Drone Challenge (UAV)

Dinosaur Rescue

Nashville, Tennessee
2025

1366-1

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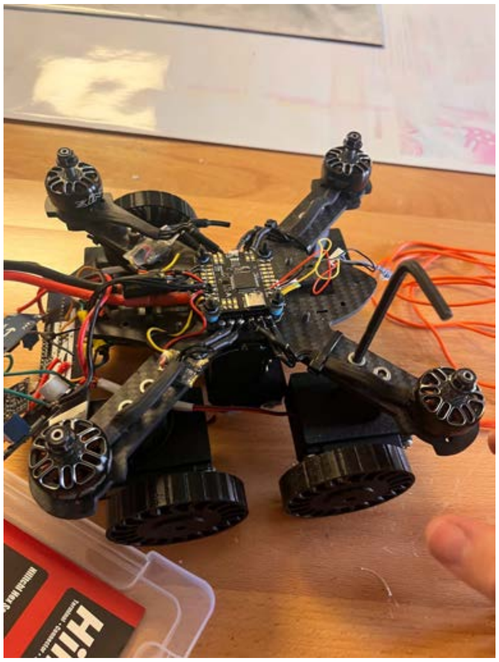
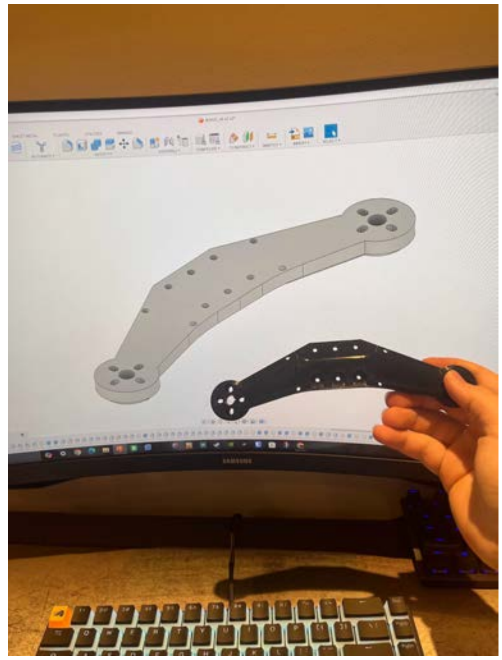
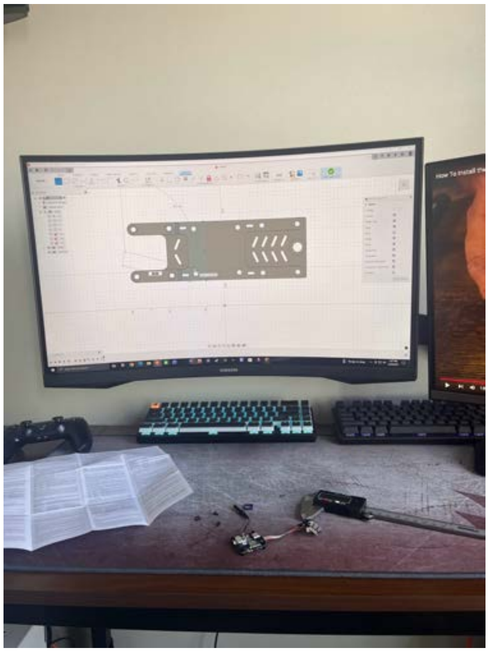
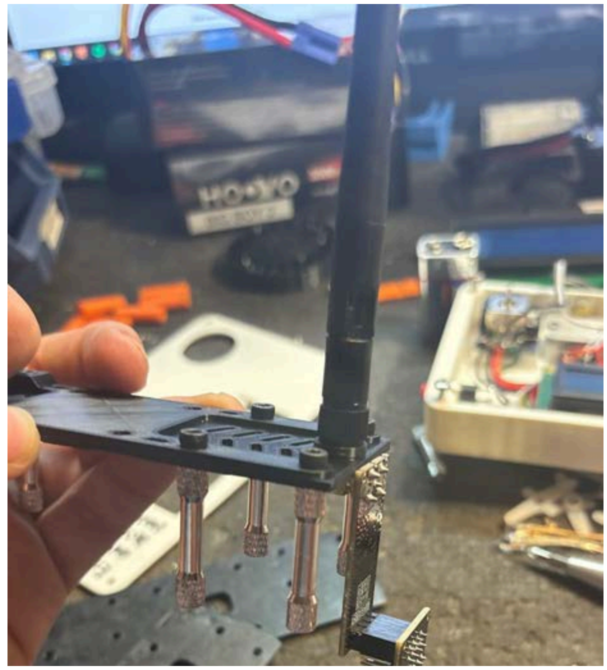
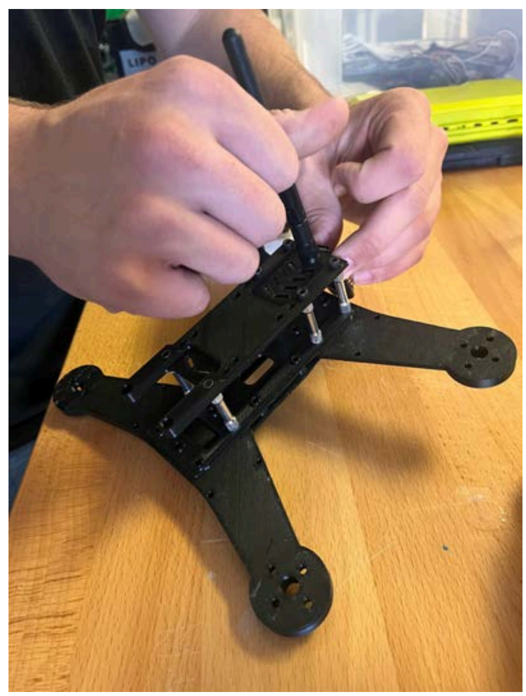
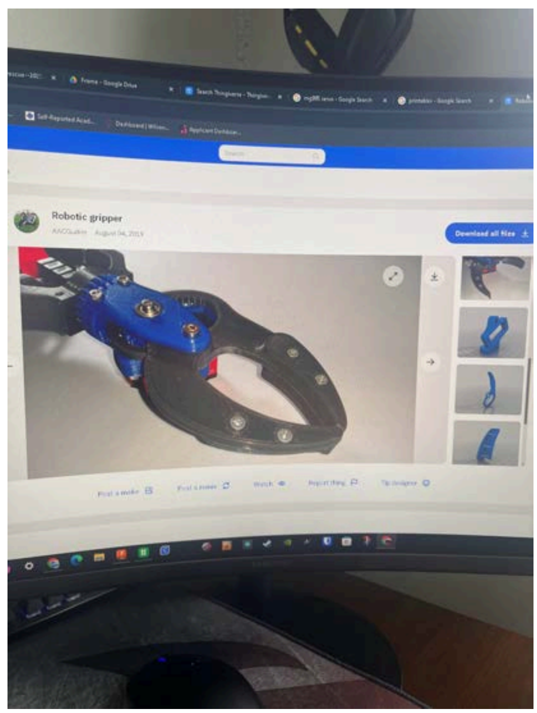
Photo Log

	
The first step that we took was the disassembly of the old drone from 2024	After some initial research, we began to design and print the new 3D frame
	
Did a stress test on the body of the drone to make sure the 3D printed part would be able to handle flight	Was able to handle 250 lbs with only .195 displacement.

	
Continuation of the mid part of the frame	Begin to screw vertical posts and NRF into the top plate to make sure the screw holes fit
	
Constructing the 3D-printed frame of the new drone	Attaching the top plate of the drone where the battery would sit.

<table>
<tr><td></td><td></td></tr>
<tr><td>Screwing the motors into the new frame</td><td>The old frame compared to the new frame.
The new frame is more customizable</td></tr>
<tr><td></td><td>
</td></tr>
<tr><td>Motors taken off the old frame</td><td>Did some research on possible claw designs
for the challenge</td></tr>
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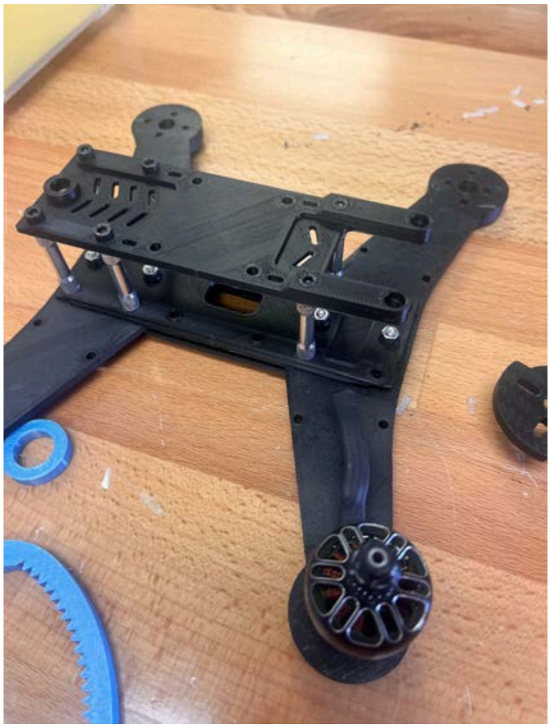
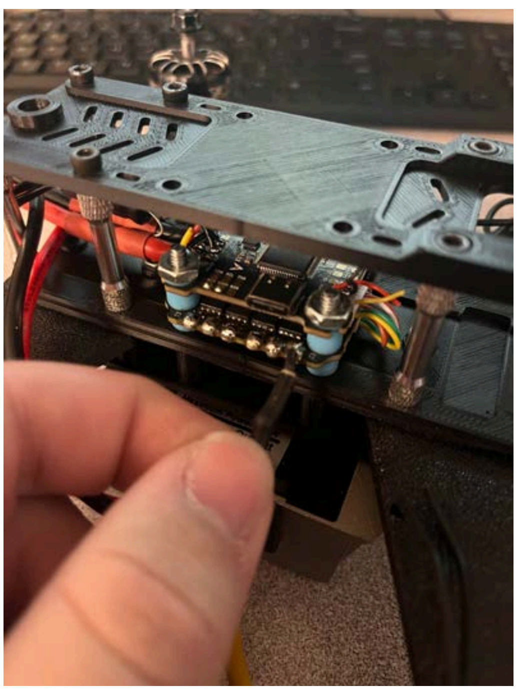
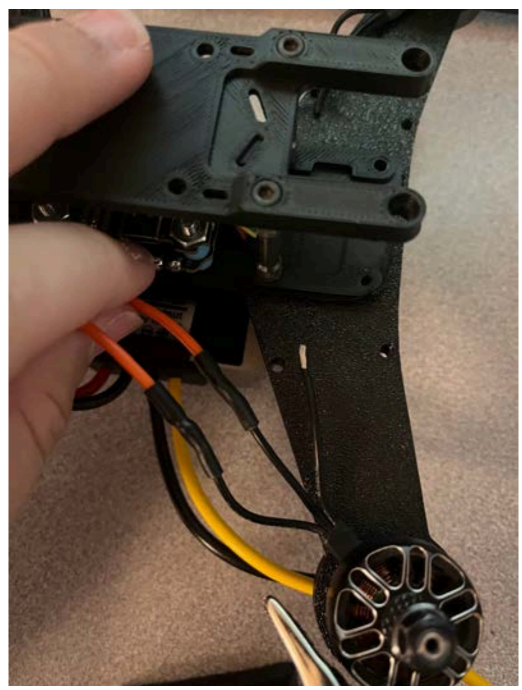
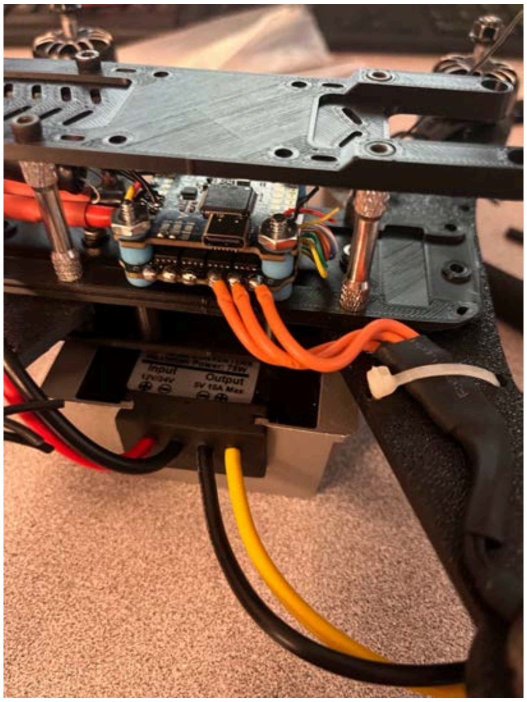
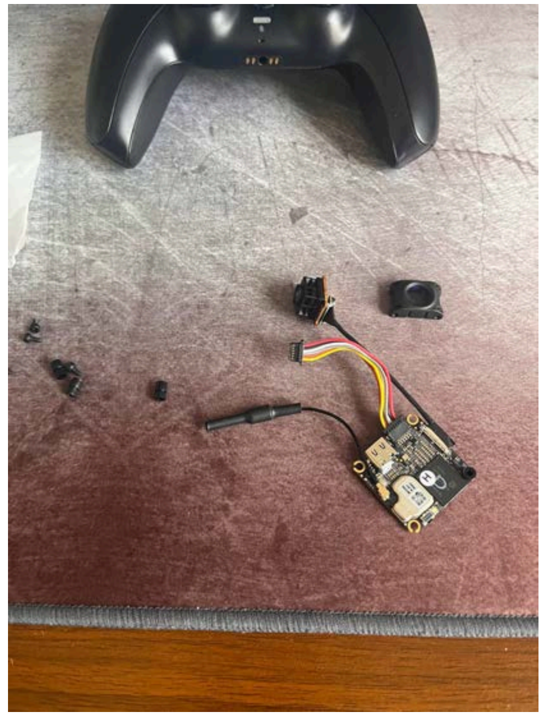
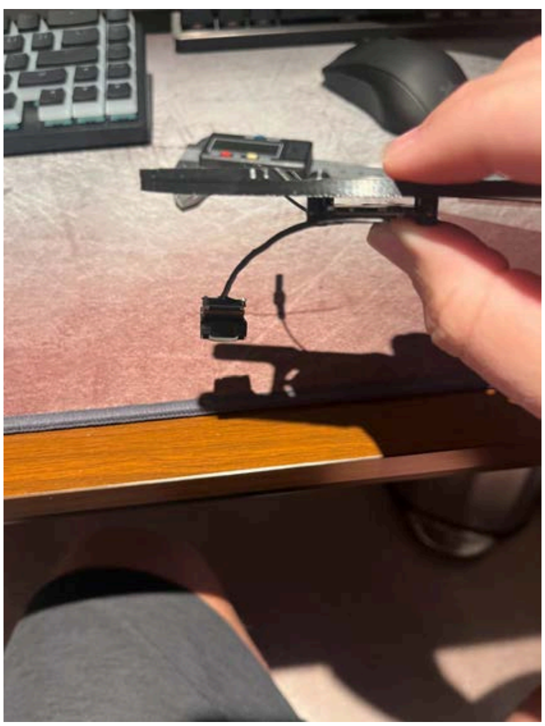
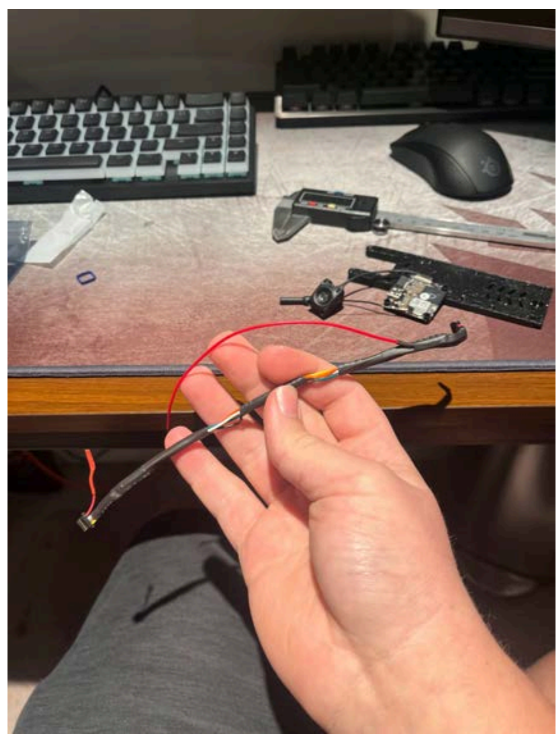
	
Began to attach motors from the old frame to the newly printed frame	The new buck converter was installed to handle the currents from the servos.
	
The flight computer was attached to the frame as well as the electronic speed control	Began to fix up the motor wires to be soldered to the flight computer. Did this for all motors

	
Started the soldering process, soldering the motor wires to the flight computer	DJI 04 air unit piece that is just a camera and transmitter
	
Seeing how the air unit would be able to attached to the top plate of the drone	Extended wires for the air unit

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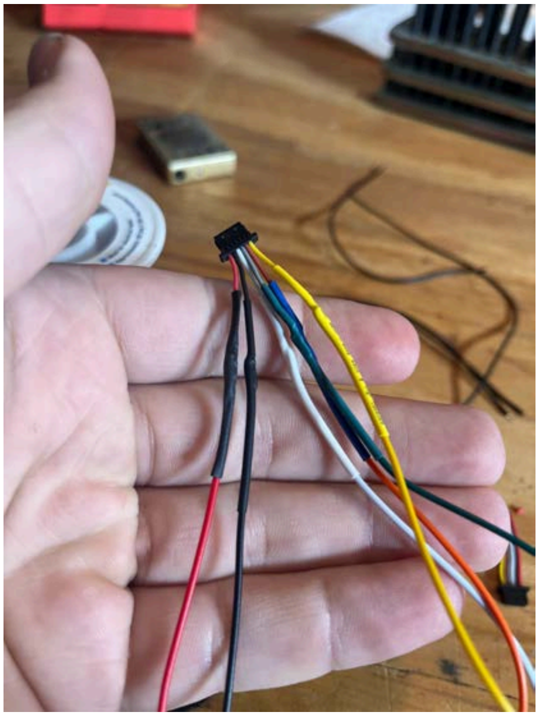
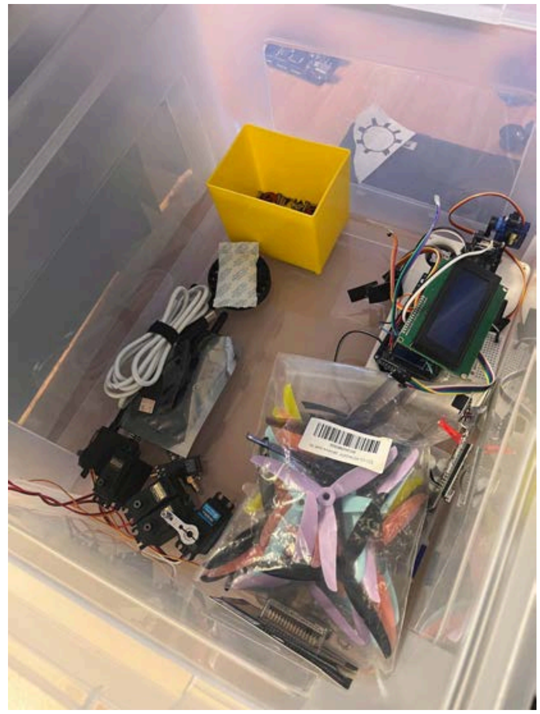
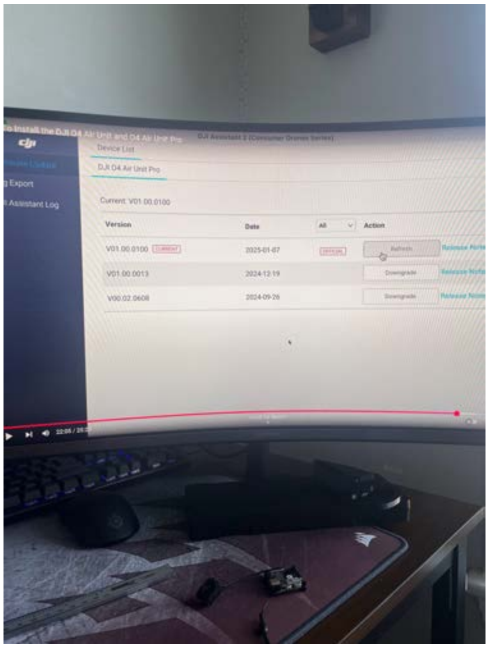
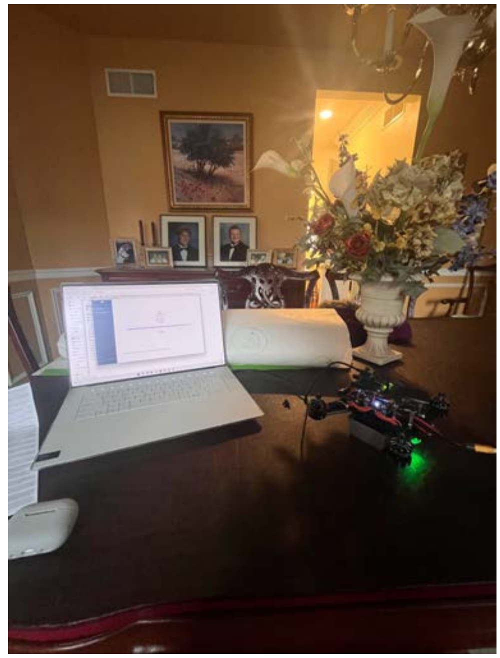
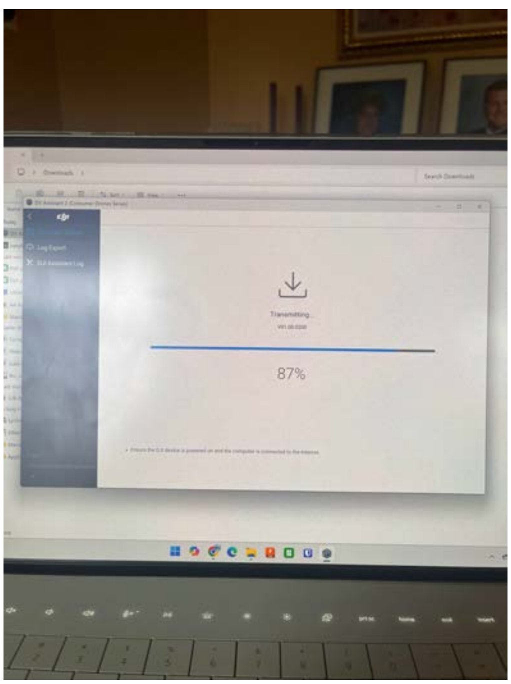
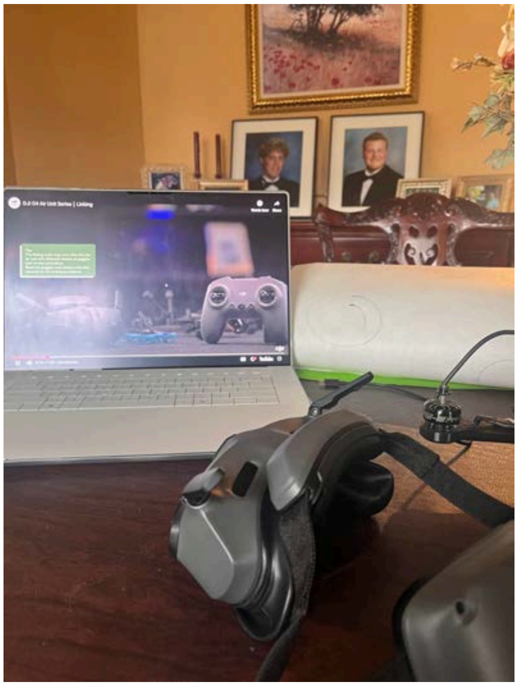
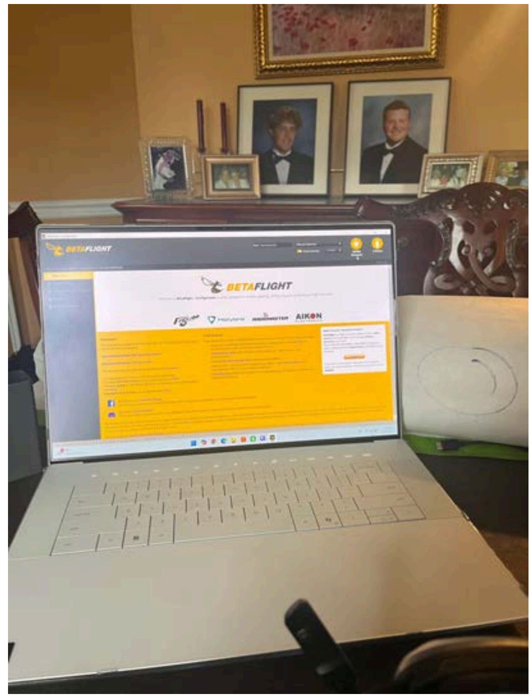
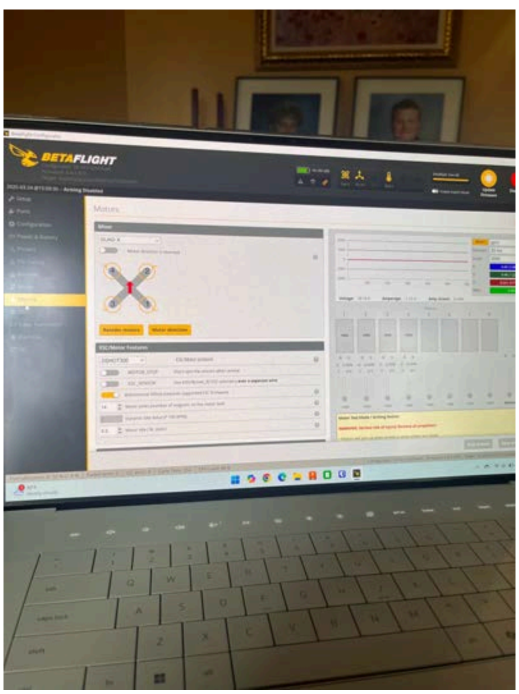
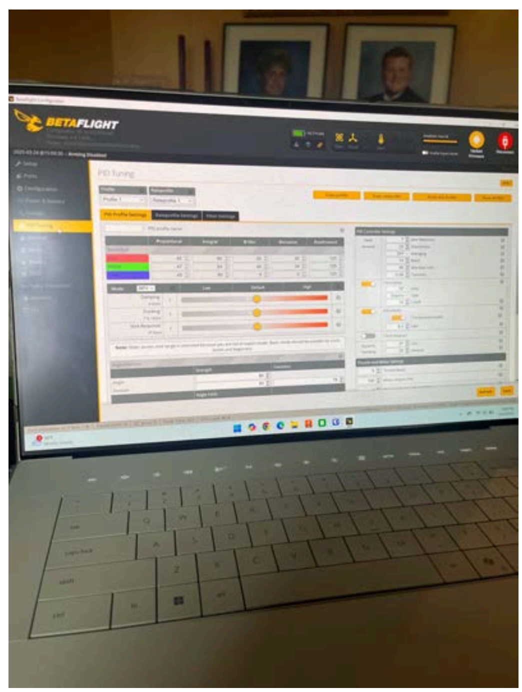
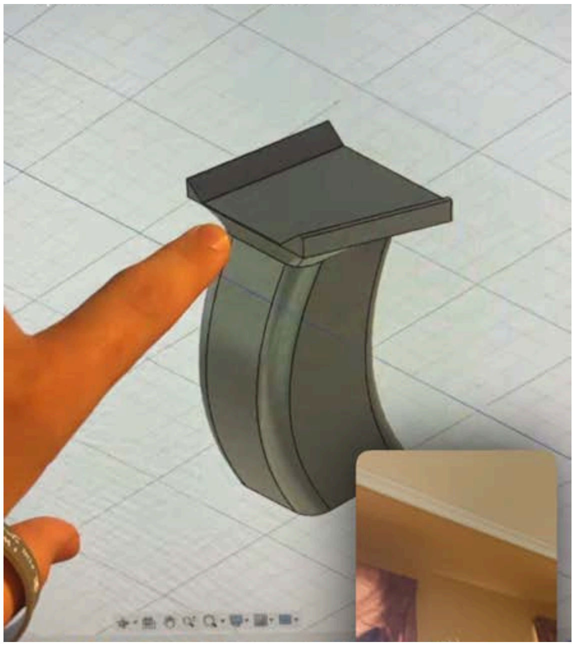
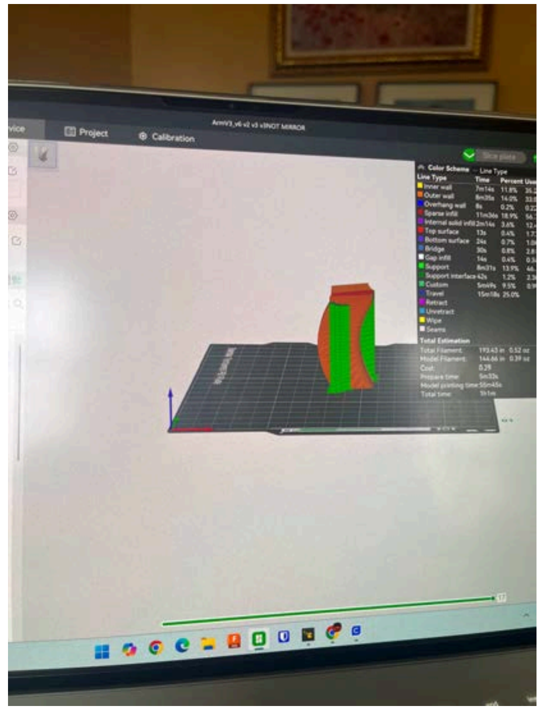
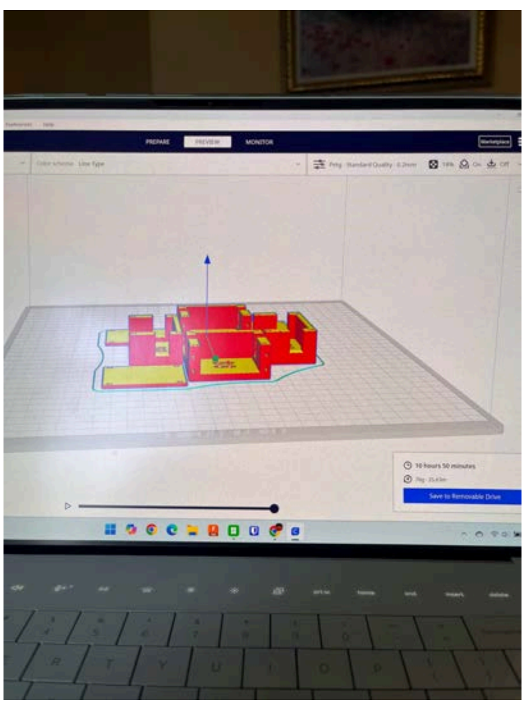
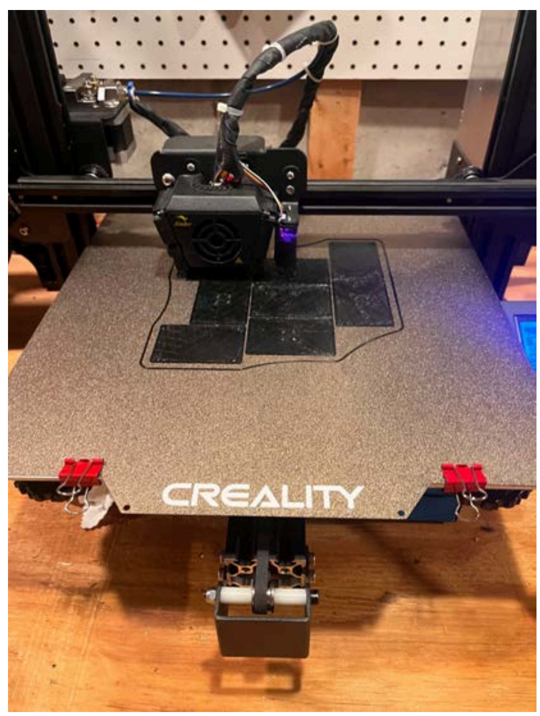
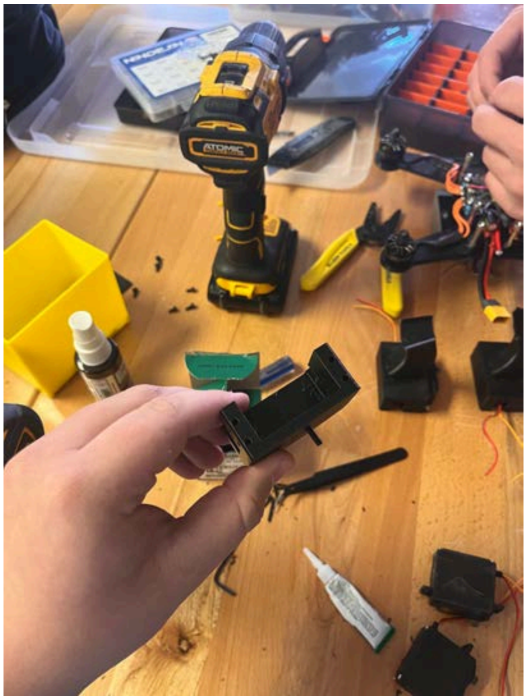
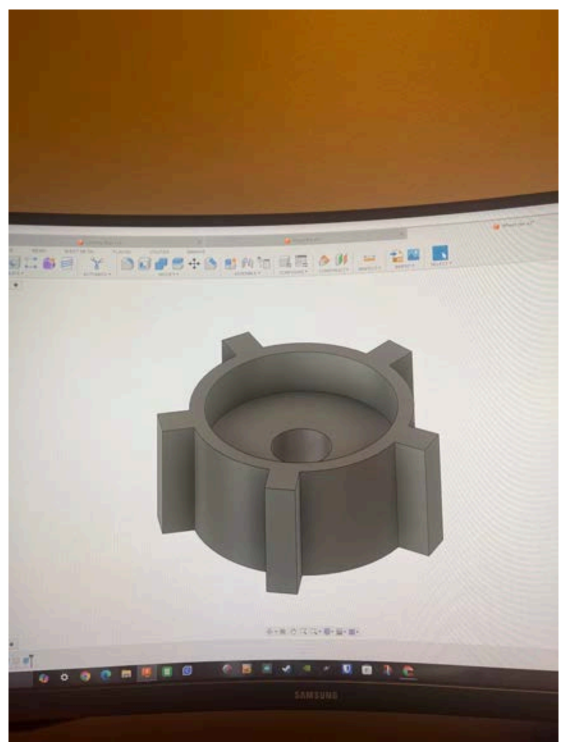
<tr><td></td><td></td></tr>
<tr><td>Extend the more of the wire that lead to the DJI 04 air unit</td><td>Organizing old drone material that we may be able to reuse</td></tr>
<tr><td></td><td></td></tr>
<tr><td>We soldered all of the motor wires onto the ESC and also soldered the 5v + wire on the flight computer to give the 04 air unit power</td><td>Another angle of the extension wire and all of the motor wires soldered in.</td></tr>
</table>

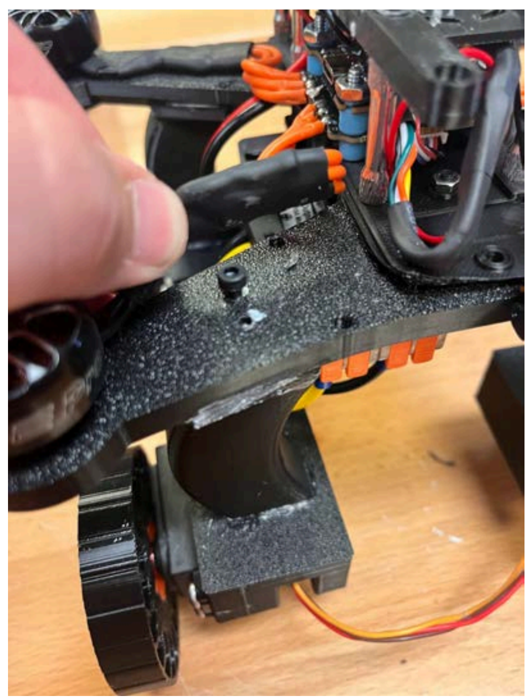
	
Watching and researching how to set up the DJI goggles	Setting up the DJI 04 air unit, this is the setup in the DJI assistant
	
After everything was set up in DJI Assistant, we updated the firmware on the air unit	Here, we had the air unit plugged into the computer to complete the update

	
Watching a YouTube video to understand how to pair the DJI goggles to the air unit	Starting up Betaflight to begin the programming of the drone
	
This is the motors tab, where we calibrate the direction each motor spins and where we can test each motor individually	This is the PID tuning tab where you can tune the throttle curve, the max tilt angle, and other drone tuning options.

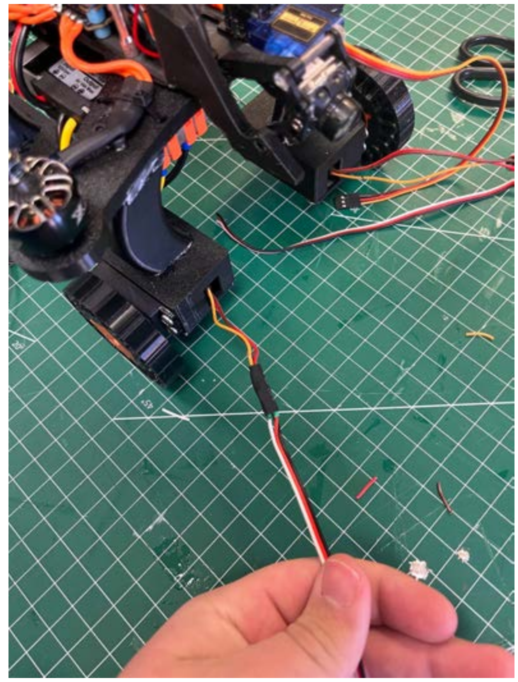
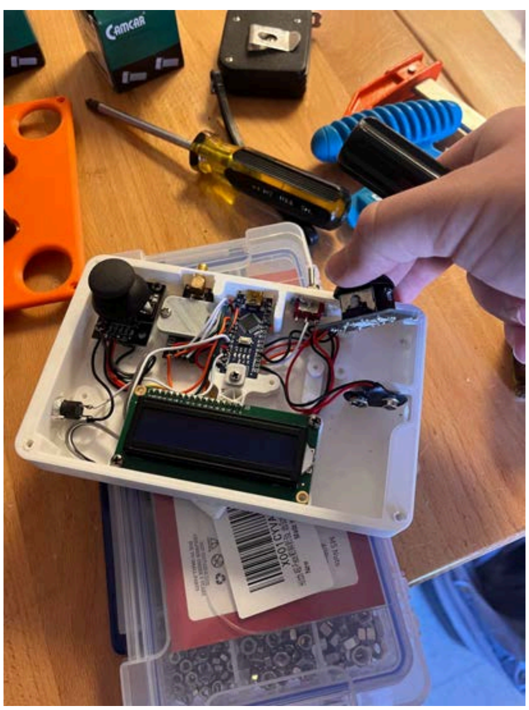
	
Next, we focused on the drone's legs/wheels. This is the 3D design of the legs of the drone	Slicing the 3D printing file and getting it ready to be printed
	
Designed the box/feet of the drone that would house the servos for the wheels	The housing of the servos is being printed

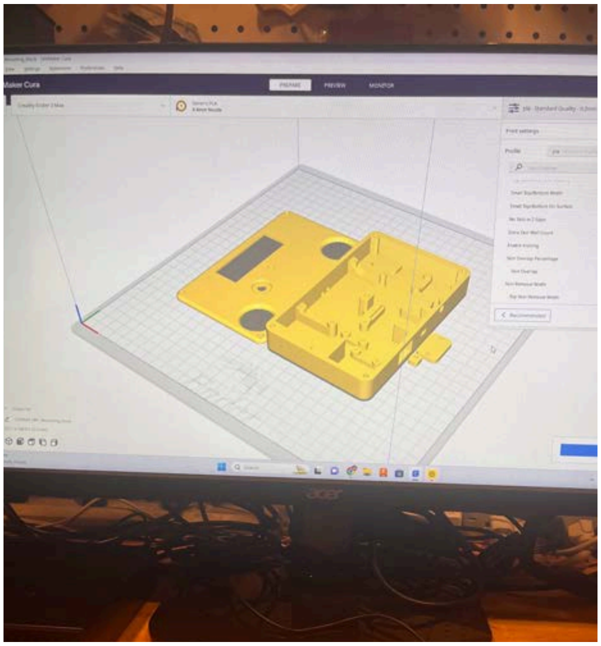
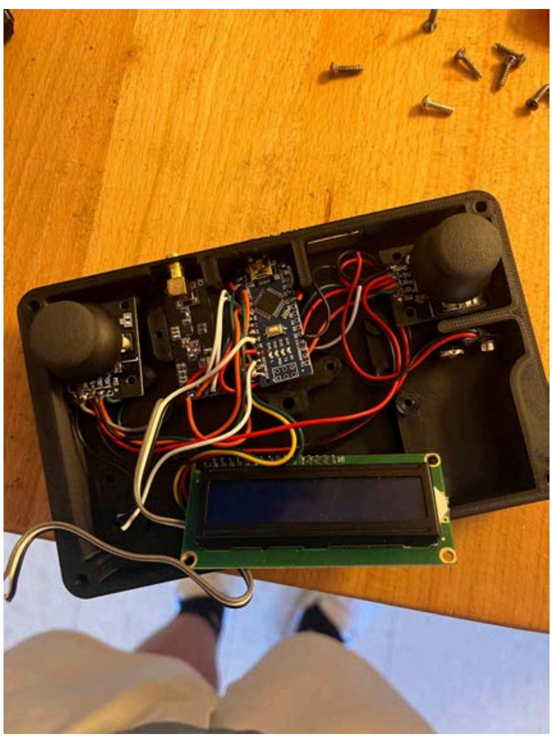
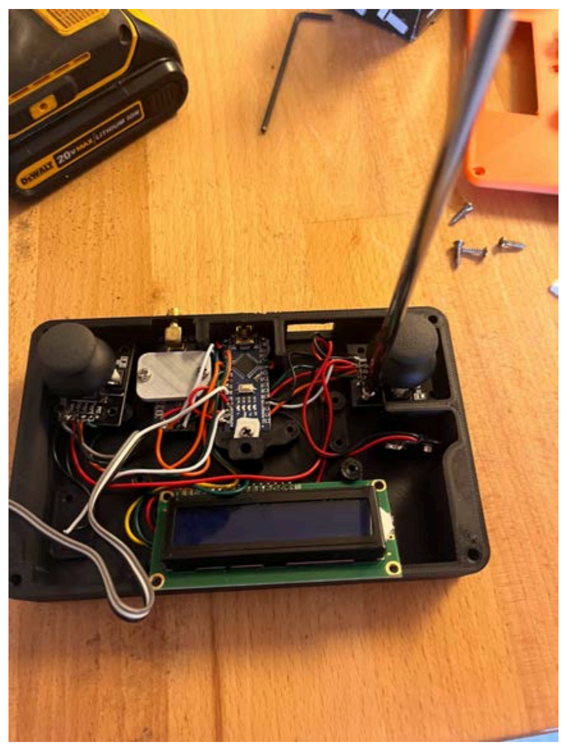
	
After all the pieces were printed, the construction of the legs began	Shows the servo sitting in the housing
	
All four legs of the drone are completed	Began to design the rims.

Designed the tire of the wheels, which fits around the rim	The tire is being printed using a specific filament called TPU to make it rubbery



Attached the tire to the rims. Then screwed the wheel into the servo	Made screw holes in the frame of the drone to be able to screw the legs into the frame

	
All four legs are attached to the body of the drone via screw	Extended the wires of the servos to connect them to the buck converter. Also, heat-struck the wires to organize
	
Began to disassemble the old controller for the wheel and claw servos	Unscrewing the joystick and the LCD screen, as well as the Arduino

	
Needed a new frame for the remote, so we reprinted the same file from last year	Everything was removed from the old frame
	
Transferred all the electronics to a new body, 3D printed from the same file as last year	Screwed down components` and fixed wiring

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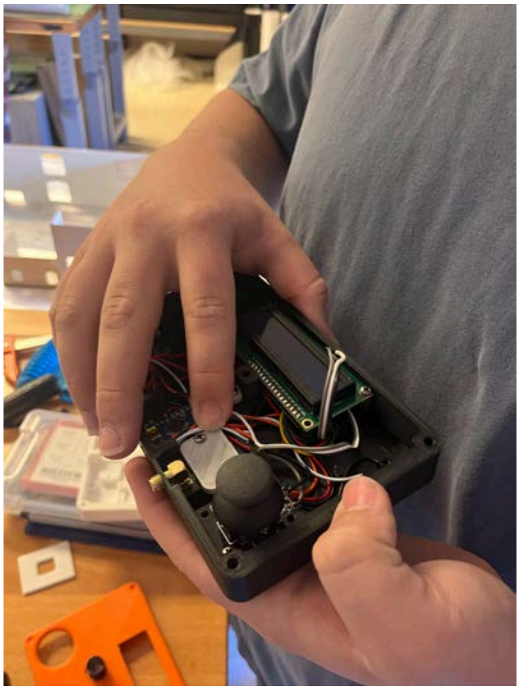
<td></td>
<td></td>
</tr>
<tr>
<td>Fitting the electronics in to make sure the lid would fit</td>
<td>Placed and screwed on the lid, making sure the joystick and potentiometers sat correct</td>
</tr>
<tr>
<td>
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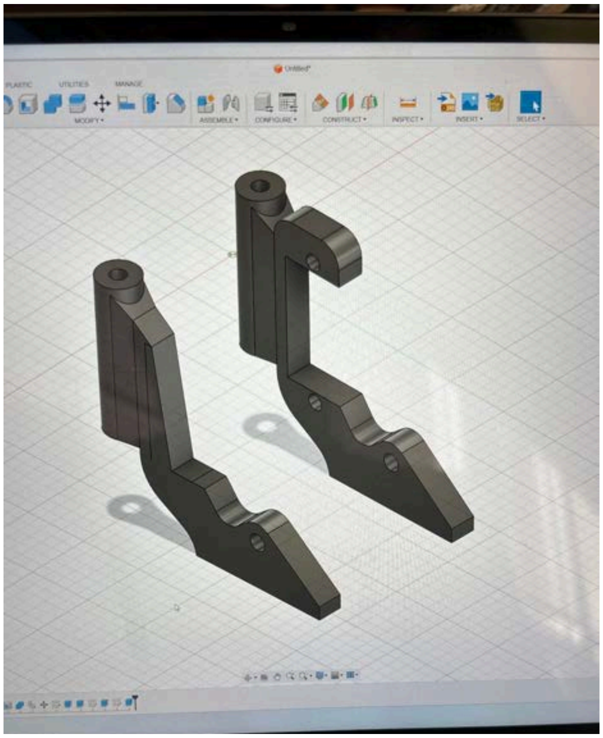
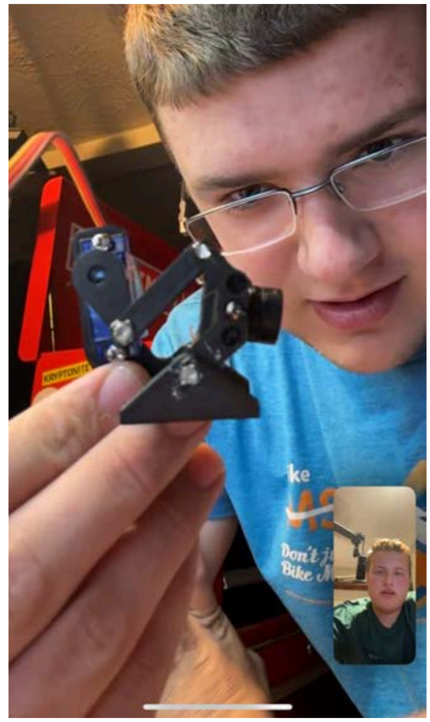
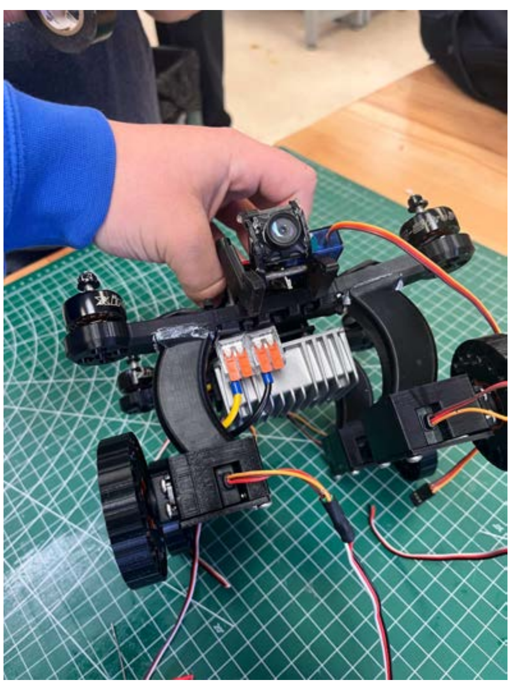
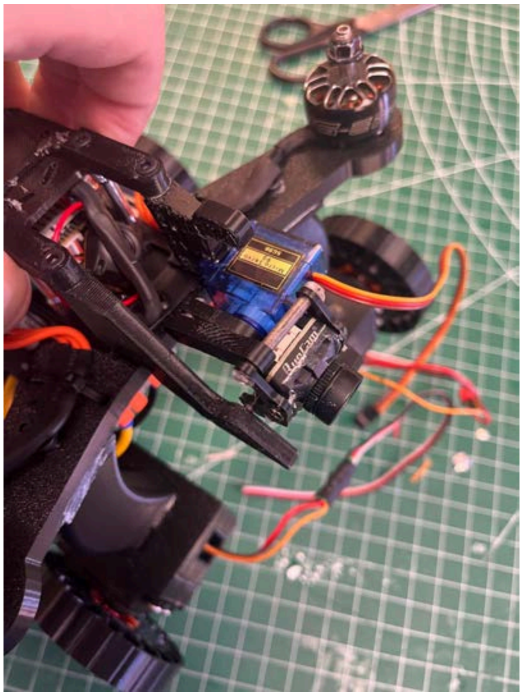
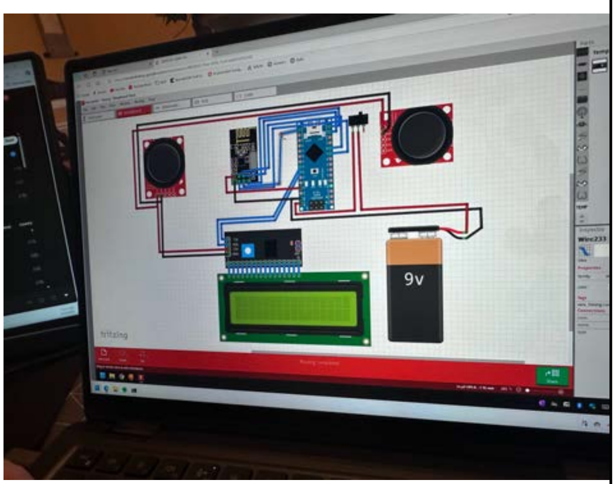
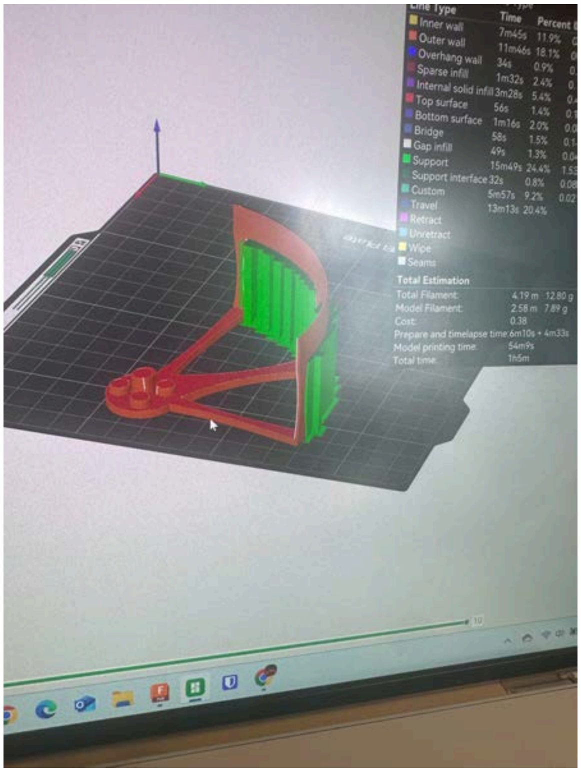
</tr>
<tr>
<td>Measuring the camera to be able to model it in Fusion</td>
<td>Another measurement of the camera’s length instead of its width</td>
</tr>
</table>

	
Design of the mount for the camera that would connect the camera to the drone	Working together on FaceTime to get the mount of the drone working, enabling the camera to move up and down
	
Attaching the camera mount to the frame of the drone	A picture showing how the camera can look straight down

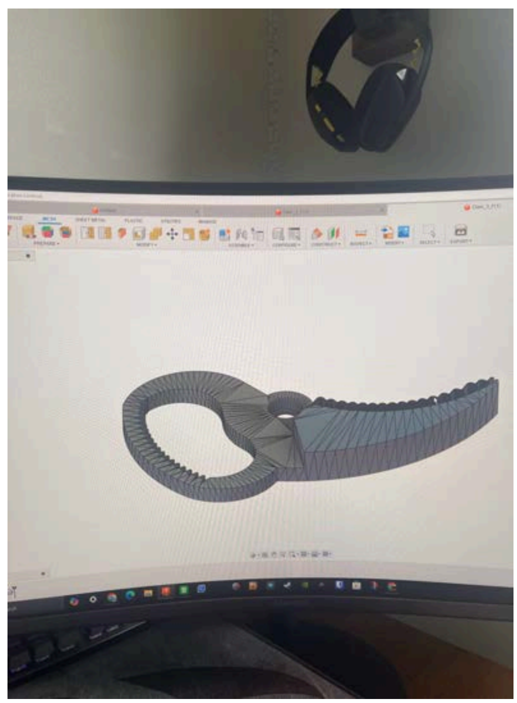
	
Mount can tilt to see anything in front and below	Plug in the drone to make sure that everything is working, and test the motors
	
Working on the wiring schematics and wiring diagrams	Began designing the prop guards for the drone in Fusion



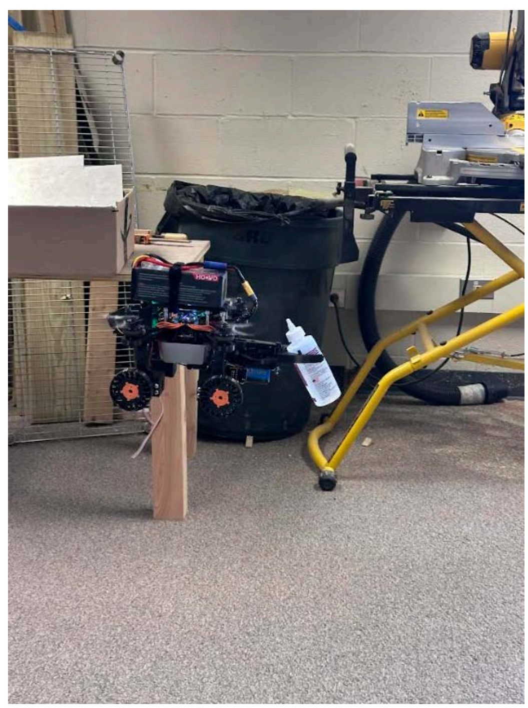
Slicing the design in Bambu Lab, getting it ready to print

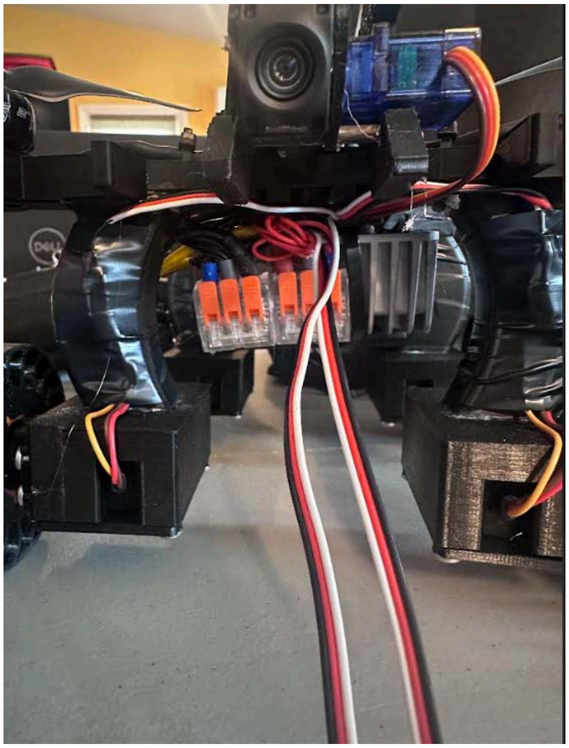
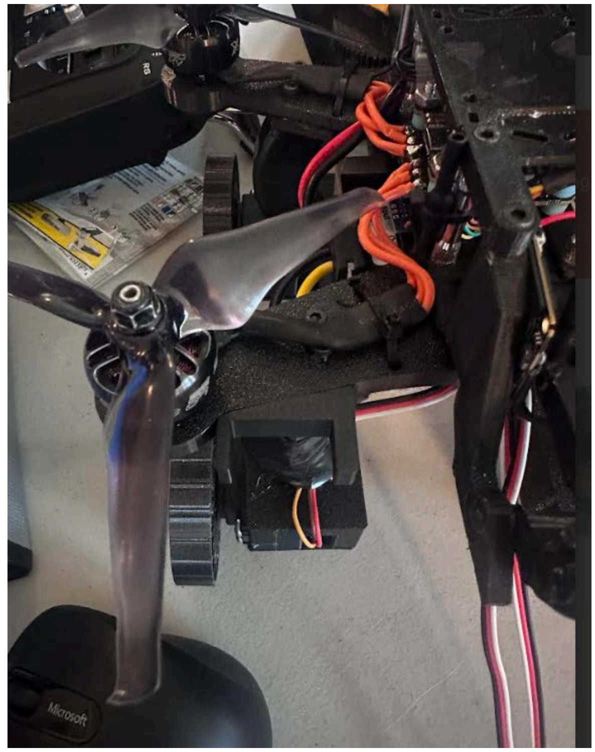
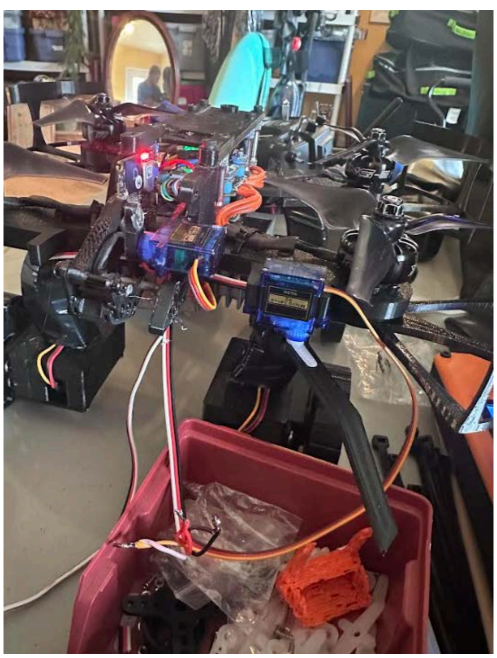
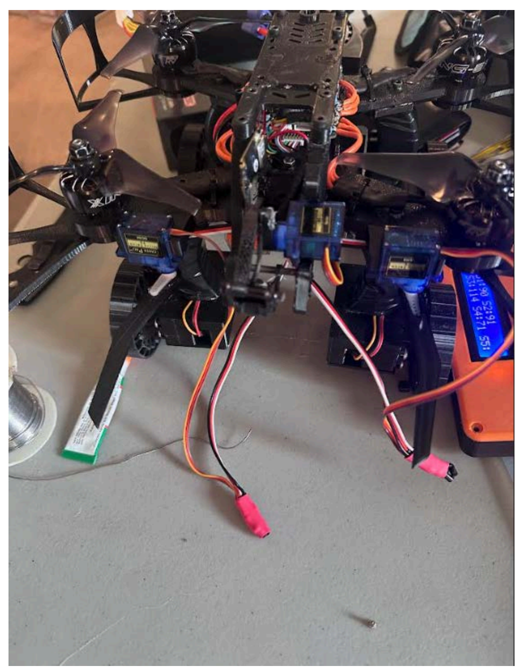
Prop guards printed

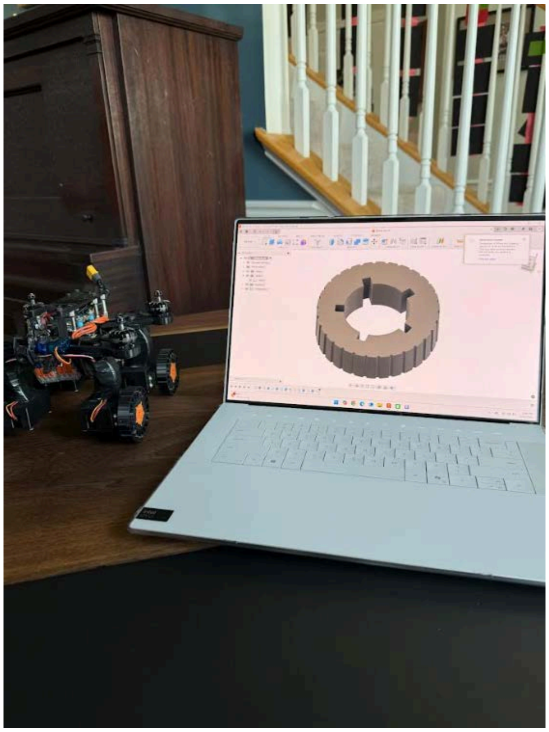
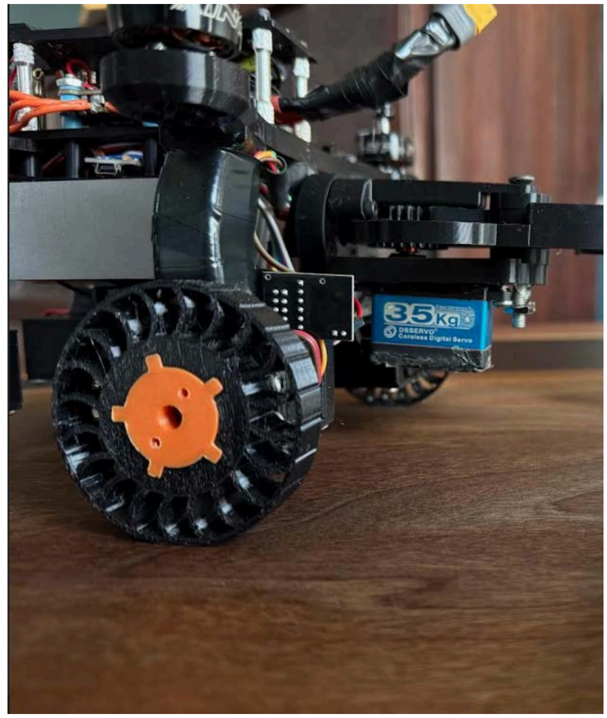
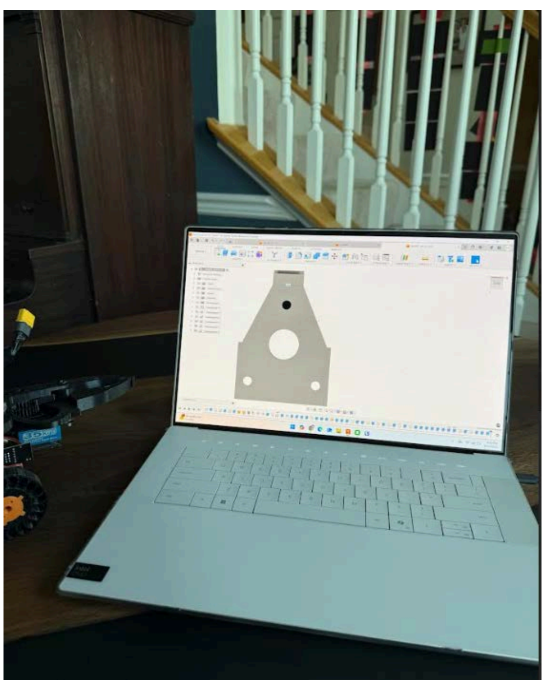
The prop guards attached to the drone



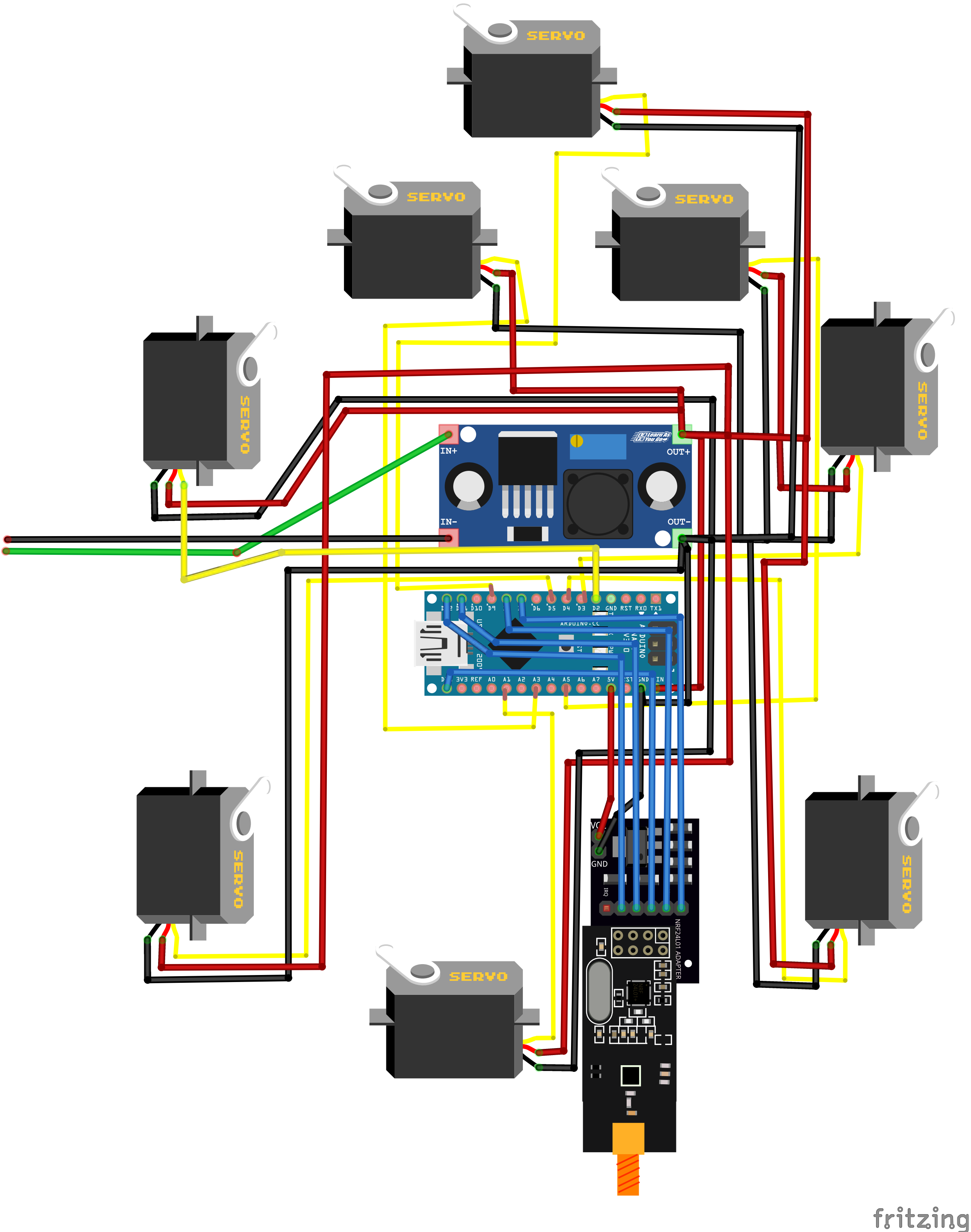
Began scaling the claw in fusion

	
Printing was a test to ensure the claw would fit in the frame like a drone. Had to scale down due to the claw being too wide	After some testing, the claw was printed and attached to the drone.
	
Another angle of the claw attached to the drone	Test flying the drone, trying to simulate the challenge at states.

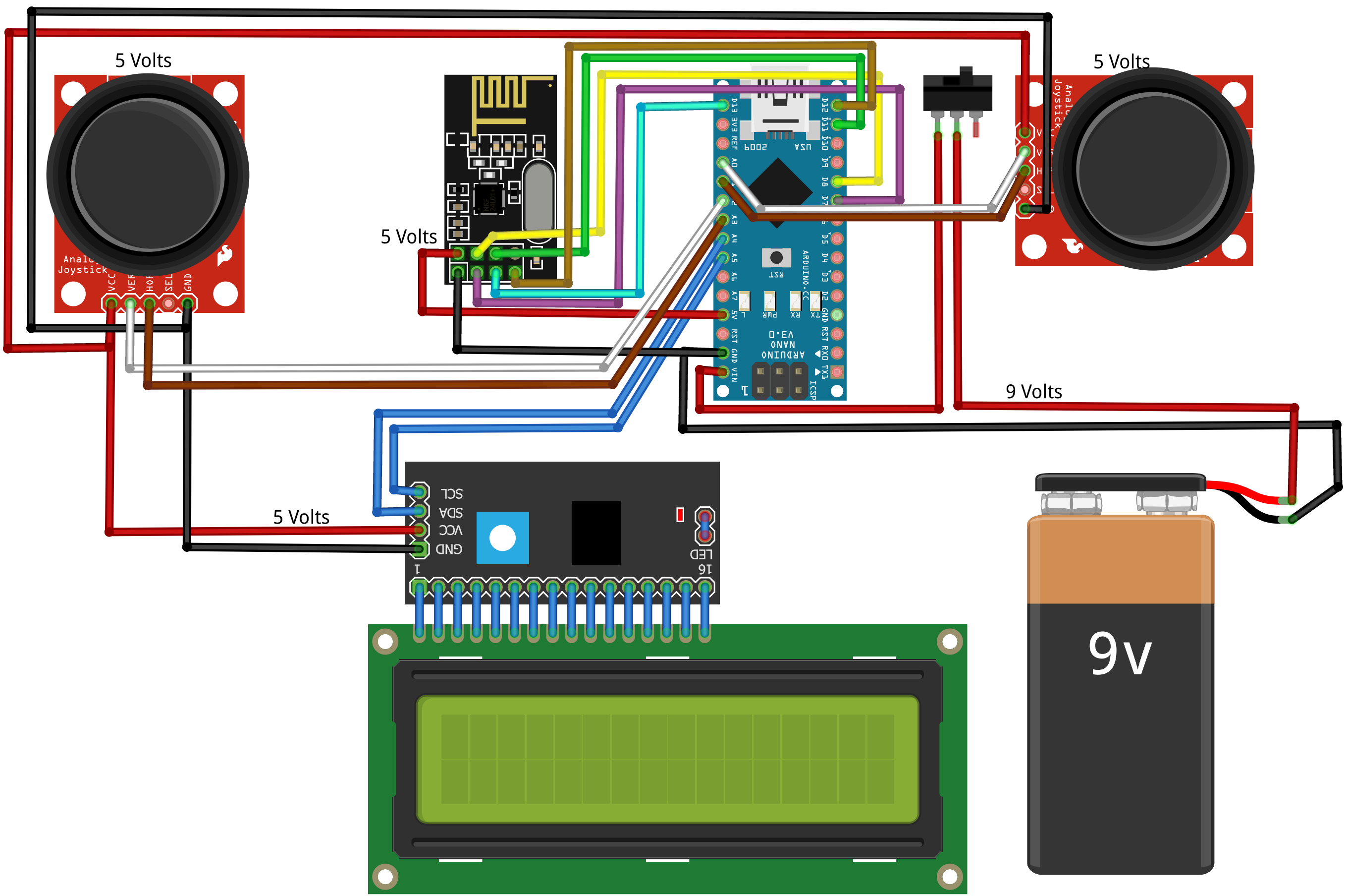
	
Began wiring for our secondary claw.	The mounts of the servos for the secondary drone are attached.
	
The servo is attached to the mount with the claw	Both of the servos for the back claw have been glued on, all the wires have been organized.

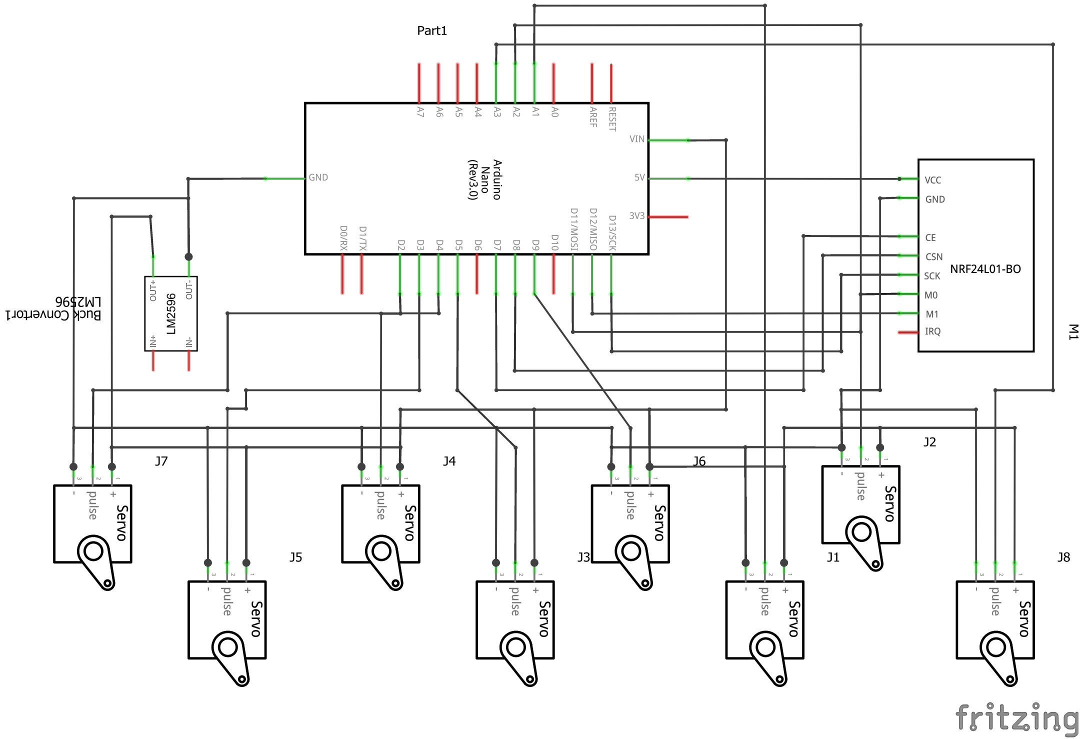
	
New wheels, same design, but smaller to decrease the height of the drone	New drone wheels can be taken off and replaced with old ones if needed.
	
Design of a new claw mount to lower the claw	Claw attached to new mount.

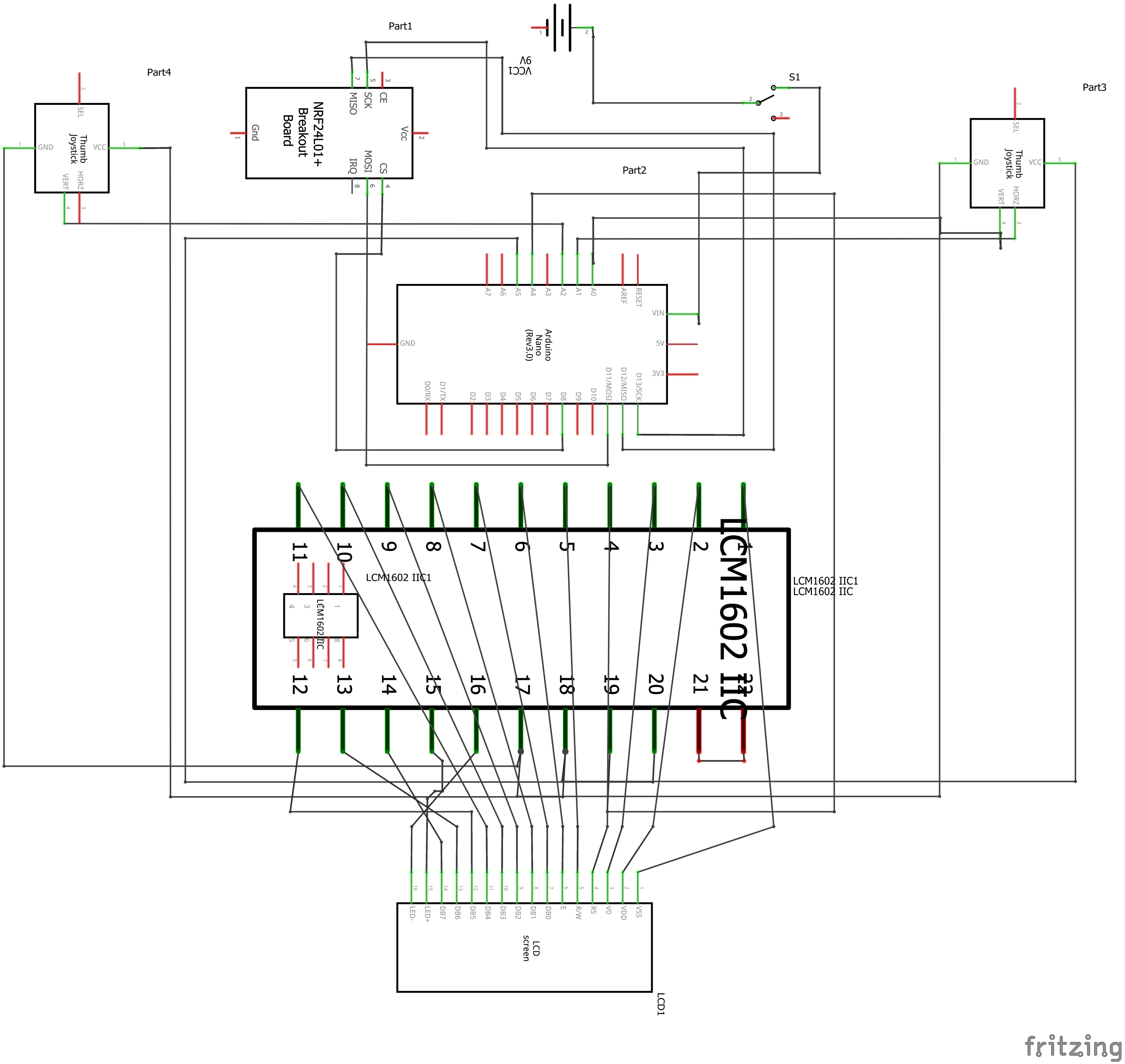
Servo Controller Diagram
All red wires are 5 volts, and the green is battery voltage



Secondary Controller Diagram Breadboard View




Part1
A7
A6
A5
A4
A3
A2
A1
A0
AREF
RESET
VIN
5V
3V3
GND
Arduino Nano (Rev3.0)
D0/RX
D1/TX
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11/MOSI
D12/MISO
D13/SCK
VCC
GND
CE
CSN
SCK
M0
M1
IRQ
NRF24L01-BO
M1
OUT+
OUT-
LM2596
IN+
IN-
Buck Convertor1
LM2596
J7
J4
J6
J2
J5
J3
J1
J8
Servo
pulse
fritzing


Part1
Part2
Part3
Part4
S1
VCC1
9V
NRF24L01+ Breakout Board
MISO
SCK
CE
Gnd
Vcc
MOSI
IRQ
CS
Thumb Joystick
GND
VCC
SEL
VERT
HORZ
Arduino Nano (Rev3.0)
A7
A6
A5
A4
A3
A2
A1
A0
AREF
RESET
VIN
5V
3V3
GND
D0/RX
D1/TX
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11/MOSI
D12/MISO
D13/SCK
LCM1602 IIC
LCM1602 IIC1
LCD screen
LCD1
LED-
LED+
DB7
DB6
DB5
DB4
DB3
DB2
DB1
DB0
E
R/W
RS
V0
VDD
VSS
fritzing

Explanation of Programming Software

Beta Flight

The leading software that we chose to use for our flight control software is BetaFlight. BetaFlight is a common and well-known open-source firmware for FPV or first-person view drones. Betaflight acts as the backbone or the brain of the drone for configuring and fine-tuning the flight and features. Betaflight controls every aspect of the flight. When a pilot maneuvers the drone input, commands are sent from the transmitter to the receiver, which is then processed by the flight computer. The flight computer uses these commands to calculate the motor outputs, and the pilot is assisted by complex sensors in the flight controller. This includes accelerometers and gyroscopes, which are sensors that help ensure the stability of the drone if the inputs from the pilot are not desired by the flight controller.

The PID controller within Betaflight finetunes the process by dynamically adjusting the three parameters: proportional, integral, and derivative gains. The proportional gain determines how aggressively the flight controller responds to errors between the desired and actual drone orientation. The integral gain accounts for accumulated errors over time, helping the drone maintain a constant level. Finally, the derivative gain anticipates changes in error rates, smoothing out the drone’s response to sudden movements or external disturbances like wind. Betaflight also contains feedforward control, which predicts motor outputs based on anticipated movement. Filtering algorithms within Betaflight help remove noise from sensor data or battery spikes to help ensure accurate feedback and precise control.

In addition, Betaflight has different flight modes to allow pilots to tune the drone's behavior. For instance in “Acro” mode, the drone responds directly to pilot inputs without any stabilization assistance, offering maximum agility and is only for experienced pilots, then there is “Angle” or “Horizon” mode which provides varying degrees of stabilization, making it easier for beginners to maintain control and level flight. The flight controller archives this with its onboard accelerometer and gyroscope to level the quad to a certain degree set in the Betaflight configurator. The difference between these two modes is quite minuscule. “Angle” limits the maximum angle of the drone to a specified limit, while “Horizon” only applies some stability to the quad when there is no controller input. To ensure that the quad is flying to the pilot's liking, a long and crucial configuration needs to take place. Before flight, pilots use Betaflight to configure various settings such as motor layout, motor spin direction, receiver configuration, flight modes, and more. Overall, Betaflight's intricate control algorithms, coupled with its customizable features and flight modes, allow the pilots to modify and control their drones to the best of their ability and even tune them to function for events like this TSA Challenge.

Other Software Used

There are also other IDEs or software used in this project. Although it had a small role, another software that was used was DJI Assistant, which allows a person to activate the 04 air unit and update the firmware to the latest version for the DJI 04 air unit, which sends the video feed to the goggles. While the drone flight and stability functions are off of Betaflight, the claw and wheel servos use an Arduino controlled by the Arduino IDE. Off the battery, we have a voltage step-down converter to change the roughly 16 volts from the 4s lipo to 5 volts so that it can power the Arduino and the servo motors. This Arduino nano on the drone receives a signal from the NRF transmitters that are sent from another NRF transmitter on the homemade controller in the second pilot's hand. This signal is then read by the Arduino on the drone and determines which servo it needs to send its PWM signal to. All this is done by coding in the Arduino IDE (Integrated Development Environment), a platform for programming Arduino microcontrollers. It provides a user-friendly interface for writing, compiling, and uploading code to Arduino boards. On the drone, there are a total of 5 servo motors, 4 of which are 360-degree servos for the wheels on the drone, and the other one is the claw. On the controller of the second pilot, there are 3 different potentiometers 2 of them controls the wheel direction and the other controls the position of the claw allowing the pilot to clamp down on the object, all of this is accomplished through the use of the Arduino IDE which is a foundational tool for electronic enthusiasts, hobbyists, and professionals, allowing them to code and program a wide range of microcontrollers to tailor them to specialized tasks like this TSA Challenge. Following this is the code that we used to transmit and receive the controls to the wheels. This code was self-made and written by us to help control the claw and wheels. The code allows us to send commands from the joysticks and potentiometers via an NRF to the Arduino. The NRF in the secondary controller will send the commands to the NRF on the drone connected to the Arduino. The Arduino will then take command and control the servos that are connected to the wheels and the claw.

Receiver Code

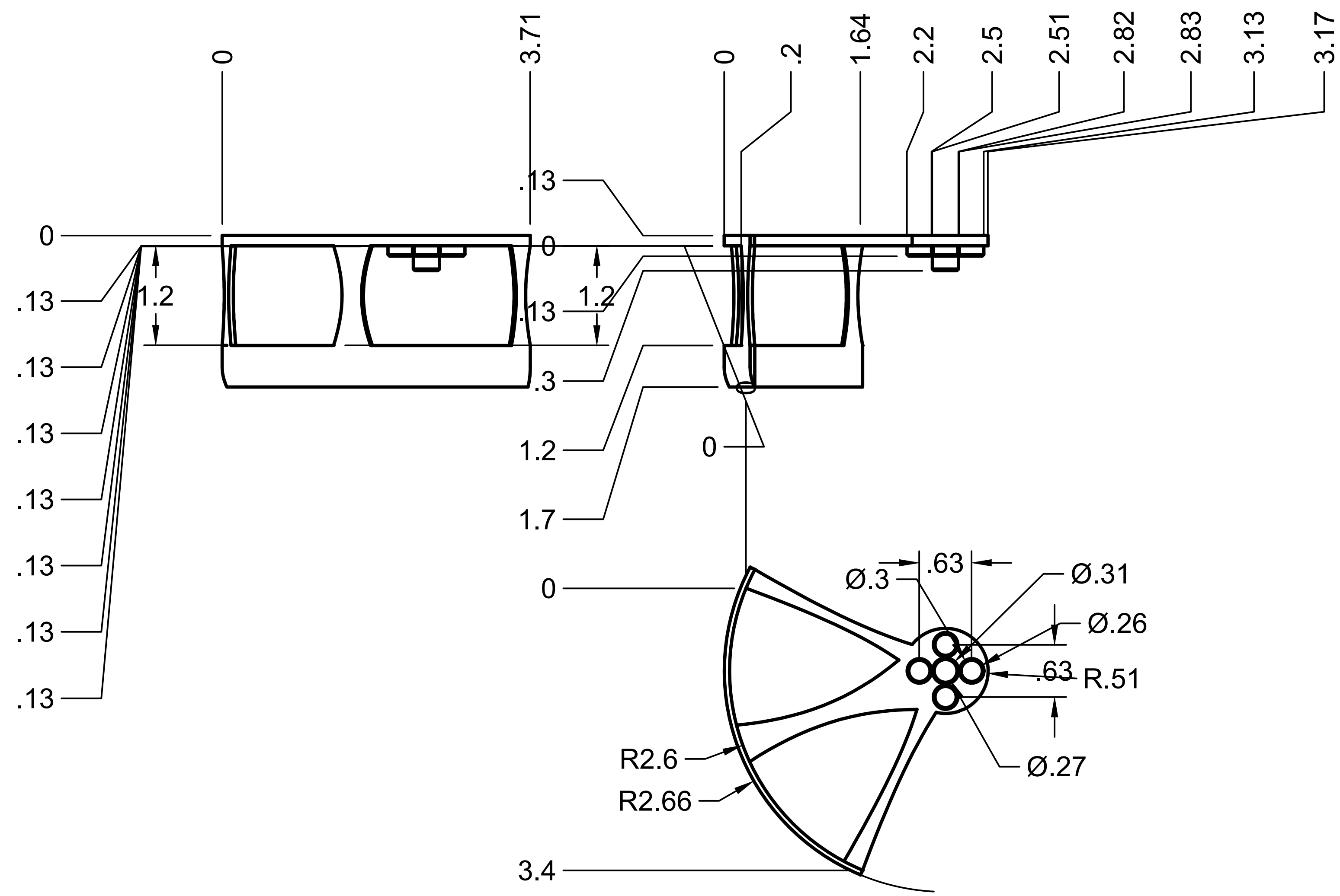
```
#include <SPI.h>
#include <RF24.h>
#include <Servo.h>

RF24 radio(7, 8);

const byte address[6] = "00001";

Servo servo1, servo2, servo3, servo4, servo5, servo6, servo7, servo8;

int pos1 = 0, pos2 = 0, pos3 = 0, pos4 = 0, pos5 = 0;

void setup() {
  Serial.begin(9600);

  radio.begin();
  radio.openReadingPipe(1, address);
  radio.setPALevel(RF24_PA_LOW);
  radio.startListening();

  servo1.attach(2);
  servo2.attach(4);
  servo3.attach(3);
  servo4.attach(5);
  servo5.attach(9);
  servo6.attach(A1);
  servo7.attach(A3);
  servo8.attach(A5);
}

void loop() {
  if (radio.available()) {
    int servoData[5];
    radio.read(&servoData, sizeof(servoData));

    pos1 = servoData[0];
    pos2 = servoData[1];
    pos3 = servoData[2];
    pos4 = servoData[3];
    pos5 = servoData[4];

    servo1.write(pos1);
    servo2.write(pos1);
    servo3.write(pos2);
    servo4.write(pos2);
    servo5.write(pos5);
    servo6.write(pos3);
    servo7.write(pos3);
    servo8.write(pos4);

    Serial.print("Received Positions: ");
    Serial.print(pos1);
    Serial.print(", ");
    Serial.print(pos2);
    Serial.print(", ");
    Serial.print(pos3);
    Serial.print(", ");
    Serial.println(pos4);
  }
}
```

Transmitter Code

```
#include <SPI.h>
#include <RF24.h>
#include <LiquidCrystal_I2C.h>

RF24 radio(7, 8);

const byte address[6] = "00001";

LiquidCrystal_I2C lcd(0x27, 16, 2);

int pos1 = 90, pos2 = 90, pos3 = 90, pos4 = 90, pos5 = 90;
int i = 0;
int j = 0;
int randomnum;
int z = 0;
int k = 0;
int array1[] = { 5, 5, 3, 4, 1,
                 2, 5, 5, 5, 5,
                 3, 4, 1, 2, 5,
                 5, 5, 5, 3, 4,
                 1, 2, 5, 5, 5,
                 5, 3, 4, 1, 2,
                 5, 5 };
int array2[] = { 3, 4, 0, 0, 0,
                 0, 1, 2, 3, 4,
                 0, 0, 0, 0, 1,
                 2, 3, 4, 0, 0,
                 0, 0, 1, 2, 3,
                 4, 0, 0, 0, 0,
                 1, 2 };
byte customChar1[] = {
  0x1B,
  0x1B,
  0x1B,
  0x1B,
  0x1B,
  0x1B,
  0x1B,
  0x1B
};

byte customChar2[] = {
  0x18,
  0x18,
  0x1B,
  0x1B,
  0x1B,
  0x1B,
  0x1B,
  0x1B
};
byte customChar3[] = {
  0x00,
  0x00,
  0x00,
  0x00,
  0x18,
  0x18,
  0x1B,
  0x1B
};

byte customChar4[] = {
  0x00,
  0x00,
  0x00,
```

```
  0x00,
  0x03,
  0x03,
  0x1B,
  0x1B
};

byte customChar5[] = {
  0x03,
  0x03,
  0x1B,
  0x1B,
  0x1B,
  0x1B,
  0x1B,
  0x1B
};

byte customChar6[] = {
  0x00,
  0x00,
  0x00,
  0x00,
  0x00,
  0x00,
  0x00,
  0x00
};

void setup() {
  Serial.begin(9600);

  radio.begin();
  radio.openWritingPipe(address);
  radio.setPALevel(RF24_PA_LOW);

  lcd.init();
  lcd.backlight();
  lcd.createChar(0, customChar1);
  lcd.createChar(1, customChar2);
  lcd.createChar(2, customChar3);
  lcd.createChar(3, customChar4);
  lcd.createChar(4, customChar5);
  lcd.createChar(5, customChar6);
  lcd.clear();
  for (int g = 0; g < 3; g++) {
    for (z = 7; z >= 0; z--) {
      i = z;
      for (k = 0; k < 16; k++) {
        lcd.setCursor(k, 0);
        lcd.write(array1[i]);
        lcd.setCursor(k, 1);
        lcd.write(array2[i]);
        i++;
      }
      delay(200);
      lcd.clear();
    }
  }
  lcd.clear();
  delay(2000);
}

void loop() {
  pos1 = map(analogRead(A2), 0, 1023, 0, 180);
  pos2 = map(analogRead(A1), 0, 1023, 180, 0);
```

```
  pos3 = map(analogRead(A7), 0, 1023, 180, 0);
  pos4 = map(analogRead(A6), 0, 1023, 180, 0);
  pos5 = map(analogRead(A0), 0, 1023, 180, 0);

  int servoData[5] = { pos1, pos2, pos3, pos4, pos5 };
  radio.write(&servoData, sizeof(servoData));

  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("S1:");
  lcd.print(pos1);
  lcd.print(" S2:");
  lcd.print(pos2);

  lcd.setCursor(0, 1);
  lcd.print("S3:");
  lcd.print(pos3);
  lcd.print(" S4:");
  lcd.print(pos4);
  lcd.print(" S5:");
  lcd.print(pos5);

  Serial.print("Sending: ");
  Serial.print(pos1);
  Serial.print(", ");
  Serial.print(pos2);
  Serial.print(", ");
  Serial.print(pos3);
  Serial.print(", ");
  Serial.print(pos4);
  Serial.print(", ");
  Serial.println(pos5);

  delay(200);
}
```



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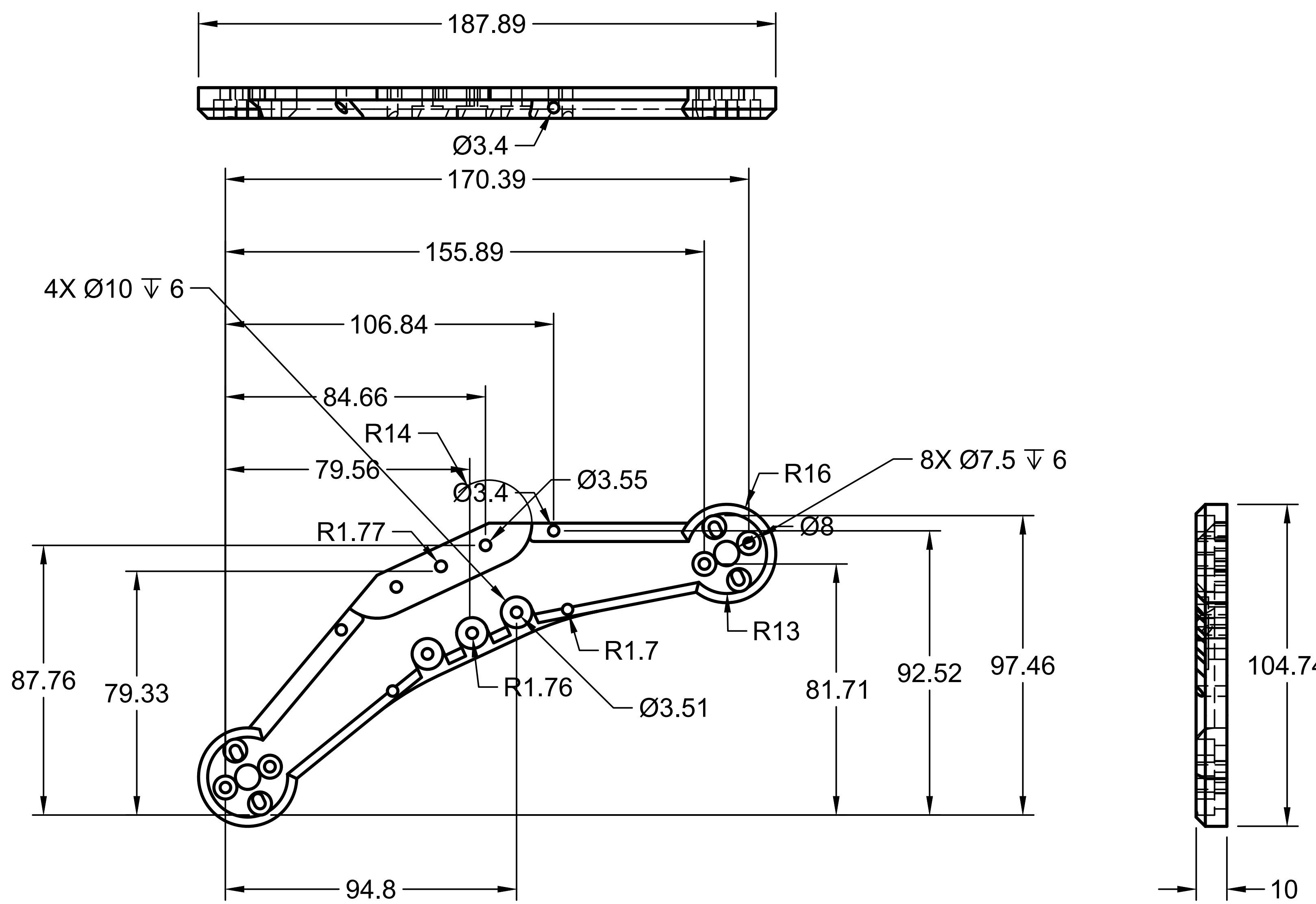
	TITLE Prop Guard			
APPROVED	SIZE B	CODE	DWG NO	REV
CHECKED				
DRAWN Luke Boland 4/22/2025	SCALE 1:2	WEIGHT	SHEET 2/5	



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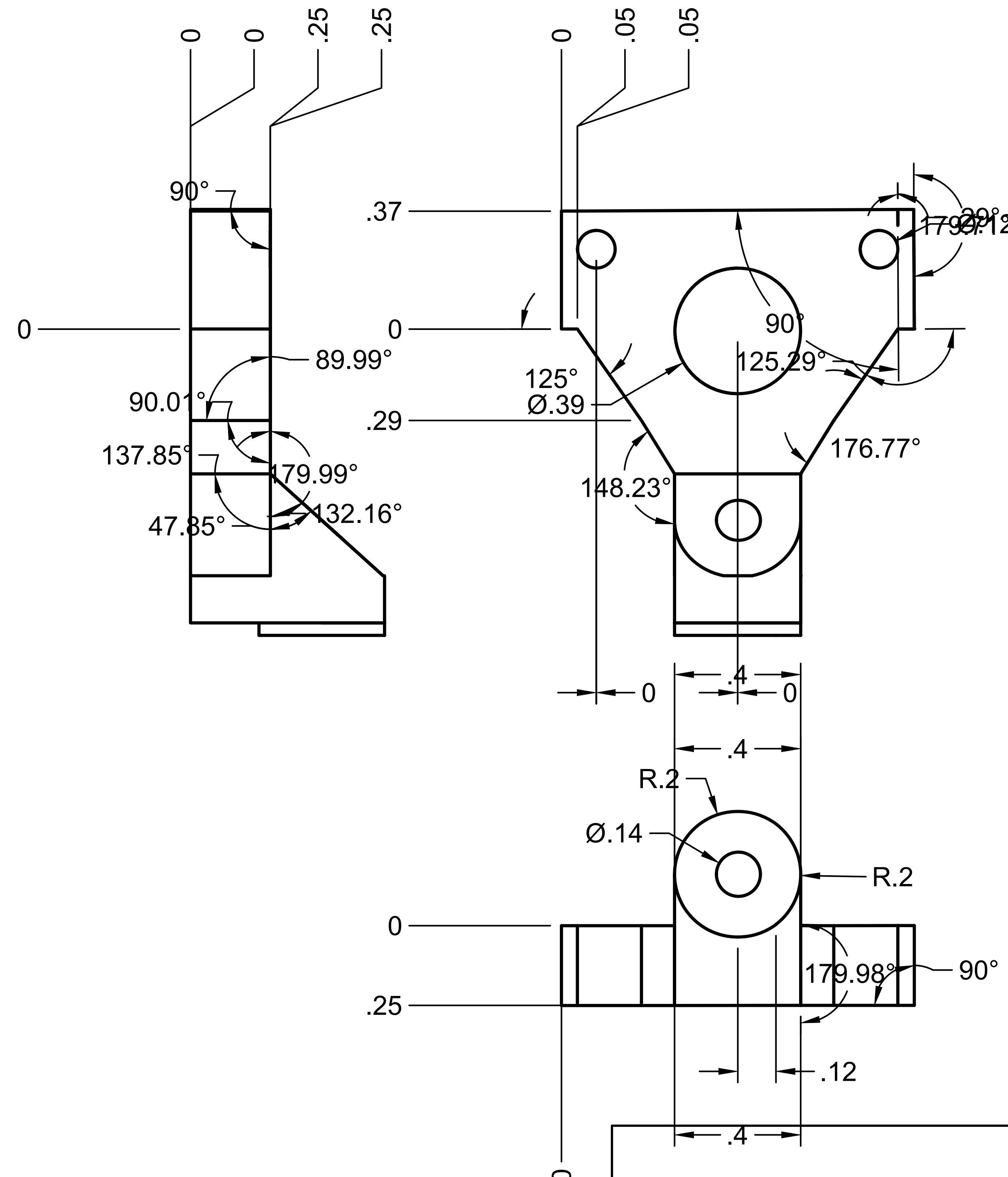
	TITLE ArmV3_v6
APPROVED	SIZE B	CODE	DWG NO	REV
CHECKED	
DRAWN William Arnholt 4/16/2025	SCALE 1:2	WEIGHT	SHEET 1/1



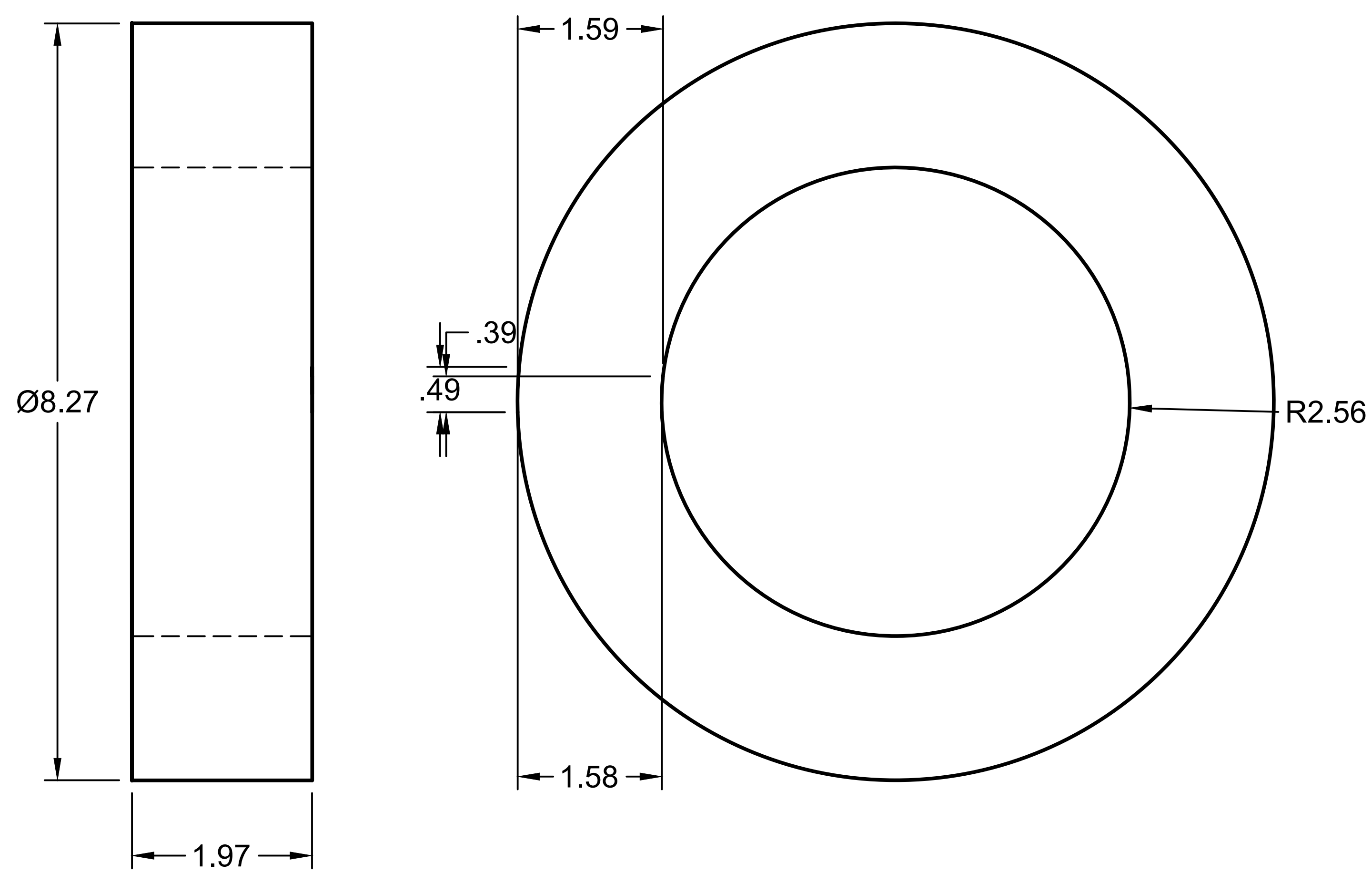
PROJECT

TSA

TITLE

Claw mount bracket

APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	B			
DRAWN Luke Boland 4/22/2025	SCALE 2:1	WEIGHT	SHEET 1/5	



PROJECT
TSA

TITLE
BearingFix_2x

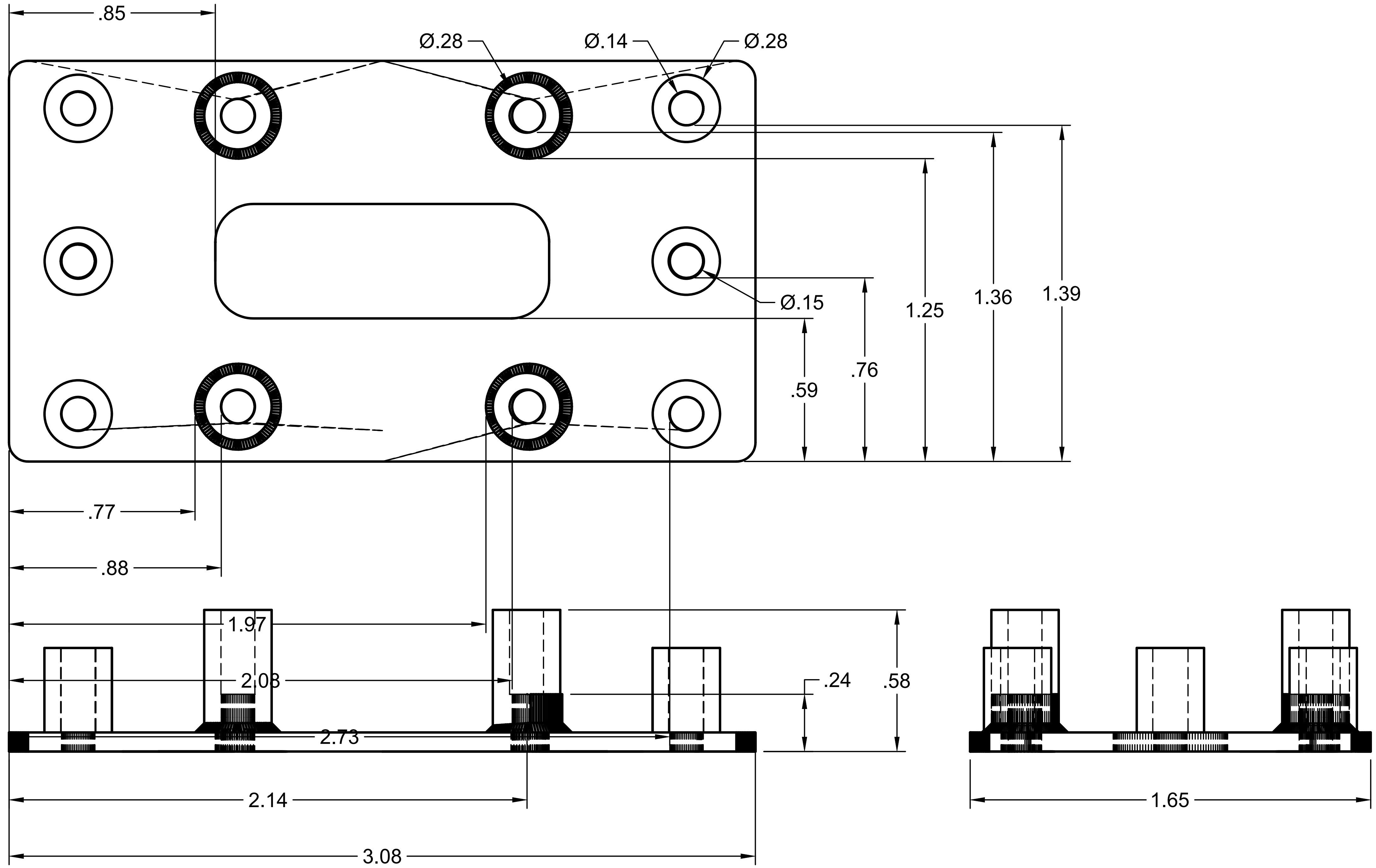
APPROVED

CHECKED

DRAWN Luke Boland 4/22/2025

SIZE B | CODE | DWG NO | REV

SCALE 1:2 | WEIGHT | SHEET 1/1



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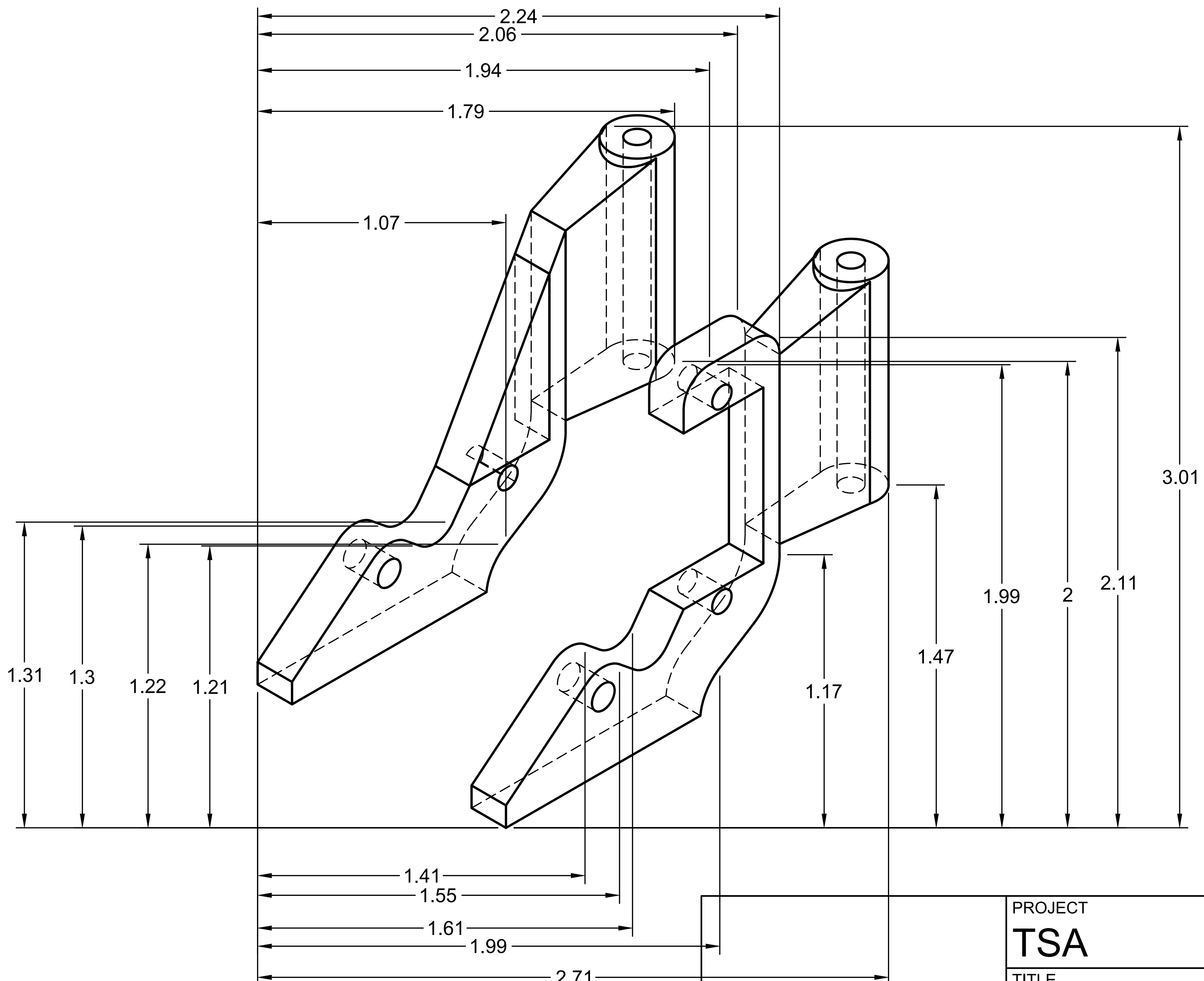
APPROVED	SIZE	CODE	DWG NO		REV
CHECKED	B				
DRAWN William Arnholt 4/16/2025	SCALE 2:1		WEIGHT	SHEET 1/1	



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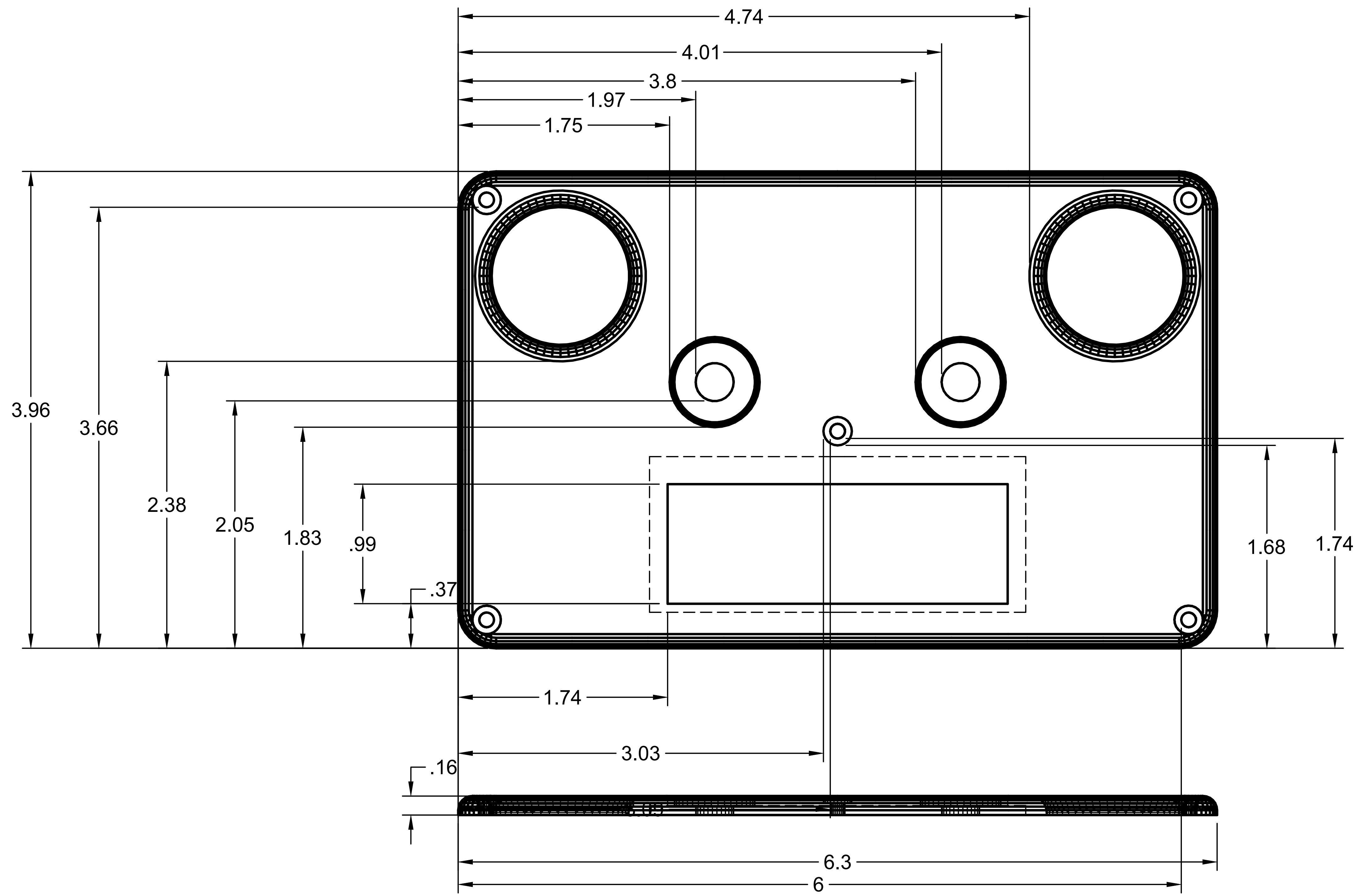
	TITLE Camera Mounts			
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	B			
DRAWN William Arnholt 4/16/2025	SCALE 2:1	WEIGHT	SHEET 1/1	



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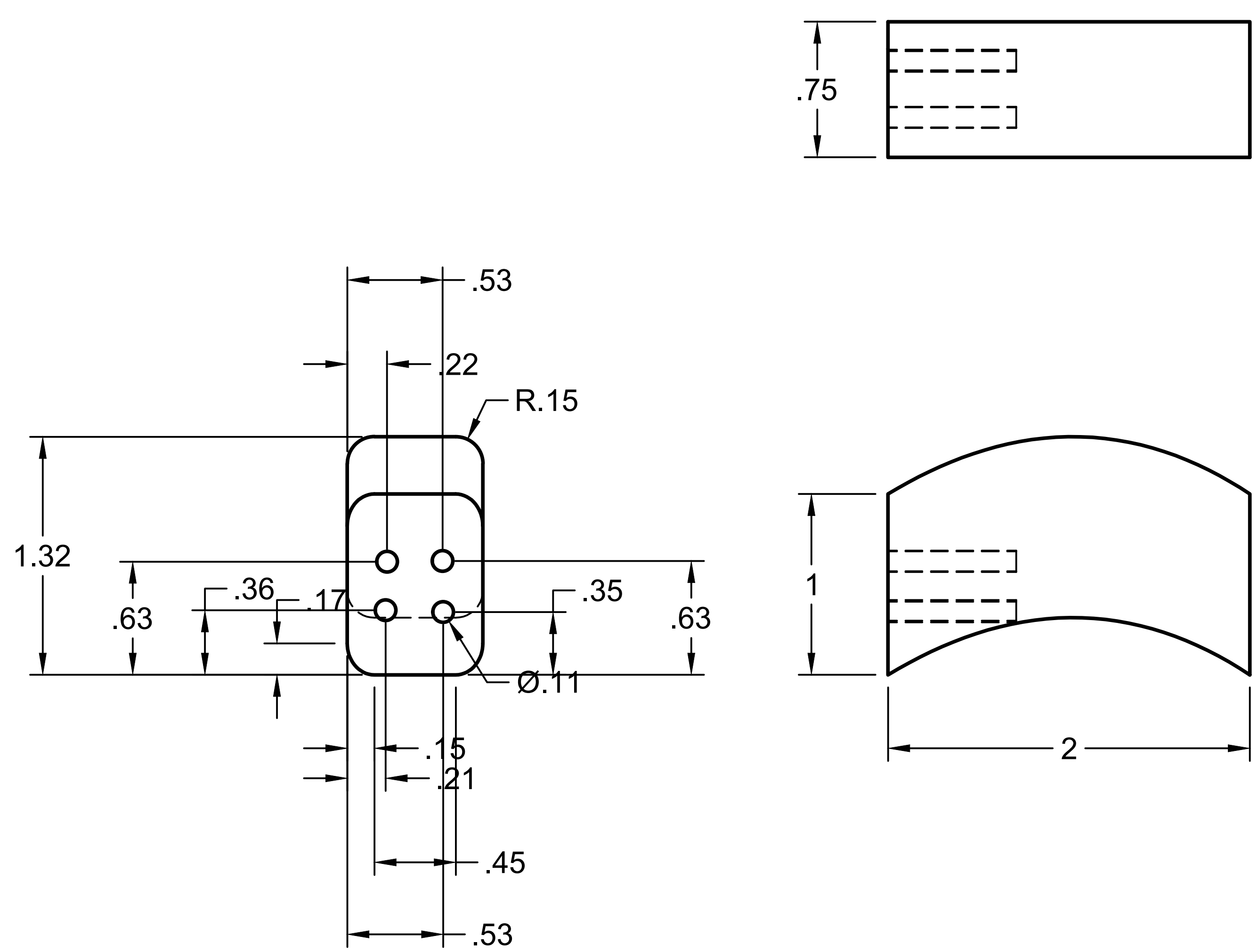
	TITLE Cover			
APPROVED	SIZE B	CODE	DWG NO	REV
CHECKED				
DRAWN William Arnholt 4/16/2025	SCALE 1:1		WEIGHT	SHEET 1/1



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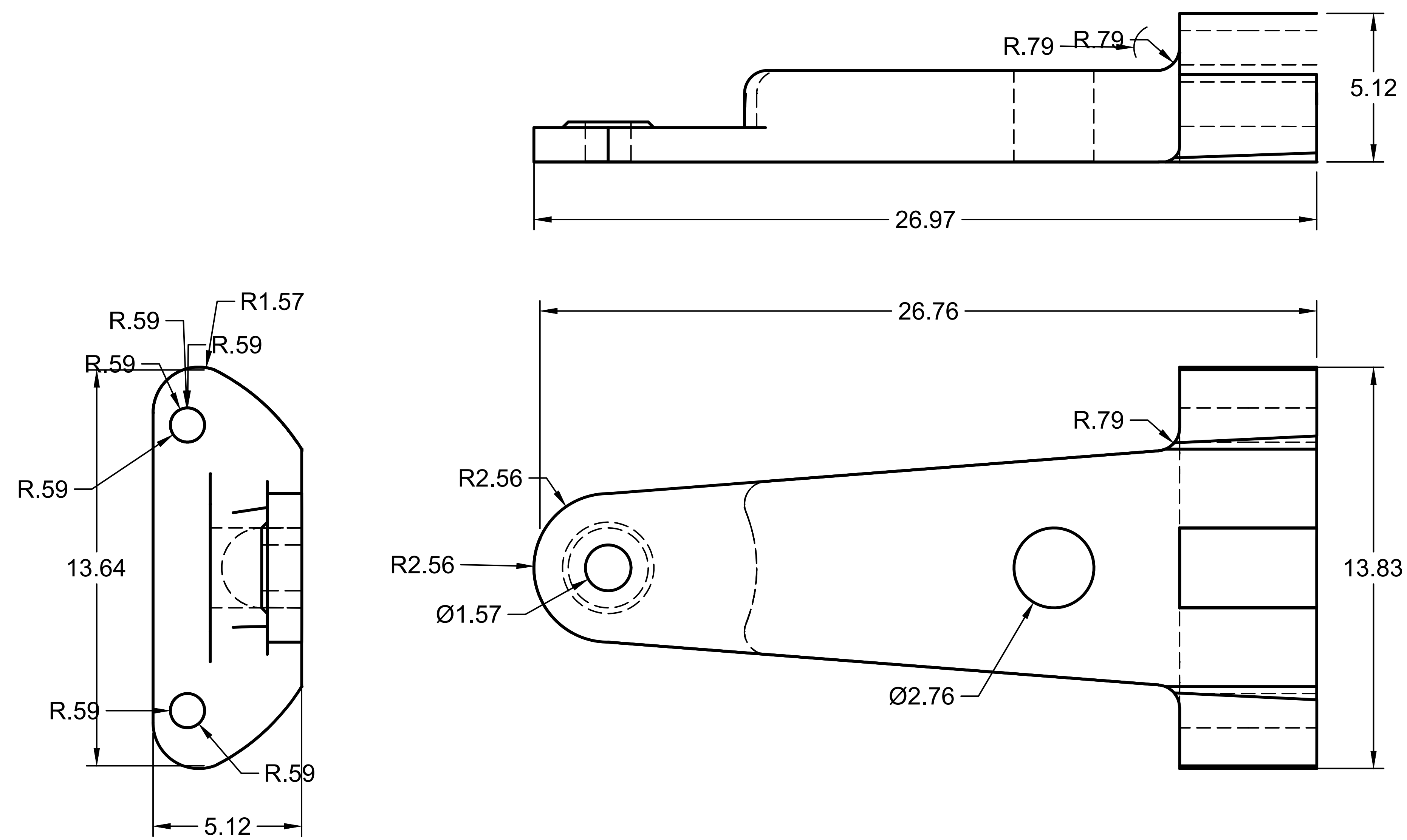
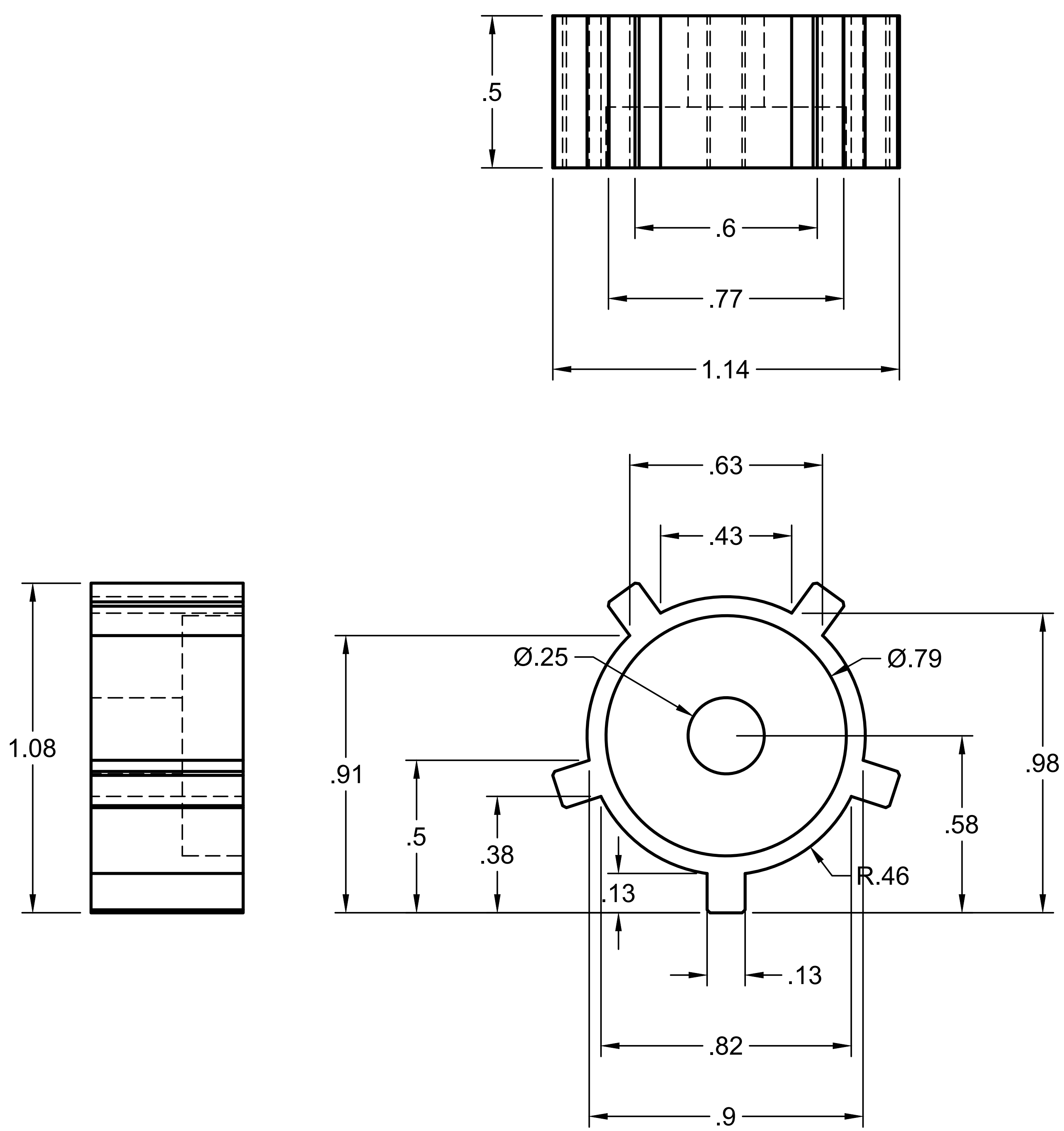
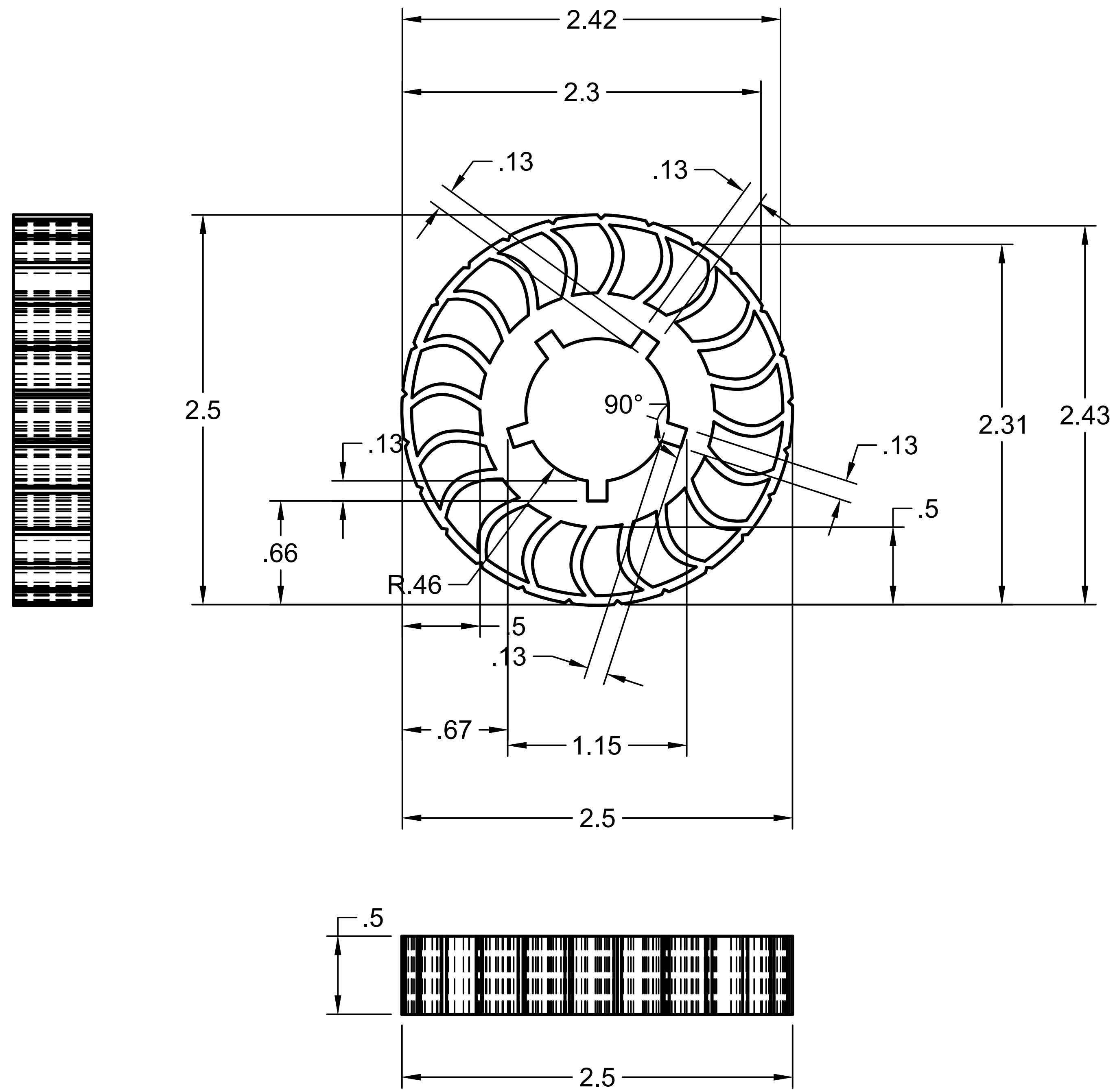
	TITLE Leg Arm Connector				
APPROVED	SIZE B	CODE	DWG NO		REV
CHECKED					
DRAWN William Arnholt 4/16/2025	SCALE 1:1		WEIGHT	SHEET 1/1	



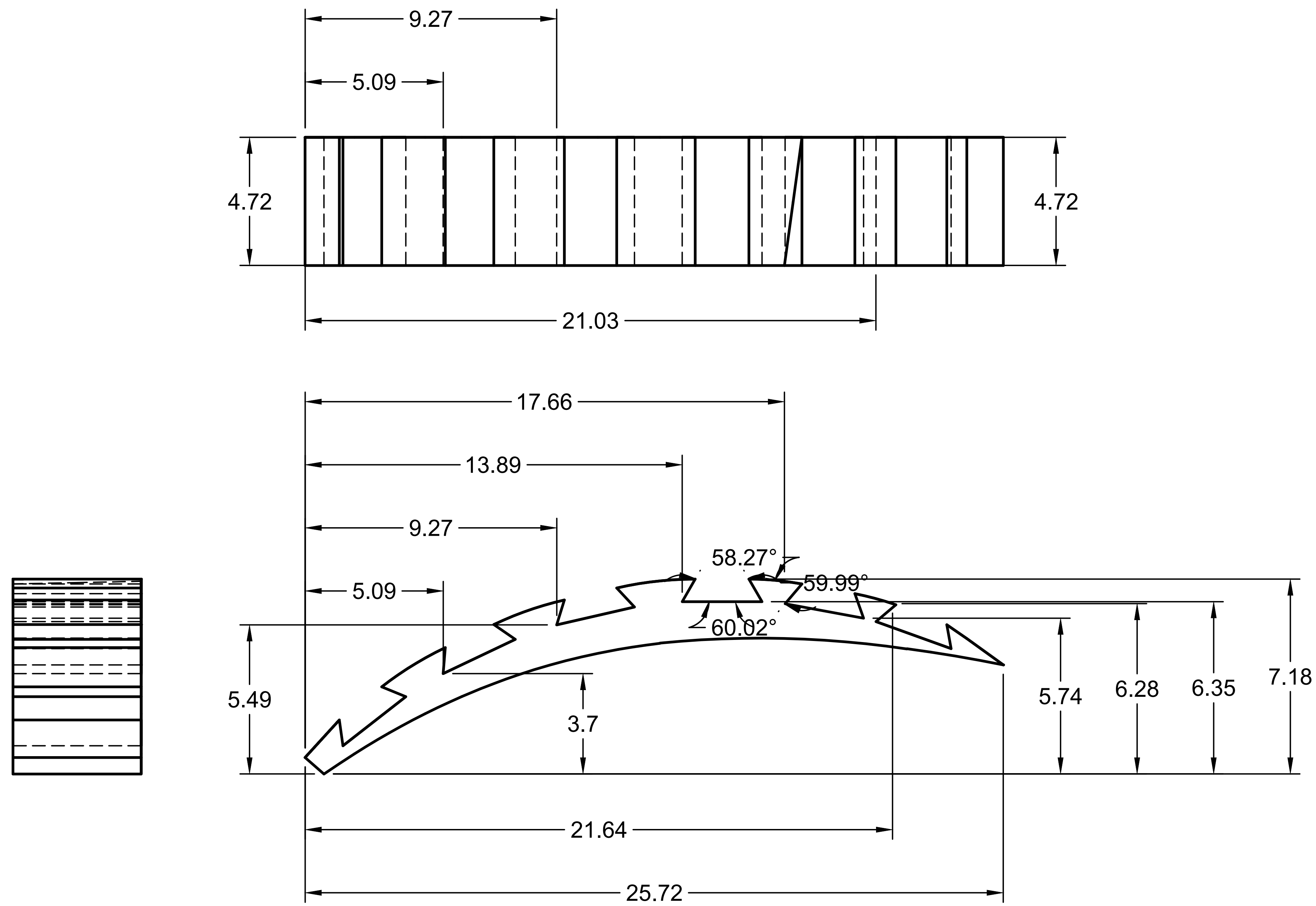
	PROJECT TSA			
	TITLE Mount_B			
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	B			
DRAWN Luke Boland 4/22/2025	SCALE 1:5	WEIGHT	SHEET 1/1	



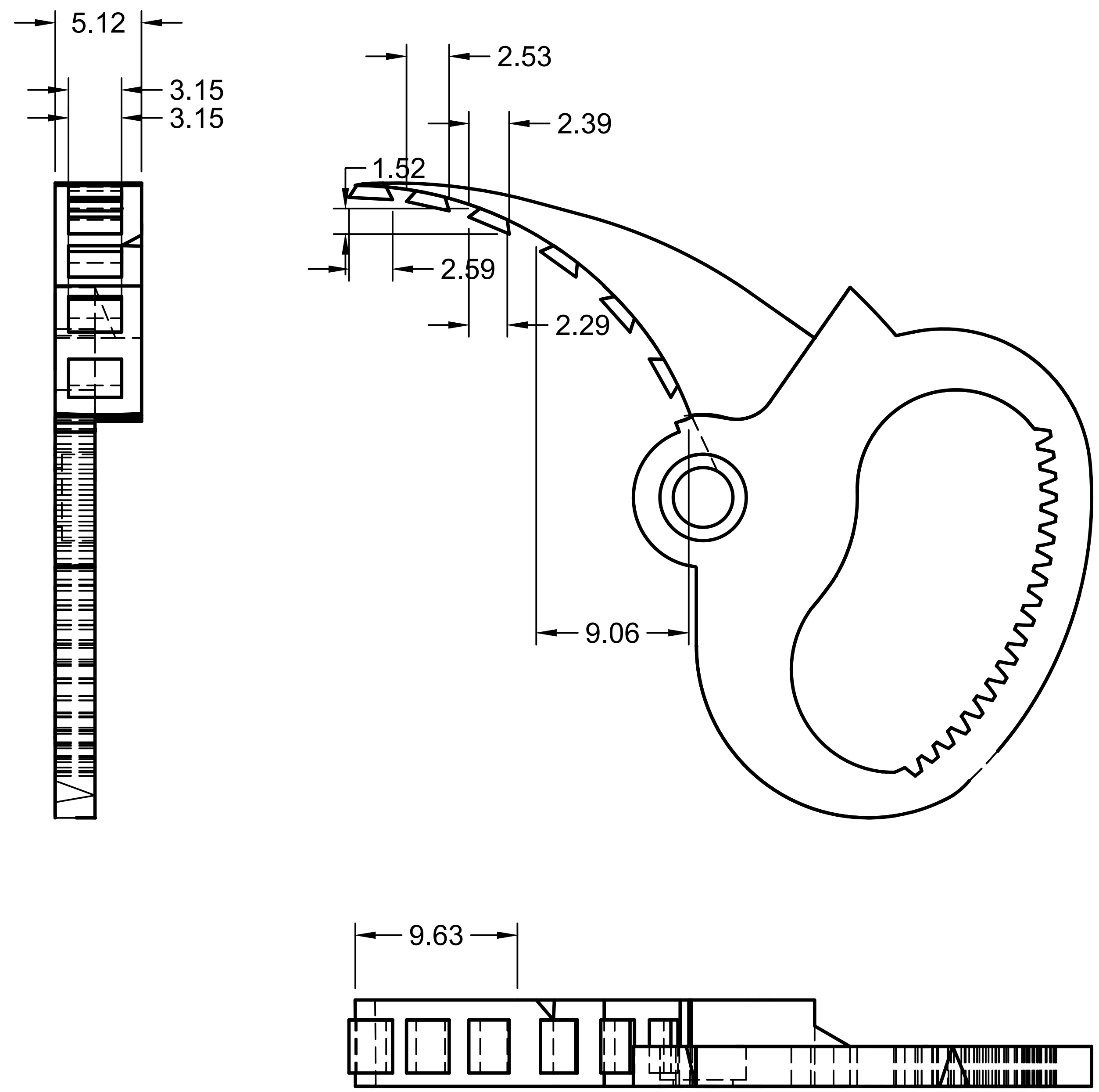
	PROJECT TSA				
	TITLE Wheel rim v4				
APPROVED	SIZE B	CODE	DWG NO		REV
CHECKED					
DRAWN William Arnholt 4/16/2025	SCALE 2:1		WEIGHT	SHEET 1/1	



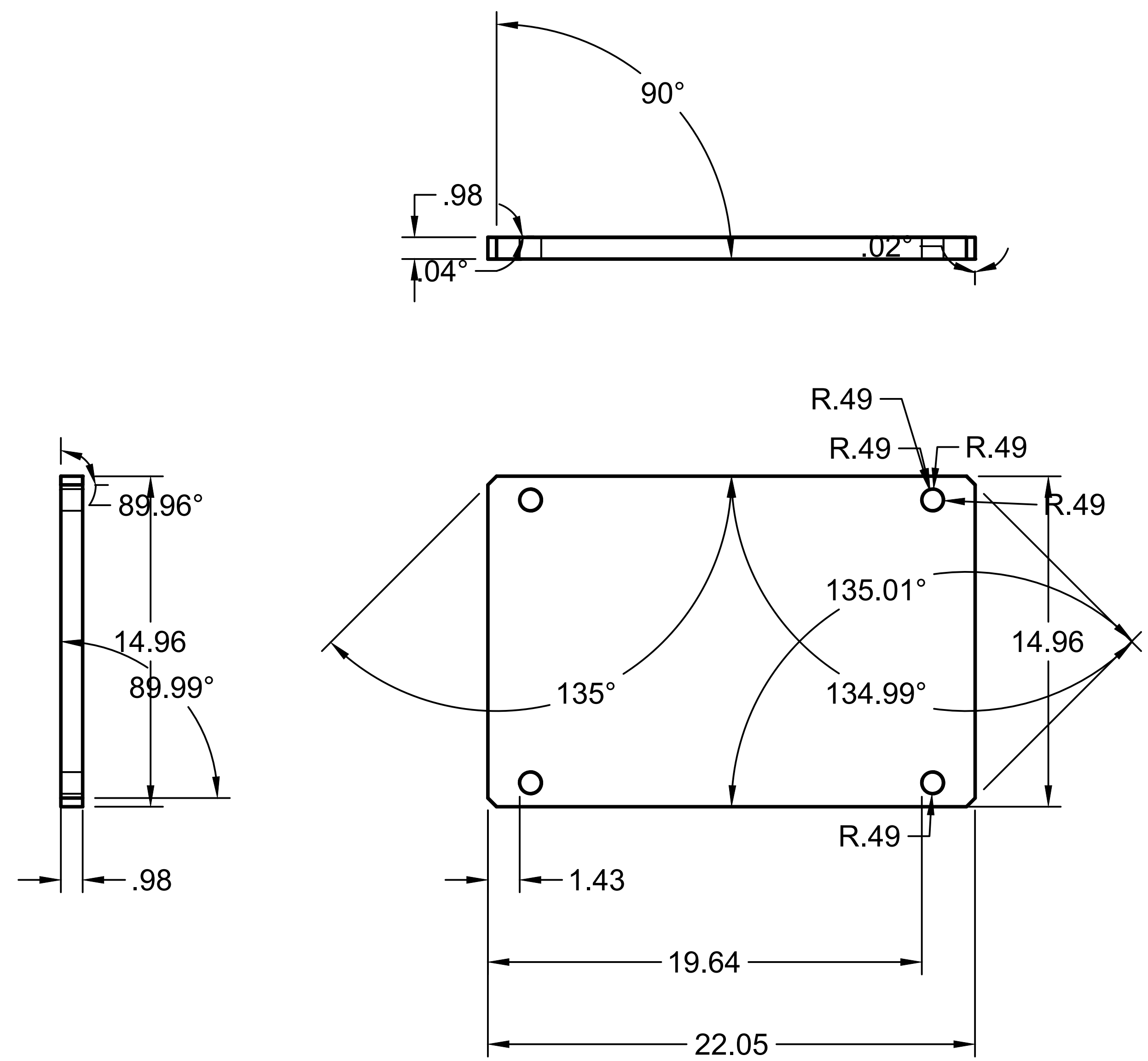
	PROJECT TSA				
	TITLE Wheel tire				
APPROVED	SIZE B	CODE	DWG NO		REV
CHECKED					
DRAWN Luke Boland 4/22/2025	SCALE 1:1		WEIGHT	SHEET 1/1	



	PROJECT TSA			
	TITLE Claw - Part 2			
APPROVED	SIZE B	CODE	DWG NO	REV
CHECKED				
DRAWN Luke Boland 4/22/2025	SCALE 1:5	WEIGHT	SHEET 1/1	



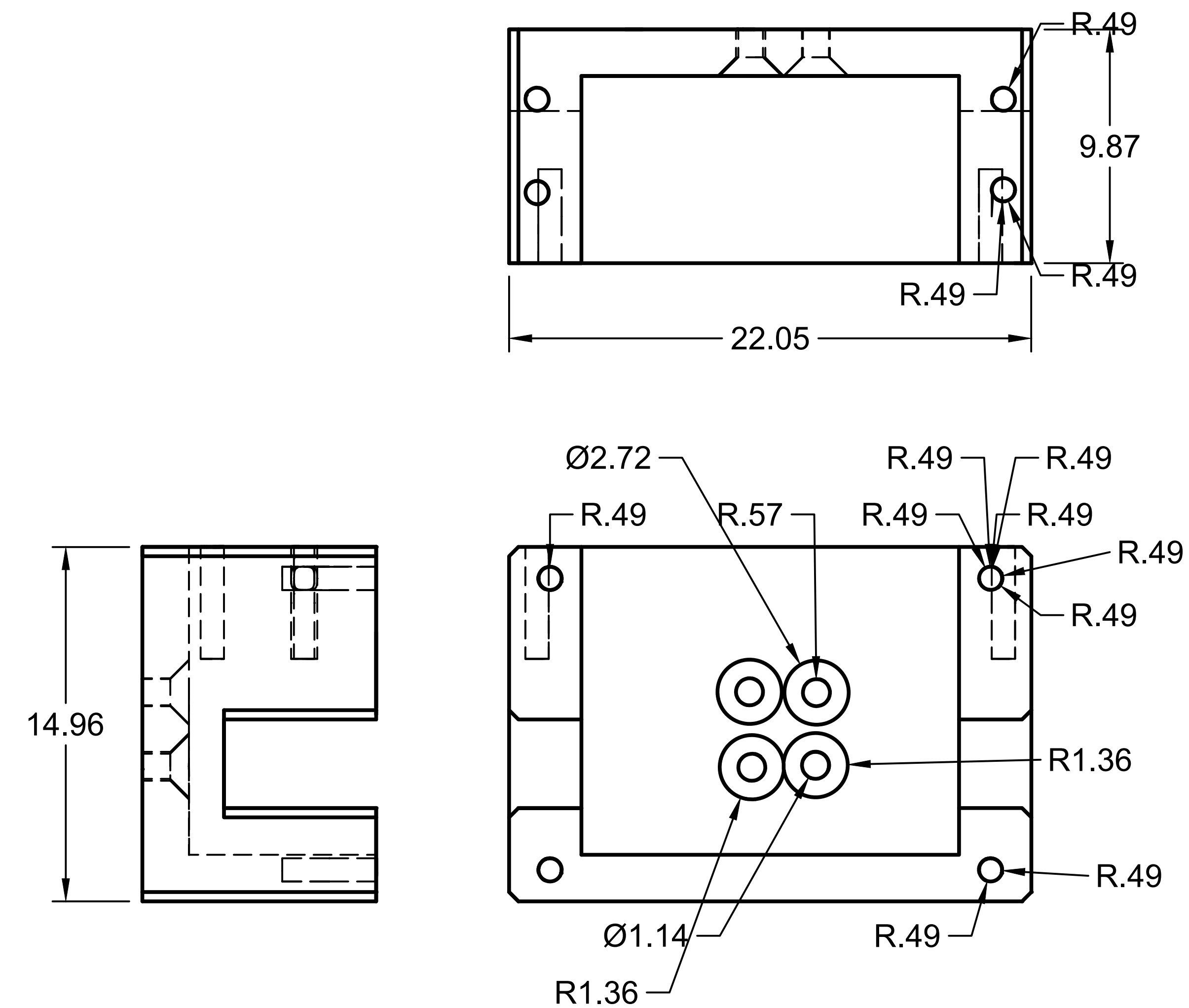
	PROJECT TSA
	TITLE Claw - Part 3
APPROVED	SIZE: B · CODE · DWG NO · REV
CHECKED	
DRAWN Luke Boland 4/22/2025	SCALE 1:10 · WEIGHT · SHEET 1/1



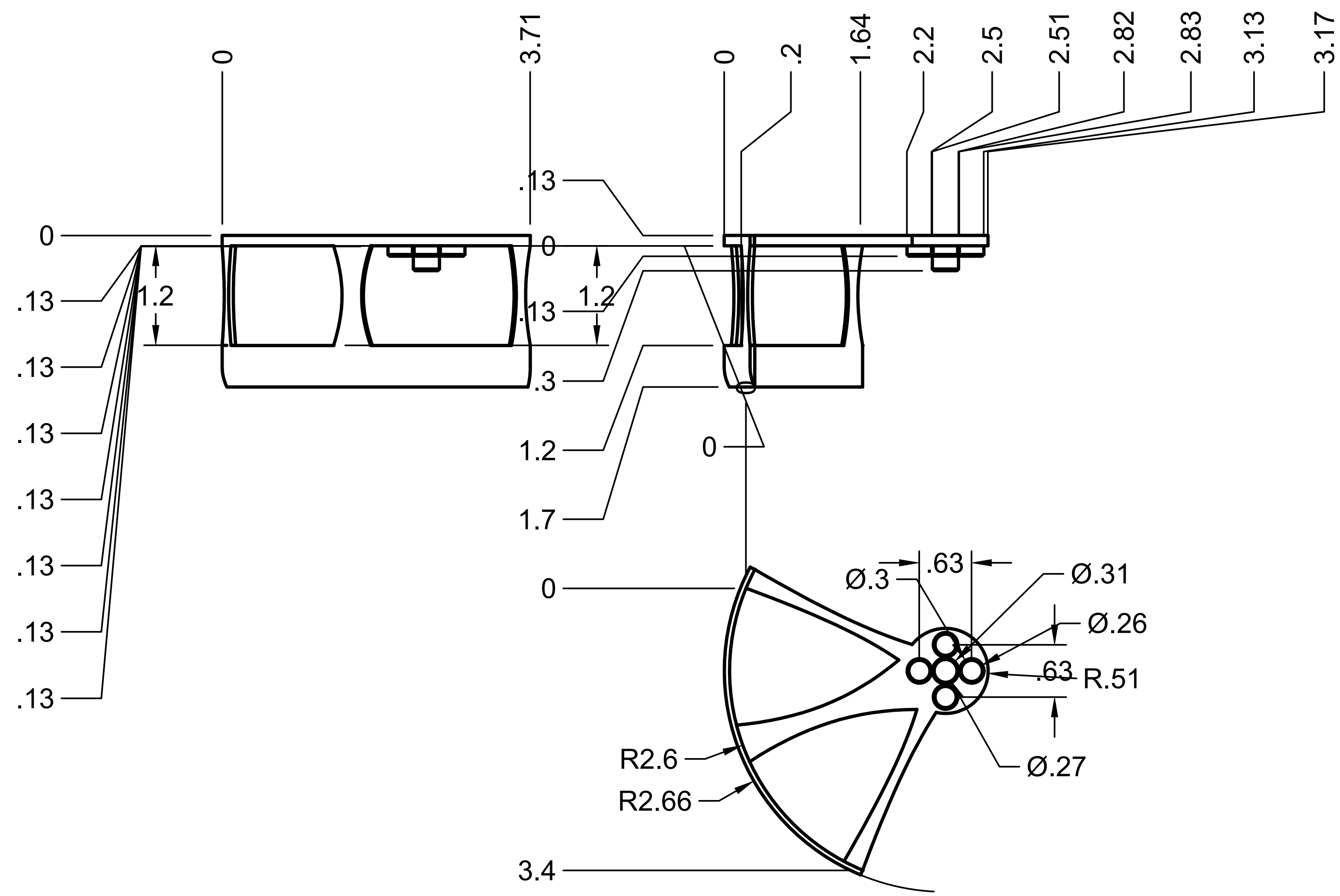
PROJECT
TSA

TITLE
Servo pod cap

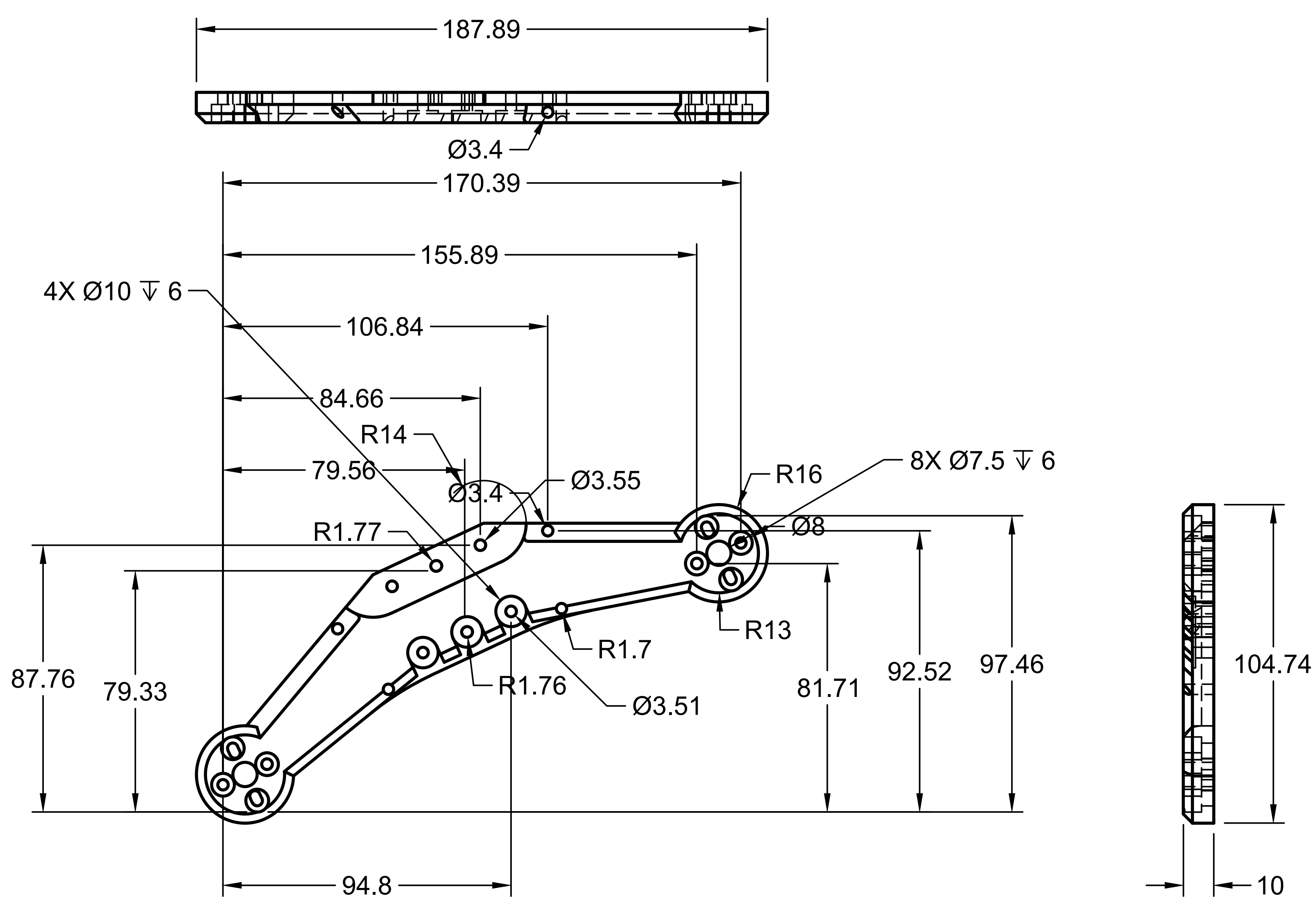
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	B			
DRAWN Luke Boland 4/22/2025	SCALE 1:8	WEIGHT	SHEET 1/1	



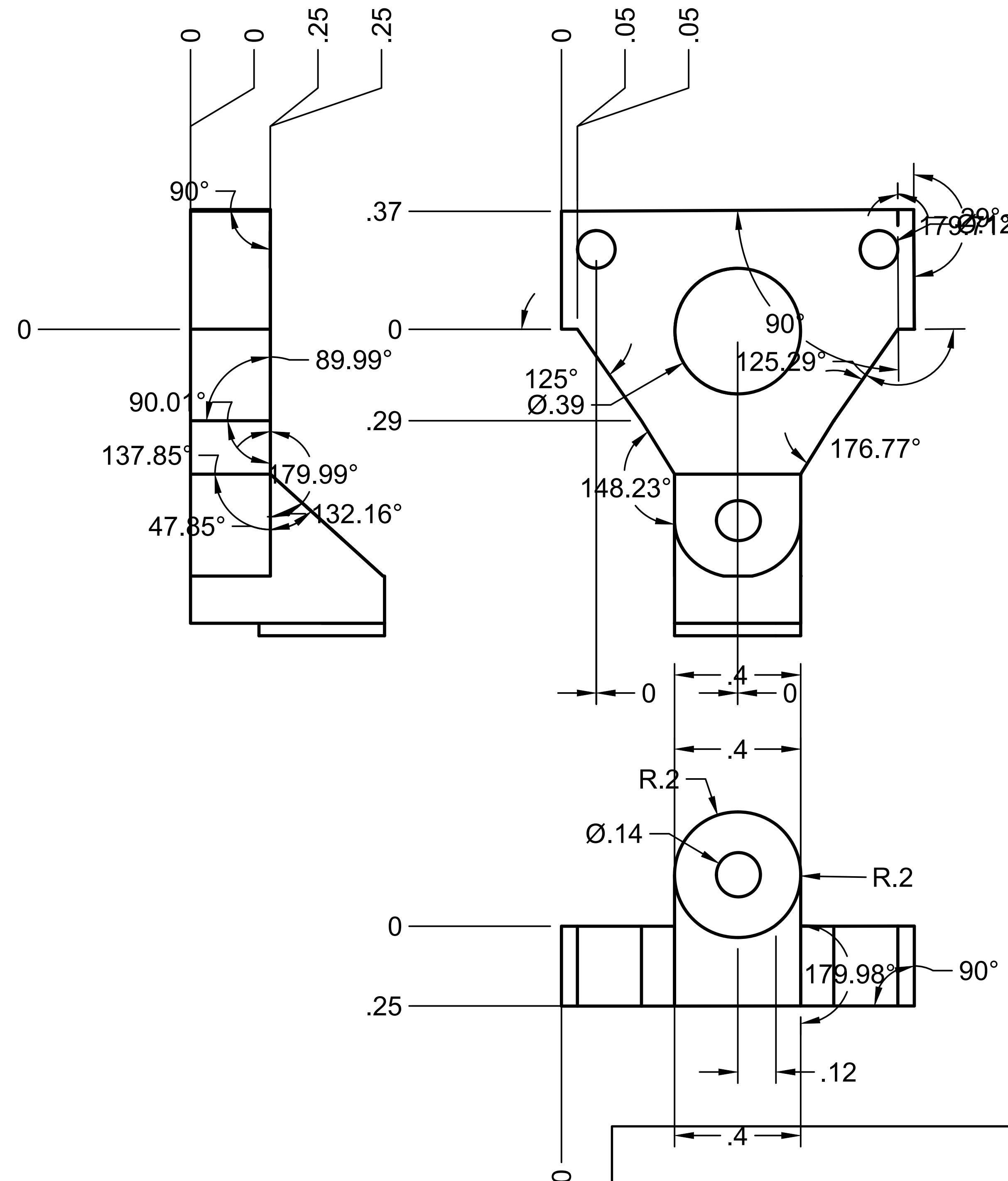
	PROJECT TSA				
	TITLE Servo pod				
APPROVED	SIZE B	CODE	DWG NO		REV
CHECKED					
DRAWN Luke Boland 4/22/2025	SCALE 1:8		WEIGHT	SHEET 1/1	



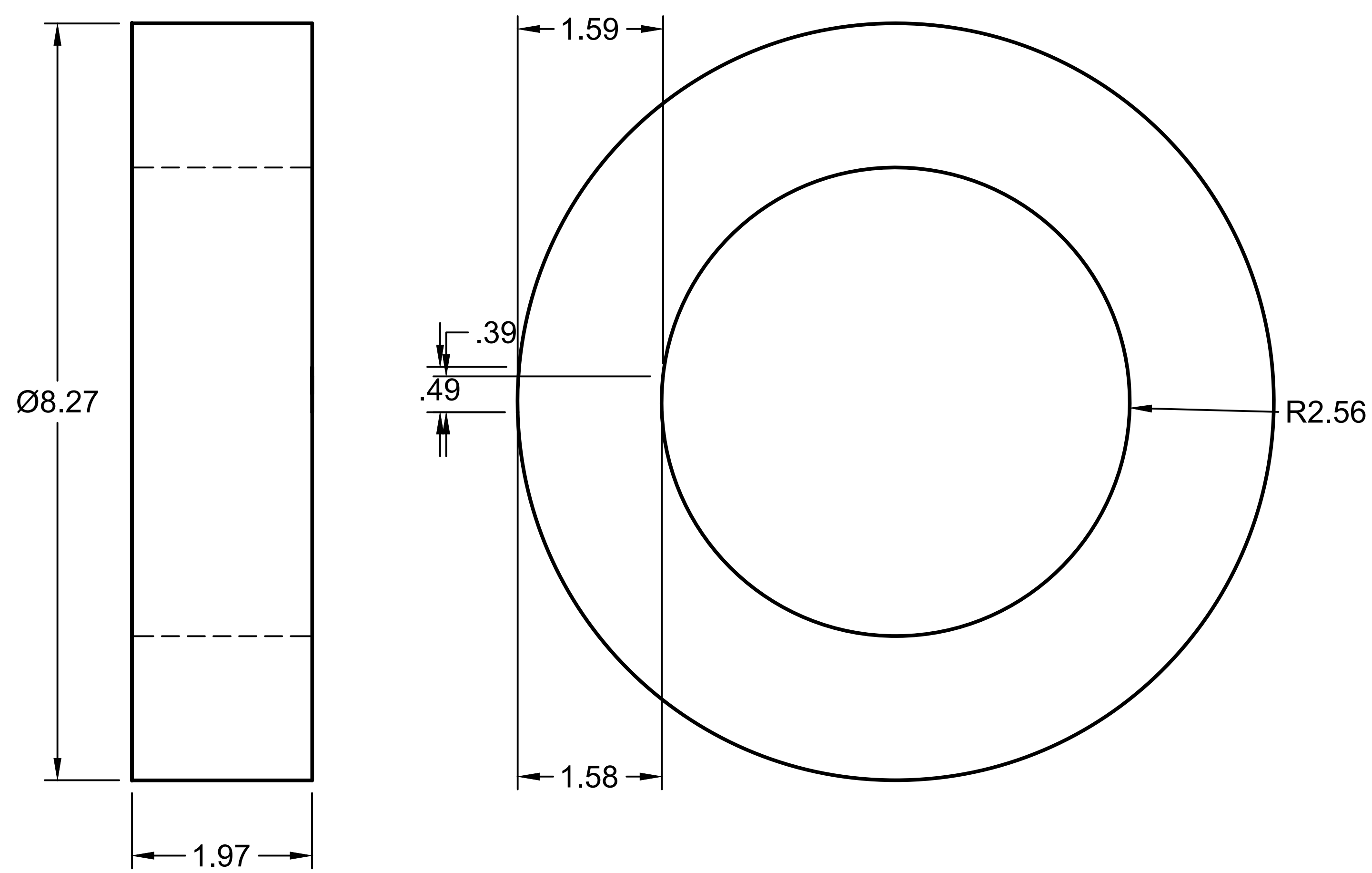
	PROJECT TSA			
	TITLE Prop Guard			
APPROVED	SIZE B	CODE	DWG NO	REV
CHECKED				
DRAWN Luke Boland 4/22/2025	SCALE 1:2	WEIGHT	SHEET 2/5	



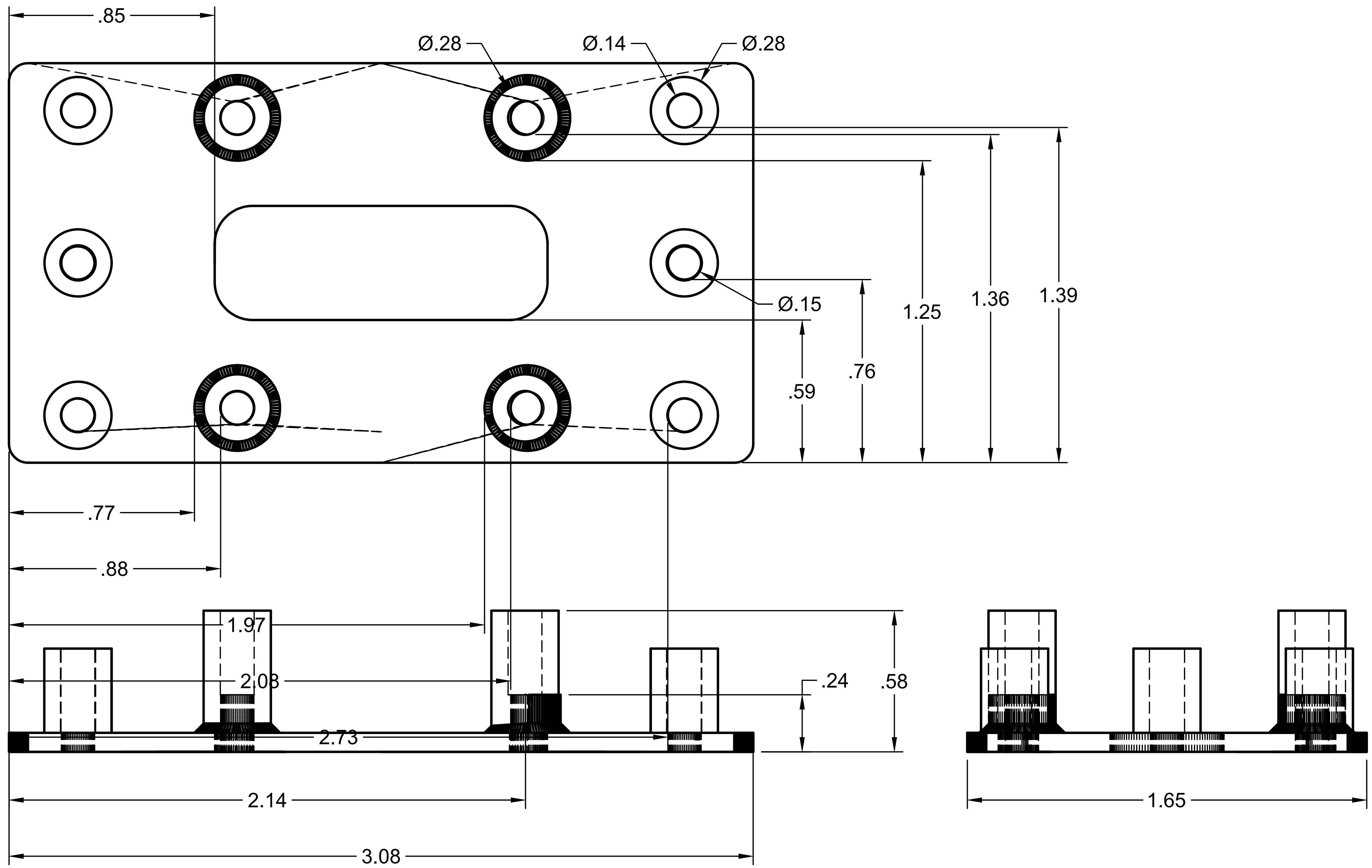
	PROJECT TSA			
	TITLE ArmV3_v6			
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	B			
DRAWN William Arnholt 4/16/2025	SCALE 1:2	WEIGHT		SHEET 1/1



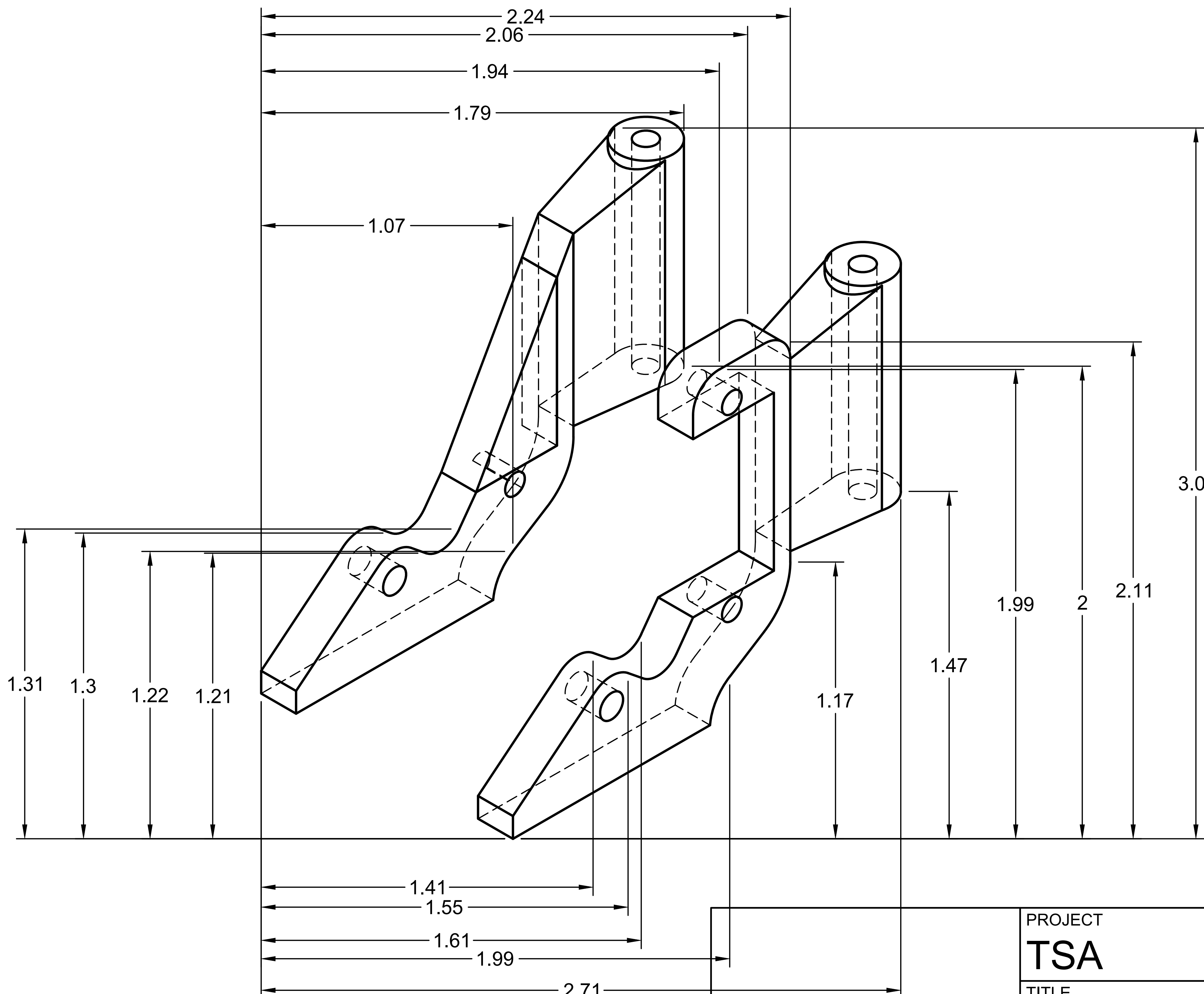
	PROJECT TSA				
	TITLE Claw mount bracket				
APPROVED	SIZE B	CODE	DWG NO		REV
CHECKED					
DRAWN Luke Boland 4/22/2025	SCALE 2:1		WEIGHT	SHEET 1/5	



	PROJECT TSA			
	TITLE BearingFix_2x			
APPROVED	SIZE B	CODE	DWG NO	REV
CHECKED				
DRAWN Luke Boland 4/22/2025	SCALE 1:2	WEIGHT	SHEET 1/1	



	PROJECT TSA				
	TITLE Bottom Plate				
APPROVED	SIZE	CODE	DWG NO		REV
CHECKED	B				
DRAWN William Arnholt 4/16/2025	SCALE 2:1		WEIGHT	SHEET 1/1	



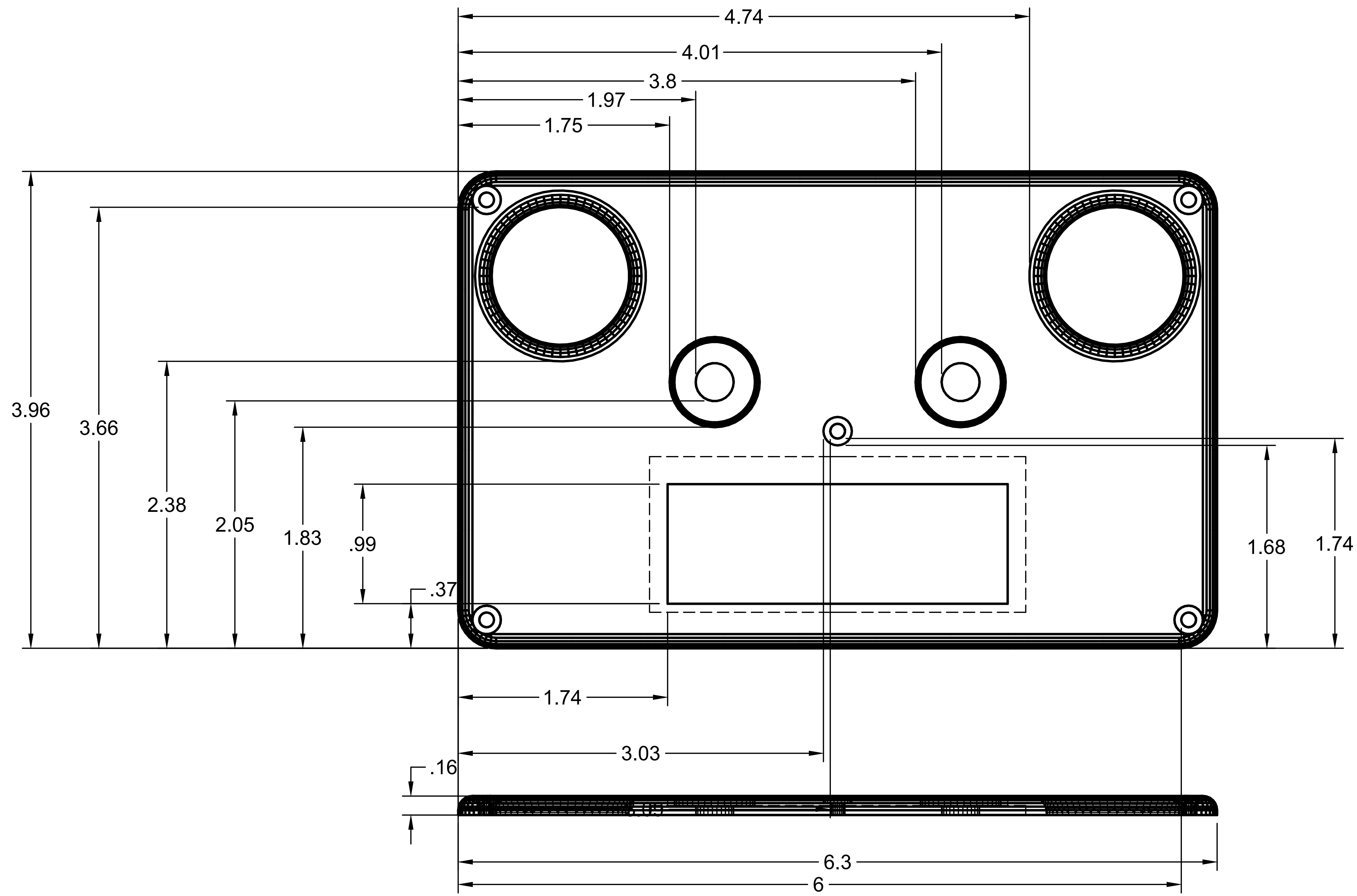
PROJECT

TSA

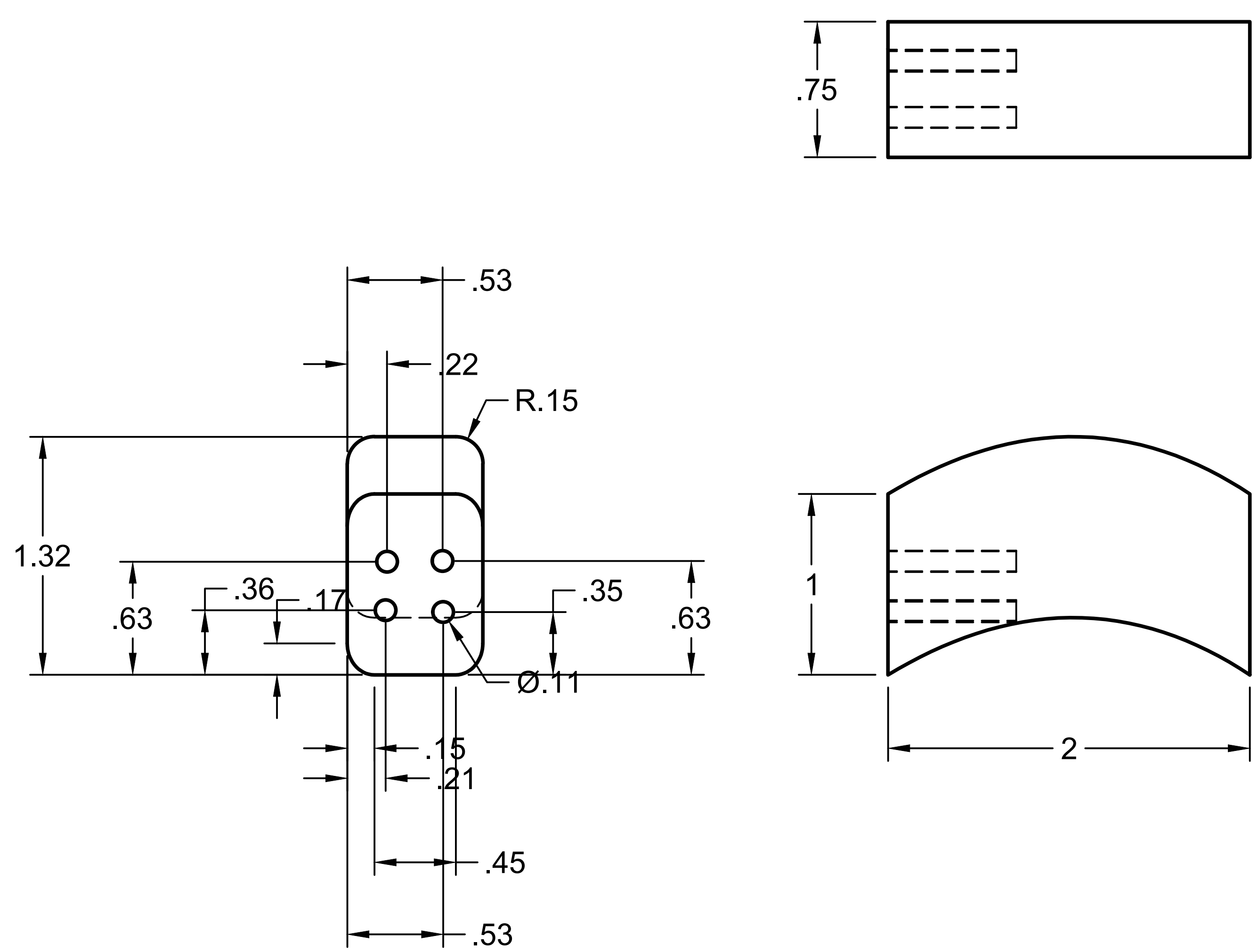
TITLE

Camera Mounts

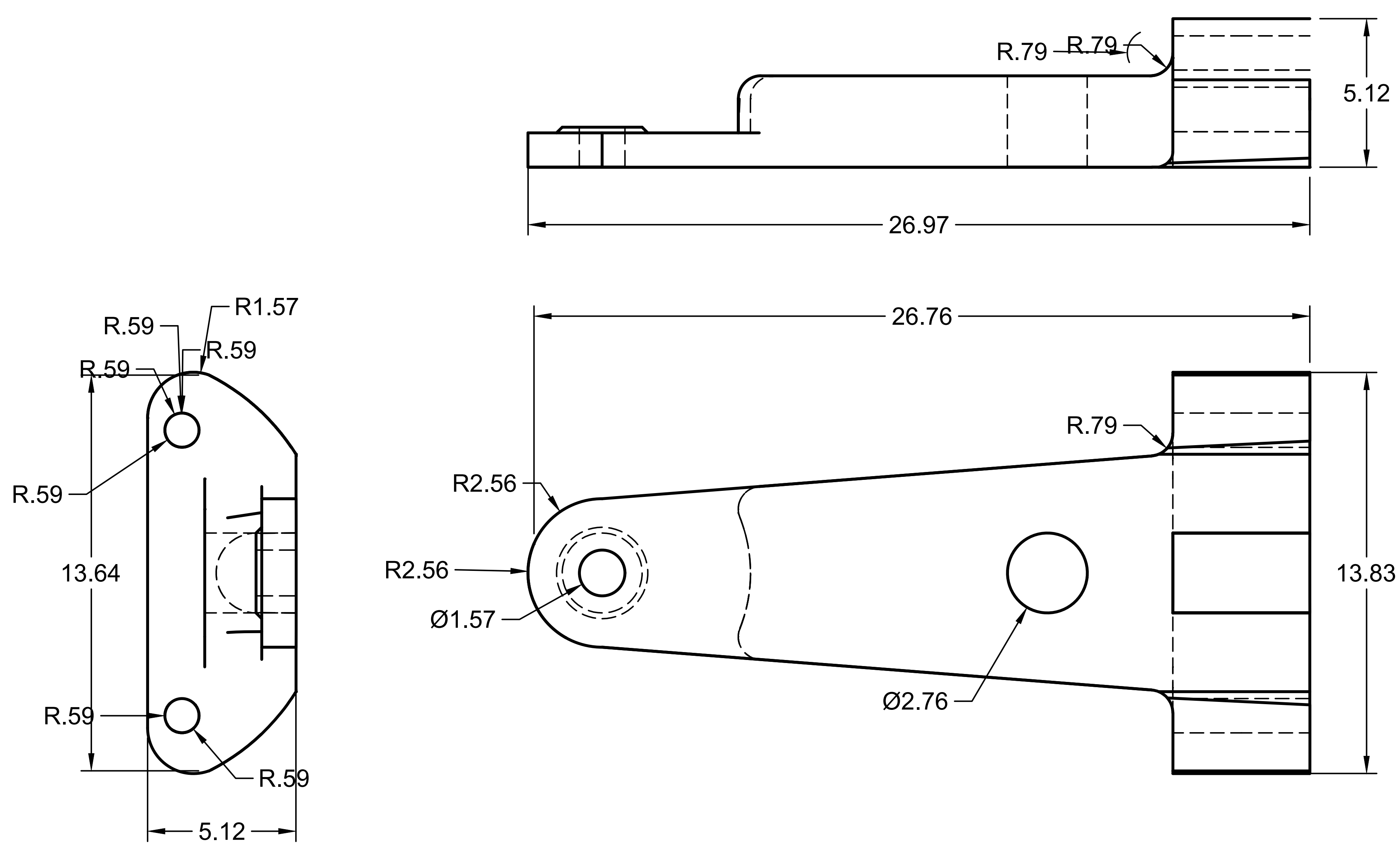
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	B			
DRAWN William Arnholt 4/16/2025	SCALE 2:1	WEIGHT		SHEET 1/1



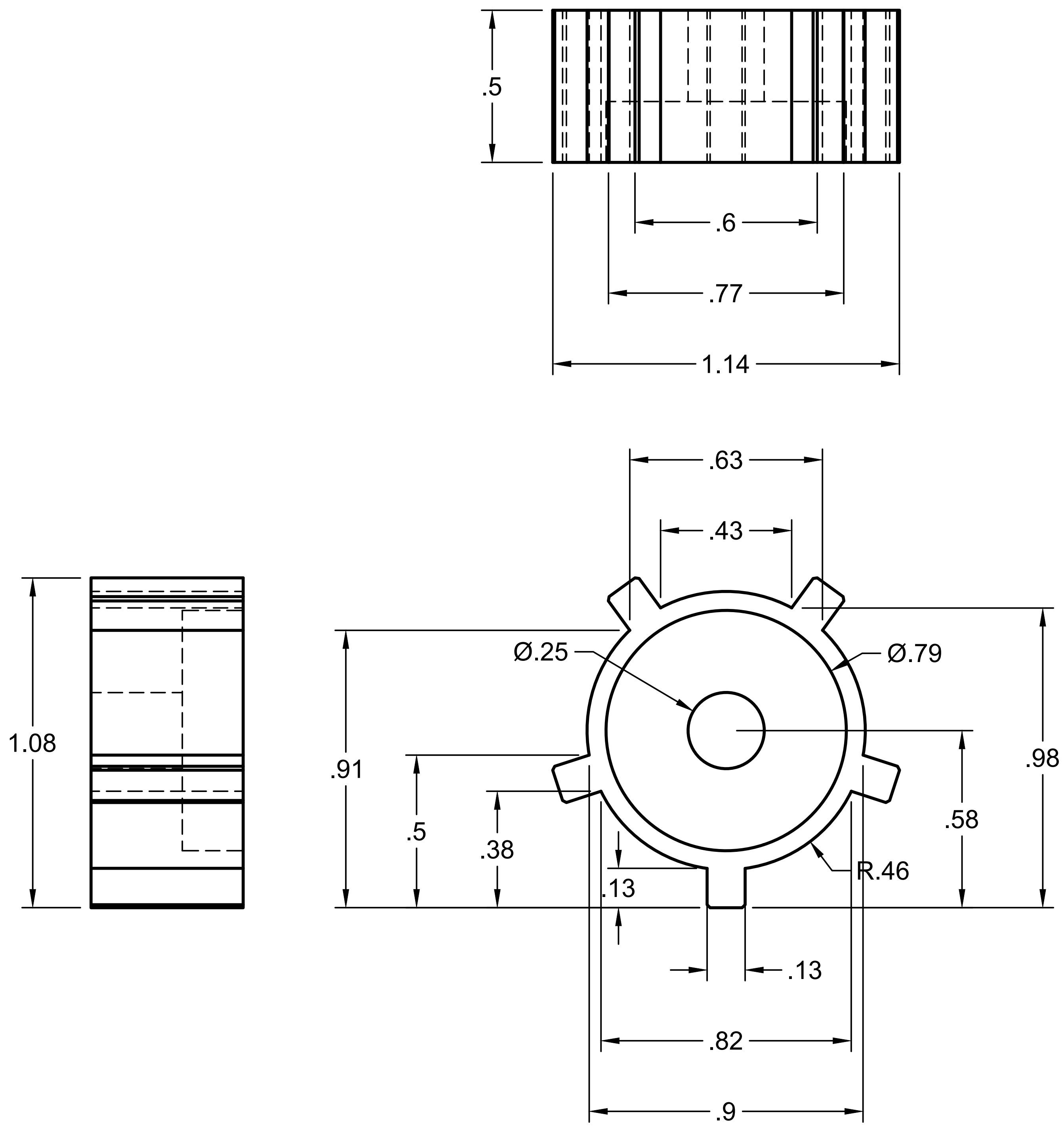
	PROJECT TSA				
	TITLE Cover				
APPROVED	SIZE	CODE	DWG NO		REV
CHECKED	B				
DRAWN William Arnholt 4/16/2025	SCALE 1:1		WEIGHT	SHEET 1/1	



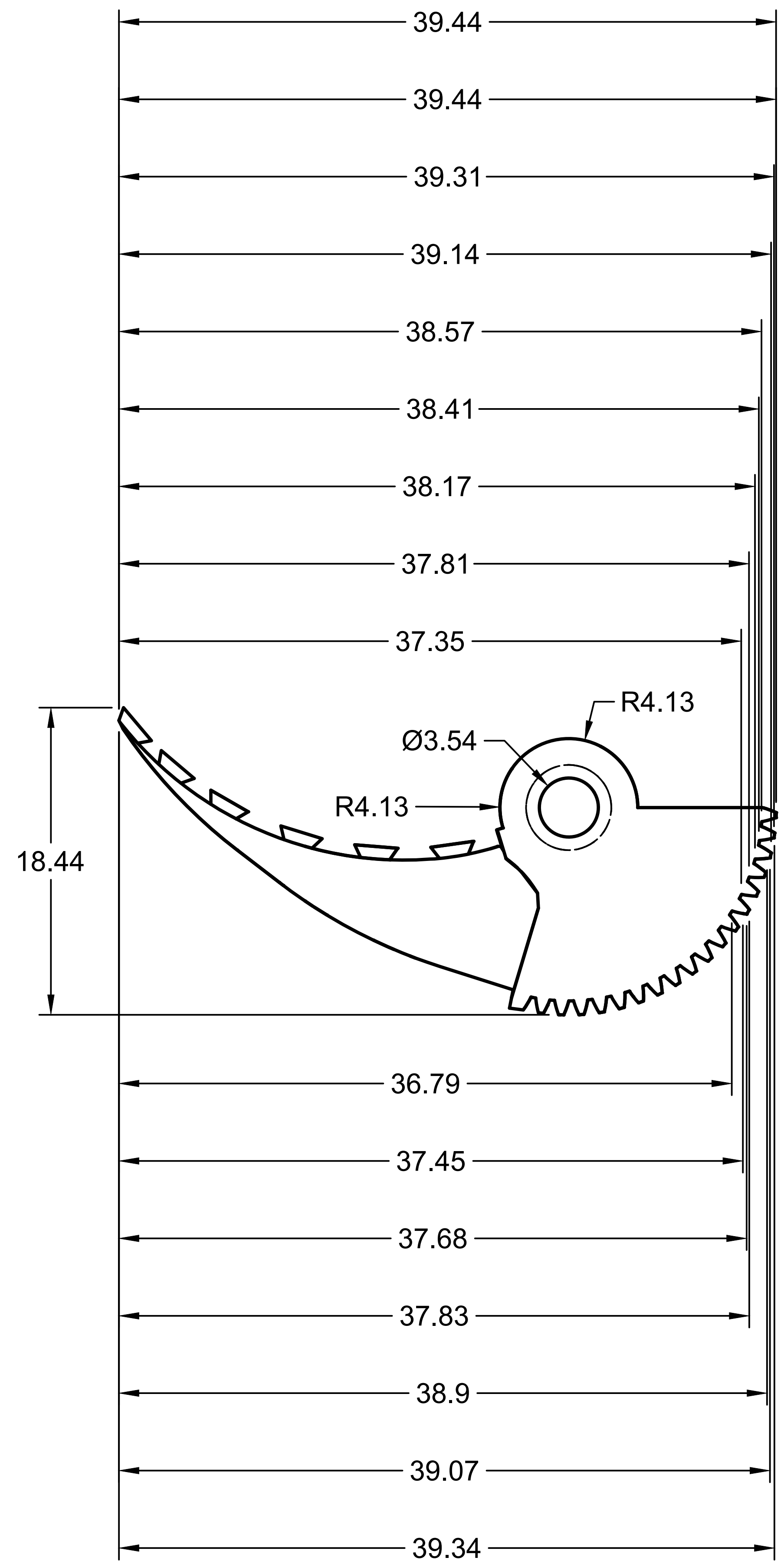
PROJECT	TSA
TITLE	Leg Arm Connector
APPROVED	
CHECKED	
DRAWN	William Arnholt 4/16/2025
SIZE	B
CODE	
DWG NO	
REV	
SCALE	1:1
WEIGHT	
SHEET	1/1



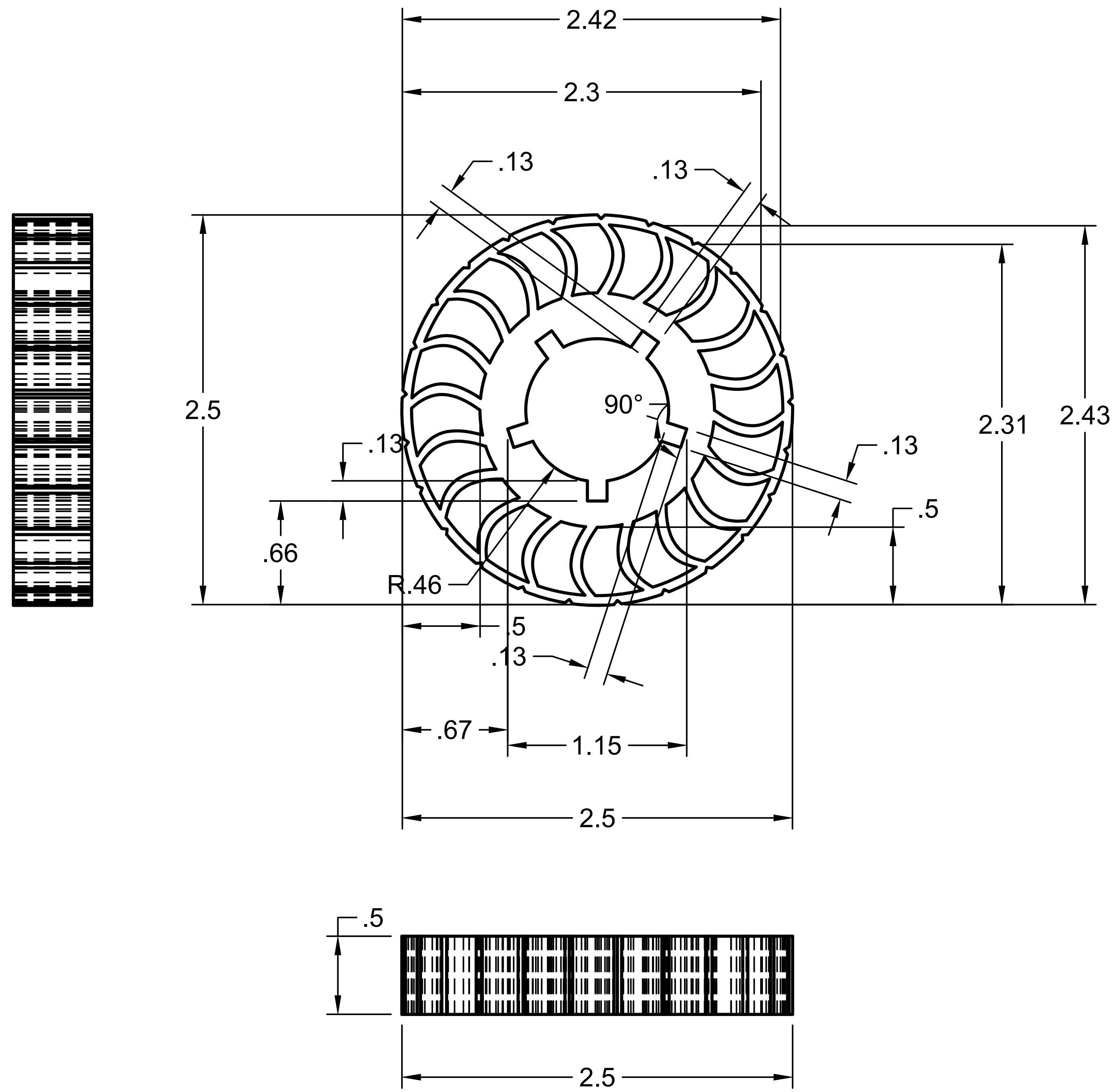
	PROJECT TSA			
	TITLE Mount_B			
APPROVED	SIZE B	CODE	DWG NO	REV
CHECKED				
DRAWN Luke Boland 4/22/2025	SCALE 1:5	WEIGHT	SHEET 1/1	



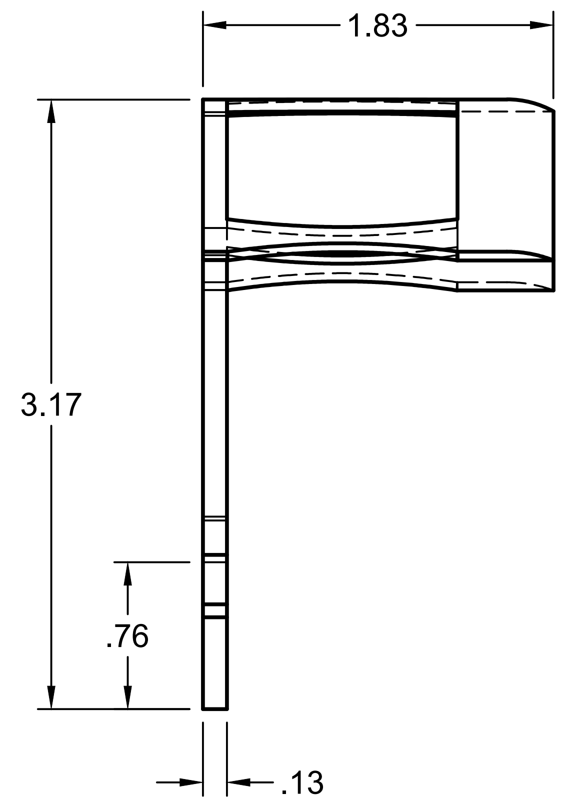
	PROJECT TSA
	TITLE Wheel rim v4
APPROVED	SIZE B · CODE · DWG NO · REV
CHECKED	
DRAWN William Arnholt 4/16/2025	SCALE 2:1 · WEIGHT · SHEET 1/1

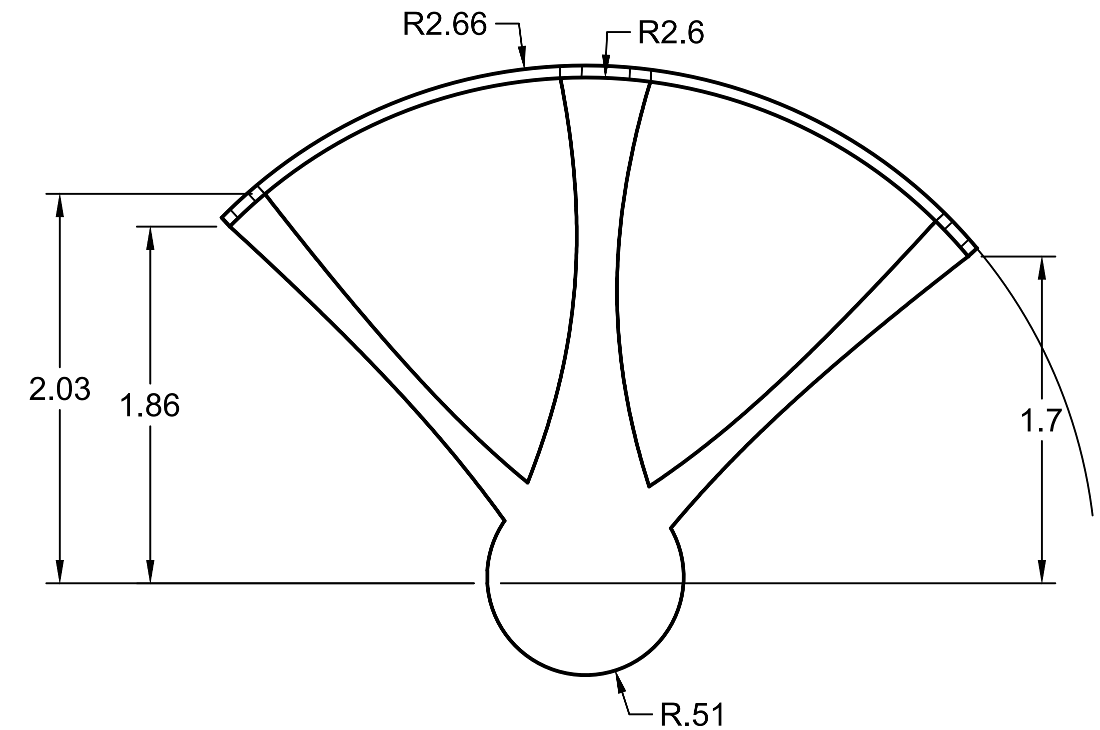


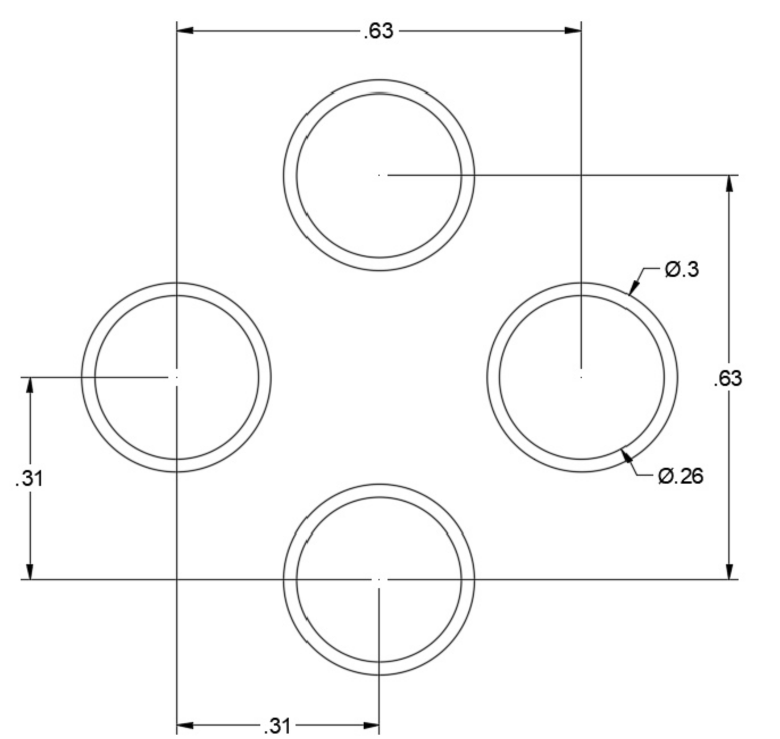
	PROJECT TSA				
	TITLE Claw - Part 1				
APPROVED	SIZE B	CODE	DWG NO		REV
CHECKED					
DRAWN Luke Boland 4/22/2025	SCALE 1:10		WEIGHT	SHEET 1/1	

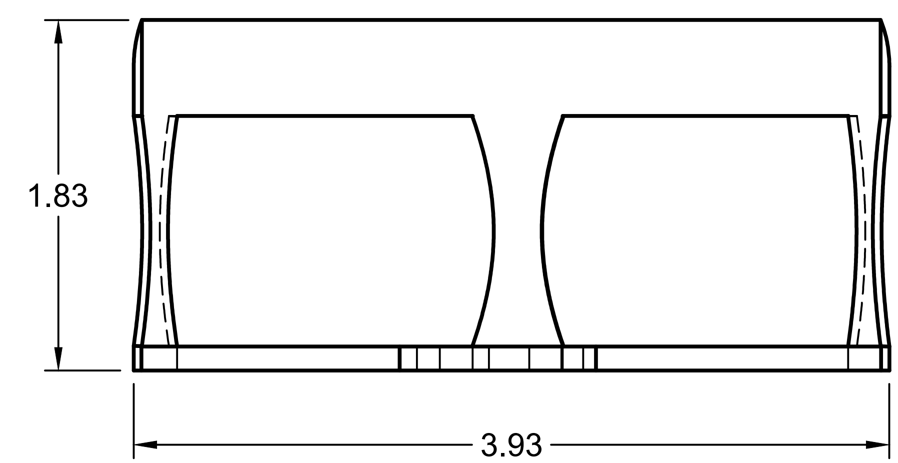


	PROJECT TSA			
	TITLE Wheel tire			
APPROVED	SIZE B	CODE	DWG NO	REV
CHECKED				
DRAWN Luke Boland 4/22/2025	SCALE 1:1	WEIGHT	SHEET 1/1	

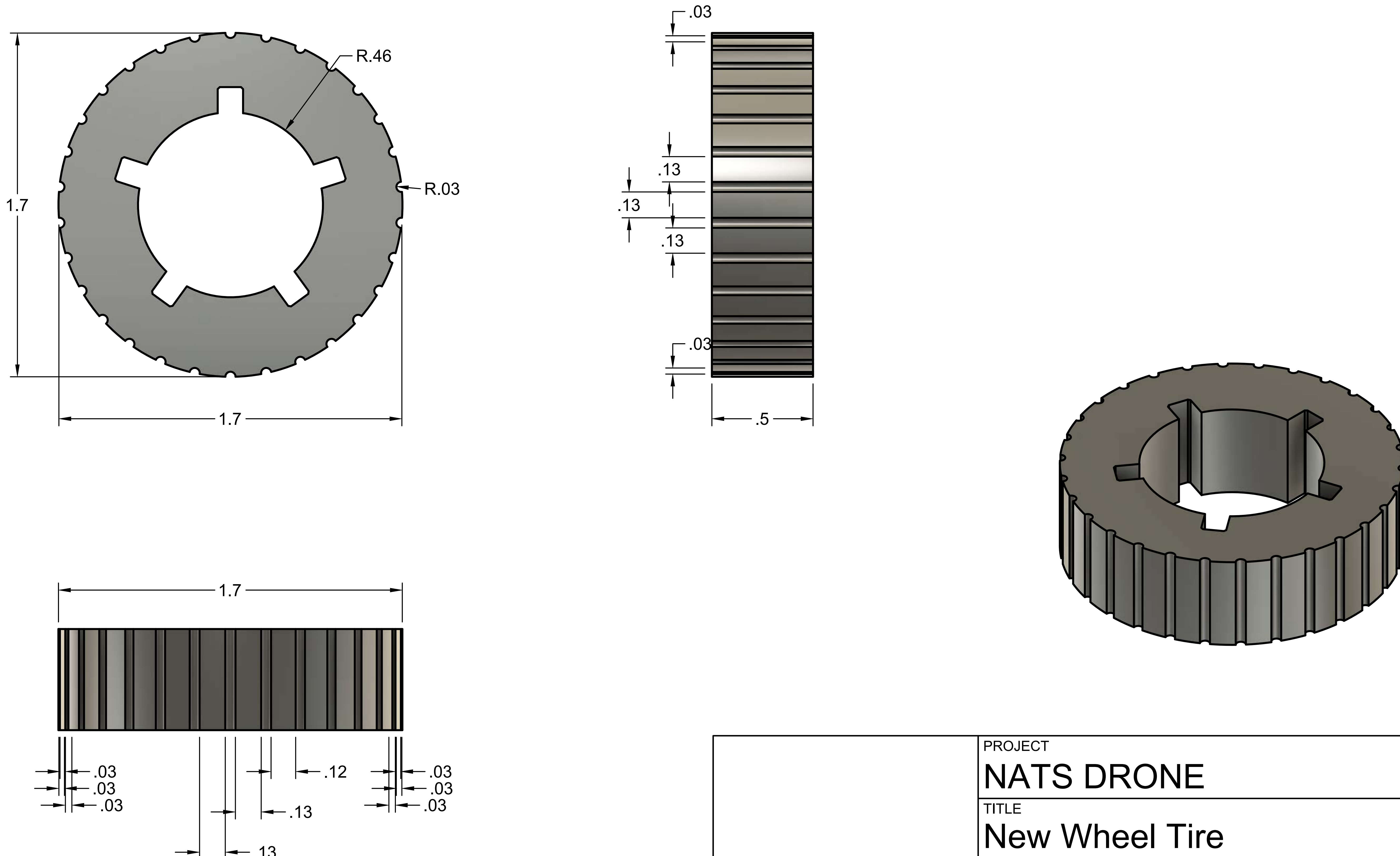








	PROJECT TSA				
	TITLE Prop Guard				
APPROVED	SIZE	CODE	DWG NO		REV
CHECKED	B				
DRAWN William Arnholt 6/26/2025	SCALE 1:2		WEIGHT	SHEET 5/5	



PROJECT	NATS DRONE
TITLE	New Wheel Tire
APPROVED	
CHECKED	
DRAWN	Luke Boland 6/26/2025
SIZE	B
CODE	
DWG NO	
REV	
SCALE	1:.5
WEIGHT	
SHEET	1/1

Bill of Materials						
Parts	**Type**	**Link**	**Price**	**QTY**	**P*QTY**	**Final Price**
iFlight 4pcs XING-E Pro 2207 2750KV	Motor	https://www.c	$64.00	1	$64.00	
SoloGood F405 Flight Controller Stack 30x30 55A	Flight Controller/ESC	https://www.c	$59.99	1	$59.99	
Aideepen 3PCS NRF24L01+PA+LNA Module with SMA 2.4 GHz 1100m+3PCS N	NRF Module	https://www.c	$17.99	1	$17.99	
16pcs Avan 5 Inch 3-Blade Racing High Efficiency Propellers for Drones	Props	https://www.c	$23.98	1	$23.98	
Happymodel 0.42g Tiny 2.4GHz ExpressLRS EP1 Nano	Receiver	https://www.c	$22.99	1	$22.99	
RadioMaster TX16S MKII V4.0 16CH 2.4G Hall Gimbals Radio Transmitter Remo	Transmitter/Controller	https://www.c	$209.9	1	$209.99	
35kg high Torque Coreless Motor servo Metal Gear	Claw Servo	https://www.c	$28.99	1	$28.99	
4PCS MG995 360°High Speed Torque Metal Gear Servo Motor	Wheel Servos	https://www.c	$25.99	1	$25.99	
CNHL 1500mAh 4S Lipo Battery 14.8V 100C (Burst 200C)	Batteries	https://www.c	$43.99	1	$43.99	
Taiss 60PCS Potentiometer Kit B5K 10K 20K 50K 100K Ohm	Potentiometers	https://www.c	$13.99	1	$13.99	
Nano V3.0, Nano Board ATmega328P 5V 16M Micro-Controller Board Compatib	Arduino Nano	https://www.c	$19.99	2	$39.98	
WINGONEER 5PCS PS2 Joystick Game Controller XY Two-Axis Joystick Breakout	Joystick	https://www.c	$8.05	1	$8.05	
DJI O4 Air Unit for FPV Drone, Digital Transmission System, 20ms Low Latency, 1	VTX and Camera	https://www.c	$126.1	1	$126.18	
15A 75W Buck Converter DC-DC12V 24V to DC 5V Step Down Converter Regula	Buck Convertor	https://www.c	$16.99	1	$16.99	
Geeetech 95A TPU Filament 1.75mm, Soft Flexible Consumables for 3D Printer, I	TPU filament	https://www.c	$18.68	1	$18.68	
Official CR PETG 3D Printer Filament 1.75mm 1KG (2.2lbs), High Precision Stron	PETG filament	https://www.c	$12.99	1	$12.99	
HATCHBOX 1.75mm Orange PLA 3D Printer Filament, 1 KG Spool, Dimensional A	PLA filament	https://www.c	$28.00	1	$28.00	
900 Pcs Wire Heat Shrink Tubing Kit, Industrial Heat-Shrink Tubing for Wires, 2:1	Heat Shrink	https://www.c	$6.59	1	$6.59	
10 Pcs SG90 9G Micro Servo Metal Geared Motor Kit for RC Robot Arm/Hand/Cc	Servos	https://www.c	$18.99	1	$18.99	
						$788.35

Drone Rules and Regulations

City of Nashville Municipal Laws (Use of Drones)

- Metro Parks are not able to allow the use of drones in parks outside of designated areas, flying areas for any purpose, including photography or filming
- Drone flight is not allowed in Nashville Metro Parks except in three designated areas: Warner Park, Peeler Park, and Cane Ridge
- In addition, pilots must have a permit necessary to fly drones, as stated by the FFA

Tennessee State Drone Laws

- According to Tennessee State Park Policies, drone operations, launching, and landing in State Parks are not allowed unless permission from the Park Manager has been obtained
- Senate Bill 2106 prohibits drone operation within 250 feet of any critical infrastructure to conduct surveillance or unlawfully gather information
- House Bill 153 bans drone operation over any fireworks display or open-air event without the owner's consent.
- House Bill 2376 clarifies that it is permissible for a person to use UAS through a public or private institution of higher education, rather than just public institutions
- Senate Bill 796 enables law enforcement to use drones in compliance with a search warrant.
- In addition, all drone pilots operating commercially in the state of Tennessee are subjected to the FAA's part 107 rules

Federal Laws by the Federal Aviation Administration (FAA) for drones under 55 lbs

- As a pilot, you must have a remote pilot certificate with a small UAS rating or be in the presence and supervision of one
- Drones must be registered under the FAA ($5 cost)
- Avoid manned aircraft and operating in a reckless manner
- Do not operate over a moving vehicle unless the area is sparsely populated
- The drone has to be in view, and there must always be a visual observer keeping your drone in unaided sight
- You cannot pilot or observe more than one drone operation at a time
- Do not fly over people unless they are participating in the activity
- Do not operate from a plane or a moving aircraft
- Your drone can fly in daylight with anti-collision lighting (daylight refers to 30 minutes before sunrise to 30 minutes after sunset)
- The minimum weather visibility is three miles from your control stations

- Maximum altitude of 400 feet from the ground, but can go higher if the drone is 400 feet above a structure
- Maximum speed is 87 knots or 100 mph
- An external load on the drone requires a secure attachment and full aircraft safety. Property can be transported provided the flight rules are followed.
- Your drone must be provided for inspection to the FAA upon request, and any activity or operation that results in a serious injury or damage of at least $500 must be reported to the FAA
- Airways and other important areas, such as military installations, must not be disturbed.

Resources

Drone Laws in Tennessee (2023) - Pilot Institute. (2024, May 17). Pilot Institute. https://pilotinstitute.com/drones/states/tennessee/

Drone Laws in Tennessee (2024) - UAV Coach. (2023, December 21). UAV Coach. https://uavcoach.com/drone-laws-tennessee/

Federal Aviation Administration. (2022). Unmanned Aircraft Systems (UAS) | Federal Aviation Administration. Faa.gov. https://www.faa.gov/uas

Film and Video Permits. (2025). Nashville.gov. https://www.nashville.gov/departments/parks/permits-rentals-and-reservations/film-video-and-photography-permit

Thingiverse.com. (2019). Thingiverse - Digital Designs for Physical Objects. Thingiverse. https://www.thingiverse.com/

TECHNOLOGY STUDENT ASSOCIATION WORK LOG

Date	Task	Time involved	Team member responsible (student initials)	Comments
1. 2/2	Begin research on new drone challenge	9:45 am - 10:30 am	LB, JL, WA	As a group, we began to review the new 2025 UAV drone challenge and what necessary developments we needed to make the mission successful. We decided we needed 2 gripper devices due to the addition of a new cage.
2. 2/6	Reflected on what we can improve on last years drone	5:30 pm - 6:50 pm	LB, JL, WA	From making nationals in the drone challenge in 2024, we reflected on what needed to be changed in our design and made adaptations to our old design for the new challenge. One change we added was a more powerful buck converter as
3. 2/10	Begin designing the frame of the drone	9:30 am - 10:00 am	WA, LB	Redesigned frame from last year. We no longer wanted to use a carbon fiber frame and decided to use one that was 3D printed. We also redesigned the controller that was used to control the wheels and claw.
4. 2/14	Disassemble old drone	6:00 pm - 7:30 pm	LB	Began to disassemble old drones, separating what could be reused and what needed to be new.
5. 2/18	Finish design of the frame and get ready to print the frame	9:45 am - 10:35 am	JL, WA, LB	For our new drone, we began by designing a more customizable frame. What we noticed from last year is that the carbon frame was not as customizable, so we decided to 3D print a frame so we could easily make adjustments, too.
6. 2/22	Start the documentation	2:30 pm - 4:00 pm	JL	Began organizing documentation and sorting out what we would be able to use from last year and what needed to be improved upon. Got all the work log and photo log caught up

TECHNOLOGY STUDENT ASSOCIATION WORK LOG

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6. 2/22	Start the documentation	2:30 pm - 4:00 pm	JL	Began organizing documentation and sorting out what we would be able to use from last year and what needed to be improved upon. Got all the work log and photo log caught up

TECHNOLOGY STUDENT ASSOCIATION WORK LOG

Date	Task	Time involved	Team member responsible (student initials)	Comments
1. 2/23	Research claws that would fit this years challenge	10:00 am - 10:30 am	WA, LB	Did research on different claws, concluded to use 2 different claws so we would be able to pick up the dinosaurs and the cage. Also redesigned the legs and wheels.
2. 2/26	Finish printing the frame	7:00 pm - 7:20 pm	LB	Printed the frame of the drone, as well as the legs and wheels.
3. 2/28	Begin building the drone	9:30 am - 10:35 am	LB, WA, JL	We began to build the basic frame, gluing it together. Attached the flight computer to the center of the frame and began to solder/attach different components of the drone to the flight computer. ESC boards, XT 60, motors, receiver, etc
4. 2/30	Continue building the drone	9:30 am - 10:35 am	LB, WA, JL	Continued what was not finished the day before. Also, 3D printed and constructed the cage that would hold the servo to move the wheel, to be able to move the drone on top of/near the object.
5. 3/1	Find solutions for issues we had last year	4:30 pm - 5:15 pm	LB, WA	A problem that we ended up having last year was that our motors ended up pulling too much current from the buck converter, which led to the buck converter blowing. To fix this problem, we looked online and bought a new buck converter that would be able to handle the current.
6. 3/4	Continue with the drone	9:45 am - 10:30 am	WA, JL	Installed the new buck converter and wired the battery into the input of the buck converter. The output leads to the wheel servos, claw servos, and the Arduino

TECHNOLOGY STUDENT ASSOCIATION WORK LOG

Date	Task	Time involved	Team member responsible (student initials)	Comments
1. 3/8	Make sure the drone is able to fly	10:00 am - 10:15 am	JL, WA, LB	Did our first test flight with the drone. We had some concerns about the weight, but decided that we needed all of the components on the drone. It still flew fine but needed more throttle than we wanted.
2. 3/12	Do more documentation and more research on a claw design	4:30 pm - 5:15 pm	JL	Continued to update documentation. Also, did some research on what the best type of claw for the drone would be in the scenario. Extended the wires from the servos for the wheels.
3. 3/13	Print wheels	7:00 pm - 7:30 pm	LB	Printed the tire of the wheel that would be placed around the rim that was printed. Used TPU which is a bit rubbery
4. 3/15	Work on secondary remote	9:45 am - 10:30 am	WA, LB	Started to construct the remote that would control the wheel servos and the claw servo. We had a design from last year that we decided to reuse but make it easier to control.
5. 3/16	Begin designing the legs and housing for servos	6:30 pm - 6:45 pm	LB, WA	Design the leg and servo housing that will hold in the wheel servos and connect it to the rest of the frame.
6. 3/17	Print what was previously designed	5:00 pm - 5:15 pm	LB	3D print the servo housing that we designed the day before, and print the legs that connect the housing to the wings of the frame. This was all printed out of black PETG.

TECHNOLOGY STUDENT ASSOCIATION WORK LOG

Date	Task	Time involved	Team member responsible (student initials)	Comments
1. 3/18	Begin assembling the legs	9:00 am - 10:15 am	LB, WA, JL	Take all of the parts that were printed overnight and begin to assemble the leg and servo housing, this consists of screwing in the servo into the housing and then connecting the housing to the leg with screws then put the top cap over the servo to keep it locked in.
2. 3/19	Continue the work for the day before	9:30 am - 10:35 am	LB, WA, JL	Took the housing that we previously made and connected the wheel rim and the tire. This consists of taking the servo horn and screwing it into the rim, then pressing it onto the end of the servo, then screwing that in, then just sliding the rubber tire on.
3. 3/20	Connect the legs to the drone frame	8:45 am - 9:30 am	LB, WA, JL	Now that the wheel assembly is complete we need to attach it to the rest of the drone, this is done by using 2 screws and a bit of glue. This is closer to the actual weight of the completed drone so we can do another lift test. The drone was able to fly with all of the extra weight.
4. 3/21	Continue work for secondary controller	9:45 am - 10:35 am	LB, WA	Continue to work on the remote for the wheels and claw, which meant taking the previous year's one and moving all of the parts to the new one, this is because we are using most of the same components
5. 3/23	Begin working on the camera for the drone	5:35 pm - 7:00 pm	LB	DJI 04 air unit arrived. The wire that connects the air unit to the flight computer was too short for our needs, so the wire's length was extended. It was plugged into the wire to the flight computer and soldered the positive to the board. After it was plugged into the air unit and battery
6. 3/24	Set up the DJI camera	10:00 am - 10:30 am	LB	After the air unit was installed, it needed to be set up, This included downloading the DJI assistant to activate the air unit and to make sure the firmware was up to date. Then by using the pairing button on both the DJI goggles and the air unit, we paired the goggles to the drone.

TECHNOLOGY STUDENT ASSOCIATION WORK LOG

Date	Task	Time involved	Team member responsible (student initials)	Comments
1. 3/28	Clean up drone	9:00 am - 10:10 am	WA, LB, JL	Begin to tidy up the wires from the wheel motors, which meant adding on extension wires so that the wire can reach where we need it to go, then we began securing the wires to the legs and up into the bottom of the drone next the buck converter.
2. 4/3	Design a mount for the camera	6:00 pm - 6:50 pm	WA	Designed a way to tilt the camera up and down, this will allow us to use the camera to view the message around the course. This consisted of 3d printed arms and a spot to mount the camera and a small servo, this will be connected to the secondary controller.
3. 4/4	3D print the camera mount	8:45 am - 9:30 am	WA	3D print the arms designed to tilt the camera and assemble the mechanism, this consisted of screwing in the camera and the servo and adding in 3mm rods as joints to allow parts to rotate about them.
4. 4/5	Update Documentation	6:00 pm - 8:00 pm	JL, LB	Continue to work on the documentation and update all of the progress that we have made over the past couple of days
5. 4/7	Finish up wiring	9:00 am - 9:50 am	WA, LB	Wrote out a wiring diagram of the secondary remote so that we can write the code Soldered the servo wires, the power wires, and the wires for the NRF to an Arduino nano. Routed all of the power wires together and put them in wire ferrules and slid them in to a wago connector that connects it to the buck converter
6. 4/7	Finish secondary controller	6:30 pm - 8:00 pm	WA, LB, JL	Started to screw the bottom back on and route the wires at the same time. wrote the code that was needed so that we could use the secondary remote to send a signal via the NRF then receive the signal with the NRF on the drone to send the signal to the arduino to move the wheels and claw

TECHNOLOGY STUDENT ASSOCIATION WORK LOG

Date	Task	Time involved	Team member responsible (student initials)	Comments
1. 4/9	Test the drone	6:00 pm - 6:15 pm	JL, LB	Test flew the drone. Tried different propellers and battery sizes to see which would work best. We also made sure that the drone flew smoothly, as we were concerned about the weight
2. 4/11	Design and 3D print the claw	7:00 pm - 8:00 pm	LB, JL, WA	Designed the claw and the prop guards that are required for the drone
3. 4/12	Update Documentation and design prop guards	10:00 pm - 12:00 pm	JL, WA, LB	Updating parts of documentation, like Bill of Materials and Wiring Schematics. Design prop guards as they are required for the drone this year.
4. 4/14	Finish claws and make sure secondary controller works	8:00 am - 10:30 am	JL, WA, LB	Print the claw and attached it to the drone. Made sure that the secondary controller worked with the claw, servos, and camera
5. 4/15	Finish up documentation	7:00 pm - 8:30 pm	JL, WA	Got all the wiring diagrams, fusion drawings and uploading most of the photos besides testing
6. 4/16	Testing and trial run	9:00 am - 10:00 am	WA, LB, JL	Did a trail run of the challenge using paint bottles as the dinosaur. We also flew through obstacles and looked at numbers through our camera to ensure we were prepared

TECHNOLOGY STUDENT ASSOCIATION WORK LOG

Date	Task	Time involved	Team member responsible (student initials)	Comments
1. 4/18	Print and attach the prop guards	6:00 pm - 7:15 pm	JL, LB	Designed the prop guards in fusion and 3D printed them. After attached them to the drone.
2. 4/19	Begin designing and printing the mounts for the secondary claw	10:00 am - 10:30 am	WA	Made a 3D file for the mounts that would hold the servos for the front claw. We decided to have a front claw in order to make the weight distrubuted more evenly.
3. 4/20	Print the secondary claw	10:00 pm - 11:20 pm	WA, LB	We printed out the mounts and the secondary claw was also printed out
4. 4/21	Connect wires for the secondary claw	8:00 pm - 10:30 pm	WA, LB	Attached the servos to the mount and connected the servo wire to the Arduino.
5. 4/22	Testing and trial run	3:00 pm - 4:30 pm	JL, WA, LB	Did one final trial run, ensuring all the drone components worked.
6. 4/22	Finish up documentation	4:40 pm - 6:30 pm	JL	Completely finished documentation, updating the photo log, work log and downloaded the documentation onto USB.

TECHNOLOGY STUDENT ASSOCIATION WORK LOG

Date	Task	Time involved	Team member responsible (student initials)	Comments
1. 5/2	Come up with plan to adjust drone	3:00 pm - 7:30 pm	JL, LB, WA	Our drone was too tall to pick up the cage that the dinosaurs were in so our first step was to come up try and fix that issue. We decided that we would make smaller wheels and lower the claw on the drone.
2. 5/16	Begin designing new wheels and claw mount in order to lower the drone	10:30 am - 12:30 pm	JL, WA	Came up and designed a new way to attach the claw of the drone in order to pick up the cage. Also scaled the wheels down in order to lower the overall body of the drone.
3. 5/20	Make new propguards	4:00 pm - 6:00 pm	LB	Previous prop guards were weak and broke on impact so we redesigned them in order to make them stronger and able to withstand the impact of landing
4. 6/4	Print the new designs of the claw mount and wheel	3:30 pm - 4:00 pm	LB	Took the new designs and printed them out on 3D printer
5. 6/14	Attach all new components to drone	6:00 pm - 9:30 pm	JL, LB, WA	After all our new designs were printed out, we attached them to the drone. It lower the drone around an inch which would allow the drone claw to slip into the cage and not be blocked by the middle bar.
6. 6/20	Make sure everything worked and update fix up documentation.	12:00 pm - 3:30 pm	JL, LB, WA	Made sure everything on the drone as functional and tweaked the documentation to be updated.

STUDENT COPYRIGHT CHECKLIST *(for students to complete and advisors to verify)*

STUDENT: Answer question 1 below.

1) Does your solution to the competitive event integrate any type of music and/or sound? ☑ YES ☐ NO
   If NO, go to question 2.
   If YES, is the music and/or sound copyrighted? ☐ YES ☑ NO
   If YES, move to question 1A. If NO, move to question 1B.
   1A) Have you asked for author permission to use the music and/or sound in your solution and included that permission (letter/form) in your documentation? If YES, move to question 2. If NO, ask for permission and if permission is granted, include the permission in your documentation.
   1B) Is the music/sound royalty free, or did you create the music/sound yourself? If YES, cite the royalty free music/sound OR your original music/sound properly in your documentation.

CHAPTER ADVISOR: Sign below regarding your student's answer(s) to the use of music/sound in his/her competitive event solution. Even if your student answers "NO" to question 1, please sign below noting that you have evaluated the competitive event solution and the student answered the question(s) accurately.

I, ______________________ (chapter advisor), have checked my student's solution and confirm that any use of music/sound is done so with proper permission and is cited correctly in the student's documentation and/or the solution has been found to have no music/sound included.

STUDENT: Answer question 2 below.

2) Does your solution to the competitive event integrate any graphics/videos? ☑ YES ☐ NO
   If NO, go to question 3.
   If YES, is(are) the graphics/videos copyrighted, registered and/or trademarked? ☐ YES ☑ NO
   If YES, move to question 2A. If NO, move to question 2B.
   2A) Have you asked for author permission to use the graphics and/or videos in your solution and included a permission (letter/form) in your documentation for graphic/video used? If YES, move to question 3. If NO, ask for permission and if permission is granted, include the permission in your documentation.
   2B) Is(are) the graphics/videos royalty free, or did you create your own graphic? If YES, cite the royalty free graphics/videos OR your own original graphics/videos properly in your documentation.

CHAPTER ADVISOR: Sign below regarding your student's answer(s) to the use of graphics/videos in his/her competitive event solution. Even if your student answers "NO" to question 2, please sign below noting that you have evaluated the competitive event solution and the student answered the question(s) accurately.

I, ______________________ (chapter advisor), have checked my student's solution and confirm that the use of graphics/videos with proper permission and is cited correctly in the student's documentation and/or the solution has been found to have no graphics/videos included.

STUDENT: Answer question 3 below.

3) Does your solution to the competitive event use another's thoughts or research? ☐ YES ☑ NO
   If NO, this is the end of the checklist.
   If YES, have you properly cited other's thoughts or research in your documentation? ☐ YES ☐ NO

   CHAPTER ADVISOR: Sign below regarding your student's answer(s) to having integrated any thoughts/research of others in his/her competitive event solution. Even if your student answers "NO" to question 3, please sign below noting that you have evaluated the competitive event solution and the student answered the question(s) accurately.

   I, ______________________ (chapter advisor), have checked my student's solution and confirm that the use of the thoughts/research of others is done so with proper permission and is cited correctly in the student's documentation and/or the solution has been found to have all original thought with no use of other's thoughts/research.

Student Initials: JL, LB, WA

Chapter Advisor Signature: ______________________