Design Project 2 – Get a Grip (Design a System for Sterilizing Surgical Tools using Remote Sensing and Actuation)

ENGINEER 1P13 – Integrated Cornerstone Design Projects in Engineering

Tutorial 09

Team 50

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Submitted: December 5th, 2023

Course Instructors: Dr. McDonald, Dr. Doyle, Dr. Ebrahimi, Dr. Fleisig, Dr. Hassan, Dr. Zurob

Table of Contents

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khurramf 400514719

(Student Signature) *

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.

elfaress 400525799

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(Student Signature) *

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.

duongj21 400510627

_____
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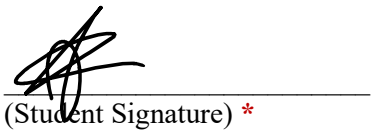
ricaforj 400526118



(Student Signature) *

Executive Summary

In the healthcare industry, surgical tools are used by doctors and surgeons daily, and it is vital for these tools to be sterilized after each use to prevent infections caused by pathogens and bacteria [2]. The sterilization process is usually done through an autoclave, which can be challenging for individual healthcare workers to consistently manage. However, robotic-device assistance can enhance this process by safely transferring the surgical tools to their specified autoclave for sterilization [2].

The main objective of the "Get a Grip" project was to design a robotic arm system that transfers surgical tools that are placed in a specifically designed container into their designated autoclave for sterilization [3]. To create this system, students were split into a modeling sub-team, and computing sub-team. The modeling sub-team utilized Autodesk Inventor to design a solid model of the proposed sterilization container, and the computing sub-team utilized Python to design a computer program that would control the movement of the robotic arm to safely pick up and transfer a container for sterilization [3]. During this process, the modeling sub-team had to ensure that the design was durable, and efficient to withstand the sterilization process. This meant to consider the build of the container, and the materials used to guarantee a durable container that weighed under a threshold of 350g. On the other hand, the computing sub-team had to ensure that the process of transferring the container was safe and reliable. This was done by creating a variety of functions that made up the general algorithm of the system such as a "drop_off" function, "rotate_base" function, and "spawn_container" function by utilizing the Q-Arm specific code and general python programming. Together, both sub-teams created a general flow for the robotic arm system to effectively perform its functions.

This project served as an opportunity for students to explore rapid prototyping and physical computing by developing a system that uses remote sensing and actuation to assist healthcare workers. By eliminating the need of directly placing surgical tools into the autoclave, the project's robotic arm can eliminate the burden of efficiently transferring these instruments for sterilization. Furthermore, the Q-Arm system not only enhanced the sterilization process but also reduced the risk of potential contamination from pathogens and bacteria, offering a safer method for healthcare workers to maintain the sterility of their tools.

Main Body

Summary of Design Objectives

Table 1 Objectives, Constraints and Functions Table

Objectives	Constraints	Functions
Safely pick-up box.	Q-Arm should not break/drop the box.	Box allows tool to be sterilized on all surfaces.
Durable	Dimensions of each box to weigh below 350g.	Box securely holds surgical tool.
Efficient	Cannot be slow during transfer.	Able to safely transfer the box to sterilization area
Simple design	Shape of box – can only fit one tool	Maintains organization of tools.
Safety to deliver the tool	Smaller boxes must be smaller or equal or less than 80mm in width and larger boxes must be 150mm or less in width.	Not drop the box through delivery

Background and Research Summary

The main objective of this design project was to create a container to hold a surgical tool and to write a computer program that instructs a robotic arm to move the container to an autoclave. The container and the computer program were to be used for health support on the first crewed mission to the moon called Artemis II [3]. The main objectives for the container were that it should be able to securely hold a surgical tool in place, the shape of the container should have allowed it to be easily picked up by a robotic arm for transfer, and that it should allow complete sterilization of the surgical tool [3]. The mission will have access to limited resources once it left earth meaning that the surgical tools had to stay in peak condition for each use, the container had to be able to securely hold the tool in place to prevent any damage during transport between the autoclave and when it was being used. While the space mission was manned the crew used robotic assistance for many tasks including in the health support which is why the container be shaped so that the robot arm effector will be able to grip it securely for transport [3]. After use, the surgical tool was susceptible to many bacteria and fungi, to eliminate the risk of these health concerns the container had to be designed in a way that allowed steam to penetrate every surface of the tool, cleaning it of any foreign or dangerous organisms. The objectives for the computer program were that it should be able to operate a

robotic arm using two virtual potentiometers [3]. The virtual potentiometers and the program allowed the sterilization to be completed with minimal effort and helped prevent foreign or dangerous organisms from infecting the surgical tool after sterilization. Overall, the container design and the computer program were designed to allow minimal human interaction during the space mission.

Description of Proposed Solution

In the creation of the bone-saw container, Autodesk Inventor was utilized as the primary modelling software. The extrusion technique was employed to create the basic shape of the container, using precise measurements to ensure a snug fit for the bone-saw (Figure 1). The rectangular pattern created the basis of the design to add additional sterilization functionality. In addition, the fillet tool was used to round off the edges of the container, enhancing both its aesthetic appeal and its safety for handling. Ensuring a proper fit, the assembly feature played a crucial role in confirming the precise fitting of the bone-saw within the container, ensuring that the design not only met the requirements but fell within our constraints.

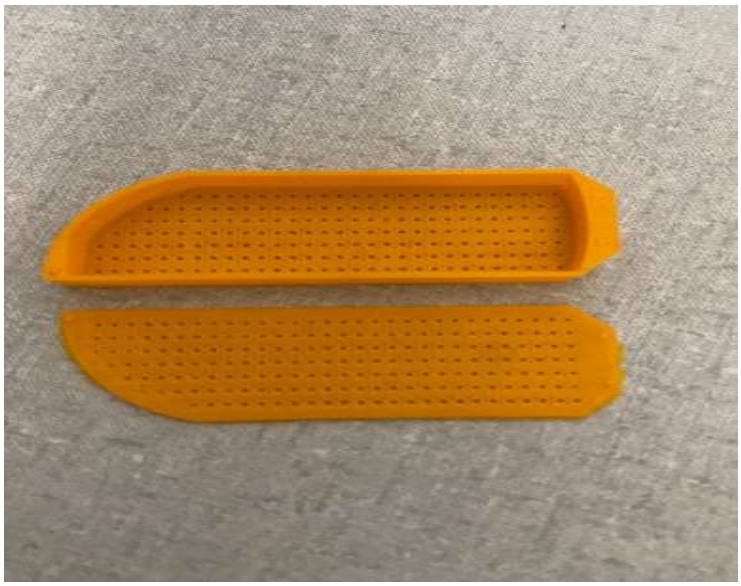


Figure 1. Top View of model

The fabrication of the model involved preparing the G-code, slicing the model virtually, and preparing it for printing, this process took 45-60 minutes. Although the model was printed using PLA, the optimized material under our chosen MPI would be stainless steel. Due to its, heat resistant and medical grade properties, it performs the best under the price and density limitations.

The code for both the pickup and transfer process was created using the commands in the Python documentation library and functions learned in the lab portion of the course. First the position of the pickup location and home location were determined, then the move arm function was used with the coordinates previously found. After the arm moved the time sleep, gripper control, and move arm functions were used completing the pickup portion of the code. The transfer function and the drop off functions were created together, they were created using a series of if, elif, and or statements. Before the statements were utilized the coordinates of each drop off location were determined with the same process for the pickup location.

The statements determined which coordinate the container went to and what values the potentiometer had to be between depending on if it was large or small and what colour the containers were. While statements were also used to determine if the potentiometers were in the correct range so they could initiate the drop off function.

Strength and Limitations of Design

The design was based on the shape of the tool it will hold (Bone Saw) and the dimensions of the design were chosen with two main factors in mind. The design should provide a snug fit of the bone saw, while being big enough to place the bone saw in it. At the same time, the design should minimize the mass and amount of material used which in turn leads to lower cost. Both these factors are correlated however considering them both added strengths as well as some limitations to the design.

Strengths

The design performs an exceptional job at minimizing mass and quantity of material used due to the sheer amount of sanitation holes that decreased the total mass considerably. There were 200 holes in the box (Figure 2) that decreased the overall mass from 177g to 104g [3] (Figure 3). The second way our design minimized the mass and quantity of the container was to make the container fit well to the bone saw. Figure 4 demonstrates that there was minimal space between the edges of the bone saw and the walls of the container. This means there was minimal waste of material, and the design can also fit the bone saw comfortably.

Limitations

With the above strengths also come certain limitations in the design. The thin walls of the box cause minor issues with rigidity when gripped robustly externally. This design is built well to be a holder for sanitation and to go into a footprint. However, if the container itself was gripped then it could deform if pressed too hard. Some other minor limitations of the box are a lack of padding and slight excess of space near the bottom of the container which could mean the bottom, heavier end of the bone saw might be moving around slightly when being transferred within the footprint. The other limitation in the design is the holes that were made for the lid. The holes need to be perfectly aligned with the extrusions on the lid which could make it slightly challenging to place the lid on the box.

Conclusion

Overall, the strength of the design was its capability of minimizing its mass and material while providing a snug fit to the bone saw. This was our main objective from the initial stages of the project and if the

performance of the design was based solely on how well the objectives were reached, the design has surpassed the expectations. However, minor limitations such as the rigidity, lack of padding and the placement of the lid are areas of improvement for the design which can make it an ever better overall product.

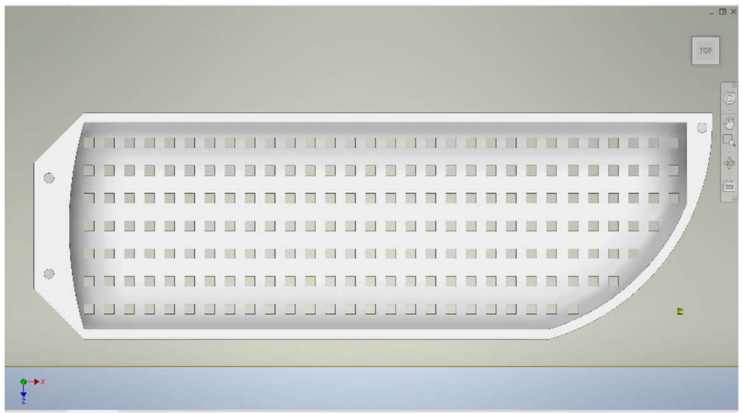


Figure 2. Top View of Design

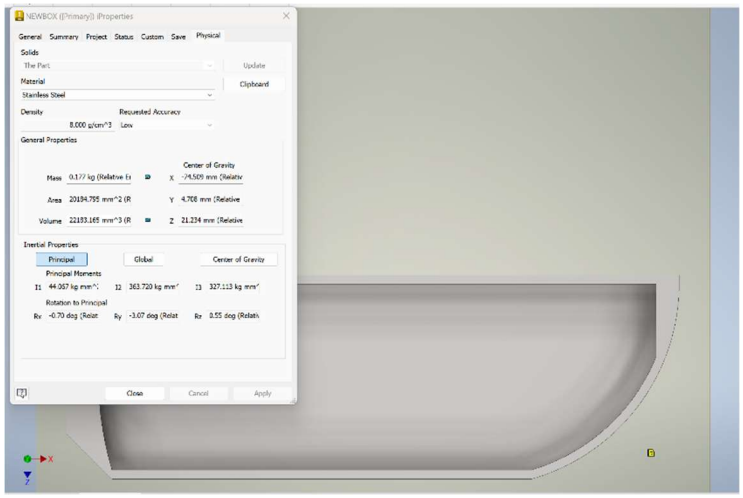


Figure 3. View of box without holes with iProperties.

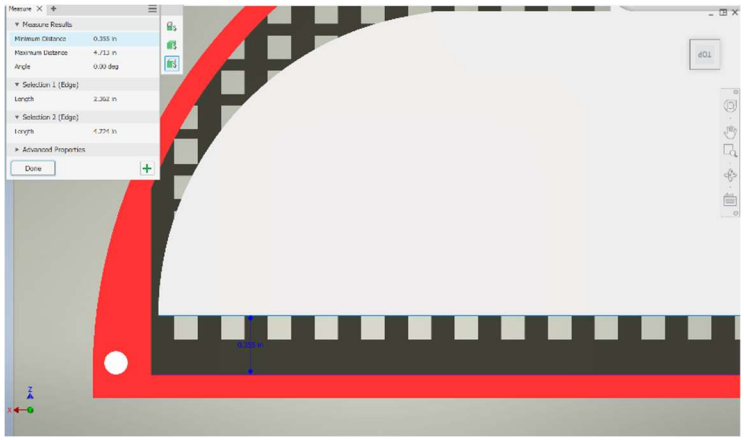


Figure 4. Distance from edges.

Summary of Contributions

Table 2: Contributions

Group member	Position	Contributions in Design Report
Furqaan Khurram Qamar	Admin 2	Source Materials Database, Strength and Limitations of Design, Modelling Design Studio Worksheets, Final Report Review, Division of Tasks with Shadi, Creating preliminary and final design.
Shadi El-Fares	Coordinator	As coordinator, I maintained a database of meeting notes, ensuring to capture key talks and decision for future reference. I also kept a record of additional discussion, noting unplanned chats and ideas to contribute to the project. Outside the maintenance of team dialogue, I collaborated with Furqaan to create the preliminary design.
Jennifer Duong	Admin 1	Final Gantt Chart, Executive Summary, Summary of Design Objectives, Computing Design Studio Worksheets
Jessica Ricafort	Manager	Preliminary Gantt Chart, Weekly Design Studio Agendas, Background and Research Summary, Description of Proposed Solutions(computing)

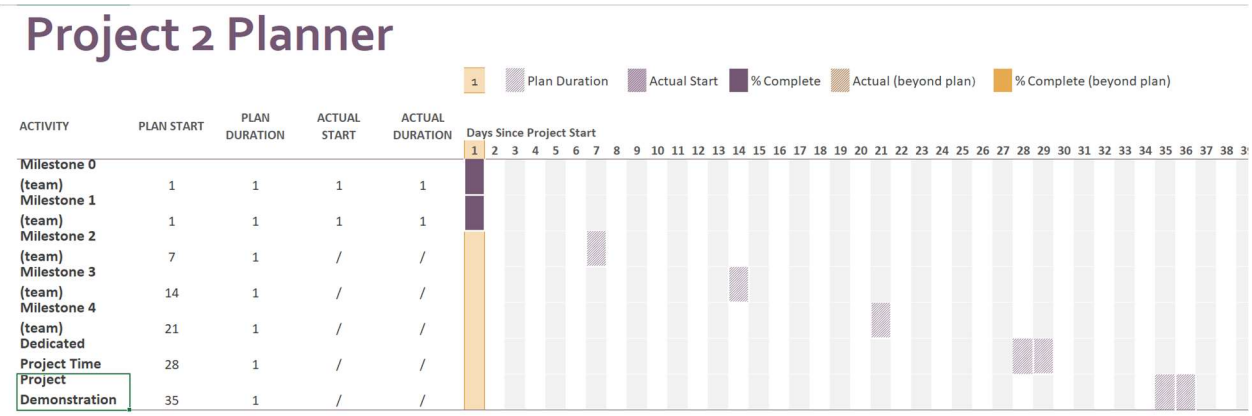
Reference List

[1] “Understanding stainless steel in healthcare,” Understanding Stainless Steel In Healthcare, https://www.statmedicalcanada.com/blog/blog/understanding-stainless-steel-in-healthcare (accessed Dec. 2, 2023).
[2] “The Importance of Sterilization for Surgical Tools”, Arbutus Medical, https://arbutusmedical.com/blog-the-importance-of-sterilization-for-surgical-tools/ (accessed Dec.3, 2023)
[3] P2 - Project Module, McMaster University, Hamilton, Canada, 2023
[4] Autodesk® Inventor 2024 LT™ software, Autodesk, Inc, 2023 (www.autodesk.com).
[5] Ansys GRANTA EduPack software, ANSYS, Inc., Cambridge, UK, 2023 (www.ansys.com/materials)

Appendices

Appendix A: Project Schedule

Preliminary Gantt Chart:



Final Gantt Chart:

Logbook of Additional Discussions:

[10/26 7:03 PM] Furqaan Khurram Qamar

"Today's files have been submitted."

[11/2 6:21 PM] Jennifer Duong

"I have submitted the computing milestone 2."

[11/2 7:39 PM] Furqaan Khurram Qamar

"The modelling has also been submitted."

[11/8 9:27 PM] Shadi El-Fares

"Jessica Ricafort, the notes from the interview were taken on your laptop while the TA was helping you set up the Quanser environment. Were these notes taken in the Teams worksheet file or in a different document?"

[11/8 9:30 PM] Jessica Ricafort

"The notes are in a Word document on my laptop. I'm not sure how to share it."

[11/8 9:32 PM] Shadi El-Fares

"No worries, we will share it tomorrow. We just have to make it available."

[11/9 5:08 PM] Jennifer Duong

"For next week."

[11/10 9:00 PM] Furqaan Khurram Qamar

"I have shared pictures of the modelled container."

[11/10 9:00 PM] Furqaan Khurram Qamar

"Okay, I was bored and did some work on the container."

[11/10 9:01 PM] Furqaan Khurram Qamar

"I'm thinking of making the cover sort of netted as well."

[11/10 9:01 PM] Furqaan Khurram Qamar

"Let me know if there are any improvements I can add."

[11/10 9:04 PM] Shadi El-Fares

"Great job, but could you make it rounder?"

[11/10 9:04 PM] Shadi El-Fares

"I have shared the meeting minutes."

[11/25 11:02 AM] Shadi El-Fares

"Jessica Ricafort, I'm going to add one for Nov. 23 in a second."

[11/25 12:36 PM] Shadi El-Fares

"Jessica Ricafort, please send a picture of the current 3-D printed model in this group chat as soon as possible."

[11/25 12:37 PM] Jessica Ricafort

"I am out until about 4:30. Can you wait until then?"

[11/25 12:37 PM] Shadi El-Fares

"Yes, no worries. Just make sure it's done today, please."

[11/25 12:38 PM] Jennifer Duong

"Guys, for the materials assignment, are there instructions on what to do?"

[11/25 12:38 PM] Jessica Ricafort

"It's in the project module."

[11/25 12:38 PM] Jennifer Duong

"Because I can't find it anywhere."

[11/25 12:38 PM] Jennifer Duong

"Oh."

[11/25 12:38 PM] Jennifer Duong

"Oh my god."

[11/25 12:38 PM] Jennifer Duong

"That's smart."

[11/25 12:38 PM] Jennifer Duong

"Thank you."

[11/25/ 3:54PM] Shadi El-Fares

"Also: Project 2 Design Project Report is due on Wednesday, December 6."

[11/25/ 6:18PM] Furqaan Khurram Qamar

"I have shared the final design report template."

[11/25/ 6:18PM] Furqaan Khurram Qamar

"There it is."

[11/27/ 9:43 AM] Jessica Ricafort

"Hey everyone! What day works best for our project interview? We need a 30-minute timeslot between Thursday, November 30th and Wednesday, December 6th (9:00am – 5:00pm EST)."

[11/27/ 10:54AM] Shadi El-Fares (In-Response to Jessica)

"Is this online or in-person?"

[11/27/ 10:54AM] Jessica Ricafort

"It's in person at ETB."

[11/27/ 10:58 AM] Shadi El-Fares

"6PM on December Thursday following the design studio is best for me and Furqaan. We are station number 5 for the arm challenge. It's worth 1 mark."

[11/27 11:47 AM] Jessica Ricafort

"There are no times past 5pm and all the 5 pm slots are booked."

[11/27/ 12:12 PM] Shadi El-Fares

"Furqaan Khurram Qamar, is 4:00pm on December 6th okay?"

[11/27/ 12:15 PM] Furqaan Khurram Qamar

"Sure, yeah."

[11/27/ 12:15 PM] Furqaan Khurram Qamar

"Wait, that is during my econ lecture. Give me a second."

[11/27/ 12:15 PM] Furqaan Khurram Qamar

"Is 3:30-4 okay?"

[11/27/ 12:17 PM] Jessica Ricafort

"That works for Jen and I."

[11/27/ 4:46 PM] Jessica Ricafort

"Shadi El-Fares, Furqaan Khurram Qamar, is it okay to book the interview for 3:30 - 4 on December 6?"

[11/27/ 5:27 PM] Shadi El-Fares

"Yes, it is."

[12/1/ 1:21 PM] Shadi El-Fares

"Also, Jennifer Duong, Jessica Ricafort, closer to 4PM today, the distribution of final deliverable work will be posted."

[12/1/5:17 PM] Furqaan Khurram Qamar

"I have shared a picture."

[12/1/ 5:17 PM] Furqaan Khurram Qamar

"Here is the outline of everything we're supposed to have done."

[12/1/ 5:17 PM] Furqaan Khurram Qamar

"We tried dividing the work fairly and based on what everyone did for P2."

[12/1/ 5:17 PM] Furqaan Khurram Qamar

"We should be done with this around Monday since it isn't much work individually."

[12/1/ 5:18 PM] Furqaan Khurram Qamar

"Jennifer Duong, if you could send me all the computing team files, I can add them all together and submit them."

[12/1/ 5:19 PM] Jennifer Duong

"Okay, that sounds good."

[12/1/ 5:23 PM] Jennifer Duong

"I'm going to look over the rubric for the code one more time before I send the final files."

[12/1/ 5:23 PM] Jennifer Duong

"I'll send them by tonight though."

[12/2/ 2:12PM] Furqaan Khurram Qamar

"Jennifer Duong, the project module says we have to submit individual files as well. I think we have to add our individual sheets for computing and modelling. I will compile a modelling PDF with the team and my individual files. Could you do the same with the computing files? Thank you."

Appendix B: Scheduled Weekly Meetings

Thursday November 2, 2023

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Jessica Ricafort**	**ricaforj**	**Yes**
Administrator	**Jennifer Duong**	**Duongj21**	**Yes**
Coordinator	**Shadi El-Fares**	**elfaress**	**Yes**
Administrator	**Furqaan Khurram Qamar**	**khurramf**	**Yes**

Agenda Items

1. Attendance and updates
2. How the predesign studio activities went
3. Any questions and concerns about the project so far
4. Action items for next meeting
5. Wrap up

Meeting Minutes

- Presenting the cad-design, elaborating on the mesh design, grip-sockets. Elaborated on design-constraints and how we choose the design of our box.
- Slight difficulty to get adjusted to defining the correct functions for the q-arm. Looking for procedure/ pseuocode to begin defining the functions.
- Advise from TA would be to attend design studio office hours, look into documentation

Post-Meeting Action Items

- *Complete Preliminary Model {Furqaan & Shadi}*
- *Prove the justification of design features {Furqaan and Shadi}*
- *Become adjusted with Q-arm interface {Jessica & Jennifer}*

Thursday November 9, 2023

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Jessica Ricafort**	**ricaforj**	**Yes**
Administrator	**Jennifer Duong**	**Duongj21**	**Yes**
Coordinator	**Shadi El-Fares**	**elfaress**	**Yes**
Administrator	**Furqaan Khurram Qamar**	**khurramf**	**Yes**

Agenda Items

1. Attendance and updates
2. How the predesign studio activities went
    a. Questions about pre design studio activities
3. Any questions/concerns about what is being worked on in design studio
4. Any questions/concerns about project overall
5. Wrap up

Meeting Minutes

- Preparation for next weeks design review
- Constraining the design of the container with the tool.
- Smallest dimension of the container? (*45mm)*
    - ***No part should be less than 2mm for printing***
- Learning how to mesh the box (will reduce weight amount)
- Reviewing Coding teams pseudo-code.
- Double checking final objective.
    - Greenlight on pseudo-code.
- Familiarizing syntax with coding team.
    - Receiving a run-through of how the functions will interact with each other.

Post-Meeting Action Items

- *Design team: Mesh the box*
- *Make sure we have no dimension less than 2mm. {Design Team}*

- *Begin the writing of the code {Coding Team}*

Thursday November 16, 2023

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Jessica Ricafort**	**ricaforj**	**Yes**
Administrator	**Jennifer Duong**	**Duongj21**	**Yes**
Coordinator	**Shadi El-Fares**	**elfaress**	**Yes**
Administrator	**Furqaan Khurram Qamar**	**khurramf**	**Yes**

Agenda Items

1. Attendance and updates
2. How the predesign studio assignment went
    a. Questions about pre design studio assignment
    b. Concerns about any aspects of assignment
3. Any questions/concerns/clarification needed about what is being worked on in design studio
4. Any questions/concerns/clarification about project overall
6. Wrap up

Meeting Minutes

- The overall design is good, however the separation between each square spacing is too thin.
- When printing, we should change it to the 4mm for it to be good printing quality, it will take an hour to print which is ample time.
- Coding feedback is waiting:
    - No use of potentiometer, the code runs perfectly fine for the use of functions but needs to incorporate the conversion of potentiometer revolutions to degrees.
    - Use time.sleep() function and utilize potentiometer to drop the box.
    - Using the sample solution to incorporate the rotation of the base and drop of the box.

Post-Meeting Action Items

- *Print the box.*

- *Use potentiometer.*

Thursday November 23, 2023

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Jessica Ricafort**	**ricaforj**	**Yes**
Administrator	**Jennifer Duong**	**Duongj21**	**Yes**
Coordinator	**Shadi El-Fares**	**elfaress**	**Yes**
Administrator	**Furqaan Khurram Qamar**	**khurramf**	**Yes**

Agenda Items

1. Attendance and updates
2. Any questions/concerns/clarification needed about what is being worked on in design studio
3. Any questions/concerns/clarification about project overall
4. Wrap up

Meeting Minutes

- G code was approved and design was sent to the printer
- Coding feedback:
    - Potentiometer is being used but incorrectly
        - It moves the q arm in the wrong direction
    - The code did not run smoothly in front of the TA so there will be a deduction to the final mark for project 2

Post-Meeting Action Items

- *Cut the box out of the structure from when it was 3d printed*
- *Attend office hours and watch the potentiometer video to better understand how to use it*

Appendix C: Source Materials Database

1. "Understanding stainless steel in healthcare," Understanding Stainless Steel in Healthcare, https://www.statmedicalcanada.com/blog/blog/understanding-stainless-steel-in-healthcare (accessed Dec. 2, 2023).
2. "The Importance of Sterilization for Surgical Tools", Arbutus Medical, https://arbutusmedical.com/blog-the-importance-of-sterilization-for-surgical-tools/ (accessed Dec.3, 2023)
3. GRANTA EduPack software, ANSYS, Inc., Cambridge, UK, 2023 (www.ansys.com/materials)
4. Autodesk Inventor 2023 software, Autodesk Inc., San Francisco, USA, 2023 (https://www.autodesk.com/ca-en/products/inventor/overview)


```
ip_address = 'localhost' # Enter your IP Address here
project_identifier = 'P2B' # Enter the project identifier i.e. P2A or P2B
#---------------------------------------------------------------------------
import sys
sys.path.append('../')
from Common.simulation_project_library import *

hardware = False
QLabs = configure_environment(project_identifier, ip_address, hardware).QLabs
arm = qarm(project_identifier,ip_address,QLabs,hardware)
potentiometer = potentiometer_interface()
#---------------------------------------------------------------------------
# STUDENT CODE BEGINS
#---------------------------------------------------------------------------

# Function that picks up the container
# Author: Jessica Ricafort
def pick_up():
    arm.move_arm(0.617, 0.054, 0.044)
    time.sleep(2)
    arm.control_gripper(45)

# Function to return back to home position
# Author: Jessica Ricafort
def return_home():
    arm.move_arm(0.406, 0.0, 0.483)

# Function that drops off the container
# Author: Jennifer Duong
def drop_off(container):

    if container== 1 or container== 2 or container== 3:     # If the container is a small
        while potentiometer.left() <= 0.5 or potentiometer.left()== 1.0: # Arm does not drop the container
            time.sleep(0.1)

        if container== 1:        # Small red container
            arm.activate_autoclaves()
            time.sleep(1)
            arm.move_arm(-0.642, 0.26, 0.267)
        elif container== 2:     # Small green container
            arm.activate_autoclaves()
            time.sleep(1)
            arm.move_arm(0.0, -0.673, 0.284)
        else:                   # Small blue container
            arm.activate_autoclaves()
            time.sleep(1)
            arm.move_arm(0.0, 0.649, 0.291),
        time.sleep(2)
        arm.control_gripper(-45)
        arm.deactivate_autoclaves()
    elif container== 4 or container== 5 or container== 6:     # If the container is a large
        while potentiometer.left() < 1.0:
            time.sleep(0.1)
        if container== 4:        # Large red container
            arm.activate_autoclaves()
            time.sleep(1)
            arm.open_autoclave('red')
            time.sleep(1)
            arm.move_arm(-0.422, 0.17, 0.228)
            time.sleep(1)
            arm.control_gripper(-45)
            time.sleep(2)
            arm.open_autoclave('red', False)

        elif container== 5:     # Large green container
            arm.activate_autoclaves()
            time.sleep(1)
            arm.open_autoclave('green')
            time.sleep(1)
            arm.move_arm(0.0, -0.433, 0.2)
            time.sleep(1)
            arm.control_gripper(-45)
            time.sleep(2)
            arm.open_autoclave('green', False)
        else:                   # Large blue container

            arm.activate_autoclaves()
            time.sleep(1)
            arm.open_autoclave('blue')
            time.sleep(1)
            arm.move_arm(0.0, 0.45, 0.175)
            time.sleep(1)
            arm.control_gripper(-45)
            time.sleep(2)
            arm.open_autoclave('blue', False)
        arm.deactivate_autoclaves()
```

5.

Appendix D: Design Studio Worksheets

Modelling (Individual and Team Submissions)

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE 1 (STAGE 3) – PRELIMINARY CONCEPT SKETCHES (MODELLING SUB-TEAM)

Team ID: Thursday-50

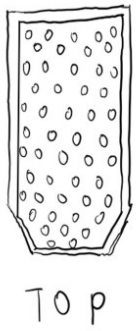
1. Complete your sketch on a separate sheet of paper
   → Be sure to clearly write your Team ID, Name and MacID
2. Take a photo of your sketch
3. Insert your photo as a Picture (Insert > Picture > This Device)

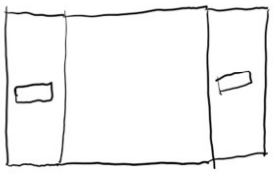
ENGINEER 1P13 – Project Two: *Get a Grip*

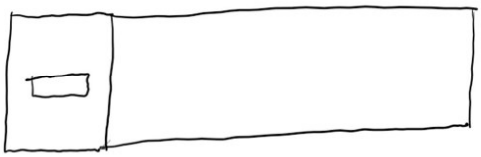
Team ID: Thursday-50

Name: Furqaan Khurram Qamar	MacID: khurramf

Insert screenshot(s) of your preliminary sketch below







*For multiple sketches, please copy and paste the above on a new page

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE TWO (INDIVIDUAL): SUBTEAMS, SKETCHES, & WORKFLOW

MILESTONE 2 (STAGE 1) – LOW-FIDELITY PROTOTYPE (MODELLING SUB-TEAM)

Team ID: Thurs-50

Complete this worksheet before design studio 8 while creating the low-fidelity prototype based on your group members preliminary concept sketch.

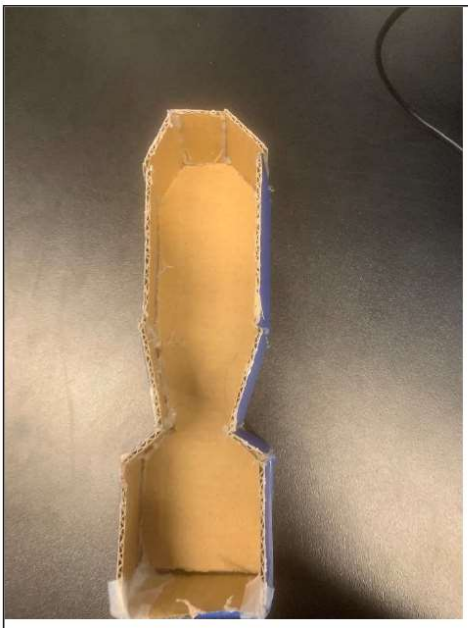
1. Take multiple photos of the low-fidelity prototype
   - Include an index card (or similar) next to the prototype, clearly indicating your Team Number, Name and MacID on *each* picture
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)

Team ID: Thurs-50

Name: Furqaan Khurram Qamar	MacID: khurramf
Insert screenshot(s) of the low-fidelity prototype below	

ENGINEER 1P13 – Project Two: *Get a Grip*

ENGINEER 1P13 – Project Two: *Get a Grip*



ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE 2 (STAGE 3) – PRELIMINARY SOLID MODEL (MODELLING SUB-TEAM)

Team ID: Thurs-50

Complete this worksheet individually during Design Studio 8.

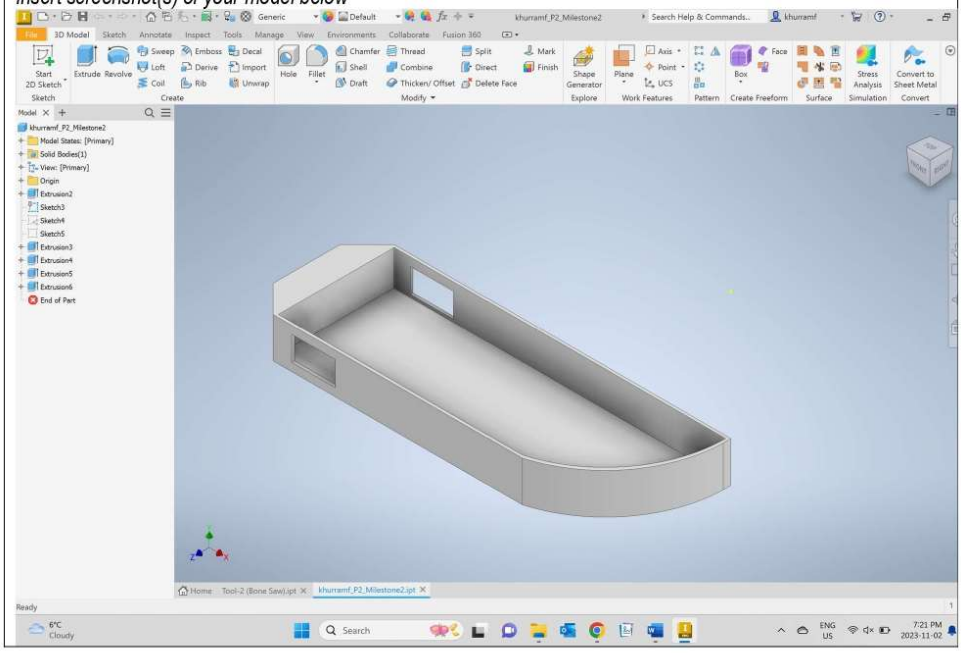
1. Take multiple screenshots of your preliminary solid model
   → You are also required to submit an IPT file of each solid model (see Submission Details section above)
   → Be sure to label model with your Name and MacID
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **Do not include more than *two* solid modelling screenshots per page**

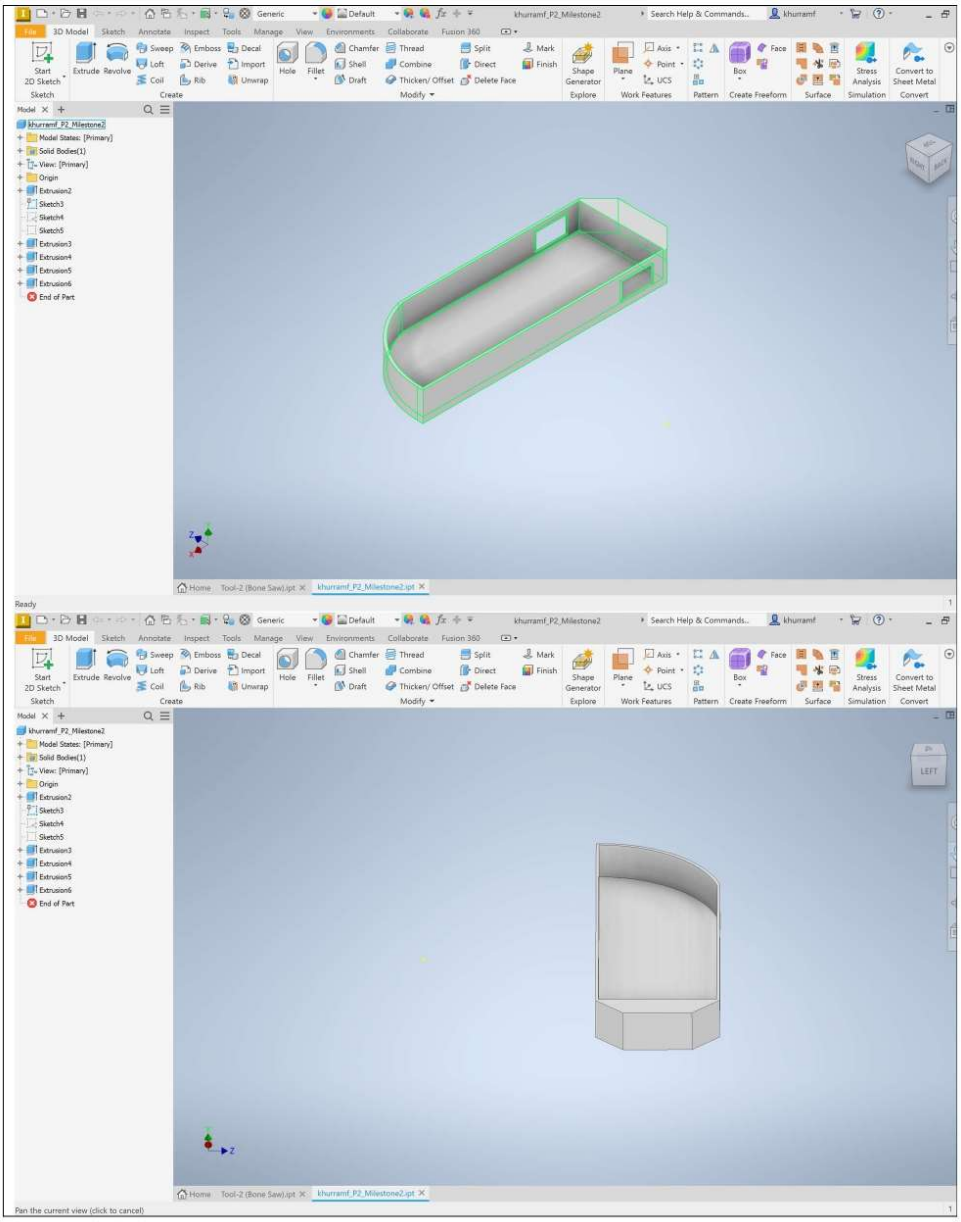
ENGINEER 1P13 – Project Two: *Get a Grip*

Team ID: Thurs-50

Name: Furqaan Khurram Qamar	MacID: khurramf

Insert screenshot(s) of your model below





*Limit screenshots to no more than 2 per page. For additional screenshots, please copy and paste the above on a new page

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE 0 – SUB-TEAM CHARTER

Team ID: Thurs-50

Indicate which team member is on each sub-team in the table below.

- You may refer to the **P2P3 Overview** document on Avenue for information on each sub-team's requirements

Sub-Team	Team Member's Full Name
Modelling	Furqaan Qamar
	Shadi El-Fares
Computing	Jessica Ricafort
	Jennifer Duong

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE 0 – TEAM CHARTER

Team ID: Thurs-50

Incoming Personnel Administrative Portfolio:

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

	Team Member Name:	Project Leads
1.	Jennifer Duong	☐M ☒A ☐C ☐A2
2.	Furqaan Khurram Qamar	☐M ☐A ☐C ☒A2
3.	Shadi El-Fares	☐M ☐A ☒C ☐A2
4.	Jessica Ricafort	☒M ☐A ☐C ☐A2
		☐M ☐A ☐C ☐A2

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	Jessica Ricafort	ricaforj
Administrator 1	Jennifer Duong	duongj21
Administrator 2	Furqaan Khurram Qamar	khurramf
Coordinator	Shadi El-Fares	elfaress

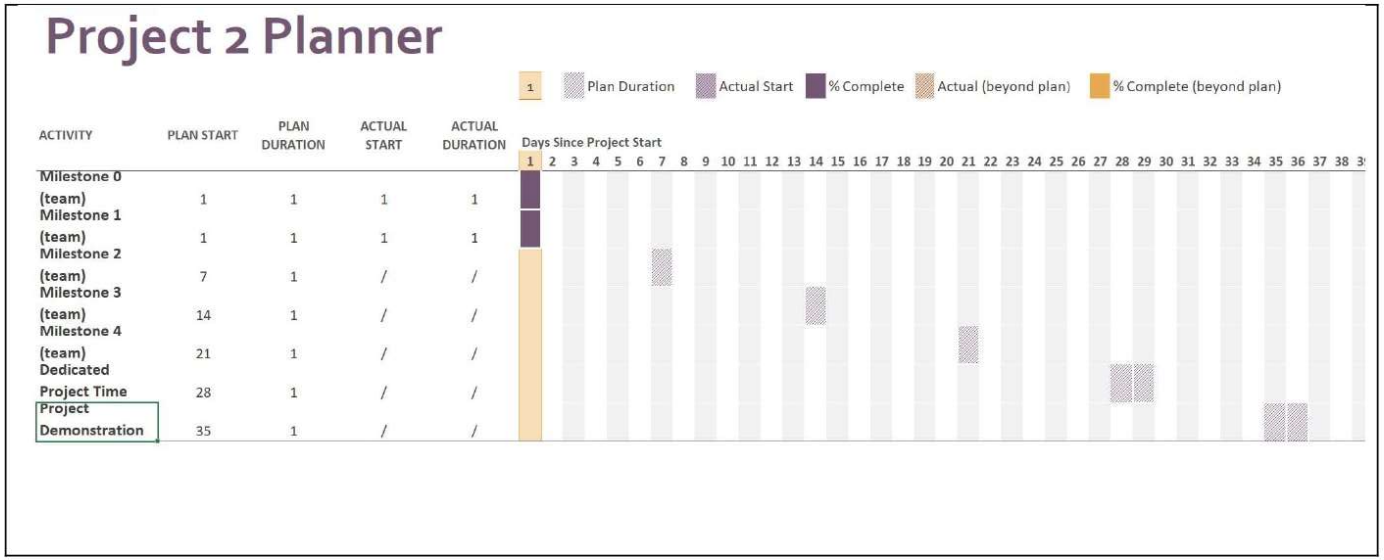
MILESTONE 0 – PRELIMINARY GANTT CHART (TEAM MANAGER ONLY)

Team ID: Thurs-50

Only the **Team Manager** is completing this section!

Full Name of Team Manager:	MacID:
Jessica Ricafort	ricaforj

Preliminary Gantt chart:



ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE ONE (TEAM): OBJECTIVES, MORPH CHART, & INITIAL DESIGN

PROJECT TWO: MILESTONE 1 – COVER PAGE

Team ID: Thurs-50

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

Full Name:	MacID:
Jessica Ricafort	ricaforj
Jennifer Duong	duongj21
Furqaan Khurram Qamar	khurramff
Shadi El-Fares	elfaress

ENGINEER 1P13 – Project Two: *Get a Grip*

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

Team ID: Thurs-50

1. As a team, create a list of objectives, constraints, and functions in the table below.
   → The exact number you should have depends on what information you have gathered from the Project Module.

Objectives	Constraints	Functions
Safely pick-up box.	Q-Arm should not break/drop the box.	Box allows tool to be sterilized on all surfaces.
Durable	Dimensions of each box to weigh below 350g.	Box securely holds surgical tool.
Efficient	Cannot be slow during transfer.	Able to safely transfer the box to sterilization area
Simple design	Shape of box – can only fit one tool	Maintains organization of tools.
Safety to deliver the tool	Smaller boxes must be smaller or equal or less than 80mm in width and larger boxes must be 150mm or less in width.	Not drop the box through delivery.

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

To safely transfer unsterile surgical tools within the secure container.

3. What are the secondary functions?

Pick-up the box.
Displace the box.
Gently releasing the box.
Secure box

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE 1 (STAGE 2) – MORPHOLOGICAL ANALYSIS

Team ID: Thurs-50

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	Gripper	Potentiometer	Safety Protocols	Instructions (code)	Gears	Resistors
Secure the Box	Lock system	Fits tightly	Indents to allow for greater friction	Maximize tensile strength		
Gently release		Padding at the bottom of the box	Shape bottom of container to absorb impact		Code to change time of release	Material of container

ENGINEER 1P13 – Project Two: *Get a Grip*

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

Team ID: Thurs-50

As a sub-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 being picked up by the QArm
→ Reliability of the design in securing the surgical tool
→ Extent to which it allows for tool sterilization

*Document your observations for each prototype in the space below. It is recommended you document observations in a **table** or in bullet form (it should be clear which prototype you are referring to for each observation.*	
SHADI'S PROTOTYPE	*Advantages:* - *Durable design* - *Compact size* - *Extremely light* - *Aesthetically pleasing* *Disadvantages:* - *No tensile strength* - *Not enough space for good grip* - *Not spacious for tool itself* - *Unnecessarily **long***
FURQAAN'S PROTOTYPE	*Advantages:* - *Simple design* - *Easy to grip.* - *Secure* - *Spacious to fit a tool.* - *The holes act as a drainage system* - *Holes reduce weight.* *Disadvantages:* - *Too much space, the tool will be loose.* - *Not secure to fit the tools* - *Should be more compact*

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE THREE (TEAM): PRELIMINARY MODEL & CODE

PROJECT TWO: MILESTONE 3 – COVER PAGE

Team ID: Thurs-50

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

Full Name:	MacID:
Jessica Ricafort	ricaforj
Jennifer Duong	duongj21
Furqaan Khurram Qamar	khurramff
Shadi El-Fares	elfaress

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE 3 (STAGE 3) – PRELIMINARY DESIGN REVIEWS

Team ID: Thurs-50

Preliminary Design Review Planning:

Create an outline of topics you will cover during your preliminary design review. You should cover the following topics:

1. Both sub-teams:
    a. Integration of both sub-teams for the final deliverables
    b. Timeline for project completion
2. Modelling sub-team:
    a. Demonstrate your most recent prototype
    b. How your current sterilization container meets project objectives.
    c. Plan for fabrication
3. Computing sub-team:
    a. Demonstrate your current program.
    b. Updates on the workflow implementation (i.e. how much of the workflow has been implemented)
    c. Process of integrating both group member's code.

Timeline:
Coding – 2 weeks
Graphics – 1 week

Graphics Team:

- **November 10: Adding Meshed Design and Ribs**
- **November 11: Finalize Container and Generate G-Code**

Modelling Sub-Team Preliminary Design Review Notes:

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE 4 CHECKLISTS

Mentors and sub-teams will go through each checklist **together** and check off items if the design meets expectations. Mentors will give verbal feedback for each item on the checklists, and students will **summarize the feedback** before creating a list of **Action Items** to be completed before final project submission. *Note that these checklists are not project rubrics. They are a tool to help guide students to successfully meet certain project requirements.*

ENGINEER 1P13 – Project Two: *Get a Grip*

Team ID: Thurs-50

MODELLING SUB-TEAM

☑ Design Meets Design Objectives

- → Container fits inside the assigned footprint
- → Surgical tools fit securely inside the container
- → Container facilitates sterilization
- → Design is creative with interesting features and/or connections

☑ Assembly model is complete and aesthetic, properly grounded and has no interference or errors

☐ Mass constraint is satisfied (does not exceed 350 g prior to scaling or 43.75 g after scaling to 50%)

- → The design should intentionally minimize materials

☐ Total print time of **ALL** components does not exceed 2 hours

- → All components on the bed when evaluating this
- → Discuss if components need any support for 3D printing (i.e., for any overhanging features). If so, TA's will assist the sub-team in adding support.

☑ ALL features of container are 2mm or more

- → Not only do features need to be 2mm or greater, but spaces between them as well
- → Features between 2mm and 4mm are appropriately sized and will not compromise the printed design

☑ **APPROVED FOR PRINTING**

Mentor Comments: Use the space below to document mentor feedback for your design, including requirement for reviewing progress next design studio.

N/A

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

N/A

27 | Project-2

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE ZERO (TEAM): TEAM DEVELOPMENT AND PROJECT PLANNING

PROJECT TWO: MILESTONE 0 – COVER PAGE

Team ID: Thurs-50

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

Full Name:	MacID:
Jennifer Duong	duongj21
Furqaan Khurram Qamar	khurramf
Shadi El-Fares	elfaress
Jessica Ricafort	ricaforj

Insert your Team Portrait in the dialog box below

3 | Project-2

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE TWO (TEAM): SUBTEAMS, SKETCHES, & WORKFLOW

PROJECT TWO: MILESTONE 2 – COVER PAGE

Team ID: Thurs-50

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

Full Name:	MacID:
Jessica Ricafort	ricaforj
Jennifer Duong	duongj21
Furqaan Khurram Qamar	khurramff
Shadi El-Fares	elfaress

10 | Project-2

MILESTONE 3 (STAGE 1) – INITIAL DESIGN OF FINALIZED STERILIZATION CONTAINER (MODELLING SUB-TEAM)

Team ID: Thurs-50

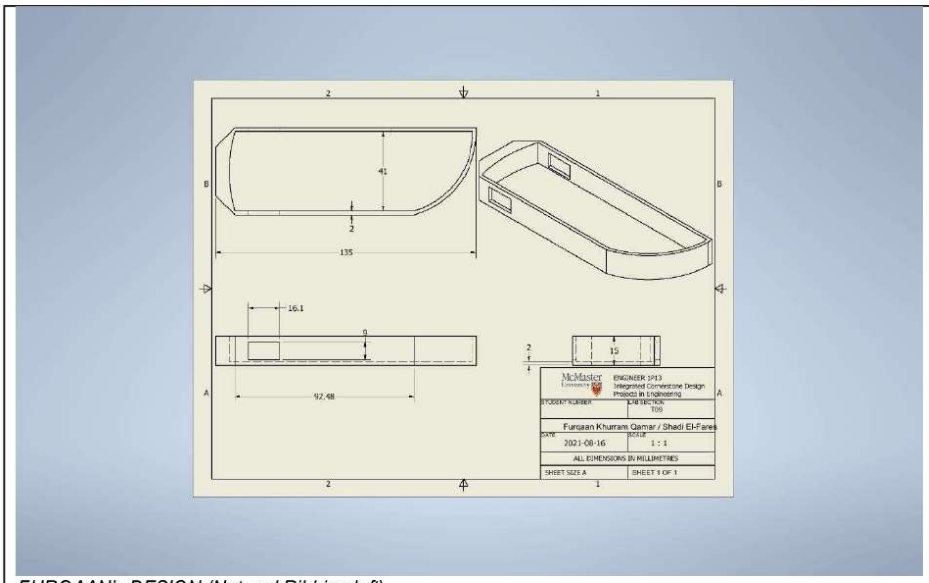
As a team, review each others preliminary solid models and discuss which features from each others models align best with the project objectives, constraints and functions. Summarize this in the table below.

Container	Feature	How it aligns with project objectives, constraints and functions.
Bone-Saw	Snug Fit	Ensures safe travel of surgical equipment and reduces overall weight amount.
Bone-Saw	Curved Bezel	Ensures the bone-saw remains sharp and in-line with the container shape.
Bone-Saw	Gripper Placeholders	Allows for a safe and secure grasp of the container for the Q-arm to grip.

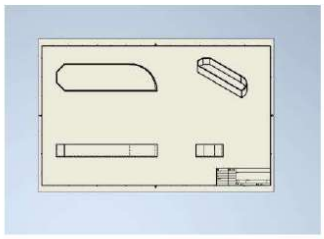
Create a preliminary sketch of your finalized sterilization container. This sketch should consider features from both team-members preliminary solid models.

Name (Team Member #1): **Shadi El-Fares**	**Name (Team Member #2):** **FurqaanKhurram Qamar**
Insert an image of your sketch here.	

ENGINEER 1P13 – Project Two: *Get a Grip*



FURQAAN's DESIGN (Net and Ribbing left)



Shadi's Design

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE 3 (STAGE 2) – STERILIZATION CONTAINER DESIGN EVALUATION (MODELING SUB-TEAM)

Team ID: Thurs-50

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	Netted + Ribbed Gripper Hole Design	Solid, Non Netted	**Finalized Design**
Sterilization	S	+	-	+
Ability to Grib	S	+	-	+
size	S	S	S	S
Rigidity	S	-	+	S
Complexity (Less				

complexity means good)	S	-	S	-
Equipment Security	S	+	+	+
Total +	0	3	2	3
Total –	0	2	2	1
Total	0	1	0	2

*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

(Shadi's Design) Non-Netted, Solid Design

- It needs a better method of securing the equipment.
- The container needs to be thicker; it currently has a thickness of 1mm which is enough to perform its primary task and allows more free space for the equipment, but low thickness will be a disadvantage as the arm's end effector might exert too much force and crush the container.

Furqaan's design

- Design and make tools holders to make sure they don't drop, slide etc.
- Add netted design for sterilization.
- Add extra supports near edges for strength

Use the space below to document feedback for your design.

The feedback we reeived revolved around the following points:

Make sure it is within weight limit.

Securing Blade within Design

Discuss about how gas will go through container

Minimum constraint per feature of 2mm

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

-Meshed Design

-Support Ribs at Corners

Computing Sub-Team Preliminary Design Review Notes:

Use the space below to document feedback for your design.

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

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE FOUR: DETAIL DESIGN (DESIGN REVIEW AND FEEDBACK)

PROJECT TWO: MILESTONE 4 – COVER PAGE

Team ID: Thurs-50

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

Full Name:	MacID:
Jessica Ricafort	ricaforj
Jennifer Duong	duongj21
Furqaan Khurram Qamar	khurramff
Shadi El-Fares	elfaress

25 | Project-2

Computing (Individual and Team Submissions)

ENGINEER 1P13 – Project Two: *Get a Grip*

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

Team ID: Thurs-50

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

Document your observations for each visual storyboard / flowchart in the space below.

Similarities	Differences
- Same procedure of flowchart - Actions are the same for each steps - Both have start positions -	- More decisions made in one flowchart than the other - One does not have an end to the flowchart - One flowchart addresses the thresholds while the other doesn't - -

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

Team ID: Thurs-50

As a sub-team, write out a pseudocode outlining the high-level workflow of your computer program in the space below. This should be a compilation of the pseudocode completed by each group member in Milestone 1.

Rotate arm to face the container and stay on the same axis.
Open the grip of arm if not already open.
Lower the arm down towards the container until it on the same level as the container.
Close the grip until it is secure around the box.
Rotate the arm back up so that the box leaves the ground.
Roate the arm towards the place to sterilization.
Slowly lower the arm down towards the surface until it is reached.
Gently open the grip of the arm and release the container.
Close the grip of the box.
Rotate the arm away from the sterilization area.

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE THREE (TEAM): PRELIMINARY MODEL & CODE

PROJECT TWO: MILESTONE 3 – COVER PAGE

Team ID: Thurs-50

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

Full Name:	MacID:
Jessica Ricafort	ricaforj
Jennifer Duong	duongj21
Furqaan Khurram Qamar	khurramff
Shadi El-Fares	elfaress

15 | Project-2

MILESTONE 3 (STAGE 1) – PROGRAM TASK PSEUDOCODE (COMPUTATION SUB-TEAM)

Team ID: Thurs-50

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

Pick-up Container

- Input the container number and identity (size and colour)
- If the container identity is equal to green, the q-bot arm moves to the green box's position
  - If the container number is 2, the q-bot arm moves to the top of the green box
  - If the container number is 5, the q-bot arm moves to the open drawer
- If the container identity is equal to red, the q-bot arm moves to the red box's position
  - If the container number is 1, the q-bot arm moves to the top of the green box
  - If the container number is 4, the q-bot arm moves to the open drawer
- If the container identity is equal to blue, the q-bot arm moves to the blue box's position
  - If the container number is 3, the q-bot arm moves to the top of the green box
  - If the container number is 6, the q-bot arm moves to the open drawer

Continue or Terminate Program

- Program will ask for container colour
- Program will ask for container identity
- If the container identity of the last input is equal to the newest container identity input, then the program does not continue, and asks to enter a different value of the identity instead

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE 3 (STAGE 2) – CODE PEER-REVIEW (COMPUTATION SUB-TEAM)

Team ID: Thurs-50

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

Rotate Q-arm Base	**Team Member Name**: Jennifer Duong

Preliminary code:

```
# Declare variables

initialPosition= arm.effector_position() # Find the coordinates of initial positoin of Q-arm


x1= initialPosition[0]
y1= initialPosition[1]
z1= initialPosition[2]

box1Position= box1.effector_position() # Find the position of the first box
x2= initialPosition[0]
y2= initialPosition[1]
z2= initialPosition[2]


# Rotate towards the green container

while(x1!= x2):             # Rotate arm until the x coordinates align
    arm.rotate_base(1)

while(y1!= y2):             # Rotate arm until the y coordinates align
    arm.rotate_base(1)

while(z1!= z2):             # Rotate arm until the z coordinates align
    arm.rotate_base(1)
```

Errors:

- No code which activates the potentiometer
- Does not have any way of accessing the initial positions of the containers
- There is no specified angle to rotate the arm base
- Does not run whatsoever with the q-arm

Drop-off Container & Return Home	**Team Member Name**: Jessica Ricafort

Preliminary code:

Modelling Sub-Team Preliminary Design Review Notes:

Use the space below to document feedback for your design.

The feedback we reeived revolved around the following points:

Make sure it is within weight limit.

Securing Blade within Design

Discuss about how gas will go through container

Minimum constraint per feature of 2mm

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

-Meshed Design

-Support Ribs at Corners

Computing Sub-Team Preliminary Design Review Notes:

Use the space below to document feedback for your design.

- Do not have to identify different pick up locations, all of the boxes spawn in the same location
- Activating the autoclaves should be the first line of code
- Opening the autoclave drawer can be run while the q arm is holding the containers
-
- Create your functions in the python file and run the code in the IDLE
- Figure out an algorithm as to how the container will be picked up and dropped off

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

- Have functions for each step of the movement
- Have functions that determine the size and colour of the container
- Create an algorithm for the general flow of the container pick up/drop off

ENGINEER 1P13 – Project Two: *Get a Grip*

COMPUTATION SUB-TEAM

Team ID: Thurs-50

- [x] One cycle of pick-up/rotate/drop-off (one container of any size) sufficiently executes
  - → The general flow should be home → pick-up → rotate → drop-off → home
  - → Containers dropped in random order, program identifies the correct drop off location and places the container successfully
  - → *If* there is time, demo both a small and a large container, and experiment using the potentiometers incorrectly to test for malfunctions
- [x] All required program tasks are written as their own function (Pick-Up Container, Rotate Q-arm Base , Drop-Off Container & Return Home)
- [ ] All program tasks are accounted for (Pick-Up Container, Rotate Q-arm Base , Drop-Off Container & Return Home, Continue or Terminate Program)
- [ ] Each task requiring potentiometer input (Rotate Q-arm Base , Drop-Off Container & Return Home) evaluates the potentiometer values before executing an action
  - → Potentiometer values are evaluated *INSIDE* the functions and not outside and passing their values as arguments.
- [x] Team is running their program in their assigned environment.
- [x] No errors in program
- [x] Code well commented

Mentor Comments: Use the space below to document mentor feedback for your design, including requirement for reviewing progress next design studio.

- Use potentiometer to rotate the base and to move the arm to the upper or lower drop off positions
- User can not input the box number to be generated, it has to be drawn from a list and the number has to delete after it was used

Action Items:

- Watch the p2 video about how to implement the potentiometer into the code
- Change the rotate base and drop off function to work with the potentiometer
- Make a function to randomly generate a box which corresponds to its destination place (delete the container that has already been dropped off)

28 | Project-2

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE TWO (TEAM): SUBTEAMS, SKETCHES, & WORKFLOW

PROJECT TWO: MILESTONE 2 – COVER PAGE

Team ID: Thurs-50

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

Full Name:	MacID:
Jessica Ricafort	ricaforj
Jennifer Duong	duongj21
Furqaan Khurram Qamar	khurramff
Shadi El-Fares	elfaress

ENGINEER 1P13 – Project Two: *Get a Grip*

File Edit Format Run Options Window Help

```
ip_address = 'localhost' # Enter your IP Address here
project_identifier = 'P2B' # Enter the project identifier i.e. P2A or P2B
#-----------------------------------------------------------------------------
import sys
sys.path.append('../')
from Common.simulation_project_library import *

hardware = False
QLabs = configure_environment(project_identifier, ip_address, hardware).QLabs
arm = qarm(project_identifier,ip_address,QLabs,hardware)
potentiometer = potentiometer_interface()
#-----------------------------------------------------------------------------
# STUDENT CODE BEGINS
#-----------------------------------------------------------------------------

potentiometer.right()
0.4
potentiometer.left()
0.7
arm.activate_autoclaves()
arm.check_autoclaves('red')
arm.open_autoclaves('red')
arm.control_gripper(45)
arm.open_autoclaves('red',false)
arm.deactivate_autoclaves()
arm.home()
```

Errors:

- The potentiometer code will not work because there was no code that would activate the potentiometers
- There is no code that opens the gripper to actually drop off the container
- The activate autoclave line should be the first line of the code
- The deactivate autoclave line should be the last line of the code

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE 3 (STAGE 3) – PRELIMINARY DESIGN REVIEWS

Team ID: Thurs-50

Preliminary Design Review Planning:

Create an outline of topics you will cover during your preliminary design review. You should cover the following topics:

1. Both sub-teams:
    a. Integration of both sub-teams for the final deliverables
    b. Timeline for project completion
2. Modelling sub-team:
    a. Demonstrate your most recent prototype
    b. How your current sterilization container meets project objectives.
    c. Plan for fabrication
3. Computing sub-team:
    a. Demonstrate your current program.
    b. Updates on the workflow implementation (i.e. how much of the workflow has been implemented)
    c. Process of integrating both group member's code.

Timeline:
Coding – 2 weeks
Graphics – 1 week

Graphics Team:

- **November 10: Adding Meshed Design and Ribs**
- **November 11: Finalize Container and Generate G-Code**

Coding Team:

- **November 15: Finish writing all the functions for the Q-Arm code and be able to demo picking up one of the containers**

ENGINEER 1P13 – Project Two: *Get a Grip*

MILESTONE FOUR: DETAIL DESIGN (DESIGN REVIEW AND FEEDBACK)

PROJECT TWO: MILESTONE 4 – COVER PAGE

Team ID: Thurs-50

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

Full Name:	MacID:
Jessica Ricafort	ricaforj
Jennifer Duong	duongj21
Furqaan Khurram Qamar	khurramff
Shadi El-Fares	elfaress

25 | Project-2