Robotics Traveling Van

Project Management

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Fall 2025 -Spring 2026

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DISCLAIMER

This report was prepared by students as part of a university course requirement. While considerable effort has been put into the project, it is not the work of licensed engineers and has not undergone the extensive verification that is common in the profession. The information, data, conclusions, and content of this report should not be relied on or utilized without thorough, independent testing and verification. University faculty members may have been associated with this project as advisors, sponsors, or course instructors, but as such they are not responsible for the accuracy of results or conclusions.

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1 Reflection

After completing the first semester of Capstone, the team has gained a clear understanding of both the technical scope of the project and how our team functions from a project management perspective. The following reflection identifies specific successes, areas for improvement, and concrete actions the team will take to improve performance during Capstone II.

1.1 Project Management – Successes

- Over the course of Capstone I, the team established several project management practices that supported progress on both Robot 1 and Robot 2, while adapting to the challenges of managing two parallel systems.
- The team intentionally split into two sub teams, one focused on Robot 1 and one on Robot 2, which helped divide the workload and allowed each group to focus on the specific needs of their robot.
- Weekly team meetings were held to review progress, discuss upcoming assignments, and address technical or logistical issues affecting either robot.
- Early in the semester, the team clearly defined the scope for Robot 1 as an inverted pendulum system, allowing design work to begin quickly, while the Robot 2 sub team explored and evaluated multiple concepts before selecting a direction.
- The team-maintained communication with the client despite limited availability, working closely with the client's assistants to review progress, obtain feedback, and acquire parts.
- Strong collaboration with the electrical engineering team was a major success, particularly in areas such as programming, sensor integration, and PID control development.
- Team members consistently respect differing technical opinions and design ideas, enabling productive discussion and compromise when making design decisions.

1.2 Project Management – Room for Improvement

- While the team made steady progress, several areas were identified where project management and communication could be improved to better support both robot teams.
- Communication was sometimes inconsistent, with information either not shared broadly enough or communicated in ways that lacked clarity.
- Although all deliverables were submitted on time, some tasks were started too close to deadlines, reducing opportunities for review and refinement.
- Time was not always used efficiently between assignments, limiting the team's ability to cross-check work between Robot 1 and Robot 2.
- Presentation preparation was not as efficient as it could have been, leaving limited time for rehearsal or refinement.
- University and external resources were not fully utilized, particularly for analytical validation and design verification.

1.3 Project Management – Action Items

To address the areas for improvement identified above, the team will implement the following action items during Capstone II. Each action item is designed to improve organization, efficiency, and coordination across both robots.

1. **Improve structured communication across subteams**
   Clear summaries and action items will be documented after meetings to ensure all team members remain aligned.
   This will reduce miscommunication and ensure consistent information sharing.
2. **Establish earlier internal deadlines**
   Internal deadlines will be set several days before official due dates to allow time for review and integration.
   This will improve work quality and reduce last-minute pressure.
3. **Allocate dedicated time for presentation practice**
   Practice sessions will be scheduled ahead of presentations to ensure balanced participation and clear delivery.
   This will improve professionalism and presentation performance.
4. **Increase use of available resources**
   Faculty expertise, prior coursework, and external references will be used more intentionally when performing calculations and design validation.
   This will strengthen technical accuracy and design confidence.

1.4 Remaining Design Efforts

Although both robot systems are well underway, several key design efforts remain before final construction.

- **Robot 1:**
  - Redesign and refinement of the inverted pendulum structure
  - Selection of more durable, industrial-appropriate materials for the base and pendulum components
- **Robot 2:**
  - Selection of a final system configuration (ball-on-beam versus ball-on-plate)
  - Redesign of the beam mechanism to incorporate a centralized pivot beneath the beam
  - Validation of the linkage and actuation approach for the revised configuration

2 Gantt Chart

2.1 Introduction and assignee view

This section presents the updated Gantt chart for Capstone II, reflecting remaining design, manufacturing, testing, and reporting milestones. Client expectations for deployable outreach-ready robots by the end of Capstone II were considered when scheduling manufacturing and integration tasks; no external competition deadlines apply to this project The major deliverables are under the *Assignment Name* column, working chronologically down the diagonal according to the date, see figure 1.

Month	Assignment Name	Due Date	Pts	Assignee	Status	Notes		Jan 15
Jan	~~HW00 - Academic Integrity~~	~~Jan 15~~	~~20~~	~~Individual~~	~~Done~~	0		
	Staff Meeting #1 (Wk1)	Jan 15	10					
	Project Management	Jan 18	100	Team				
	Timecard Wk1	Jan 20	20	Freddy			"succinct and standalone report with accompanying files for reference only	
	Staff Meeting #2 (Wk2)	Jan 22	10				such as Gantt charts, BOMs, and potentially even Purchase Orders (POs)"	
	Engineering Calculations Summary	Jan 23	100	Team				
	Timecard Wk2	Jan 26	20	Freddy				
	Staff Meeting #3 (Wk3)	Jan 29	10					
	Self-Learning / Individual Analysis	Jan 30	200	Individual				
Feb	Timecard Wk3	Feb 2	20	Freddy				
	Hardware Status Update (33%)	Feb 5	100	Team				
	Peer Eval 1	Feb 6	20	Individual				
	Timecard Wk4	Feb 9	20	Freddy				
	Staff Meeting #4 (Wk5)	Feb 12	10					
	Timecard Wk5	Feb 16	20	Freddy				
	Staff Meeting #5 (Wk6)	Feb 19	10					
	Website Check #1	Feb 20	50					
	Timecard Wk6	Feb 23	20	Freddy				
	Hardware Status Update (67%)	Feb 26	100	Team				
	Peer Eval 2	Feb 27	20	Individual				
Mar	Timecard Wk7	Mar 2	20	Freddy				
	Staff Meeting #6 (Wk8)	Mar 5	10					
	UGRADs Registration	Mar 6	20	Kyle and Freddy				
	Timecard Wk8	Mar 16	20	Freddy				
	Staff Meeting #7 (Wk9)	Mar 19	10					
	Finalized Testing Plan	Mar 20	100					
	Timecard Wk 9	Mar 23	20	Freddy				
	Hardware Status (100% build)	Mar 25	200					
	Draft of Poster	Mar 27	100					
	Peer Eval 3	Mar 28	20					
	Timecard Wk10	Mar 30	20	Freddy				

Figure 1. Team Gantt Chart – Assignee view

2.2 Milestones, Dependencies, Deadlines, and Date view

Major Milestones, Dependencies, and Critical Deadlines

- Major milestones prior to first Hardware Status Update
- Finalize Robot 1 mechanical redesign and confirm actuator mounting and stability.
- Lock final system architecture for Robot 2 (ball-on-beam), including beam actuation and sensing strategy.
- Finalize sensor selection, mounting locations, and electrical interfaces for both robots.
- Complete preliminary mechanical–electrical integration checks to support control implementation.

Design, purchasing, manufacturing, and testing dependencies

- Mechanical and electrical designs must be frozen before component procurement can begin.
- Components lead times directly constrain manufacturing and assembly schedules.
- Fabricated hardware is required to enable subsystem integration, controller tuning, and closed-loop testing.
- Integration testing depends on timely coordination between mechanical and electrical sub-teams.

Critical deadlines

- Course-required Hardware Status Update demonstrating design readiness and procurement progress.
- Client expectations of clear progress toward robust, portable, and educational robotic demonstrations.
- Internal deadlines established to prevent late-stage design changes and integration delays observed in Capstone I.

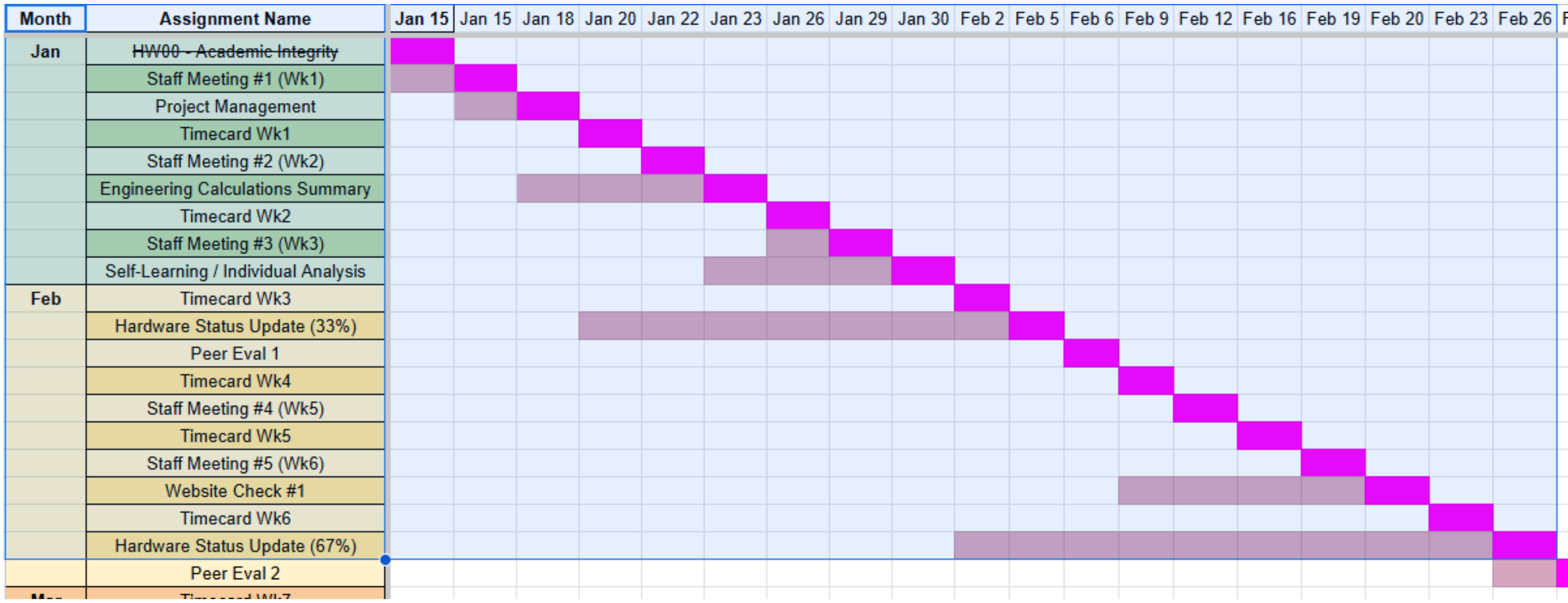


Figure 2. Team Gantt Chart – Date view

Figure 2 shows the respective assignees who are tasked with either the deliverable's completion or management. Our team has a few final touches of delegation to have, but priority will be placed on the heaviest weighted assignments.

3 Top-Level Finances

As the project moves further into the Spring 2026 build phase, maintaining a clear and organized view of overall project finances is critical to keeping both Robot 1 and Robot 2 on schedule and within budget. This section provides a top-level financial summary of the entire project, with the intention of supporting planning and decision-making as designs are finalized and hardware procurement increases.

The total project budget consists of funds provided by the client as well as additional fundraising planned by the team during the semester. The client has allocated $5,000 to support the project, and the team also plans to raise approximately $500 through fundraising activities. Rather than spending the full budget early, the team has intentionally adopted a conservative financial approach. At this stage, the working plan is to allocate approximately $1,500 per robot for prototyping, testing, and early integration, while reserving the remaining funds as contingency for unexpected costs, redesigns, or component failures later in the semester.

Robot 1 currently represents the largest source of financial risk due to its mechanical complexity and reliance on several critical hardware components with longer lead times. Early expenses for Robot 1 are focused on electronics, actuation, sensing, and fabrication materials required to validate mechanical feedback and control performance. Several components have been identified as high priority for early ordering to avoid schedule delays and to confirm design assumptions before final fabrication. Budget flexibility is especially important for Robot 1, as power requirements, material choices, and mechanical durability are still being evaluated.

Robot 2 expenses are more predictable at this stage and are largely driven by control electronics, actuation components, sensing hardware, wiring, and structural aluminum elements. Many of these components are already in-house from earlier prototyping, which reduces immediate costs and procurement risk. Planned purchases for Robot 2 primarily support the transition from prototyping materials to more robust, final-use components, such as aluminum structural elements and a rechargeable power system for standalone operation.

Budget Sheet for Robotic Traveling Van Capstone											
Budget Given by Client: $5,000			Fundraise Funds: $500					Total Budget:	$5,500		
Robot 1						Robot 2					
Item	**Description**	**Do we have it?**	**Price/Unit**	**Qty**	**Total**	**Item**	**Description**	**Do we have it?**	**Price/Unit**	**Qty**	**Total**
Motor Driver H-Bridge	Motor control	Yes	$11.99	2	$23.98	NEMA 17 Stepper Motor	Beam actuation	Yes	$13.99	1	$13.99
AC-DC Power Adapter	12V supply	Yes	$9.99	1	$9.99	Stepper Driver	Motor control	Yes	$17.99	1	$17.99
Arduino Uno R3	Main logic	Yes	$14.99	1	$14.99	Raspberry Pi Pico	Control logic	Yes	$6.00	1	$6.00
PLA Filament (1kg)	Printed parts	Yes	$21.24	1	$21.24	Ultrasonic Sensor	Ball sensing	Yes	$3.50	1	$3.50
Encoder Wheels (4-pack)	Feedback	Yes	$16.79	3	$50.37	Aluminum C-Channel	Beam	No (Planned)	$14.54	1	$14.54
Potentiometers	Angle feedback	Yes	$1.16	13	$15.08	Rechargeable Battery Pack	Power	No (Planned)	$16.99	1	$16.99
Robot 1 Total:			$135.65			Robot 2 Total:			$73.01		
Estimated Remaining Budget:						$5,291.34					

Table 1: Budget Sheet for Robotics Traveling Van

The budget table above summarizes current and anticipated expenses for both Robot 1 and Robot 2 at a top level, focusing on major cost categories rather than individual components. This table is intended to provide a clear financial snapshot of the overall project, including total expenditure, remaining funds, and contingency margins. It is expected that this table will be updated throughout the semester as purchases are completed and designs are finalized. Maintaining this high-level budget view will allow the team to monitor spending trends, identify potential financial risks early, and ensure sufficient resources remain available to successfully complete both robotic systems.

4 Purchasing Plan

4.1 Purchasing Plan – Robot 1

This report provides a strategic overview of our procurement and manufacturing roadmap as we transition into the Spring 2026 building phase. By analyzing our current inventory alongside upcoming technical requirements, we have identified critical bottlenecks in power management, lead times, and mechanical feedback. The following sections outline strategies for high-risk hardware to ensure project continuity and prevent costly component failures. These insights are intended to guide the team through final assembly and serve as the primary agenda for our next meeting.

Part Name	Units	Qty	PriceUSD/unit	Cost	Mfd/Buy	Status	Primary Vendor	Manufacturer	Use
Fall 2025									
Motor Driver H-Bridge PWM	ea	2	$11.99	$23.98	Buy	Bought	Amazon	Teyleten Robot	Power rails / Motor control
AC DC Power Supply Adapter	ea	1	$9.99	$9.99	Buy	Bought	Amazon	ALITOVE	Power robot (12V/2A Est.)
ELEGOO Arduino Uno R3	ea	1	$14.99	$14.99	Buy	Bought	Amazon	Elegoo	Main logic / Robot brain
PLA Filament (1kg)	roll	1	$21.24	$21.24	Mdf	Bought	Amazon	Overture	Robot body / Chassis
Pin Housing Connectors	set	1	$9.99	$9.99	Buy	Bought	Amazon	Glarks	Electrical headers
Zip ties (Pack)	pack	1	$0.00	$0.00	Mfd	Bought	Lab stock	Various	Cable management
Male header for breadboard	set	1	$7.49	$7.49	Buy	Bought	Amazon	Mcbazel	Electrical prototyping
Encoder Wheels (4-Pack)	set	3	$16.79	$50.37	Buy	Bought	Amazon	Aideepen	Robot wheels / Feedback
Potentiometers (Standard)	ea	13	$1.16	$15.08	Buy	Bought	Amazon	JMORCO	Control dials / Feedback
Protoboard/Soldering	ea	1	0	0	Mfd		Lab stock	Various	

Table 2: Robot 1 Purchasing Plan

Critical Planning Gaps

Power Limits: We must verify if the 12V 2A adapter can handle simultaneous motor torque and Raspberry Pi peak loads.

Hardware Handshake: Need to define the communication protocol (I2C/Serial) between the Arduino and Raspberry Pi.

Mechanical Wear: Determine if PLA is robust enough for the bearing housing or if a higher-strength material is required.

Procurement & Budget Risks

P3 America Potentiometer: 7+ day lead time; this is our most critical hardware bottleneck.

Pendulum Arm Fabrication: 3-day window for printing, post-processing, and bearing fit-testing.

Budget Risks

Component Damage: A $100+ loss risk (Pi + Screen) if the Logic Level Shifter is wired incorrectly.

Under-budgeted Power: A higher-amperage 12V supply may cost an additional $25 if current tests fail.

Items Requiring Early Ordering

The "Feedback Core": The P3 Potentiometer and 608ZZ bearings must be ordered first to verify CAD tolerances before printing the arm.

RPi Touchscreen: Due to market volatility, we should secure this early to avoid "Out of Stock" delays.

Meeting Action Items

1. IMMEDIATE ORDERING: Purchase the P3 America Potentiometer and Raspberry Pi Touchscreen this week to clear the critical path.

2. POWER LOAD TEST: Bench-test the 12V supply with motors at 100% duty cycle to ensure the 2A limit is not exceeded.

3. DESIGN FREEZE: Finalize the Pendulum Arm CAD dimensions based on the 608ZZ bearing datasheet for immediate printing.

4. WIRING SCHEMATIC: Draft a diagram for the Buck Converter and Logic Level Shifter to ensure safe 5V-to-3.3V integration.

4.2 Purchasing Plan – Robot 2

The purchasing plan for Robot 2 was developed using the most up-to-date and detailed Bill of Materials and focuses on all components that will be externally acquired. The primary objective of this plan is to ensure timely procurement, manage component lead times, and identify potential risks associated with part availability as the project transitions from prototyping materials to a final, durable design.

Table 3 presents the sorted list of purchased components for Robot 2, including cost, make/buy decisions, primary vendors, manufacturers, expected lead times, and current part status. This table reflects both components already in-house from earlier prototyping efforts and planned purchases that are dependent on final design confirmation.

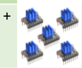
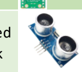
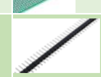
Item	Subassembly	Part Name	Description	Qty (per robot)	Make / Buy	Primary Vendor	Manufacturer	Lead Time	Cost (USD)	Part Status	Notes	Images
1	Actuation	NEMA 17 Stepper Motor (12 V)	Stepper motor used to tilt beam	1	Buy	Amazon	Generic NEMA 17	3–5 days	13.99	In house	Sized using torque calculations	
2	Actuation	Stepper Motor Driver	Driver board for stepper motor	1	Buy	Amazon	TMC2208 / A4988	3–5 days	17.99	In house	Direction + PWM control	
3	Control	Raspberry Pi Pico	Microcontroller for control logic	1	Buy	Amazon	Raspberry Pi Ltd.	3–5 days	6	In house	Cost based on 2-pack	
4	Sensing	HC-SR04 Ultrasonic Sensor	Measures ball position along beam	1	Buy	Amazon	DIYables / HC-SR04	3–5 days	3.5	In house	Cost based on 2-pack	
5	Power	5 V Regulator Module	Step-down voltage regulator	1	Buy	Amazon	Generic	3–5 days	1	In house	Cost based on 10-pack	
6	Power	9 V Battery	Power source for control electronics	1	Buy	Local / Amazon	Generic	1–3 days	3	Pending	Temporary prototype supply	
7	Prototyping	Breadboard	Solderless prototyping board	1	Buy	Amazon	Generic	3–5 days	1.66	In house	Used during development	
8	Wiring	Dupont Jumper Wires	Pre-crimped jumper wires	1	Buy	Amazon	Elegoo	3–5 days	6.98	In house	Shared kit	
9	Wiring	22 AWG Hookup Wire	Solid core wire for connections	1	Buy	Amazon	TUOFENG	3–5 days	15.29	In house	Shared across builds	
10	PCB Transition	Protoboard	Semi-permanent wiring board	1	Buy	Amazon	Generic FR-4	3–5 days	13.59	Pending	Used in later iteration	
11	PCB Transition	Header Pins	Breakaway headers	1	Buy	Amazon	Generic	3–5 days	7.39	In house	Pico + module mounting	
12	Beam	Aluminum C-Channel (1 in x 1/2 in x 8 ft)	Aluminum C-channel used as final ball-on-beam track, cut to length	1	Buy	Home Depot	Steelworks / Everbilt	3–5 days	14.54	Planned	Purchased as stock; one length supports multiple beams	
13	Base Assembly	Aluminum Base Plate (6061) 89015K214	Aluminum plate used as rigid base for Robot 2 frame	1	Buy	McMaster-Carr	McMaster-Carr	3–5 days	3.94	Planned	Thickness TBD based on final design	
14	Power	Rechargeable Battery Pack (7.4V–11.1V)	Rechargeable battery for standalone operation	1	Buy	Amazon	VICMILE	3–5 days	16.99	Planned	Exact voltage/capacity TBD	

Table 3: Robot 2 Purchasing Plan

Observations and Planning Considerations

- Most purchased components for Robot 2 are sourced from a single primary vendor (Amazon), which simplifies procurement but introduces potential supply-chain risk.

- Lead times for critical electronic components, such as the stepper motor, motor driver, ultrasonic sensor, and rechargeable battery pack, typically range from 3–5 days, requiring early ordering to avoid schedule delays.
- Several electronic components are purchased in multi-packs and shared across prototypes, requiring careful inventory management and cost allocation.
- As the project progresses toward a final design, additional structural components, such as an aluminum C-channel beam and an aluminum base plate, have been identified as planned purchases to replace prototyping materials and improve durability and manufacturability.
- Some components remain listed as planned purchases pending final confirmation of the beam geometry, pivot mechanism, and overall Robot 2 configuration.

Purchasing Plan – Action Items (Robot 2)

1. **Finalize Robot 2 mechanical configuration before placing remaining orders**
   Confirming the final beam geometry, pivot location, and sensing configuration will prevent unnecessary purchases and ensure compatibility between structural and electronic components.
2. **Order long-lead electronic components early**
   Stepper motors, motor drivers, sensors, and the rechargeable battery pack will be prioritized for early purchase to mitigate delivery delays and support early integration testing.
3. **Track part status on a weekly basis**
   The part status column in the purchasing table will be reviewed and updated during weekly team meetings to maintain clear visibility of procurement progress.
4. **Identify secondary vendors for critical components**
   Backup vendors will be identified for key electronic and structural components to reduce risk if primary vendors experience delays or shortages.

5 Manufacturing Plan

Due to the multi-part nature of the project, the manufacturing schedules are divided into two different schedules for each robot the team is working on. Each manufacturing schedule includes the time needed for purchased materials to be delivered in addition to actual manufacturing time. Robot 1 has fewer machined parts, but the main part being manufactured is subject to iteration and a long production time, while Robot 2 has many machined parts with varying levels of complexity and production times. Each production cycle should occur concurrently with each other though depending on potential iterations on components, some parts may be delayed due to the team only having regular access to one 3-D printer. The current production times may be subject to change in the event of major design changes and potential roadblocks or outside factors.

5.1 Robot 1

The production plan for robot 1 is relatively simple but is subject to change based on how well prototype testing goes. The Frame is the most time intensive of the two manufactured parts as it is being 3-D printed and is the most subject to potential future iterations. The Pendulum robot arm is much simpler in terms of manufacturing and shouldn’t take more than a few hours, and manufacturing duration accounts for the time it will take for the base parts to be delivered and potential time conflicts with machine shop operating hours.

Product Number	Item Name	Manufacturer	Duration (start - end)	Material(s)	Location of Production
1	Pendulum Robot Frame	Andres/Colin	09/31/25 – 02/01/26	PLA	In-house
2	Pendulum Robot Arm	Colin	1/23/26 - 02/01/26	Steel	In-house

Table 4: Manufacturing Plan for Robot 1 during the Spring 2026 semester

Potential Manufacturing Bottlenecks:

Primary Bottleneck – 3-D printing of the frame is extremely time consuming, and the frame is also the part that has the most potential for future iterations which are likely to add additional material which will require new prints which will take even longer. Production will likely be delayed until a final design is settled.

Secondary Bottleneck – Machining the Pendulum arm will require time set aside to go to the on-campus machine shop and depending on their operating hours and how busy they may be access to the required machines may be restricted. Additionally, the steel shafts are being ordered and will take time to arrive, which may require further adjustment of production schedule.

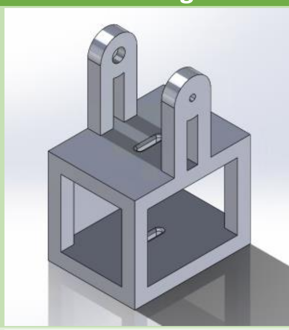
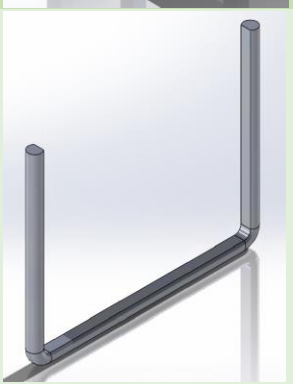
Product Number	Image	Description
1		The Pendulum Robot frame which serves as the central structure and contains or otherwise connects to every other component
2		Pendulum arms made of steel, 6mm total diameter with 1mm shaved off to facilitate the attachment of a pass-through potentiometer

Table 5: Manufactured images with descriptions of the products for robot 1

Future Iterations:

1: at the current time the frame design is purely functional and with an Arduino in mind. In the near future the Arduino will be replaced with a Raspberry Pi, which may necessitate alternate dimensioning to fit the system into the frame. Additionally, the robot's design is meant to be appealing to K-12 students and therefore is likely to see aesthetic modifications to make it more visually appealing to that demographic.

2: The new version of the robot pendulum arm is being designed to work with a pass-through potentiometer, which will need to be tested for accuracy in reading the angle of the pendulum arm. If the potentiometer's accuracy is insufficient then an alternate potentiometer or similar system must be considered, which may require an alternate arm design.

5.2 Robot 2

Robot 2's prototype was designed through SolidWorks and 3D printed with some exceptions of electrical components, flexible metal attachments, and wooden parts. 3D printing will be reduced in the final robot design with the placement of durable metal components. For customization of metal parts, metal cutting with tools like saws, grinders, mills, and plasma cutters would help with shaping, finishing, and cutting the metal (s). This will course over the span of a month or more to initiate the collection and performance of the changed products.

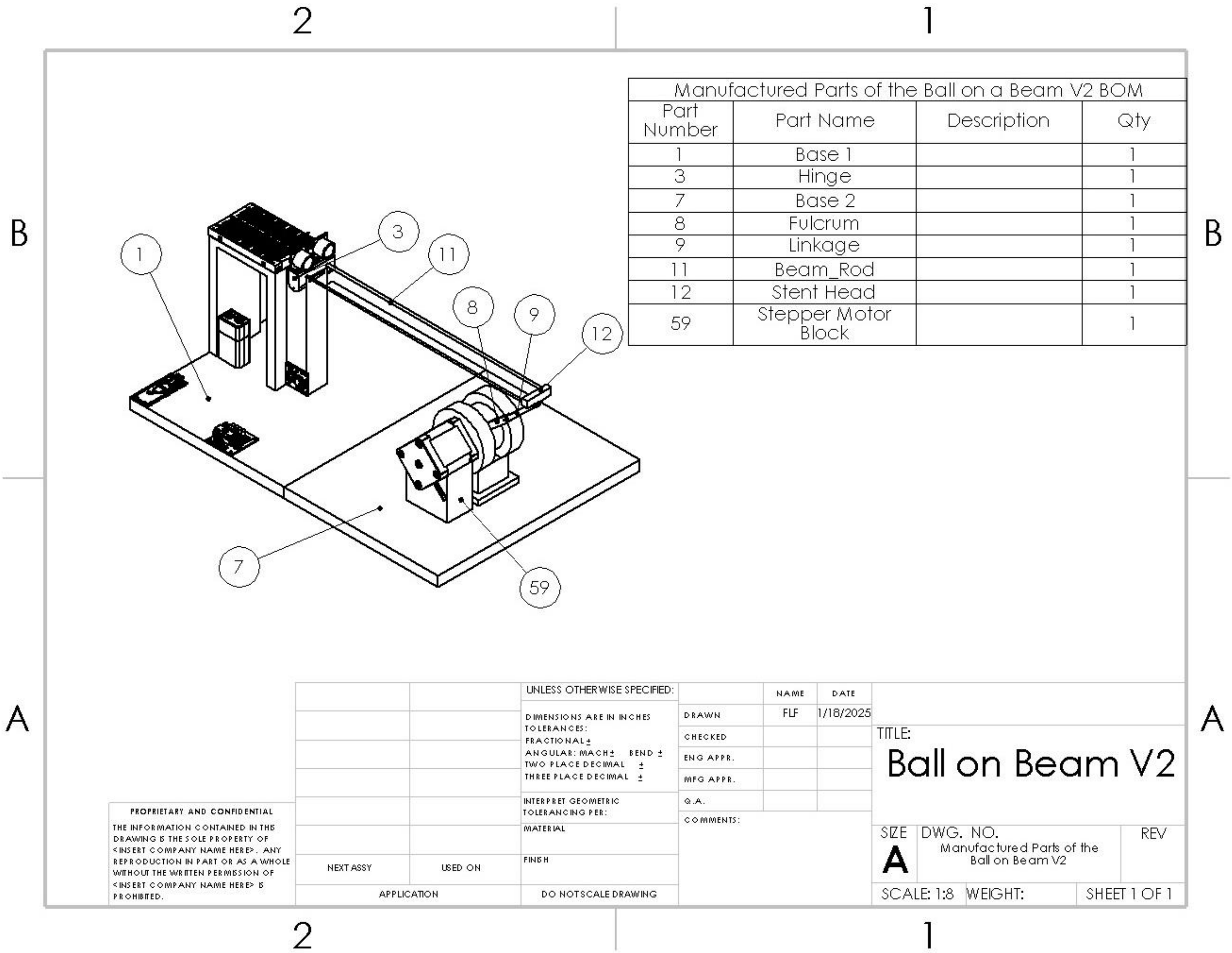


Figure 3: Manufacturing parts bill of materials (BOM) of robot 2.

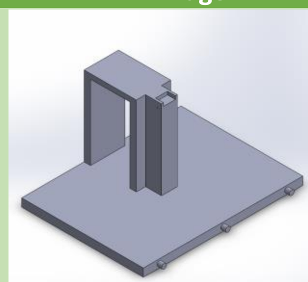
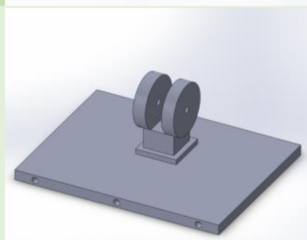
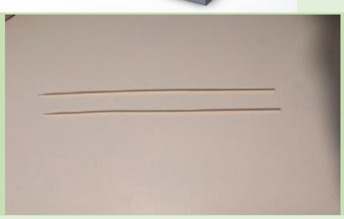
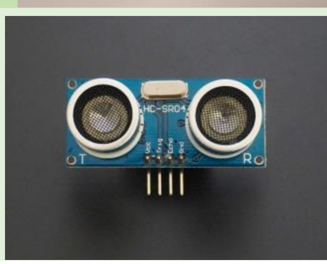
Product Number	Item Name	Manufacturer	Duration (start - end)	Material(s)	Location of Production
1	Base 1	Florence/Freddy	02/01/25 - 02/23/25	Aluminum	In-house
2	Base 2	Florence/Freddy	02/01/25 - 02/23/25	Aluminum	In-house
3	Beam	Florence	02/26/25 - 3/06/26	Aluminum	In-house
4	Sensor	Electrical Engineering	01/31/25 - 2/07/25	Various Alloys and Electrical Components	In-house
5	Hinge	Florence	02/01/25 - 02/15/25	PLA	In-house

Table 6: Manufacturing Plan for Robot 2 during the Spring 2026 semester.

Potential Manufacturing Bottlenecks:

Primary Bottleneck – Mechanical properties of the geometry of robot 2 may hinder the performance of stabilizing the beam. The greater the friction and forces applied to the ball and beam, the more complex the controls are needed to have a consistent balance of performance. Furthermore, real-time control loop can cause little inconsistencies in reading and that affects the performance of the sensor reading the angles accurately. Overall, finding constant equilibrium for every millisecond, for example, can create complications throughout the stabilization of the ball on the beam.

Secondary Bottleneck – Decrease of performance while testing can create inaccuracy within the system. Inconsistencies can affect the center of mass and shift the amount of work that the motor needs to rotate. The systems dynamic response can be modified by the components alignment to the beam, stepper driver motor. This creates surface friction and vibration which influences the component's tolerance.

Product Number	Image	Description
1		1/2 of the board that incorporates a hollow rectangular pillar for the placement of the breadboard to be set on top and a hollow space for the electrical components.
2		2/2 of the board that houses the built-in part of the fulcrum.
3		Guiding the movement of the ball.
4		Tracks the movements of the ball with measurement of distance. To a certain point, the sensor will detect the ball and then that signal will be transmitted to the motor to adjust the beam.

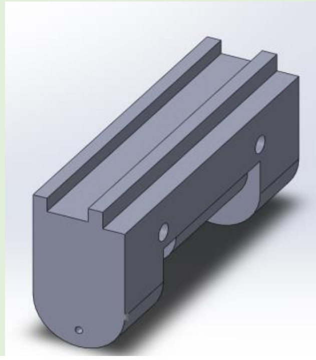
5		Connects the two beams and tilt motion occurs across the y-axis. The sensor is placed on top of the hinge slots for accurate readings when motion occurs.

Table 7: Manufactured Images with the descriptions of the products for Robot 2.

Future Iterations:

1 & 2: The base currently is created from a 3D printer made through SolidWorks. This material is a plastic called PLA. The material is strong enough for prototyping and with that, aluminum would be ideal due to its durability, strength, and lightweight. The area of the beam will be balanced; center beam, on will either be 3D-ed or made of aluminum. For the time being, the robot 2 team will first construct a 3D printed version of the center beam and move onward from how it performs with the system, dynamic, and electrical properties.

3: The beam currently are two wooden bamboo skewers that are inserted into the holes of the hinge and the stent head. Wood is quite flexible that it will cause deformation with every cycle of testing the robot and to solve that problem, aluminum would be used in the final design. Instead of two aluminum skewers, the beam will be one solid rectangular C-channel.

4: The sensor will be changed from an ultra-sonic sensor to a laser sensor and two cameras positioned above the robot. The ultra-sonic was not as responsive to reading the ball and ideally a laser with cameras has more of a precision feature compared to the ultra-sonic sensor reading the ball's distance and readjusting than beam for the ball to be centered on the beam.   The new sensors will be ordered from Amazon primarily, but they are not limited.

5: The hinge will be replaced with the center beam to add stabilization to the beam and the material will be PLA. Since there will be a single pivot point of the robot, adding something in the middle of the beam instead of on the ends of the beams. That would add more weight to the structure and more room for possible error of stabilization and stresses obtained to the motors.