

UNIVERSITY OF OTTAWA
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GNG1103 Design Project – Deliverable C
Group C2

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Wrike Snapshot Link:

<https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=0NAxNDcSR5yLIM3E0eVZ6Bg7ae4CYUo4%7CIE2DSNZVHA2DELSTGIYA>

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A. DESIGN CRITERIA

Table 1. Design Criteria

#	Need	Design Criteria
1	Automatically scan and navigate to remove the rust, spray coating or paint	Sensor (scan the geometry) Blaster (remove the rust or spray paint)
2	No technical experience required to use	Can be operated and supervised by one person.
3	Should be light and compact as possible	Size Weight (kg)
4	The arm is flexible	Degrees of freedom
5	The range of motion is around 1 meter	Length (m)
6	Can withstand significant pressure and temperature	Pressure (Bar) Temperature (°C)
7	The device is low cost	Cost (CAD)
8	The device must be able to finish the work in a certain period of time	Time (hours)
9	Safety	Number of pinch points
10	The device can operate in a significant period of time	Product life (years)
11	The product is capable of resisting corrosion and UV	The material used to make up the device.

Functional Requirements

- Removes rust from the Halifax Class
- Holds a sensor to see in low-oxygen, tight, wet spaces
- Sprays coating and spray paint
- Open source
- 3-D printed design
- Coded with Python or C++
- Easily run by someone with a high school level of education.
- Mounted on the ground
- Must hold spray painter and sensor

Constraints

- Size
- Weight
- Degrees of freedom
- Time to paint a 2 ft by 2 ft area
- Range of motion
- Withstand pressure
- Withstand temperature
- Cost

Non-Functional Requirements

- The visualized figure of the device.
- The life span of the product.
- The capability of resisting to corrosion and UV
- The device can be put mounted in different manners.
- The number of pinch points designed for the physical product.

B. BENCHMARKING

Table 2. Comparison of Existing Products

Device Name	<u>Magician</u>	<u>MPX 3500</u>	<u>KF121</u>
Company	Dobot	YASKAWA	Kawasaki
Weight (kg)	4	590	140
Cost (CAD)	1793.59	76,852.92	51,000 to 70,000
Mounting	Floor	Floor/Wall/Ceiling	Floor/Wall
Arm Dimensions (mm)	147x158x135	1,400x1,300x140	630x600x109
Material	Aluminum Alloy	Steel	Steel
Open Source	DobotStudio	DX200	KOSM OS Line Control
Repeatability (mm)	± 0.2	± 0.15	± 0.2
DOF	4	6	6
Max Reach (mm)	320	2,700	1,240
Payload (kg)	0.5	15	5
Temperature (°C)	-10 to 60	0 to 40	0 to 40
Device Name	<u>YP015A-22</u>	<u>C12XL</u>	<u>KJ125</u>
Company	HYNDAI	Epson	Kawasaki
Weight (kg)	600	63	190
Cost (CAD)	-	~ 10,000	51,000 to 70,000
Mounting	Floor/Wall	Floor/Table	Floor/Wall/Ceiling
Arm Dimensions (mm)	1,200x1,000x176	730x650x214	550x725x125
Material	-		Steel
Open Source	Hi5a-P20	.NET/GUI Builder/Epson RC+	KOSM OS Line Control
Repeatability (mm)	± 0.1	± 0.05	± 0.15
DOF	6	6	6
Max Reach (mm)	2,200	1,400	1,299
Payload (kg)	15	12	5
Temperature (°C)	0 to 40	0 to 40	0 to 40

Device Name	<u>Paint Mate 200iA/5L</u>	<u>Mini Spray Painting Robot</u>	<u>EcoRP10 R1100</u>
Company	FANUC	Robotic Paint Group	Dürr
Weight (kg)	37	50	64
Cost (CAD)	31,000 to 45,000	-	128,000
Mounting	Floor/Invert/Angle/Ceiling	Floor/Wall/Ceiling	Floor/Wall/Ceiling
Arm Dimensions (mm)	490x227x925	607x172x736	595x100x960
Material	Aluminum	Aluminum Alloy	Aluminum/Stainless Steel
Open Source	KAREL®		DXQ3D.onsite
Repeatability (mm)	± 0.02	± 0.15	(High)
DOF	6	6	6
Max Reach (mm)	892	860	1,100
Payload (kg)	5	6	10
Temperature (°C)	0 to 45	-	5 to 45

C. DESIGN SPECIFICATIONS

Table 3. Target Design Specifications

	<u>Design Specifications</u>	<u>Relation</u>	<u>Value</u>	<u>Units</u>	<u>Verification</u>
	Functional Requirements				
1	3D Printed	-	Yes	➤	Design
2	Coded off Python	-	Yes	-	Design
3	Open Source	-	Yes	-	Uploading
4	Ground Mounted	➤	Yes	-	Design
	Constraints				
1	Cost per Arm	≤	50	\$ CAD	Cost Calculations
2	Temperature to Withstand	Range	-30 - 60	°C	Testing/Analysis
2	Degrees of Freedom	=	3	-	Design
2	Weight	≤	9	Kg	Weighing
2	Size (L x H x W)	≤	0.5x1x0.25	m	Measuring
2	Payload	≈	1	Kg	Testing
2	Pressure to Withstand	≤	8	Bar	Testing/Analysis
3	Range of Motion	≥	±1	m	Testing/Calculations
4	Time to Paint 4 ft ²	≈	4	Hours	Testing
	Non-Functional Requirements				
1	Ease of Use	≤	6	Hours	Training Testing
2	Pinch Points	≥	4	-	Design
3	UV/Corrosion Resistance	-	Yes	-	Testing
4	Life Span of the Product	≥	1	Year	Use

D. REFLECTION

The client meeting had luckily pre-established many requirements and constraints, making an easier process of ranking and target specifications. The target specifications for weight, coding, 3D printing, cost, payload, pressure to withstand, degrees of freedom, opensource, and range of motion were directly given by the clients to be fulfilled. The rest of the functions were deduced by the language, approximate information, and needs of the client. For example, the size decision comes from the fact that the arm will be in small crevices, and the temperature was deduced by the rough temperature range of Canada. The rankings were also influenced by the clients' needs and examining their body language and responses to questions. They were very adamant on having a low cost, easy to use, autonomous, 3D printed arm that did the tasks they needed (such as painting, sandblasting, and coating). Other needs, such as lifespan and range of motion were not deemed as necessary, hinted with words like "if you can".

E. REFERENCES

Benchmarking Sources

<https://www.dobot.cc/dobot-magician/specification.html>

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