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Faculty of Engineering



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GNG1103 Design Project – Deliverable E

Group C2

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Wrike Snapshot Link:

<https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=EKT5xrHrHhgPpHILJsPBpRf8KLzTIrpq%7CIE2DSNZVHA2DELSTGIYA>

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SYSTEM DESIGN

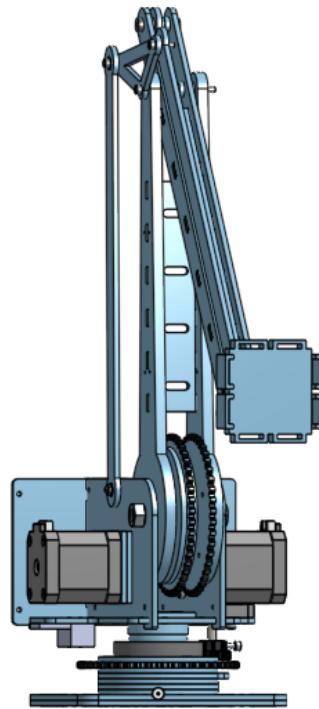


Figure 1. Overall Design of The Arm with the End Effector

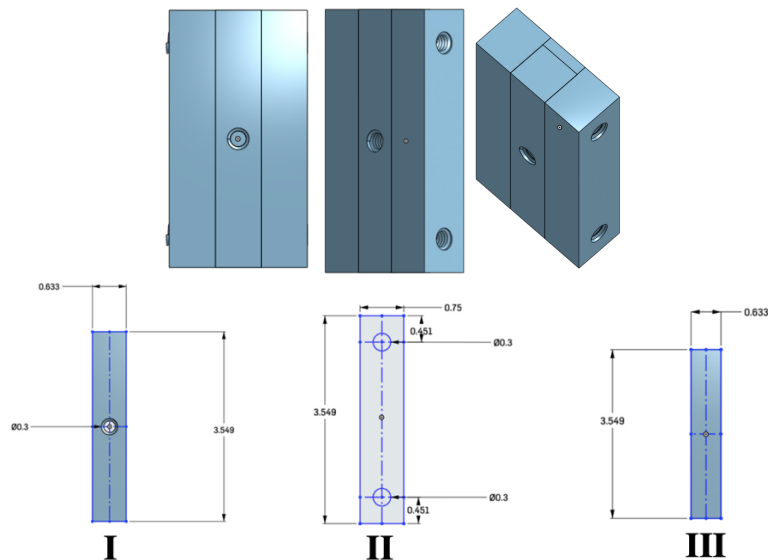
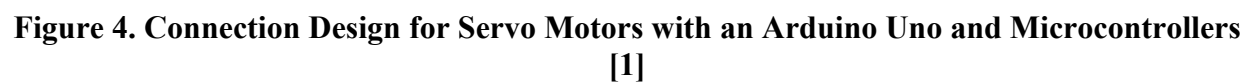


Figure 2. Design for the Connector for the End Effector (with Measurements in cm)

Table 1. Dimensions of End Effector				
Part	I	II	III	Total
Width (cm)	0.633	-	0.633	1.899
Height (cm)	3.549	3.549	3.549	3.549
Length (cm)	-	0.75	-	0.75
Volume of End Effector (cm ³)				5.055



Length of Screw: 0.6 cm



BILL OF MATERIALS

Table 2. Bill of Materials for a Degree of Freedom Robot Arm's End Effector and Electronics

Item #	Name	Description	Dimensions	Quantity	Unit Cost	Total Cost
Software						
1	Python	End effector needs open-source Python to work. Python can be download for free from the Python site and is useful and easy for coding.	-	1	\$0	\$0
Hardware						
2	Laptop	To code, prototype, and test with Python, we need a laptop. But it is free because everyone on the team has their own laptop already.	-	1	\$0	\$0
3	Arduino Uno	The Arduino uno is an open-source microcontroller board. It is required to operate the robot arm using Python.	-	1	\$25.49 [2]	\$25.49
4	ABS Filament	ABS filament is 3d printer plastic. It is easy to process, has high impact resistance and good heat resistance. It is often used as a substitute for metal in industrial products such as automobile parts and electronic device parts because of its very high strength.	-	1	\$0	\$0
5	Screw	Screws are used to connect the arm to the end effector.	M5-0.8×45mm	25	\$16.99 [3]	\$16.99
6	Wire Set	Wires are used to connect the Arduino to the end effector, supply and operate power.	-	120pcs	\$9.49 [4]	\$9.49
7	Velcro Band	Velcro band is used in this project to strap the items together by attaching them to the End effector. This is suitable for strapping items as it has a good adhesion if only a certain amount of contact area is secured.	Length: 5m Width: 3cm	1	\$20.99 [5]	\$20.99
8	Servo Motor	Servo motor is a motor that can move exactly as much as inputted by the control and measurement circuit when movement is specified. This is where the movement of the end effector helps.	13.69×9.8×3.61 cm 50g	4	\$13.89 [6]	\$13.89
					TOTAL	\$86.85
					TAX (13%)	\$11.29
					TOTAL COST	\$98.14

RISK MANAGEMENT AND CONTINGENCY PLAN

Prototype I

Table 3. Risk Management and Contingency Plan for Prototype I

Risk	Risk Management	Contingency Plan
Late/Non-Delivery of Material	<ul style="list-style-type: none"> ➤ Order all materials as soon as possible. ➤ Choose materials that will ship/arrive faster when possible. 	<ul style="list-style-type: none"> ➤ We will start putting available materials together for Prototype I. ➤ If no materials are received, we will start the prototype with Onshape.
Operational Failure	<ul style="list-style-type: none"> ➤ If possible, prototypes will first be tested through Onshape. 	<ul style="list-style-type: none"> ➤ If needed, other group members may help resolve the solution. ➤ As a last resort, the group will ask the project manager and/or TAs for help.
Inaccurate Duration Estimate	<ul style="list-style-type: none"> ➤ We schedule some buffer time. ➤ Tasks will be started as soon as possible to avoid their incompleteness. 	<ul style="list-style-type: none"> ➤ If possible, other team members will join to help complete the task on time. ➤ The project schedule would have to be updated but only in case the group is left too far behind the expected schedule.
Scope Creep	<ul style="list-style-type: none"> ➤ The design requirements have been outlined by our team and communicated with our client. 	<ul style="list-style-type: none"> ➤ Any component/aspect of the products must be approved by all team members. Also, the TAs's, project manager's and client's opinion need to be considered. ➤ If changes happen, the schedule and bill of materials would also need to be updated.
Unforeseen Addition of Workload	<ul style="list-style-type: none"> ➤ Effective planning has helped our team minimize the chances of scope creep. 	<ul style="list-style-type: none"> ➤ The member who has the least amount of work will take over this task.

Table 4. Test Plans for Prototype I

Test #	Test Objective	Results	Planned Start Date and Estimated Duration
1	To test the assembly of the mechanical components and build a physical arm with an end effector.	<ul style="list-style-type: none"> ➤ The arm with a screw-in end effector is expected to move flexibly within a one-meter range while the end effector is holding the blaster/painter strapped by Velcro straps. ➤ A screenshot of the physical product will be put in the Deliverable 	February 21st, 2022 Test Duration: 5 minutes
2	To test the code system used for product operation.	<ul style="list-style-type: none"> ➤ A screenshot of the simulation and a copy of the test code used will be included in the Deliverable. 	February 21st, 2022 Test Duration: 5 minutes
3	To test the assembly of the mechanical arm with the code system.	<ul style="list-style-type: none"> ➤ The code is expected to be compatible and operate the whole mechanical product successfully. ➤ A screenshot/recording will be taken and put in the Deliverable 	February 21st, 2022 Test Duration: 5 minutes

Prototype II**Table 5. Risk Management and Contingency Plan for Prototype II**

Risk	Risk Management	Contingency Plan
Late/Non-Delivery of Material	<ul style="list-style-type: none"> ➤ Order all materials as soon as possible. ➤ Choose products that will ship/arrive faster when possible. 	<ul style="list-style-type: none"> ➤ We will start putting available materials together for Prototype II. ➤ If no materials are received, we will start the prototype with Onshape.
Defective Product	<ul style="list-style-type: none"> ➤ We have chosen legitimate sellers to avoid this issue. 	<ul style="list-style-type: none"> ➤ If possible, the defective product will be refunded and exchanged for a new one. ➤ As the worst-case scenario, the second-best design concept will be chosen as a best substitution.
Operational/ Technical Failure	<ul style="list-style-type: none"> ➤ A visual product was first made on Onshape and the code would be tested separately before being connected for Prototype II tests. 	<ul style="list-style-type: none"> ➤ The team will work together to resolve the problem. If we are still incapable of resolving the problem on our own, we will ask the TAs and/or project manager for their assistance. ➤ If needed, the design concept will be replaced by the next best one.
Inaccurate Duration Estimate	<ul style="list-style-type: none"> ➤ If needed, the duration of tasks will be adjusted after Prototype I for better presentation 	<ul style="list-style-type: none"> ➤ If possible, other team members will help the owner of the task to complete the task on time. ➤ The project schedule would have to be updated but only in case the group is left too far behind the expected schedule.
Performance Risk	<ul style="list-style-type: none"> ➤ Tests will be done on this prototype so if there is any performance problem, it will be determined before the final prototype. 	<ul style="list-style-type: none"> ➤ The team will do some extensive research to define and resolve the problems. If the team cannot resolve the problem on our own, we will ask the TAs and project manager for assistance.

Table 6. Test Plan for Prototype II

Test #	Test Objective	Description of the Test Objective	Planned Start Date and Estimated Duration
1	To test that the assembly of the mechanical arm.	<ul style="list-style-type: none"> ➤ Robotic arm can move flexibly within a one-meter range can bear the weight of the requested object. ➤ A screenshot/recording will be taken and put in the Deliverable. 	March 7th, 2021 Test Duration: 5 minutes
2	To test the code.	<ul style="list-style-type: none"> ➤ A screenshot/recording will be taken and put in the Deliverable. 	March 7th, 2022 Test Duration: 5 minutes
3	To test the assembly of the mechanical arm with the code system.	<ul style="list-style-type: none"> ➤ The robotic arm and the code system will be connected to test if the robotic arm can operate as required by the code system. 	March 7th, 2022 Test Duration: 5 minutes

Prototype III

Table 7. Risk Management and Contingency Plan for Prototype III		
Risk	Risk Management	Contingency Plan
Non-Delivery of Material	<ul style="list-style-type: none"> ➤ If there are still materials that have not been delivered yet, then those materials will not be included in the final prototype 	<ul style="list-style-type: none"> ➤ The next best designs which do not include those materials will be chosen alternatively. ➤ The project schedule will be updated.
Operational/ Technical Failure	<ul style="list-style-type: none"> ➤ The testing results done in the last prototype will reduce the probability of operational failure in this prototype phase. 	<ul style="list-style-type: none"> ➤ If the problem cannot be resolved, then the product will not include that aspect.
Inaccurate Duration Estimate	<ul style="list-style-type: none"> ➤ As this is a two-week prototype, buffer time has been allocated 	<ul style="list-style-type: none"> ➤ More time will be allocated to finish whilst all team members will assist to catch up with the project schedule. ➤ If the problem cannot be resolved, then the product will not include that aspect.
Scope Creep	<ul style="list-style-type: none"> ➤ We will seek regular customer/client feedback as well as the project manager's and TAs' opinions to minimize the probability of this risk. 	<ul style="list-style-type: none"> ➤ The requirement is expected to be integrated successfully in the final product. ➤ If the solution is not possible, the final product will not include the aspect.
Performance Risk	<ul style="list-style-type: none"> ➤ Tests will be done on this prototype so if there is any performance problem, it will be determined before the final presentation 	<ul style="list-style-type: none"> ➤ The team will do some extensive research to define and resolve the problems. If the team cannot resolve the problem, we will ask the TAs and/or project manager for assistance. ➤ If it still does not help resolve the problem, the final product will not include the aspect.

Table 8. Test Plan for Prototype III			
Test #	Test Objective	Description of the Test Objectives	Planned Start Date and Estimated Duration
1	To test that the assembly of the mechanical arm if it satisfies the design criteria	<ul style="list-style-type: none"> ➤ The 3 dots of freedom will allow the arm to move flexibly while having a blaster/painter strapped into the end effector within a one-meter range. ➤ A screenshot/recording will be taken and put in the Deliverable. 	March 21st, 2022 Test Duration: 15 minutes
2	To test the code system if it satisfies the design criteria	<ul style="list-style-type: none"> ➤ A screenshot/recording of the simulation of the code will be taken and put in the Deliverable. 	March 21st, 2022 Test Duration: 15 minutes
3	To test the assembly of the mechanical arm with the code system if it satisfies the design criteria	<ul style="list-style-type: none"> ➤ The connection between the physical arm and the code will be tested if the code system can be compatible with the robotic arm and operate it. 	March 21st, 2022 Test Duration: 15 minutes

REFERENCES

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- [2] "Amazon," [Online]. Available: https://www.amazon.ca/gp/product/B07PXQFFW9/ref=ox_sc_act_title_6?smid=AS9HA2ZZEADNP&psc=1.
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