Dead-Blow Hammer for Orthopedics

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Presentation Overview

I. Problem statement/background knowledge
II. Design specifications from client
III. Three preliminary designs
IV. Design matrix
V. Future work

Problem Statement

- Orthopaedic surgeries involving joint replacement take a lot of force to perform effectively
- Want to find a way to…
  - Limit blowback from the hammer when striking the target
  - Increase the amount of force generated by a single strike with the same swing velocity

Figure 1: Coronal (left) and sagittal (right) views of a knee replacement [1].

Dead Blow Hammer

- Primarily used in the construction industry [2]
  - Minimize damage to the struck surface
  - Allow one to help control their striking force
  - Produce minimal rebound comparatively
- This device has not been utilized effectively in the medical industry yet
  - Several patents currently exist
- Orthopaedic surgeries currently use a “surgical hammer” for large joint replacements (i.e. knee, hip, etc.) [3]

Figure 2: Dead-blow hammer for construction and manufacturing (top) [2] and orthopedic mallet (bottom) [3].

Product Design Specifications

- Lightweight (1-2 lbs): limit physical stress of surgeon while swinging [4]
- Able to exert 30 kN for the intended surgery [5]
- Able to withstand 40 kN of force without breaking [5]
- Limit recoil upon impact compared to current mallets
- Must not leak beads/shot onto the surgical area [6]
- Able to withstand the autoclave sterilization process (121℃) [7]
- Materials of the device must not interfere with the patient's biological systems
- FDA rule set by Code of Federal Regulations Title 21, Sec. 878.4800 [8]
- Must be produced for less than $300 [9, 10]

Design Concepts

Design 1: The Piston

- Solid dead-blow design
  - Solid ring
  - Travels along a rod
- Handle welded on
- Non-replaceable pieces

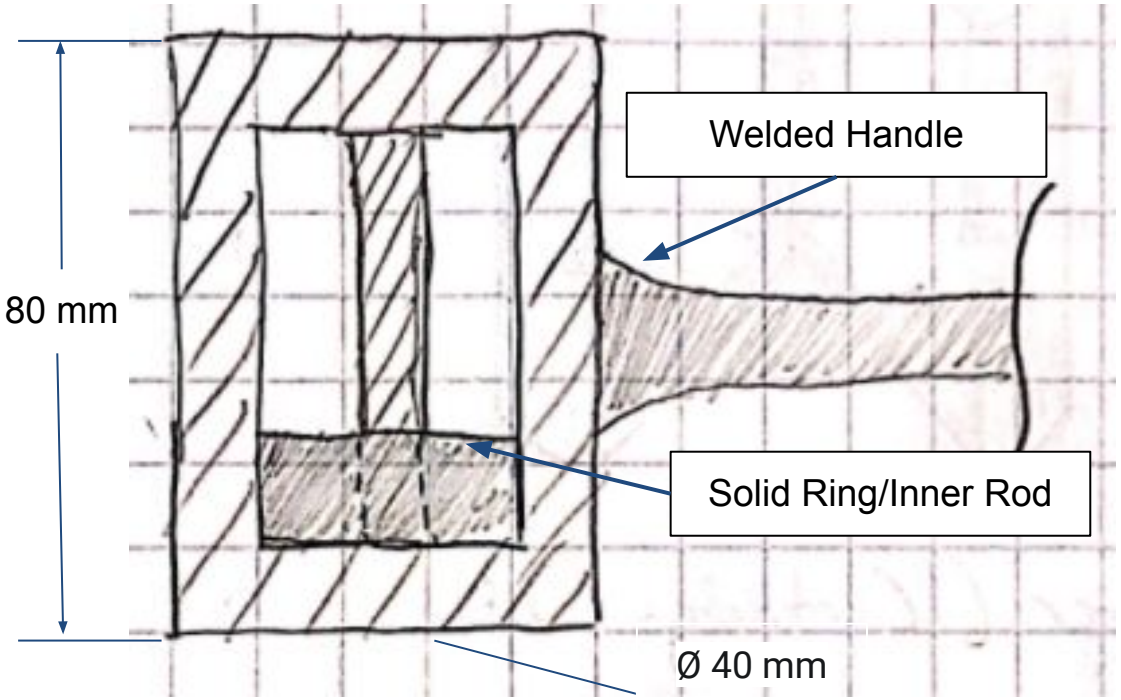


Figure 3: Hand-drawn design of an orthopedic dead-blow mallet using a solid ring and guiding rod.

Design 1: The Piston

Pros

- + Increased safety (no loose beads)
- + Easy to sterilize

Cons

- - Difficult to Fabricate
- - Damage requires replacement of whole mallet
- - Requires direct blow

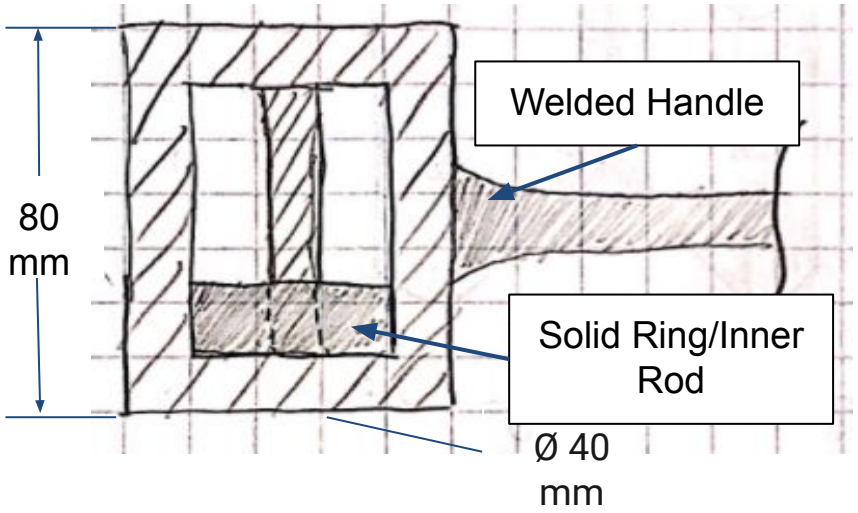


Figure 3: Hand-drawn design of an orthopedic dead-blow mallet using a solid ring and guiding rod.

Design 2: Fully Replaceable

- Replaceable caps and handle
  - Large threads
- Metal beads for dead-blow effect
- Flexible Inner casing

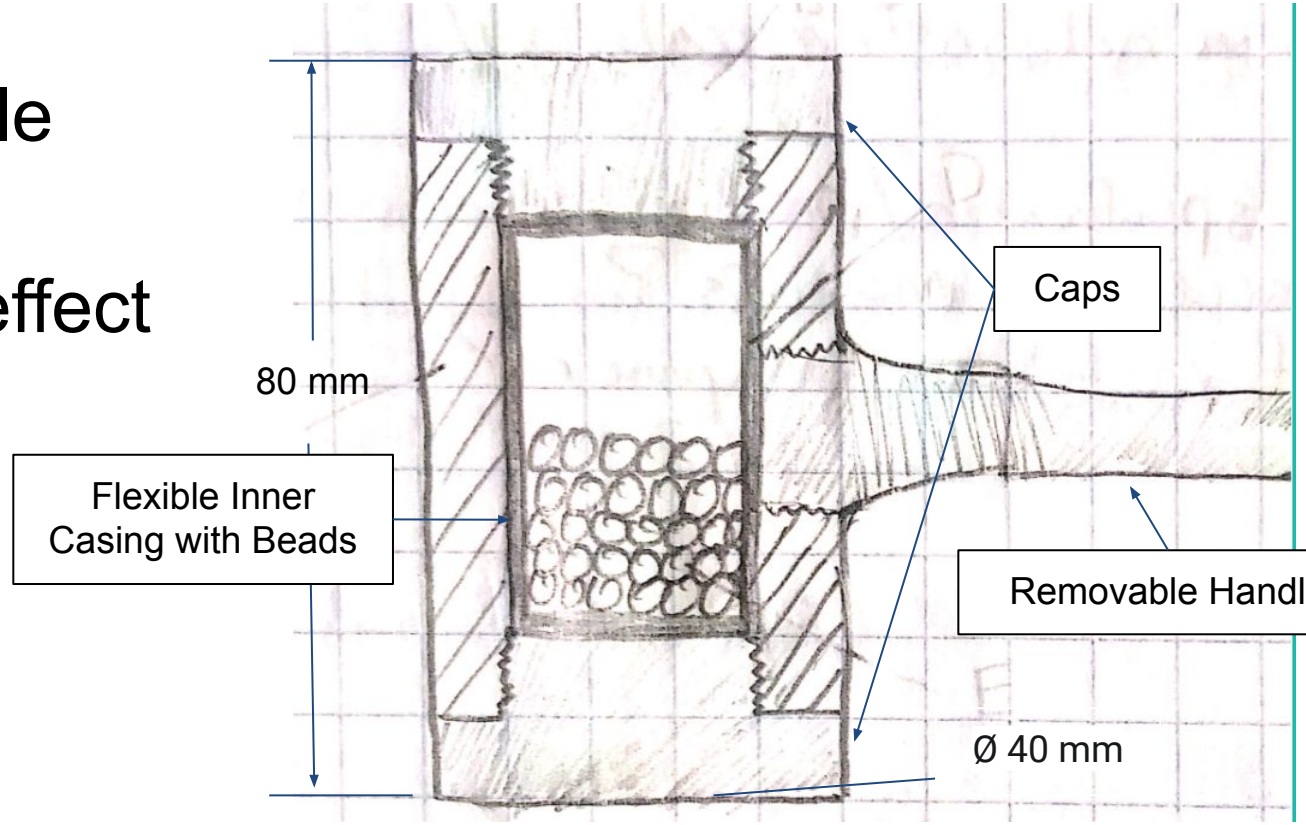


Figure 4: Hand-drawn design of an orthopedic dead-blow mallet with fully replaceable parts and metal bead media.

Design 2: Fully Replaceable

Pros

- + Replaceable pieces when damaged
- + Easier to fabricate in pieces
- + Different materials for caps/handles
- + Safety from inner casing

Cons

- - More difficult to sterilize
- - Possible bacteria growth/rust at threads
- - Weak points in handle threads

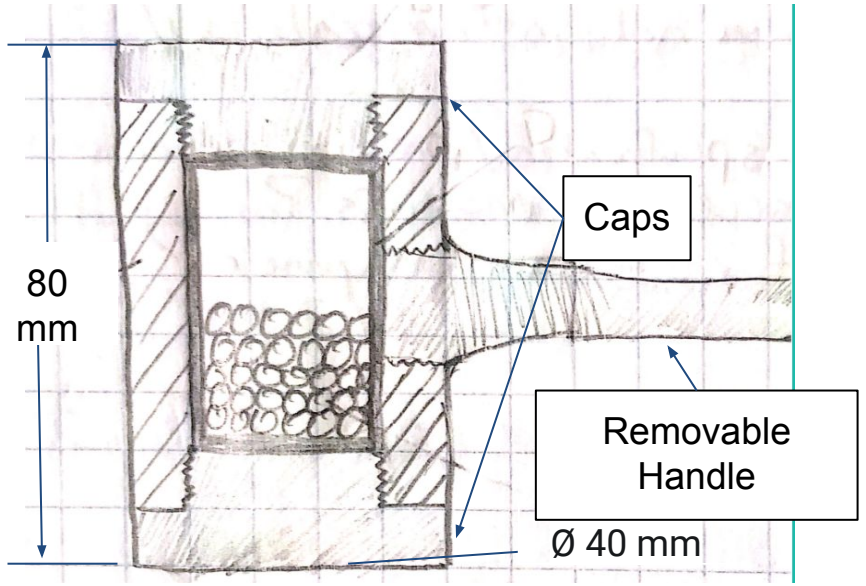


Figure 4: Hand-drawn design of an orthopedic dead-blow mallet with fully replaceable parts and metal bead media.

Design 3: Replaceable Caps

- Replaceable caps only
  - Large threads
- Welded handle
- Metal beads for dead-blow effect
- Flexible Inner casing

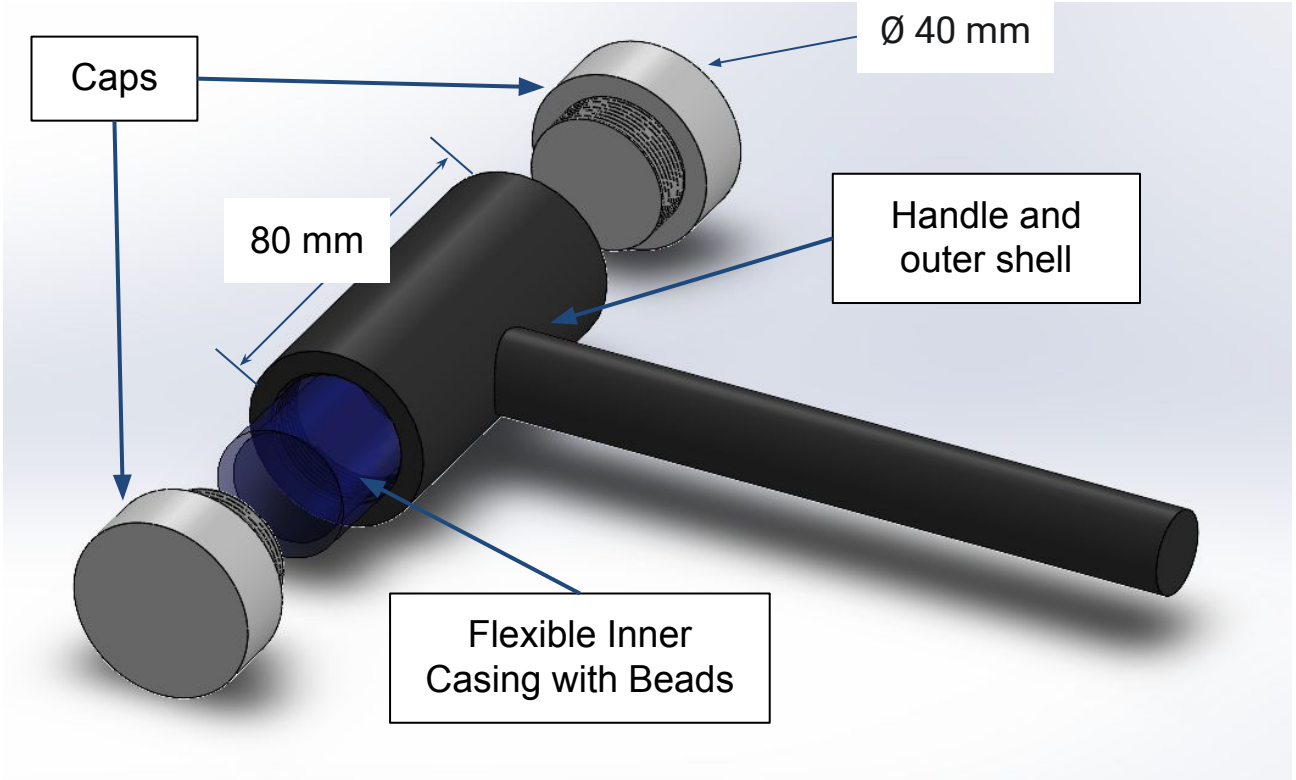


Figure 5: Orthopedic mallet design with replaceable caps, welded handle, and a flexible inner casing with metal bead media. Designed in Solidworks.

Design 3: Replaceable Caps

Pros

- + Replaceable caps when damaged
- + Easier to fabricate in pieces
- + Different materials for caps/handles
- + Safety from inner casing

Cons

- - More difficult to sterilize
- - Possible bacteria growth/rust at threads

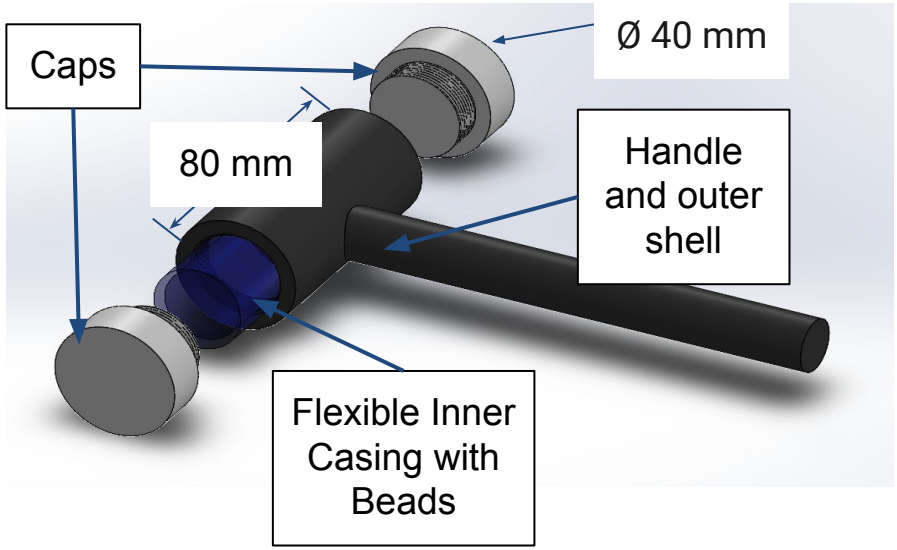
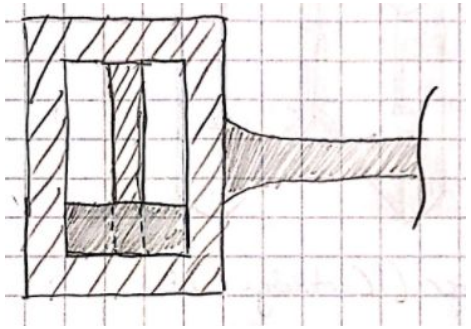
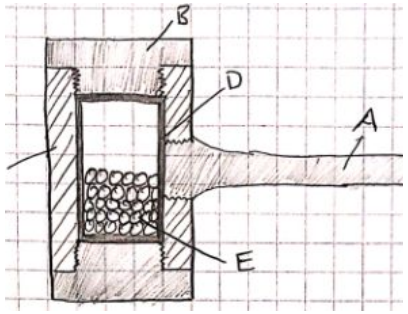
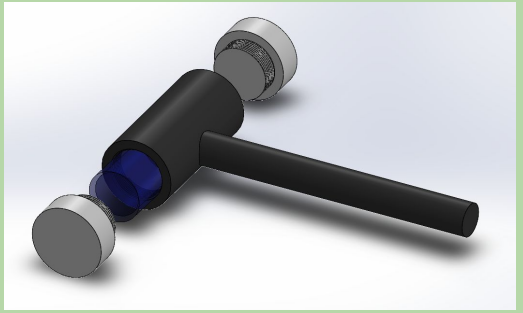
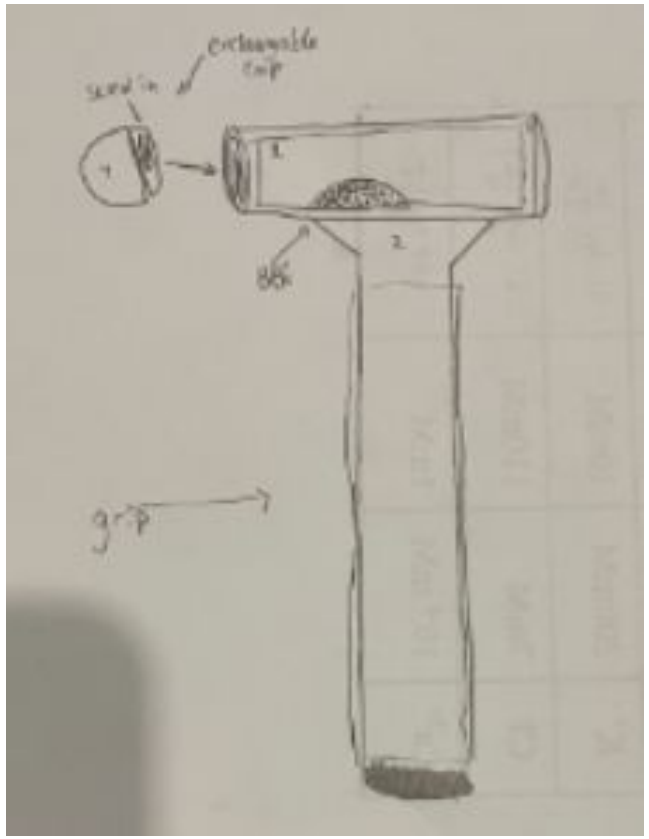


Figure 5: Orthopedic mallet design with replaceable caps, welded handle, and a flexible inner casing with metal bead media. Designed in Solidworks.

Design Matrix

Criteria (Weight)	Design 1: The Piston 		Design 2: Fully Replaceable (with Inner Casing) 		Design 3: Replaceable Caps (with Inner Casing) 	
Durability (25)	2/5	10	5/5	25	4/5	20
Effectiveness (20)	2/5	8	5/5	20	5/5	20
Safety (15)	5/5	15	3/5	9	4/5	12
Ergonomics (10)	3/5	6	4/5	8	4/5	8
Cost (10)	4/5	8	2/5	4	3/5	6
Ability to be sterilized (10)	5/5	10	2/5	4	3/5	6
Ease of fabrication (5)	4/5	4	3/5	3	4/5	4
Total 100	61		73		76	

Final Design



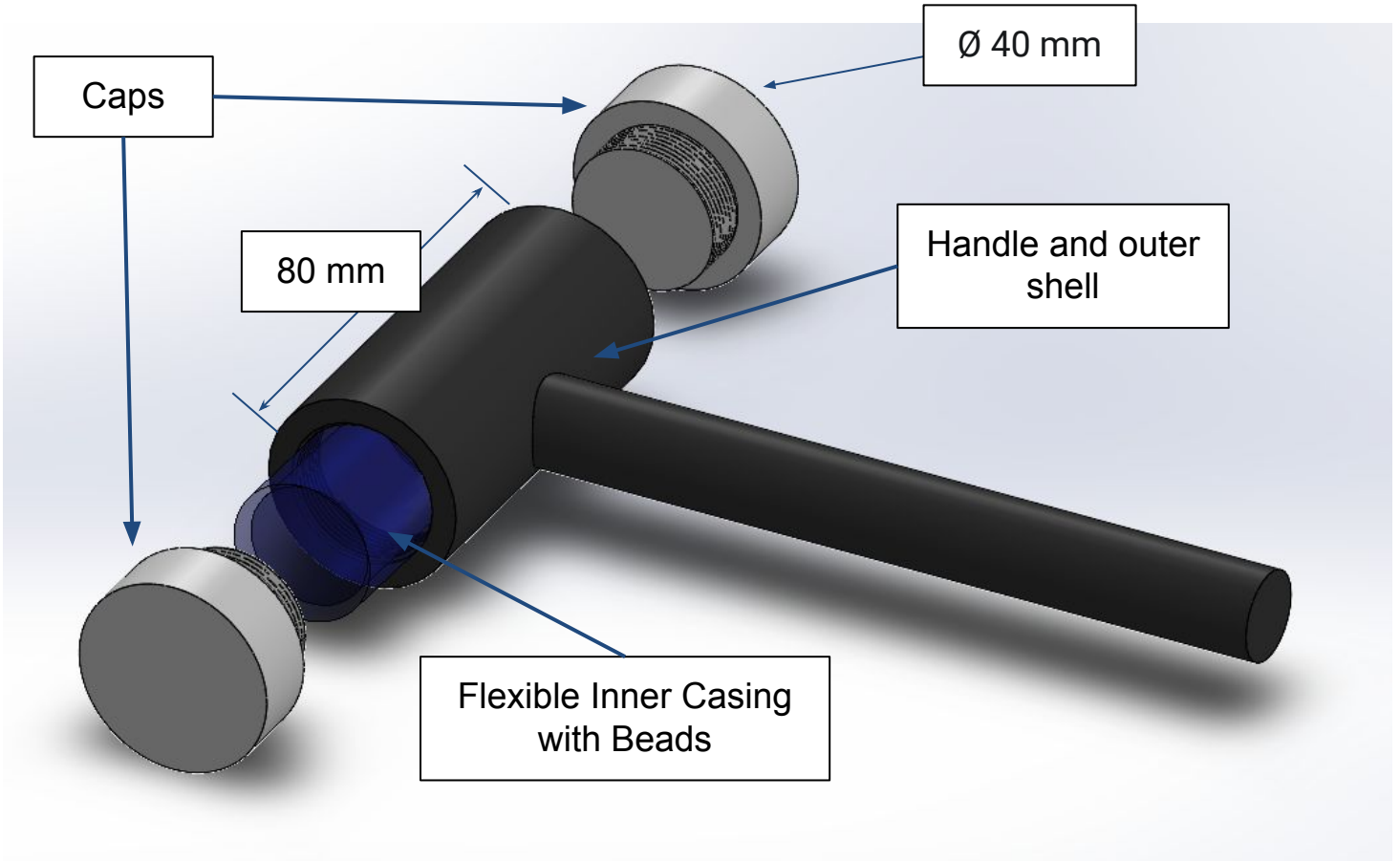


Figure 5: Orthopedic mallet design with replaceable caps, welded handle, and a flexible inner casing with metal bead media. Designed in Solidworks.

Future Work

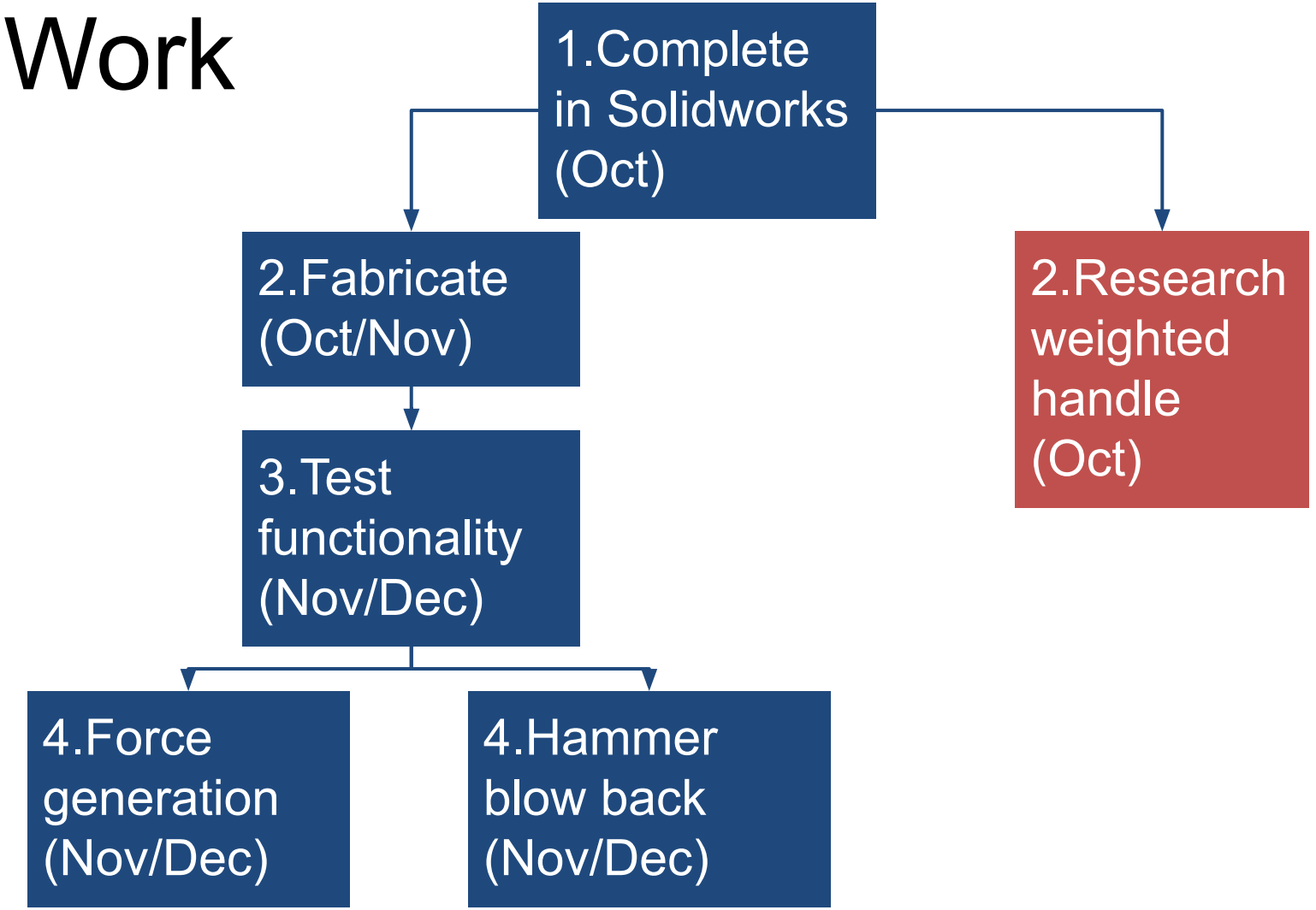


Figure 6: Flowchart of future work for the dead-blow mallet in orthopedics.

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Questions?