

Epoxy Problems?

Messy!



Inconsistent!





Solution?



Mixing Nozzles

14 ml Two Part Epoxy



<http://www.tigerdirect.com/applications/SearchTools/item-details.asp?EdpNo=6759210>

50 ml Two Part Epoxy



<http://www.fastenal.com/web/products/detail.ex?sku=0151173&ucst=t>

What about 25 ml Two Part
Epoxy?

EPOXY SOLUTIONS

Joe Hoyt
Lizzi Snyder
Brent Roth
Jeremy Banks

Discoveries

Two Different Cartridges



Type B
Type A

One Mixing Nozzle

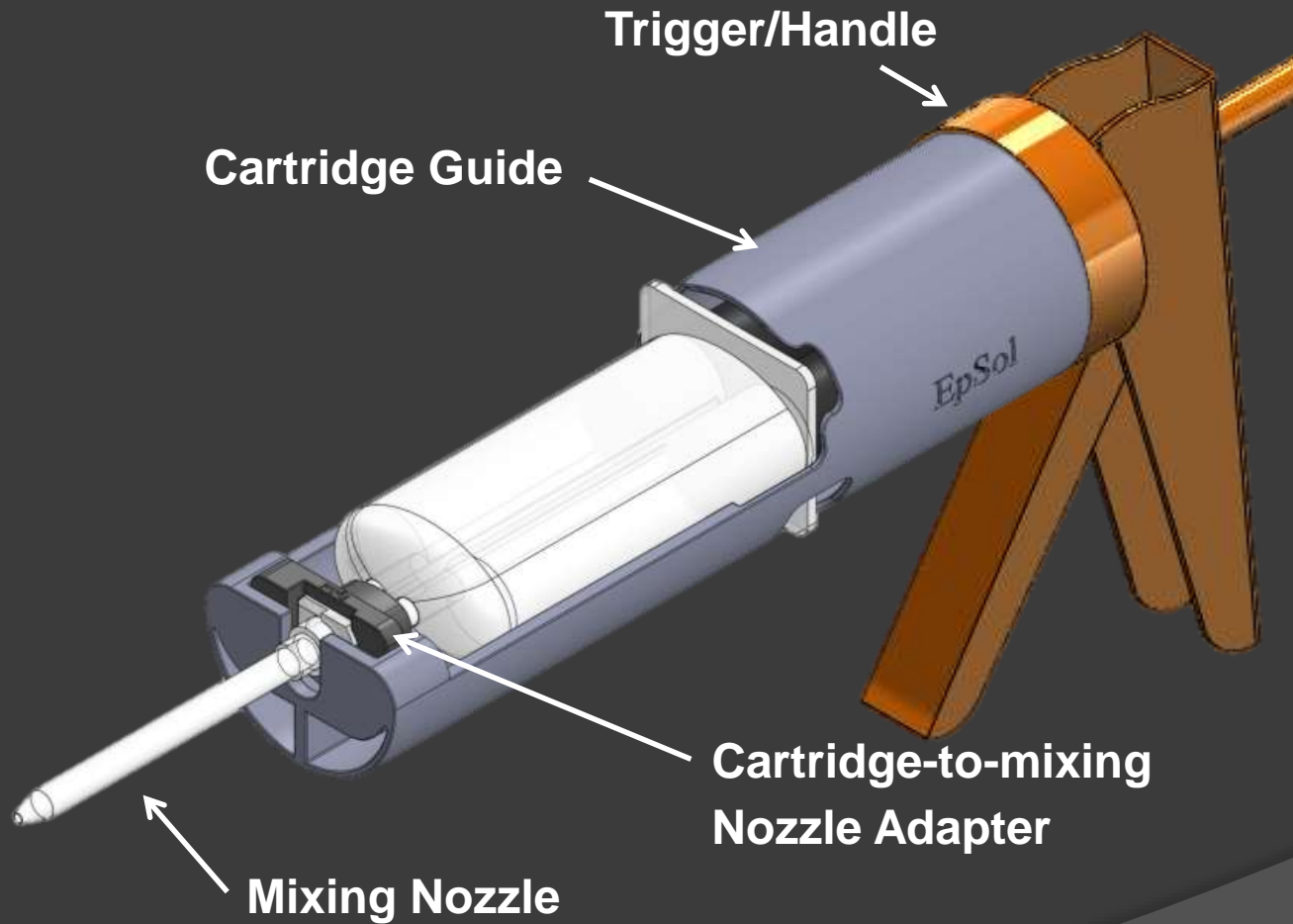
Epoxy Dispensing Device



Overview:

- ① Design Approach
- ② Modeling
- ③ Prototype Development
- ④ Compliance Testing

Design Approach



Design Approach

Mixing Nozzle?

Ellsworth Brand Nozzle



Design Approach

Trigger/Handle?

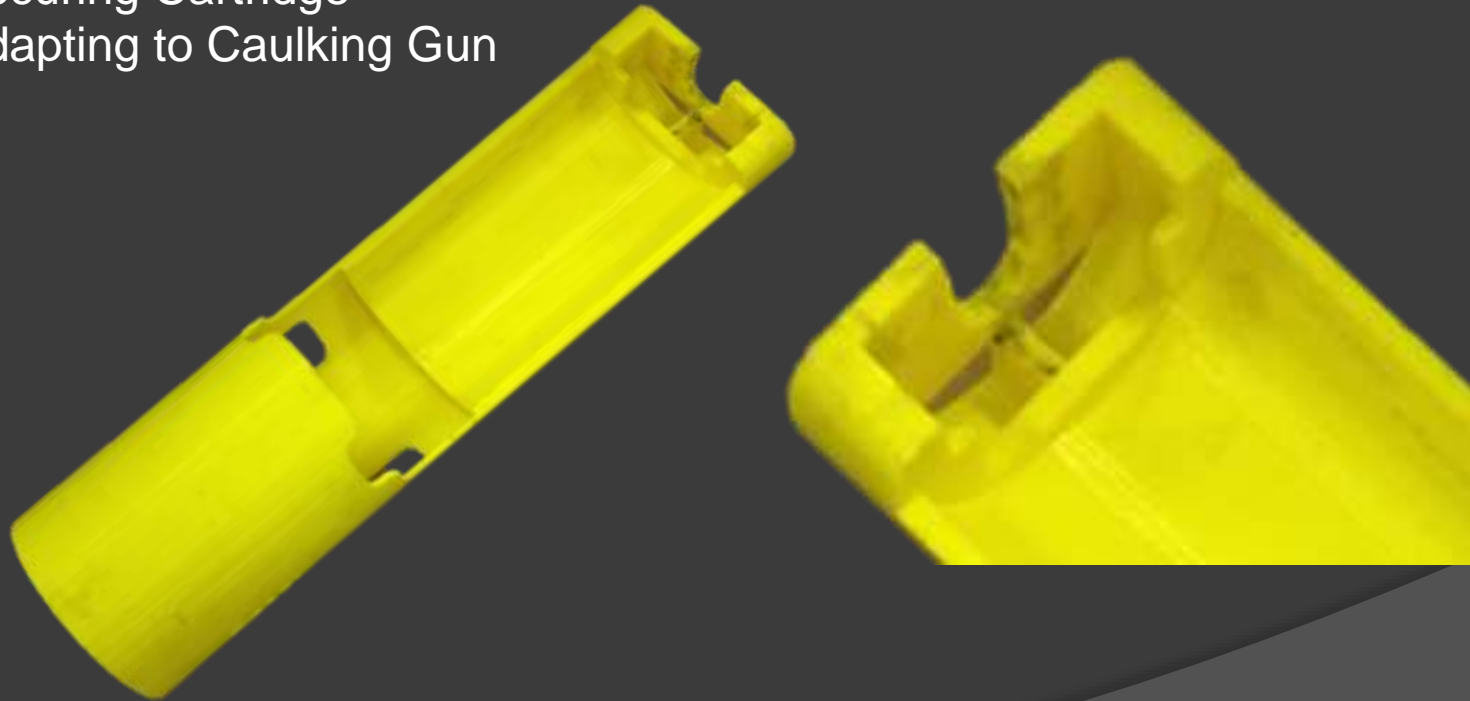
- Modify Existing Epoxy Gun
- Trigger from Scratch
- Standard Caulking Gun



Design Approach

Cartridge Guide?

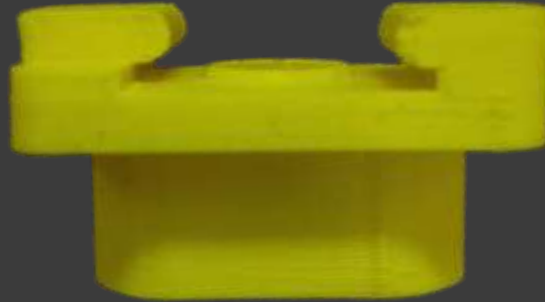
- Securing Cartridge
- Adapting to Caulking Gun



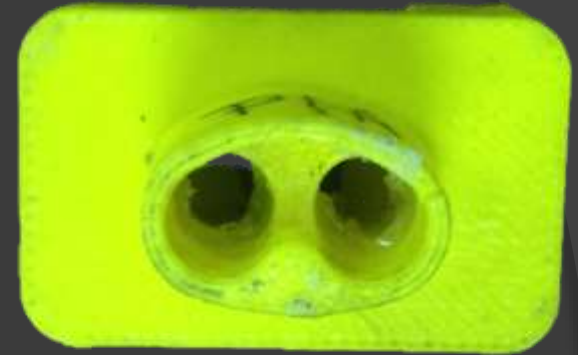
Design Approach

Adapters?

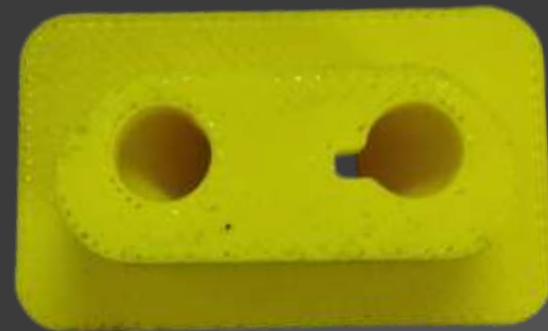
- Attached
- Detachable



Type A



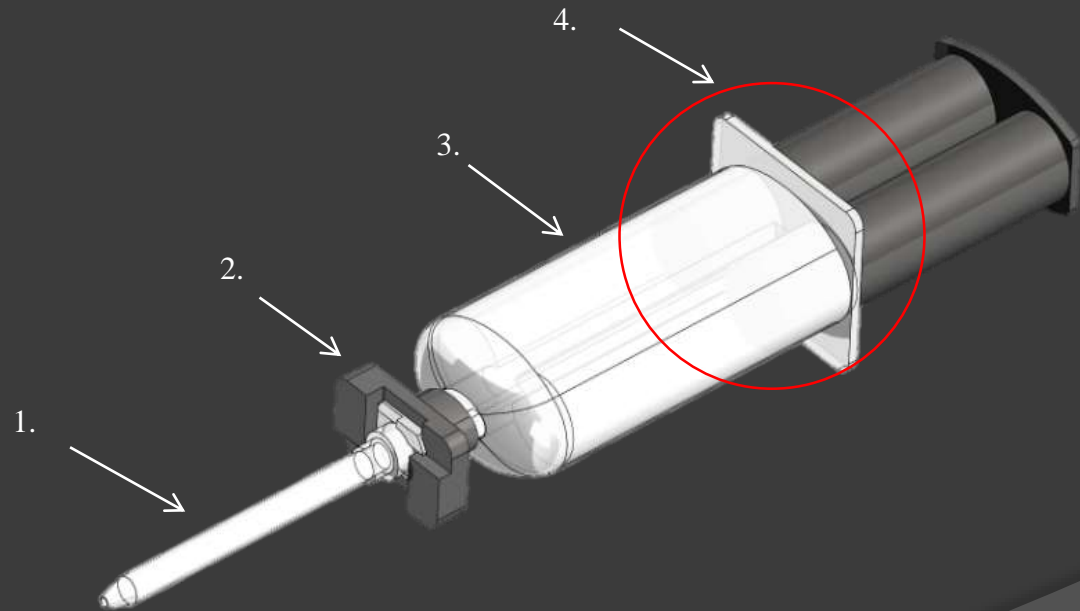
Type B



Modeling

Fluid Flow Model

1. Mixing Nozzle
2. Adapter
3. Cartridge Body
4. Plunger Head



Modeling

Fluid Flow Model

Assumptions

- Flow is fully developed.
- Flow is steady. (Not time dependent)
- Flow is laminar. ($Re \leq 2000$)
- Fluid is Newtonian.
- Fluid properties are at room temperature.

Modeling

Fluid Flow Model

Pressure Drop

1. Mixing Nozzle

$$\Delta P_{nozzle} = \frac{32\mu l V_A}{D_A^2} + \frac{1}{2} K_L \rho V_A^2$$

2. Adapter

$$\Delta P_{adapter} = \frac{1}{2} \rho V_E^2 [K_{L,area} + 2 * K_{L,elbow}]$$

3. Cartridge Body

$$\Delta P_{cartridge} = \frac{32\mu l_E V_E}{D_C^2}$$

4. Plunger Head

Experimentally Determined

Modeling

Fluid Flow Model

$$F_i = \sum \Delta P_i * A_i$$

$$F_{hf} = F_{nozzle} + F_{adapter} + F_{ff} + F_f$$

Results

- Hand Force to Move Fluid **62 lbf**

Modeling

Caulking Gun Force Model

NASA: *Human Performance Capabilities*

$$F_H = 140 \text{ lbf}$$

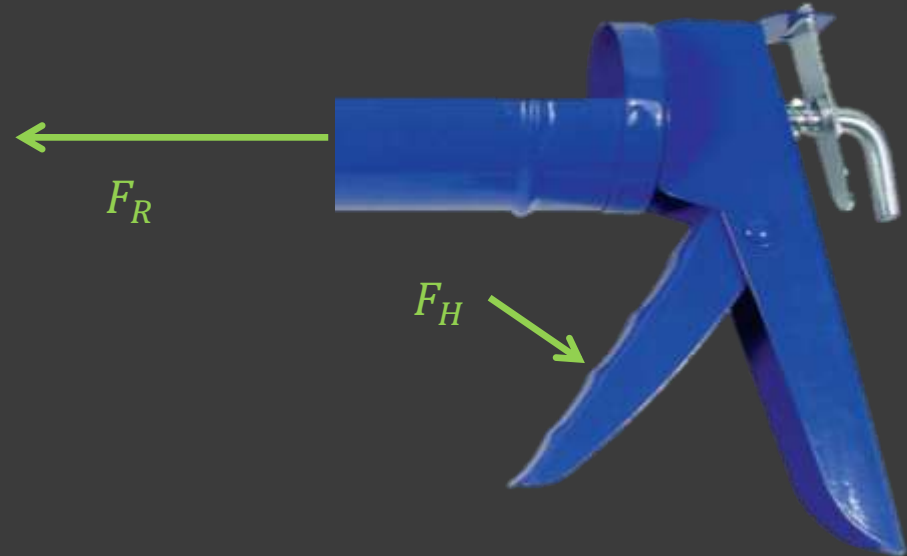
$$F_R = F_H \left(\frac{L_H}{2 \cos \theta L_R} \right)$$

Results

- Max Caulking Gun Force

260 lbf

Force Diagram



Modeling

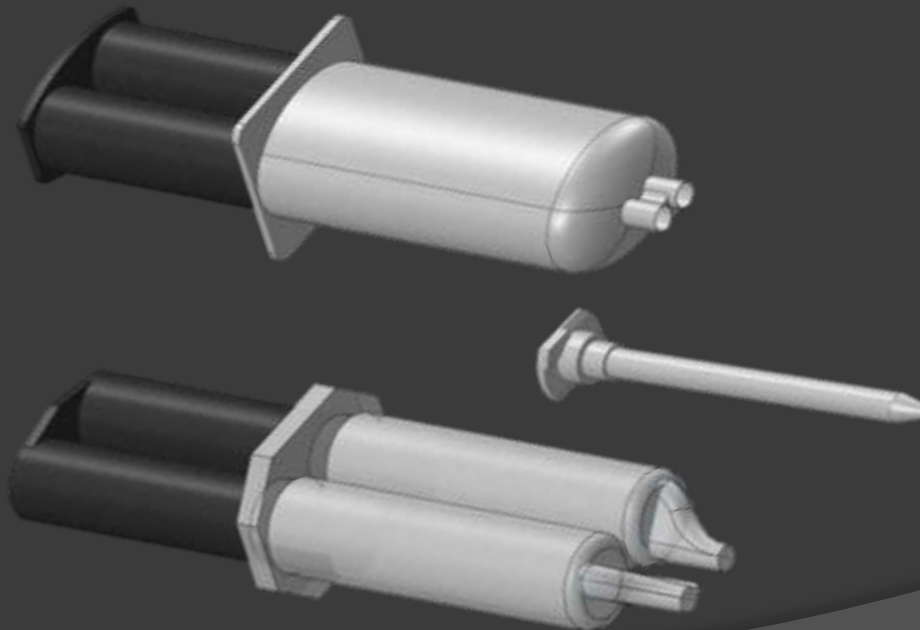
Conclusions

- Caulking Gun is sufficient to use as trigger
- Adapters were designed to the 260 lbf

Prototype Development

Steps to Final Adapter Design

- Create SolidWorks Models
- Compare SolidWorks Models to Actual



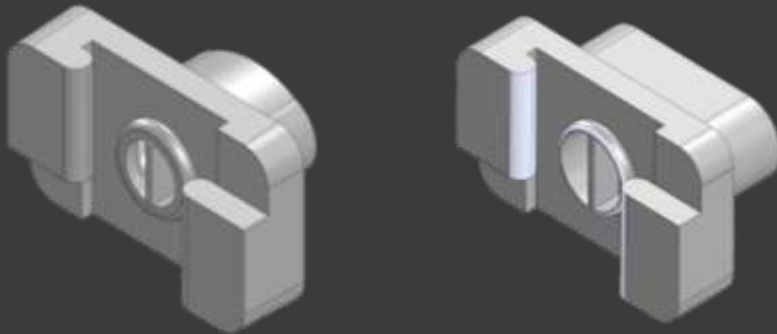
Coordinate Measuring Machine



Prototype Development

Steps to Final Adapter Design

- Design and Print Adapters
- Test For Fit and Modify Design



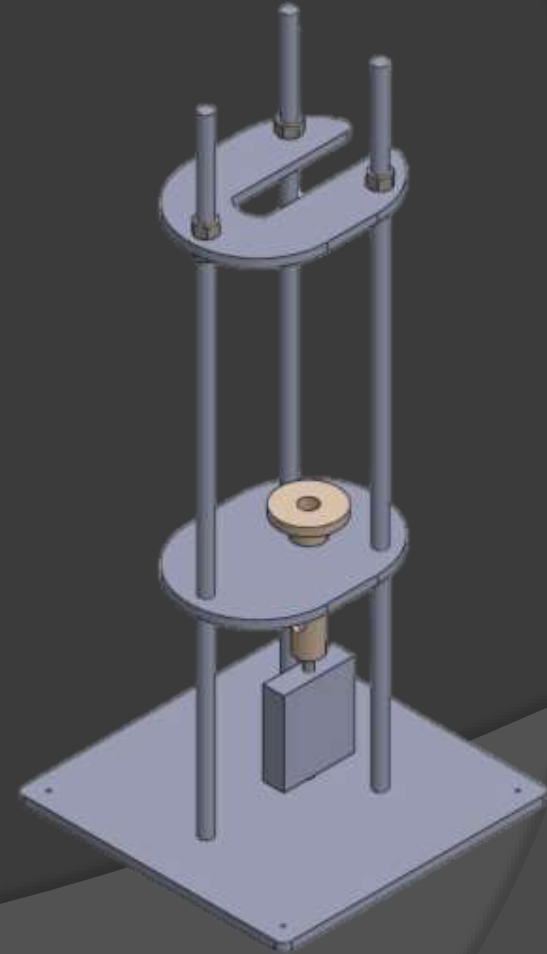
3-D Printer



Compliance Testing

Four Tests Performed

1. Caulking Gun Maximum Force Test
2. Starting Force Test
3. Fluid Force Test
4. Maximum Fluid Force Test



Compliance Testing

1. Caulking Gun Maximum Force Test

Model:
260 lbf

Testing:
 206 ± 7 lbf



Compliance Testing

2. Starting Force Test

Brand New Cartridges

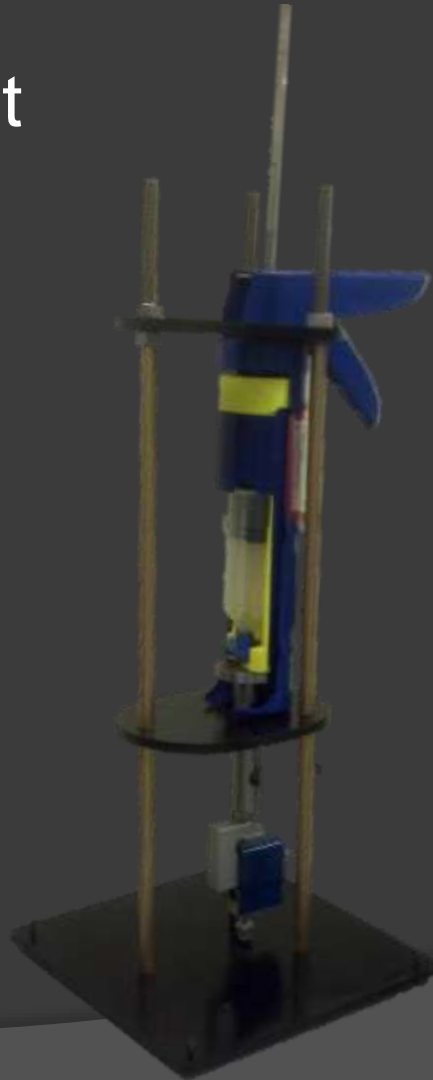
Testing:
 50 ± 8 lbf



Compliance Testing

3. Fluid Force Test

Model:
62 lbf



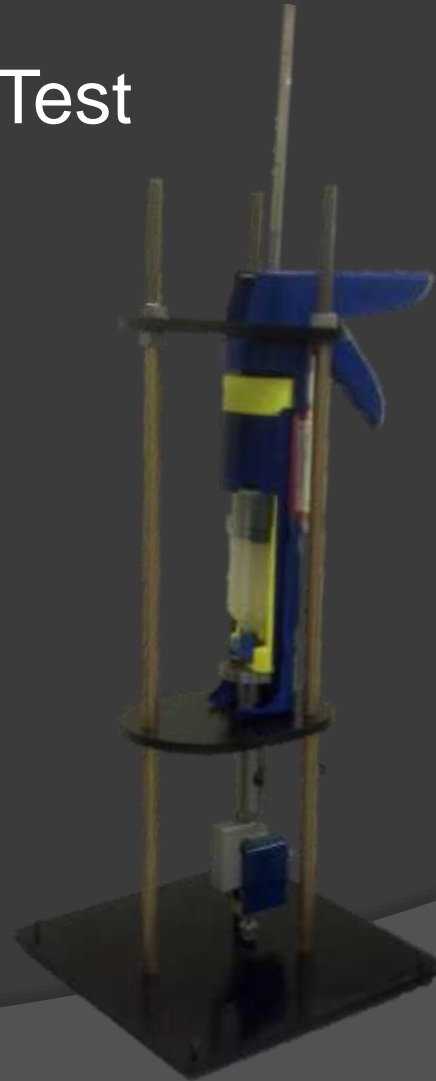
Testing: Type A
 34 ± 1 lbf

Testing: Type B
 24 ± 1 lbf

Compliance Testing

4. Maximum Fluid Force Test

Testing:
 100 ± 9 lbf



Compliance Testing

Conclusions

| Test | 1 | 2 | 3 | 4 |
|--------------|-------------|------------|------------|-------------|
| Model (lbf) | 260 | 62 | 62 | |
| Actual (lbf) | 206 ± 7 | 50 ± 8 | 34 ± 1 | 100 ± 9 |

1. Caulking Gun Maximum Force Test
2. Starting Force Test
3. Fluid Force Test
4. Maximum Fluid Force Test



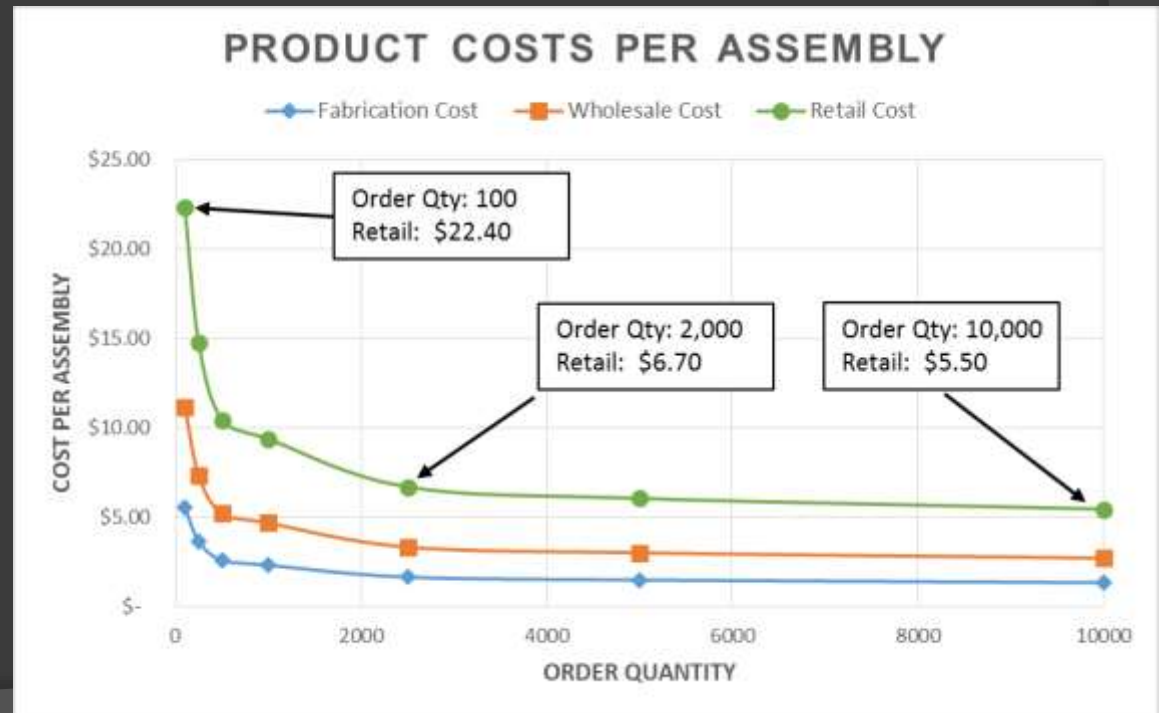
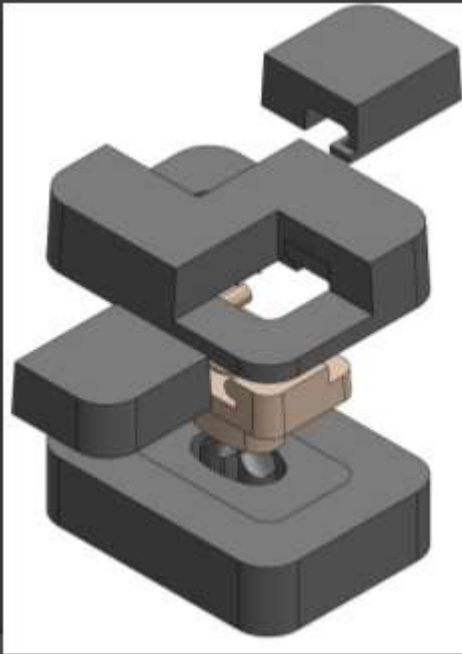
Cost Analysis

| | |
|--------------------------------------|-----------------|
| Prototype Printing: | \$150 |
| Fabrication & Shop Labor: | \$310 |
| Materials: | \$170 |
| Engineering Cost: | \$29,000 |
| Total Cost: | \$29,630 |

Product Future

1. Marketability
2. Manufacturing Process
3. Production Cost
4. Consumer Cost

Injection Molding
Mold Cost: \$10,000-\$20,000



Thank You

Sponsor: Mr. Ron Borgialli, Camworks, LLC

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Questions?