

ME 476C Capstone Project – Robotics Traveling Van

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Northern Arizona University

Sponsor: Michael Shafer

Engineering Drawings/Designs/Tables

Fall 2025

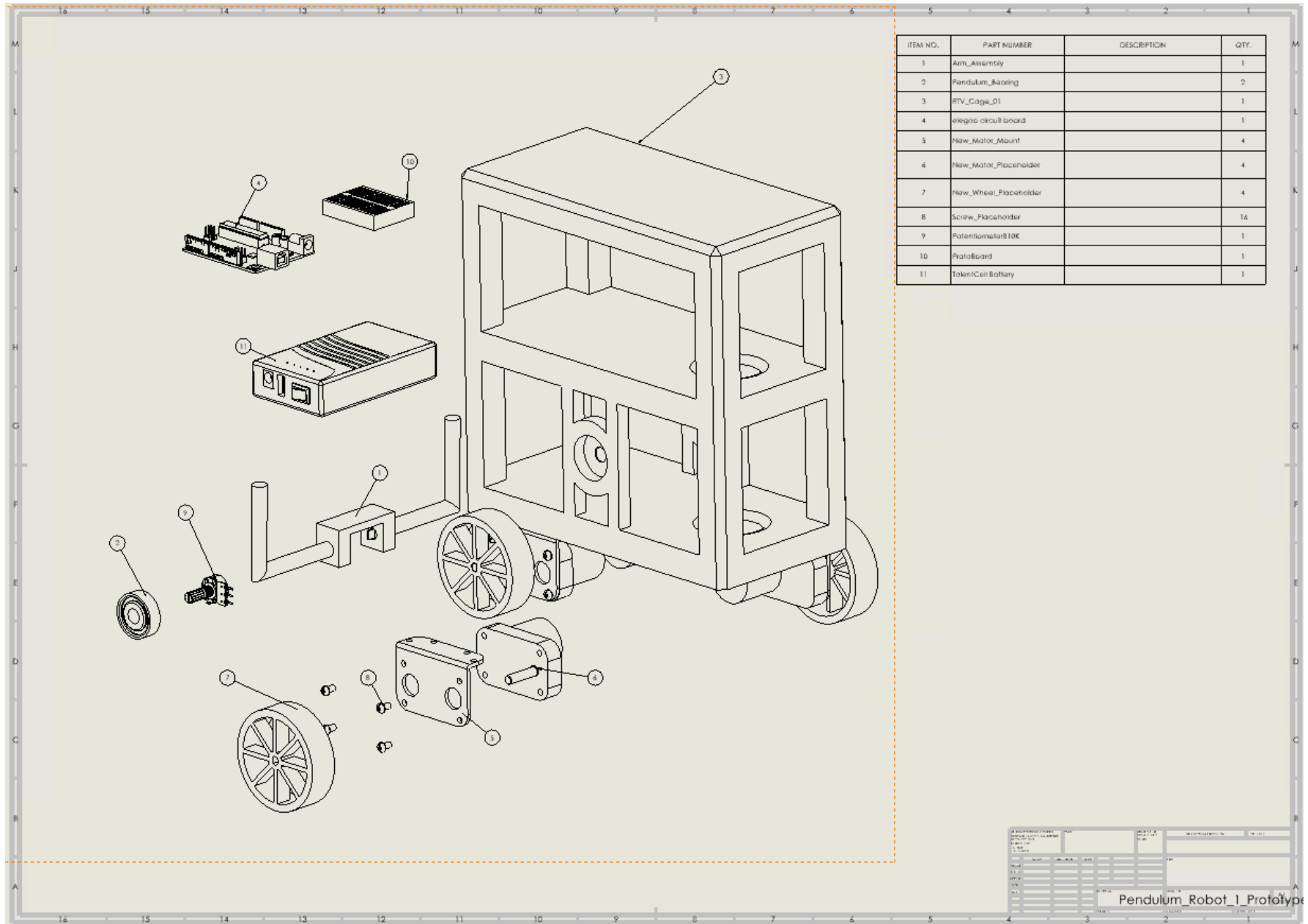
Instructor: David Willy

Robotics Traveling Van – Presentation 03

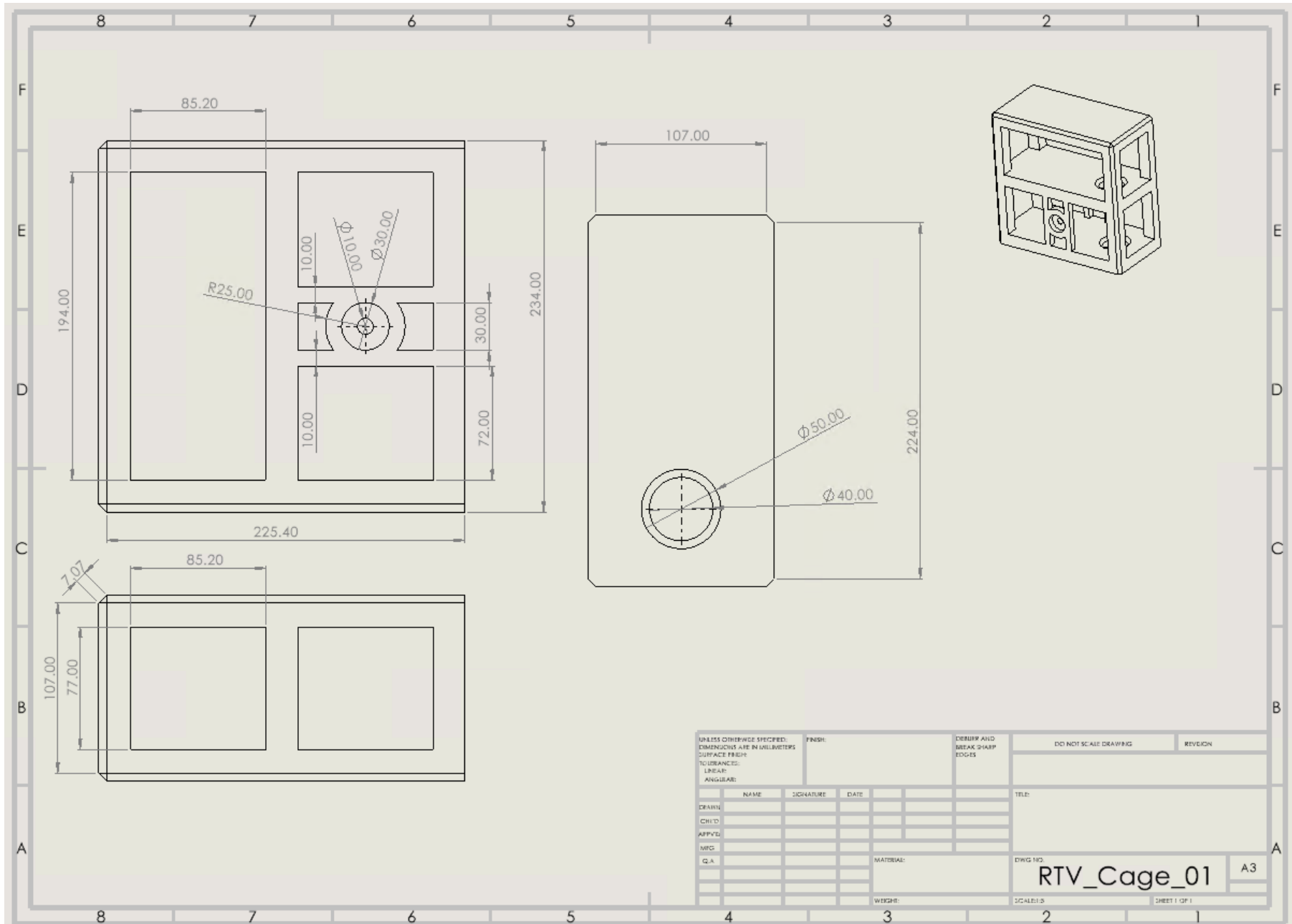
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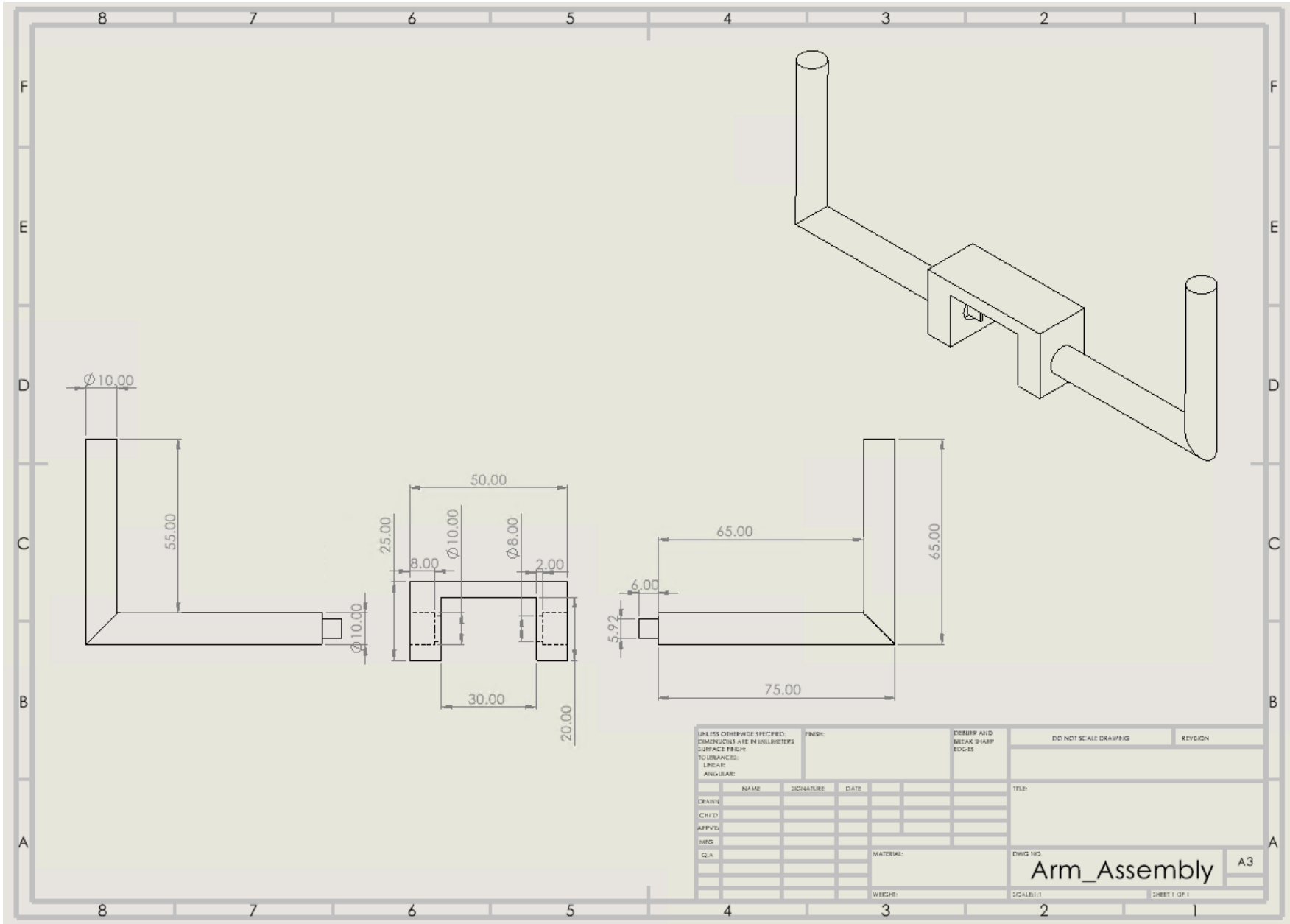
Robot 1 - Full CAD Assembly



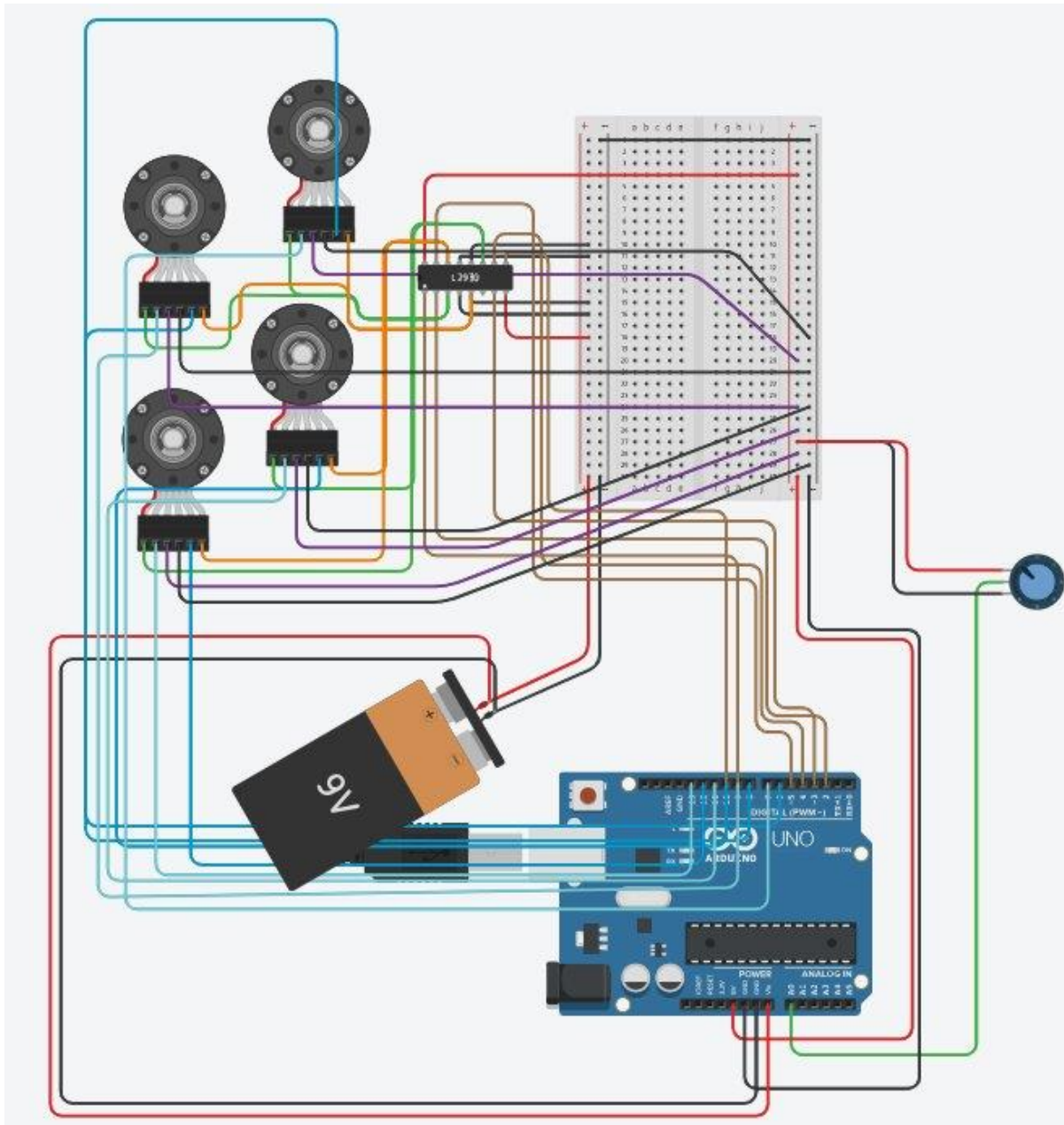
Robot 1 Subassembly 01:CCAD Cage



Robot 1 Subassembly 02: CAD Arm



Robot 1 Subassembly 03: Circuit Design



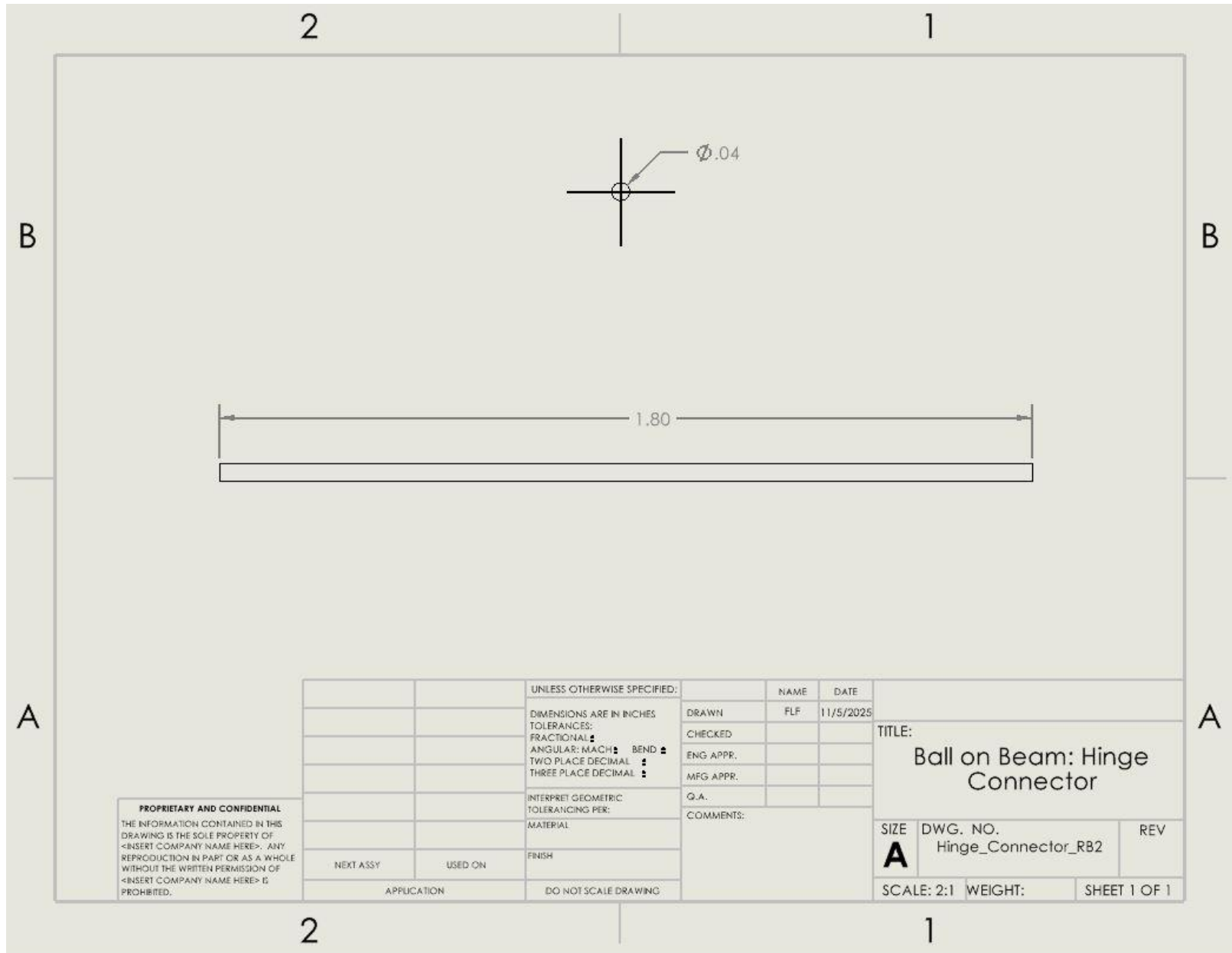
Robot 2 CAD – Full Assembly

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Base_RB2		1
2	Fulcrum_RB2		1
3	Stent_RB2		1
4	Rod_RB2		2
5	Hinge_RB2		1
6	Breadboard 400		1
7	9V-battery	PART-layer1 [1]-DESC	1
8	12v stepper motor 17HS19-2004S1 (1)		1
9	Hinge_Connector_RB2		1
10	Fulcrum_Connector_RB2		1
11	sensor_assy	VL53L0X distance sensor simple model for integration	1
12	Raspberry Pi Pico-R3		1
13	User Library-SCV0050	NONE	1
14	User Library-ULN2003 Driver		1

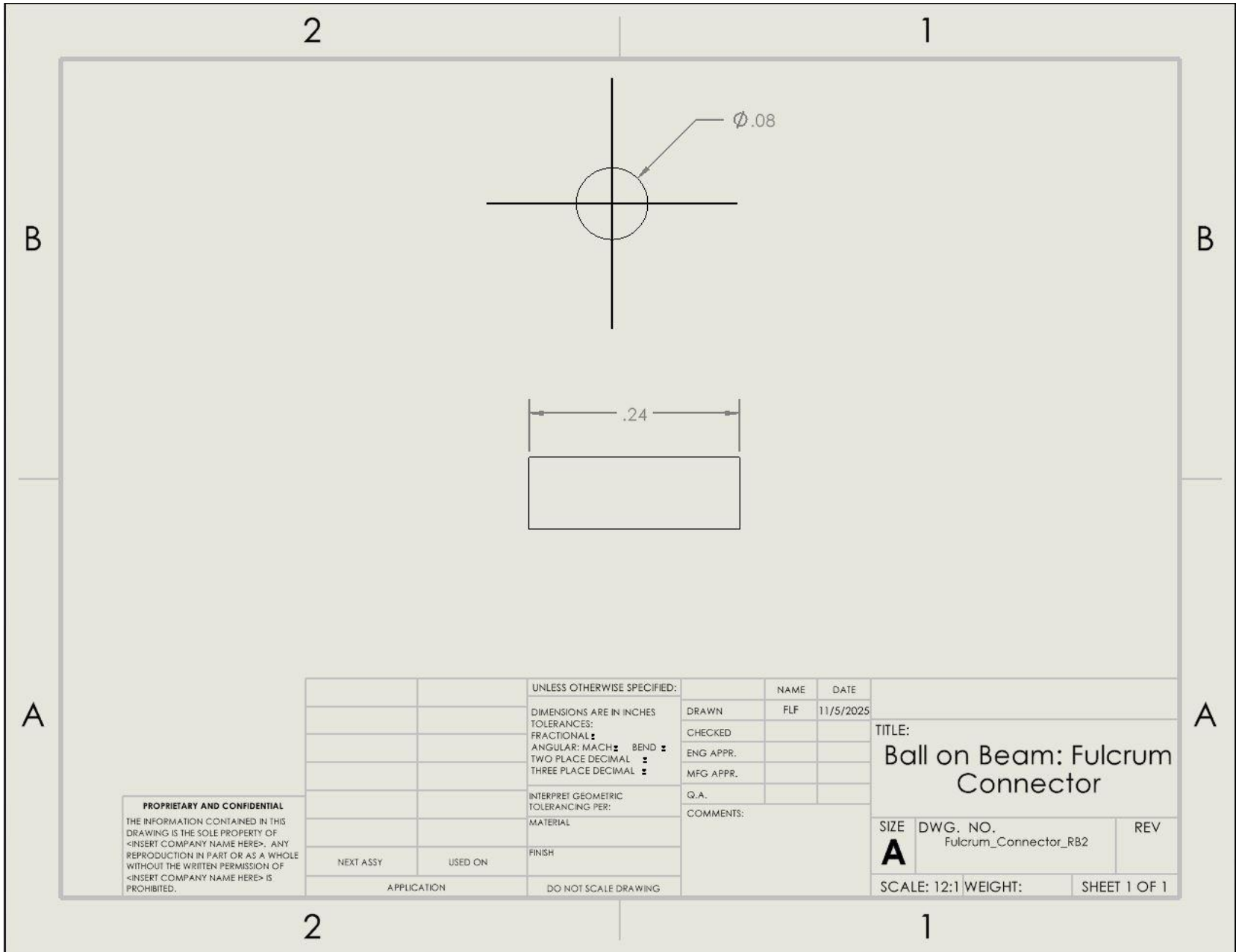
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DIMENSIONS ARE IN INCHES		DRAWN	FLF 11/5/2025
TOLERANCES:		CHECKED	
FRACTIONAL: $\frac{\quad}{\quad}$		ENG APPR.	
ANGULAR: MACH \pm BEND \pm		MFG APPR.	
TWO PLACE DECIMAL \pm		Q.A.	
THREE PLACE DECIMAL \pm		COMMENTS:	
INTERPRET GEOMETRIC TOLERANCING PER:			
MATERIAL			
FINISH			
NEXT ASSY	USED ON		
APPLICATION			
DO NOT SCALE DRAWING			

<p>PROPRIETARY AND CONFIDENTIAL</p> <p>THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.</p>		
<p>TITLE: Ball on Beam Assembly</p>		
SIZE A	DWG. NO. Robot2	REV
SCALE: 1:8	WEIGHT:	SHEET 1 OF 1

Robot 2 Subassembly 01: Beam CAD



Robot 2 Subassembly 02: CAD Pin

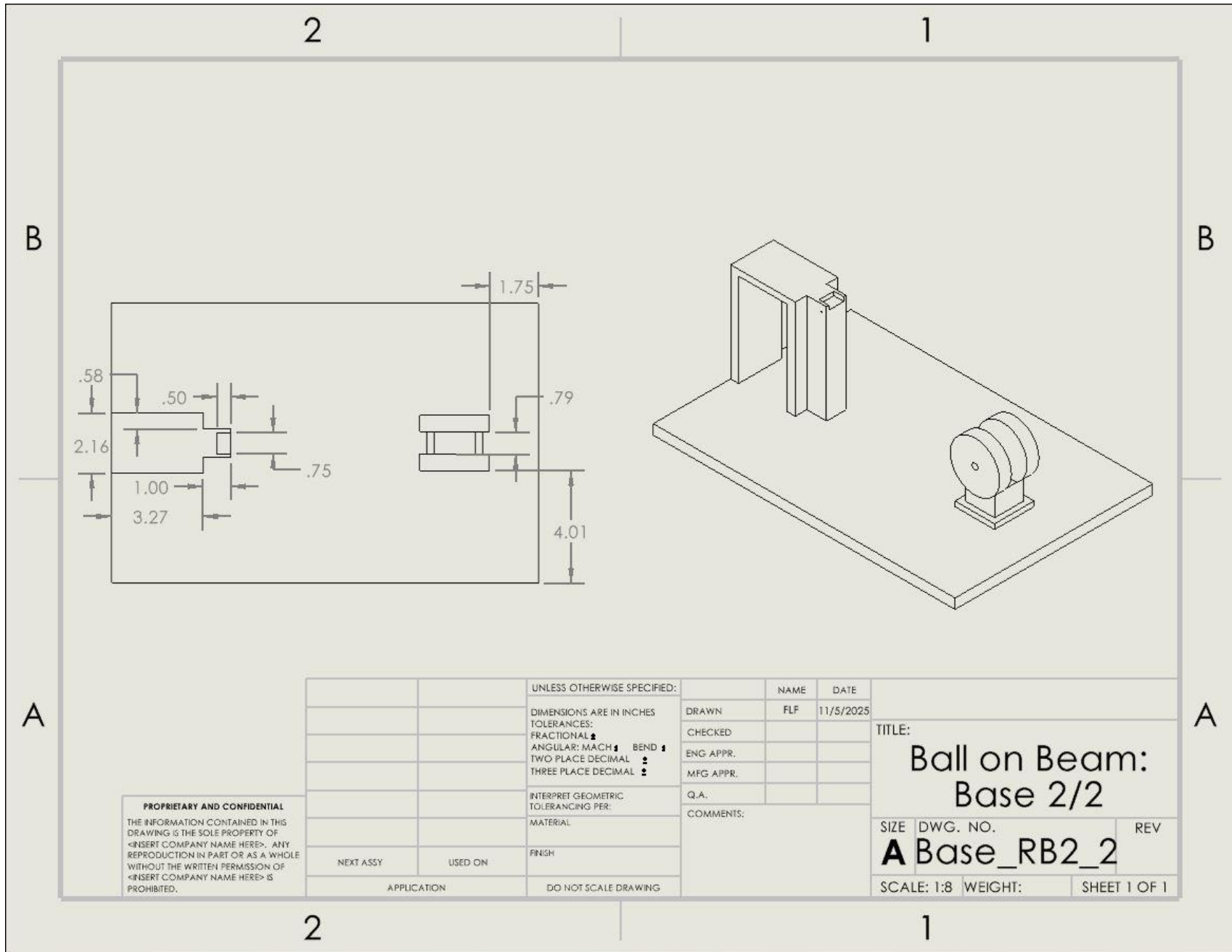


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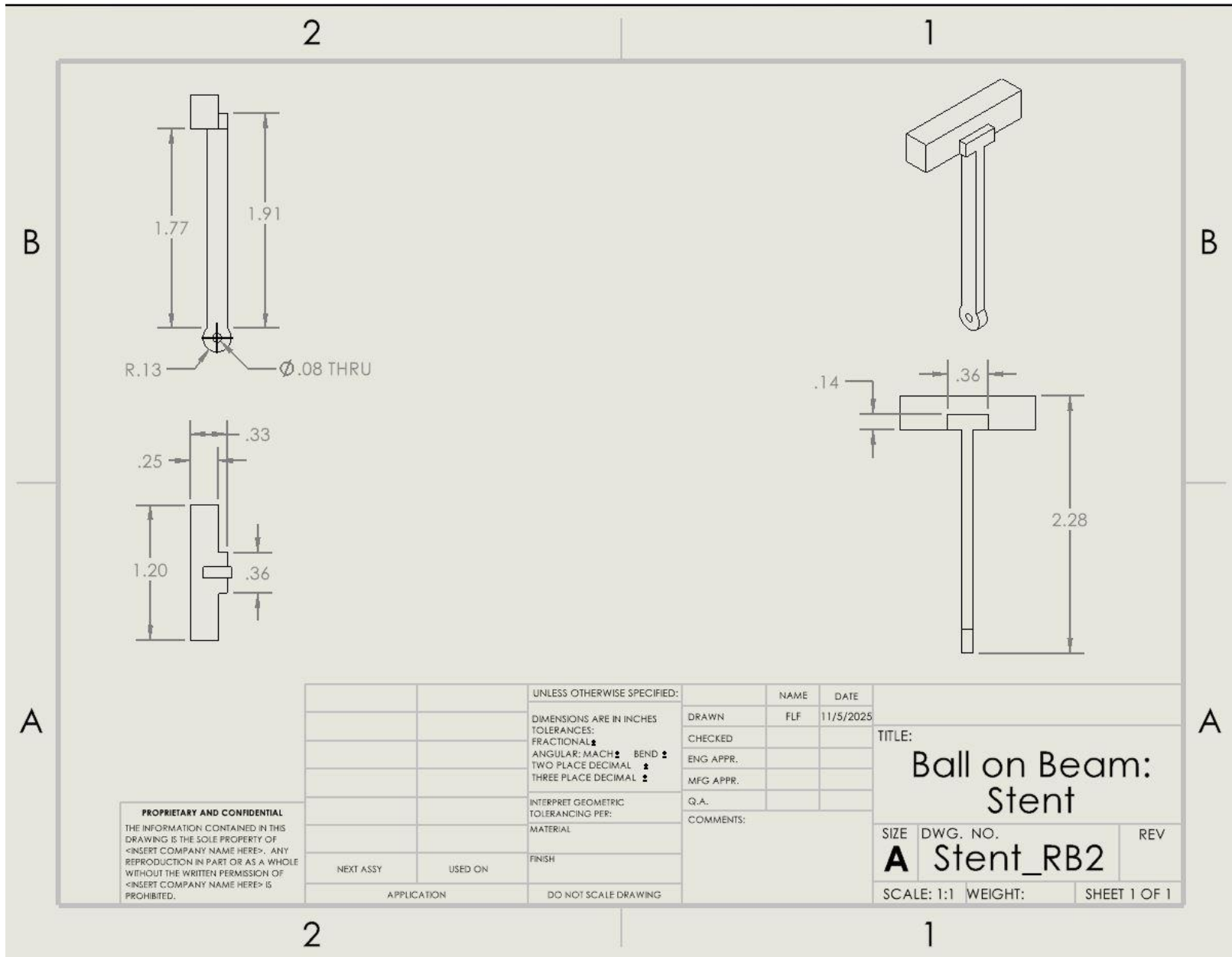
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		THREE PLACE DECIMAL: \pm	COMMENTS:		
		INTERPRET GEOMETRIC TOLERANCING PER:			
		MATERIAL			
		FINISH			
NEXT ASSY	USED ON				
APPLICATION		DO NOT SCALE DRAWING			

TITLE:		
Ball on Beam: Fulcrum Connector		
SIZE	DWG. NO.	REV
A	Fulcrum_Connector_RB2	
SCALE: 12:1	WEIGHT:	SHEET 1 OF 1

Robot 2 Subassembly 03: CAD Base



Robot 2 Subassembly 05: CAD Stent

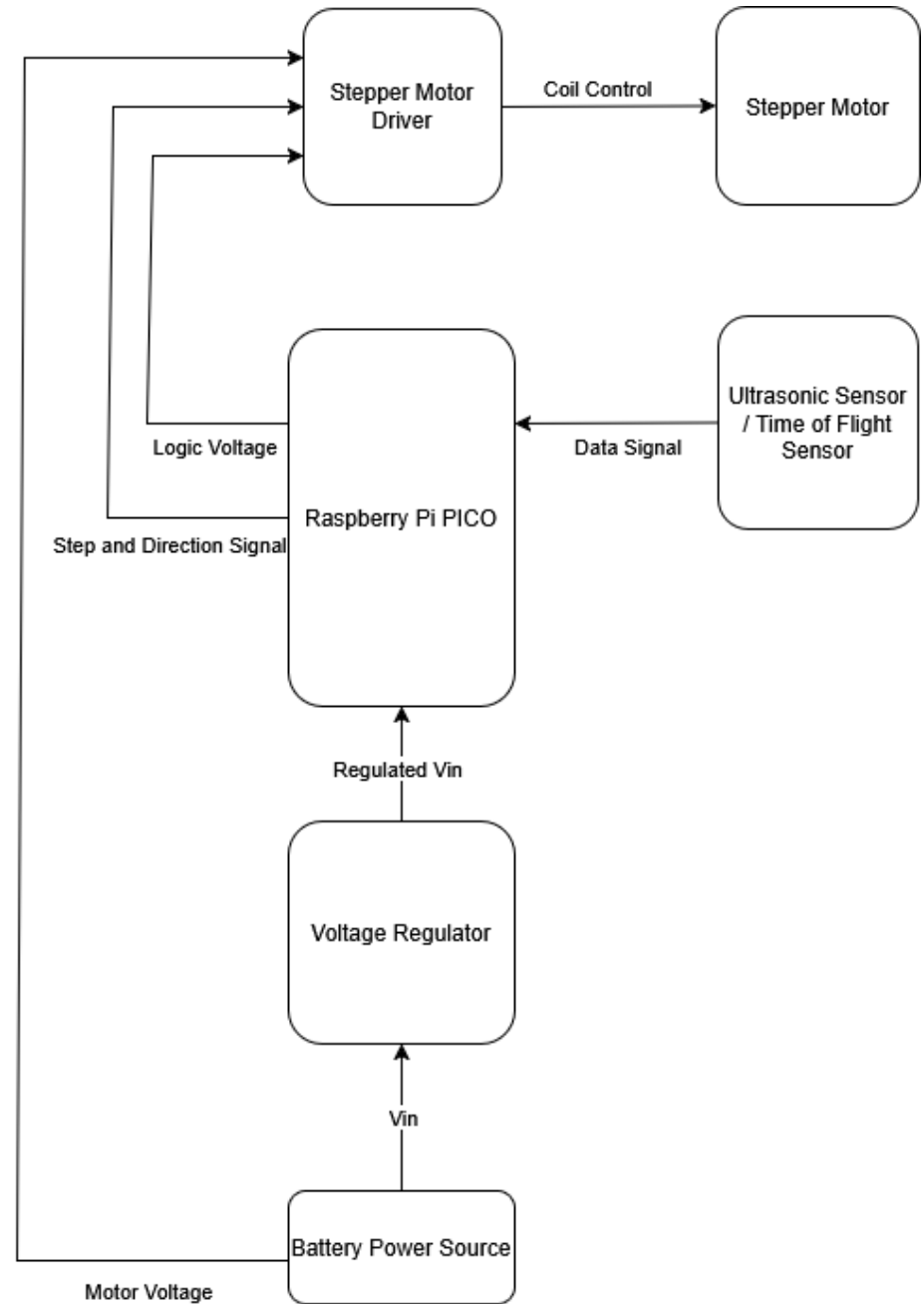


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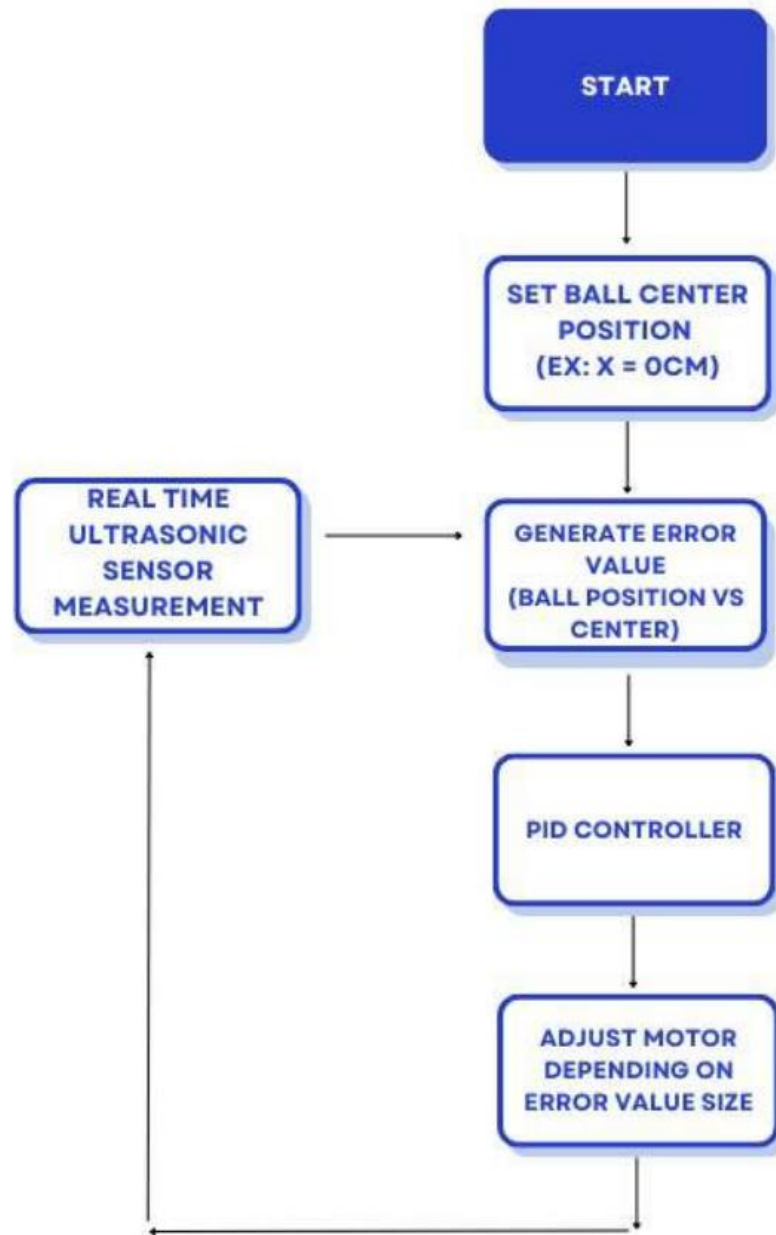
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		TOLERANCES:	CHECKED	11/5/2025
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		ANGULAR: MACH ± BEND ±	MFG APPR.	
		TWO PLACE DECIMAL ±	Q.A.	
		THREE PLACE DECIMAL ±	COMMENTS:	
		INTERPRET GEOMETRIC TOLERANCING PER:		
		MATERIAL		
		FINISH		
NEXT ASSY	USED ON			
APPLICATION		DO NOT SCALE DRAWING		

TITLE:		
Ball on Beam: Stent		
SIZE	DWG. NO.	REV
A	Stent_RB2	
SCALE: 1:1	WEIGHT:	SHEET 1 OF 1

Robot 2 Subassembly 01: Circuit Diagram



Robot 2 Subassembly 02: Program Block Diagram



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Robot 2 FMEA:

Subassembly	Component	Function	Failure Mode	Potential Effect(s) of Failure	S	O	D	DRPN	Recommended Action
Base / Stand	Base plate	Support robot	Slips/shocks	Control lost	7	4	3	84	Increase weight or clamp base during demo
Base / Stand	Base plate	Maintain	Mounting	Assemble leveling	6	3	4	72	Apply thread locker; retighten before demos
Structure	Plate panel	Provide surface	Plate cracks or	Ball drifts despite	8	3	3	72	Use aluminum or composite plate
Structure	Plate panel	Provide low-	Surface dirty	Ball sticks/slow	6	4	3	72	Apply smooth matte coating; routine cleaning
Structure	Plate edge	Contain	Edge missing	Ball falls off during	6	2	2	24	Add 1–2 cm guard wall around plate
Mechanism	Ball joint /	Allow (X,Y)	Joint binds	Use/rotation:	8	3	3	72	Use precision ball joints; routine maintenance
Mechanism	Ball joint /	Allow plate	Joint base	Use/rotation or delayed	7	4	4	112	Replace worn joints; tighten tolerance
Actuation	Servo (x3)	Turn plate	Ball serv drifts	Plate tilts/droops	9	3	3	81	Use identical servos; test prior to demo
Actuation	Servo (x3)	Continuous	Motor heats or	Servo shuts down	8	3	4	96	Add cooling; tune PID gains
Subassembly	Component	Function	Failure Mode	Potential Effect(s) of Failure	S	O	D	DRPN	Recommended Action
Base / Stand	Base plate	Support robot	Slips/shocks	Control lost	7	4	3	84	Increase weight or clamp base during demo
Base / Stand	Base plate	Maintain	Mounting	Assemble leveling	6	3	4	72	Apply thread locker; retighten before demos
Structure	Plate panel	Provide surface	Plate cracks or	Ball drifts despite	8	3	3	72	Use aluminum or composite plate

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Structure	Plate panel	Plate low-contrast	Surface dirty	Balls pick up	6 Dust; fingerprints	4 Clean	3	72	Apply smooth matte coating; routine cleaning
Structure	Plate edge	Keypads	Edges snag	Balls fall off during	6 Design oversight	2 Visual check	2	24	Add 1–2 cm guard wall around plate
Mechanism	Ball joint / Actuator (X)	Joint binds	Use wrong	8 Dust; tight fit	3 Lubrication	3	72	Use precision ball joints; routine maintenance	
Mechanism	Ball joint / Actuator	Worn plate	Loose base	Unstable or delayed	7 Wear over	4 Metal disc check	4	112	Replace worn joints; tighten tolerance
Actuation	Servo (x3)	Tilt plate	Plate or drifts	Plateable system	9 Interference	3 Matched servos	3	81	Use identical servos; test prior to demo
Actuation	Servo (x3)	Continuous	Overheats or	System shutdown	8 Aggressive PID	3 Temperature testing	4	96	Add cooling; tune PID gains