FAMU-FSU College of Engineering

JTEKT Bearing Painter
VDR 2

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

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Sponsor and Advisor

Engineering Mentor
Joshua Jones
Process Engineer
JTEKT North America

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

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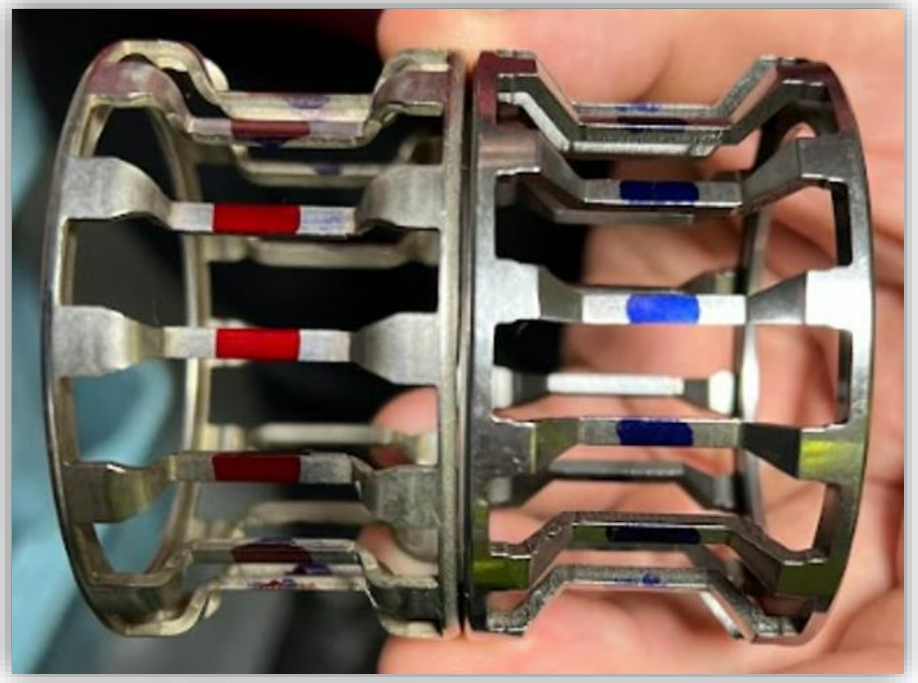
Project Objective



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

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Project Overview

Wesley Jean-Pierre

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Key Goals

Accurately Apply Metal Paint to the Bearing

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

Automate Bearing Painting Process

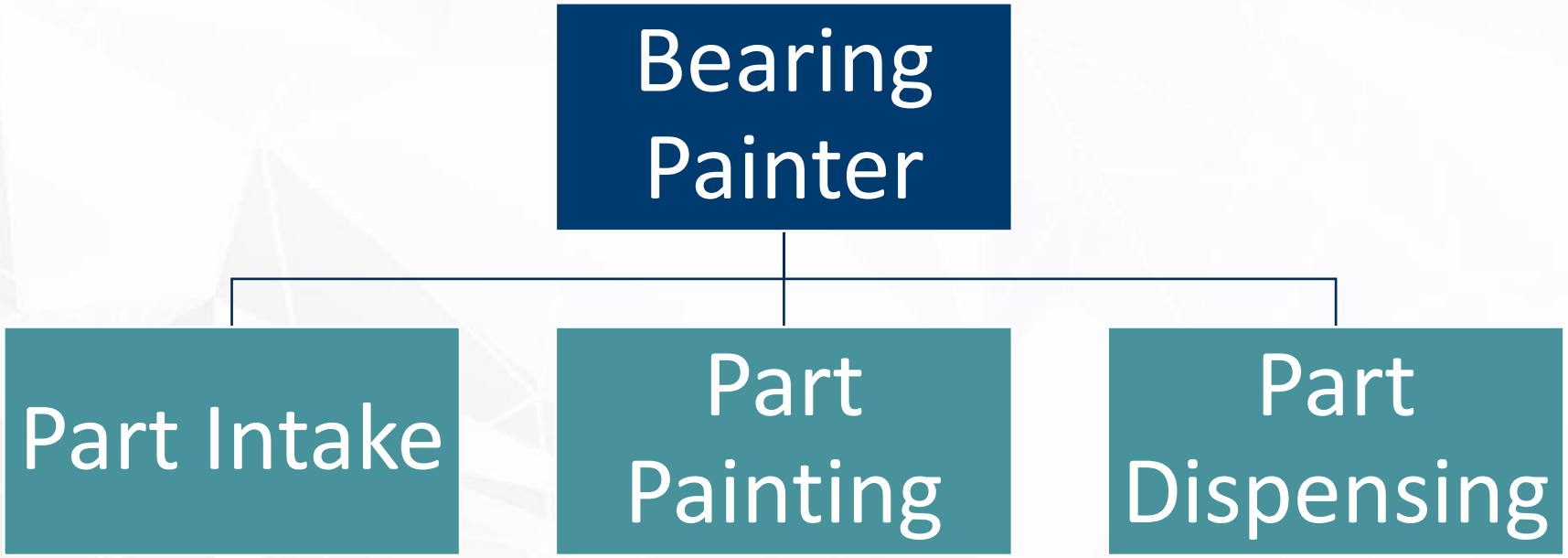
Assumptions

- 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

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



Targets & Metrics

Andrew McClung

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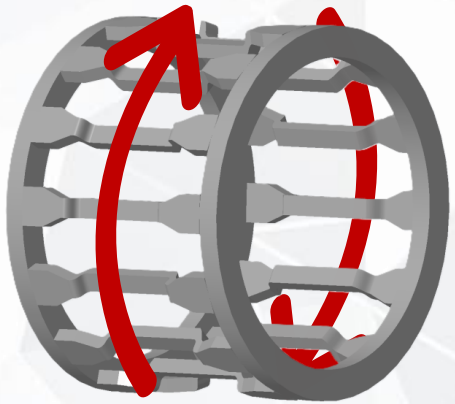
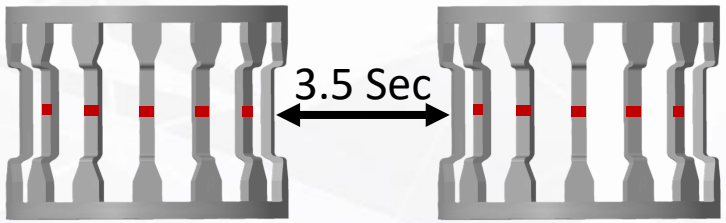
Critical Targets

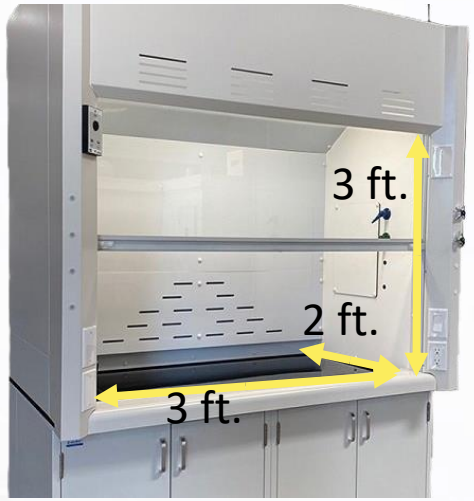
Consistently paint full 360° of retainers

Cycle time of 3.5 seconds

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







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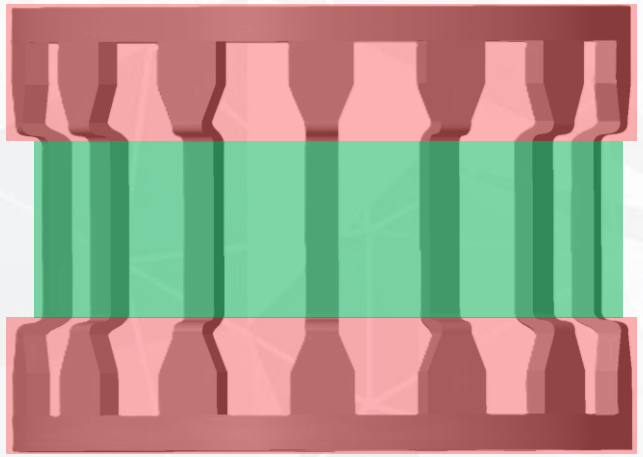
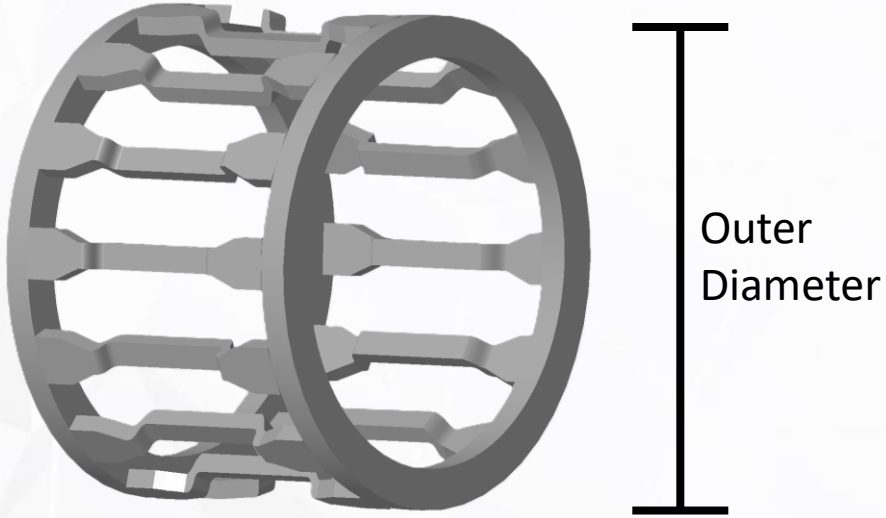
Critical Targets

Limit Extraneous paint on working surface to 1 mm^2



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



Concept Generation

Mason Gibson

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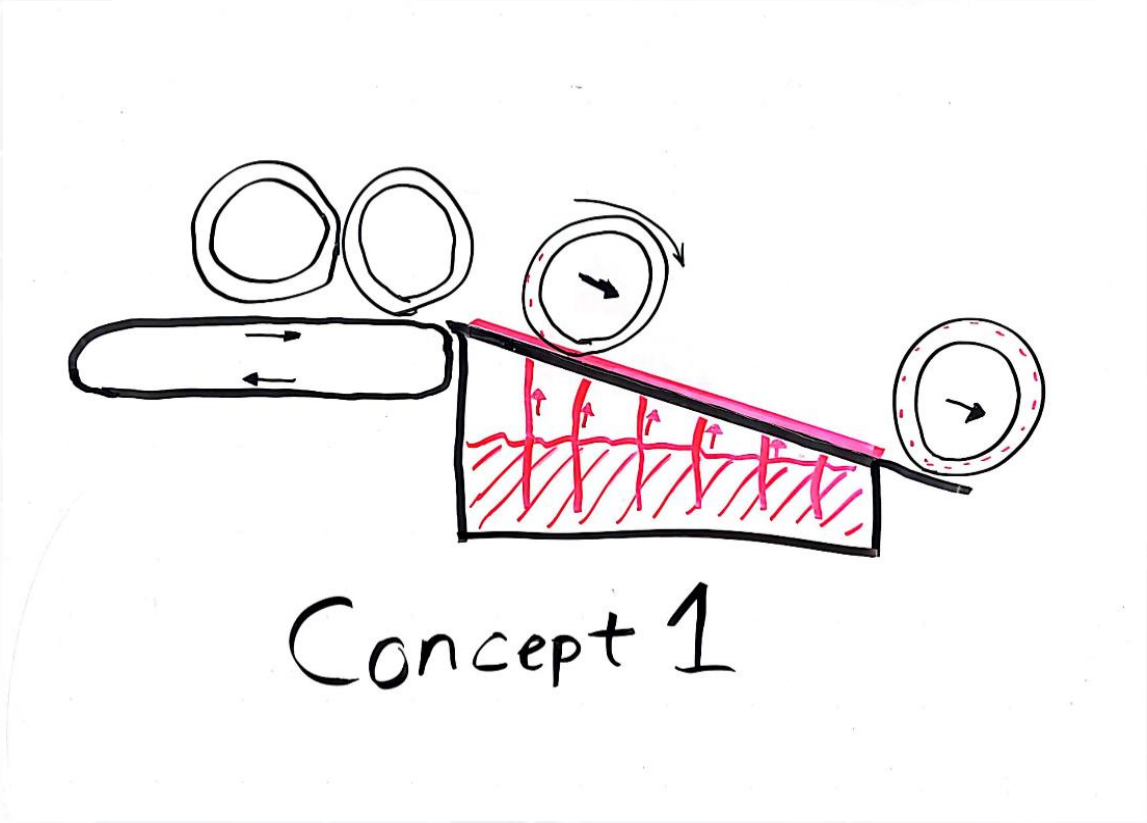
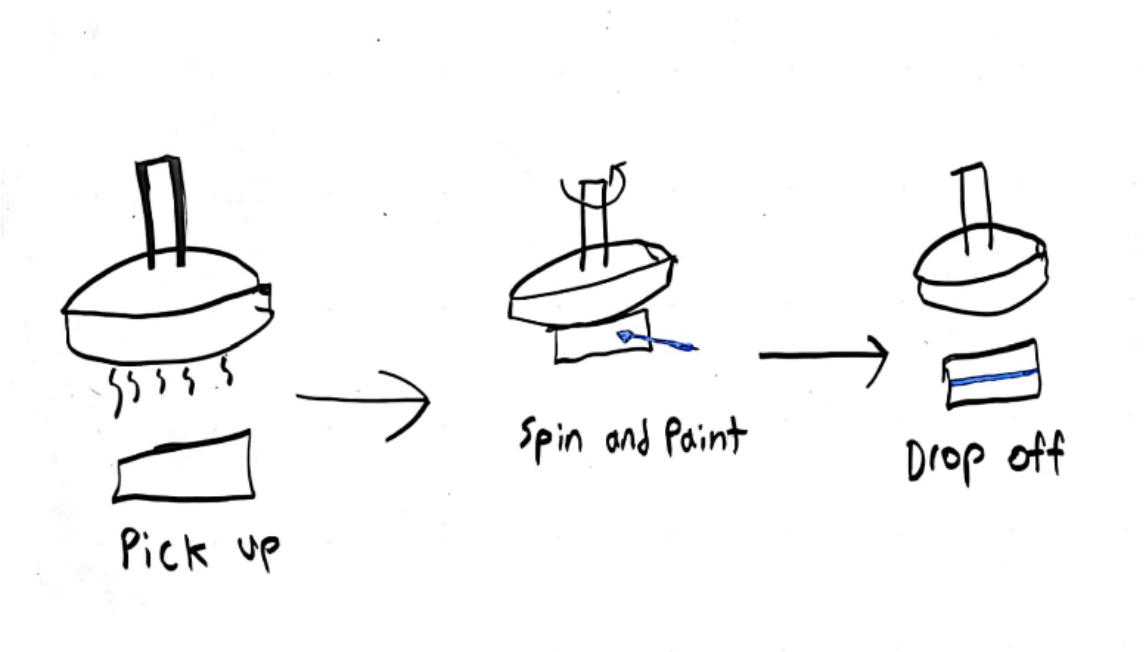
Medium Fidelity Concept 1



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

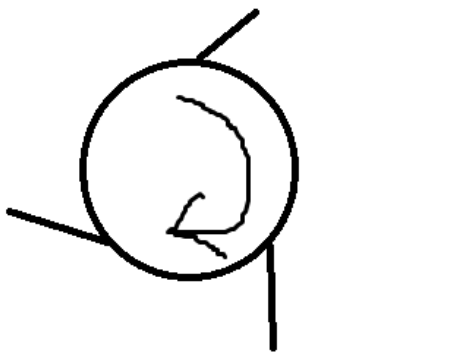
Medium Fidelity Concept 2



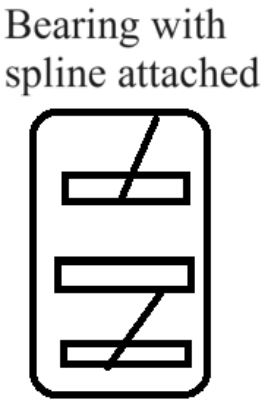
Key Features

- Parts fed by a hopper mechanism
- An electromagnet is activated to pick up the bearings
- The magnet rotates to paint the bearing

Medium Fidelity Concept 3



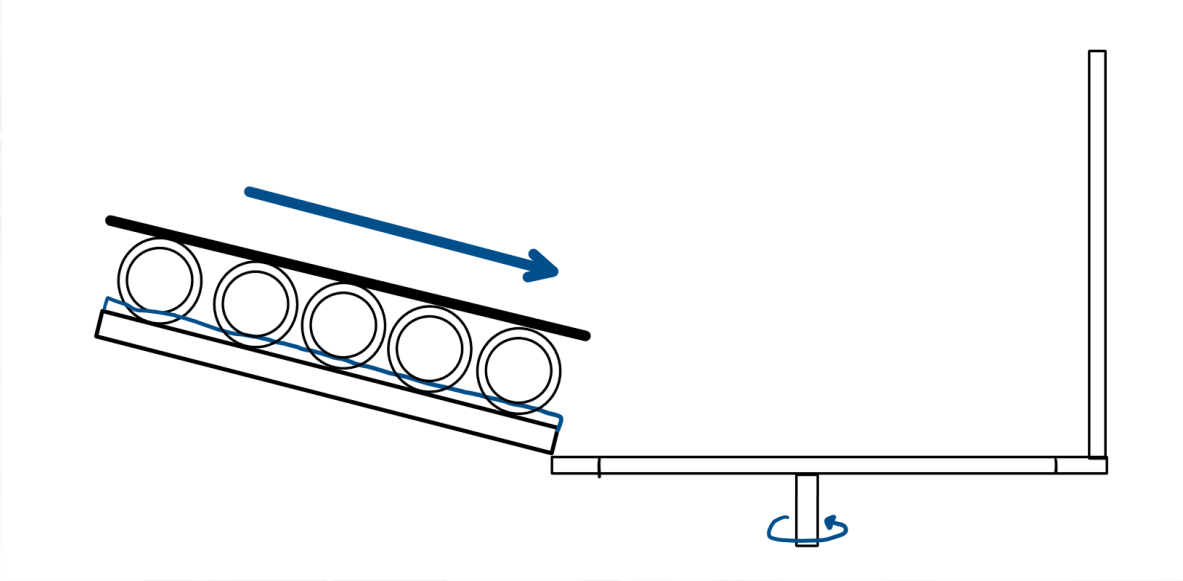
Cylinder with retractable spline



Key Features

- Retractable spline
- Multiple bearings can be stacked down the spline
- The spline is manually loaded

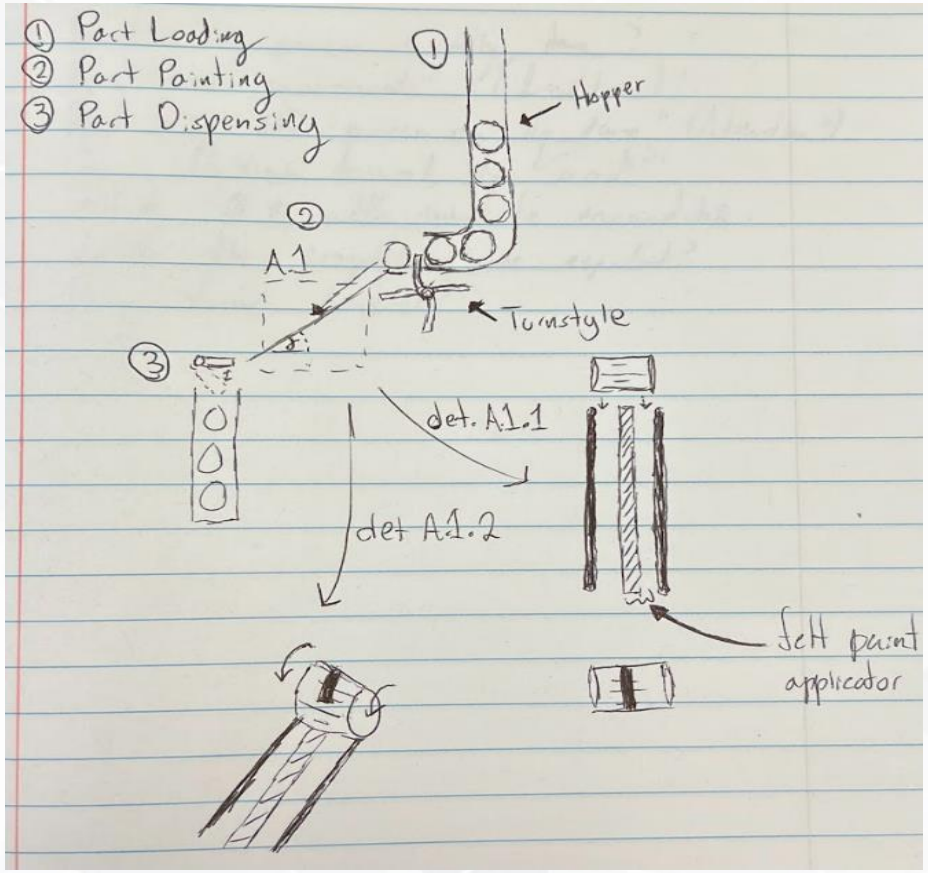
Medium Fidelity Concept 4



Key Features

- Parts roll down an inclined track
- Rotating disk to assist with drying
- Would paint parts in batches instead of continuously

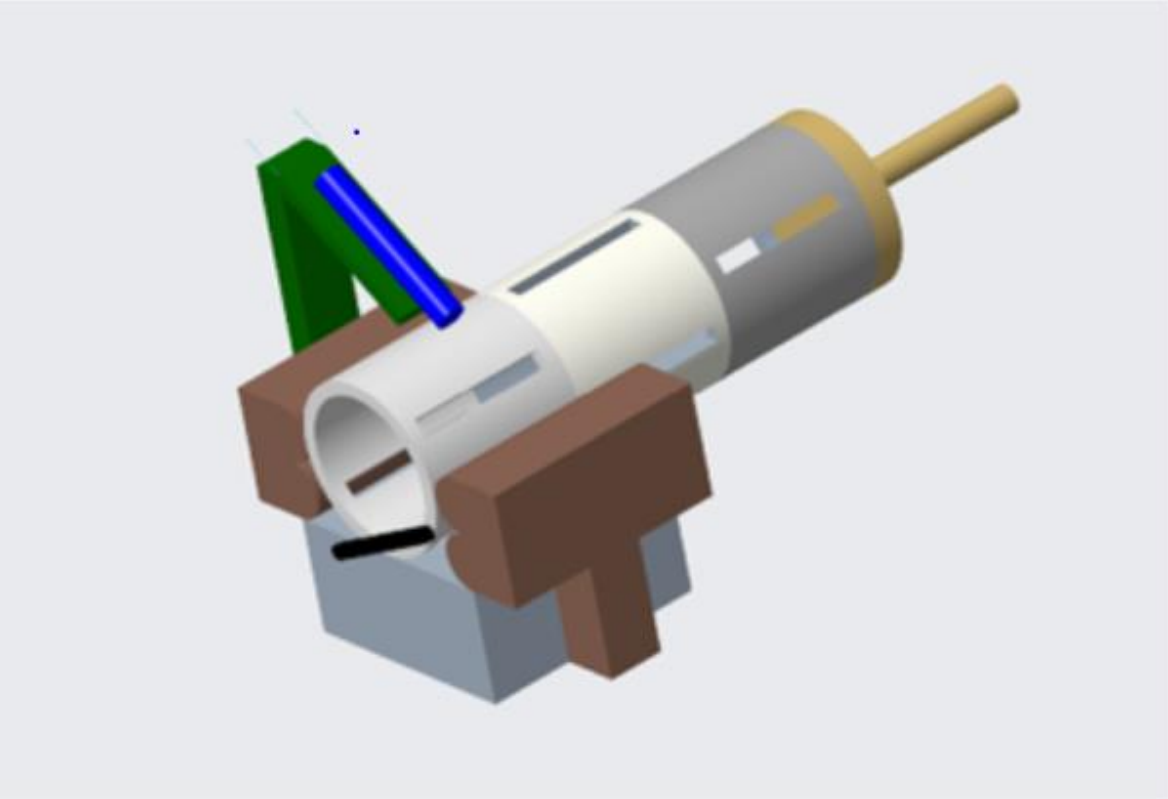
Medium Fidelity Concept 5



Key Features

- Uses a vertical hopper that leads to a turnstile
- Inclined ramp that parts would roll down to get painted
- Finished bearings would stack at the base

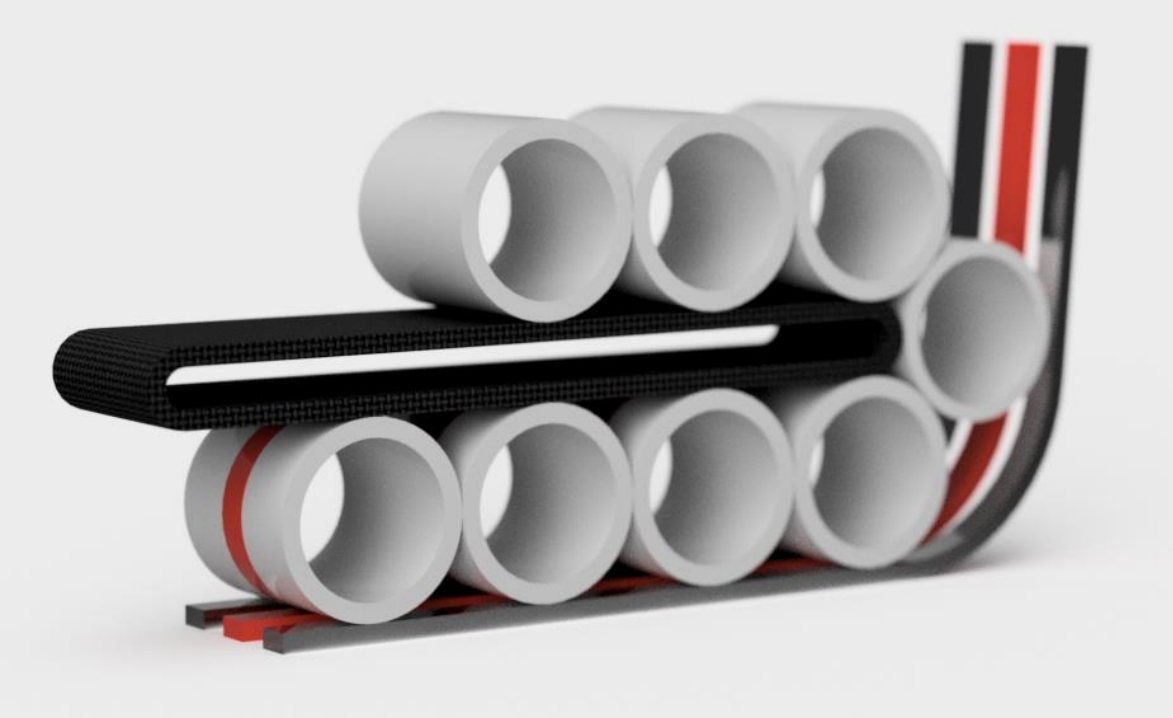
High Fidelity Concept 1 (Linear Processor)



Key Features

- Parts stack in line with a linear actuator
- Part at the end would be pushed on a belt and rotated
- Painting arm that pivots to paint the part

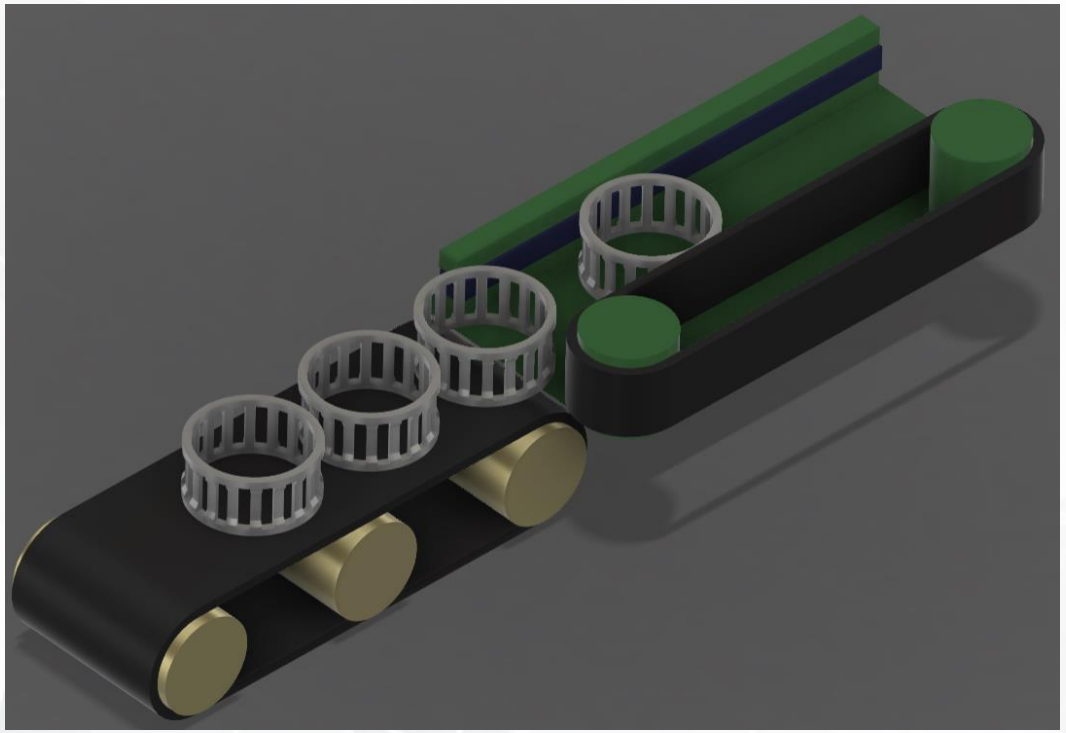
High Fidelity Concept 2 (Inverted Treadmill)



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

Concept Selection

Andrew McClung

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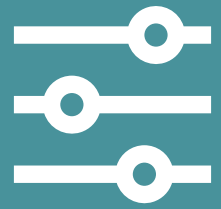
Selection Process

Binary Pairwise Comparison

House of Quality

Pugh Chart



Analytical Hierarchy Process

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

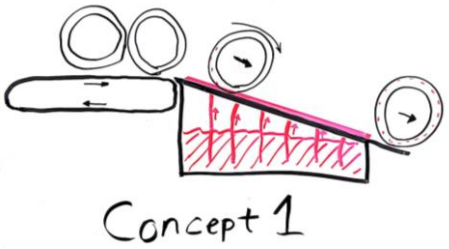
The 3 most important requirements were found to be:

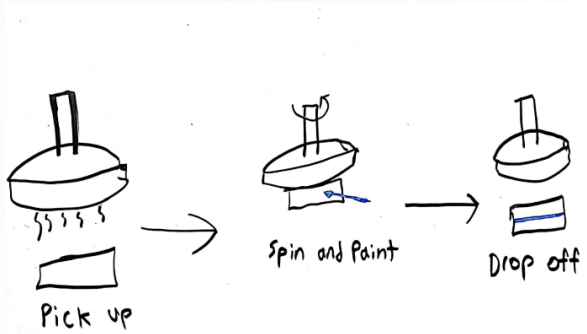
1. Paint correct area
2. Process range of sizes
3. Use multiple colors

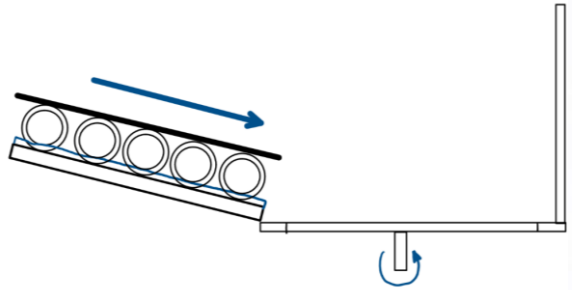
House of Quality

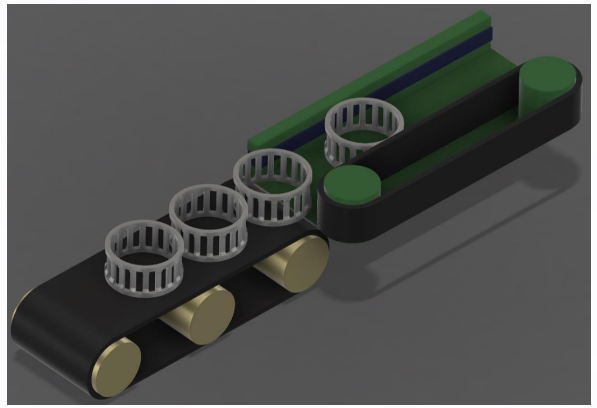
- Production Rate
- Part Intake Limit
- Processing Accuracy
- Automatic Operation %
- Compatibility
- Reliability
- Size
- Maintenance Interval

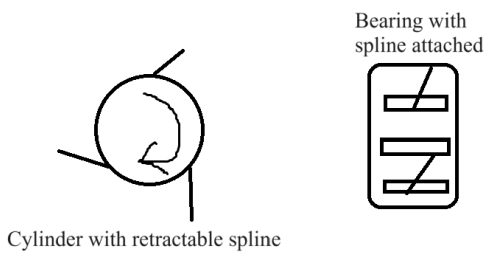
Pugh Chart

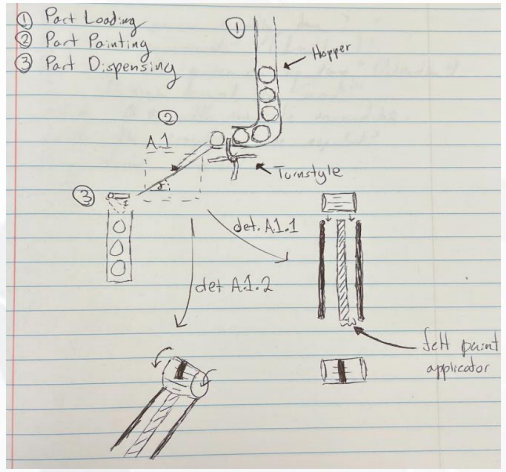




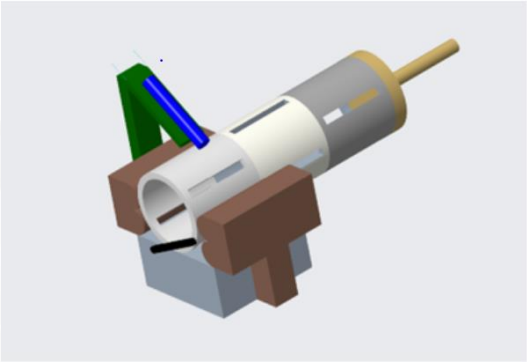


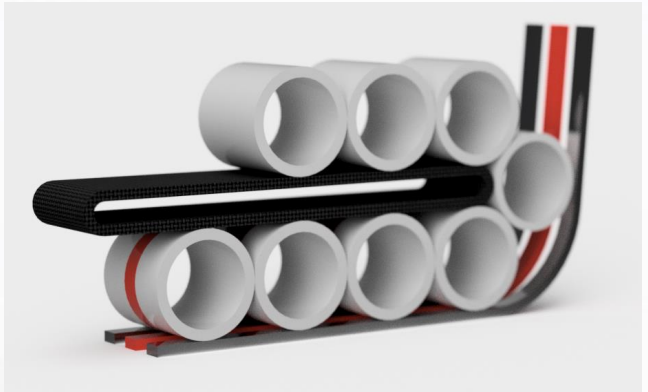






DATUM





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Analytical Hierarchy Process

Function

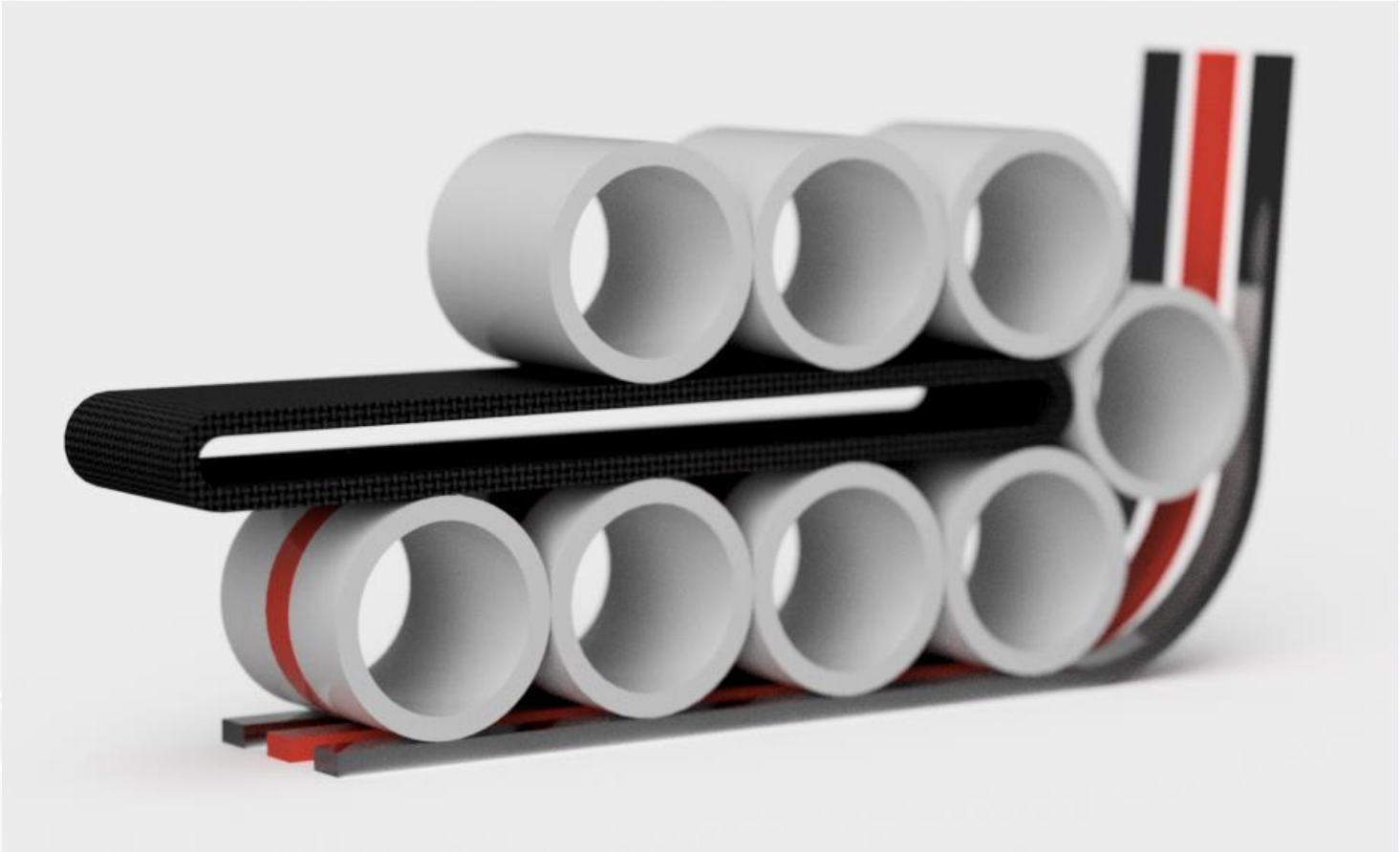
- Utilizes matrices to compare importance of criteria
- Criteria are Engineering characteristics & design concepts

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

Final Selection



"Inverted Treadmill"

Future Work

- Testing with Dykem
- Design Analysis
- Developing CAD Models
- Bill of Materials and Ordering

Questions?

- Team Introduction
- Project Objective
- Project Overview
- Targets
- Concept Generation
- Selected Concept

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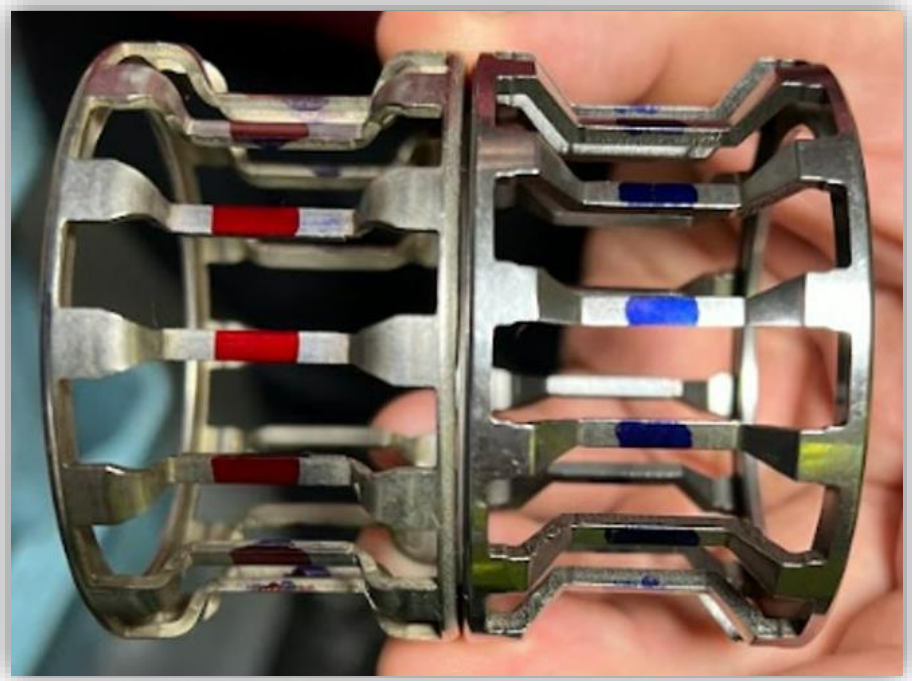
Retainer Painting

Some Customers Require Part Marking
To Help Distinguish Similar Parts

- Low Production Runs

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



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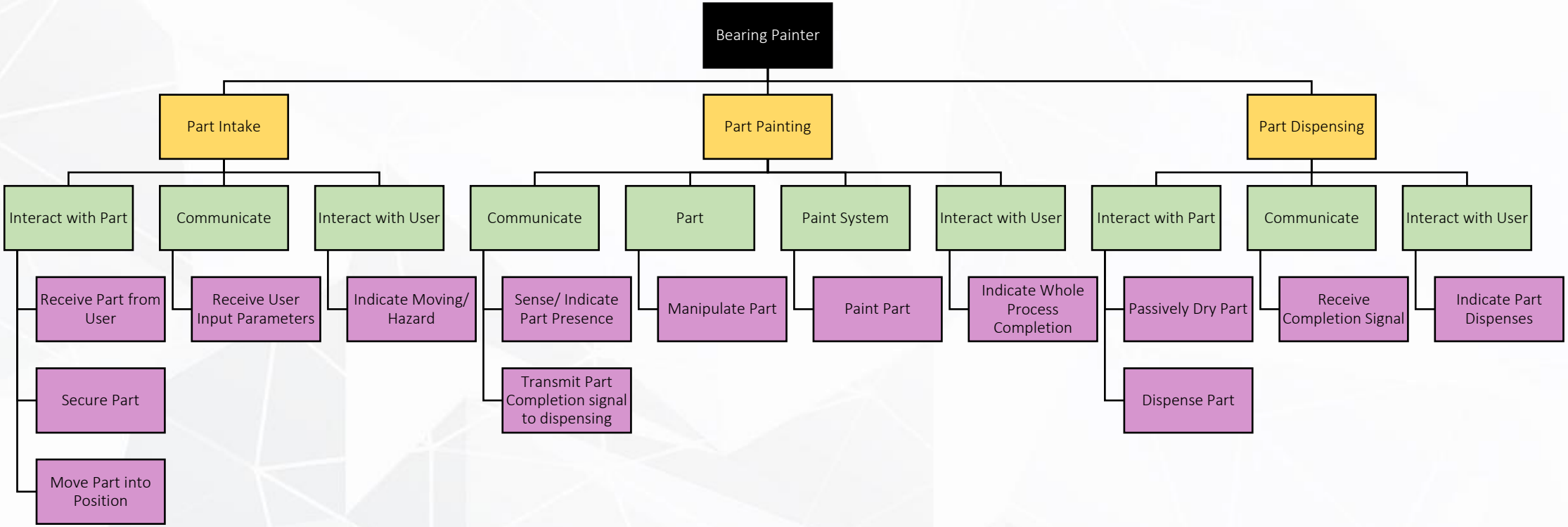
Functions Hierarchy Chart



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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

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

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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

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[C] Matrix							
	Analytical Hierarchy Process	A	A	A	A	A	
B	**Engineering Characersitic**	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

Backup Slides

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- 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

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