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# InvenTeam National Grants Initiative

- **Applications for next school year are due 4/9:**  
<https://lemelsonmit.slideroom.com/#/permalink/program/39708>
- **National grants of up to \$10,000** for teams of high school students, educators, and mentors to create technological solutions to real world problems.
- Up to 35 national finalists receive **all-expense paid PD** at MIT in invention education
- Fifteen grantees awarded grant, showcase working prototypes at MIT at the end of the school year

Who should apply?

**High School Teachers** who can lead a group of students through a year-long, open-ended invention project



Contact Tony Perry ([aperry@mit.edu](mailto:aperry@mit.edu), 617-253-7301) for more information

# Sign Up at LemelsonX

- Check our Online Invention Educator Community  
**lemelsonx.mit.edu**

The screenshot shows the homepage of the LemelsonX website. At the top left is the logo "LEMELSON-MIT Celebrating invention, inspiring youth". To the right are navigation links for "Content", "People", "Log In", and "Sign Up", along with a search bar and the MIT logo. Below the navigation is a horizontal menu with "Home", "Learn", "Connect", "Share", and "About". The main banner features a large graphic with a lightbulb, gears, and a Wi-Fi symbol, with the text "Celebrating invention, inspiring youth" and a "Sign Up" button. Below the banner is a post titled "1 Minute Rube Goldberg" by Doug Scott, showing a student's invention. To the right is a section for "19 members in 1 country" with profile pictures. At the bottom right is a "RECENT ACTIVITIES" section showing a comment by Ed Hernandez.

**LEMELSON-MIT**  
Celebrating invention, inspiring youth

Content ● People ●

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**POST**





**1 Minute Rube Goldberg**





Students are broken up into 2 teams. They are provided 1 metal wire shelving unit. They utilize the shelving unit to house their Rube Goldberg...

 2 weeks ago


 Doug Scott 0 4 [Add Comment](#)

**19 members in 1 country**

    H

**RECENT ACTIVITIES**

 Ed Hernandez commented on [Educating Young Engineers \(EYE\)](#) about 2 weeks 5 days ago

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**THANK YOU!**

Contact Us at  
[PD-lemelson@mit.edu](mailto:PD-lemelson@mit.edu)

Invention Education  
Webinar Series

