FAMU-FSU College of Engineering

JTEKT Bearing Painter
VDR 5

Senior Design Team 515

Team Introductions

Mason Gibson
Manufacturing Engineer

Wesley Jean-Pierre
Mechanical Design Engineer

Max Jones
Project Manager & Control Engineer

Andrew McClung
Systems Integration Engineer

Anthony Wuerth
Manufacturing & Design Engineer

FAMU-FSU College of Engineering

Sponsors and Advisor

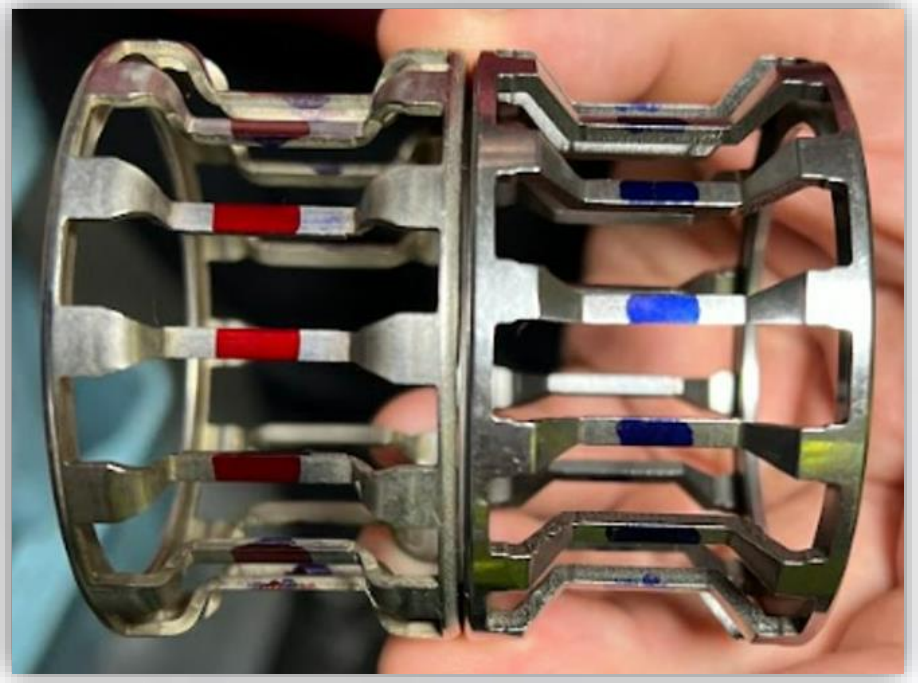
Engineering Mentor
Coltin Fortner
Mechanical Engineer
JTEKT North America

Engineering Mentor
Joshua Jones
Senior Product Engineer
JTEKT North America

Academic Advisor
Shayne McConomy, Ph.D.
Senior Design Professor

FAMU-FSU College of Engineering

Project Objective



The objective of this project is to automate the process of painting needle bearing retainers.

FAMU-FSU College of Engineering

Project Overview

Maximilian Jones

FAMU-FSU College of Engineering

Key Goals

Accurately Apply Metal Paint to the Bearing

Accommodate Bearings from 7/8-2 ½ in. (Outer Diameter)

Automate Bearing Painting Process

Assumptions

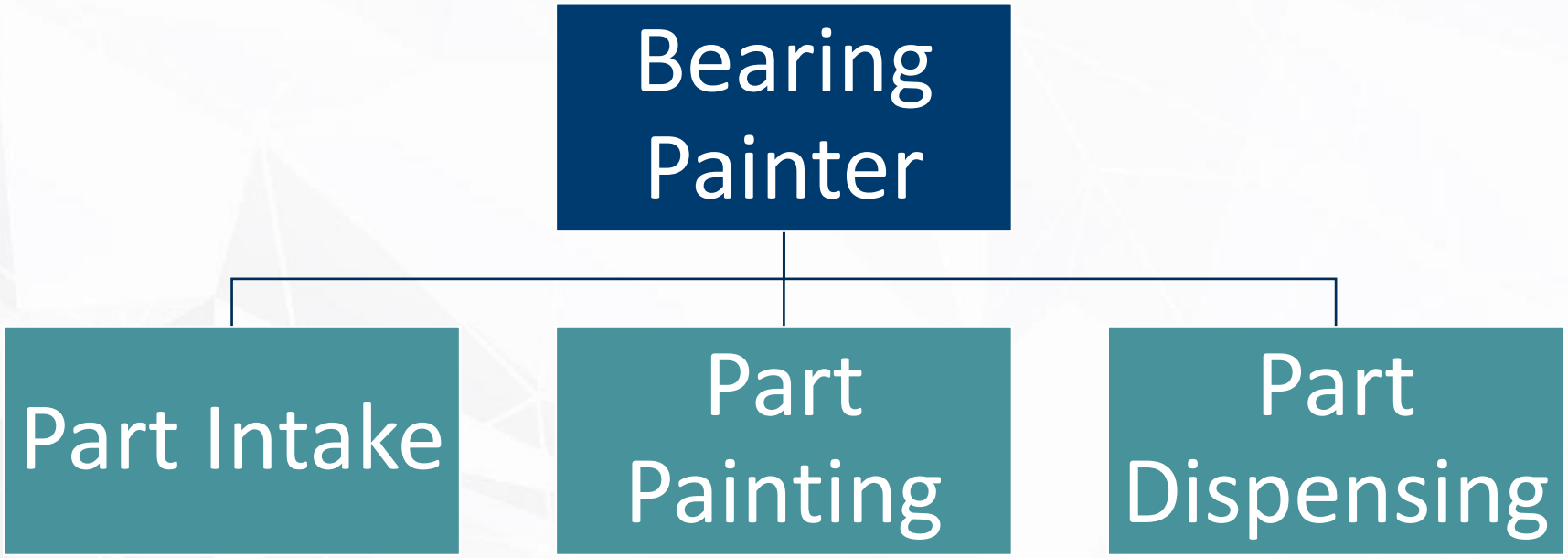
- Manually Loaded and Unloaded
- Loaded with One Type of Bearing at a Time
- A standard 120V Wall Outlet is Available
- Paint With One Color per Load

FAMU-FSU College of Engineering

Customer Needs

- Fully Automated (except loading)
- Fit Into Existing Fume Hood
- Accommodate Different Sized Bearings
- Able to Load 10 Bearings at a Time
- 3.5 Second Cycle Time
- Paint Non-Working Surface Only

Defined Systems



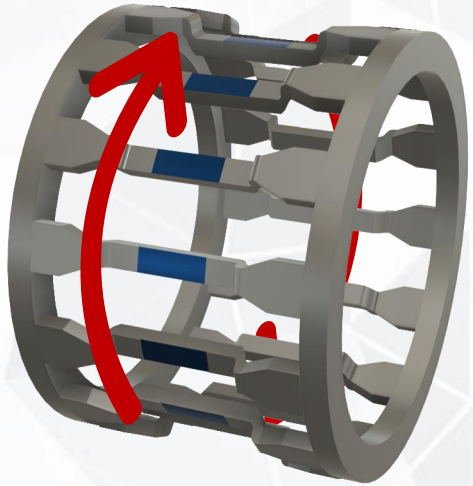
FAMU-FSU College of Engineering

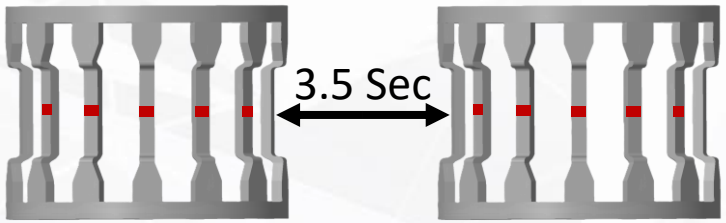
Critical Targets

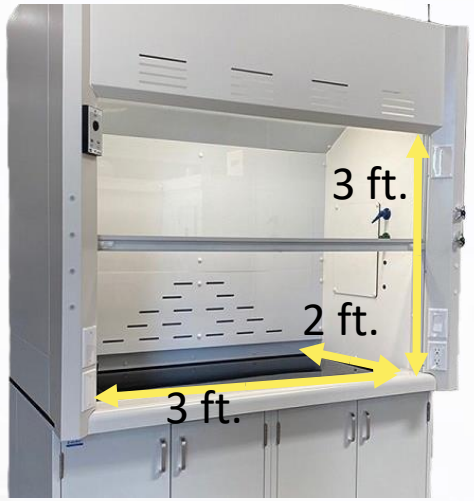
Consistently paint full 360° of retainers

Cycle time of 3.5 seconds

Fit inside a pre-existing Fume Hood (2ft. X 3ft. X 3ft.)



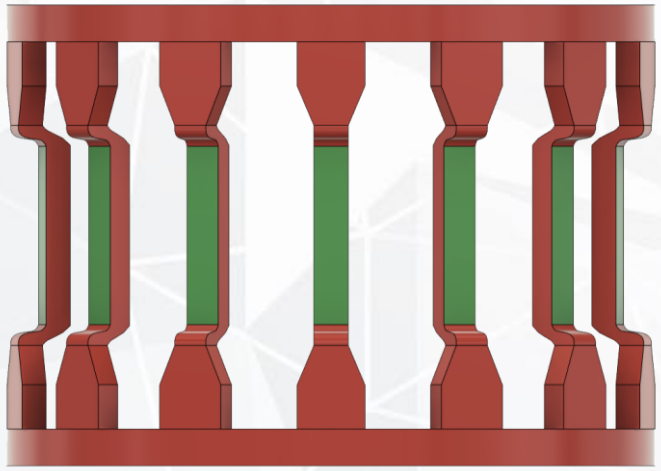




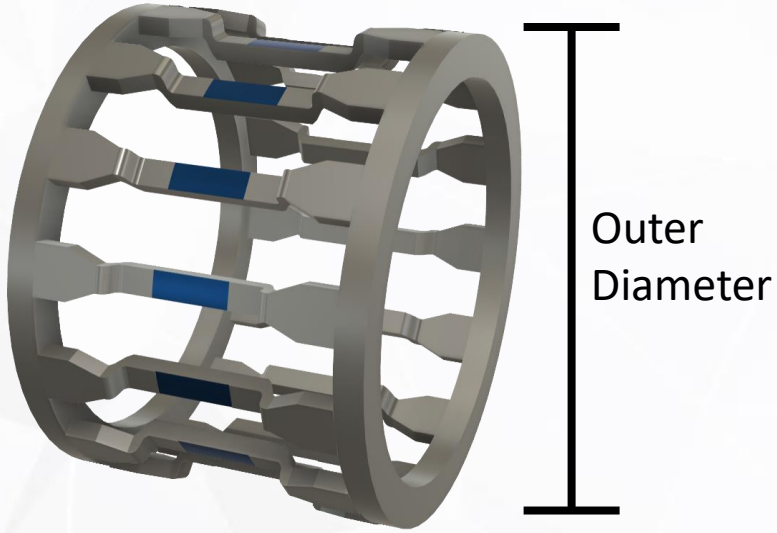
FAMU-FSU College of Engineering

Critical Targets

Limit Extraneous paint on working surface to 1 mm^2



Accommodate retainers from 7/8 to 2 ½ inches in diameter



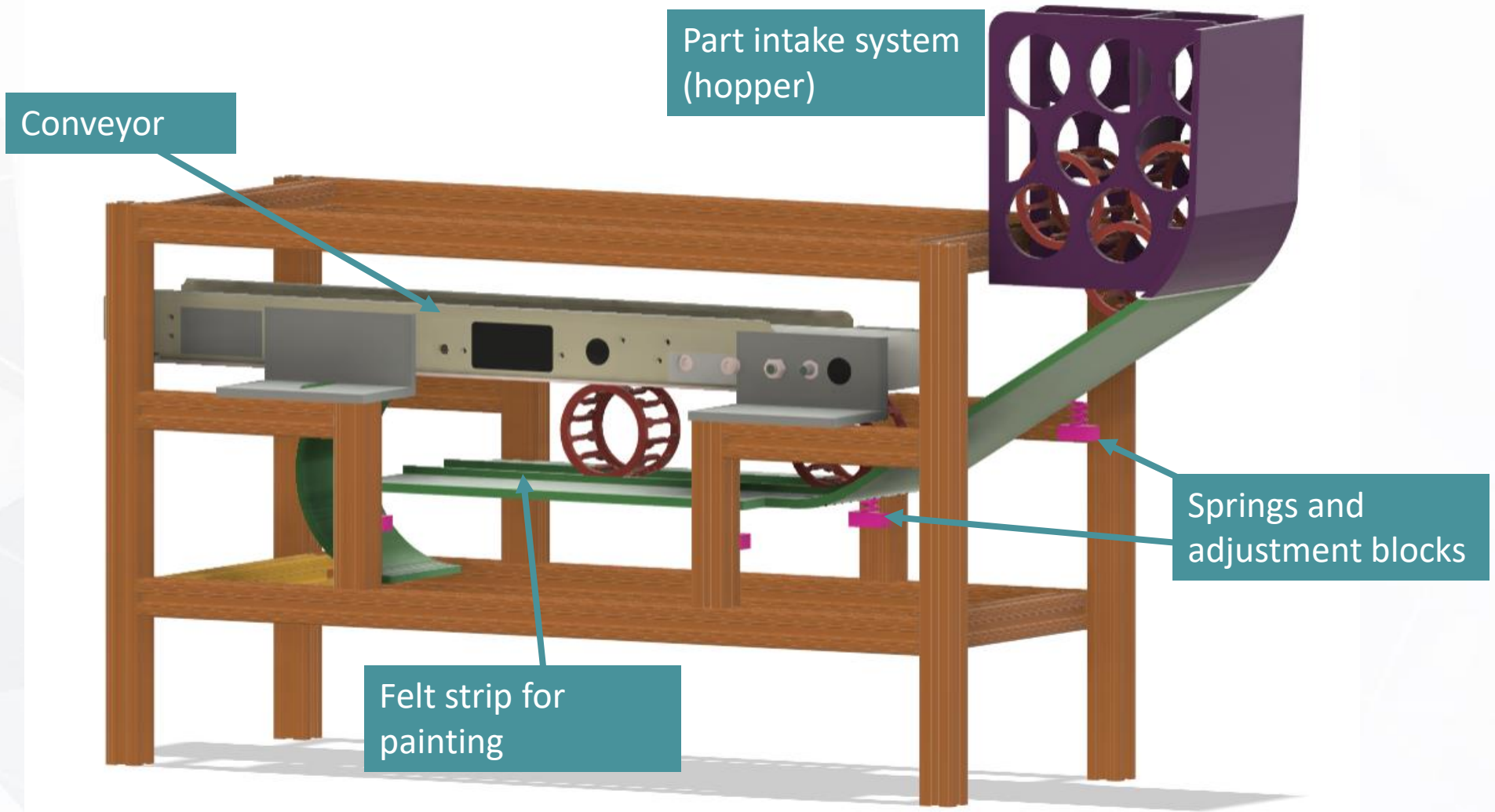
Safety & Industry Standards

- Conveyor Systems must have all access points guarded to eliminate pinch points.
- All Systems Must have an Emergency Stop Pushbutton Located near the Discharge point of the Conveyor.

- Highly flammable
- Should be used in well-ventilated areas
- Excess Dykem should be disposed to the nearest hazardous waste facility

- Incoming voltage must be labeled in bright orange near the main disconnect

Updated CAD Model



FAMU-FSU College of Engineering

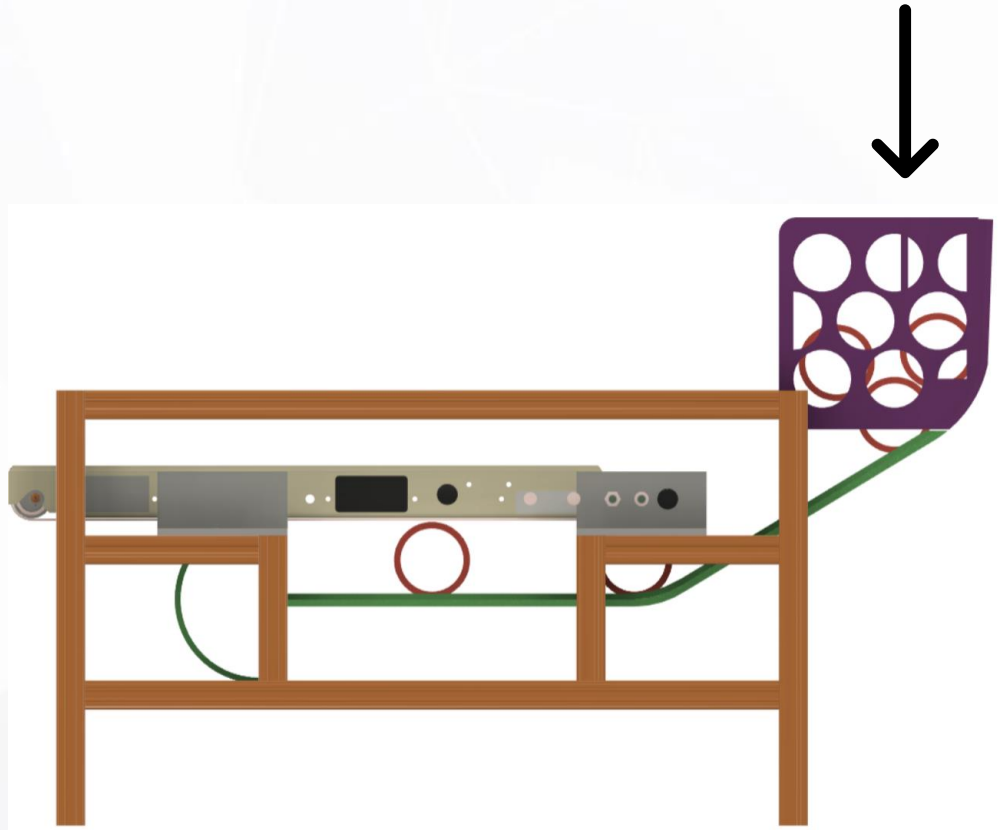
Testing Plan

Mason Gibson

FAMU-FSU College of Engineering

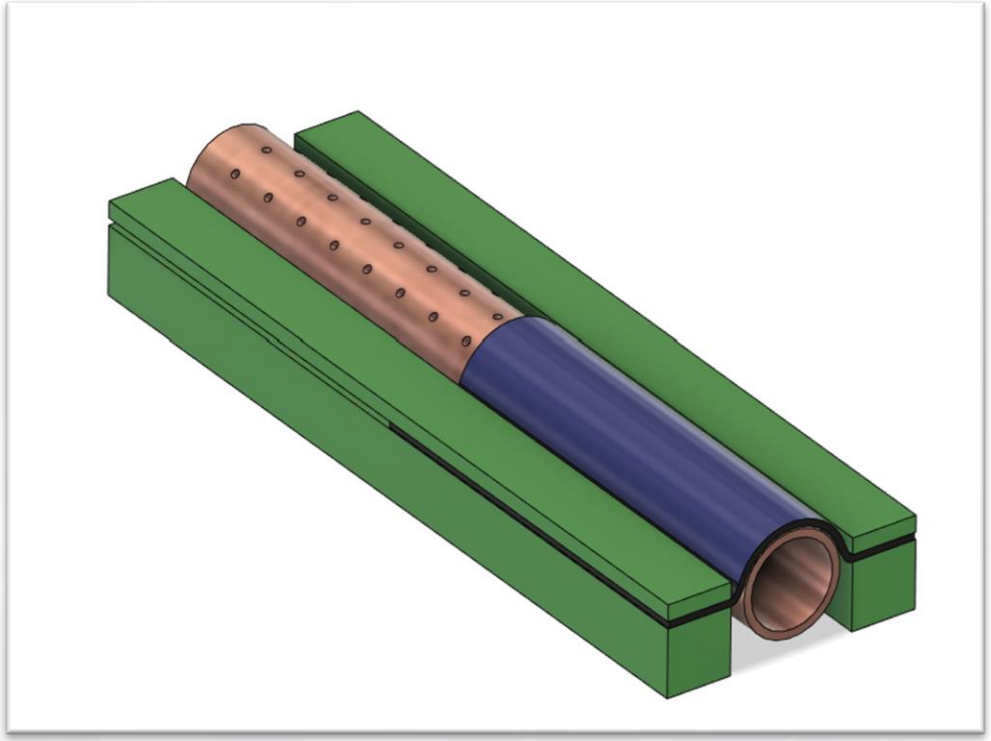
Part Intake Testing

- The ability to load and unload bearing retainers into the hopper
- Further develop timing mechanisms or lack thereof



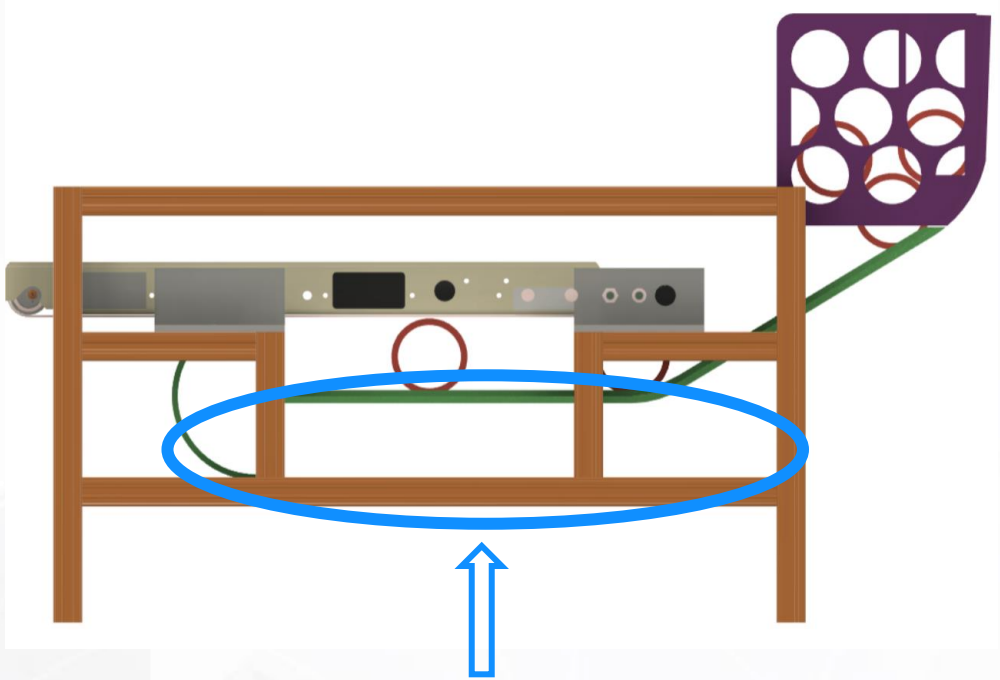
Part Painting Testing

- Test ways of keeping felt applicator properly saturated during duration of the run
- Ways of cleaning painting mechanism for a change of Dykem color
- Test for optimal spring stiffness under application bed



Part Dispensing Testing

- Ensure freshly painted non-working surfaces are not tampered with
- Test to guarantee organized deposition of bearing retainers



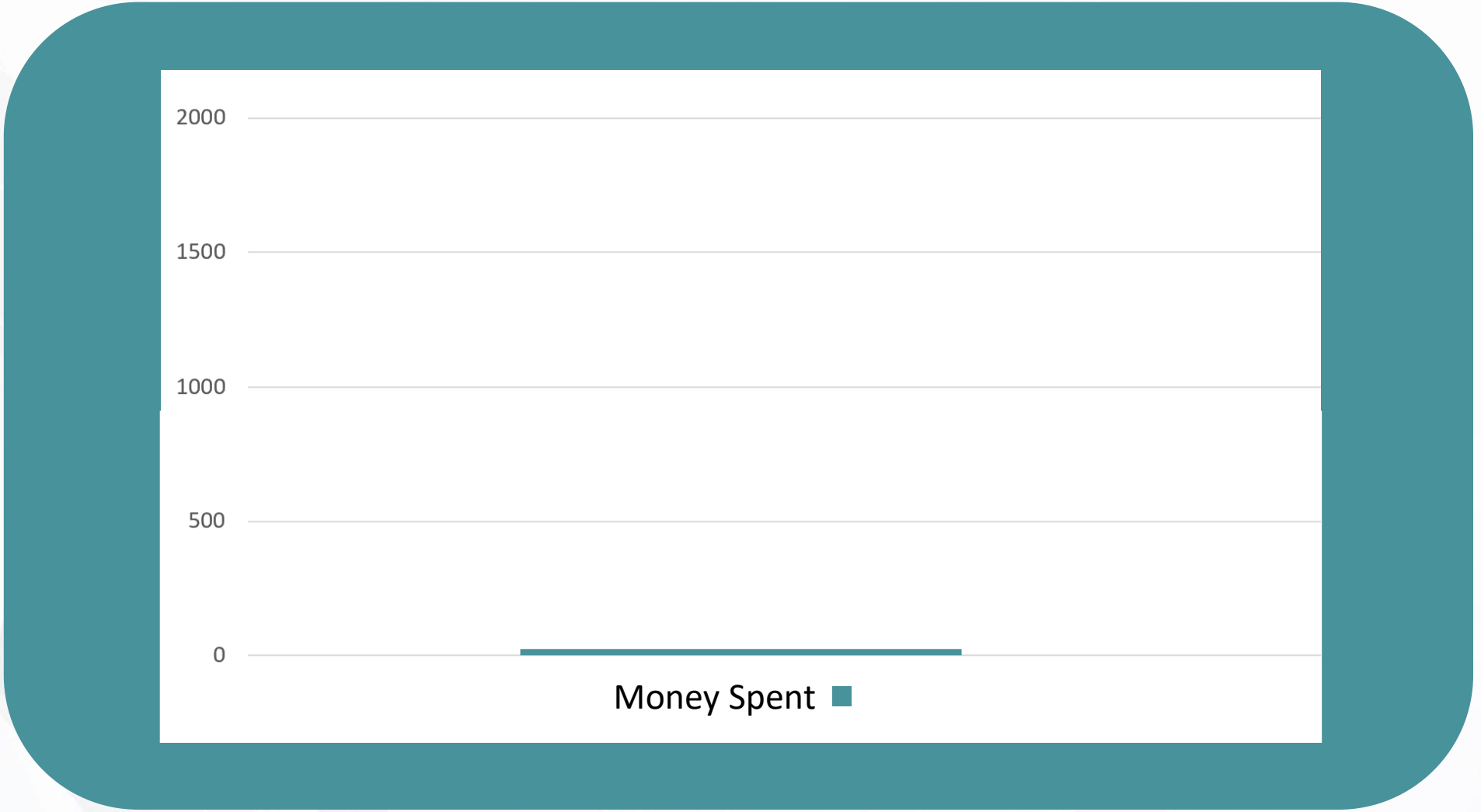
FAMU-FSU College of Engineering

Budget

Andrew McClung

FAMU-FSU College of Engineering

Project Budget



FAMU-FSU College of Engineering

Product Budget

Name	Unit Cost	Quantity	Total
1 in. x 1 in. T-slot Aluminum Extrusion	$5.30 /ft.	17 ft.	$90.05
NEMA 23 Stepper Motor	$23.02	1	$23.02
QC Conveyors IS125	~ $400	1	~ $400
Felt Strip, 2 in. wide, 1/16 in. thick	$2.59 /ft.	50 ft.	$129.52
			$642.59

Future Work

- Continue Building Painting System
- Develop Side Rails
- System Testing
- Further Improve CAD Model

FAMU-FSU College of Engineering

Questions?

Team Introduction

Project Overview

CAD Model

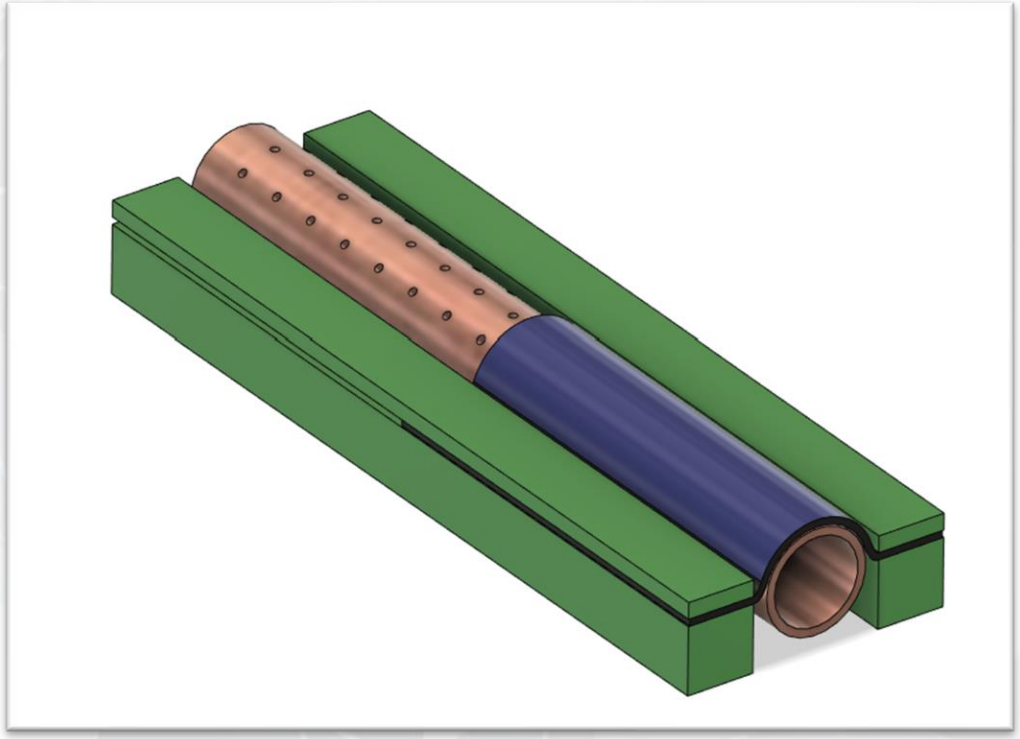
Testing Plan

Budget

FAMU-FSU College of Engineering

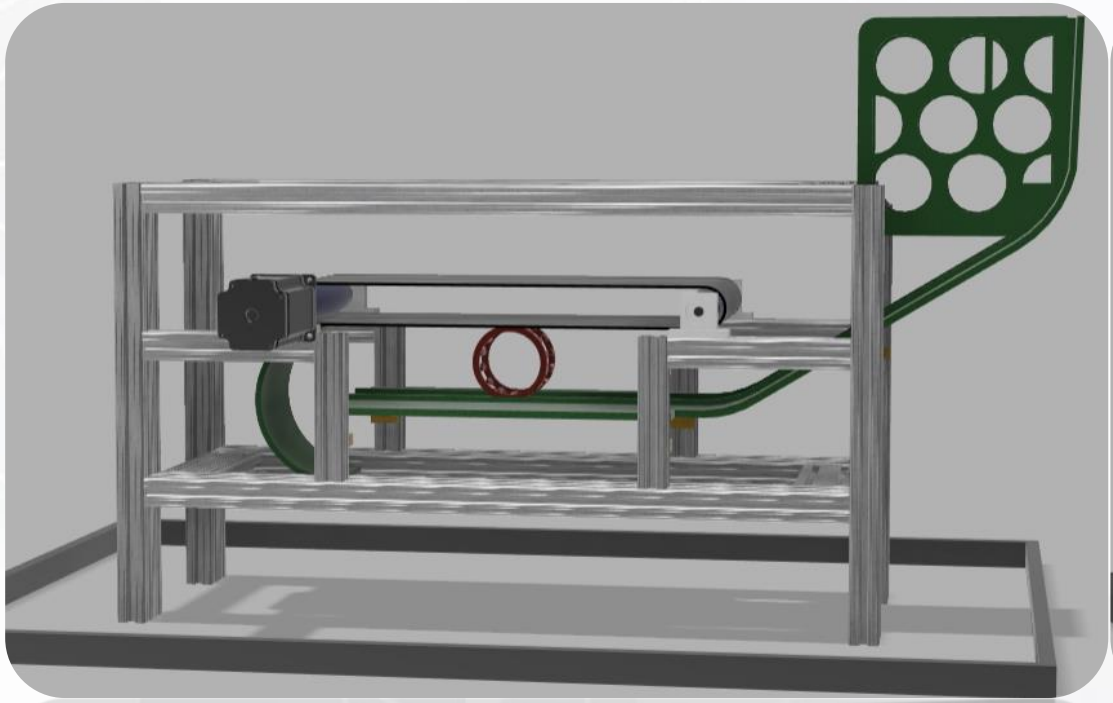
FAMU-FSU College of Engineering

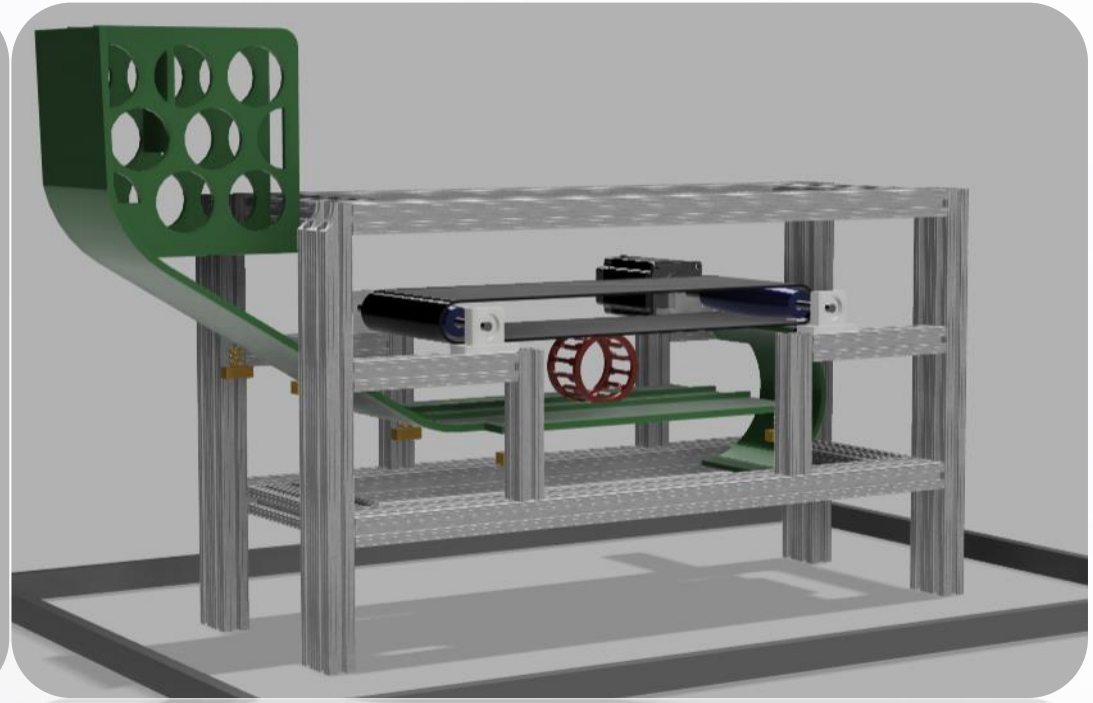
Improvements



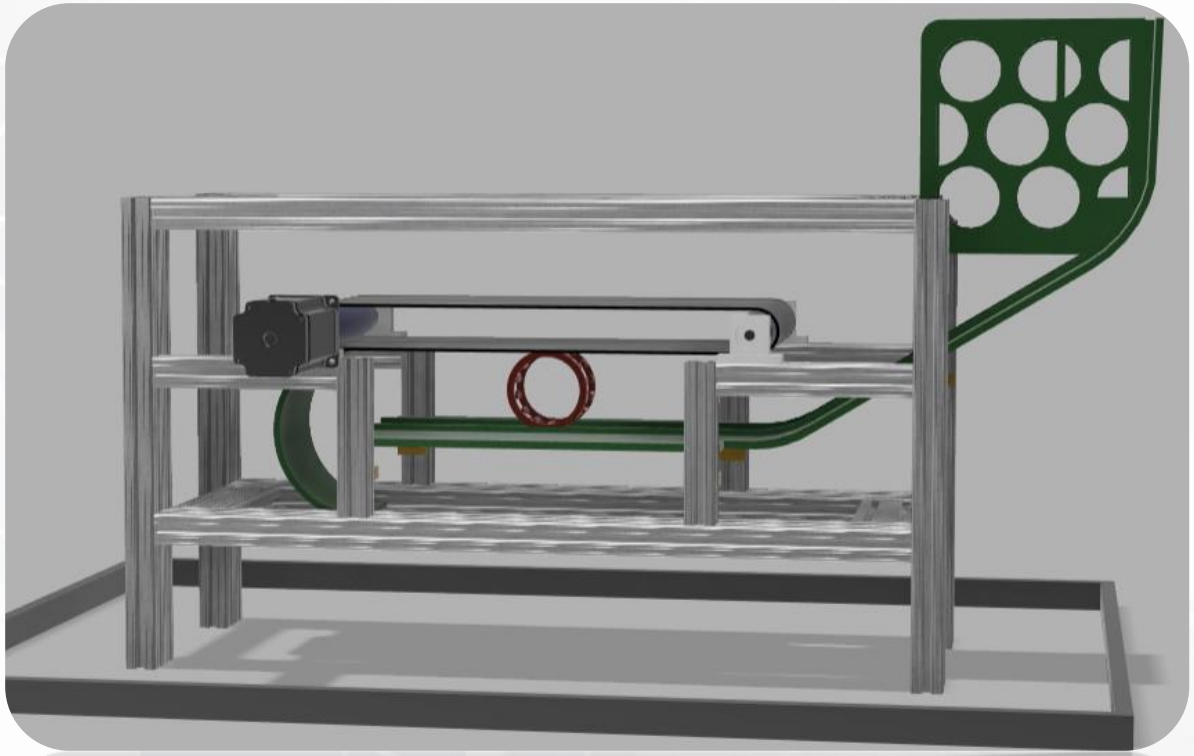
- Copper pipe holds Dykem from reservoir
- Felt pad is replaceable
- Minimizes fumes

Improved CAD Model





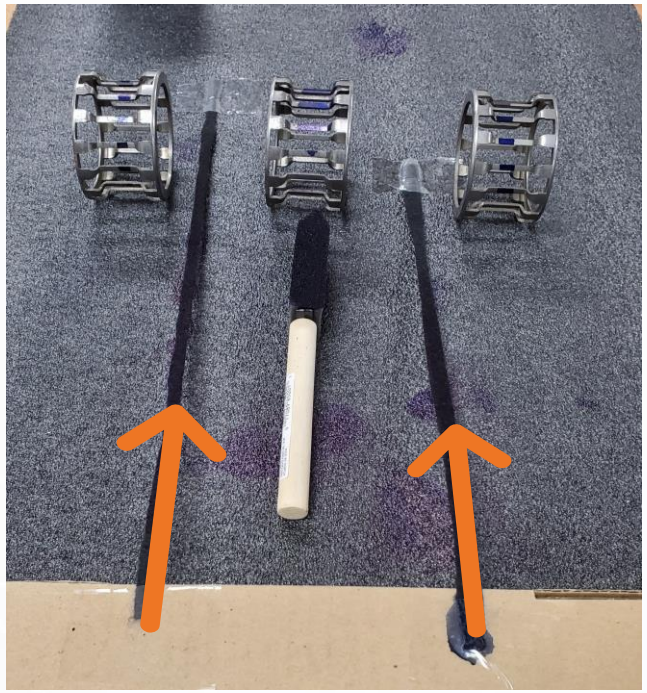
Improvements



- Hopper addition
- Removal of pinch point prior to painting
- Adjustment of painting mechanism

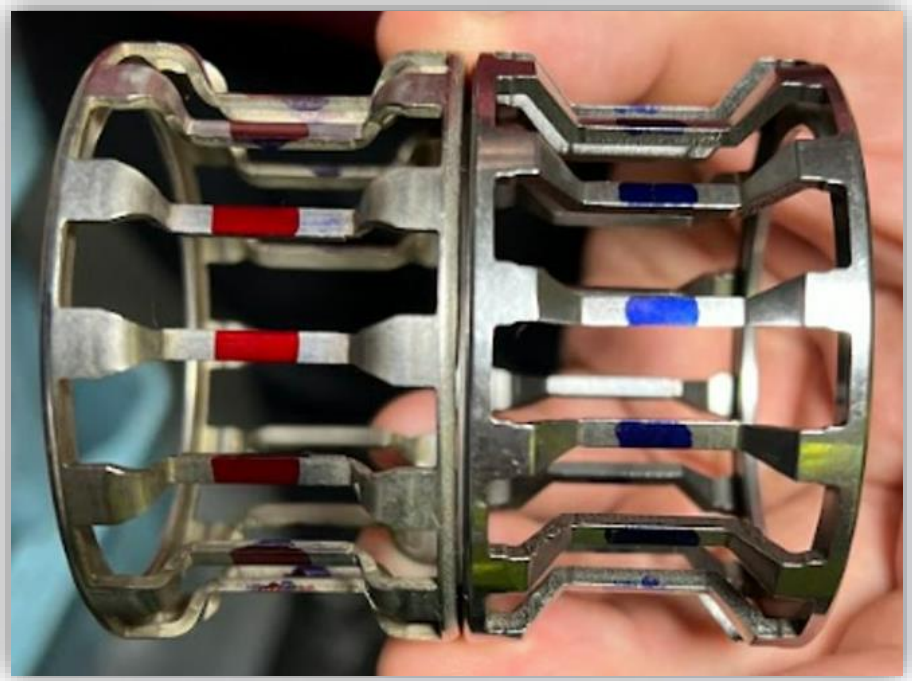
Testing Procedure

- Felt
- Sponge
- Brush



Retainer Painting

Some Customers Require Part Marking
To Help Distinguish Similar Parts

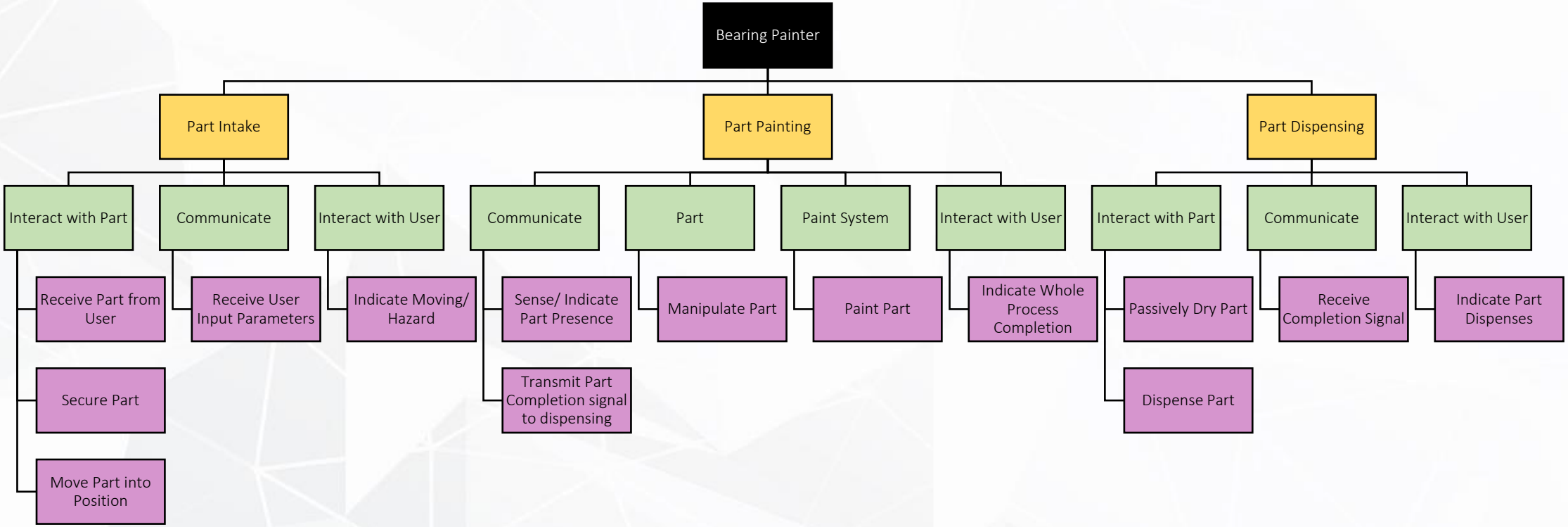


- Low Production Runs

- Tedious, Manual Process
  - Operator Pulled From Position
    - Decreased Efficiency

FAMU-FSU College of Engineering

Functions Hierarchy Chart



FAMU-FSU College of Engineering

Binary Pairwise Comparison Chart									
Customer Requirements	1	2	3	4	5	6	7	8	Total
1. Atomated Process	-	1	0	0	0	1	0	1	3
2. Cycle Time	0	-	1	0	0	1	0	1	3
3. Paint Correct Area	1	0	-	1	1	1	1	1	6
4. Fit in Fume Hood	1	1	0	-	0	1	0	1	4
5. Process Range of Sizes	1	1	0	1	-	1	0	1	5
6. Quickly Configurable	0	0	0	0	0	-	0	1	1
7. Use Multiple Colors	1	1	0	1	1	1	-	0	5
8. Indicate Operation Status	0	0	0	0	0	0	1	-	1
Total	4	4	1	3	2	6	2	6	n - 1 = 7

FAMU-FSU College of Engineering

Binary Pairwise Comparison

Function

- Tool to assist in ranking the importance of customer requirements
- Assigns each requirement an importance weight factor
- Requirements and weight factors assist in the development of the House of Quality

Results

The 3 most important requirements were found to be:

1. Paint correct area
2. Process range of sizes
3. Use multiple colors

Engineering Characteristic									
Improvement Direction		↑	-	↑	↓	↑	↓	↓	-
Units		Part/min	mm^2	Diameter	Sqft	Part/Load	%	%	Part/invl
Customer Requirements	**Importance Weight Factor**	Production Rate	Processing Accuracy	Compatibility	Size	Part Intake Limit	Automatic Operation %	Reliability	Maintenance Interval
1. Atomated Process	**3**	9		3	9	9	9		
2. Cycle Time	**3**	3	9	9		9	9	3	3
3. Paint Correct Area	**6**	1	9	9				1	1
4. Fit in Fume Hood	**4**			3	9	9			
5. Process Range of Sizes	**5**	1	9	9	9	3	9		
6. Quickly Configurable	**1**	3	3	9	3	9	3		
7. Use Multiple Colors	**5**	3	3		9	3	3	1	3
8. Indicate Operation Status	**1**	3		1		3	3	3	1
Raw Score (628)		68	144	157	156	132	120	23	31
Relative Weight %		10.83	22.93	25.00	24.84	21.02	19.11	3.66	4.94
Rank Order		6	3	1	2	4	5	8	7

FAMU-FSU College of Engineering

House of Quality

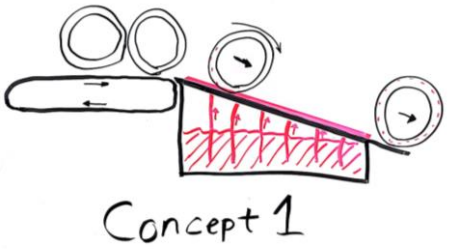
- Production Rate
- Processing Accuracy
- Compatibility
- Size
- Part Intake Limit
- Automatic Operation %
- Reliability
- Maintenance Interval

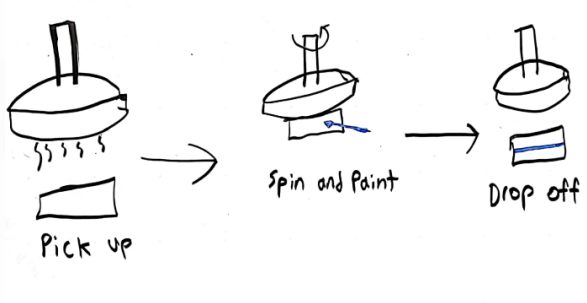
Concepts									
Engineering Characteristics	RANDBRIGHT RB 60	Linear Processor	Inverted Treadmill	Double Conveyor	Felt Ramp	Electromagnet	Spline	Pore Track	Gravity Ramp
Compatibility	- DATUM -	S	S	-	S	-	S	+	+
Size		S	+	S	+	S	S	-	-
Part Intake Limit		S	+	S	S	S	S	S	S
Processing Accuracy		S	S	S	-	-	S	S	-
Automatic Operation %		S	+	+	S	+	S	S	-
Total Pluses		0	3	1	1	1	0	1	1
Total Satisfactory		5	2	3	3	2	5	3	1
Total Minuses		0	0	1	1	2	0	1	3

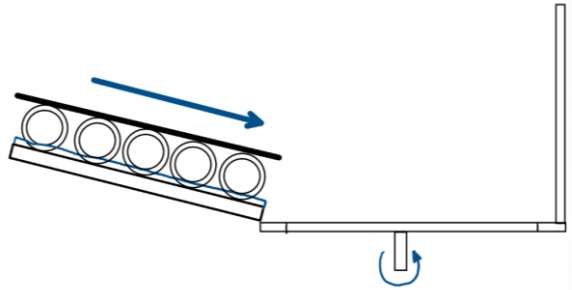
Concepts					
Engineering Characteristics	Linear Procesor	Inverted Treadmill	Double Conveyor	Felt Ramp	Pore Track
Compatibility	- DATUM -	S	S	+	-
Size		+	S	-	-
Part Intake Limit		+	+	S	S
Processing Accuracy		+	+	-	-
Automatic Operation %		+	+	S	S
Total Pluses		4	3	1	0
Total Satisfactory		1	2	2	2
Total Minuses		0	0	2	3

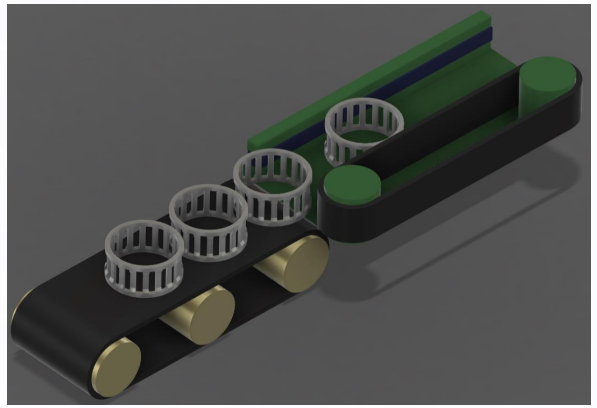
FAMU-FSU College of Engineering

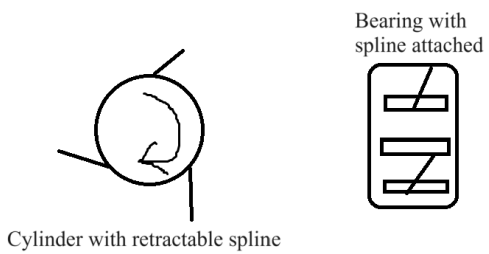
Pugh Chart

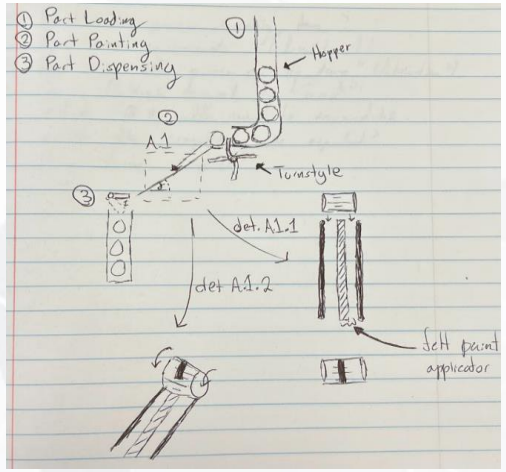




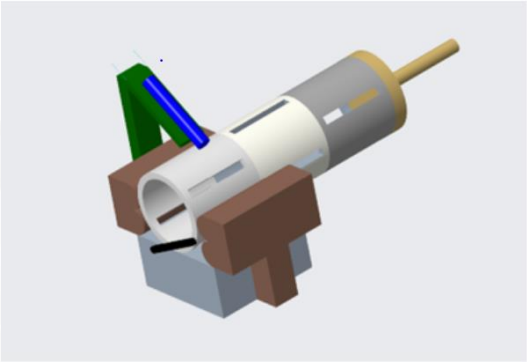


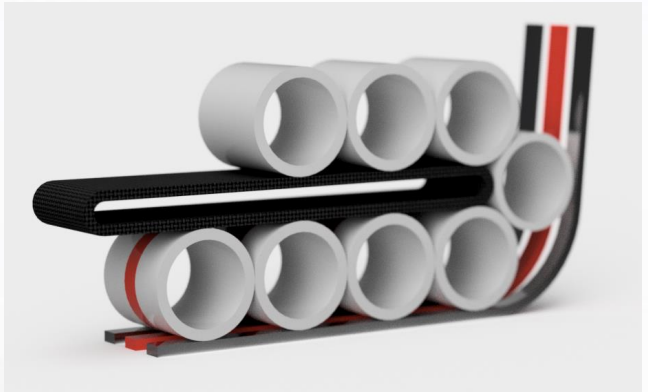






DATUM





FAMU-FSU College of Engineering

[C] Matrix							
	Analytical Hierarchy Process	A	A	A	A	A	
B	**Engineering Characteristic**	Compatibility	Size	Part Intake Limit	Processing Accuracy	Automatic Operation %	**Average**
B	Compatibility	1	3.000	3.000	7.000	5.000	3.800
B	Size	0.333	1	0.333	5.000	0.333	1.400
B	Part Intake Limit	0.333	3.000	1	7.000	1.000	2.467
B	Processing Accuracy	0.143	0.200	0.143	1	0.200	0.337
B	Automatic Operation %	0.200	3.000	1.000	5.000	1	2.040
	Total	2.010	10.200	5.476	25.000	7.533	10.044
	Average	0.402	2.040	1.095	5.000	1.507	

Concept	Alternative Value
Inverted Treadmill	0.401
Double Conveyor	0.271
Felt Ramp	0.327

Analytical Hierarchy Process

Function

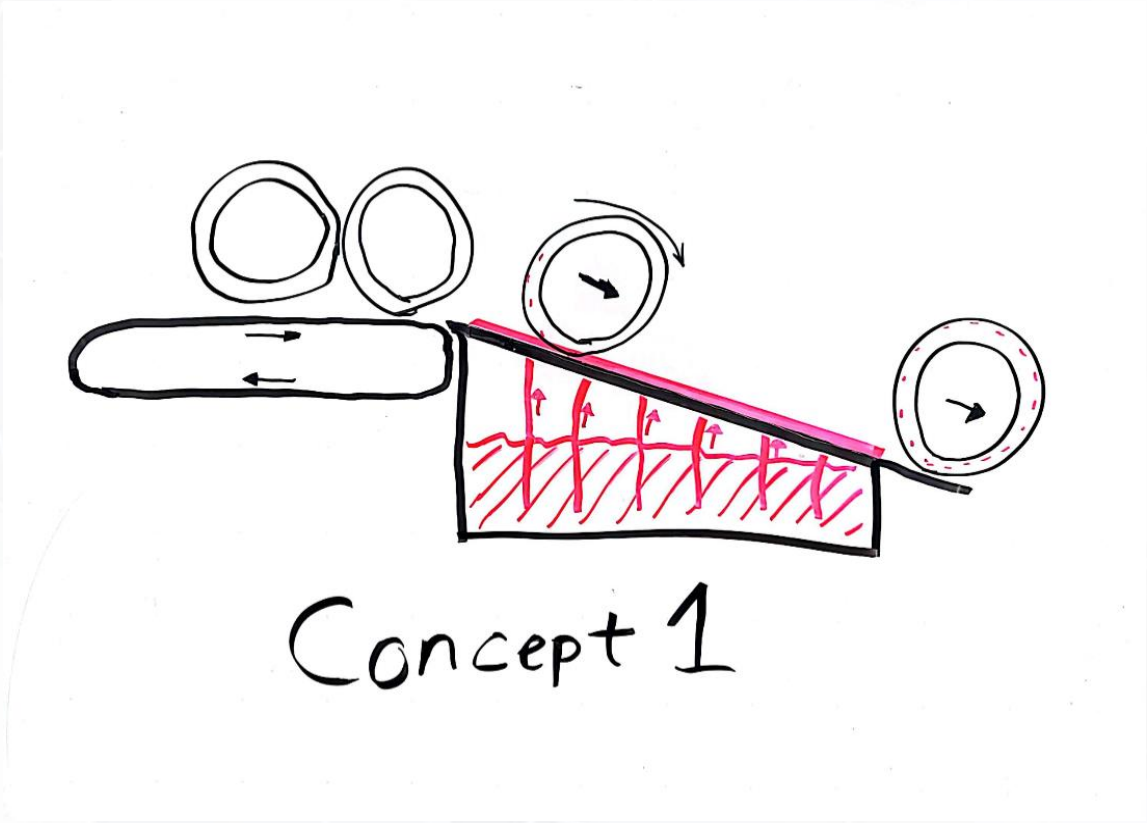
- Utilizes matrices to compare importance of criteria
- Criteria are Engineering characteristics & design concepts

Results

- Compatibility is the highest weighted engineering characteristic
- Inverted Treadmill with the highest rating of importance on criteria

Concept	Alternative Value
Inverted Treadmill	0.401
Double Conveyor	0.271
Felt Ramp	0.327

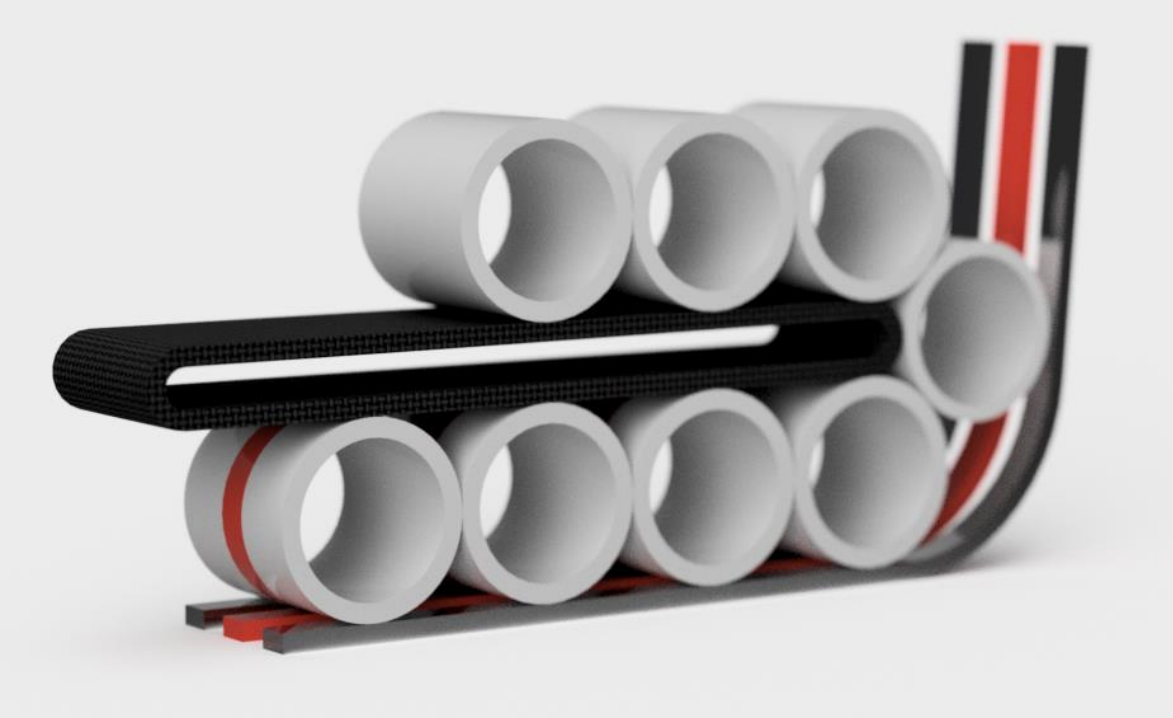
Medium Fidelity Concept 1



Key Features

- Conveyor belt feeds the bearings
- Bearing rolls down a ramp to be painted
- Paint felt strip fed by a reservoir of Dykem underneath

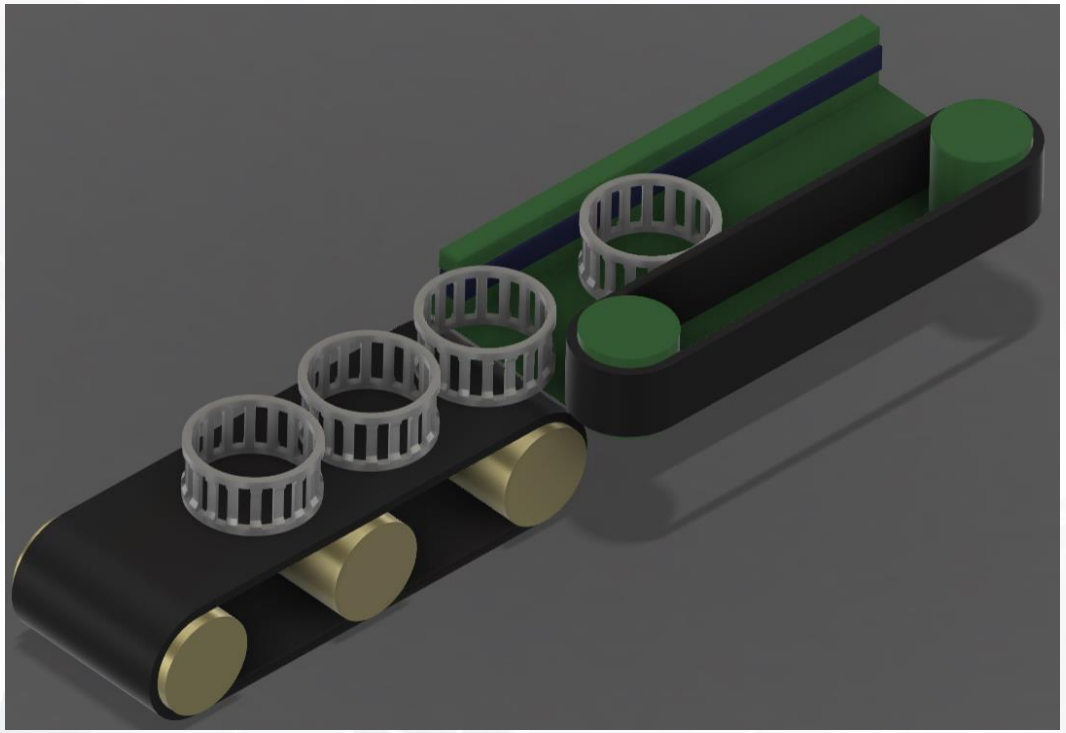
High Fidelity Concept 2 (Inverted Treadmill)



Key Features

- Parts are moved along a belt to a surface with Dykem
- Pushed along the Dykem by the bottom of the belt
- Allows for compact design

High Fidelity Concept 3
(Double Conveyor)



Key Features

- Belt brings the parts into the painting system
- One belt moves the parts along while the other side paints
- Benchmarked from a labeling machine

Backup Slides

FAMU-FSU College of Engineering

FAMU-FSU College of Engineering

- This is 10-point
- This is 15–point Times
- This is 20–point
- This is 25–point
- This is 30–point
- This is 35–point
- This is 40–point
- This is 50–point
- This is 60–point

FAMU-FSU College of Engineering