



FAMU-FSU
College of
Engineering

JTEKT Bearing Painter VDR 6

Senior Design Team 515



Team Introductions



Mason Gibson
*Manufacturing
Engineer*



Wesley Jean-Pierre
Design Engineer



Max Jones
*Project Manager &
Control Engineer*



Andrew McClung
*Systems Integration
Engineer*



Anthony Wuerth
*Manufacturing &
Design Engineer*



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



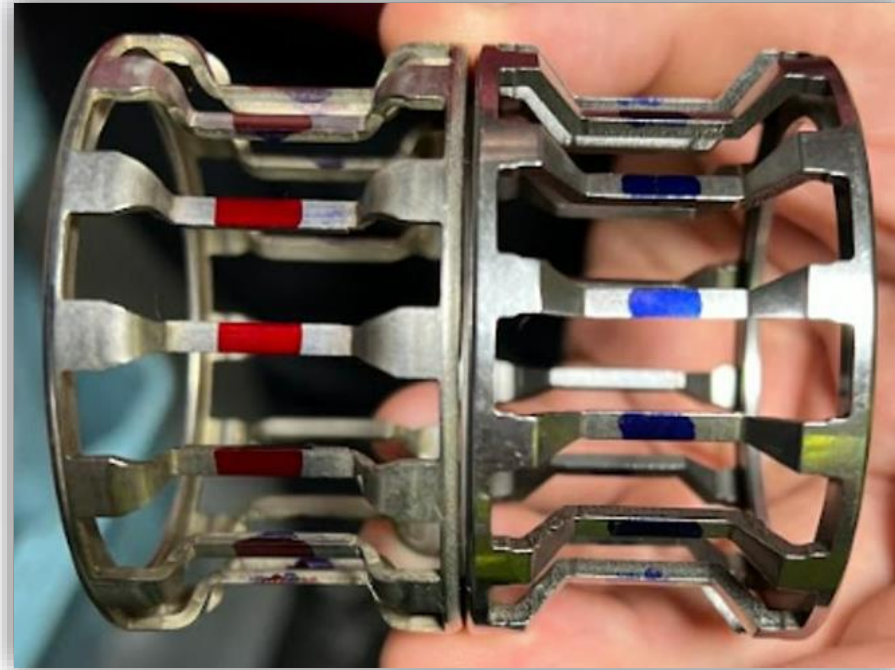
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Project Objective

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



Project Overview

Maximilian Jones



Background

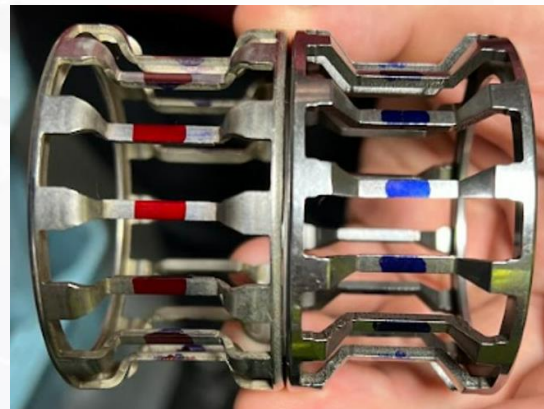
- Creates line contact using rollers
- Commonly used in transmissions
- The retainer houses the rollers



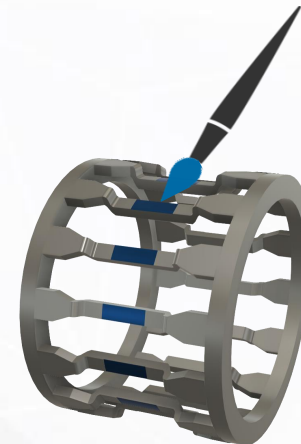
Team 515 – VDR 6

- Paint is used by customers to identify different parts

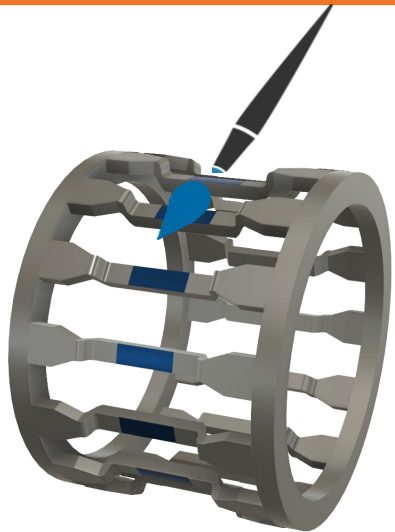
CAT



- Currently hand-painted under a fume hood
- Roughly 200 are needed per month but this may be increasing



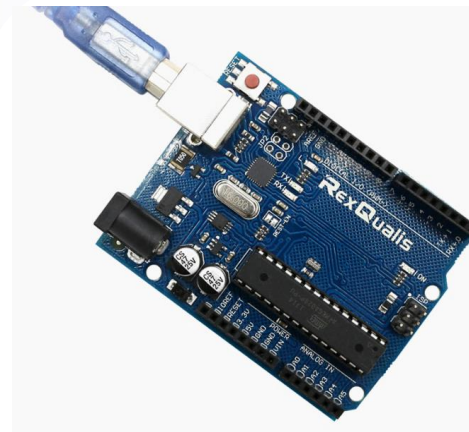
Key Goals



Accurately Apply Metal
Paint to the Bearing

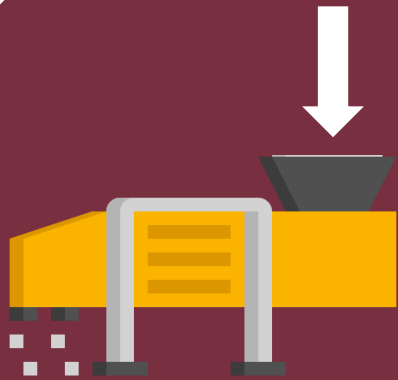


Accommodate Bearings
from 7/8-2 ½ in.
(Outer Diameter)

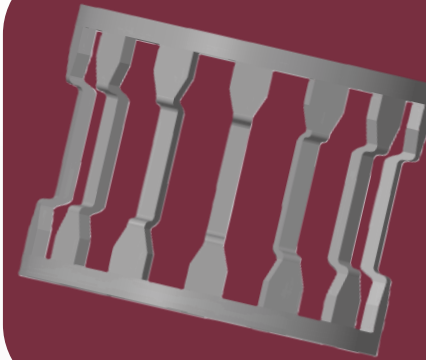


Automate Bearing
Painting Process

Assumptions



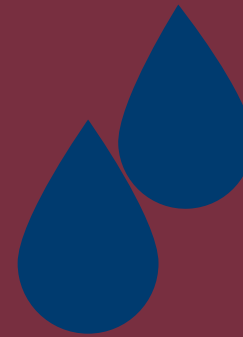
Manually loaded
and unloaded



Loaded with one
type of bearing at
a time



A standard 120V wall
outlet is available



Paint with one color
per load

Customer Design Needs



Accommodate Different
Sized Bearings



Fit Into Existing Fume Hood

Customer Performance Needs



Fully Automated
(except loading)



3.5 Second Cycle Time

10

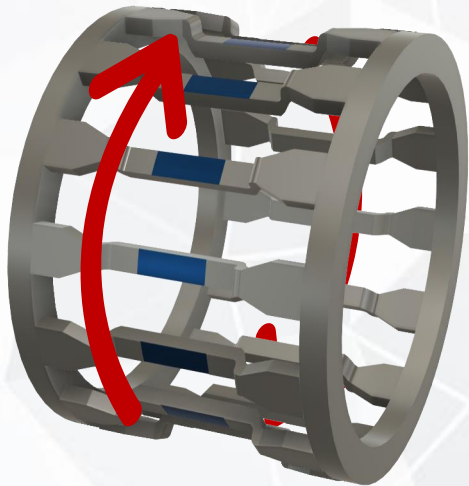
Able to load 10 bearings at a
time



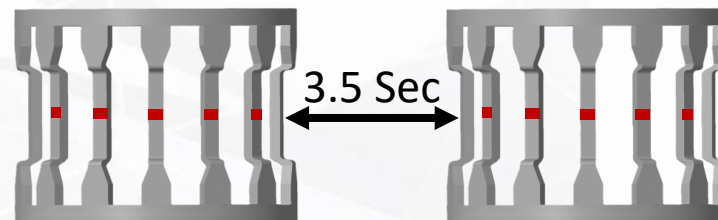
Paint Non-Working Surface
Only

Critical Targets

Consistently paint full 360° of retainers



Cycle time of 3.5 seconds

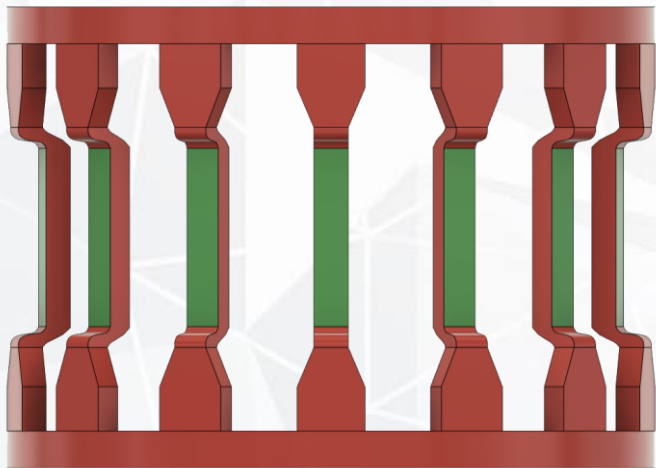


Fit inside a pre-existing fume hood (2ft. X 3ft. X 3ft.)

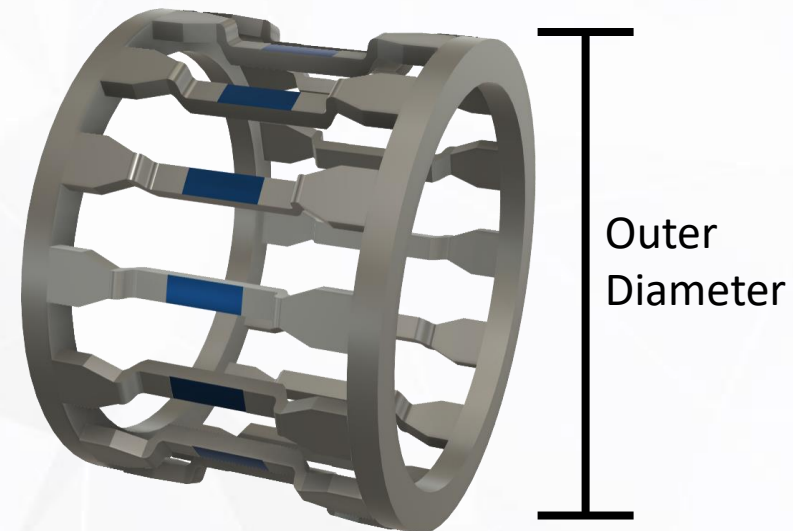


Critical Targets

Limit extraneous paint on working surface to 1 mm²



Accommodate retainers from 7/8 to 2 1/2 inches in diameter

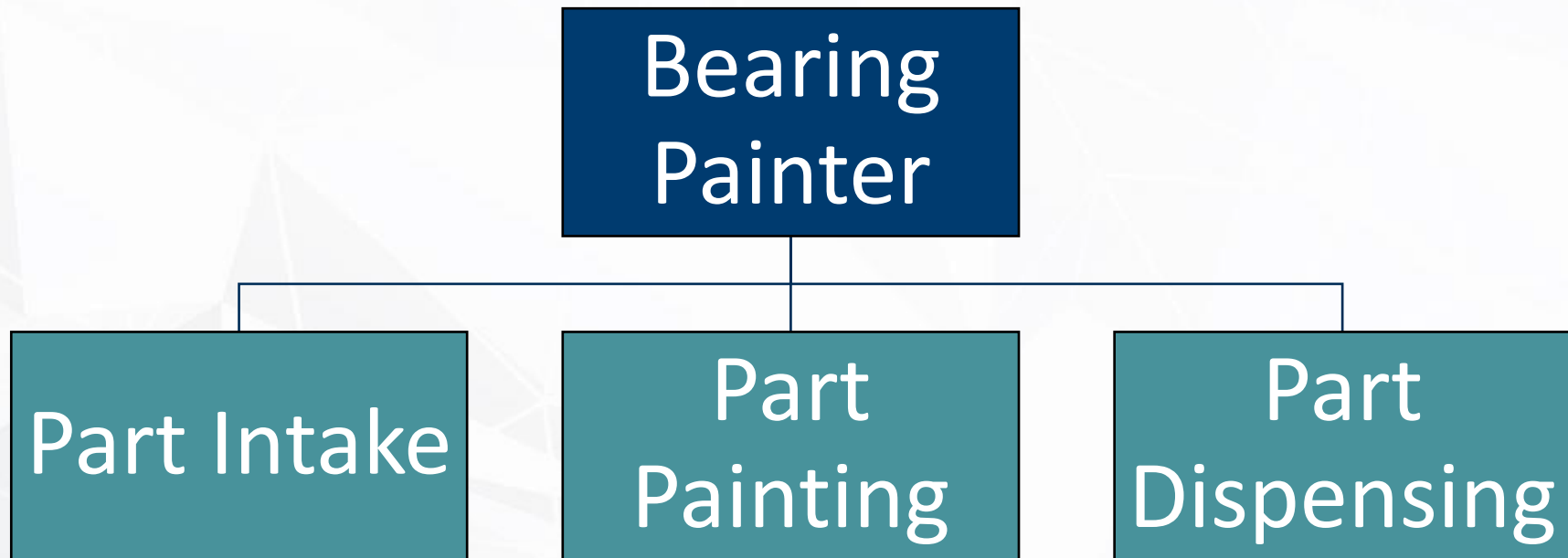


Ideation and Selection

Mason Gibson



Defined Systems



System Responsibilities

Part Intake

- Controls flow of parts into the device
- Allows for easy loading/removal

Part Painting

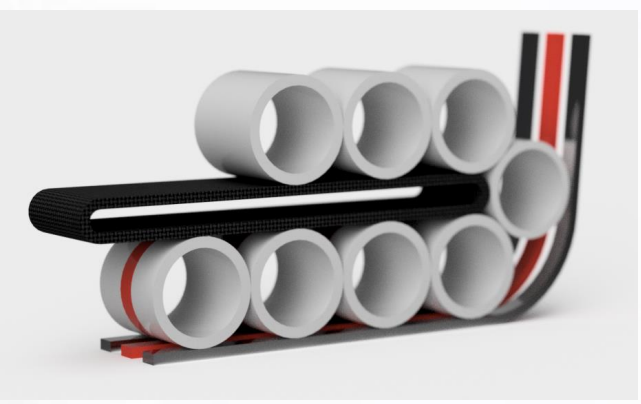
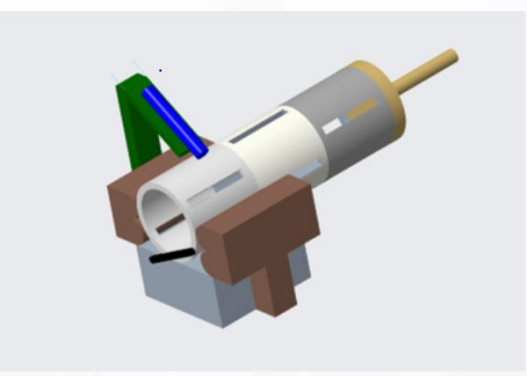
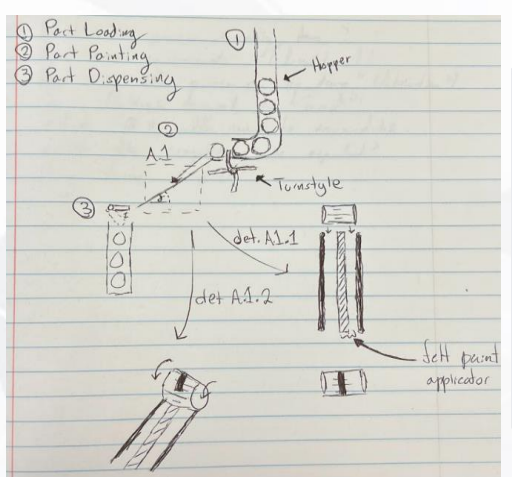
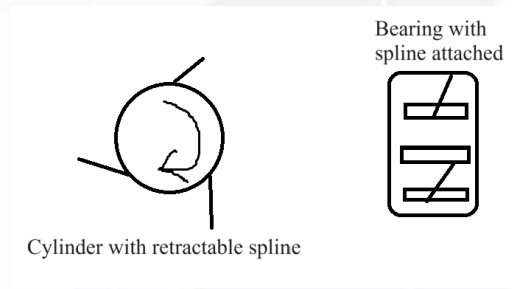
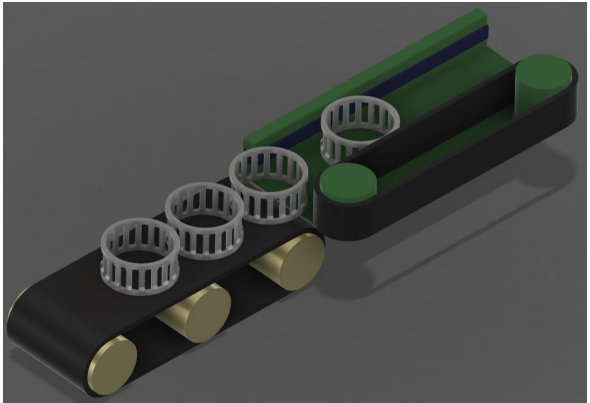
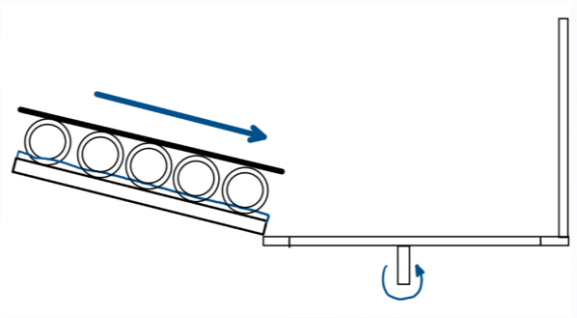
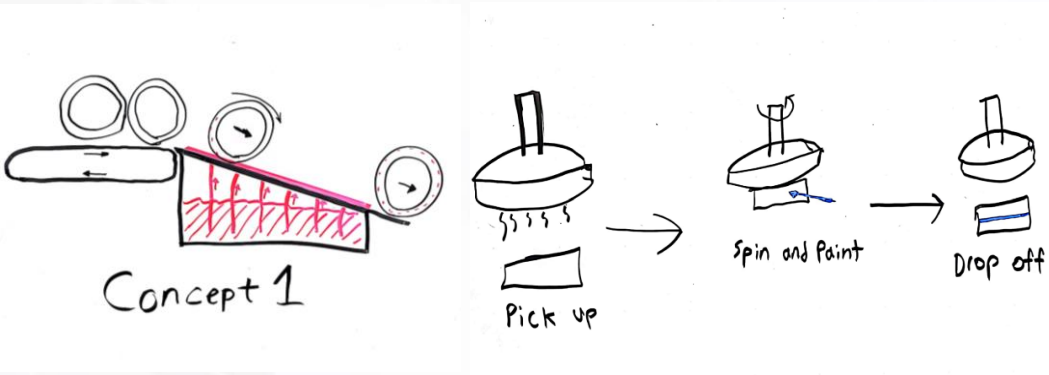
- Paints each part
- Pushes parts from Intake to Dispensing

Part Dispensing

- Maintains integrity of painted surfaces
- Allows for easy removal
- Signals end of cycle



Ideation



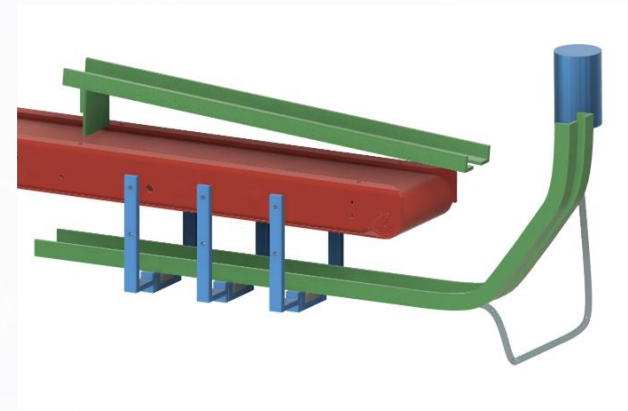
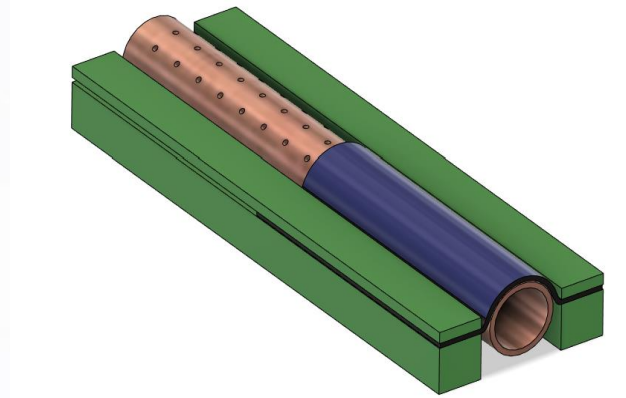
Selected Concept (Inverted Treadmill)



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

Concept Refining

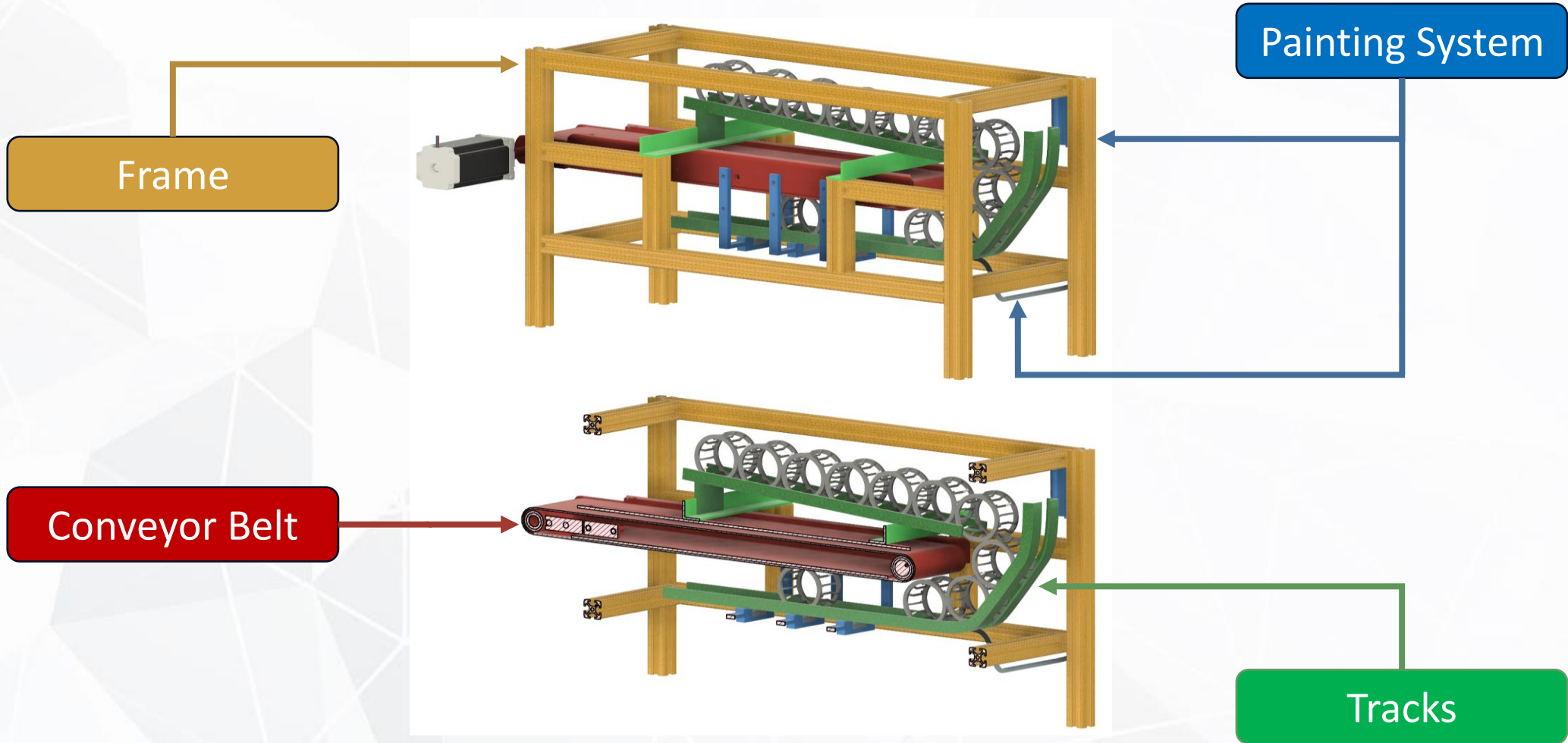


Open Frame
Concept

Pressure Head
Painting System

Removal of Pinch
Point

Final Design Overview



Frame

Frame



Frame

Frame

80/20 Aluminum
Extrusion
Construction



Sturdy

Modular

Adjustable



Conveyor

Conveyor Belt



Conveyor

Conveyor Belt

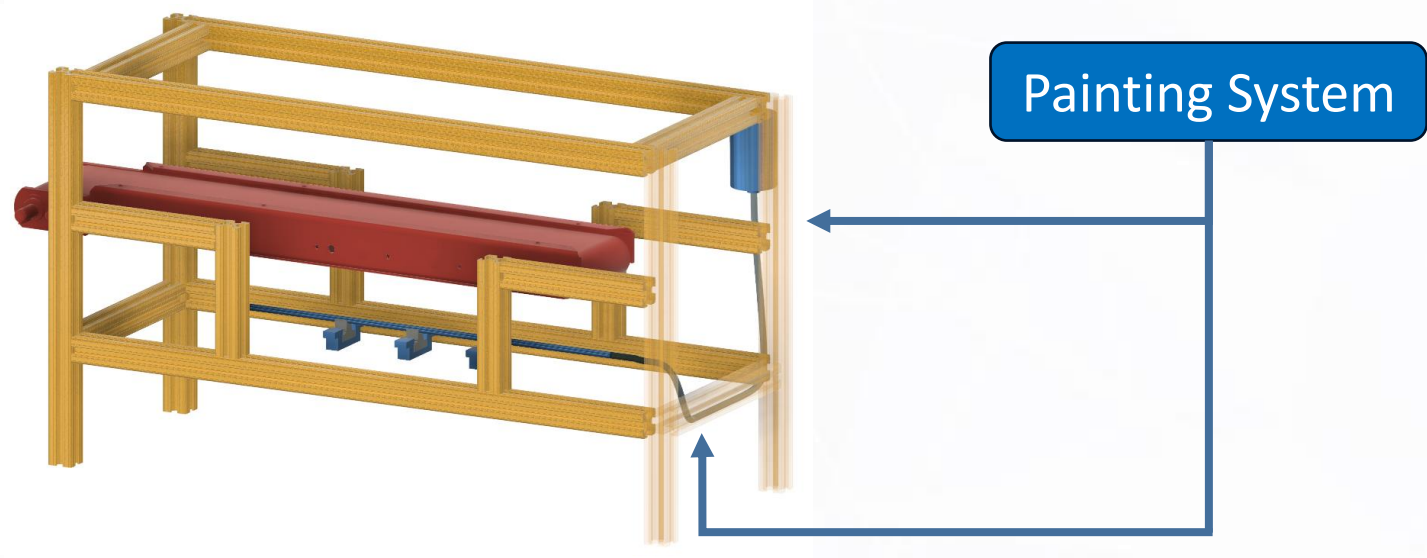


Pre-made Belt and Tensioner Assembly

Reliability

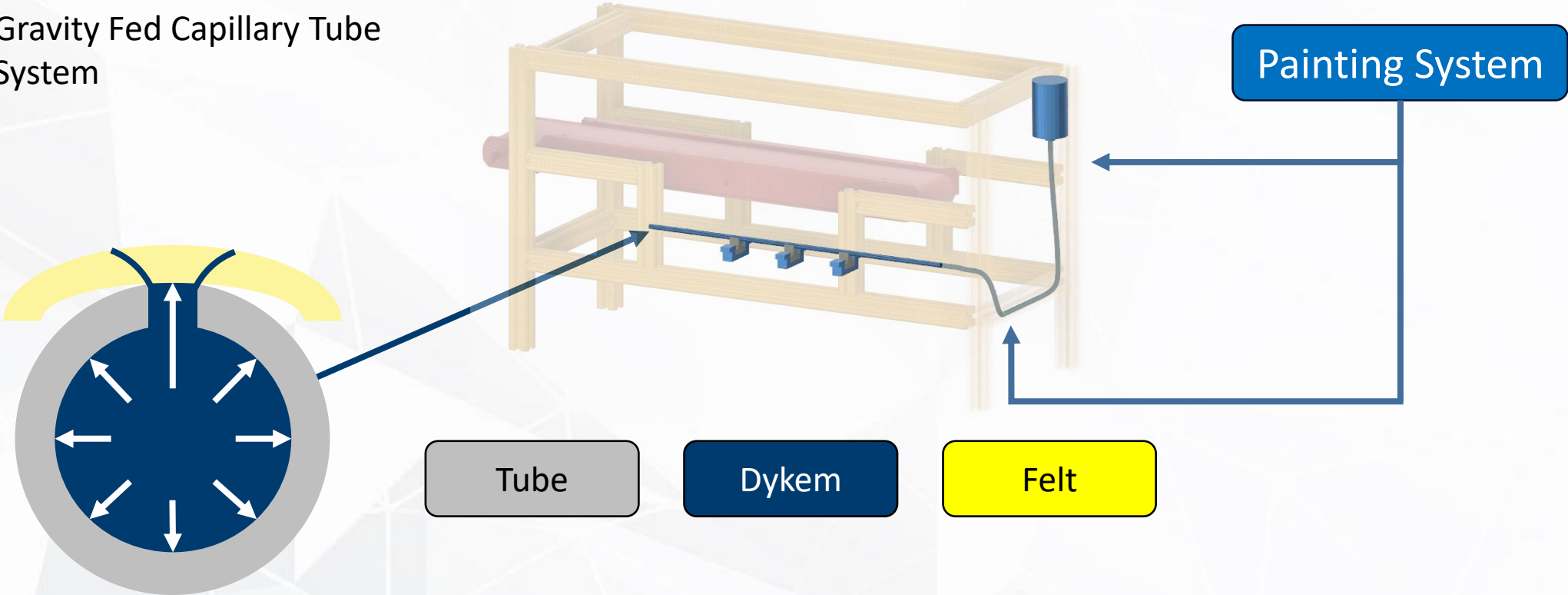
Performance

Painting System



Painting System

Gravity Fed Capillary Tube System



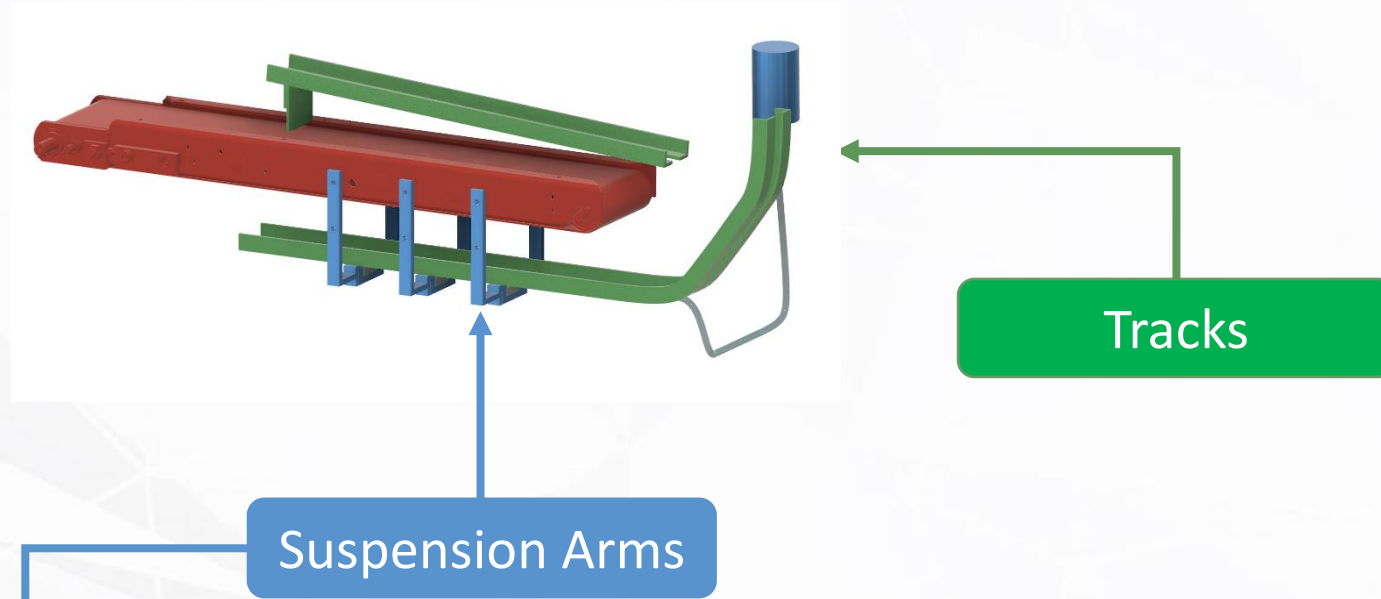
Track System



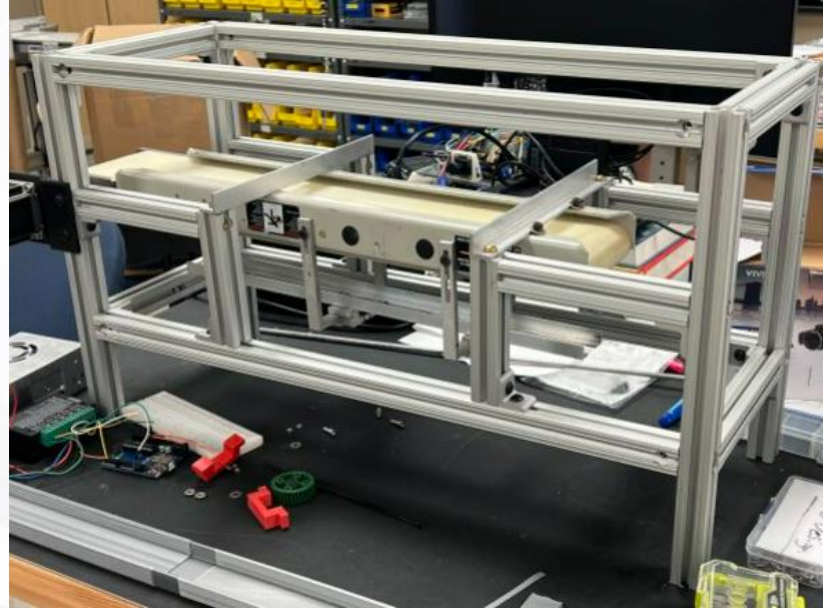
Tracks

Track System

Suspended/Sprung
Aluminum Angle
Construction



Physical Design Overview

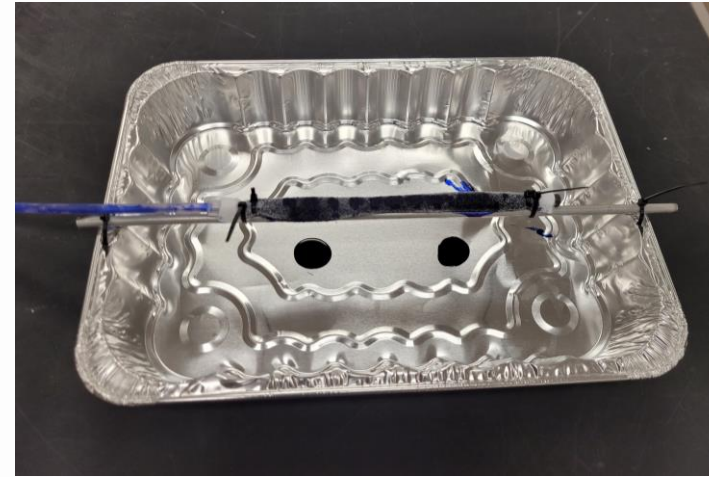


Results

Andrew McClung



Painting System Testing



- Confirmed that the tubing is effective for painting
- Raised concern about directly connecting a bottle of Dykem to the tube

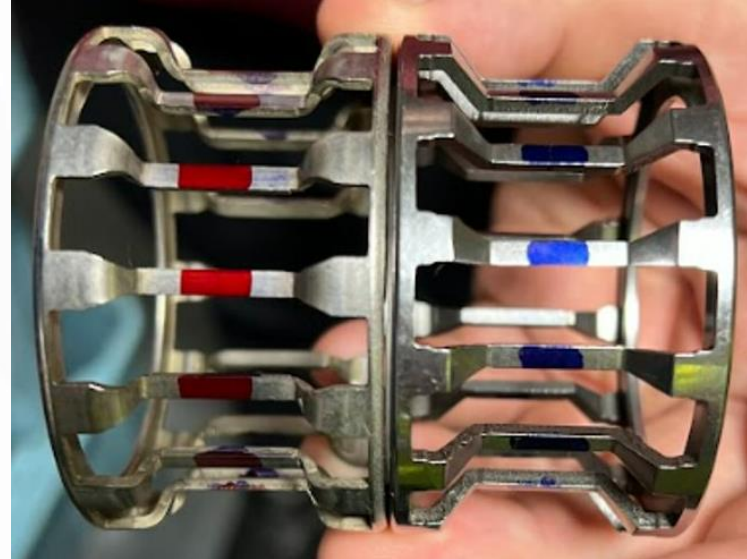
Painting System Testing



Painting System Testing



Machine Processed



Hand Painted at JTEKT

Validation

Target

Result

Paint 360° of retainer

Continuous paint all the way around,
easy to identify the color

3 ½ second cycle time

Anticipate a cycle time closer to 1.5-2.5 seconds
(In the process of testing)

Limit Extraneous paint on
working surface to 1 mm²

Plan on validating next week, will run a full
cycle of 10 bearings and average the results

Retainer diameters
from 7/8 to 2 ½ inches

Accepts bearings from 2.97in to 0.97in
(need 0.10in shim for smallest bearing)

Fit in fume hood
41in x 24in x 18in

Project dimensions are 29.5in x 15in x 14.5in,
this leaves plenty of room for the user to operate

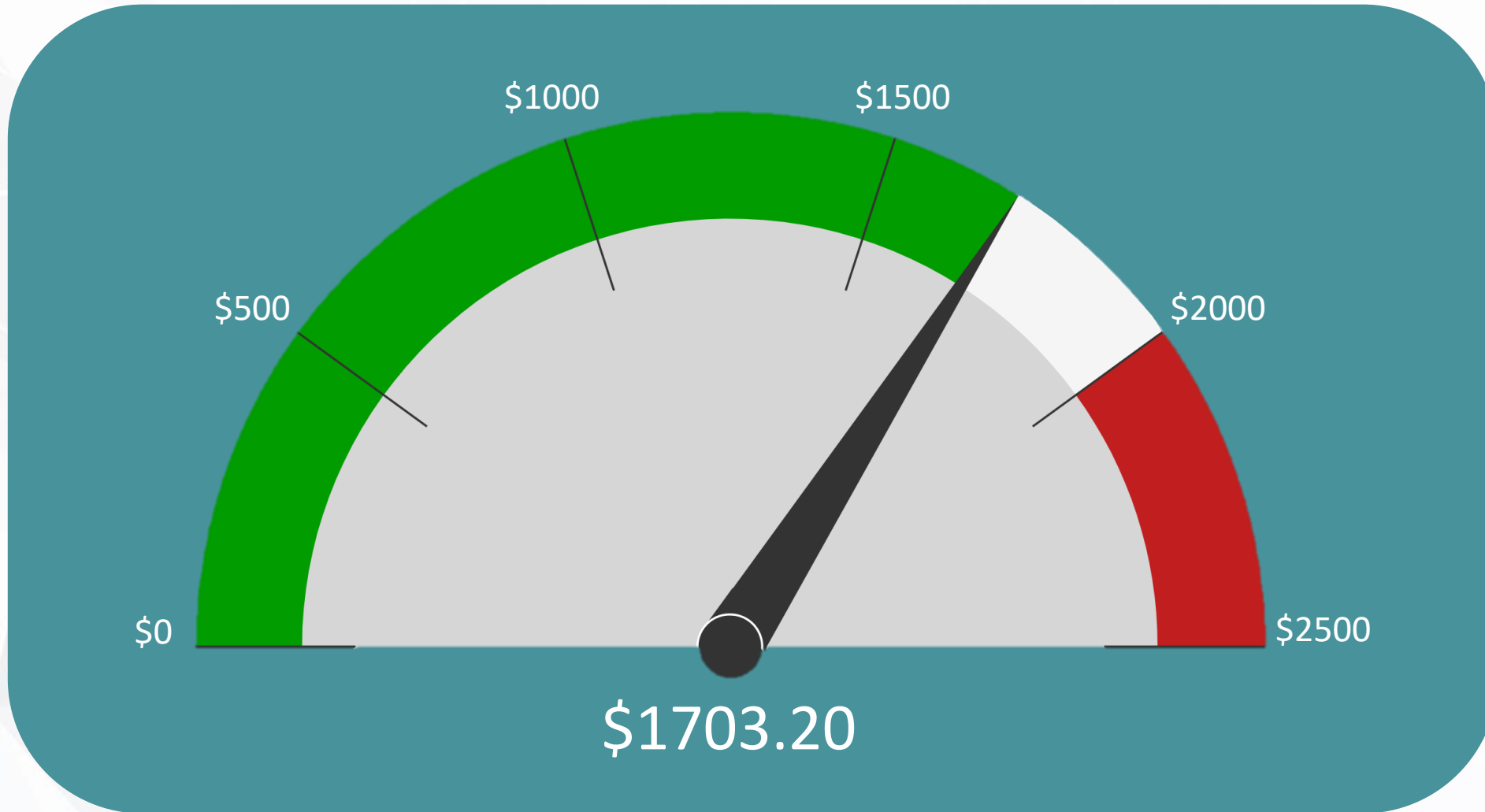


Budget

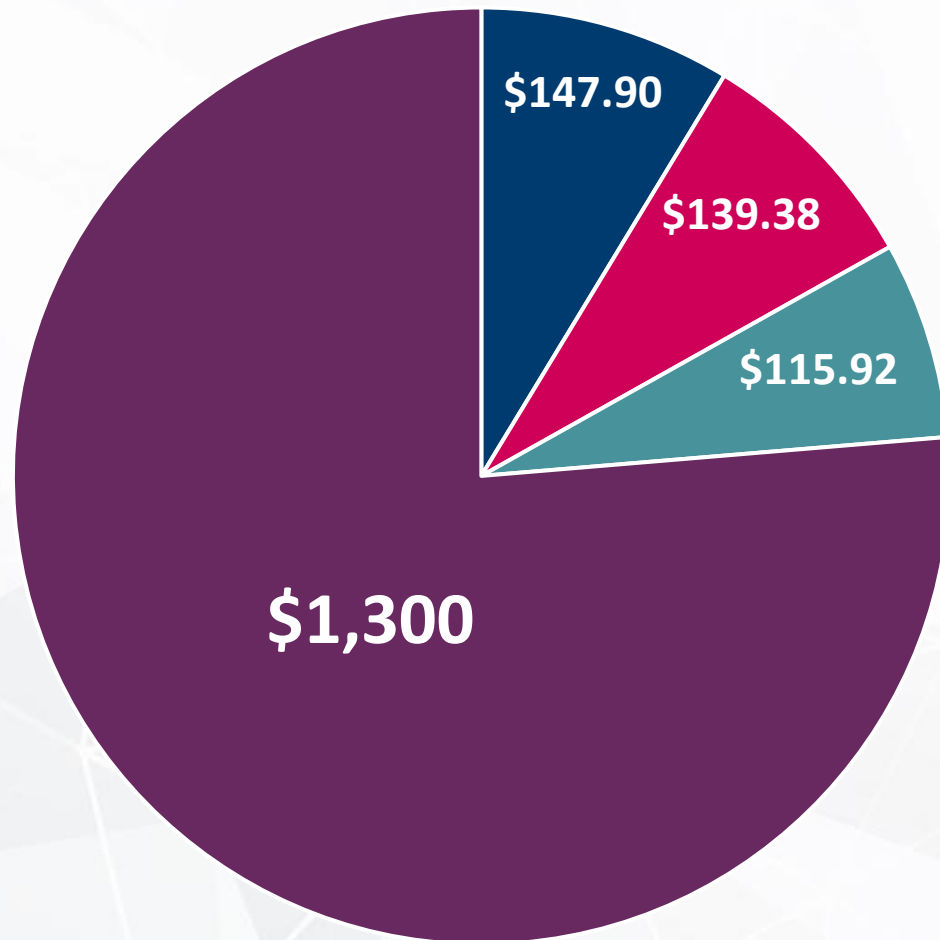
Andrew McClung



Project Budget



Project Budget



- Structural Components
- Paint System Components
- Electrical Components
- Conveyor Belt



Project Budget

Name	Unit Cost	Quantity	Total
Aluminum Extrusion	\$5.30 /ft.	19 ft.	\$100.70
Corner Bracket	\$2.36	20	\$47.20
Felt Strip	\$2.59 /ft.	50 ft.	\$129.50
Aluminum Pipe	\$9.88 /ft.	1	\$9.88
AC to DC power supply	\$59.00	1	\$59.00
Stepper Motor	\$23.02	1	\$23.02
Stepper Motor Driver	\$20.00	1	\$20.00
Microcontroller	\$13.90	1	\$13.90
Conveyor Belt	~ \$1300	1	~ \$1300
			\$1703.20



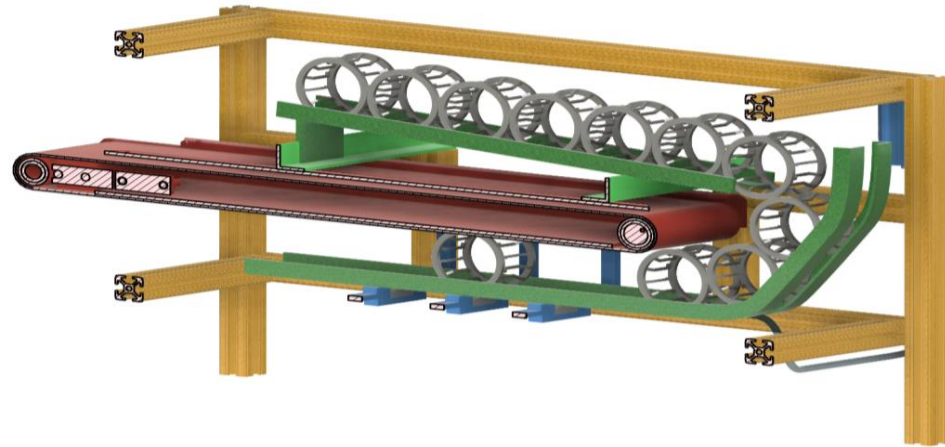
Closing Content

Wesley Jean-Pierre



Incomplete Work

- ◆ **Part Intake**
 - ✓ Installing intake system
- ◆ **Part Dispensing**
 - ✓ Installing dispensing system
- ◆ **Electrical**
 - ✓ Installing toggle switch
- ◆ **Testing**
 - ✓ Testing a batch of 10 bearings together
 - ✓ Switching between different colors of Dykem



Lessons Learned

Lesson 1

Lesson 2

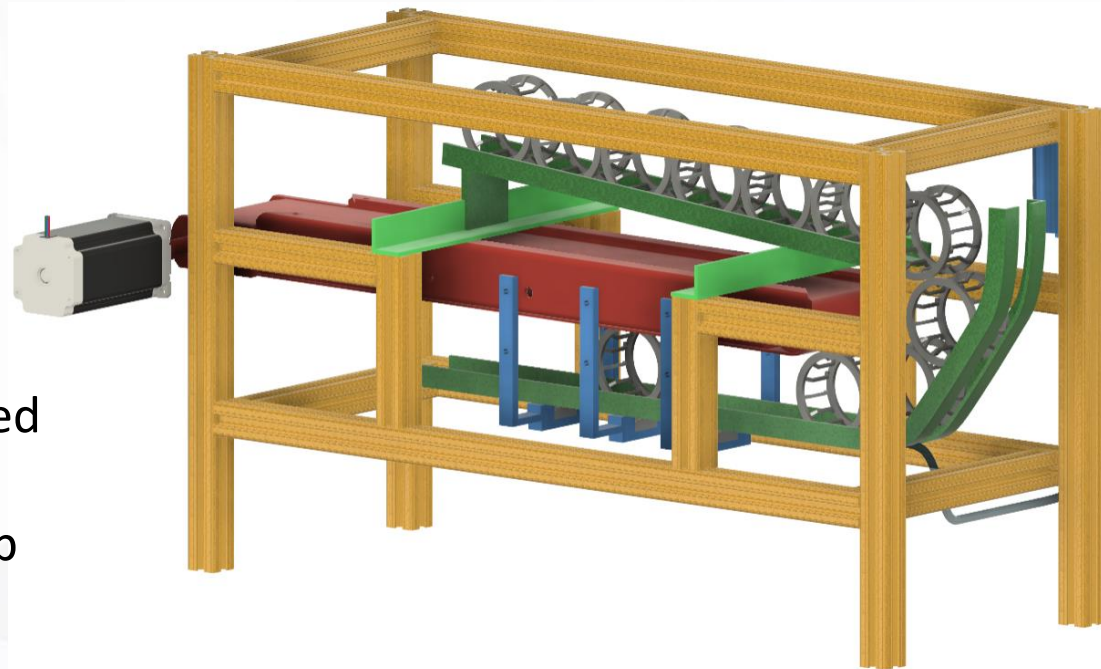
Lesson 3

Lesson 4



Summary

- ◆ **Objective**
 - ✓ Automate the process of painting needle bearing retainers
- ◆ **Targets**
 - ✓ Fully operational retainer painting device under \$2000
- ◆ **Design**
 - ✓ A motor, conveyor, and track mounted to an aluminum frame, which rolls the retainers over a felt painting strip
- ◆ **Outcome**
 - ✓ A design that successfully paints bearing in the nonworking surface area



Questions?



Team Introduction



Project Overview



CAD Model



Results



Budget



Contacts



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Team 515 – VDR 6



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Backup Slides

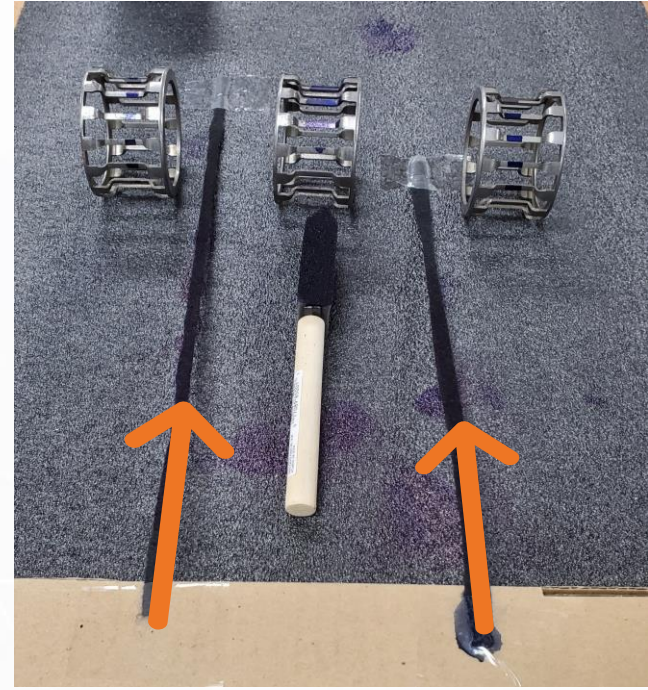
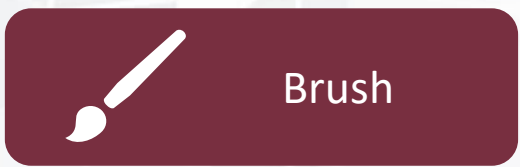


Product Budget

Name	Unit Cost	Quantity	Total
QC Conveyors IS125	~ \$1300	1	~ \$1300
Felt Strip, 2 in. wide, 1/16 in. thick	\$2.59 /ft.	50 ft.	\$129.50
1 in. x 1 in. T-slot Aluminum Extrusion	\$5.30 /ft.	19 ft.	\$100.70
Mean Well AC to DC power supply	\$59.00	1	\$59.00
Inside Corner Bracket for T-slot framing	\$2.36	20	\$47.20
NEMA 23 Stepper Motor	\$23.02	1	\$23.02
TB6600 Stepper Motor Driver	\$20.00	1	\$20.00
RexQualis Uno R3 board	\$13.90	1	\$13.90
Al 6061 1/8 in pipe	\$9.88 /ft.	1	\$9.88
			\$1703.20



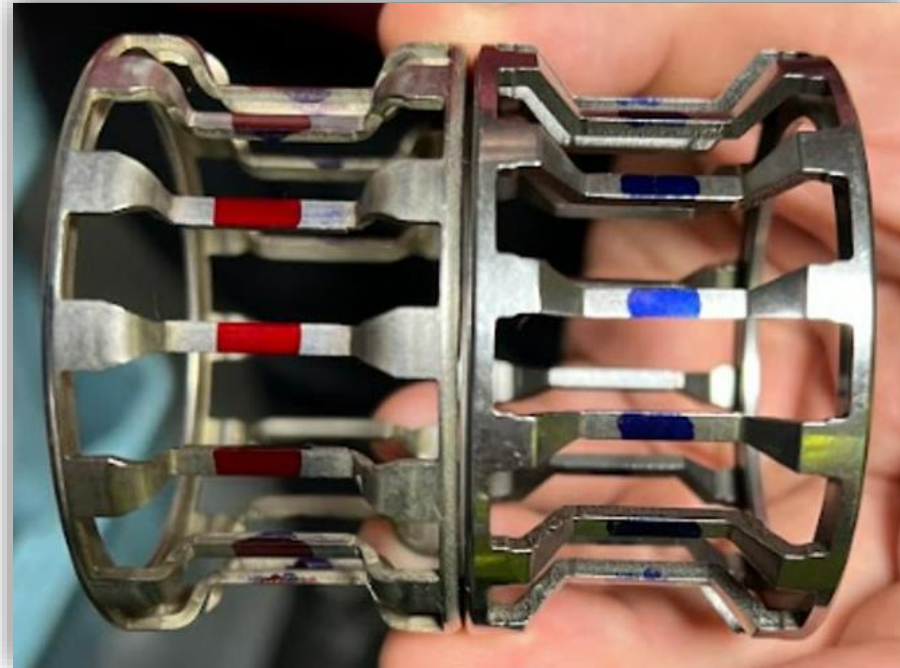
Testing Procedure



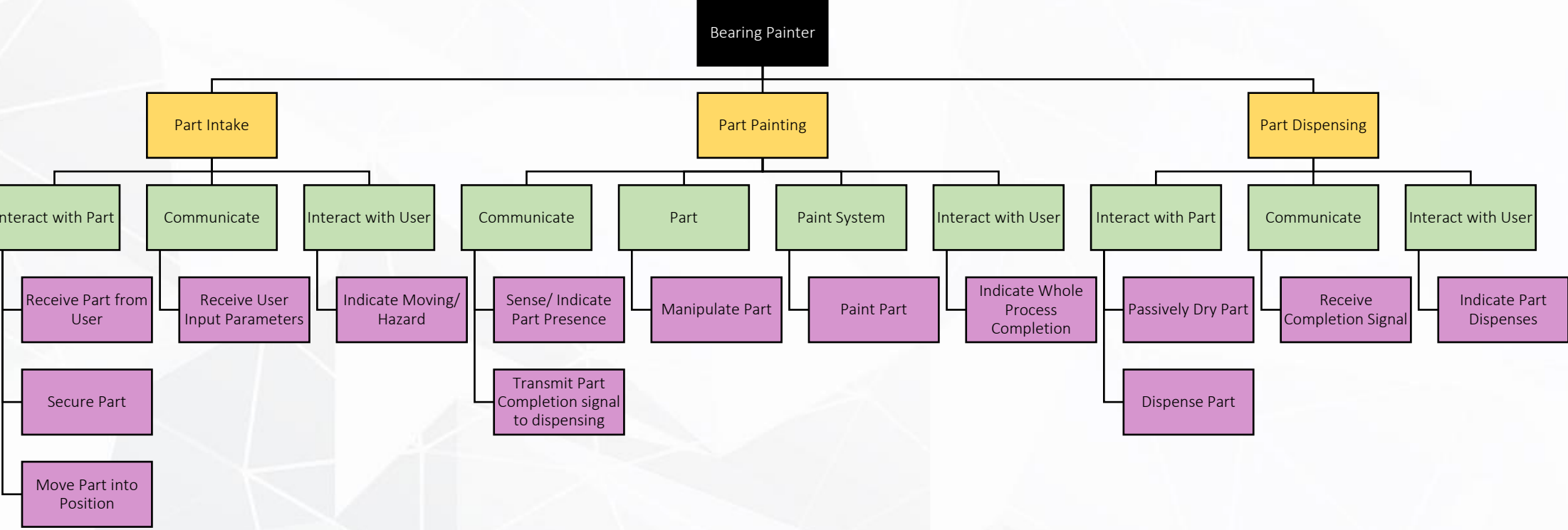
Retainer Painting

Some Customers Require Part Marking To Help Distinguish Similar Parts

- Low Production Runs
- Tedious, Manual Process
 - Operator Pulled From Position
 - Decreased Efficiency



Functions Hierarchy Chart



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	$n - 1 = 7$



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



House of Quality

Production Rate

Part Intake Limit

Processing Accuracy

Automatic Operation %

Compatibility

Reliability

Size

Maintenance Interval



Concepts									
Engineering Characteristics	RANDBRIG HT 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 Processor	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



[C] Matrix

[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

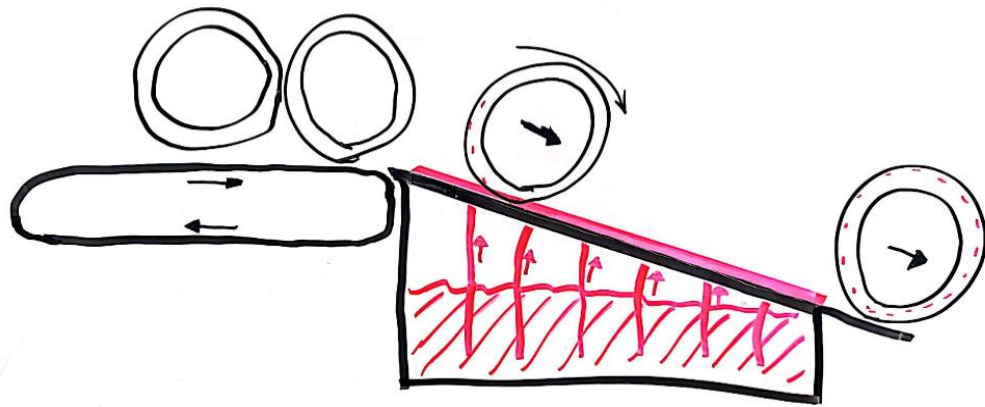


Results

- 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

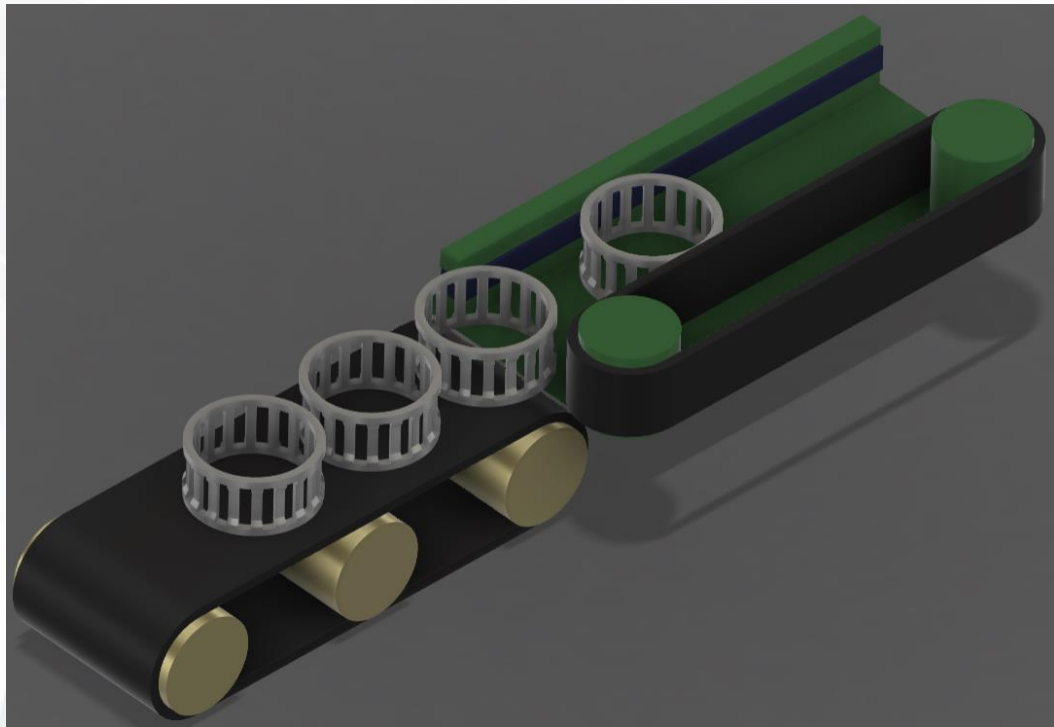


Concept 1

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 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



- 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 ⁶¹

