

# 3D Printing in the FIRST Community

IN FIRST FORUMS

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# Hello, I am Rufus Cochran

- 447 student from 2001 to 2006
  - From Co-Operation FIRST to Aim High
- FIRST mentor for a decade
  - 447 and 5010
- Rose-Hulman Alumni
  - Computer Engineering
  - Mechatronics
- Controls Engineer at Roche Diabetes Care
  - High Speed Vision Systems
- Started a BattleBots team last year
  - [denkbots.com](http://denkbots.com)

# Overview of Presentation

- Introduction to 3D Printing
- History of 3D Printing
- Future of 3D Printing
  
- The Design Process and 3D Printing
- FIRST and 3D Printing
- Open Hardware and You

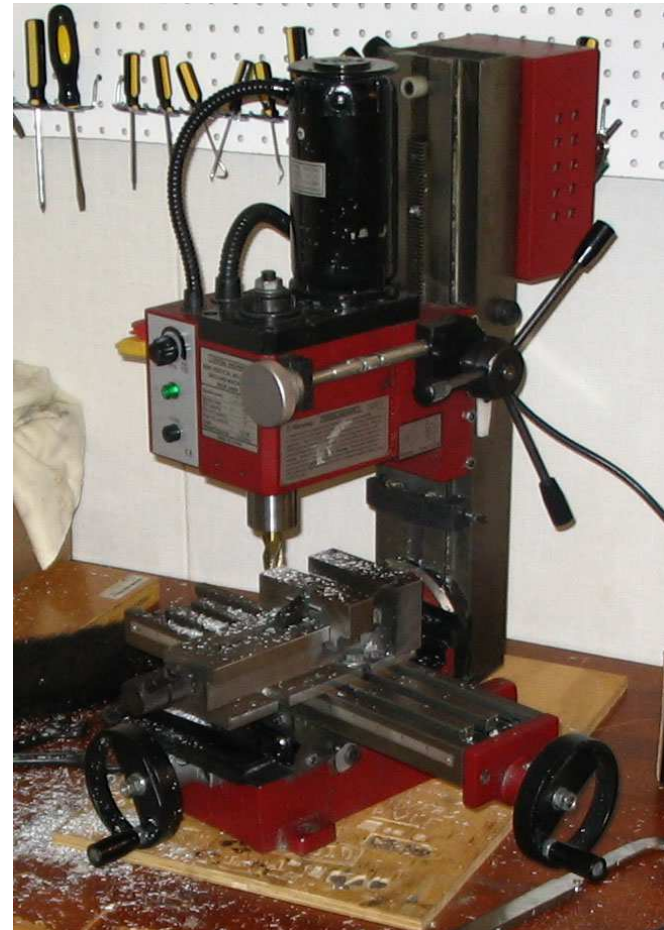
# Warm Up Questions

- Who has heard 3D Printing?
- Who has a 3D Printer readily available?
- Who owns a 3D Printer?
  
- Can you think of anything you could have 3D printed on your robot last year?
  - Write ideas down as they come to you, we will share at the end of the show

# What is 3D Printing?

## Wikipedia

- Additive Manufacturing process for printing a three-dimensional object.
- Production had classically been done by casting, fabrication, stamping, and machining; transforming a mass of raw material into a desired shape layer by layer was associated with processes that removed material (rather than adding it), such as CNC milling.

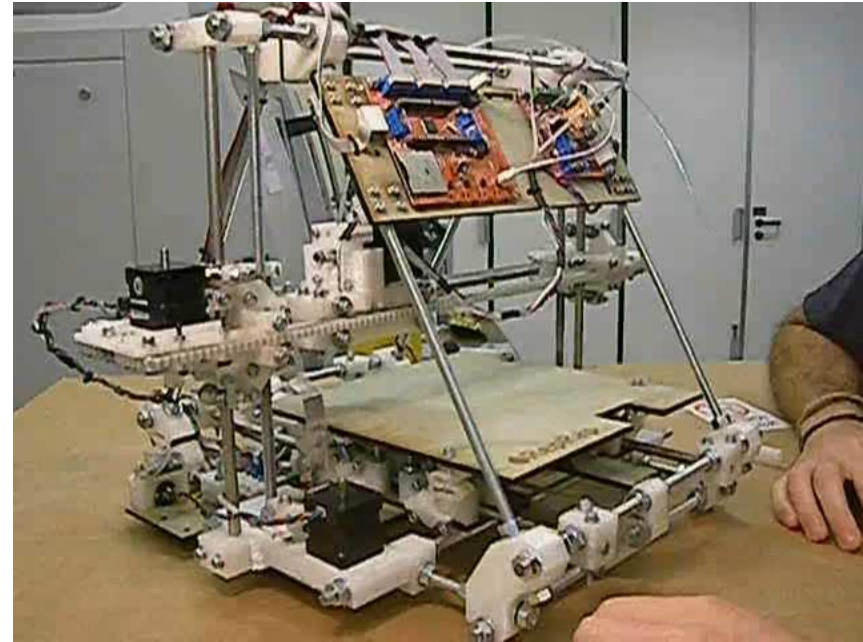


**(Not a 3D Printer)**

# Why is 3D Printing?

## Der Spiegel

- "Assembling, screwing together, adhering, welding -- all these processes are rendered obsolete when even the most complex shapes can be produced by a single machine using this casting technique."

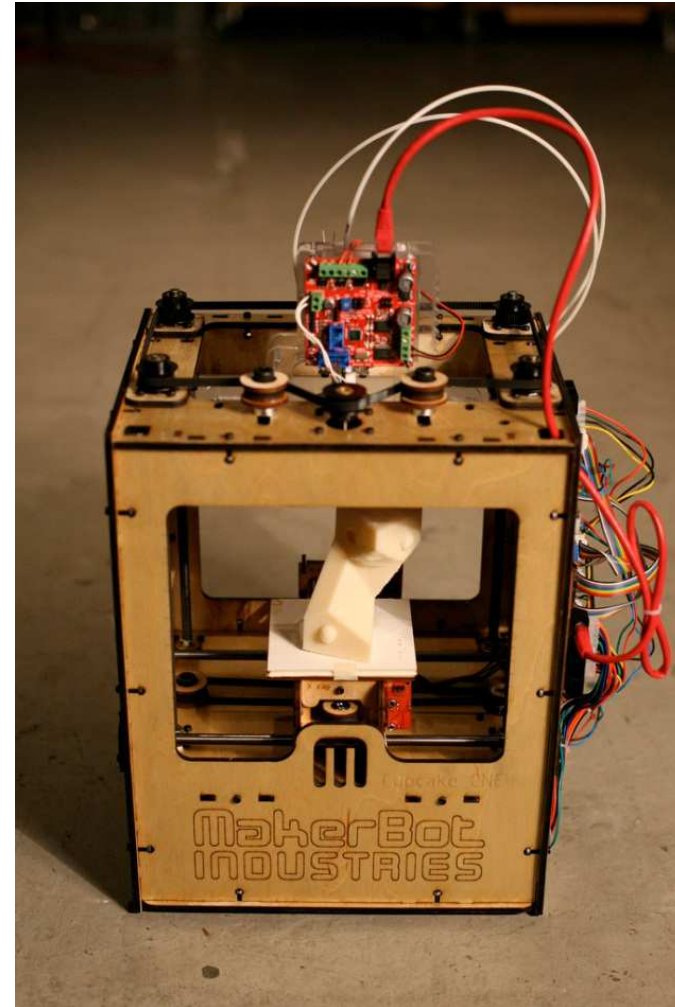


**(3D Printer? Or Siege-Engine?)**

# How does 3D Printing?

## Main Types of 3D Printing

- SLA
  - StereoLithography Apparatus
- SLS
  - Selective Laser Sintering
- FDM
  - Fused Deposition Modeling

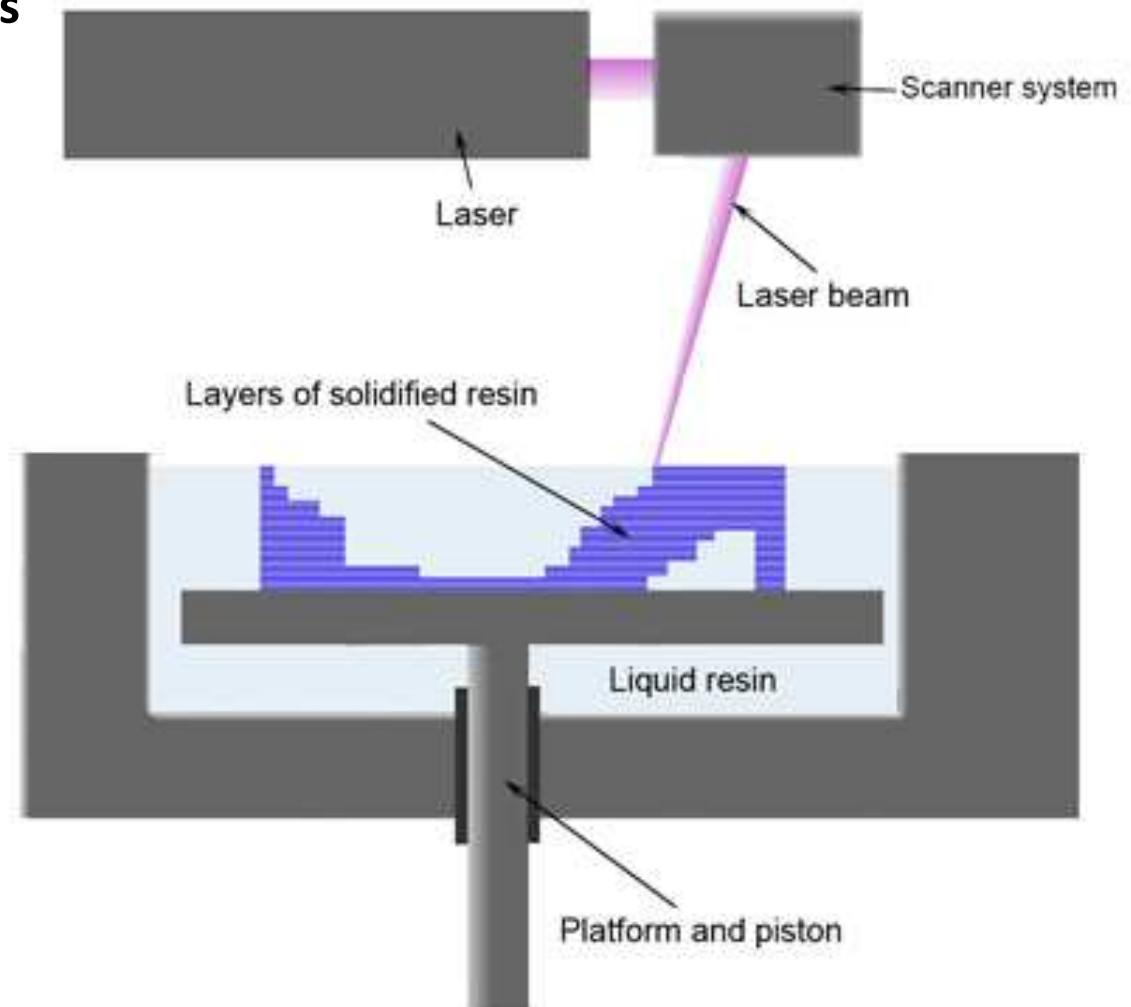


**(Ok, here is a 3D Printer)**

# Types of 3D Printing (SLA)

## StereoLithography Apparatus

- Creates layers by curing a photo-reactive resin with a UV laser
- Pro:
  - Quick print time
- Con:
  - Brittle prototype





# SLA (skip to 1m)

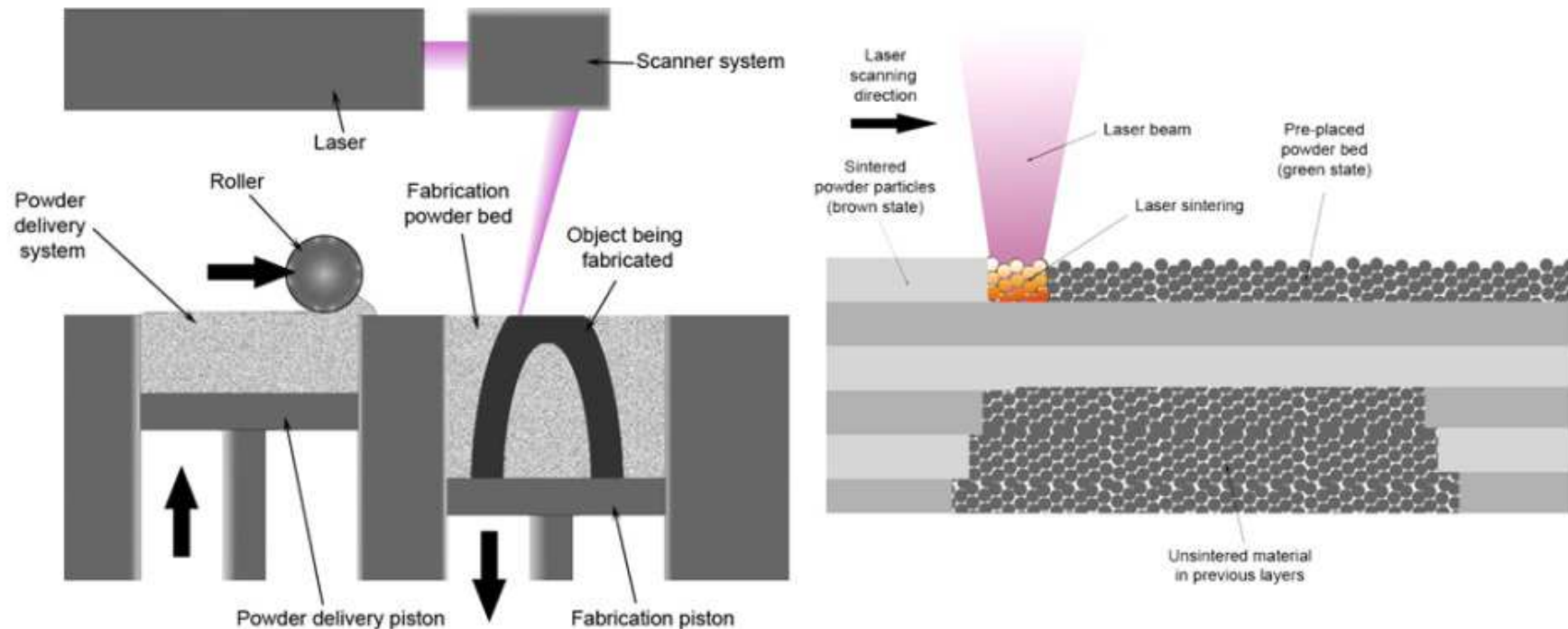
<https://www.youtube.com/watch?v=enJq2PquuPE>

# Types of 3D Printing (SLS)

## Selective Laser Sintering

- Uses a laser to sinter powdered material (typically metal), by aiming laser at points, binding the material together to create a solid structure

- Pro:
  - Wide range of material
- Con:
  - Longer print time



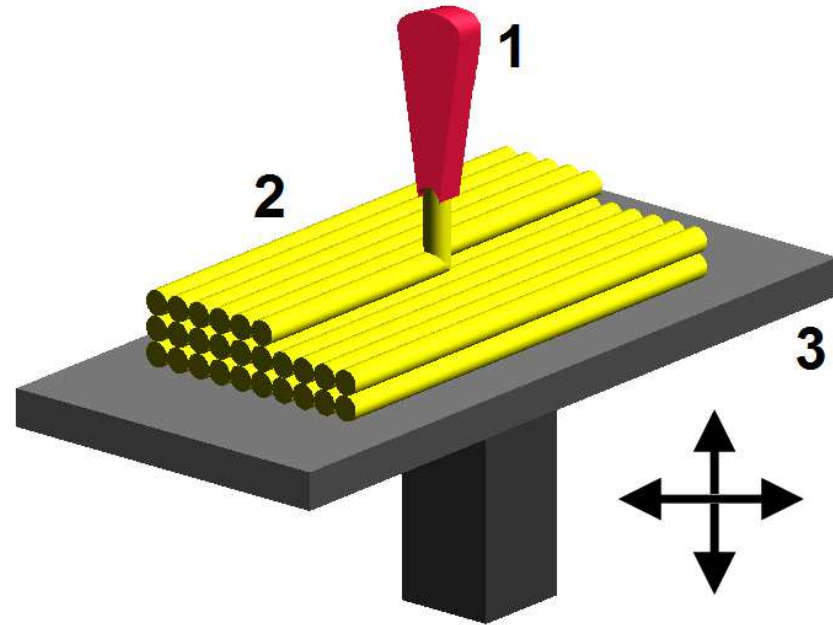
# SLS (DMLS)

<https://www.youtube.com/watch?v=VImKhUD-8hk>

# Types of 3D Printing (FDM)

## Fused deposition modeling

- Creates object by laying down material in layers
- Pro:
  - Quick print time
  - Inexpensive
- Con:
  - Bridge material required for hanging edges



## Fused deposition modelling:

- 1 – Nozzle ejecting molten plastic
- 2 – Deposited material (modeled part)
- 3 – Controlled movable table

# FDM

[https://www.youtube.com/watch?v=vsBVU8PMN\\_c](https://www.youtube.com/watch?v=vsBVU8PMN_c)

# History of 3D Printing

## Roots of the Technology

- **1972** - Mastubara of Mitsubishi motors proposes that photo-hardened materials (photopolymers) are used to produce layered parts
- **1981** - Hideo Kodama of Nagoya Municipal Industrial Research Institute publishes first account of working photopolymer rapid prototyping system
- **1984** - Charles Hull invents [stereolithography](#) (SLA) (patented in 1987)

## Origin of the Methods

- **1991** - Stratasys produces the world's first [FDM \(fused deposition modelling\)](#) machine. This technology uses plastic and an extruder to deposit layers on a print bed
- **1992** - 3D systems produce the first SLA 3D Printer machine
- **1992** - DTM produces first [SLS \(selective laser sintering\)](#) machine. This machine is similar to SLA technology but uses a powder (and laser) instead of a liquid

# History of 3D Printing

## Groundwork for Consumer Applications

- **2000** - The first 3D inkjet printer
- **2000** - The first multicolour 3D
- **2001** - The first desktop 3D printer

## Seeds of Revolution

- **2005** - The [Reprap project](#) is founded; intended as a democratization of 3D printing

# History of 3D Printing

## The Revolution Begins

- **2008** - The Reprap Darwin is the first 3D printer able to produce many of its own parts
- **2008** - The first biocompatible FDM material
- **2008** - The first 3D prosthetic leg is produced
- **2008** - Makerbot's [Thingiverse](#) launches – a website for free 3D model file sharing



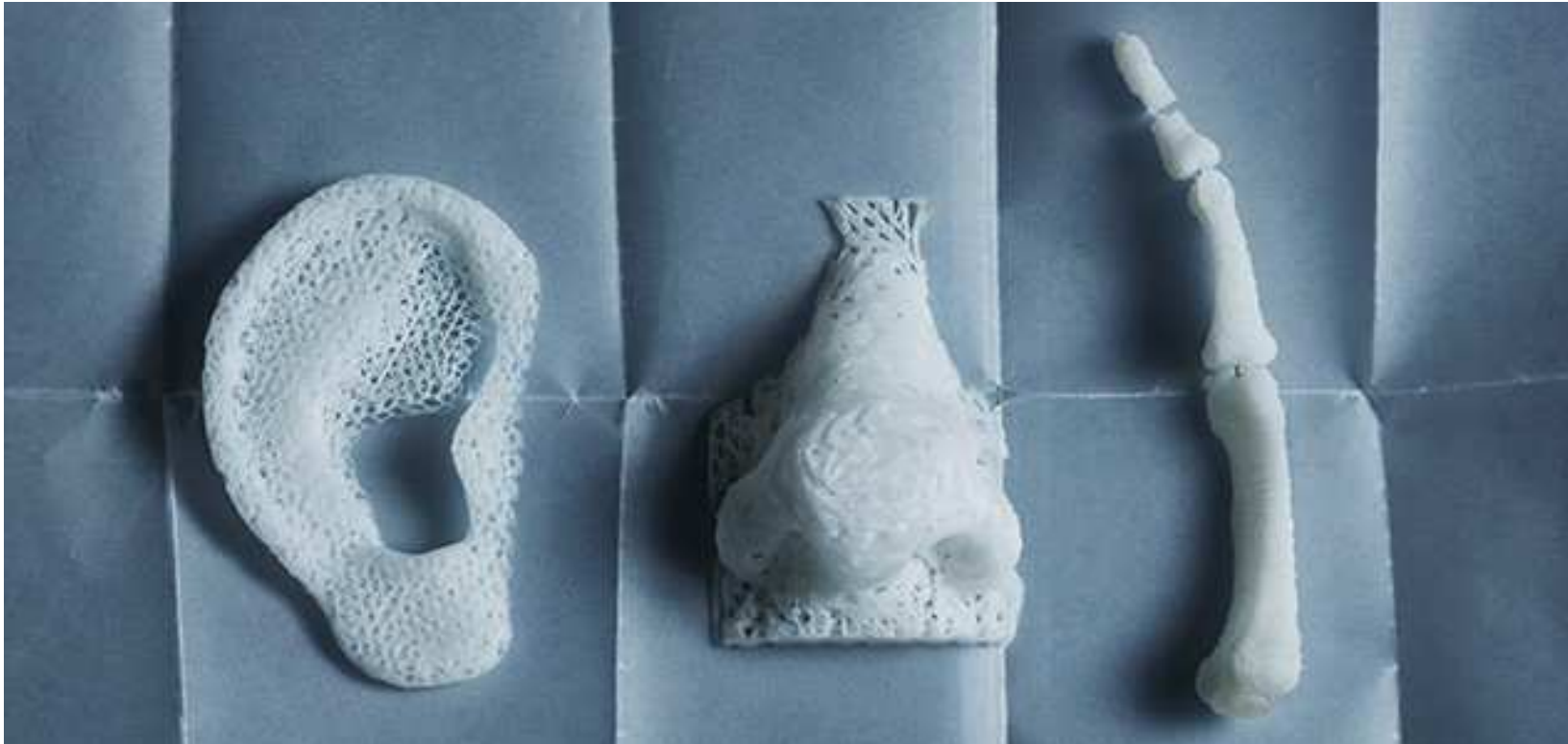
# History of 3D Printing

## Recent Steps Forward

- **2009** - The first 3D printed blood vessel
- **2011** - The first 3D printed car
- **2012** - The first 3D printed jaw is produced
- **2013** - Cody Wilson of [Defense Distributed](#) is asked to remove designs for the world's first 3D printed gun and the domain is seized.

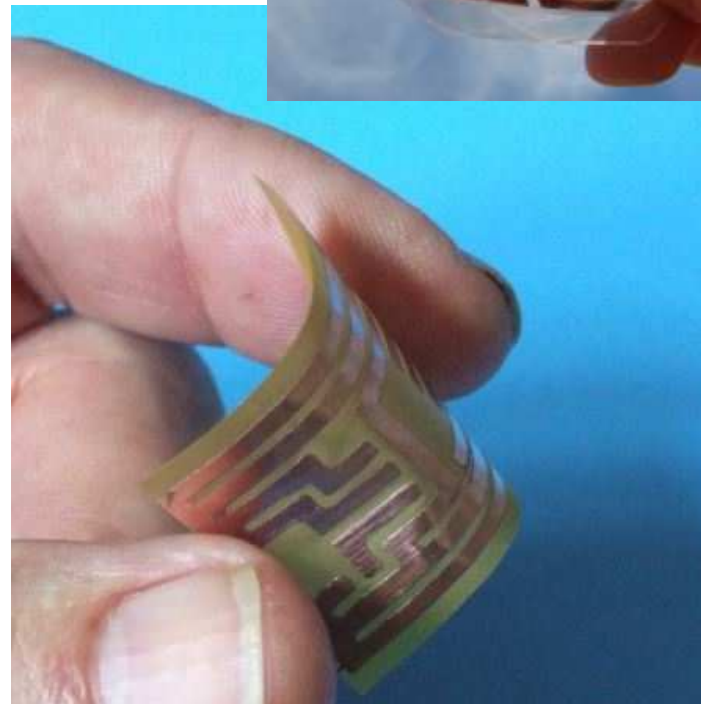
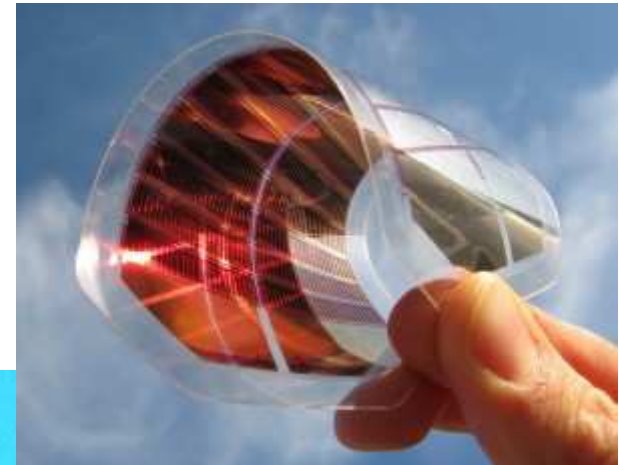
# Future of 3D Printing

- “A factory in every home”
- Mass Customization
- Bioprinting
- Food



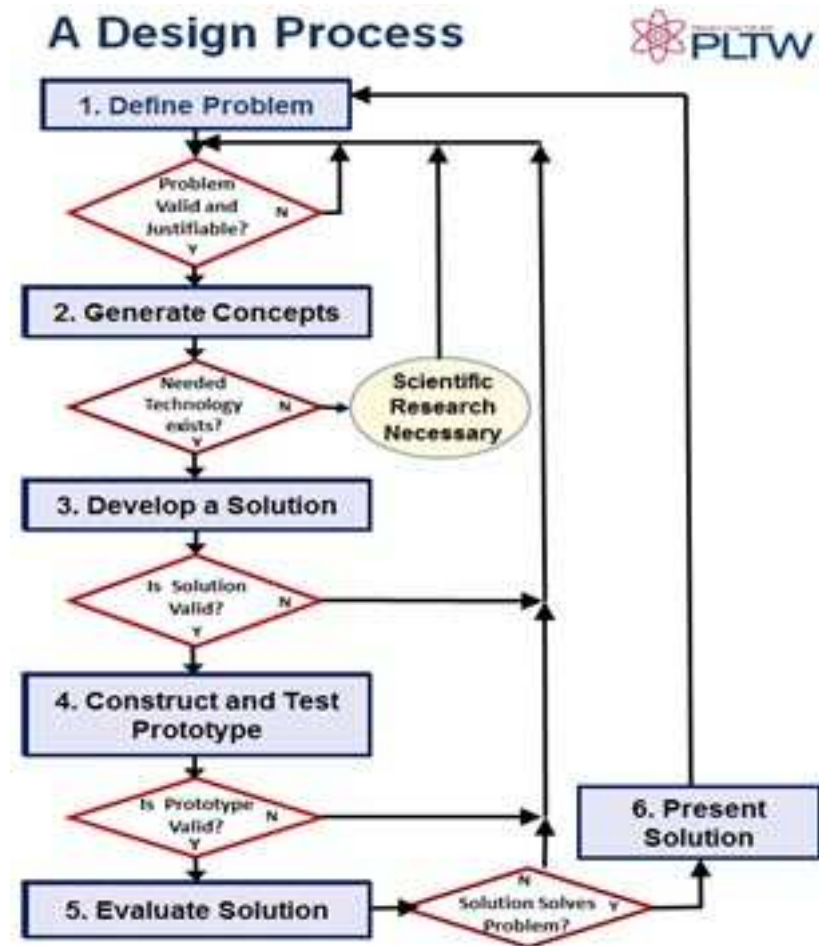
# Extensions/Applications of 3D Printing

- Microsoft Kinect as 3D Scanner
- Printed PCBs
- 3D Printed Solar Panels
- Solar Powered 3D Printers



# But what can 3D Printing do for me?

- The Design Process
- The most expensive and time consuming part of the design process, is prototyping
- Students can see their ideas almost instantly materialize in front of them, revise, and retry



# But I bet it costs over \$9,000?

- \$30 for 1kg spool of PLA
- \$350 to \$600 for very capable 3D Printers
- Doesn't your school already have a 3D Printer?



printrobot simple

(Assembled for \$599)

(Wood kit for \$349)

# But I can't afford/use that CAD program.

- hackaday.com has free tutorials for:
  - OpenSCAD
  - AutoCAD
  - Blender
  - SketchUp
  - Autodesk 123D
  - FreeCAD
  - Solidworks
- What are the benefits of using CAD?
- There are several free CAD softwares
- Does your school PLTW?
  - Your kids might already know, and have access to, a CAD software

[https://denkbots.com/links/links\\_prototyping/](https://denkbots.com/links/links_prototyping/)

# Intro 3D Printing exercise for teams

- Have students design a team keychain
- Print out all the different designs
- Figure out what doesn't work, why it doesn't work, and iterate the designs
- Students make giveaways for competition
- Students learn how to design parts to be 3D printed
- Team learns strengths and limitations of 3D parts

Think Twice

U U



Instant

W

Draw a card.  
Flashback 2 (You may cast this card from your graveyard for its flashback cost. Then exile it.)  
"Either I know just the spell I need, or I'm about to."





# So how do we leverage this technology to improve the FIRST community?

- OPEN HARDWARE
- Who has heard of thingiverse?
- We build an open repository of robotics (FRC, botball, VEX) focused parts

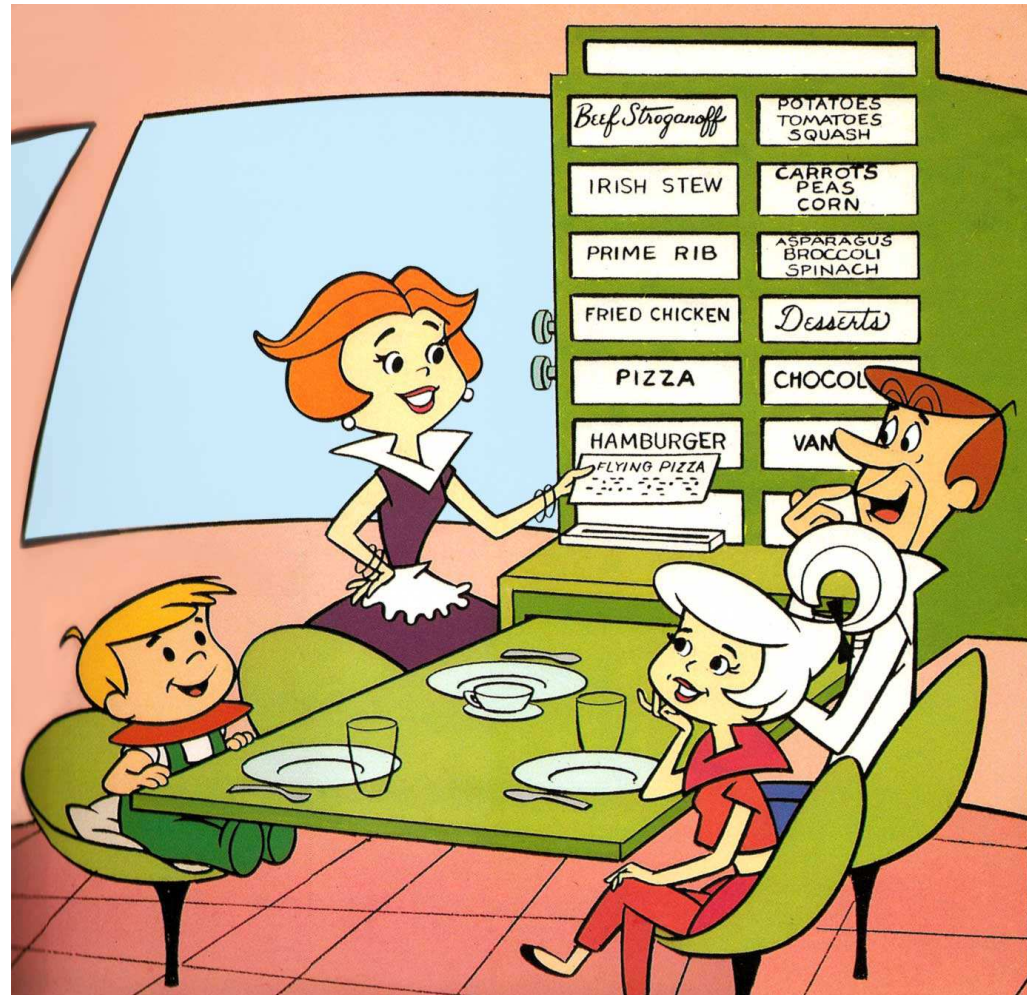


# Some Notes

- AndyMark has 3D Parts
- A team 3D printed their whole chassis
- What if you downloaded your kit of parts?
- Any part made in CAD software can be exported to an STL file
- Then software like Cura and Slic3r can turn it into reprop instructions for any 3D printer

# Remember those parts you wrote down?

- Share your ideas
- What if you had designed and shared those parts?
- What if other teams had already designed and shared those parts?



# Questions?

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Presentation at [denkbots.com](http://denkbots.com)

