

# LEMELSON-MIT

*Celebrating invention, inspiring youth*

## Additive Fabrication: CAD and 3D printing

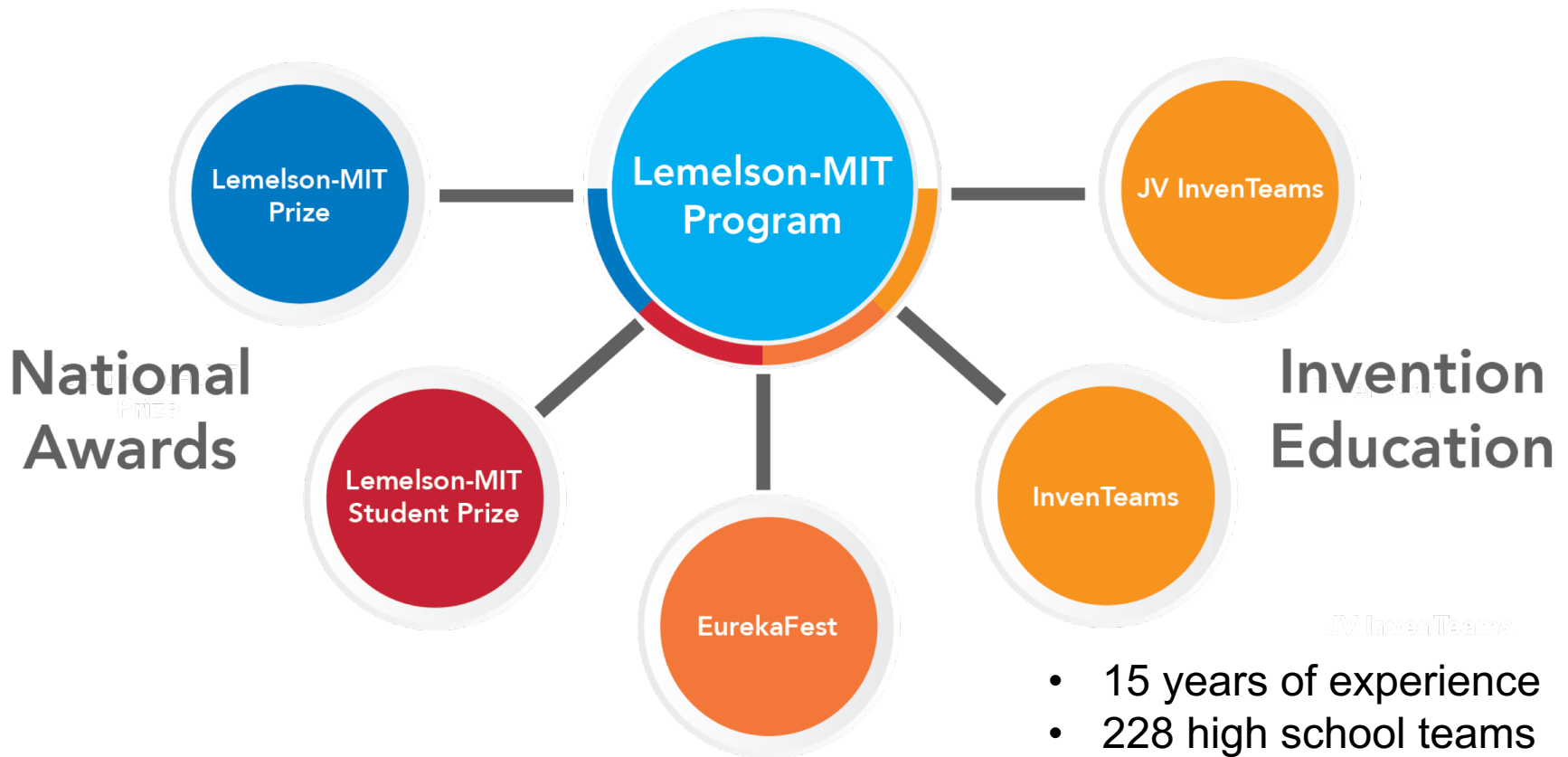
Invention Education  
Webinar Series



Thursday, April 19, 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 Mike Gallagher

- Technology Education department chairperson at Saratoga Springs High School, NY
- Master teacher PLTW
- Leader for Educating Young Engineers Program

## Lemelson-MIT InvenTeam Experience

Saratoga High School InvenTeam  
2008: The Garden Consultant



# 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

# 3D Printing in Invention

Technical inventions are

- Useful
- Unique
- Reduced to practice

## ***3D Printing or Additive Fabrication***

- Allow for rapid prototype development and testing, enable students to materialize their ideas in a fast and affordable way
- Accelerate invention processes



# Additive Fabrication: 3D Printing

- **Additive fabrication:** creating an object by laying down successive layers of material until it becomes a predesigned shape.
  - Opposite to subtractive fabrication: the cutting out / hollowing out a piece of metal or plastic with machines or tools
  - 3D printing is an additive fabrication process

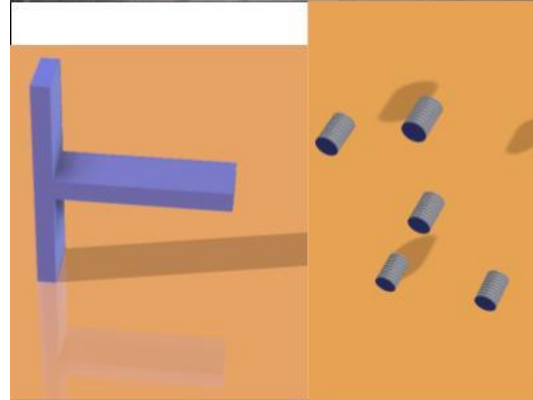
- **Benefits of 3D printing:**

- ✓ Fast and cheap
- ✓ Saves more material than traditional manufacturing methods

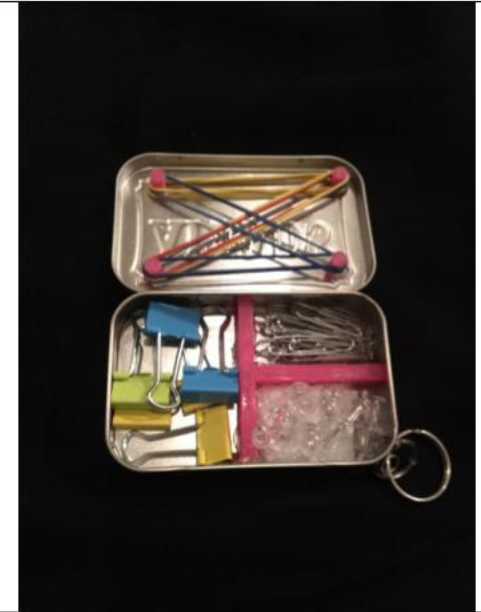


# 3-D Printing for Prototyping Solutions

*Altoids Tin project where students created a clay model, CAD graphic of the design, and a 3D printed prototype*



Office supply Organizer



## Purpose

The Office supply Organizer offers a small, compact, and organized place to store any small office supplies. Many people struggle to find office supplies like rubber bands and thumb tacks when they need them, but with the Office supply Organizer, this will no longer be an issue. The three main compartments are specially designed to hold binder clips, paper clips, and thumb tacks. There is even a foam insets to pin the thumb tacks into so that people will not poke themselves trying to get them. The inside cover is made to efficiently hold rubber bands while maximizing space within the storage unit. There is even an attached keychain so that one may attach the Office supply Organizer to a bag or backpack, so that it will not easily get lost.

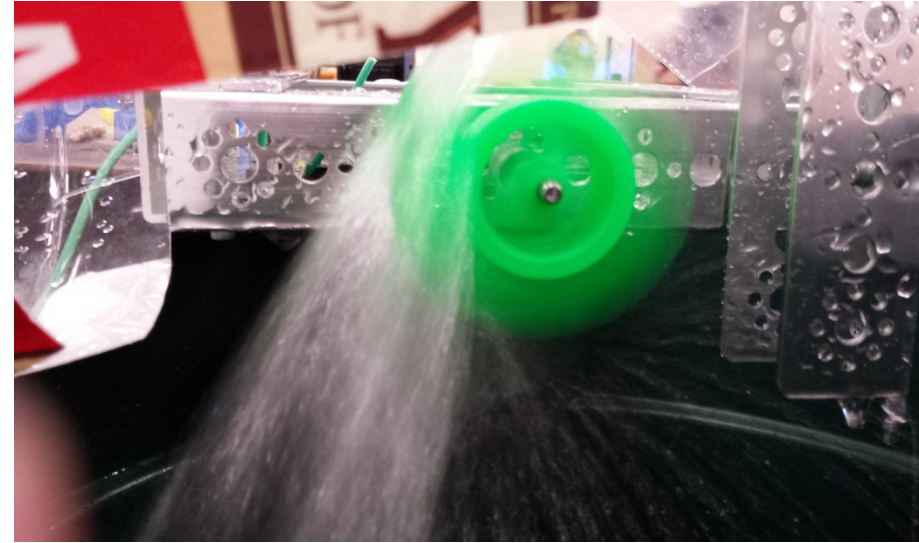
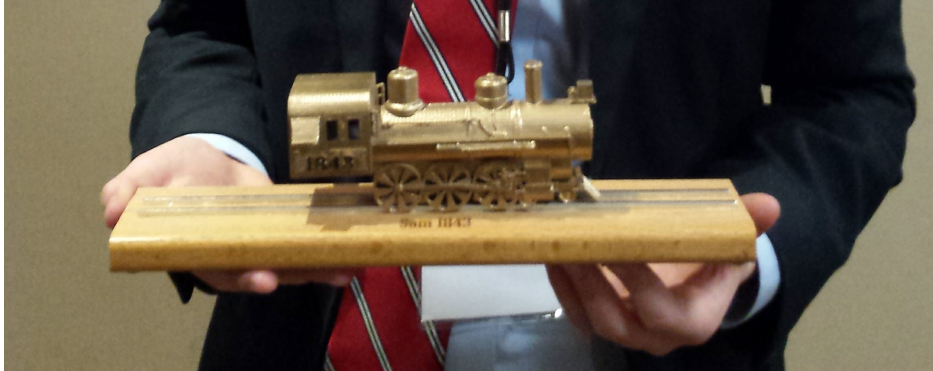
## Other uses:

This storage unit can be used to hold a number of small items. The three main compartments can be used to store different types of gum and candy or small jewelry pieces like earrings, rings, and bracelets. The pegs at the top can be used to organize stretchy bracelets, and the foam insert can be used to stick earrings into. It can even be turned into a first aid kit by putting in bandages, gauze, and a small container of rubbing alcohol or disinfectant. The organizer's design is purposefully versatile so that there are endless ways to use it.

# 3D Printing Project Ideas



*3D printed locomotive*



*3D printed hydropower wheel prototype*



# Basic Safety Rules



**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.**

# Low Budget 3D Printers (Below \$500)

**Monoprice MP Select Mini 3D Printer V2 (around \$200)**

[https://www.monoprice.com/product?p\\_id=15365](https://www.monoprice.com/product?p_id=15365)



**For large prints: Maker Select Plus 3D Printer (around \$400)**

[https://www.monoprice.com/product?p\\_id=15711](https://www.monoprice.com/product?p_id=15711)



# Mid Price Range 3D Printers (Below \$2,000)

## LulzBot TAZ 5

small \$1200 large  
\$1600

<https://www.lulzbot.com>



## Afinia H800+ 3D Printer \$1890

<http://afinia.com/3d-printers/h800/>



## Dremel Digilab 3D45 3D Printer \$1,800



# Mid to High Price Range 3D Printers

**Ultimaker \$ 3400**

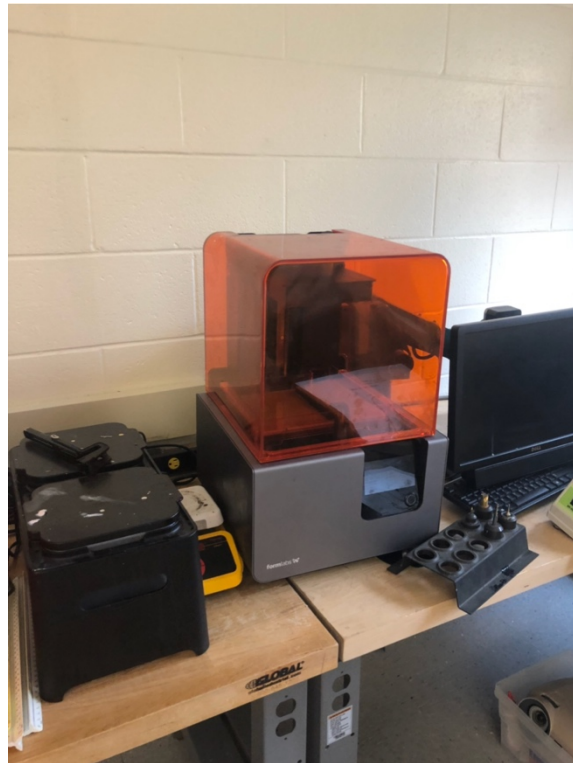
<https://ultimaker.com/>



**Formlabs Form 2**

**\$3330**

<https://formlabs.com/store/us/form-2/buy-printer/>



**Hyrel3d \$6,000**

<http://www.hyrel3d.com/core-suystems/system-30m/>



# CAD tools

For Elementary and Middle School students:  
[Tinkercad](#)



For High School students:  
[AutoCAD](#)  
[Autodesk Inventor](#)  
[SolidWorks](#)  
[Fusion360](#)  
[Onshape](#)  
[Sketchup](#)



# Setting up 3D Printers in Classrooms

- Set up a dedicated 3D printing space
- Store PLA filament for 3D printing
  - ✓ Prepare 10 spools of 1.75mm PLA filament
  - <http://gizmodorks.com/pla-3d-printer-filament/>
  - ✓ Store the filament in sealed buckets....it will degrade
  - ✓ Always budget for purchasing the filament
- Always have at least two 3D printers in the classroom



# 3D Printers in Classrooms

- Set up a dedicated set of tools for 3D printers including
  - ✓ *Wrenches* for disassembling various parts and accessing the extruder motor
  - ✓ *Needle-nose pliers with side cutters* for cutting filament and removing pieces of filament that sometimes get caught in the extruder head
  - ✓ *Screwdrivers*
  - ✓ *Tape measure* - for measuring larger items
  - ✓ *Lubricant*
  - ✓ *Box cutter*



# 3D Printing in Your Community

- 3D printing is a powerful tool for prototyping invention solutions.
- The printers, materials, and maintenance are expensive.
- Be proactive in seeking help from your community. Search for 3D printing services offered in local libraries, community centers, maker spaces, and at local businesses.



# Lemelson-MIT Resources

- 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

- [Reviews and recommendations of 3D printers](#)
- [3D printed shoes: a revolution in the footwear industry!](#)
- [3D printing educational projects](#)
- Books:  
3D Printing with MatterControl  
(<https://www.matterhackers.com/store/l/3d-printing-with-mattercontrol/sk/M0HQ1YCZ>)

[The Invent To Learn Guide to 3D Printing in the Classroom: Recipes for Success](#)

# Q & A

## *Which brands of PLA do you recommend?*

We recommend using translucent colors in PLA from Gizmo Dorks which are cheap and high quality. The link is <https://gizmodorks.com/pla-3d-printer-filament/>. Always prepare multiple spools of PLA filament and store the filament in sealed containers since it will degrade over time with exposure to air and direct sunlight.

One important tip is to set up an email account for a designated printing computer and students can email the file and set up a queue to print. This will make the printing more efficient.

## *Where would you get funding for the class equipment and materials?*

We have worked with teachers who were able to get funds through corporate grants, private donors, community organizations, PTA/education foundations, and school budgeting. [DonorsChoose.org](https://www.donorschoose.org) is a website used by public school teachers to post a project including the need for materials and resources for their classrooms.

Did you know that [UPS](https://www.ups.com/3dprinting) is rolling out 3D printing services? All you need is a 3D CAD file. You won't have the expense of purchase and maintenance of the printer and filament.

# Q & A

*Could you talk more about the CAD tools and the targeted students? Which ones are free and do not require cloud?*

CAD tools are used in various industries and specialty fields. They run on different computer systems and may have academic and professional versions. Price points vary from free to thousands of dollars a year for a license. Typically, the more professional the targeted user or the more specialized the field, the more training will be required to become proficient with the tool. Wikipedia offers a thorough [comparison of CAD](#) tools.

InvenTeam students are supported by [SolidWorks Education](#). It is available for the classroom and in two student packages. This is a professional tool and excellent for students interested in engineering careers to learn. SolidWorks has introduced [Apps for Kids](#) – a free, web-based tool for elementary school students. Not all InvenTeams use SolidWorks. Some use Autodesk’s [Fusion 360](#) (free for education) and [Inventor](#). [Onshape](#) offers free plans for hobbyists and makers that are cloud-based.

Spend time reviewing CAD tools to select the “best” one for your use. Free is not always better – nor is spending a lot of money. Check with your district—they may have an existing education license for Inventor or SolidWorks.

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**THANK YOU!**

Contact Us at  
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Invention Education  
Webinar Series

