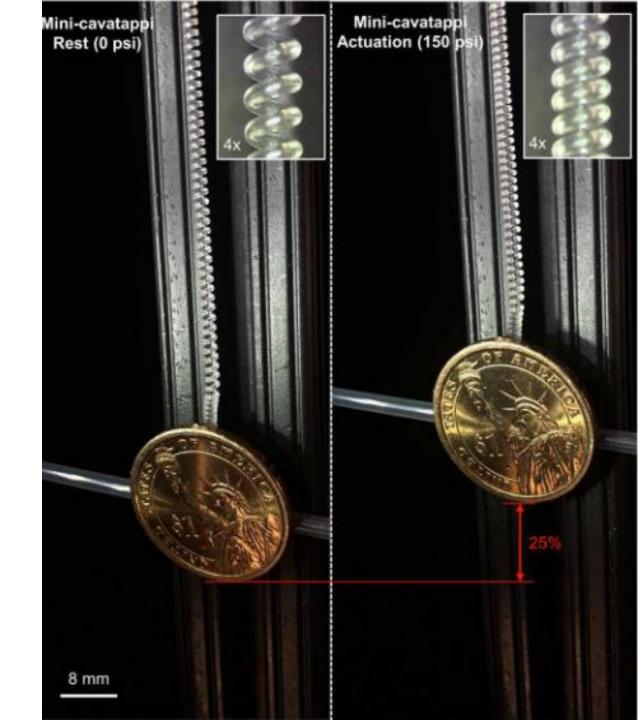
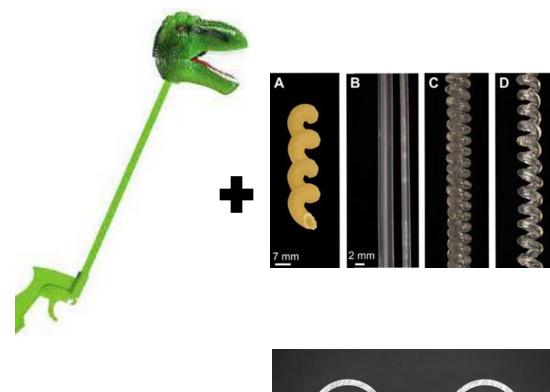
# MINI-CAVATAPPI ACTUATED LAPAROSCOPIC TOOL

By: Ann Lester, James Bennett, Ryn Shuster





# **PROJECT DESCRIPTION**

- Our Project:
  - To design a scaled down mechanical hand powered by Cavatappi muscle actuation
    - Must be able to pick up a coin from a flat surface
    - Has multiple independent degrees of actuation



Figure 1:: Project Description graphic

Ann, Team Cavatappi

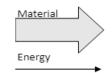
### UPDATED GANTT

			2 23 2 V T	24 25 20 F S S		8 29 3 W	30 1 T F	2 3 S S	<b>4</b> 5 M	56 TW	7 8 T F	9 ' S	10 11 S M	<b>12</b>	<b>13 14</b> W T	15 16 F S	6 17 S S	18 19 M T	<b>20</b> W	21 22 T F	2 23 S	5 26	27 W	28 2 T F	9 30 S	31 S	12 M T	3 W	4 5 T F	6 S	78 5 M	9 T	<b>0 11</b> W T	<b>12</b>	<b>13 14</b> S S
Cavatappi		52%																																	
Capstone Project Selection		100%																																	
<ul> <li>Charter Drafting/Role Assignment</li> </ul>		100%																																	
Presentation 1		100%																																	
Peer Evaluation		100%																																	
<ul> <li>Manufacturing Practice</li> </ul>		100%																																	
► Self-Learning		100%																																	
Presentation 2: Concept Gen./Eval.		100%																																	
▼ Beginning of Concept Testing		0%																																	
3D Print Model		0%							3D F	Print Mo	odel																								
Muscle Bundle		0%							Mus	cle Bur	ndle																								
▼ Preliminary Report		0%																																	
Background	Ann	0%							Bac	kgroun	d																								
Requirements	James	0%							Req	uireme	nts																								
Design Space Research	James	0%							Des	ign Spa	ice Res	earch																							
Benchmarking	Ann	0%								Be	nchma	rking																							
Functional Decomposition	Ann	0%								Fu	nctiona	l Decor	mpositi	ion																					
Concept Generation	James, Ryn	0%											Co	oncept	Ge																				
Design Selection	James, Ryn	0%											De	esign S	Sele																				
Rationale for Design	Ryn	0%											Ra	ational	e for																				
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# PROJECT DESCRIPTION (CONT.)

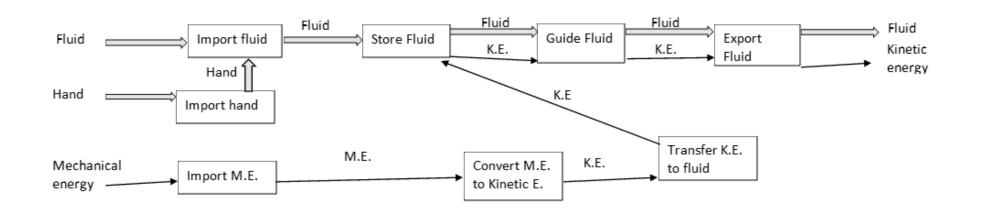
Material

Energy









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### DATUM

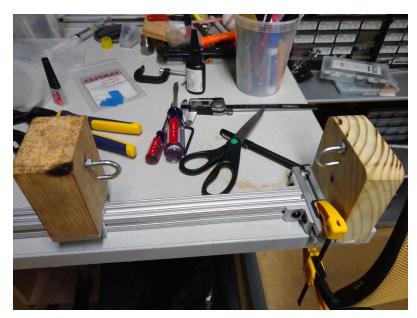


Figure 2: Current Coiling setup



Figure 3: Current Heating setup



Figure 3: Current Clamps

## CONCEPT GENERATION-MECHANICAL HAND

Criteria	Datum (Farman	<b>F</b> inana anila	Finana Tin aning	Tournat			Rubber Finger	Flashu Usad	Diagon	Flouible Jainte -	Thumb muscle
Criteria 💌	Datum (Forcep	Finger nalis	Finger Tip grips 🔻	Irumpet 💽	Capsule 💌	Fingers 💌	Tips 💌	Fleshy Hand	Pincer 💌	Flexible Joints	pattern 💌
A-Aesthetic	Same	Inferior	Exceeds	Exceeds	Exceeds	Inferior	Same	Exceeds	Same	Same	Inferior
B-Reliability	Same	Exceeds	Exceeds	Inferior	Same	Inferior	Exceeds	Exceeds	Exceeds	Inferior	Exceeds
C-Degrees of freedom	Same	Same	Same	Exceeds	Same	Same	Same	Same	Same	Exceeds	Exceeds
D-Ease of Construction	Same	Exceeds	Inferior	Inferior	Same	Inferior	Exceeds	Inferior	Same	Inferior	Inferior
SUM Exceeds	0	2	2	2	1	0	2	2	1	1	2
SUM Inferior	0	1	1	2	0	3	0	1	0	2	2
SUM Same	4	1	1	0	3	1	2	1	3	1	0

### CONCEPTION GENERATION-MECHANICAL HAND

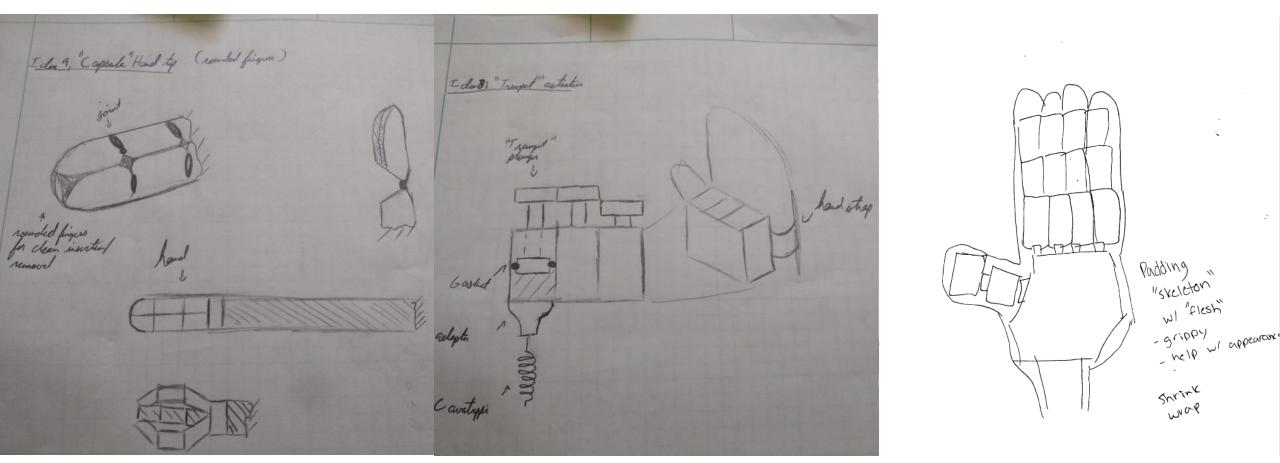


Figure 5: Sample Hand Concept 1

Figure 6: Sample Actuation Concept

Figure 7: Sample Hand Concept 2 Ann, Team Cavatappi

### CAVATAPPI MANUFACTURE: PUGH CHART

		Annealing							Clamping						
Criteria	Datum Values	Resistive Heating Element	Current Heating Method with Larger Rack	Sous-Vide Heating	Annealing Mandrel Stand	Respool Precoiled Tubing	Reusable Mandrel Design	Perpendicular Spooling Method	Double- Motor Method	Auto- Adjusting Mandrel Mount	Navajo String- Coil Method	Carrier Held Mandrel	Updated Clamp Ideas	Workout Clamp	Alligator Clamp
A-Scalability of Muscle	10 - 90 mm	Exceeds	Exceeds	Same	Same	Same	Exceeds	Exceeds	Same	Inferior	Exceeds	Exceeds	Exceeds	Same	Exceeds
B-Reliabity of System	40%	Exceeds	Same	Exceeds	Same	Exceeds	Exceeds	Exceeds	Inferior	Exceeds	Same	Same	Exceeds	Same	Exceeds
C-Flexibility of System	#coils /cm, coil diam.	Exceeds	Exceeds	Exceeds	Exceeds	Inferior	Same	Exceeds	Inferior	Inferior	Same	Exceeds	Same	Same	Same
D-Quality of Muscle	50%	Exceeds	Same	Exceeds	Same	Exceeds	Exceeds	Exceeds	Same	Exceeds	Same	Exceeds	Same	Same	Exceeds
E-Simplicity of Design	# of Parts	Inferior	Exceeds	Exceeds	Exceeds	Exceeds	Exceeds	Exceeds	Inferior	Inferior	Inferior	Inferior	Exceeds	Inferior	Exceeds
F-Heating Consistency	170 °F	Exceeds	Same	Exceeds	Exceeds	Same	Same	Same	Same	Same	Same	Same	Same	Same	Same
G-Expected Additional Cost	~\$130.00	Exceeds	Inferior	Exceeds	Exceeds	Inferior	Exceeds	Exceeds	Inferior	Inferior	Inferior	Inferior	Exceeds	Inferior	Exceeds
SUM Exceeds	C		6 3	8 6	5	4 3	3	5	<mark>6 (</mark>		2	1 3	3 .	4 (	0 5
SUM Inferior SUM Same	7	)	1 1 0 3	. () () () () () () () () () () () () () (		0 2 3 2	2	2	0 5 1 2	5 <u> </u>	4 2 1 4	2 2 1 2	2	0 2 3 1	2 <u>0</u> 522

James, Team Cavatappi

# CAVATAPPI MANUFACTURE: COILING

- Best Concepts
  - Carrier Method
    - Tygon in middle, mandrel rotates on carrier
    - Less moving parts
    - May be more difficult to make
  - Spooling Method
    - Mandrel in middle, Tygon spooled separately
    - Spool runs perpendicular to mandrel
    - Easy to make
    - A few more moving parts, more clamps necessary

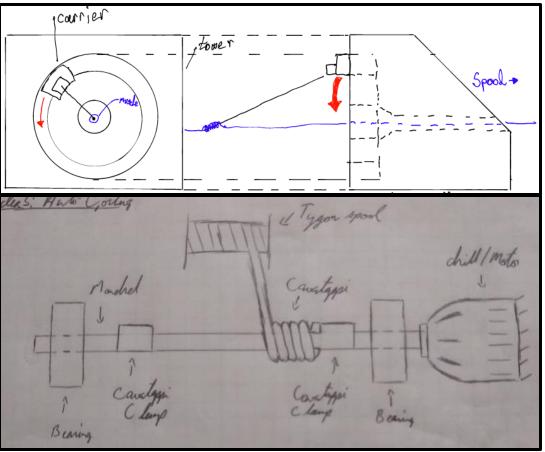


Figure 7: Carrier Method (top) vs. Spooling Method (bottom)

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# CAVATAPPI MANUFACTURE: ANNEALING

- Best Concepts:
  - Sous-Vide
    - Even heating
    - Easily controlled
    - Long warmup time
  - Resistive Heating Element (RHE)
    - Quick warmup time
    - Easy to use
    - Concerns about even heating
    - Potentially complex setup
    - Needs assembly/ fan system/ enclosure





Figure 8: Sous Vide (left) and RHE system controls (right)

#### James, Team Cavatappi

# MANUFACTURING DECISION MATRIX

- Carrier vs. Spooling
  - Criteria based on Pugh Chart
  - Heavy weighting
    - System Reliability (30 %)
    - Muscle Quality (25 %)
  - Percentages vs. Weights
    - How well do we think it'll perform?
    - Weights are out of 100 points

	De	cision Matrix: N	/luscle Product	ion					
		Carrier I	Vethod	Spooling Method					
		Percentage	Weighted	Percentage	Weighted				
Criteria	Weight	Met	Score	Met	Score				
A-Scalability of									
Muscle Length	10.00	80%	8.00	80%	8.00				
B-Reliabity of									
system	30.00	70%	21.00	85%	25.50				
C-Flexibility of system	5.00	80%	4.00	85%	4.2				
System	5.00	0070		0070	7.2				
D-Quality of Muscle	25.00	90%	22.50	90%	22.5				
E-Simplicity of Design	15.00	60%	9.00	85%	12.7				
F-Ease of	15.00	00%	9.00	00/0	12.7				
Construction	15.00	55%	8.25	85%	12.7				
Total Points	100		72.75		85.7				
Relative Ranking	1st/2nd	2n	d	1:	st				

# CAD: SPOOLING METHOD

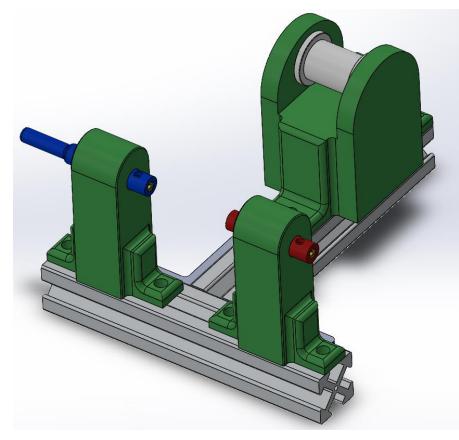


Figure 9: Spooling Method CAD model



Figure 10: Spooling Method Clamp model

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### CAD: SPOOLING METHOD

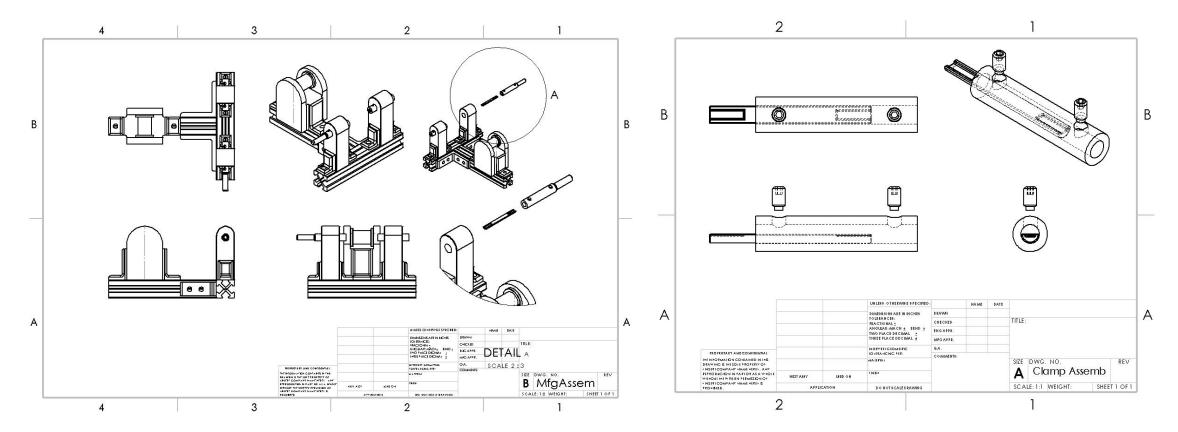


Figure 11: Spooling Method Drawing

Figure 12: Spooling Method Clamp Drawing

Ryn, Team Cavatappi

### BUDGET PLANNING: TENTATIVE MFG. BOM

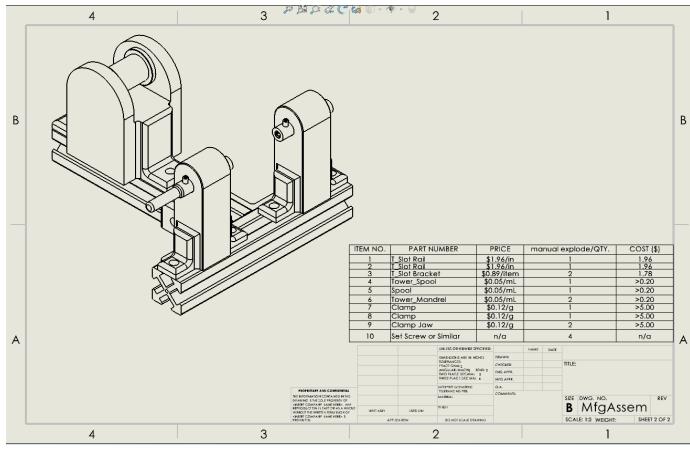


Figure 13: Spooling Method BOM

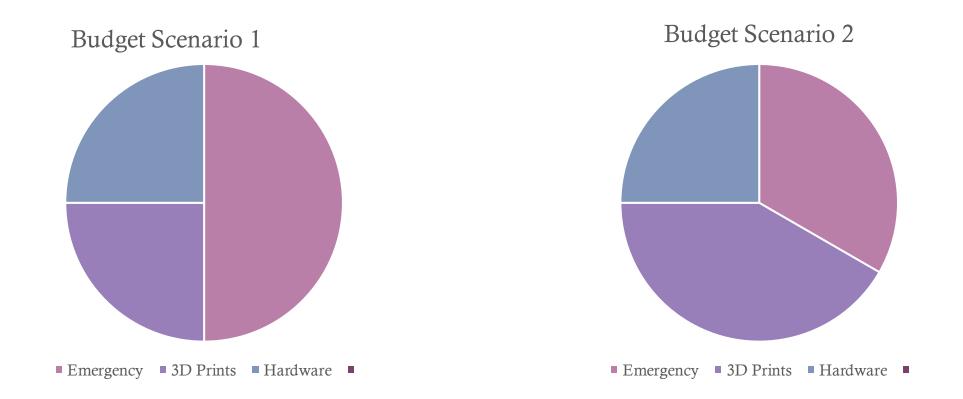
- Listed prices in the current BOM do not reflect available materials.
- Clamps would be printed at Cline.
  - Only item currently requiring purchase.

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# BUDGET PLANNING: UPDATES

- Actual financial budget is small \$200 to be used for:
  - 3D Prints
  - Extra muscle material
  - Extra hardware not present in the lab
    - Fasteners
    - Pins
    - Motor
- Most will be set aside as an "emergency fund"
- No money has been spent yet

# **BUDGET PLANNING: SCENARIOS**



Name, Team Cavatappi