Tech Expo, Fall 2025 – Team 13

AIRpen Project

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Problem Statement

The AIRpen Capstone Project client (Professor Milton Aguirre), needs a Design for Assembly (DFA) strategy to efficiently and affordably implement for the assembly of the AIRpen product, because the AIRpen is comprised of multiple parts of smaller geometries which may require precise assembly operations and movements performed on them either through manual or automated work.

Customer Background

Prof. Milton Aguirre, is developing a stress management device (AIRpen) that encourages slow-paced breathing exercise in real-world situations.

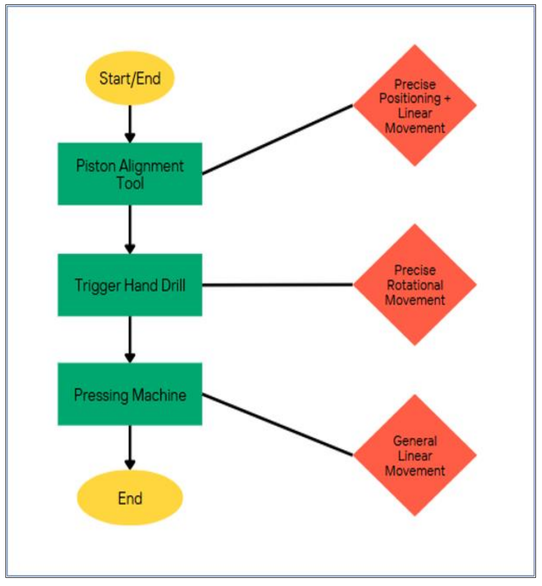
Scope of Work-
Focus: Develop a low to mid-volume assembly process and its tool for producing 500+ AIRpens needed for NIH-funded clinical trials. (product efficiency, cost, end customer)
Current Issues: Small lead to inconsistent and expensive assembly times

Process Requirements

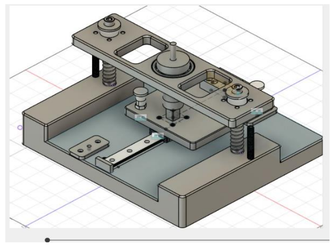
Create a Design for Assembly (DfA) strategy to assemble the device quickly and in budget.

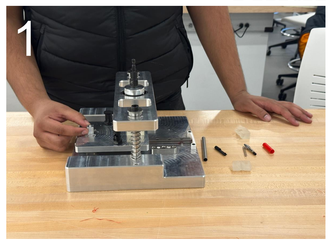
1) **Conceptual Design –** Identify conventional(manual) and advanced(automated) manufacturing techniques to effectively assemble the device.
2) **Feasibility Testing –** Design a series of prototypes that demonstrate the viability of the DoA strategy. Develop testing procedures to evaluate the DoA assumptions and ideas quickly and cheaply.
3) **System Integration –** Build the assembly processes and tooling to assemble the device effectively.
4) **Experimental Testing –** Verify the durability, accuracy, and repeatability of the DoA process under laboratory conditions.

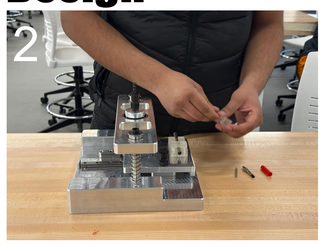
Experimentation and Concepts

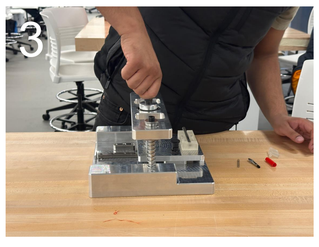


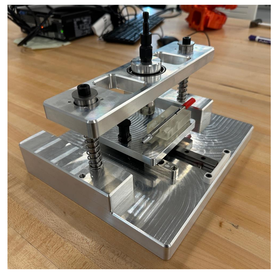
Final Design

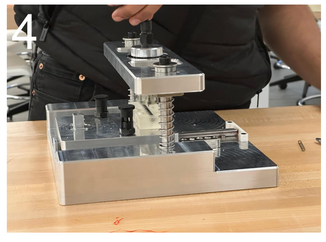


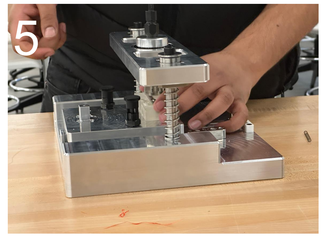


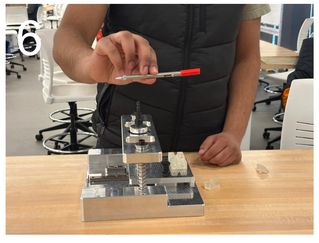












Testing and Results

Testing Conditions:
[Manual Assembly]-
- 5 participants
- Measuring time to assemble each part and product

[Semi-Automatic Assembly]-
- 1 participant
- Measuring time to assemble each part and product

	Final Manual Trial Data (5 Trials)				
	Piston	Trigger	Spring	Writing Pen	Mouthpiece
Avg Assm. Times	9.23	45.15	4.16	3.65	3.52
Avg Sample Stnd Dev.	1.36	7.34	0.49	0.42	0.18

	Final Fixture Trial Data (5 Trials)					
	Piston	Trigger	Spring	Writing Pen	Mouthpiece	Total
Avg Assm. Times	3.02	8.53	2.40	2.47	3.61	20.03
Avg Sample Stnd Dev.	0.82	0.43	0.63	1.29	0.60	1.60

Testing:
The team conducted cycle time tests using various levels of tooling, from fully manual to semi-automatic...

Tests were conducted w/ the following method:
- Simple hand assembly
- Simple hand tooling
- A prototype fixture
- Custom CNC machined fixture

Results & Conclusions:
(1) The average time to assemble the pens by hand compared to assembly using the fixture were about the same
(2) The standard deviation of assembly times at various stages dramatically reduced. Notably, the standard deviation for the trigger assembly reduced from 7.34 seconds to 0.43 seconds