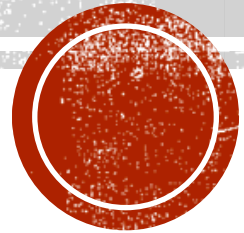
RAPID PROTOTYPING

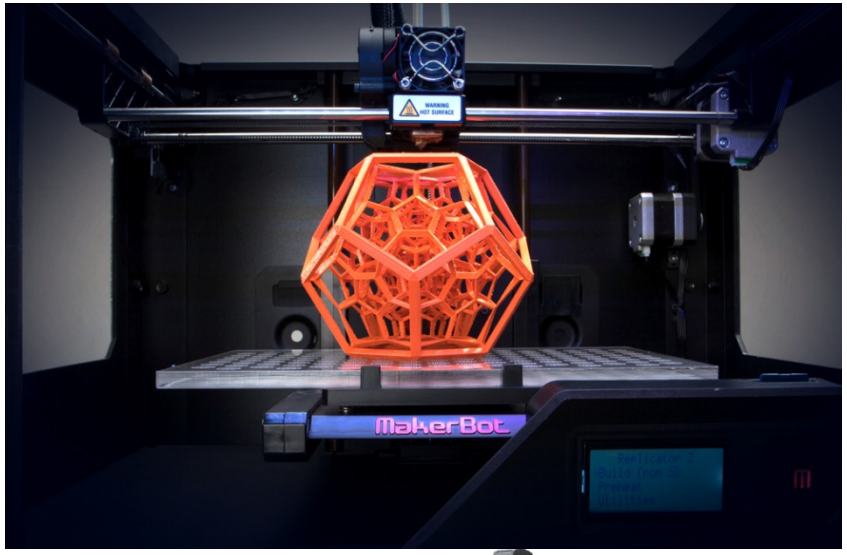
Concepts and Overview

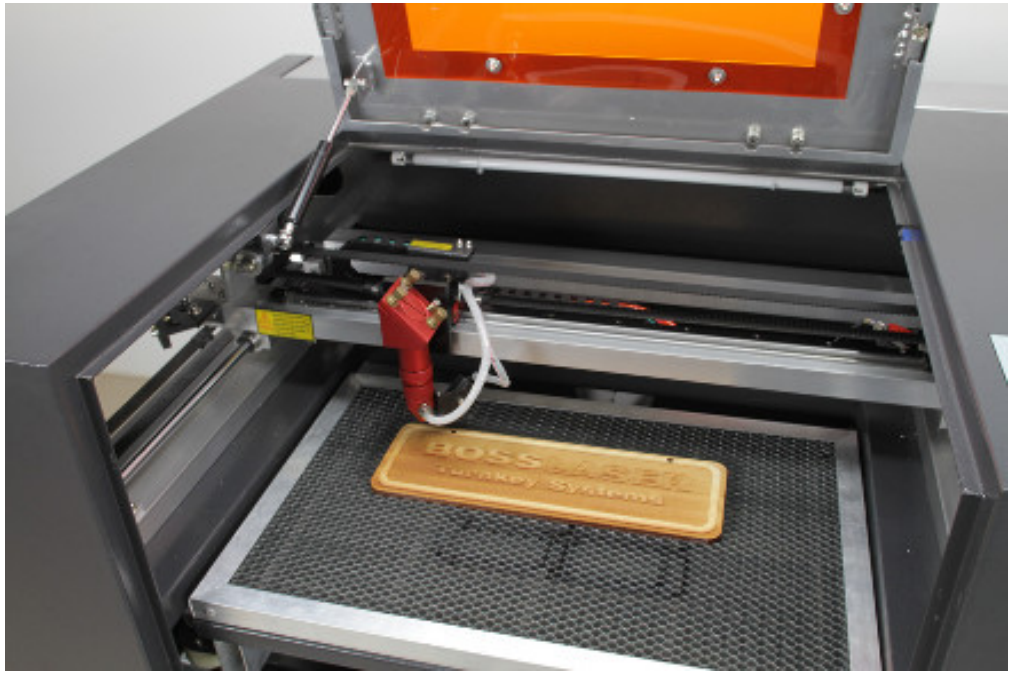


DEFINITIONS

- ***Prototyping*** is a design method that uses models to test how a object will:
  - *Look*
  - *Function*
  - *Be perceived*
  - *Be manufactured*
  - *Be priced and marketed*
- ***Rapid Prototyping*** adds digital fabrication technologies to traditional modelmaking to accelerate the prototyping process. Digital technologies offer advantages:
  - *A quicker design, build, test, fail, redesign process*
  - *Lower cost model making*
  - *Exotic design and sometimes materials*
  - *2D and 3D files that can be exported to manufacturing design processes.*

- Rapid Prototyping uses a variety of digital fabrication technologies





- Digital fabrication uses a similar basic process across tools:

1. Design software, 2D or 3D
    1. 3D design software, Tinkercad to Autocad
    2. 2D design software that produces vector art
2. Machine preparation software
    1. Slicer software for 3D models
    2. CAM software for 2D designs
3. Code the tool can understand
    1. Gcode

Comfort with using small scale digital fabrication usually translates well as things scale up.

```
G21G40G56G90
M3
G0 X0.0 Y0.0 Z0.0 A0.0 B0.0
X0.0 Y-1.2136 Z34.5493 A0.0 B0.0
G1 F50.0 X0.0 Y-1.2136 Z9.5493 A0.0 B0.0
G1 F100.0 X5.0 Y-1.2136 Z9.5493 A0.0 B0.0
X10.0 Y-1.2136 Z9.5493 A0.0 B0.0
X20.0 Y-1.2136 Z9.5493 A0.0 B0.0
X25.0 Y-1.2136 Z9.5493 A0.0 B0.0
X30.0 Y-1.2136 Z9.5493 A0.0 B0.0
X35.0 Y-1.2136 Z9.5493 A0.0 B0.0
X40.0 Y-1.2136 Z9.5493 A0.0 B0.0
X45.0 Y-1.2136 Z9.5493 A0.0 B0.0
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X55.0 Y-1.2136 Z9.5493 A0.0 B0.0
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X65.0 Y-1.2136 Z9.5493 A0.0 B0.0
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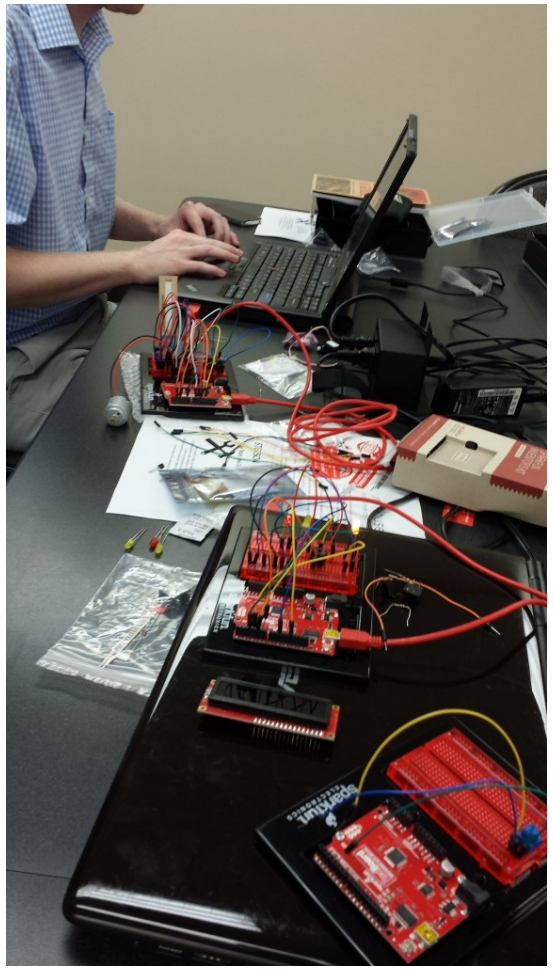
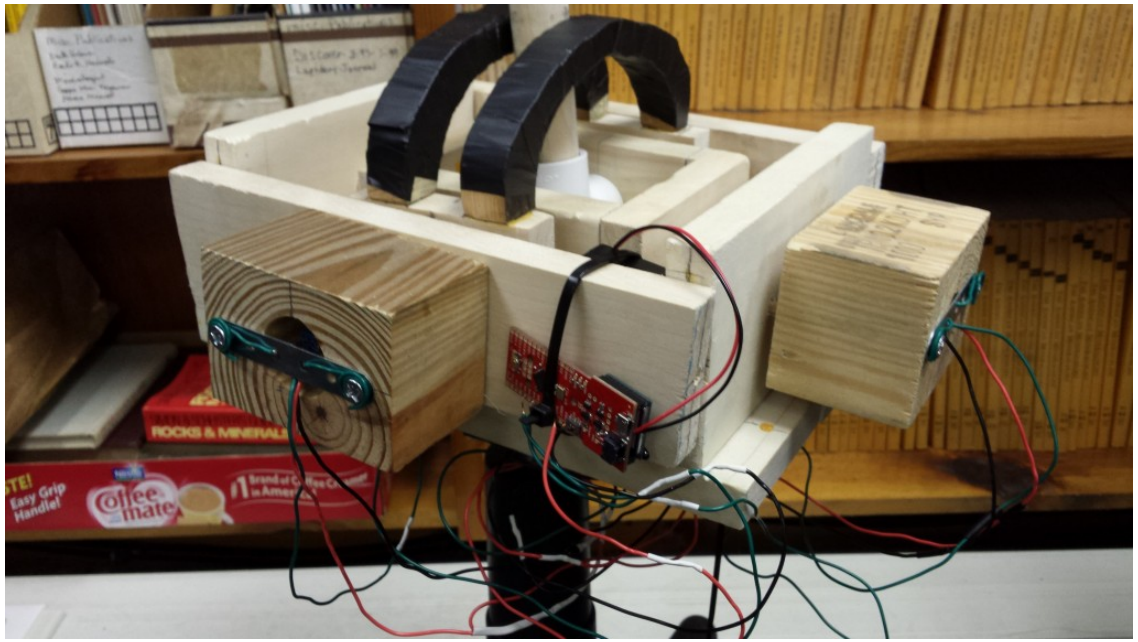
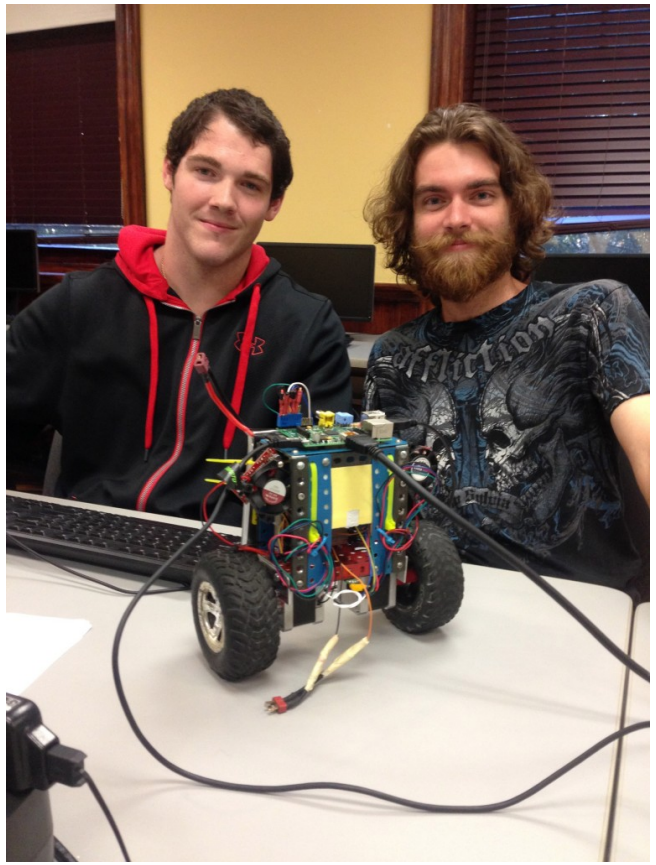
- Rapid prototyping concepts have been extended to electronics (Arduino, Raspberry Pi, Photon, Edison, etc.)

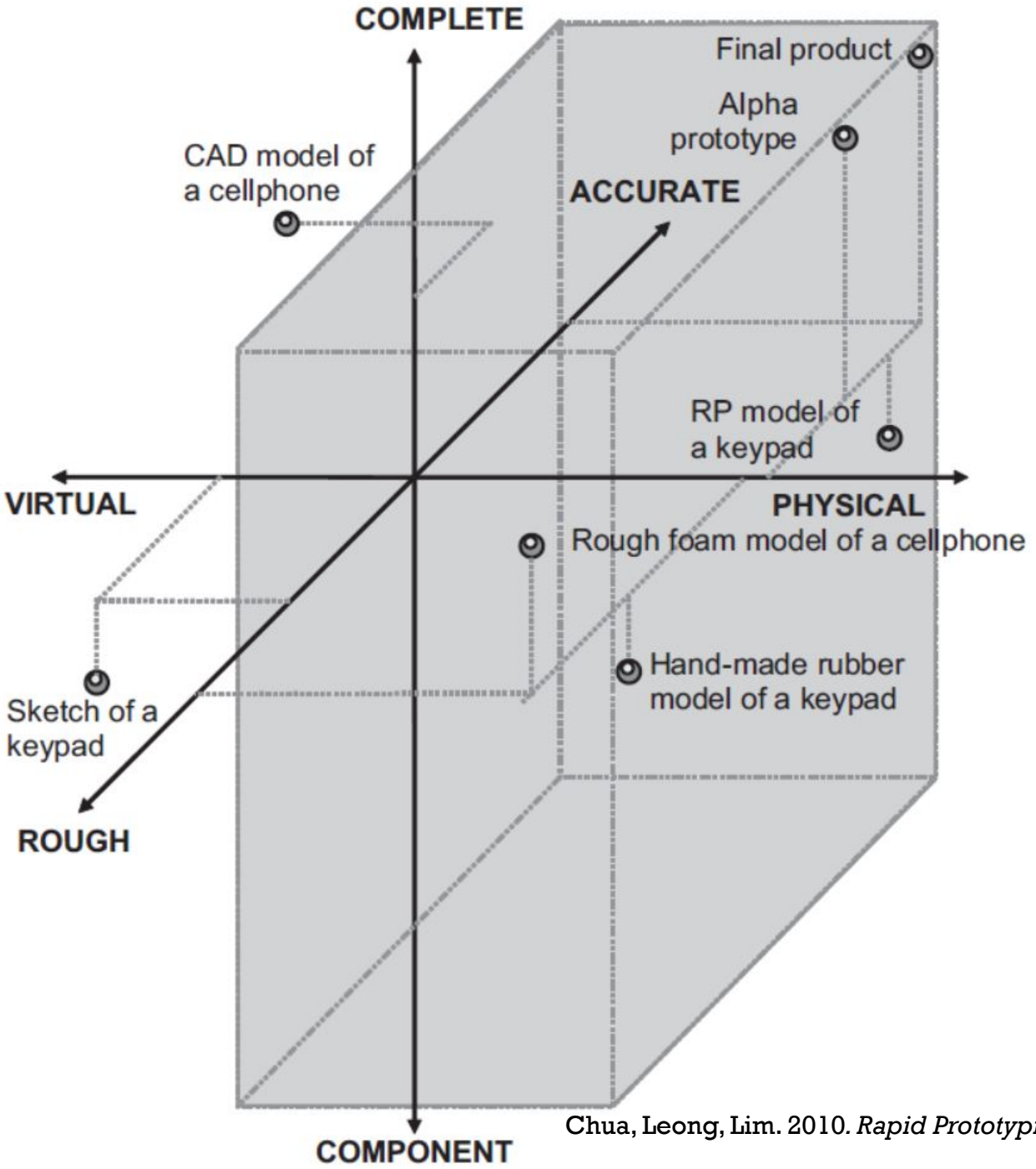






RAPID PROTOTYPING DIMENSIONS

1. Implementation
    1. Component
    2. Complete
2. Form
    1. Virtual
    2. Physical
3. Degree of Approximation
    1. Rough
    2. Accurate



Chua, Leong, Lim. 2010. *Rapid Prototyping*

PROTOTYPE ROLES

1. Experimentation and learning
   Explorative idea generation is a playful process using rapid and sequential model making as a supplement to sketches.
2. Testing and proofing
   Rapid prototyping allows testing with end users using looks alike models.
3. Communication and interaction
   --among designers, manufacturers, marketers, etc.
4. Synthesis and integration
   Parts can be tested together at low cost
5. Scheduling and markers

Chua, Leong, Lim. 2010. *Rapid Prototyping.*
Hallgrimsson. 2012. *Prototyping and Modelmaking.*

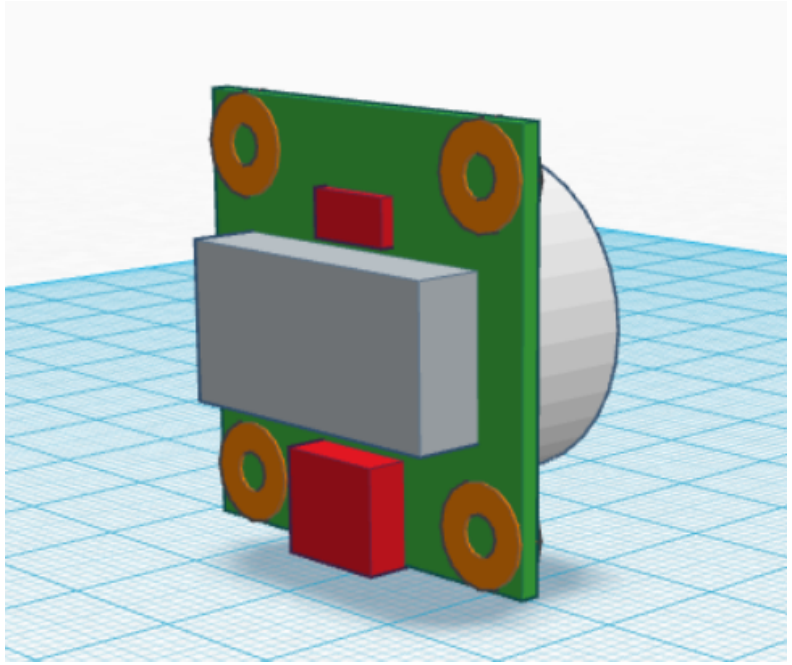
PROTOTYPING VS. MANUFACTURING

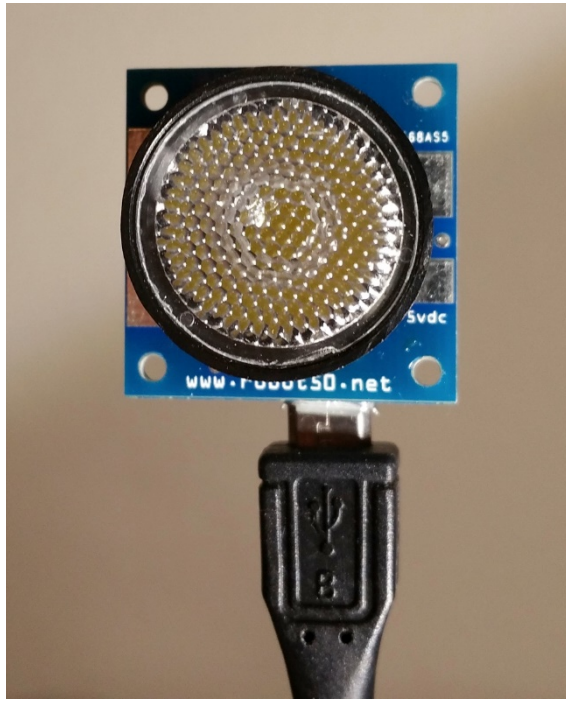
- Generally, the tools and processes of prototyping do not scale well to large volume manufacturing.
  - 3D printing, especially on consumer level machines, is extremely slow and low fidelity.
    - High-end 3D printers can manufacture small, expensive, and custom parts.
    - 3D printing has different build requirements than manufacturing techniques such as injection molding.
  - Small volume manufacturing can be done on milling and 2D machines.
  - Electronics often have to be completely redesigned for manufacture.
- But the design work and testing in the prototyping phase carry over.

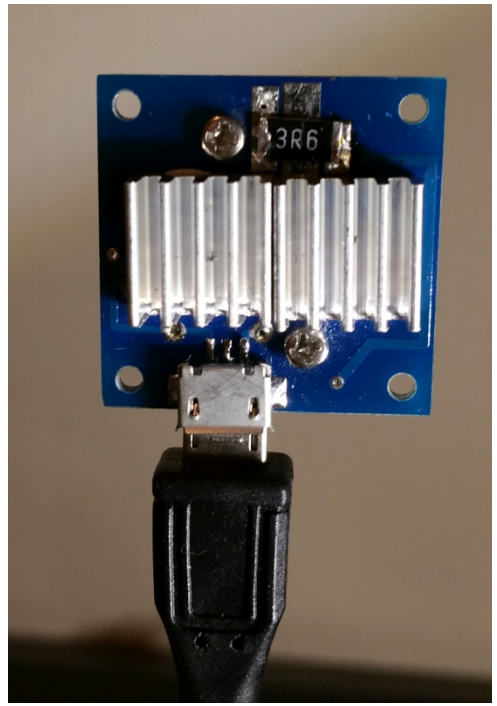
EXAMPLE: THE LED LAMP

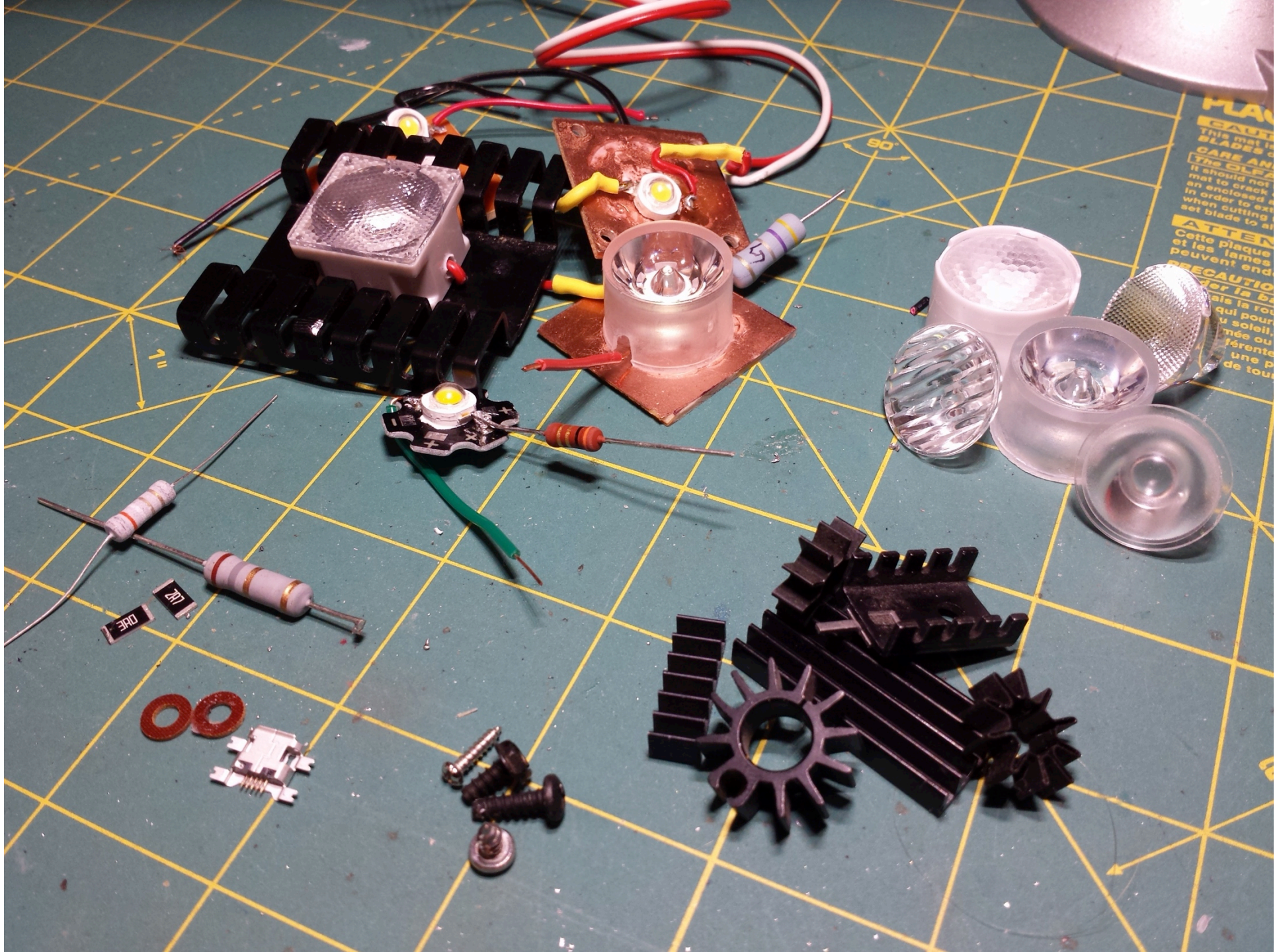
- Goal of the project: to provide 3D printer owners something functional to create with their machine.
- Product: a LED lamp module for sale and accompanying free 3D design files for printing.
- Process (for the LED module):
  - Scan for competing products
  - Paper sketches
  - 3D designed and printed looks-alike prototypes
  - Hand fabricated works-alike prototypes

- Iterating prototypes of the LED module to balance:
  1. Small size
  2. Low cost
  3. Minimal part count
  4. Design for manufacturing
  5. High light output
  6. Neutral light color
  7. Good light dispersion
  8. Appropriate power consumption
  9. Acceptable heat generation
  10. Flexibility for different applications
  11. Ease of use









- Individual prototypes were made for:
  1. Electronics schematic
  2. Component placement (switch, USB jack)
  3. Color of LED emitter
  4. Lens spread and surface pattern
  5. Heat sinks
  6. Overall size
  7. 3D printed mounting rings
  8. 3D printed lamp components