

# Final Report

## Whisky Business

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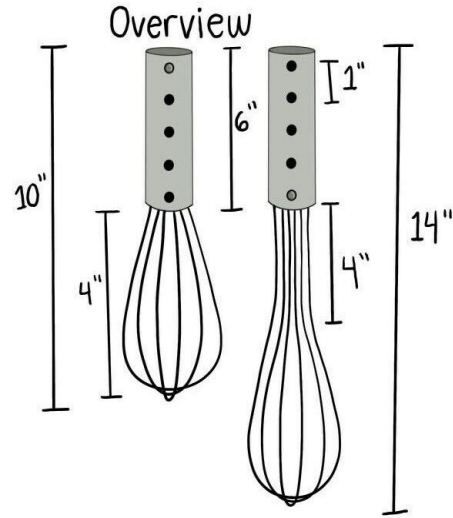


# Report Overview

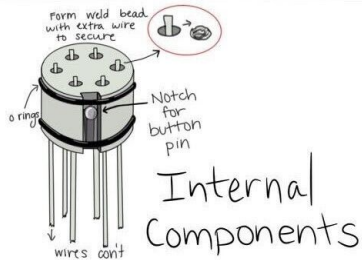
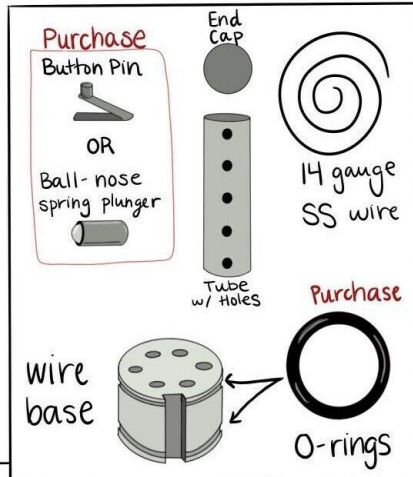
- The Beginning
- Product Evolution
- Final Result
- Quality Testing
- Successes
- Difficulties & Learnings
- Manufacturing
- FlexSim Process Simulation
- Cost Summary
- Future Development



# The Beginning



## Parts



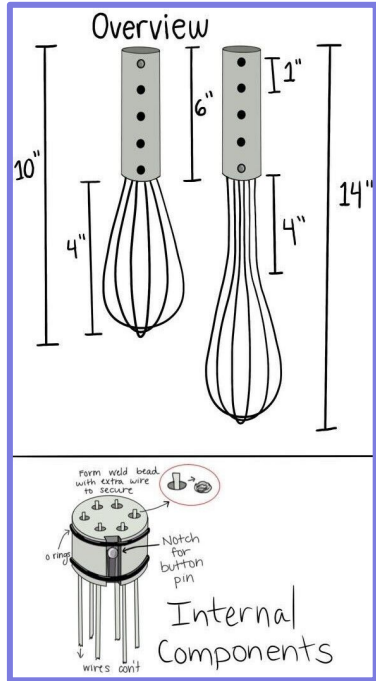
- 2 purchased parts
- 1 complex machine
- 2 simple machine
- 1 bend process

- In the beginning, we were inspired to design a whisk that would allow the user to change the overall length of the wire loops to put multiple whisk sizes into one easy package.
- Surprising, though there was significant deviation in the middle of our journey, the final product ended up coming full circle back to elements of the original design (handle with spaced holes)
- The initial concept's greatest flaw was improperly accounting for the space the button would occupy which eventually rendered this design defunct



# Production Evolution

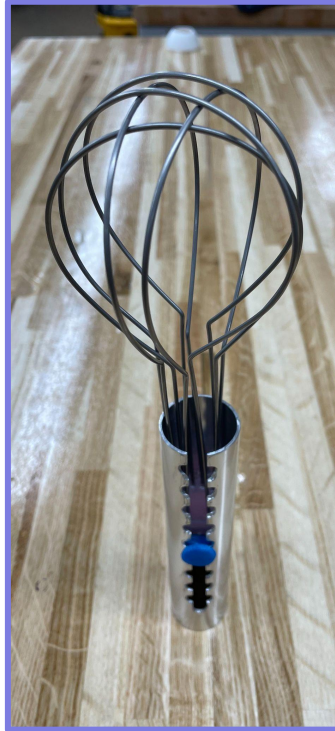
## Concept



## Prototype



## EVT



## DVT



## PVT



With each prototype we learned what would work and what would not. This prompted significant design changes at every turn.

# Final Result

The final result of this iterative process was 6 fully functioning adjustable whisks

- The wire assembly is fully removable for easy cleaning, addressing a major risk item identified early on
- The button design held extremely secure, allowing vigorous whisking without wobbles
- We were able to consistently bend wires into an attractive and useful shape using specialized tooling



Final 6 PVT whisks display the full range of adjustment

# Quality Testing

We learned the importance of in-situ quality testing which identified a key vulnerability to the whisk of the current design

- Whisks passed all quality tests that involved pulling directly on the wires or crushing the wires
- Testing the whisk on very thick brownie batter, 2 wires pulled free from the combination of spinning and sideways force that was not captured in the earlier quality tests that pulled the wires directly outwards



Using the Whisk-y Business whisk to mix thick brownie batter, once the whisk was removed 2 wires popped loose



# Successes

The successes this over the course of this project far outnumbered the failures, leading to a beautiful, complex, & functional product

- We successfully managed 5 different manufacturing processes and 8 unique components to build 8 whisks (DVT & PVT together)
- We successfully iterated through 4 versions of a wire bending tool to produce repeatable and accurate wire bending
- We successfully overmolded silicone in a custom mold, overcoming the small spaces and viscosity to get full penetration
- We successfully evolved our design to be both food safe through material and process choices, sealing all crevices
- We successfully learned from earlier prototypes what changes would allow us to progress, changing geometries and strategies
- We successfully worked as a team over the course of the entire semester, helping each other to complete all deliverables



Overmolding using SLA printed 2 part molds



All 8 components (wires and silicone in background)

# Difficulties & Learnings

The complexity of our design led to many difficulties, but we learned from each and took the various design and process lessons to heart

- In Situ quality testing showed the wires didn't hold (connected with food safe Epoxy, potentially too little Epoxy on some wires) → **Relying on glue brings high risk and mechanical connections will be much more reliable. Remove glue from designs where possible, and quality test thoroughly!**
- Machining complexity led to multiple redesigns when components could not be machined feasibly (handle slot and small wire holes) → **Testing machining and interviewing machinists is essential, never assume that something can be easily machined until you have seen it done!**
- Wire assembly into the base was very difficult manually without a fixturing tool, and inconsistent epoxy as a result may have led to some of the wire detachments → **Tooling to aid in assembly is just as important as tooling for creating parts, do not underestimate the value of assembly aids!**



Poor machining of tube stock → Design Change



Wire holes were too small to machine → Design Change



Wire holes were too small to mold → Design Change



Welded thin aluminum was limiting → Design Change



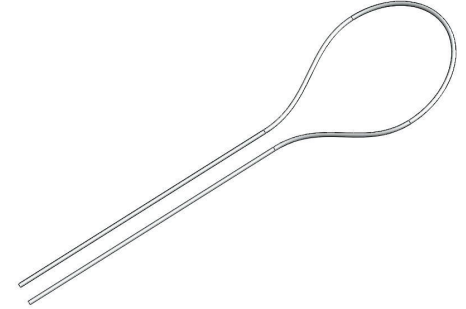
# Manufacturing



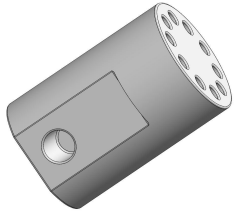
**End Cap** - Turned on the Lathe



**Handle** - Turned on the Lathe & Milled



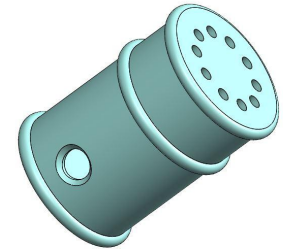
**Whisk Wire** - Bent using Wire Bending Tool



**Wire Base** - Turned on the lathe & Milled



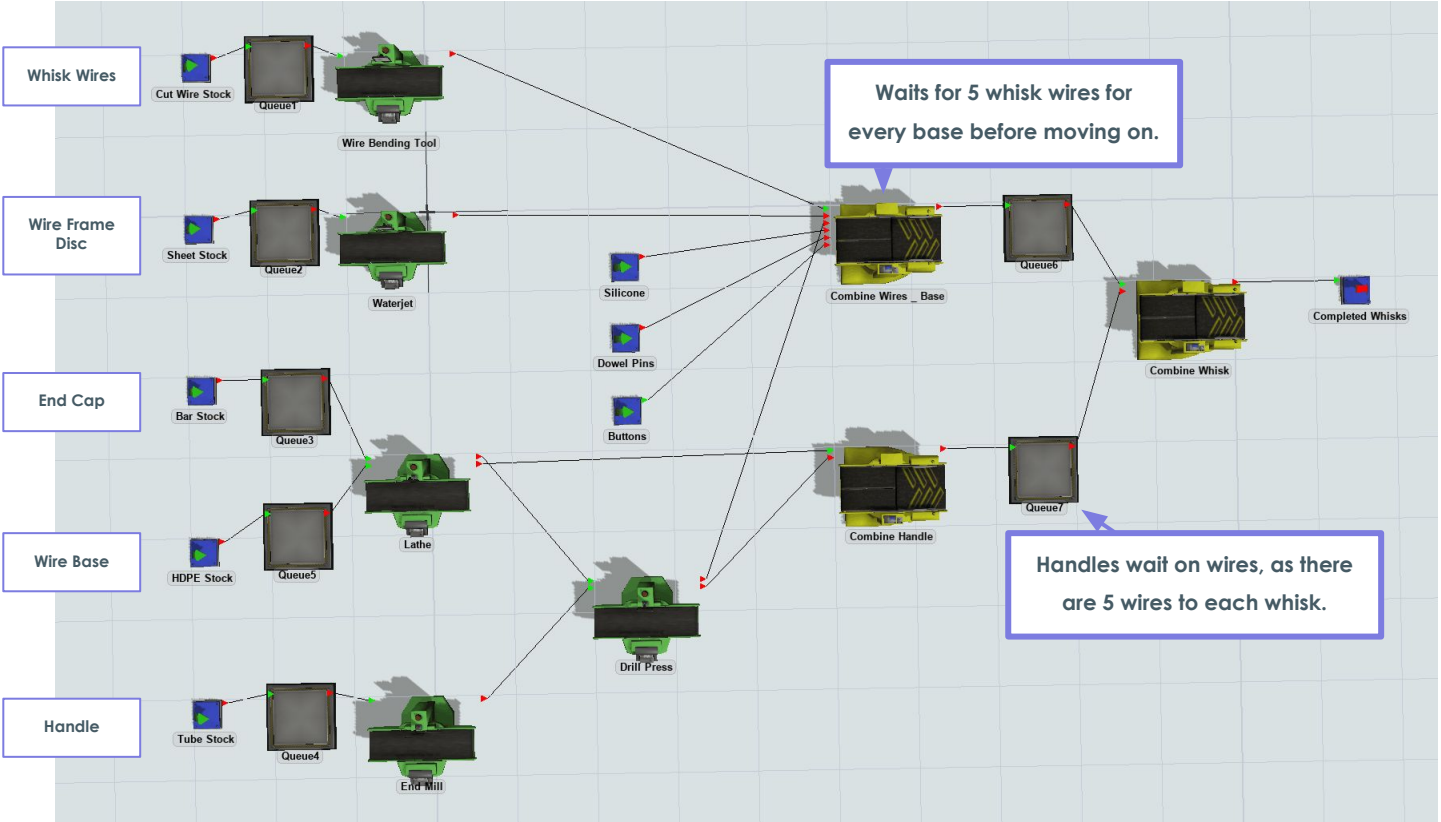
**Wire Guide** - Cut on the Water Jet



**Mold** - Silicone Casting

# FlexSim Manufacturing Simulation

FlexSim allows us to visualize the chokepoints based on what piles up. As we experienced, the lathe machining and drill press took the most time and were process limiters.



# Cost Summary

- **Material Costs have remained pretty constant from EVT to PVT.**
- **We anticipate the quick start guide and packaging to be a simple design and inexpensive.**
- **The manufacturing overhead of 8% and scrap rate of 10% gives us enough overhead to make mistakes, but remain profitable with well estimated COGS.**

ME537 - PRODUCT REALIZATION - VARIABLE COSTS					
Cost Name	COMMENT	EVT (BOM-V2)	DVT (BOM-V3)	PVT (BOM-V4)	MP
Material costs	Linked from BOM	\$14.20	\$12.59	\$14.60	\$15.21
Other	See notes on these costs for each milestone. (ex. Hover mouse over cell C4 for EVT)	\$2.50	\$0.00	\$0.00	\$0.00
Packaging	Small gift box with assembled product, and pamphlets inside.	\$2.50	\$2.50	\$2.50	\$2.50
Accessories	User Instructions and Regulatory pamphlets	\$0.25	\$0.25	\$0.25	\$0.25
Labor hours	Assembly labor hours	0.100	0.100	0.100	0.100
Labor cost	Assembly labor costs	\$1.80	\$1.80	\$1.80	\$1.80
Mfg overhead %	Pick a value based on the complexity of the product	8.00%	8.00%	8.00%	8.00%
Scrap rate	Pick based on complexity	10%	10%	10%	10%
<b>Total COGS</b>		<b>\$23.32</b>	<b>\$18.44</b>	<b>\$20.83</b>	<b>\$21.55</b>



# Future Development

There is still room for improvement before the adjustable whisk would be ready for customers, namely improvements to durability and ergonomics

- Texture the ends of the whisk wire and wire holes to ensure a stronger epoxy hold in the wire base, introducing mechanical grip and press fit wire holes.
- Round the button top to ease adjustment so it more easily slides under the chamfer without need for extreme compression to adjust.
- Reduce the diameter of the silicone insert to allow easier sliding within the handle and reduce wear on the silicone surface.
- Perform lifetime quality testing on the product and observe where further durability improvements would be required.
- Gather customer feedback from focus groups to improve user experience.

# Cheers to an Amazing Semester!



Thank you for a wonderful semester - The Whisk-y Business Team