

Ergonomic Prosthetic Ear Attachment

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Outline

- Motivation for a reliable prosthetic
- Market alternatives
- Design criteria
- Design alternatives
- Selection of final design
- Testing and obstacles to overcome
- Future outlook

Motivation for Reliable Prostheses

- Observable defects are a source of psychological trauma
- Options are available to assist people with facial defects
 - Surgical reconstruction
 - Prosthetic device
 - Ear
 - Nose
 - Eye



Before



After



Before



After



Before



After

The Need for Ear Prostheses

- Physical Trauma
- Cancer
- Microtia
 - Congenital deformity of outer ear occurring in every 1 of 10,000 births
- Certain Syndromes
 - Malformed/absent outer ear, incomplete development of ear



Figure 1. Child with microtia.



Figure 2. Man with ear trauma.

Current Strategies

- Slip-on prosthesis
 - Implant not used
 - Not secure
- Magnet-abutment cap techniques
 - Attachment not secure
- Bar-clip method
 - Difficult to clean under
 - Can become loose or get bent
 - No absolute measure of security



Figure 1. Slip-on prosthesis.



Figure 2. Magnet-abutment cap technique.



Figure 3. Bar-clip method.

Prior Course Projects

- Spring and sheath – Fall 2009
 - Provides lateral stability
 - Use of spring decreases odds of sheath fracture
 - Sheath allows for easy attachment/detachment
 - Lacks magnets
 - Silicone can leak into spring and sheath
- Prong and flange – Fall 2008
 - Made from plastic
 - Ear must be rotated – implants must be perfectly aligned
 - Secure attachment



Figure 1. Spring and sheath design.

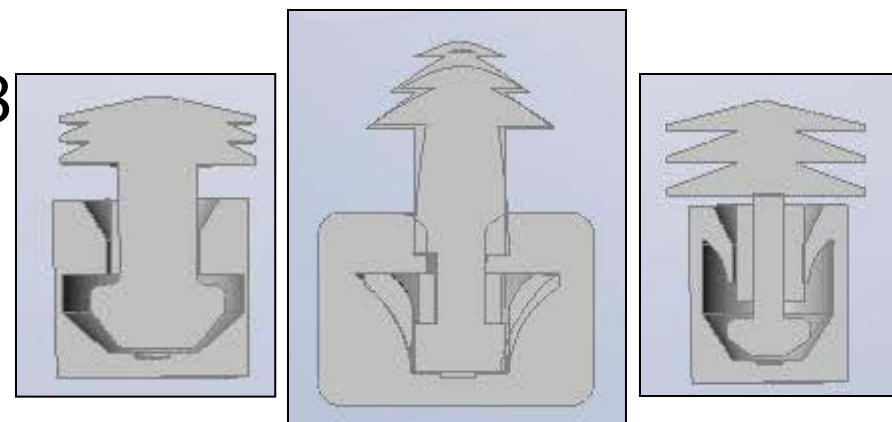


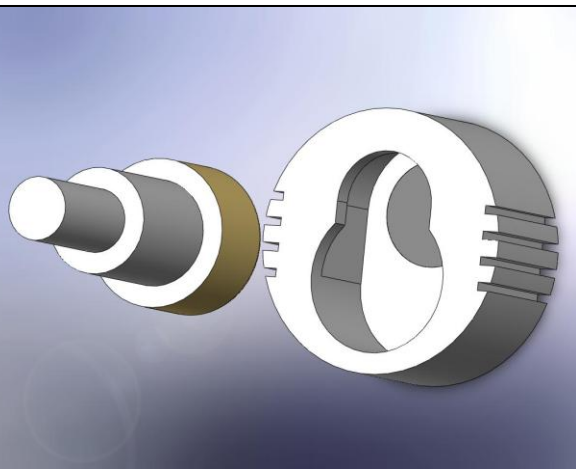
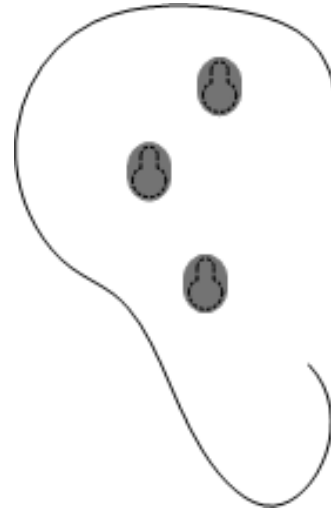
Figure 2. Prong and flange design.

Design Criteria

- Resists unintentional dislodgement
- Is low profile
- Contained within the prosthesis
- Withstands anterior and posterior forces
- Fits current abutment sizes – 4.4 mm diameter
- Requires minimal effort to remove and attach
- Is easy to clean
- Fabricated from titanium or stainless steel

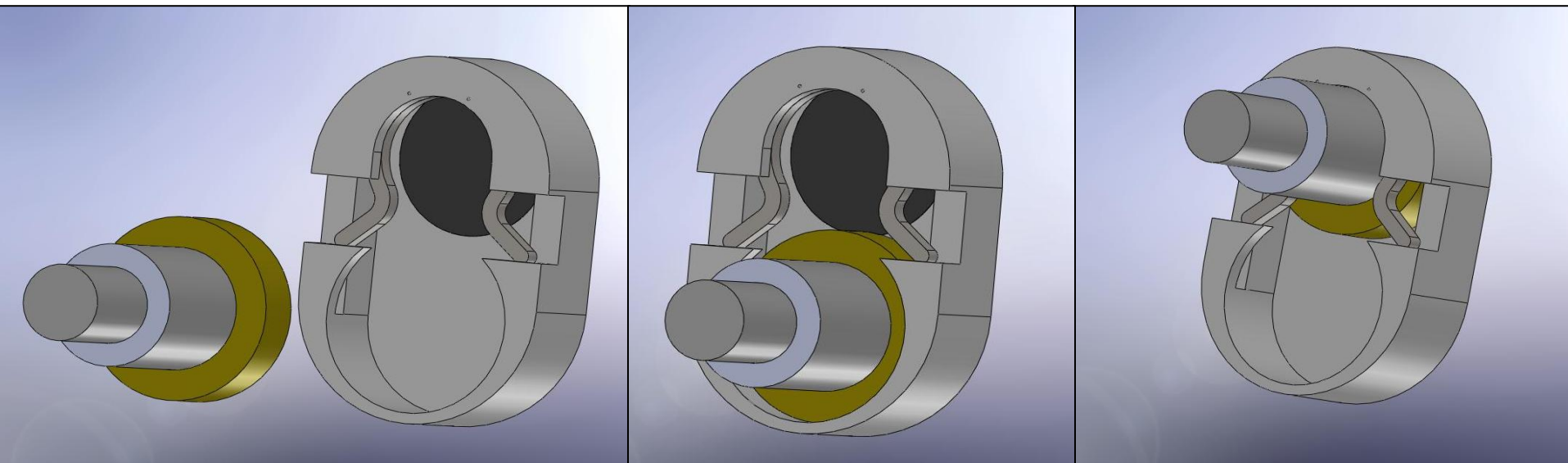
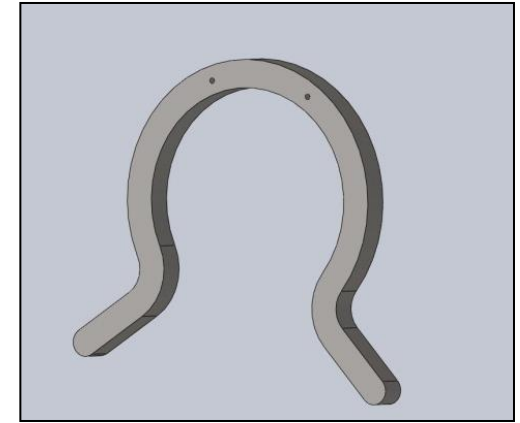
Vertical Track Design

- Three vertical tracks positioned in prosthesis
- Stainless steel or titanium
- Secured using:
 - Lips of the track
 - Gravity
 - Magnets



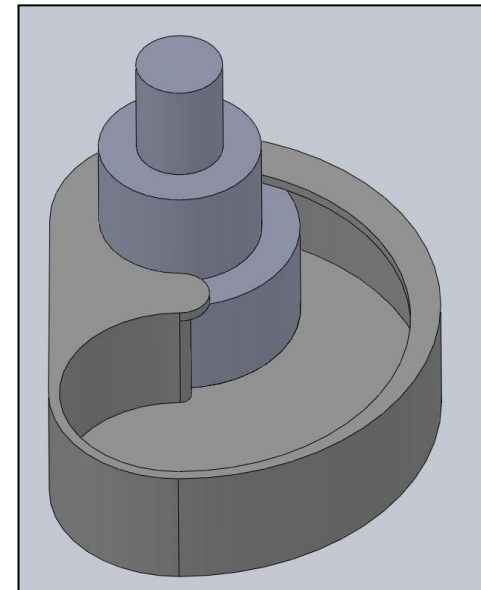
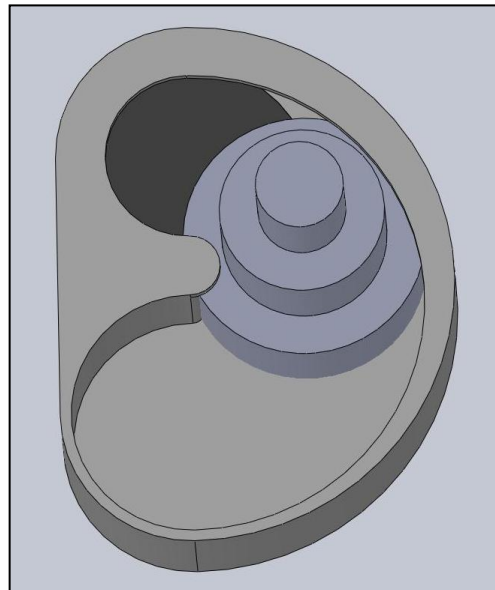
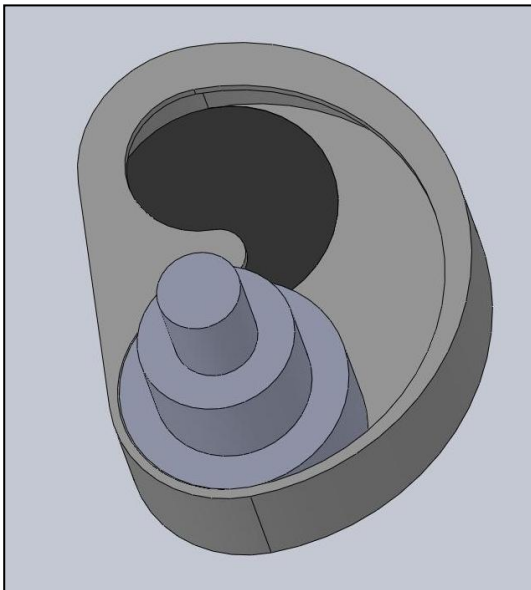
C-Ring Attachment Design

- Same concept as vertical track design
- Added replaceable C-retaining ring
- Added attachment security compared to free track



Curl Track Design

- User moves ear in semicircle motion onto abutment
- More secure attachment than current magnets
- Attachment and removal process is more complicated
- Track is too large for small space available



Evaluation of Design Alternatives

Criteria	Vertical Track	Curl Track	C-Ring
Quality of Attachment (30)	25	27	27
Ease of Attachment (20)	17	13	16
Ease of Removal (20)	18	16	15
Ease of Cleaning (15)	14	14	12
Feasibility (10)	6	3	5
Cost (5)	4	3	2
TOTAL	84	76	77

Testing of Device

- Mold attachment devices in silicone ear
- Determine if they fit spatial requirements
- Repeat attachment and detachment to test durability of materials and design
- Test lateral and vertical forces with force gage



Where will we go from here?

- Fabrication
 - Device will be extremely small
- Alignment of attachment and abutments
- Implantation in silicone
 - Primed titanium/stainless steel
 - Plastic sheath
- Force testing
 - Safety breakage
 - Attachment quality
- Reduce attachment visibility
 - Conceal slot
 - Reduce size



Questions?