Project Management Plan: *The Baristas: Lazy Latte Art*

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Intelligent System Design II
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Project Charter: one line (Scope, Time, Cost)

Build a Latte Art Machine by April 17, 2023 for $450

Project Specifications:

Espresso will be brewed using a separate coffee maker and poured into a cup which is placed in the cup holder. Milk will be frothed separately and placed in the milk spout. The coffee cup will be on a platform that will tilt. The milk spout will tilt, as well as move laterally and vertically to pour milk into the cup in a design such as a tulip.

The coffee mug is on a platform that will be rotated with a servo motor to be angled correctly when the milk is poured into the mug. The coffee mug and platform will rotate up to 30 degrees.

The milk spout will move in 3 directions. The left platform in its entirety will move vertically between 4-5 inches controlled by a linear actuator. The platform directly under the milk spout will move laterally 2-3 inches on a track controlled by a second linear actuator. Finally, the milk spout will rotate to pour the milk controlled by the DC motor. The estimated rotation for the milk spout is between 45 to 150 degrees.

A Raspberry pi will be used to control the various hardware systems. The raspberry pi and hardware connection will be programmed by importing the Python library ‘gpiozero’. The functions contained in this library will allow for pin to component specification and component controls.

The input will be a user selection from a GUI. The GUI will be written using Python and the library ‘kiviy’. The main menu will have 5 buttons: 3 separate buttons for each of the designs, 1 start button, and 1 exit button. Once ‘Start’ is selected the GUI will display the loading screen and the system will execute the code to control the timing of the motors and create the latte art design. At the end of the execution, the GUI will return to the main menu. This process repeats until the user selects ‘Exit’, which ends the program.

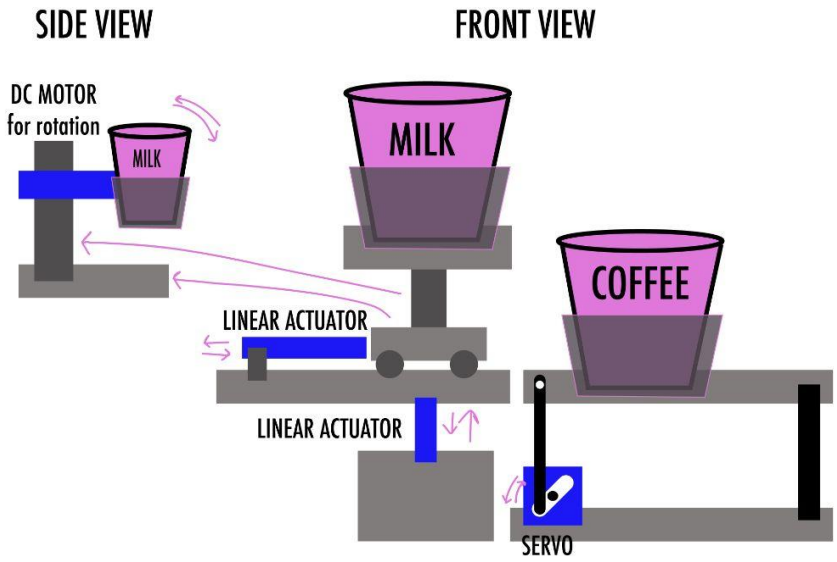


Figure 1: Final Prototype Design

Project Requirements:

Milestone 1: (Project Manager: Leah and Jackie)

Milestone 1 will include finishing the first draft of a physical prototype and demonstration of high level algorithm flow charts and plans for implementation of 1 DC motor, 1 servo, and 2 linear actuators into the design.

Milestone 2: (Project Manager: Mariah And Elise)

Milestone 2 will include 1 physical prototype with 1 DC motor, 1 servo, and 2 linear actuators integrated into the design. Additionally, milestone 2 will include code that moves the spout vertically 4-5 inches, laterally 2-3 inches, and rotates to pour the milk. The code will also rotate the mug for effective latte art pouring.

Final Deliverable: (Project Manager: Derrick and Luke)

The final deliverable will refine the precision of the latte art pouring. It will require that the specifics of the latte art designs are met within ~0.5cm of expected placement when the spout is pouring milk into the mug.

Methodology:

The system will be programmed using Python with a Raspberry Pi. The GUI will also be created with Python and used to start the system. The Raspberry Pi will have 1 stepper motor

which will control the angle of tilting for the coffee platform. It will also control two linear actuators used to move the milk horizontally and vertically. Finally, a DC motor will be used to control the tilting of the milk cup to allow pouring.

The GUI will display the Main Menu upon opening the program. The Main Menu will include 3 separate buttons for each latte art design, a Start button, and an Exit button. The variable that will hold the design the user chooses, 'designType', will be set to the default of design 1. If the user selects any of the other designs, said variable will be updated. Once 'Start' is selected the hardware program will execute in one of three patterns depending on 'designType' and the loading screen will pop up. Once execution is complete, the GUI will return to the Main Menu and the process can repeat until the user ends the program by selecting the 'Exit' button.

The motors and actuators will move depending on the 'designType' from the GUI. When signaled by the GUI the components will move until signaled to stop.

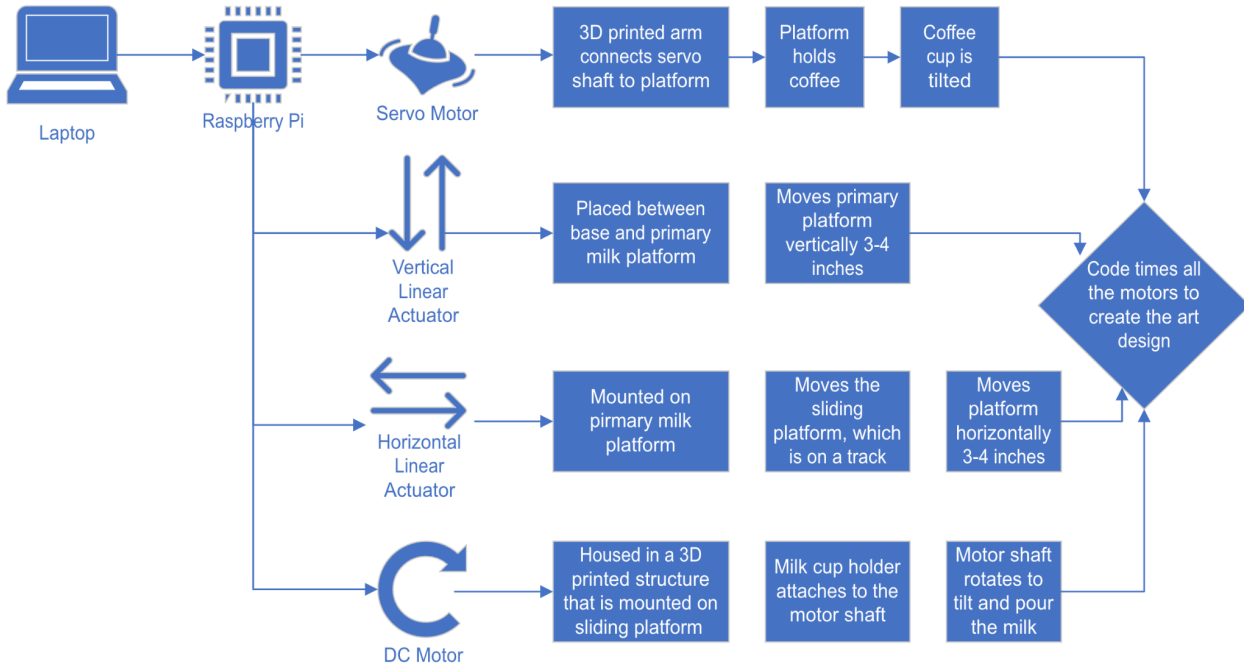


Figure 2: Hardware Block Diagram

Drawing.vsdx

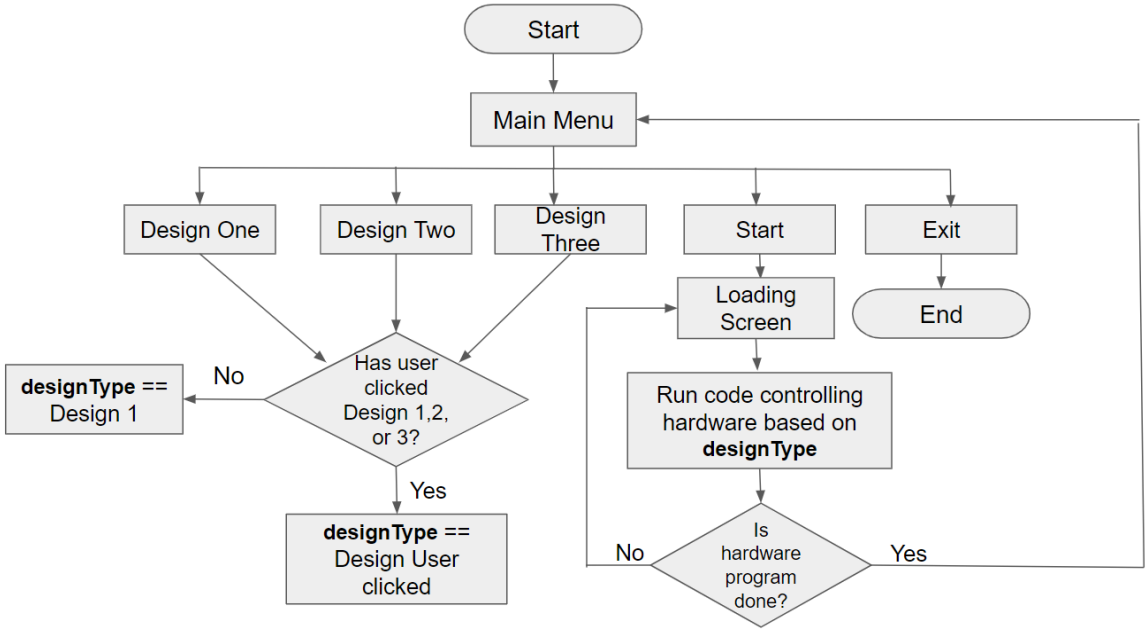


Figure 3: GUI Flowchart

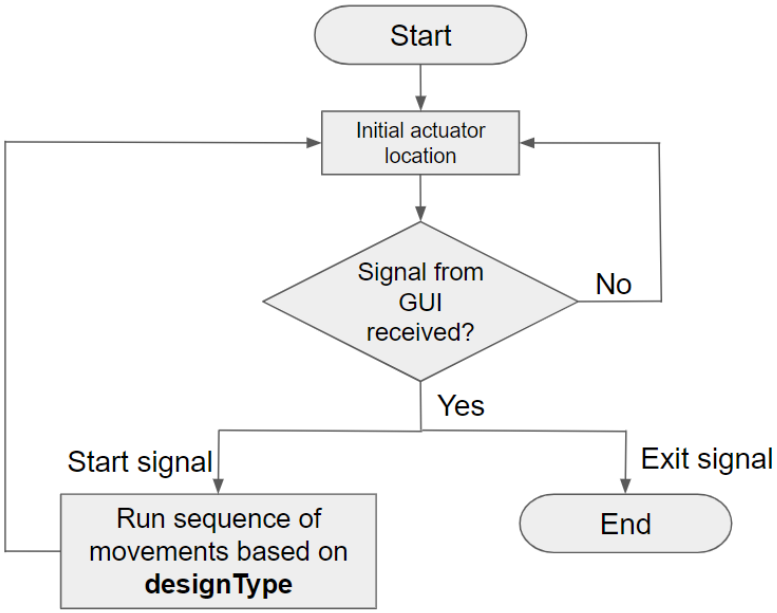


Figure 4: Actuator Control Flowchart

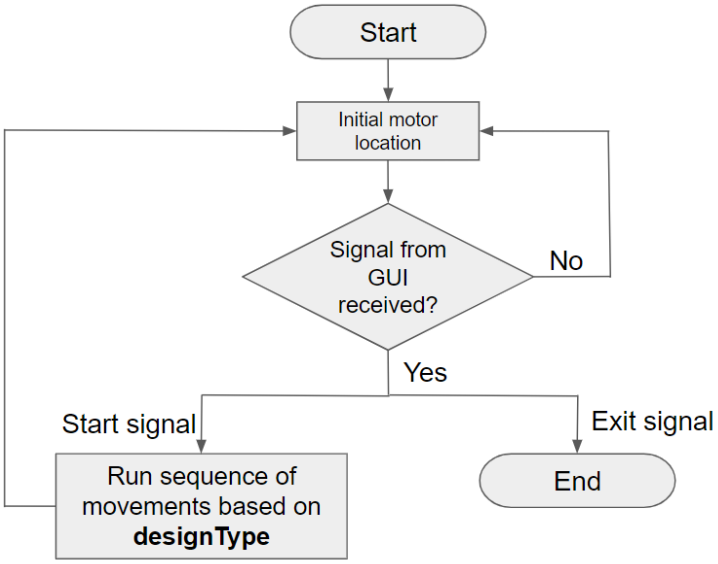


Figure 4: Motor Control Flowchart

Tasks and Precedence Chart:

Task structure

0.0 Build a Latte Art Machine by April 17, 2023 for $450

1.0 Machining

- 1.1 Tilt Cup
- 1.2 Elevator Mechanism
- 1.3 Shift forward and back
- 1.4 Tilt spout
- 1.5 Determine timing of movements
- 1.6 Determine tilt angles
- 1.7 Program motors and actuators
- 1.8 Integrate components together

2.0 Materials

- 2.1 Purchasing
- 2.2 Delivery
- 2.3 Creating physical design

2.4 Testing physical design

3.0 Latte/Art

3.1 Frothing Consistency

3.2 Creating designs

3.3 Define quantitative requirements (define successful latte art pours)

3.4 Timing each movement of mug

3.5 Timing each movement of spout

3.5 Program designs/movements

3.6 Create GUI

3.6 Test designs on prototype

Precedence Chart

	Precedence	Duration
WP1.1 Tilt Cup	2.2	3
WP1.2 Elevator Mechanism	2.2	3
WP1.3 Shift forward and back	2.2	3
WP1.4 Tilt spout	2.2	3
WP1.5 Determine timing of movements	1.1,1.4	4
WP1.6 Determine tilt angles	1.2,1.3	4
WP1.7 Program motors and actuators	1.5,1.6	10
WP1.8 Integrate components together	1.7	12
WP2.1 Purchasing	None	2
WP2.2 Delivery	2.1	7
WP2.3 Creating physical design	2.2	20
WP2.4 Testing physical design	1.8,2.3	7
WP3.1 Frothing consistency	None	2
WP3.2 Creating designs	3.1	5
WP3.3 Define quantitative requirements	3.2	1
WP3.4 Timing each movement of mug	3.3	3

WP3.5 Timing each movement of spout	3.3	7
WP3.6 Program designs/movements	2.4,3.4,3.5	20
WP3.7 Create GUI	None	2
WP3.8 Test designs on prototype	3.6	15

Resource Planning Matrix:

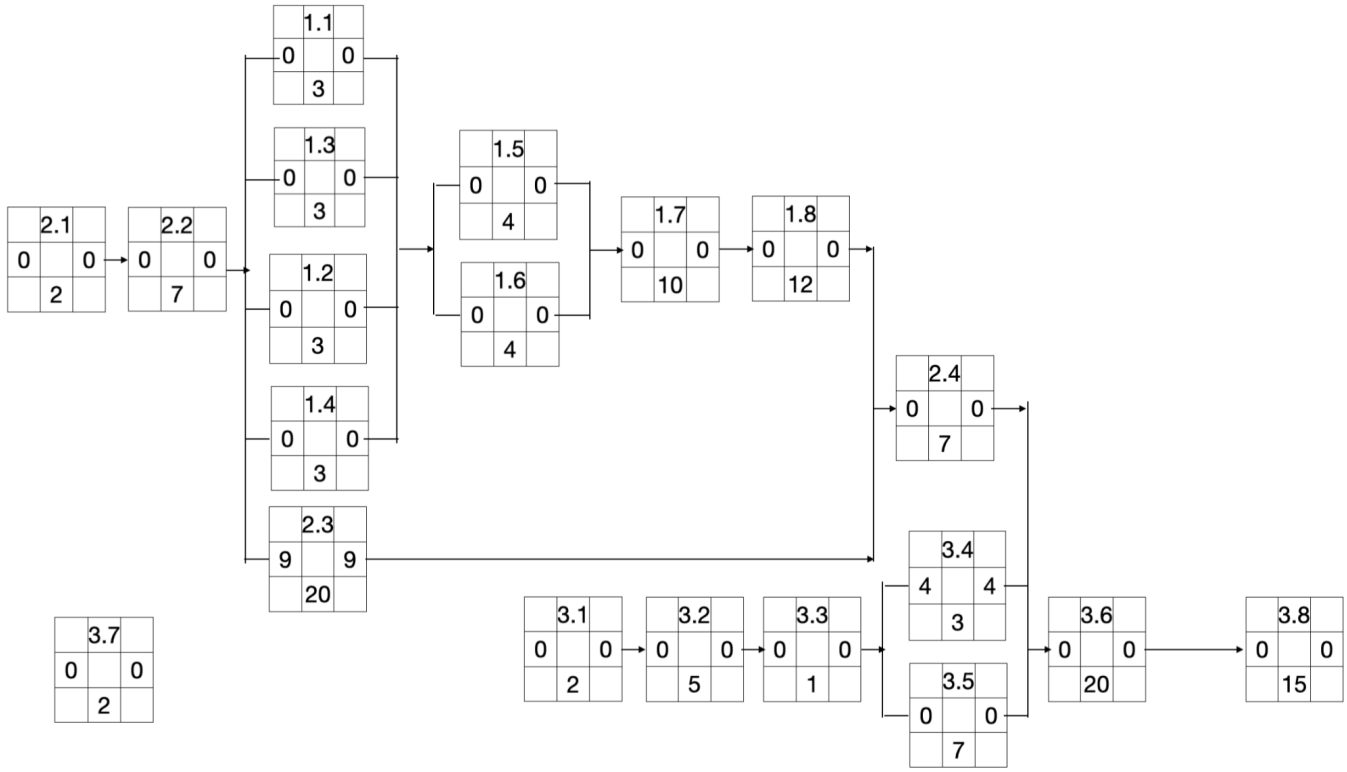
	Skills	Equipment	Material
WP1.1 Tilt Cup	Python	Raspberry Pi	Motors
WP1.2 Elevator Mechanism	Python	Raspberry Pi	Actuator
WP1.3 Shift forward and back	Python	Raspberry Pi	Actuators
WP1.4 Tilt spout	Python	Raspberry Pi	Motor
WP1.5 Determine timing of movements			
WP1.6 Determine tilt angles			
WP1.7 Program motors and actuators	Python	Raspberry Pi	Motor, actuators
WP1.8 Integrate components together	Python	Raspberry Pi	Motor, actuators
WP2.1 Purchasing			
WP2.2 Delivery			
WP2.3 Creating physical design	SolidWorks	3D printer, solder	Motor, actuators, cups, spout. PLA
WP2.4 Testing physical design		Raspberry Pi	
WP3.1 Frothing consistency		Espresso Machine, Frother	Coffee, Milk, Cups
WP3.2 Creating designs	Latte Art	Espresso Machine, Frother	Coffee, Milk, Cups
WP3.3 Define quantitative requirements			
WP3.4 Timing each movement of mug		Espresso Machine, Frother, Clock	Coffee, Milk, Cups
WP3.5 Timing each movement of spout		Espresso Machine,	Coffee, Milk,

		Frother, Clock	Cups
WP3.6 Program designs/movements	Python	Raspberry Pi	
WP3.7 Create GUI	Python	Raspberry Pi	
WP3.8 Test designs on prototype		Espresso Machine, Frother, Raspberry Pi	Coffee, Milk, Cups, Motors, Actuator

Responsibility Requirement Matrix: (OS = Oversee)

	Derrick	Elise	Jackie	Leah	Luke	Mariah
WP1.1 Tilt Cup		OS			OS	
WP1.2 Elevator Mechanism	OS		OS			
WP1.3 Shift forward and back	OS		OS			
WP1.4 Tilt spout		OS			OS	
WP1.5 Determine timing of movements				OS		
WP1.6 Determine tilt angles				OS		
WP1.7 Program motors and actuators						OS
WP1.8 Integrate components together	OS	OS			OS	
WP2.1 Purchasing		OS				
WP2.2 Delivery		OS				
WP2.3 Creating physical design		OS	OS	OS		
WP2.4 Testing physical design		OS	OS	OS		
WP3.1 Frothing consistency				OS		OS
WP3.2 Creating designs				OS		OS
WP3.3 Define quantitative requirements			OS			
WP3.4 Timing each movement of mug				OS		OS
WP3.5 Timing each movement of spout				OS		OS
WP3.6 Program designs/movements	OS				OS	OS
WP3.7 Create GUI	OS				OS	OS
WP3.9 Test designs on prototype	OS	OS	OS	OS	OS	OS

Network Diagram:

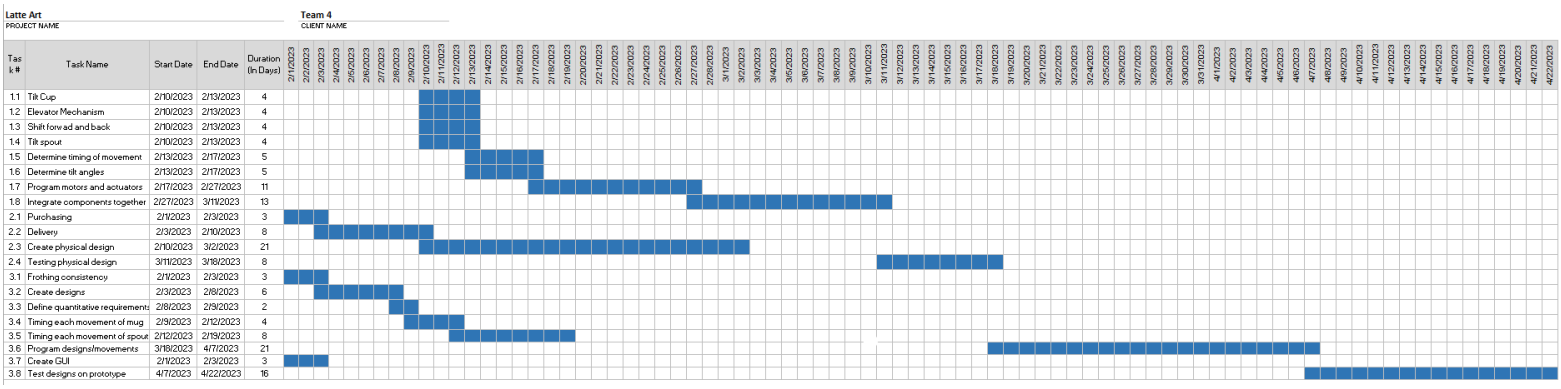


Start and Finish Chart:

	Start	Finish
WP1.1 Tilt Cup	2/10	2/13
WP1.2 Elevator Mechanism	2/10	2/13
WP1.3 Shift forward and back	2/10	2/13
WP1.4 Tilt spout	2/10	2/13
WP1.5 Determine timing of movements	2/13	2/17
WP1.6 Determine tilt angles	2/13	2/17
WP1.7 Program motors and actuators	2/17	2/27

WP1.8 Integrate components together	2/27	3/11
WP2.1 Purchasing	2/1	2/3
WP2.2 Delivery	2/3	2/10
WP2.3 Creating physical design	2/10	3/2
WP2.4 Testing physical design	3/11	3/18
WP3.1 Frothing consistency	2/1	2/3
WP3.2 Creating designs	2/3	2/8
WP3.3 Define quantitative requirements	2/8	2/9
WP3.4 Timing each movement of mug	2/9	2/12
WP3.5 Timing each movement of spout	2/12	2/19
WP3.6 Program designs/movements	3/18	4/7
WP3.7 Create GUI	2/1	2/3
WP3.8 Test designs on prototype	4/7	4/22

Gantt Chart:



Risk Management Chart:

Risks Identified	**Risk Assessment**	**Preventative Actions**	**Contingencies**
Delay of Materials	Supply Chain	Purchase materials as soon as possible	Change materials to components that will get here in time to build our design
Liquid spill on electrical equipment	User error	Wrap all electrical components in spill-proof casings	Purchase extra components (within reason) in case any need replacement due to damage
Team members get sick/out of town/unable to meet		Communicate as soon as possible	Establish Zoom option for meetings.

References:

[1] https://pic-microcontroller.com/ece-4760-latte-art-machine/amp/

[2]

[3]

[4]

Add more references if applicable.