ENGINEERING

McMaster University

Project Two – Get a Grip:

ENGINEER 1P13 – Integrated Cornerstone Design Projects

Tutorial 07

Team Thurs-23

Vaisnavi Shanthamoorthy (shanthav)

Emilie Alain (alaine1)

Ziyang Qin (Qinz36)

Arthes Matheeswaran (matheesa)

Submitted: December 9th, 2020

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Academic Integrity Statement

The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Vaisnavi Shanthamoorthy 400319038

x VAISNAVI SHANTHAMOORTHY

The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Emilie Alain 400298081

x EMILIE ALAIN

The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Arthes Matheeswaran 400291846

x Arthes Matheeswaran

The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Ziyang Qin 400245058

x Ziyang Qin

Executive Summary:

The objective for this project was to design a system for securely transferring surgical tools to the appropriate autoclave for sterilization [1]. To do so, our team split up into two sub-teams, the modelling sub-team, focusing on the design of the container so that it could securely hold the surgical tool in place and the computation sub-team, focusing on identifying a means of picking up and transferring a container to its' respective autoclave for sterilization. For the modelling sub-team, our two main objectives were to design a container that can securely hold a surgical tool that allowed for sterilization. One constraint in making the container was that it was not allowed to be greater in size than the autoclave. A second constraint was that our model had to fit within the footprint, dimensions were to be greater than 4mm and a mass no more than 350g. Our last constraint was that our container had to be designed in a way so that it could be picked up by the Q-arm. In order to follow these constraints, we designed a container in a way that it contained two separate parts. The first part was the shell which allowed for sterilization due to the gaps within the container. The second part was designed similar to the design of a drawer in the sense that it allows for the surgical tool to be held in place securely. Finally, we used G-code to 3D print our container. Furthermore, for the computation team to successfully pickup and transfer six containers to the respective autoclaves for sterilization, we designed a program to execute the following functions: identification of the location, moving the end-effector to the appropriate location, controlling the gripper, as well as opening the autoclave drawer. We defined 4 functions which utilized the muscle sensor emulators in our code to control the movement of the Q-arm by assigning 4 different scenarios, specific to each of the major functions. Our two remaining functions do not use the muscle sensor emulators since one of them is solely responsible for identifying the location, and the other is the main function responsible for calling the other functions to allow the program to run. To address the problem presented in this project, we adjusted our code in a manner where each function allows for smooth transitions so that each container can safely be transferred for sterilization. For instance, in one section of our code, we designed our program so that the Q-arm would stop at the home position between the pick-up and drop-off locations to avoid hitting an autoclave bin and damaging the surgical tool inside the container. With the knowledge gained from both the computing and modelling labs, we were able to design a program to achieve our principal goal of safely transferring the surgical tools to the correct autoclave bin location for proper sterilization and model a container that allowed for transferring and sterilizing a surgical tool that fit within the desired location of the autoclave.

Project Schedule

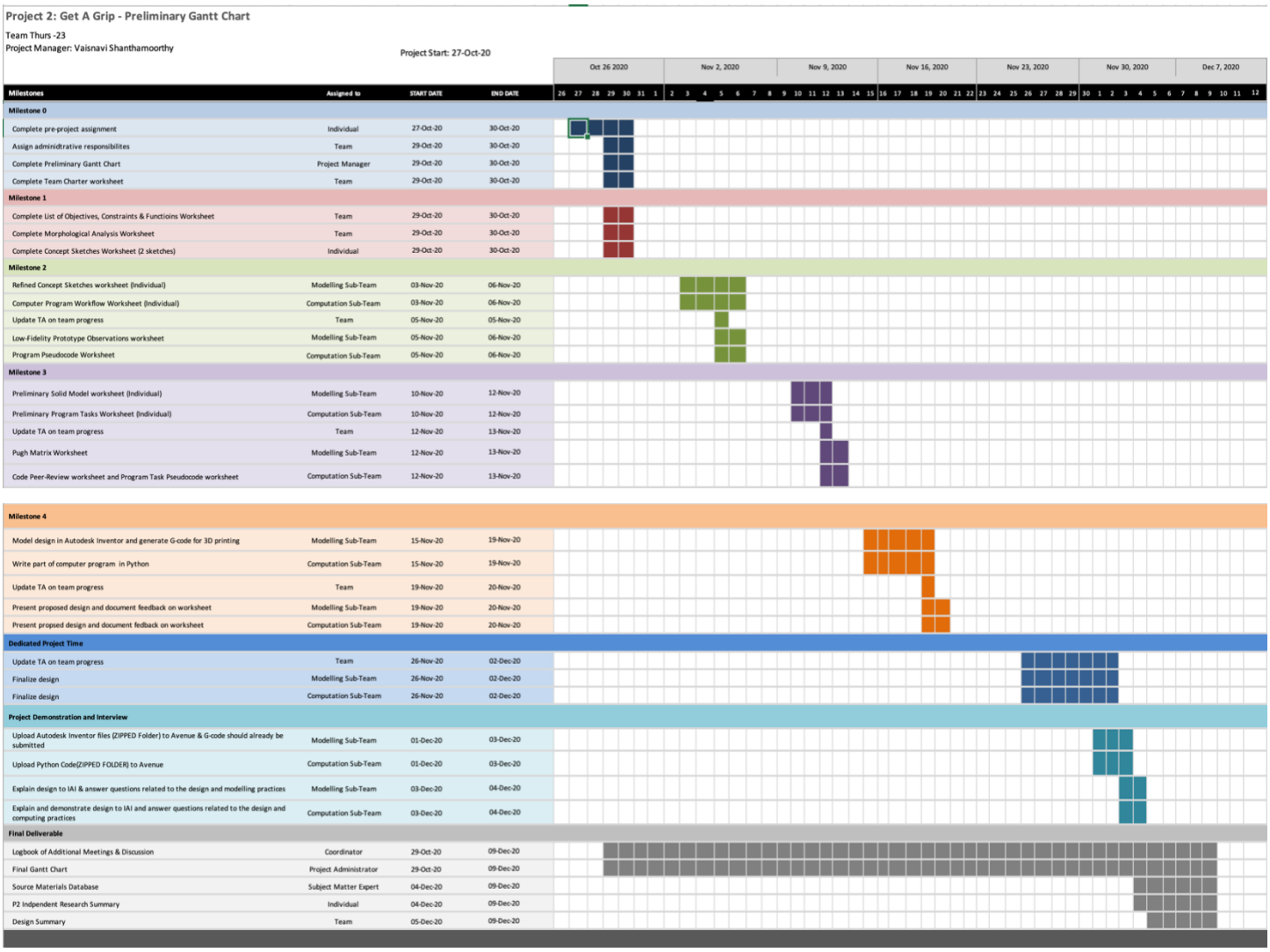
Preliminary Gantt: (Vaisnavi Shanthamoorthy)

Project 2: Get A Grip - Preliminary Gantt Chart

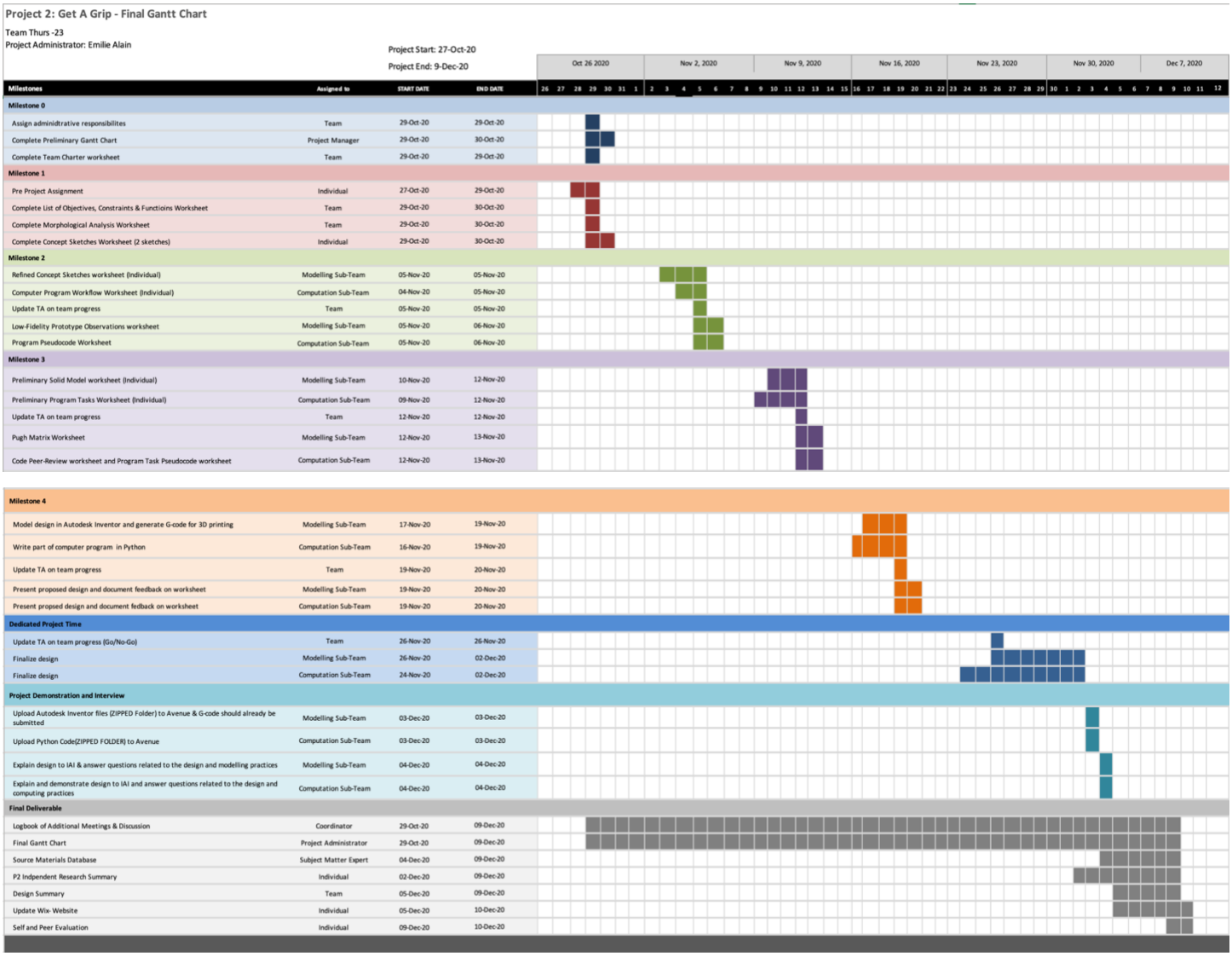
Team Thurs -23
Project Manager: Vaisnavi Shanthamoorthy

Project Start: 27-Oct-20

Milestones	Assigned to	START DATE	END DATE
Milestone 0			
Complete pre-project assignment	Individual	27-Oct-20	30-Oct-20
Assign adminidtrative responsibilites	Team	29-Oct-20	30-Oct-20
Complete Preliminary Gantt Chart	Project Manager	29-Oct-20	30-Oct-20
Complete Team Charter worksheet	Team	29-Oct-20	30-Oct-20
Milestone 1			
Complete List of Objectives, Constraints & Functioins Worksheet	Team	29-Oct-20	30-Oct-20
Complete Morphological Analysis Worksheet	Team	29-Oct-20	30-Oct-20
Complete Concept Sketches Worksheet (2 sketches)	Individual	29-Oct-20	30-Oct-20
Milestone 2			
Refined Concept Sketches worksheet (Individual)	Modelling Sub-Team	03-Nov-20	06-Nov-20
Computer Program Workflow Worksheet (Individual)	Computation Sub-Team	03-Nov-20	06-Nov-20
Update TA on team progress	Team	05-Nov-20	05-Nov-20
Low-Fidelity Prototype Observations worksheet	Modelling Sub-Team	05-Nov-20	06-Nov-20
Program Pseudocode Worksheet	Computation Sub-Team	05-Nov-20	06-Nov-20
Milestone 3			
Preliminary Solid Model worksheet (Individual)	Modelling Sub-Team	10-Nov-20	12-Nov-20
Preliminary Program Tasks Worksheet (Individual)	Computation Sub-Team	10-Nov-20	12-Nov-20
Update TA on team progress	Team	12-Nov-20	13-Nov-20
Pugh Matrix Worksheet	Modelling Sub-Team	12-Nov-20	13-Nov-20
Code Peer-Review worksheet and Program Task Pseudocode worksheet	Computation Sub-Team	12-Nov-20	13-Nov-20
Milestone 4			
Model design in Autodesk Inventor and generate G-code for 3D printing	Modelling Sub-Team	15-Nov-20	19-Nov-20
Write part of computer program in Python	Computation Sub-Team	15-Nov-20	19-Nov-20
Update TA on team progress	Team	19-Nov-20	20-Nov-20
Present proposed design and document feedback on worksheet	Modelling Sub-Team	19-Nov-20	20-Nov-20
Present propsed design and document fedback on worksheet	Computation Sub-Team	19-Nov-20	20-Nov-20
Dedicated Project Time			
Update TA on team progress	Team	26-Nov-20	02-Dec-20
Finalize design	Modelling Sub-Team	26-Nov-20	02-Dec-20
Finalize design	Computation Sub-Team	26-Nov-20	02-Dec-20
Project Demonstration and Interview			
Upload Autodesk Inventor files (ZIPPED Folder) to Avenue & G-code should already be submitted	Modelling Sub-Team	01-Dec-20	03-Dec-20
Upload Python Code(ZIPPED FOLDER) to Avenue	Computation Sub-Team	01-Dec-20	03-Dec-20
Explain design to IAI & answer questions related to the design and modelling practices	Modelling Sub-Team	03-Dec-20	04-Dec-20
Explain and demonstrate design to IAI and answer questions related to the design and computing practices	Computation Sub-Team	03-Dec-20	04-Dec-20
Final Deliverable			
Logbook of Additional Meetings & Discussion	Coordinator	29-Oct-20	09-Dec-20
Final Gantt Chart	Project Administrator	29-Oct-20	09-Dec-20
Source Materials Database	Subject Matter Expert	04-Dec-20	09-Dec-20
P2 Indpendent Research Summary	Individual	04-Dec-20	09-Dec-20
Design Summary	Team	05-Dec-20	09-Dec-20



Final Gantt Chart: (Emilie Alain)



Logbook of Additional Meetings and Discussions: (Ziyang Qin)

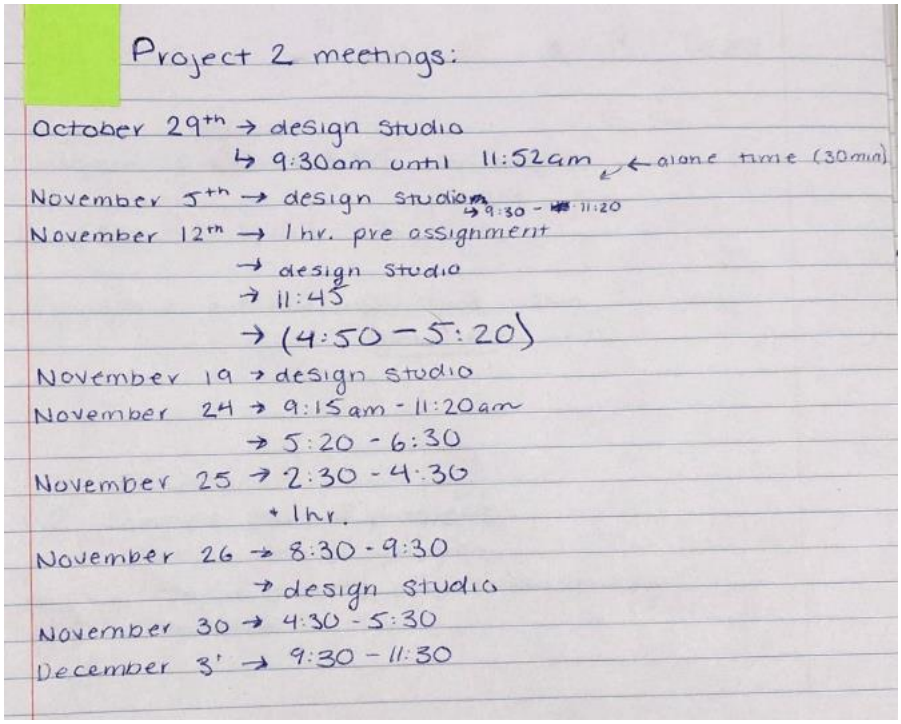
Date (Computation)	Period (Computation)	Date (Modelling)	Period (Modelling)
Oct 29th	11:30am – 11:52am	Nov 6th	10:50am – 12:00am
Nov 12th	4:50pm – 5:20pm	Nov 25th	5:50pm – 6:50pm
Nov 24th	5:20pm – 6:30pm	Dec 2nd	12:35pm – 1:15pm
Nov 25th	2:30pm – 4:30pm	Dec 7th	2:00pm – 4:20pm
Nov 26th	8:30am – 9:30am		
Nov 30th	4:30pm – 5:30pm		
Dec 3rd	9:30am – 11:30am		


So 10:30 tmr right?
as long as before 12:30a.m.
Sounds good to me
YAY!
Nov 6, 10:44 AM
You want to do it right now?
okey
do we use MS team?
Yes
Nov 12, 10:23 AM


Nov 25, 1:56 PM
Hi
You want to work on the project?
Can we do on 5pm?
I have a class to attend
Ok
Nov 25, 5:03 PM
Do you have time now?
Can we do 5:45
sure
Let's do it


Dec 2, 12:35 PM
Idk cuz i dont have internet right now
I could sent you my model and you could check the process
And if you have question feel free to ask me
Ok thank you !
You could check on MS
I'll give you the assembly later today I guess
How did you make part 1
Like the front view
Did you see the left column?


Yesterday 12:03 PM
Hey how do you think about doing our summary?
Yeh sure
When do you want to do it?
I have class at 1:30
I am free the rest of the day
Is 2 pm ok?
Sure
Yesterday 2:05 PM
Is it okay to start now?
Yes


Project 2 meetings:
October 29th → design studio
↳ 9:30am until 11:52am ← alone time (30min)
November 5th → design studio
November 12th → 1hr. pre assignment
→ design studio
→ 11:45
→ (4:50 - 5:20)
November 19 → design studio
November 24 → 9:15 am - 11:20am
→ 5:20 - 6:30
November 25 → 2:30 - 4:30
+ 1hr.
November 26 → 8:30 - 9:30
→ design studio
November 30 → 4:30 - 5:30
December 3 → 9:30 - 11:30

Scheduled Weekly Meetings (Vaisnavi Shanthamoorthy and Ziyang Qin)

ENGINEER 1P13
MEETING WITH TEAM 23 – Thursday, November 5, 2020

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Vaisnavi Shanthamoorthy**	**shanthav**	**yes**
Administrator	**Emilie Alain**	**alaine1**	**yes**
Coordinator	**Ziyang Qin**	**qinz36**	**yes**
Subject Matter Expert	**Arthes Matheeswaran**	**matheesa**	**yes**
Guest	**Alia Macarios**	**macarioa**	**Yes**

AGENDA ITEMS

1. Attendance Yes.
2. Updates
    a. Any issues from past week? No
3. Action Items

    a. Refined design sketches (Modelling sub team)

    b. Computer Program Workflow (Computation sub team)

4. Final Notes

MEETING MINUTES

1. No issues from Milestones 0 & 1
    a. Preliminary Worksheets
        i. No issues from Modelling Sub Team
        ii. Computation Sub-Team – confused on the detail level for flowchart
            1. Solution --> should just show steps
2. Action Items
    a. Modelling --> prototypes worksheet
    b. Computation --> pseudocode worksheet
3. Final notes
    a. Finish action items
    b. Finish deliverables by tomorrow

POST-MEETING ACTION ITEMS

1. *Preliminary Solid Model Worksheet [Modelling Sub Team]*
2. *Preliminary Program Tasks [Computation Sub Team]*

ENGINEER 1P13
MEETING WITH TEAM 23 – Thursday, Nov. 12, 2020

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Vaisnavi Shanthamoorthy**	**shanthav**	**Yes**
Administrator	**Emilie Alain**	**alaine1**	**Yes**
Coordinator	**Ziyang Qin**	**Qinz36**	**Yes**
Subject Matter Expert	**Arthes Matheeswaran**	**matheesa**	**Yes**
Guest	**Alia Macarios**	**macarioa**	**Yes**

AGENDA ITEMS

1. Attendance Yes.
2. Any issues from past week? No.
    a. Modelling Sub-Team --> Preliminary Solid Model WS
    b. Computation Sub-Team --> Preliminary Program Tasks WS
3. Any question about current tasks needed to be done during this DS? Yes.
    a. Modelling --> Pugh Matrix WS
    b. Computation --> Peer Review WS & Program Task Pseudocode WS
4. Action Items for next week's DS
    a. Modelling --> Model your design In Inventor & generate G-code for printing
    b. Computation -->Write part of computer program in python

MEETING MINUTES

1. Modelling
    a. Preliminary WS --> no issues
2. Computation
    a. Preliminary WS --> had questions about the code and two functions
        i. Was worked out
3. Current tasks
    a. Modelling – pugh matrix
    b. Computation – peer review & program task pseudocode ws
4. Make sure you get action items done for next week

POST-MEETING ACTION ITEMS

1. *Preliminary Solid Model (Modelling sub team)*
2. *Preliminary Program Task (Computing sub team)*

ENGINEER 1P13
MEETING WITH TEAM 23 – Thursday, November 19, 2020

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Vaisnavi Shanthamoorthy**	**shanthav**	**Yes**
Administrator	**Emilie Alain**	**alaine1**	**Yes**
Coordinator	**Ziyang Qin**	**qinz36**	**Yes**
Subject Matter Expert	**Arthes Matheeswaran**	**matheesa**	**Yes**
Guest	**Alia Macarios**	**macarioa**	**Yes**

AGENDA ITEMS

1. Any issues from past week?
    a. Modelling ST – G-code
    b. Computation ST – N/A
2. Action Items for Next Week
    a. Computing ST – finalize python program code
    b. Modelling ST – model design in inventor & generate G-code for 3D printing

MEETING MINUTES

1. Showed the modelling design
2. Ask questions about modelling instruction
    a. What is “shorten scale” means?
    b. Ask for exceptions for the final design
    c. Be aware of time limit, features, Q-arm function and mass

POST-MEETING ACTION ITEMS

1. *Dedicated project time [Modelling ST]*
2. *Dedicated project time [Computation ST]*

Design Studio Milestone Worksheets (Emilie Alain)

PROJECT TWO: MILESTONE 0 – COVER PAGE

Team Number: Thurs-23

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Emilie Alain	alaine1
Vaisnavi Shanthamoorthy	shanthav
Arthes Matheeswaran	matheesa
Ziyang Qin	qinz36

Insert your Team Portrait in the dialog box below

MILESTONE 0 – TEAM CHARTER

Team Number: Thurs-23

Incoming Personnel Administrative Portfolio:

Prior to identifying Leads, identify each team members incoming experience with various **Project Leads**

	Team Member Name:	Project Leads
1.	Vaisnavi Shanthamoorthy	☐M ☒A ☐C ☐S
2.	Emilie Alain	☒M ☐A ☐C ☐S
3.	Arthes Matheeswaran	☐M ☐A ☒C ☐S
4.	Ziyang Qin	☐M ☐A ☐C ☒S

To 'check' each box in the Project Leads column, you must have this document open in the Microsoft Word Desktop App (not the browser and not MS Teams)

Project Leads:

Identify team member details (Name and MACID) in the space below.

Role:	Team Member Name:	MacID
Manager	Vaisnavi Shanthamoorthy	shanthav
Administrator	Emilie Alain	alaine1
Coordinator	Ziyang Qin	qinz36
Subject Matter Expert	Arthes Matheeswaraan	matheesa

PROJECT TWO: MILESTONE 1 – COVER PAGE

Team Number: Thurs-23

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Arthes Matheeswaran	matheesa
Vaisnavi Shanthamoorthy	shanthav
Emilie Alain	alaine1
Ziyang Qin	Qinz36

MILESTONE 1 (STAGE 1) – PRE-PROJECT ASSIGNMENT

Team Number: Thurs-23

You should have already completed this task individually prior to Design Studio 7.

1. Copy-and-paste each team member's list of objectives, constraints and functions on the following pages (1 team member per page)
    a. Be sure to indicate each team member's Name and MacID

We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

- Each team member needs to submit their list of objectives, constraints and functions with the **Milestone One Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone One Team Worksheets** document allows you to readily access your team member's work
    - This will be especially helpful when completing ***Stage 2*** of the milestone

Team Number: Thurs-23

Name: Ziyang Qin	MacID: qinz36

Objectives:

- *Lightweight*
- *Stiffness*
- *Easy to transfer*
- *Reusable*
- *High temperature resistance*

Constraints:

- *Waterproof*
- *Heat insulation*
- *Chemical inert*
- *all features must be greater than 4mm*

Functions:

- *Able to carry liquids and solids*
- *Able to maintain inside temperature*
- *Allow for lifting*
- *Allow for transport*

Team Number: Thurs-23

Name: Emilie Alain	MacID: alaine1

Objectives

- Small and portable
- Lightweight
- Function how the client wants it to

Constraints

- Accurate to certain percent
- Objects no larger than width ~80mm
- Can hold objects with width ~150mm but with less security
- Mass cannot exceed 350g
- Features must be greater than 4mm

Functions

- Pick up objects (surgical instruments)
- Rotate
- Identify the correct bin (place in correct bin)
- Open and close the gripper
- Open and close bin drawer

Team Number: Thurs-23

Name: Arthes Matheeswaran	MacID: matheesa

Objectives

- Identify means of picking up and transferring a container to an autoclave for sterilization
- Design the container such that it can securely hold a surgical tool in place, be picked up by a robotic arm for transfer, and facilitate sterilization
- Design a computer program for operating the robotic arm using two muscle sensor emulators
- Demonstrate that our function works

Constraints

- Base of container must fit within the desired location inside the autoclave
- Container must securely hold the surgical tool in place so that its movement is restricted during transfer
- All features be greater than 4mm in size
- Mass of design prior to scaling cannot exceed 350g

Functions

- Assigning a target location within the autoclave (in XYZ Cartesian coordinates) based on the container objects known attributes
- Controlling movement of the gripper joint in response to input data
- Controlling movement of Q-arm in response to input data

Opening the autoclave bin drawer in response to input data from one or both muscle sensor emulators

Team Number: Thurs-23

Name: Vaisnavi Shanthamoorthy	MacID: shanthav

Copy-and-paste the pre-project assignment for one team member in the space below

Objectives

- Easily accessible
- Lightweight
- Portable
- Small

Constraints

- surgical tool should be held in place in a firm manner, not moving around
- mass of container should be less than the mass of the robotic arm
- all features must be greater than 4mm
- the base of the container must fit within the desired location of the autoclave
- mass cannot exceed 350g
- objects should be no larger in width of about 80mm
- able to hold objects with width of about 150mm (less securely)

Functions

- Hold objects (surgical tools) securely in place
- Grip objects
- Release objects
- Pick up objects
- Rotate
- Move forward
- Transfer objects into container
- Identify the correct target location (correct autoclave bin)
- Code should terminate or continue based upon the number of objects (containers) successfully placed in the correct container

*If you are in a team of 5, please copy and paste the above on a new page

MILESTONE 1 (STAGE 2) – LIST OF OBJECTIVES, CONSTRAINTS, AND FUNCTIONS

Team Number: Thurs-23

1. As a team, create a final a list of objectives, constraints, and functions in the table below.
   → Use your individual *Pre-Project Assignment* to build your team's final list
   → The exact number you should have depends on what information you have gathered from the Project Pack.

Objectives	Constraints	Functions
Small	All features must be greater than 4 mm in size	Identify correct bin to place objects
Portable	Can hold objects securely up to ~80mm	Picking the container up
Function how client wants	Mass of design cannot exceed 350g	Open and close gripper
Lightweight	Must be able to be picked up by the robot arm's end effector	Transferring the container to the specified autoclave
High temperature resistance	Accurate to a certain percent	Open and close bin drawer

2. What is the primary function of the entire system?

Transferring the container to the specified target location of the autoclave

3. What are the secondary functions?

Picking the container up using the arm
Identify correct bin the place the objects
Open and close gripper
Open and close bin drawer

MILESTONE 1 (STAGE 3) – MORPHOLOGICAL ANALYSIS

Team Number: Thurs-23

1. Identify multiple means to perform the secondary functions that your team came up with during Stage 1 of this milestone. One sub-function (pick up) is already listed for you. The other two sub-functions are for your team to choose.
   → Make sure that every mean for the "pick up" sub-function assumes that the end effector of the robot arm is a gripper. The means for your other sub-functions do not need to follow this assumption.

Function	**Means**					
Pick up	Handle	Magnet	Sensors	Trigger	Velcro (on both instrument and gripper)	Double sided tape
Open drawer	Gripper	Pulley System	Trigger	Magnet	By hand	String
Identifying Correct Bin	Shape	By colour	Location	Sensors	Size	Mass

MILESTONE 1 (STAGE 4) – CONCEPT SKETCHES

Team Number: Thurs-23

Complete this worksheet *after* having completed stage 3 as a team ***and*** after having ***individually*** created your concept sketches.

1. Each team member should copy-and-paste the photo of their individual concept sketches in the space indicated on the following pages
   → The photo's should be the same one your included in the **Milestone One Individual Worksheets** document
   → Be sure to include your **Team Number** on each page
   → Be sure each team member's **Name** and **MacID** are included with each sketch

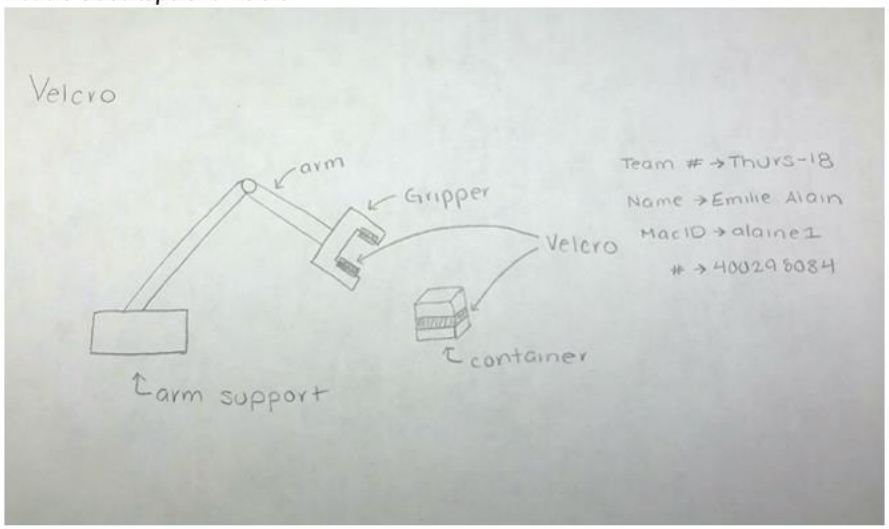
We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

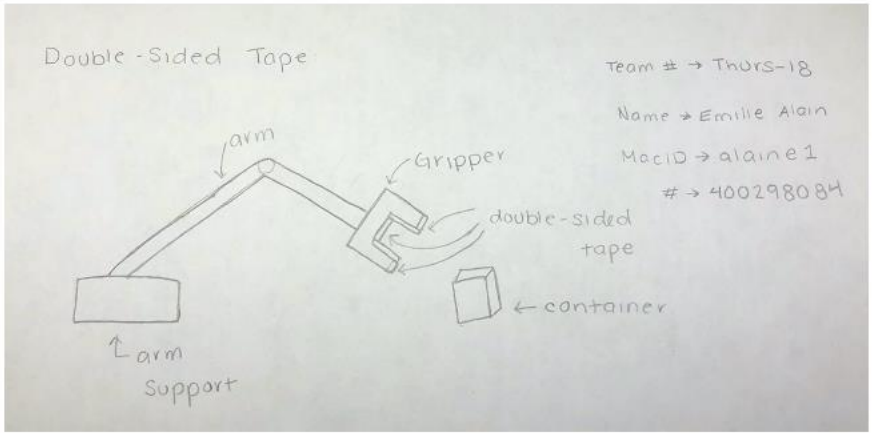
- Each team member needs to submit their sketch with the **Milestone One Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone One Team Worksheets** document allows you to readily access your team member's work

Team Number: Thurs-23

Name: Emilie Alain	MacID: alaine1

Double-sided tape and Velcro



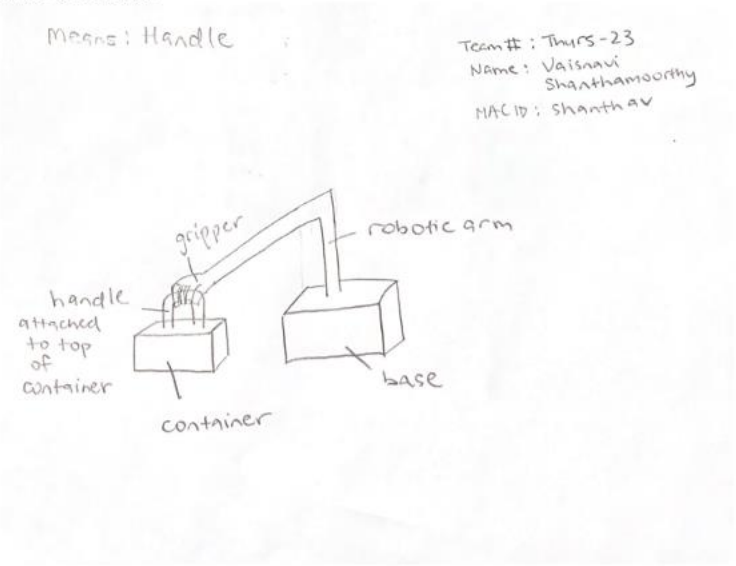


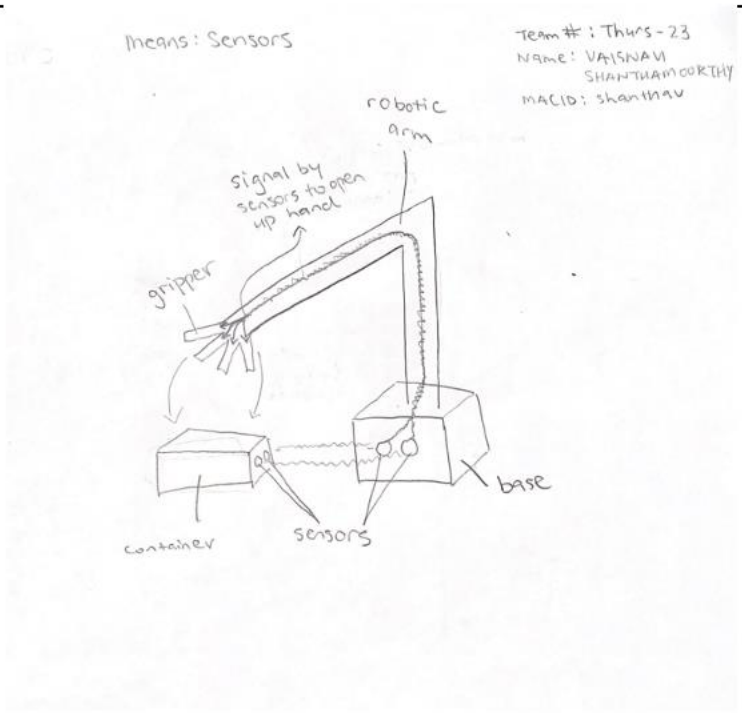
Team Number: Thurs-23

Name: Vaisnavi Shanthamoorthy	MacID: shanthav

Insert screenshot(s) of your concept sketches below

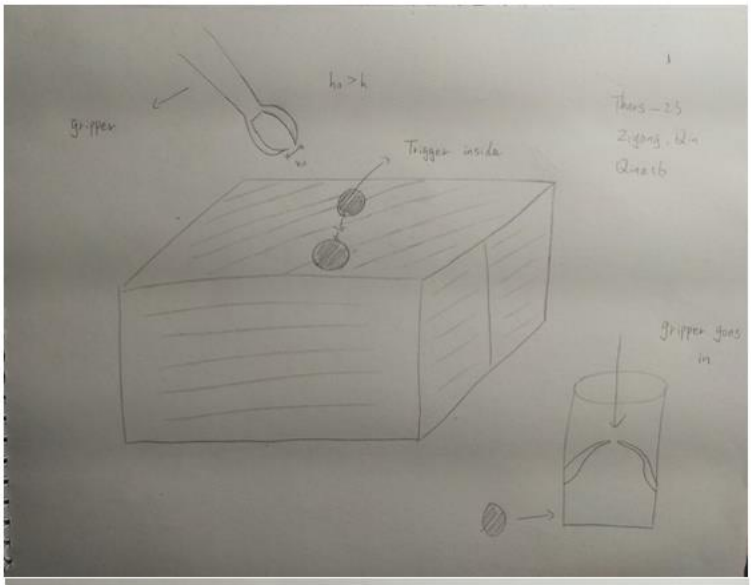
Means: Handle & Sensors

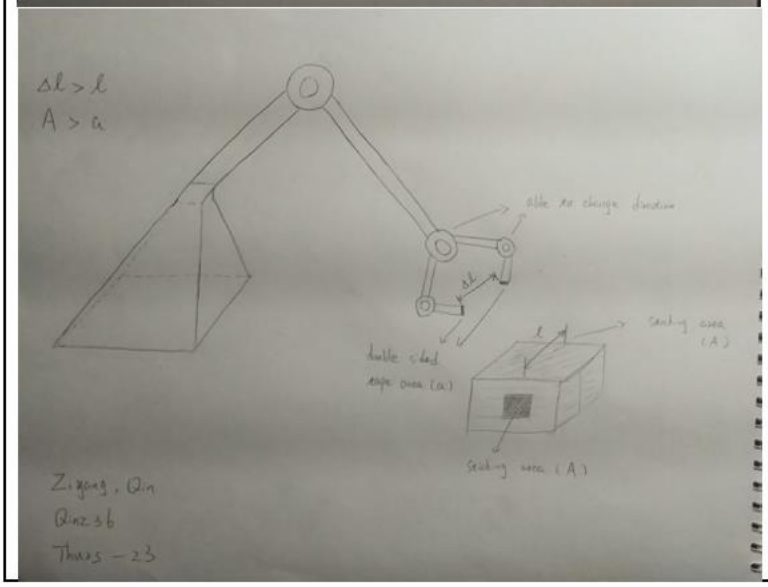




Team Number: Thurs-23

Name: Ziyang Qin	MacID: Qinz36

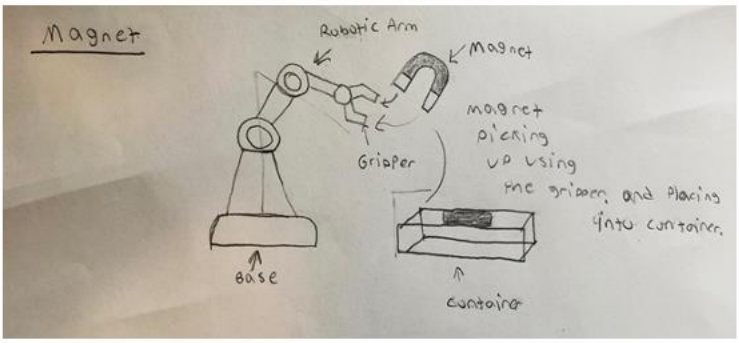


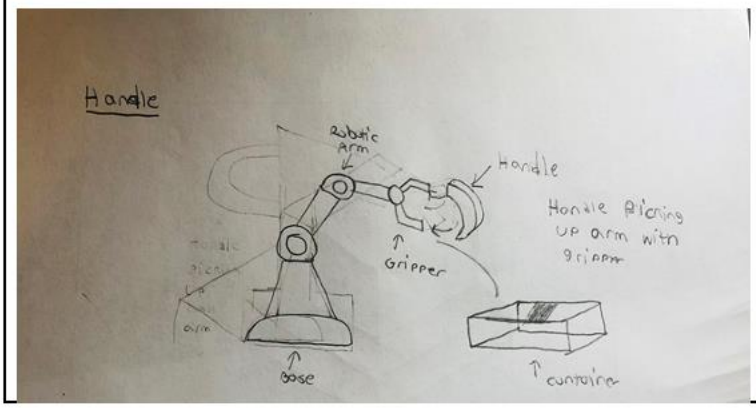


Team Number: Thurs-23

Name: Arthes Matheeswaran	MacID: matheesa

Insert screenshot(s) of your concept sketches below
Handlle and Magnet





PROJECT TWO: MILESTONE 2 – COVER PAGE

Team Number: Thurs-23

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Emilie Alain	alaine1
Vaisnavi Shanthamoorthy	shanthav
Ziyang Qin	qinz36
Arthes Matheeswaran	matheesa

MILESTONE 2 (STAGE 1) – REFINED CONCEPT SKETCHES (MODELLING SUB-TEAM)

Team Number: Thurs-23

You should have already completed this task individually prior to Design Studio 8.

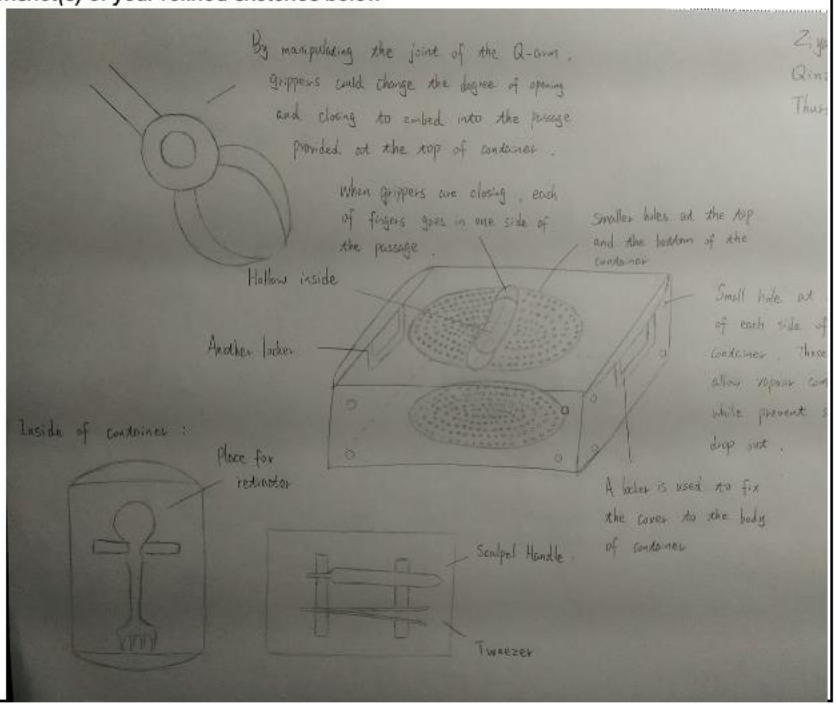
1. Copy-and-paste each sub-team member's refined sketch on the following pages (1 sketch per page)
   → Be sure to indicate each team member's Name and MacID

We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

- Each team member needs to submit their refined concept sketches with the **Milestone Two Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone Two Team Worksheets** document allows you to readily access your team member's work
  - This will be especially helpful when completing ***Stage 3*** of the milestone

Team Number: Thurs-23

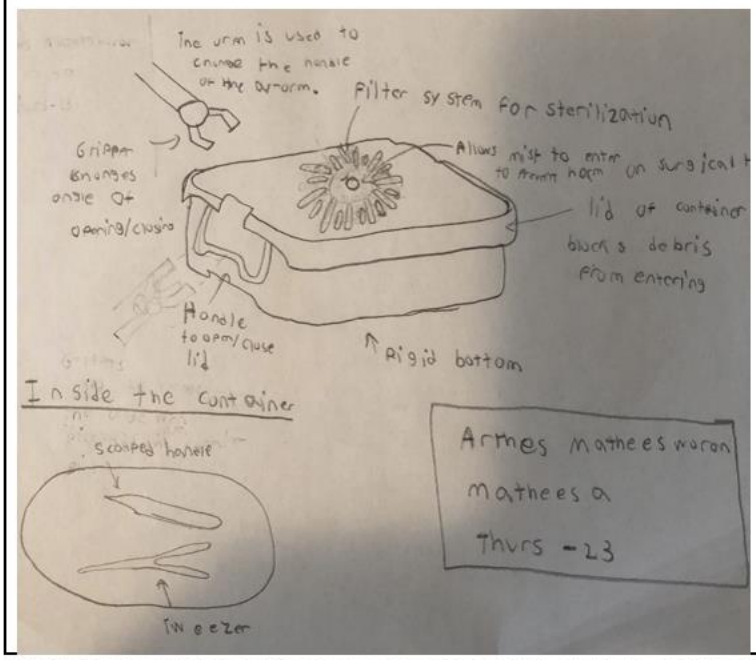
Name:Zivang Qin	MacID:Qinz36
Insert screenshot(s) of your refined sketches below	



Team Number: Thurs-23

Name: Arthes Matheeswaran	MacID: matheesa

Insert screenshot(s) of your refined sketches below



*If you are in a sub-team of 3, please copy and paste the above on a new page

MILESTONE 2 (STAGE 2) – COMPUTER PROGRAM WORKFLOW (COMPUTATION SUB-TEAM)

Team Number: Thurs-23

You should have already completed this task individually prior to Design Studio 8.

1. Copy-and-paste each team member's storyboard or flowchart sketches on the following pages (1 team member per page)
   → Be sure to indicate each team member's Name and MacID

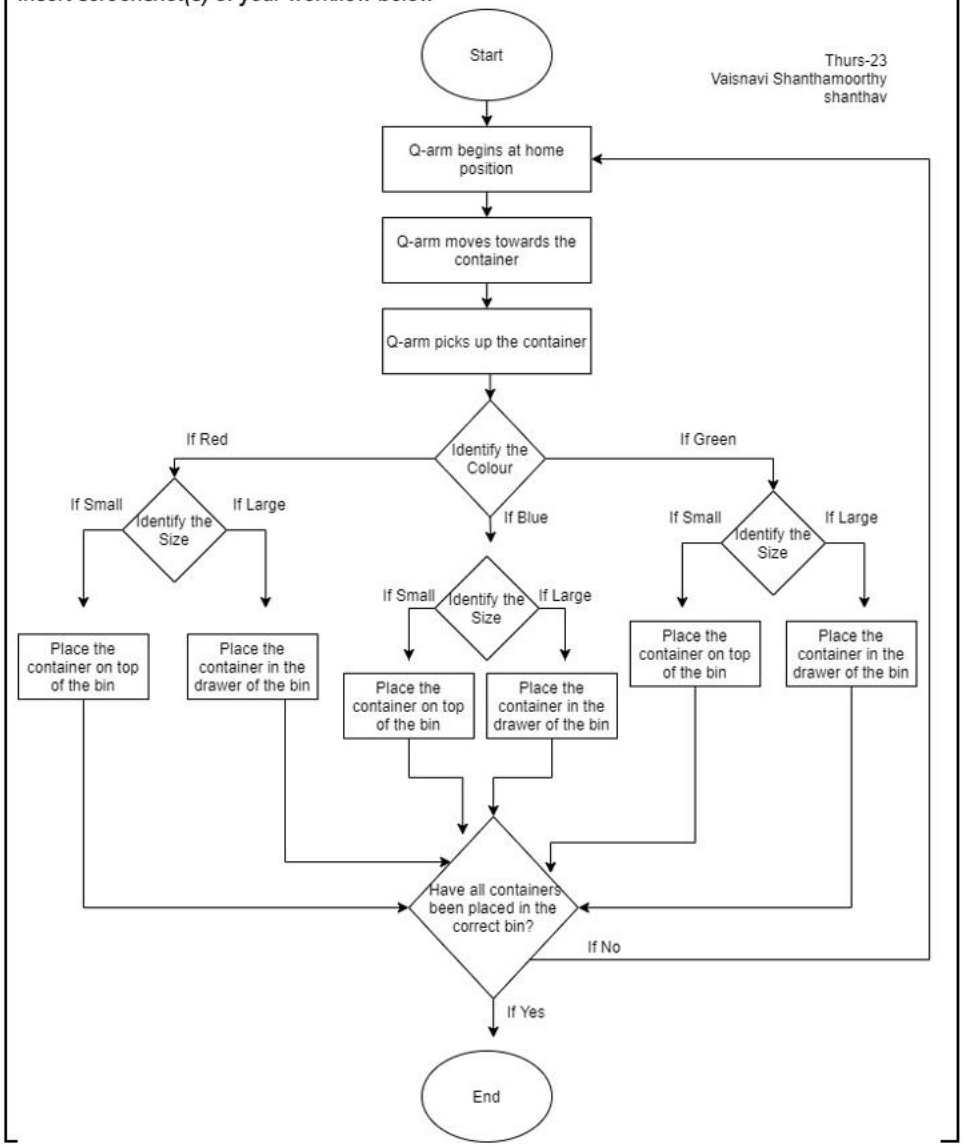
We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

- Each team member needs to submit their storyboard/flowchart with the **Milestone Two Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone Two Team Worksheets** document allows you to readily access your team member's work
  - This will be especially helpful when completing ***Stage 4*** of the milestone

Team Number: Thurs-23

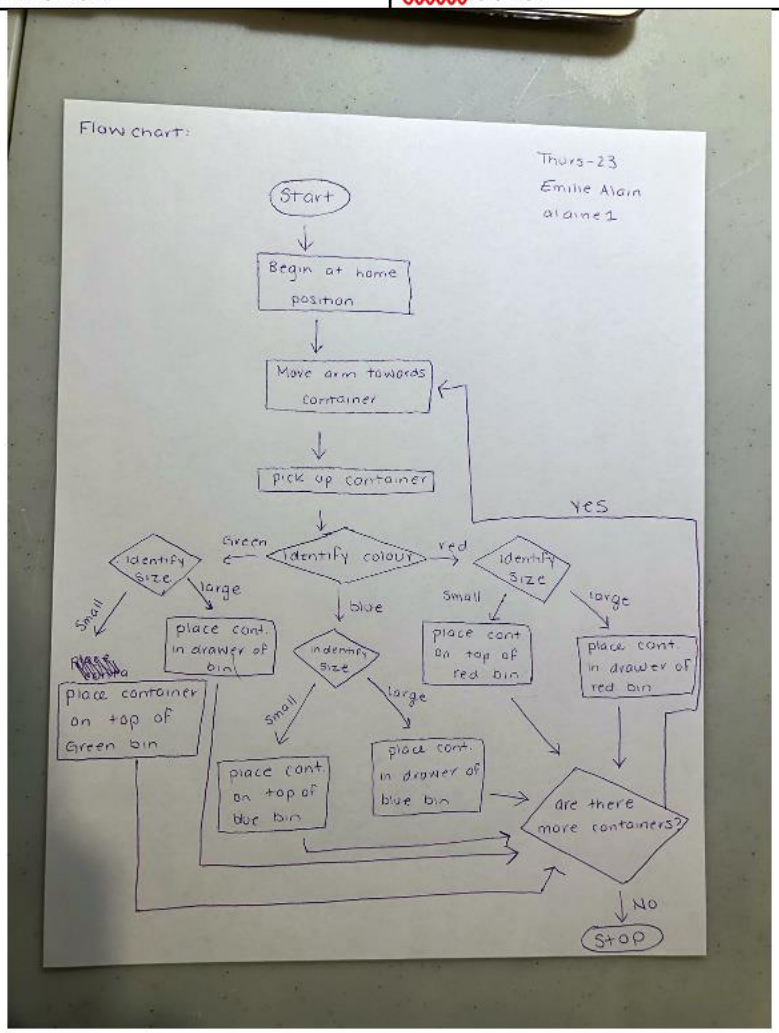
Name: Vaisnavi Shanthamoorthy	MacID: shanthav

Insert screenshot(s) of your workflow below



Team Number: Thurs-23

Name: Emilie Alain	MacID: alaine1



*If you are in a sub-team of 3, please copy and paste the above on a new page

MILESTONE 2 (STAGE 3A) – LOW-FIDELITY PROTOTYPE (MODELLING SUB-TEAM)

Team Number: Thurs-23

Complete this worksheet during design studio 8 after creating the low-fidelity prototypes.

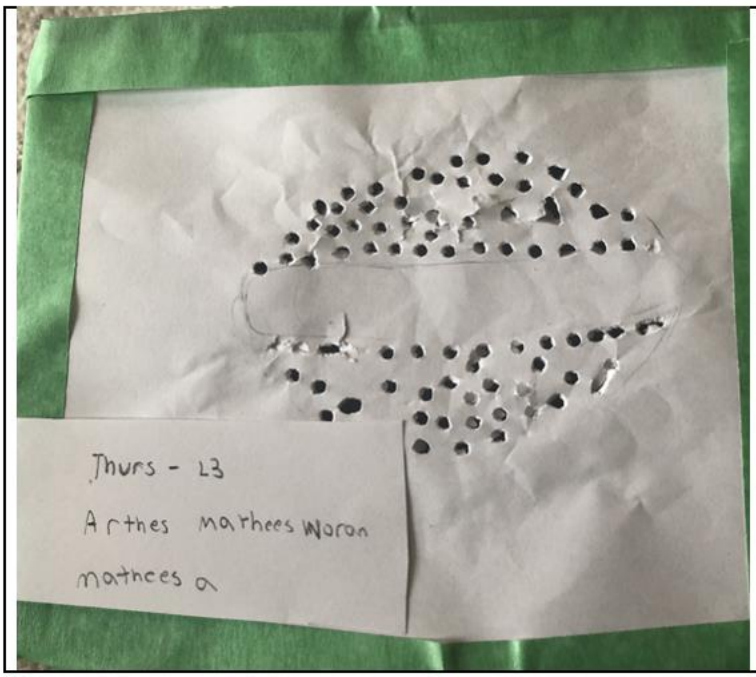
1. Take multiple photos of your low-fidelity prototypes
   → Include an index card (or similar) next to the prototype, clearly indicating your Team Number, Name and MacID on *each* sketch
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **Do not include more than *two* prototype photo's per page**

Make sure to include photos of each team member's prototype

Team Number: Thurs-23

Name:Arthes Matheeswaran	MacID: matheesa

Insert screenshot(s) of your low-fidelity prototype below



Team Number: Thurs-23

Name: Ziyang Qin	MacID: Qinz36

Insert screenshot(s) of your low-fidelity prototype below

*If you are in a sub-team of 3, please copy and paste the above on a new page

MILESTONE 2 (STAGE 3B) – LOW-FIDELITY PROTOTYPE OBSERVATIONS (MODELLING SUB-TEAM)

Team Number: Thurs-23

As a team, document your observations for each low-fidelity prototype. Make sure to label your observations to indicate which prototype it belongs to. As a starting, consider the following: (note, this does not fully encompass all discussion points)

→ Advantages and disadvantages of each prototype
→ Extent to which each concept aligns (or does not align) with the List of Objectives, Constraints, and Functions you came up with for Milestone 1
→ Reliability of the design in picking up the surgical tool
→ Reliability of the design in securing the surgical tool
→ Extent to which it allows for tool sterilization

Advantages:
-Both prototypes have an excellent sterilization system that allows for mist to enter and not harm the surgical tools
-The two prototypes have a lid that blocks debris and bacteria from entering the container
- Lids are easy to open and hardly fixed to the body of the container

Disadvantages:

- *Have air filters on the container and not just on the top of the container*
- *Inside the container both should have a cushioning for the surgical materials to be placed inside the container without any harm*
- *Surgical tools may damage when the Q-arm is dropping the container. It is better to use some tools to lower the collision between the surgical tools and the container (e.g., sponge).*

List of Objectives, Constraints and Function:
Aligns with:

- *Picking up container*
- *Both prototypes are light weight, small and portable*
- *Open and close with handle of container*

Does not align with:

- *Container does have a cooling/heating system*
- *Both prototypes don't have dimension on them*

Reliability of the design in picking up the surgical tool:

Our prototypes are not designed to pick up surgical tools as they only have a handle to open/ close the lid of the container. If our prototypes had included a magnetic handle for example, then the surgical tools would have attracted to the handle for ease of pickup.

Reliability of the design in securing the surgical tool:

Our prototypes did some designs for securing the surgical tools. We try to use some grooves to make sure that surgical tools don't move or fall apart when they're put inside of the container.

Extent to which it allows tool for Sterilization

The prototypes both have a good filter system that wouldn't allow for the tools for sterilization get affected by bacteria and allows for water vapor to come in. The lid on the container also traps and blocks microbes and waste from entering.

MILESTONE 2 (STAGE 4A) – WORKFLOW PEER-REVIEW (COMPUTATION SUB-TEAM)

Team Number: Thurs-23

As a team, document your observations, specifically any similarities and differences between each team member's visual storyboard or flowchart in the table below.

Similarities:

Some similarities present between both of our flowcharts includes the fact that we both decided to initially start with the arm at its home base. We then both said to move the arm towards the container and pick it up. Moreover, both of our flowcharts identified the colour of the container first, then moved on to identifying the size of the container in order to place the container in the correct autoclave bin. Overall, in comparison to one another, our flowcharts are quite similar.

Differences:

Our flowcharts for the most part followed the same steps, except for the last step. In Emilie's flowchart, her last step consisted of ensuring that all the containers were placed in bins and that there were no more remaining to be placed. In Vaisnavi's flowchart, she decided to make her last step to ensure that all the containers have been placed in the correct autoclave bin and if they were not, to return to home position and repeat the process until this condition is satisfied. These conditions are similar therefore, we think that both steps are equally important and both steps should be combined to ensure that every container is placed in an autoclave bin but that also every container is placed in the correct autoclave bin.

MILESTONE 2 (STAGE 4B) – PROGRAM PSEUDOCODE (COMPUTATION SUB-TEAM)

Team Number: Thurs-23

As a team, write out a pseudocode outlining the high-level workflow of your computer program in the space below.

1. Identify XYZ location of container
2. Identify XbYbZb location of blue autoclave bin
3. Identify XgYgZg location of green autoclave bin
4. Identify XrYrZr location of red autoclave bin
5. Move arm to XYZ location
6. Pick up container with gripper
7. Identify ID of container
    a. Identify size
    b. Identify shape
8. Rotate and move Q-arm to appropriate XYZ location
    a. Red – XrYrZr
    b. Green – XgYgZg
    c. Blue – XbYbZb
9. Place container in correct spot
    a. Large container – in the autoclave drawer
    b. Small container – on top of the autoclave bin
10. Release container
11. Return to home position
12. Repeat step 5-12 until all containers have been placed in correct autoclave bin
13. Once all containers have been successfully placed in their correct location according to their ID, terminate the code

PROJECT TWO: MILESTONE 3 – COVER PAGE

Team Number: Thurs-23

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Emilie Alain	alaine1
Ziyang Qin	qinz36
Vaisnavi Shanthamoorthy	shanthav
Arthes Matheeswaran	matheesa

MILESTONE 3 (STAGE 1) – PRELIMINARY SOLID MODEL (MODELLING SUB-TEAM)

Team Number: Thurs-23

You should have already completed this task individually prior to Design Studio 9.

1. Copy-and-paste each team member's screenshots of their preliminary solid model on the following pages (1 team member per page)
   → Be sure to clearly indicate who each model belongs to

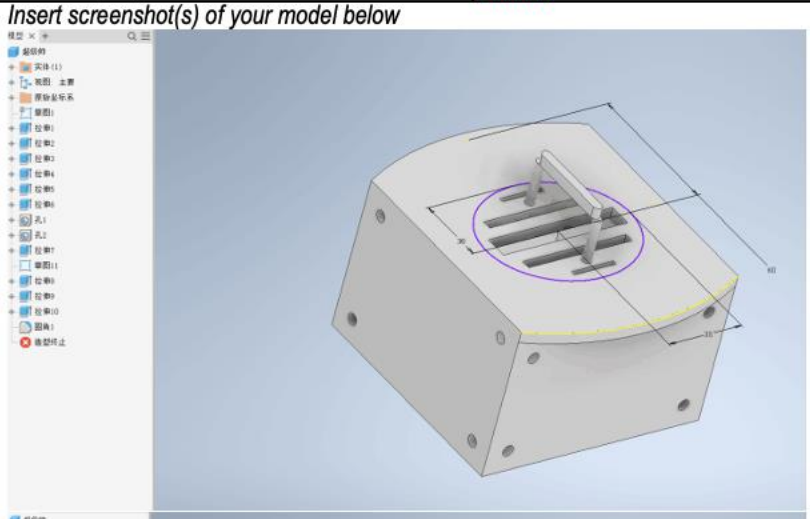
We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

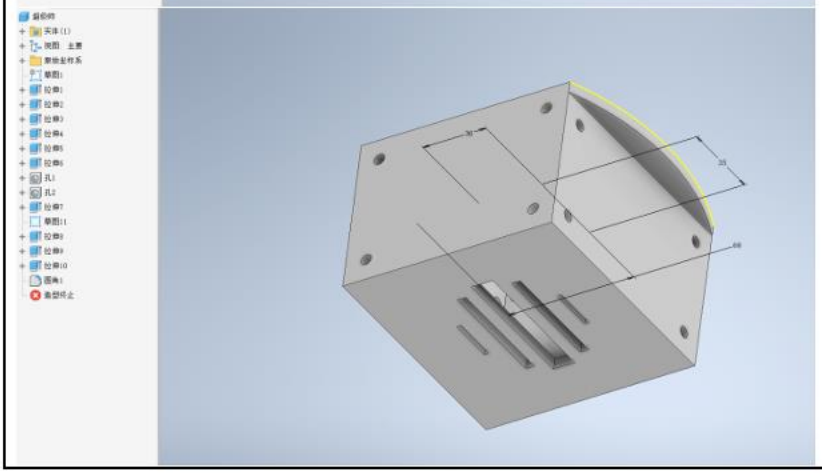
- Each team member needs to submit their solid model screenshots with the **Milestone Three Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone Three Team Worksheets** document allows you to readily access your team member's work
  - This will be especially helpful when completing ***Stage 3*** of the milestone

Team Number: Thurs-23

Name: Ziyang Qin	MacID: Qinz36

Insert screenshot(s) of your model below

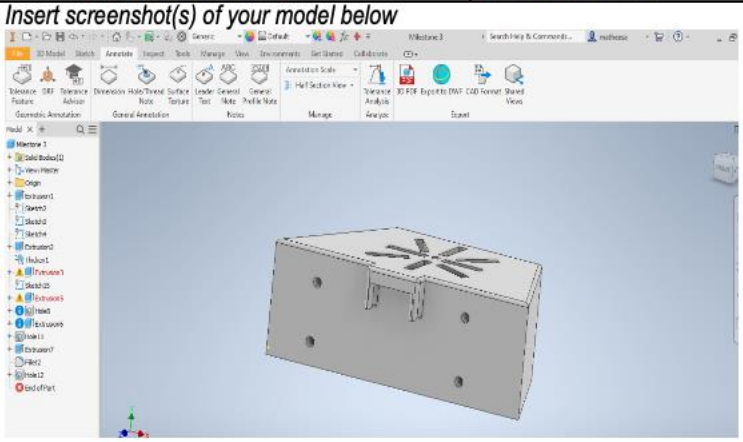


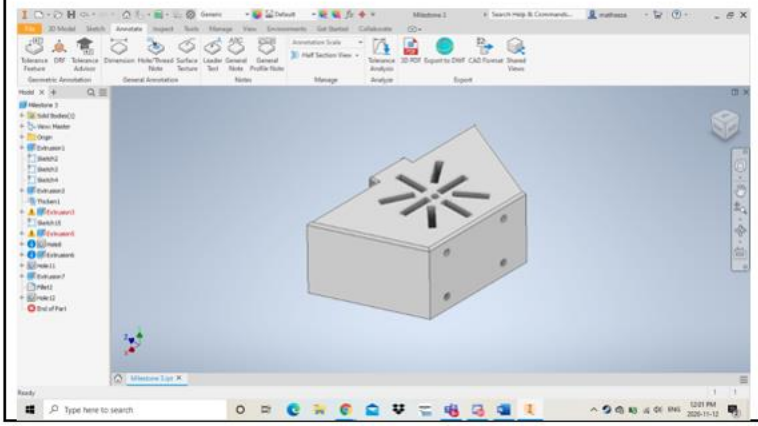


Team Number: Thurs-23

Name: Arthes Matheeswaran	MacID: matheesa

Insert screenshot(s) of your model below





*If you are in a sub-team of 3, please copy and paste the above on a new page

MILESTONE 3 (STAGE 2) – PRELIMINARY PROGRAM TASKS (COMPUTATION SUB-TEAM)

Team Number: Thurs-23

You should have already completed this task individually prior to Design Studio 9.

1. Copy-and-paste each team member's code screenshots on the following pages (1 team member per page)
   → Be sure to clearly indicate who each code belongs to

We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

- Each team member needs to submit their code screenshots with the **Milestone Three Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone Three Team Worksheets** document allows you to readily access your team member's work
  - This will be especially helpful when completing ***Stage 4*** of the milestone

Team Number: Thurs-23

Name: Emilie Alain | MacID: alaine1

```
## ------------------------------------------------------------------------------
## TEMPLATE
## Please DO NOT change the naming convention within this template. Some changes may
## lead to your program not functioning as intended.

import sys
sys.path.append('../')

from Common_Libraries.p2_lib import *

import os
from Common_Libraries.repeating_timer_lib import repeating_timer

def update_sim ():
    try:
        arm.ping()
    except Exception as error_update_sim:
        print (error_update_sim)

arm = qarm()

update_thread = repeating_timer(2, update_sim)


## STUDENT CODE BEGINS
## ------------------------------------------------------------------------------
## Example to rotate the base: arm.rotateBase(90)
arm.home()
time.sleep(2)
01 = [-0.6321, 0.2301, 0.4261]
02 = [-0.6321, 0.2301, 0.4261]
03 = [0.0, 0.6726, 0.4261]
04 = [-0.3752, 0.1366, 0.3095]
05 = [0.0, -0.3993, 0.3095]
06 = [0.0, 0.3993, 0.3095]
'''
```

```
'''
Blue box - small
>>> arm.rotate_base(90)
>>> arm.rotate_elbow(-60)
>>> arm.rotate_shoudler(50)
>>> arm.effector_position()
(0.0, 0.6726, 0.4261)
'''
'''
Blue box - large
>>> arm.rotate_base(90)
>>> arm.rotate_shoulder(5)
>>> arm.rotate_elbow(20)
>>> arm.effector_position()
(0.0, 0.3993, 0.3095)
'''

'''
Green box - small
>>> arm.rotate_base(-90)
>>> arm.rotate_elbow(-60)
>>> arm.rotate_shoulder(50)
>>> arm.effector_position()
(0.0, -0.6726, 0.4261)
'''

'''
Green box - large
>>> arm.rotate_base(-90)
>>> arm.rotate_shoulder(5)
>>> arm.rotate_elbow(20)
>>> arm.effector_position()
(0.0, -0.3993, 0.3095)
'''
```

```
'''
Red box - small
>>> arm.rotate_base(160)
>>> arm.rotate_elbow(-60)
>>> arm.rotate_shoulder(50)
>>> arm.effector_position()
(-0.6321, 0.2301, 0.4261)
'''

'''
Red box - large
>>> arm.rotate_base(160)
>>> arm.rotate_shoulder(5)
>>> arm.rotate_elbow(20)
>>> arm.effector_position()
(-0.3752, 0.1366, 0.3095)
'''
```

Team Number: Thurs-23

Name: Vaisnavi Shanthamoorthy	MacID shanthav

Insert a screenshot of your code below
First Screenshot down of code below:

File Edit Format Run Options Window Help

```
## ----------------------------------------------------------------------------------------------------------
#Name:Vaisnavi Shanthamoorthy
#macID: shanthav
#Student Number: 400319038
#Program Task: Move End Effector Function
## TEMPLATE
## Please DO NOT change the naming convention within this template. Some changes may
## lead to your program not functioning as intended.

import sys
sys.path.append('../')

from Common_Libraries.p2_lib import *

import os
from Common_Libraries.repeating_timer_lib import repeating_timer

def update_sim ():
    try:
        arm.ping()
    except Exception as error_update_sim:
        print (error_update_sim)

arm = qarm()

update_thread = repeating_timer(2, update_sim)
```

*If you are in a sub-team of 3, please copy and paste the above on a new page

Name: Vaisnavi Shanthamoorthy	MacID shanthav

Insert a screenshot of your code below
Second Screenshot of code down below:

```
## STUDENT CODE BEGINS: MOVE END EFFECTOR
## ----------------------------------------------------------------------------------------------------

from MuscleGUILib import* #import muscle sensor emulator
emg = EMGSim()

thres = 0.3 #set a threshold

#Input the xyz and abc coordinates for the respective pickup and dropoff locations
x = (float(input("Please enter the x-coordinate point for the pickup location: ")
y = (float(input("Please enter the y-coordinate point for the pickup location: ")
z = (float(input("Please enter the z-coordinate point for the pickup location: ")
a = (float(input("Please enter the a-coordinate point for the dropoff location: ")
b = (float(input("Please enter the b-coordinate point for the dropoff location: ")
c = (float(input("Please enter the c-coordinate point for the dropoff location: ")

pickup_location = [x,y,z] #store the entered values of x,y,z for the pickup location coordinates in a list
dropoff_location = [a,b,c] #store the entered values of a,b,c for the dropoff location coordinates in a list


def move_end_effector(pickup_loc,dropoff_loc):

    if arm.emg_left < thres:
        arm.control_gripper(-45) #open up the gripper fully

    if arm.emg_right >= thres:
        time.sleep(2)
        arm.move_arm (pickup_loc[0],pickup_loc[1],pickup_loc[2]) #move to the pick-up location based on the coordinates entered
        time.sleep(2)
        if arm.emg_left >= thres:
            arm.control_gripper(45) #close the gripper so that the container is secure
        time.sleep(2)
        arm.move_arm(0.4064,0.0,0.4826) #return to home base before going to the dropoff location
        time.sleep(2)
        arm.move_arm (dropoff_loc[0],dropoff_loc[1],dropoff_loc[2]) #move to the dropoff location based on the coordinates entered
        time.sleep(2)


move_end_effector(pickup_location,dropoff_location)
```

MILESTONE 3 (STAGE 3) – PUGH MATRIX (MODELLING SUB-TEAM)

Team Number: Thurs-23

1. As a team, evaluate your designs for the sterilization container in the table below
   - → List your Criteria in the first column
     - You should include a minimum of 5 criteria
   - → Fill out the table below, comparing your designs against the given baseline
     - Replace "Design A" and "Design B" with more descriptive labels (e.g., a distinguishing feature or the name of the student author)
     - Assign the datum as the baseline for comparison
     - Indicate a "+" if a concept is better than the baseline, a "–" if a concept is worse, or a "S" if a concept is the same

	Datum	Ziyang	Arthes
Stiffness	s	+	+
Gas permeability	s	-	s
Mass of design cannot exceed 350g	s	s	s
Allow for picking up	s	+	s
Small	s	+	+
Allow for sterilization	s	s	-
Portable	s	s	s
Total +	0	3	2
Total –	0	1	1
Total Score	0	2	1

*For a team of 3, click the top-right corner of the table to "Add a New Column"

2. Propose one or more suggested design refinements moving forward

(1) Try to add more thickness to the bottom of our container so tools will not go through the container and can be placed properly
(2) Add drawers within the container so tools can be placed in neatly and safely, i.e. not cluttered.

MILESTONE 3 (STAGE 4A) – CODE PEER-REVIEW (COMPUTATION SUB-TEAM)

Team Number: Thurs-23

Document any errors and/or observations for each team member's preliminary Python program in the space below

Identify Autoclave Bin Location Task	**Team Member Name**: Emilie Alain

1. One of the errors present in this code is that it only states the drop off locations, not the pickup location. The pickup location is a vital aspect as it is where the container is being picked up so to fix this, we would need to identify the pickup location as well.
2. A function was not explicitly defined, perhaps we could include one line in this code to be "def identify_autoclave_bin_loc ():" With this, it is more clear to anyone who reads the code, as to what task the code it is trying to achieve.
3. An assumption was made as to how far the drawer opens. This could potentially lead to error in the future as the position of the Q-arm may be too close or too far to correctly place the container in its respective correct location.
4. Variables were set to identify the proper location of each bin based on size and colour
5. Location was found by 'guessing', this could lead to error when dropping the container into the drawer (ie. Making sure the gripper is not too close to the bin that the container won't fit in it. Etc.) or when dropping the container on top of the bin, to ensure that the gripper is in the center of the box

Move End-Effector Task	**Team Member Name**: Vaisnavi Shanthamoorthy

1. The user was asked for input to determine the (x,y,z) and (a,b,c) coordinate positions for both the pickup and drop-off locations, and those values were then stored in a list. This ultimately aided in not having to repeat the position numerous times, it reduced a lot of repeated steps having to be made.
2. A threshold was set so that the muscle sensor emulator could be used to move the robotic arm to the specific coordinates pick-up and drop-off locations. In addition, the threshold is used to open and close the gripper fully. The use of the muscle sensor emulators seems to have been used accordingly as certain functions/tasks such as going to the pickup/drop-off location are being met when the certain threshold is passed or not.
3. An error present in the code for this function is the movement of the Q-arm back to home base after picking up the container and before heading to the drop-off location. With it there, no objective is being met so it is unnecessary for it to remain in the code and should be taken out.
4. time.sleep(2) was used numerous times to allow the Q-arm to understand and execute the code properly without being overwhelmed. However, perhaps, time.sleep(5) could have been used instead to give the Q-arm more than two seconds to rest before proceeding to the next task.

MILESTONE 3 (STAGE 4B) – PROGRAM TASK PSEUDOCODE (COMPUTATION SUB-TEAM)

Team Number: Thurs-23

As a team, write out the pseudocode for each of the *remaining* tasks in your computer program in the space below.

Control Gripper

1. Gripper end-effector is positioned at the pick-up platform
2. Gripper opens up to position itself around the container
3. Gripper closes and picks up the container
4. Once Q-arm moves to the correct autoclave bin location (depending on it's colour and size), gripper opens up to release container into the correct location
    a. for the small red bin, the gripper releases and places the container at XrYrZr
    b. for the large red bin, once the drawer opens, the gripper releases and places the container at XRYRZR
    c. for the small green bin the gripper releases and places the container at XgYgZg
    d. for the large green bin, once the drawer opens, the gripper releases and places the container at XGYGZG
    e. for the small blue bin, the gripper releases and places at XbYbZb
    f. for the large blue bin, once the drawer opens, the gripper releases and places the container at XBYBZB

Open Autoclave Bin Drawer

1. If gripper closes a certain amount to grab the container (if it closes a small amount) we know the drawer must open.
2. If the colour of the container is red – open the red drawer
3. If the colour of the container is green – open the green drawer
4. If the colour of the container is blue – open the blue drawer
5. Return home

Continue or Terminate

1. Once the six containers have been successfully been placed in the correct autoclave bins, the system should terminate. If there are more containers, the system should continue until all bins have been successfully placed in their respective correct autoclave bin.

PROJECT TWO: MILESTONE 4 – COVER PAGE

Team Number: Thurs-23

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Ziyang Qin	Qinz36
Vaisnavi Shanthamoorthy	shanthav
Emilie Alain	alaine1
Arthes Matheeswaran	matheesa

MILESTONE 4 (STAGE 3) – DESIGN REVIEW FEEDBACK (MODELLING SUB-TEAM)

Team Number: Thurs-23

Use the space below to document mentor feedback for your design.

We showed TA our current model during the meeting and how it fits the 3D printer, and we received a Go with a warning at the end of the meeting. There are some points our TA mentioned that we could improve on:

1. Remove the handle or try to add supports to it when doing the 3D printing.

<1> Our model may have to remove the handle because it can go over the autoclave dimension limitation. To do that, we have to consider the size again to avoid any possibilities that could end up with unfitted dimensions.

<2> There is a problem related to the design when it is 3D printed. The 3D printer cannot build things without the bottom layer, so we must build support to the handle in order for the printer to work probably. We could also remove the handle so that it will not affect the result and save time on printing.

2. Trying to find a way to fit the drawer or keep it not to drop off. It does not affect a lot but better consider making a change.
3. Create the autoclave model from the image to test whether our final design fits into the autoclave.
4. Finally, better to constrain the assembly model before submission.

We decide to adjust our modelling parts to meet the expectations of our TA. Firstly, we want to get rid of our handle so that it will not affect the process while printing. We have thought about adding supports to it, but it will end up elongating our printing time, so we give up this idea. By doing this, we should consider more on the constrain because the drawer cannot pull out without a handle. Moreover, we will work on creating our autoclave model for testing our final design. It is an essential step for us to know whether our design fits our expectations. Finally, before we submit our final design, we should check whether our design is fully constrained or not. We should keep the drawer moving only in one direction and not overlap with any part of the shell.

MILESTONE 4 (STAGE 3) – DESIGN REVIEW FEEDBACK (COMPUTATION SUB-TEAM)

Team Number: Thurs-23

Use the space below to document mentor feedback for your design.

Although we received a GO from our TA during our design review as our code successfully executed a single cycle of pickup, transfer and drop off of a single container, our TA mentioned to make the following adjustments to our code to further improve it and fit the rubric expectations:

- Rather than passing arm.emg_right() and arm.emg_left() to the variables left and right, our TA stated that rather we should include the actual commands.
    - For example, we should include "if arm.emg_right() > threshold instead of if right > threshold"
- We should make an additional function to close the autoclave drawer. We originally had it attached to our gripper function, but it was suggested that we define a new function to close the drawer and call that in the main function instead
- We should also have the code randomly spawn the container for us instead of manually inputting a number di which container will be spawn. This will be adjusted in our main function.
- We must define a main function. We had a main function, but we did not define it. It was suggested that we define the main function then call it afterwards.
- Finally, we were told to make sure that the q-bot arm returns home before proceeding to the drop off location so that it does not hit the autoclave bins when moving from the pickup location to the respective drop off locations.

Use the space below to propose design refinements based on the feedback.

We have and will continue to make adjustments to our program to ensure that we can have it run properly while meeting all expectations. We have started by incorporating the arm.emg_right() and arm.emg_left() commands directly into the functions that utilize them rather than passing these commands through the variables left and right. Additionally, we have created a new function to close the autoclave bins. Moreover, we adjusted our code so that the q-bot arm returns home after it has picked up the container and before it goes to the drop-off location. We have done so by using the move end-effector function and passing the argument home, with its' respective coordinates, instead of using arm.home() so that the gripper does not release the container on its' way to the home location. We then started defining a main function and getting rid of our input statement for the container spawned. We are still working through the details of this, but we are working towards a better program. Specifically, we are working to obtain a program that will randomize the spawning of the containers and loop through a cycle for each container without repeating containers on its own without any input needed. By adjusting some of these things we have run into many errors and roadblocks but after attending a few office hours we should be able to properly refine our code to ensure that every container makes it to the proper location.

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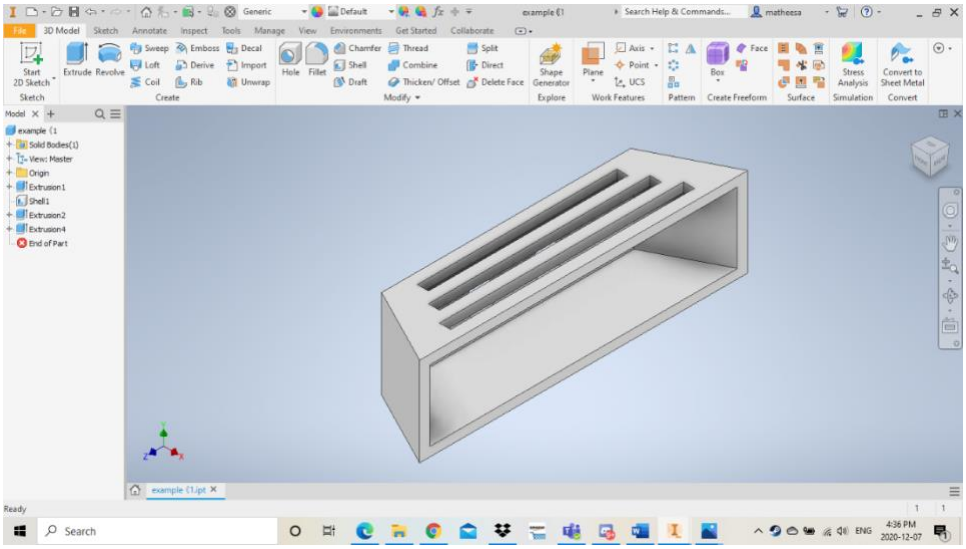
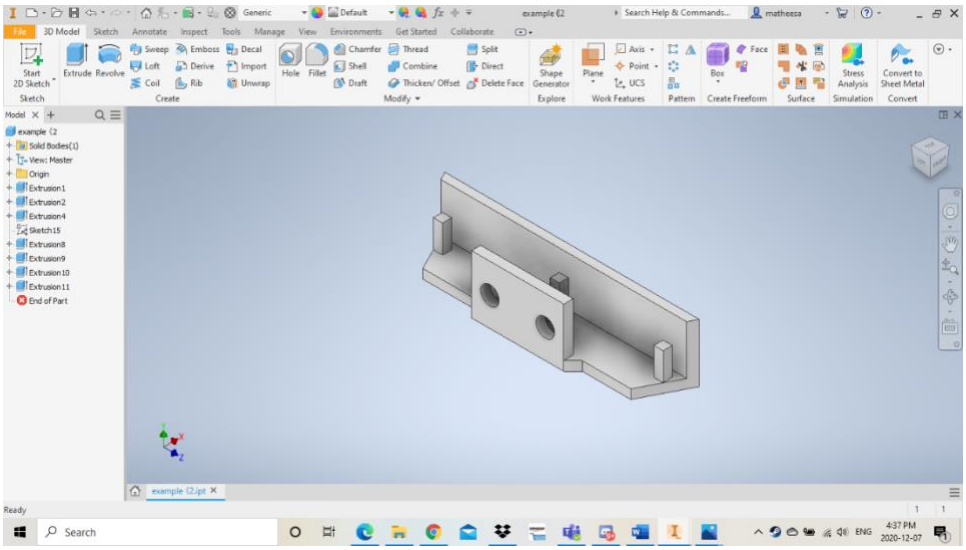
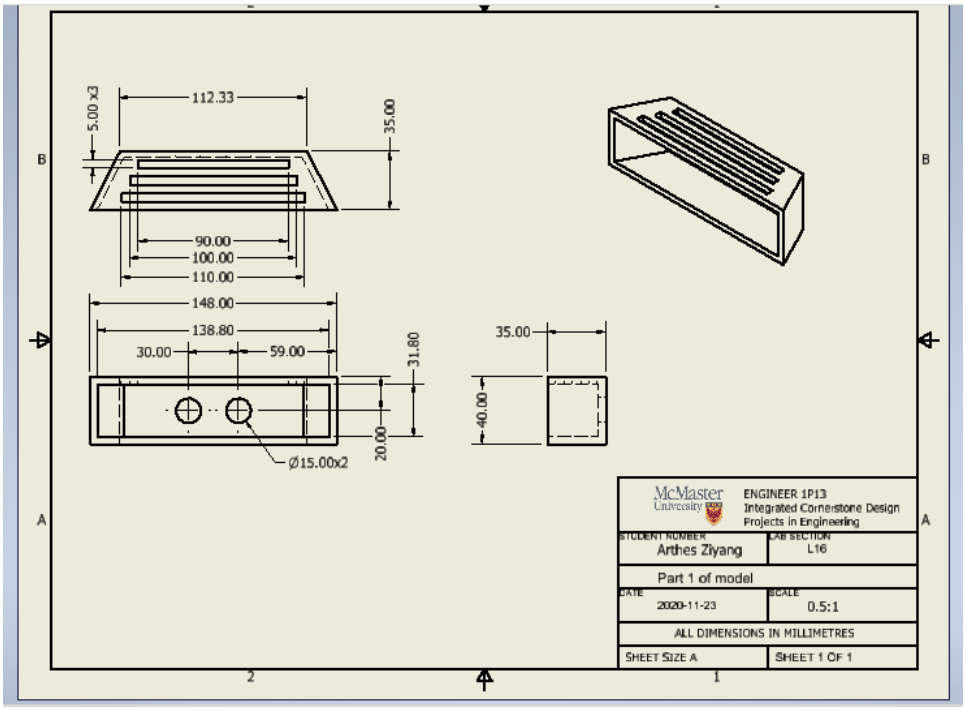
Appendices:

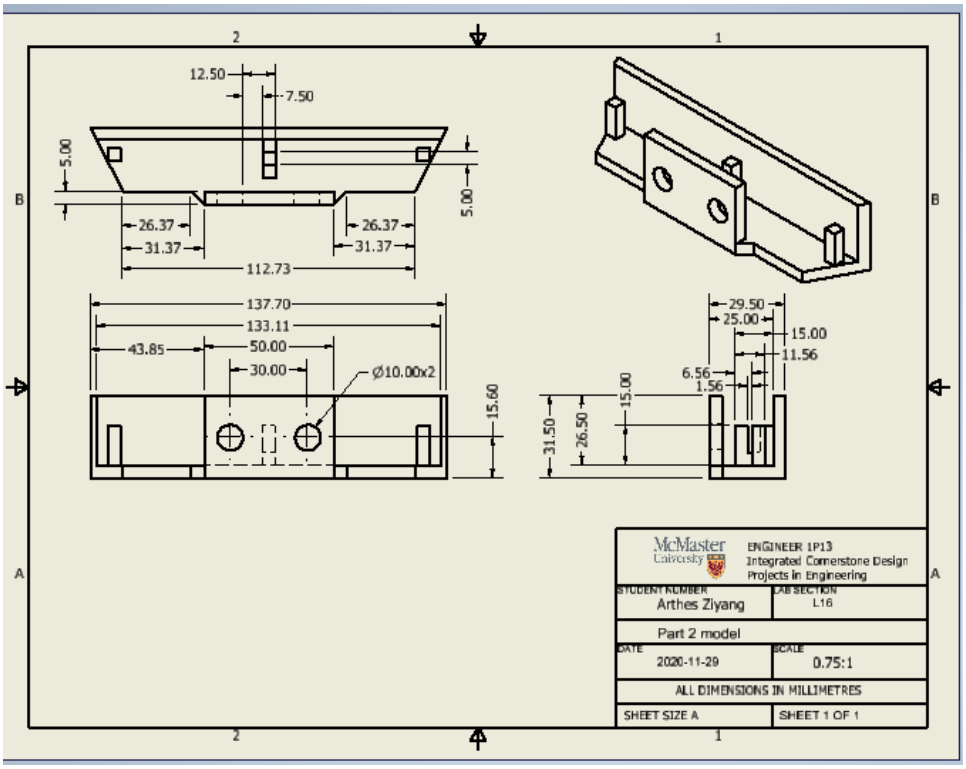
Appendix A – Screenshots of our Final Solid Model: (Arthes Matheeswaran and Ziyang Qin)





Appendix B – Fully Dimensioned Engineering Drawings of our Sterilization Container Design: (Arthes Matheeswaran and Ziyang Qui)





Appendix C – Screenshots of our Final Computer Program: (Emilie Alain and Vaisnavi Shanthamoorthy)

```
## ------------------------------------------------------------------------------------------------------------
## Team: Thurs 23
##Team Member 1: Emilie Alain, macID: alaine1, Student Number:400298084
##Team Member 2: Vaisnavi Shanthamoorthy, macID: shanthav, Student Number: 400319038
## TEMPLATE
## Please DO NOT change the naming convention within this template. Some changes may
## lead to your program not functioning as intended.
import random
import sys
sys.path.append('../')

from Common_Libraries.p2_lib import *

import os
from Common_Libraries.repeating_timer_lib import repeating_timer

def update_sim ():
    try:
        arm.ping()
    except Exception as error_update_sim:
        print (error_update_sim)

arm = qarm()

update_thread = repeating_timer(2, update_sim)
# (0.5055, 0.0, 0.0227)

## STUDENT CODE BEGINS
## ------------------------------------------------------------------------------------------------------------


# Global Variables (Vaisnavi)
home = [0.4066, 0.0, 0.4824] # Q-arm home location
pickup = [0.5055, 0.0, 0.0227] # Pickup location for containers
thres = 0.5 # Set threshold to 0.5

#Emilie found all the small locations & Vaisnavi found all the large bin locations
# Red: small, large
autoclave1 = [[-0.5893, 0.2321, 0.364], [-0.3744, 0.155, 0.3303]]
# Green: small, large
autoclave2 = [[-0.6055, -0.6337, 0.3675], [0.0, -0.3994, 0.3093]]
# Blue: small, large
autoclave3 = [[-0.6022, 0.6337, 0.3675], [0.0, 0.3993, 0.3095]]
```

```
# The following function identifies the ID of the container according to its size and colour (Emilie)
def get_location(identify):
    if identify == 1:
        location = autoclave1[0] # Small red
    elif identify == 2:
        location = autoclave2[0] # Small green
    elif identify == 3:
        location = autoclave3[0] # Small blue
    elif identify == 4:
        location = autoclave1[1] # Large red
    elif identify == 5:
        location = autoclave2[1] # Large green
    elif identify == 6:
        location = autoclave3[1] # Large blue
    return location


# This function moves the container to the pick up, dropoff and home locations (Vaisnavi)
# If left and right arm are both above the threshold then the arm will move to desired location
def move_end_effector(coordinate):
    while True:
        if arm.emg_left() > thres and arm.emg_right() > thres:
            arm.move_arm(coordinate[0], coordinate[1], coordinate[2]) #dropoff location coordinates
            break


# This function opens the drawer if the container ID corresponds to a large container (containers 4, 5 and 6) (Emilie)
# If the left arm is above the threshold, the right arm is 0 and the container is large, the corresponding drawer will open

def drawer_open(identify):
    while True:
        if identify == 4 and arm.emg_left() > thres and arm.emg_right() == 0:
            arm.open_red_autoclave(True) # Opens red drawer
            break
        elif identify == 5 and arm.emg_left() > thres and arm.emg_right() == 0:
            arm.open_green_autoclave(True) # Opens green drawer
            break
        elif identify == 6 and arm.emg_left() > thres and arm.emg_right() == 0 :
            arm.open_blue_autoclave(True) # Opens blue drawer
            break
        elif identify < 4:
            break
```

```
# This function controls the gripper in terms of opening and closing it to hold and release the container (Vaisnavi)
# If the right arm is greater than the threshold and the left arm is 0, the gripper will fully close
# If the right arm is between 0 and the threshold and the left arm is 0, the gripper will fully open
def gripper():
    while True:
        if arm.emg_right()  > thres and arm.emg_left() == 0:
            arm.control_gripper(45) # Close gripper fully
            break
        elif arm.emg_right() < thres and arm.emg_right() > 0 and arm.emg_left() == 0:
            arm.control_gripper(-45) # Open gripper fully
            break

# This function closes the drawer after the container has been placed in it (Emilie)
# If the left arm is above the threshold, the right arm is 0 and the container is large, the corresponding drawer will close
def drawer_close(identify):
   while True:
        if identify == 4 and arm.emg_right() == 0 and arm.emg_left() > thres:
            arm.open_red_autoclave(False) # Closes red drawer
            break
        elif identify == 5 and arm.emg_right() == 0 and arm.emg_left() > thres:
            arm.open_green_autoclave(False) # Closes green drawer
            break
        elif identify == 6 and arm.emg_right() == 0 and arm.emg_left() > thres:
            arm.open_blue_autoclave(False) # Closes blue drawer
            break
        elif identify < 4: # Nothing will happen if the container is small
            break

#main function (Vaisnavi & Emilie)
def main():
    container_ID = [1, 2, 3, 4, 5, 6] # List of all containers
    random.shuffle(container_ID) # Randomizes spawned container
    for identify in container_ID:
        arm.spawn_cage(identify) # Correct container will spawn
        dropoff = get_location(identify) # Gets coordinates for drop off location
        move_end_effector(pickup) # Arm moves to container's pickup location
        gripper() # Closes gripper
        move_end_effector(home) # Arm moves home
        time.sleep(5)
        move_end_effector(dropoff) # Arm moves to the container's dropoff location
        drawer_open(identify) # Opens drawer if needed (containers 4, 5 and 6)
        gripper() # Opens gripper
        time.sleep(5)
        arm.home() # Q-arm returns home
        drawer_close(identify) # If any drawer is open, it will close
        time.sleep(5)

main() # Calling main function
```