

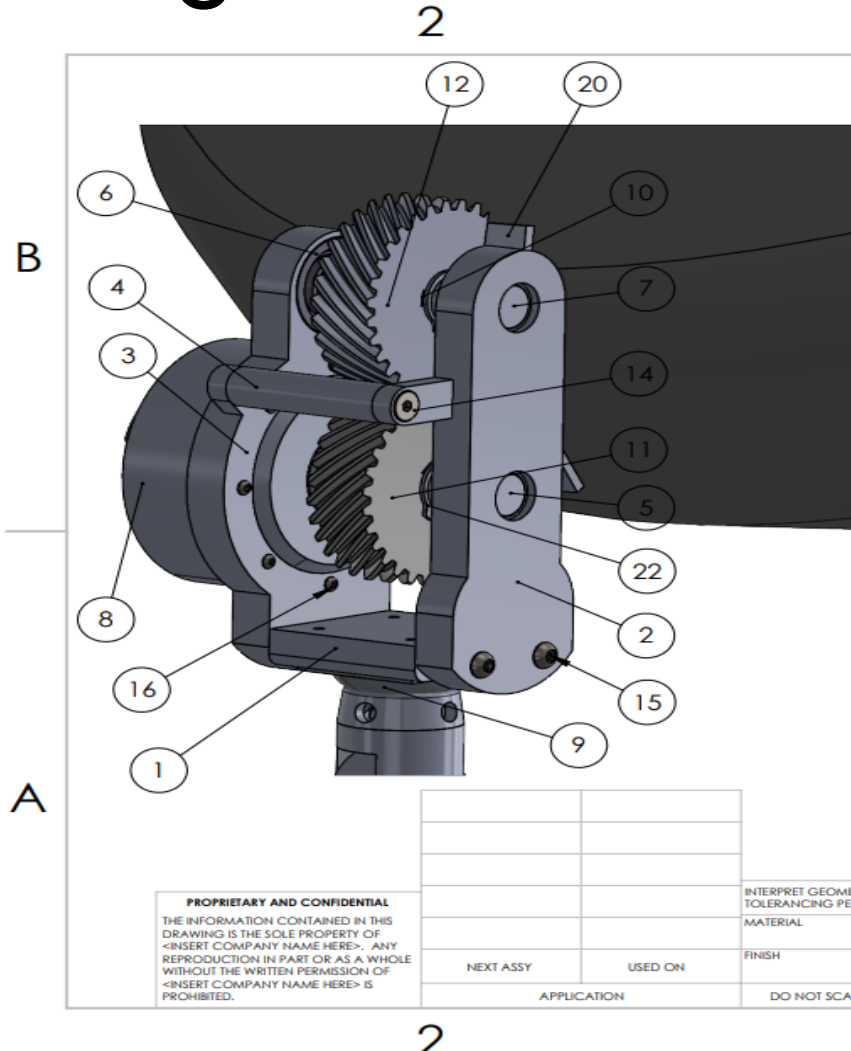
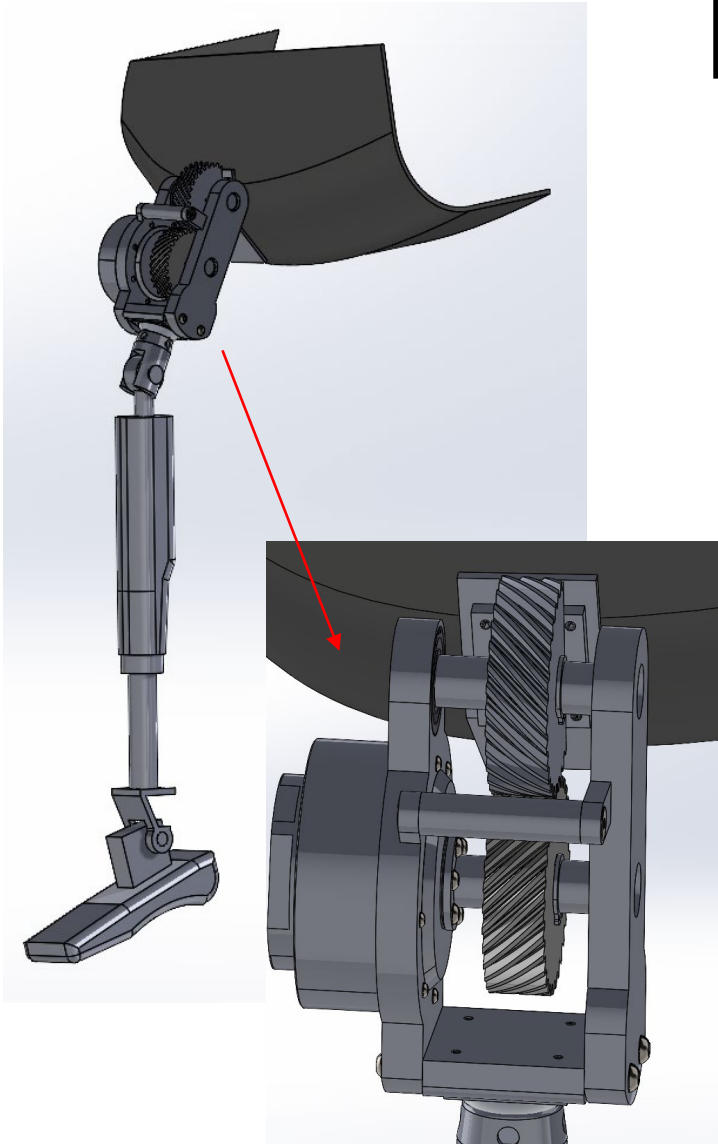
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# MECHANICAL HIP PROSTHETIC HORIZON HIP

AIDEN CAMISA, VICTORIA LYON,  
MATT MARTINEZ, QUINN O'NEILL



# Design Efforts – CAD

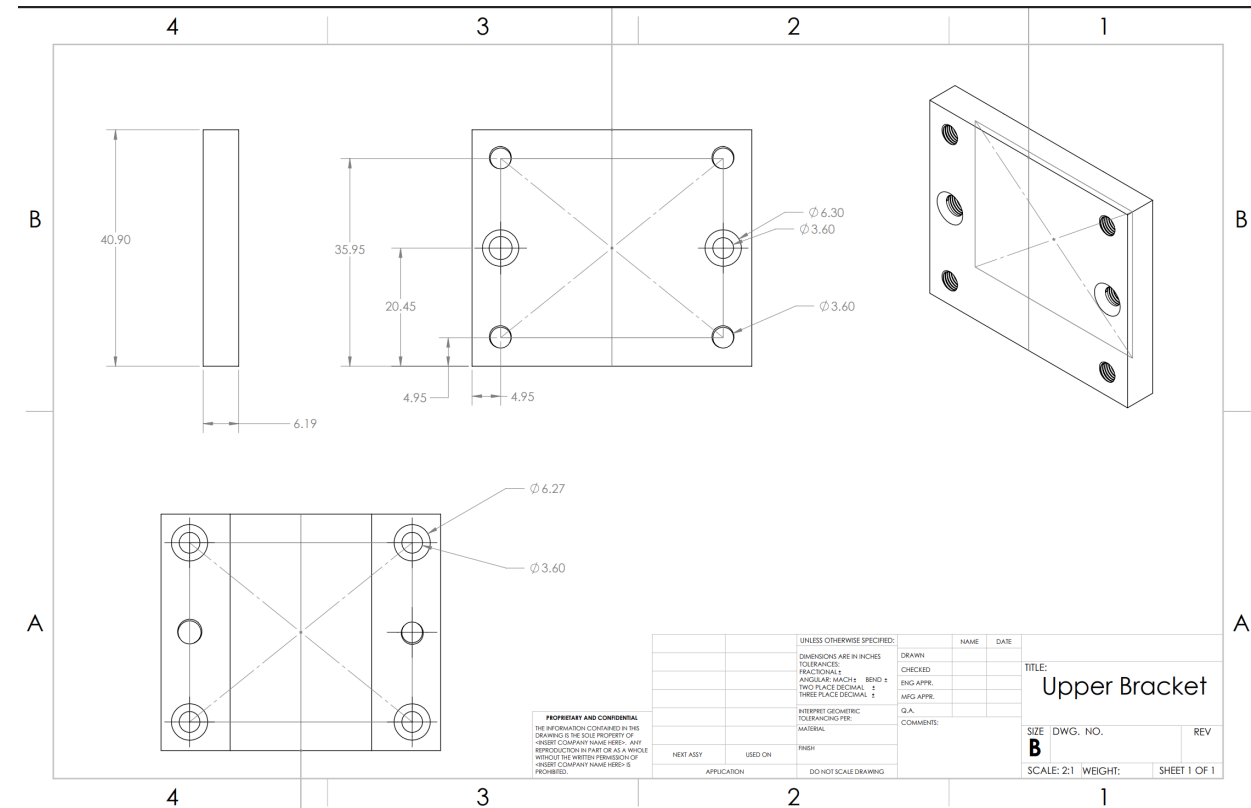
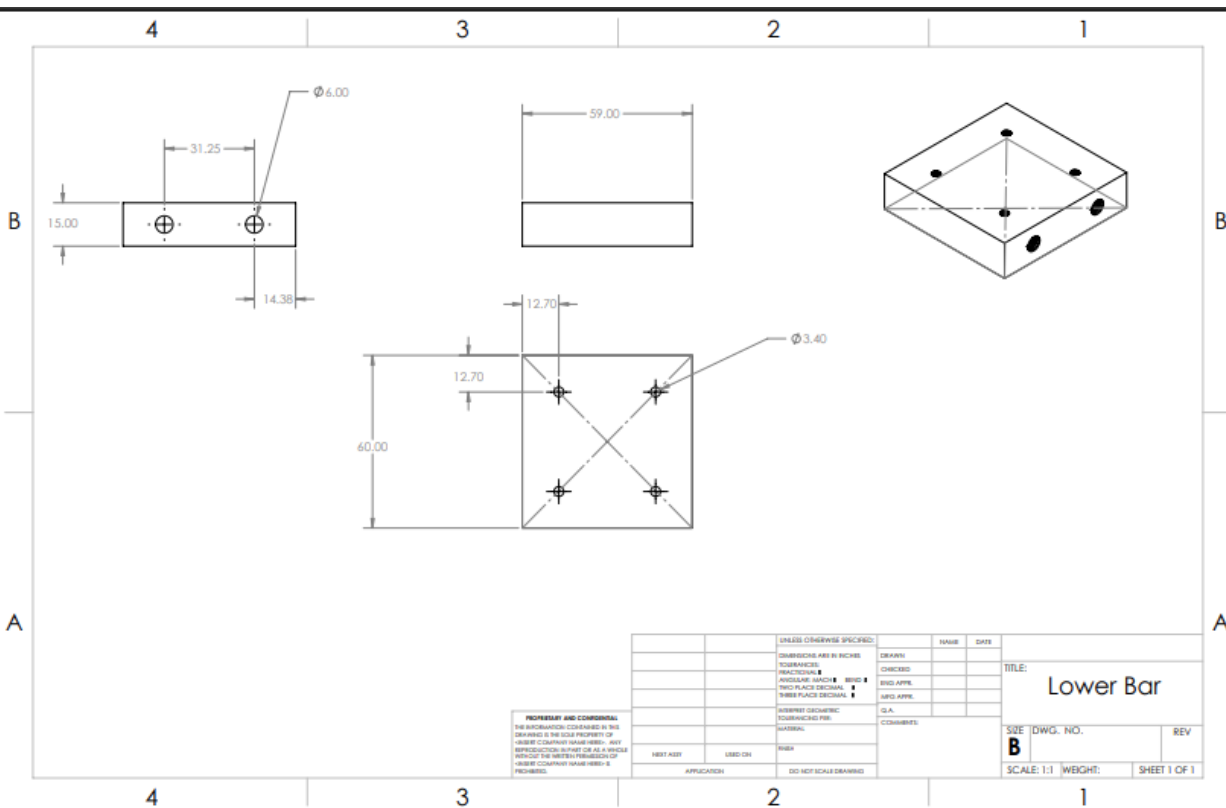


ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Base Plate	Aluminum	1
2	Bearing Side Bracket	Aluminum	1
3	Motor Side Bracket	Aluminum	1
4	Structural Bar	Aluminum	1
5	Lower Shaft	Steel	1
6	7203B Bearing	Angular Contact	3
7	Upper Shaft	Steel	1
8	Motor- AK80-64	CubeMars	1
9	Male Pyramid Adapter	TruLife	1
10	Shaft Key	Steel	2
11	1030L Gear	BostonGear	1
12	Cut 1030R Gear	BostonGear	1
13	Upper Shaft Bracket	Aluminum	1
14	M - 6 x 1.0 x 20 Countersunk	Part 4 fastener	2
15	M - 6 x 1.0 x 20	Frame to base fastener	4
16	M - 3 x 0.5 x 10	Frame to motor fastener	8
17	M - 4 x 0.7 x 10	Shaft to motor fastener	6
20	Lamination Plate	Joint to socket attachment	1
22	Retaining Ring- dsr-19	RotorClip	4

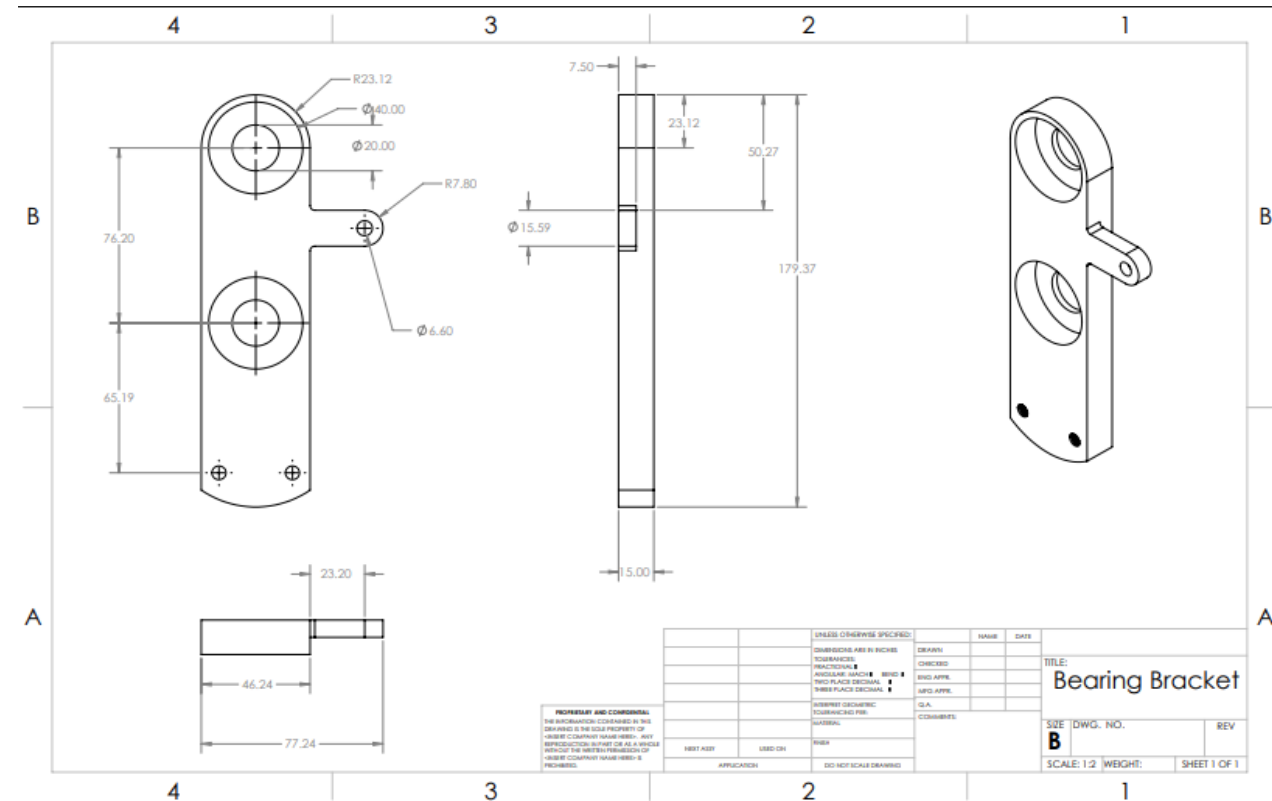
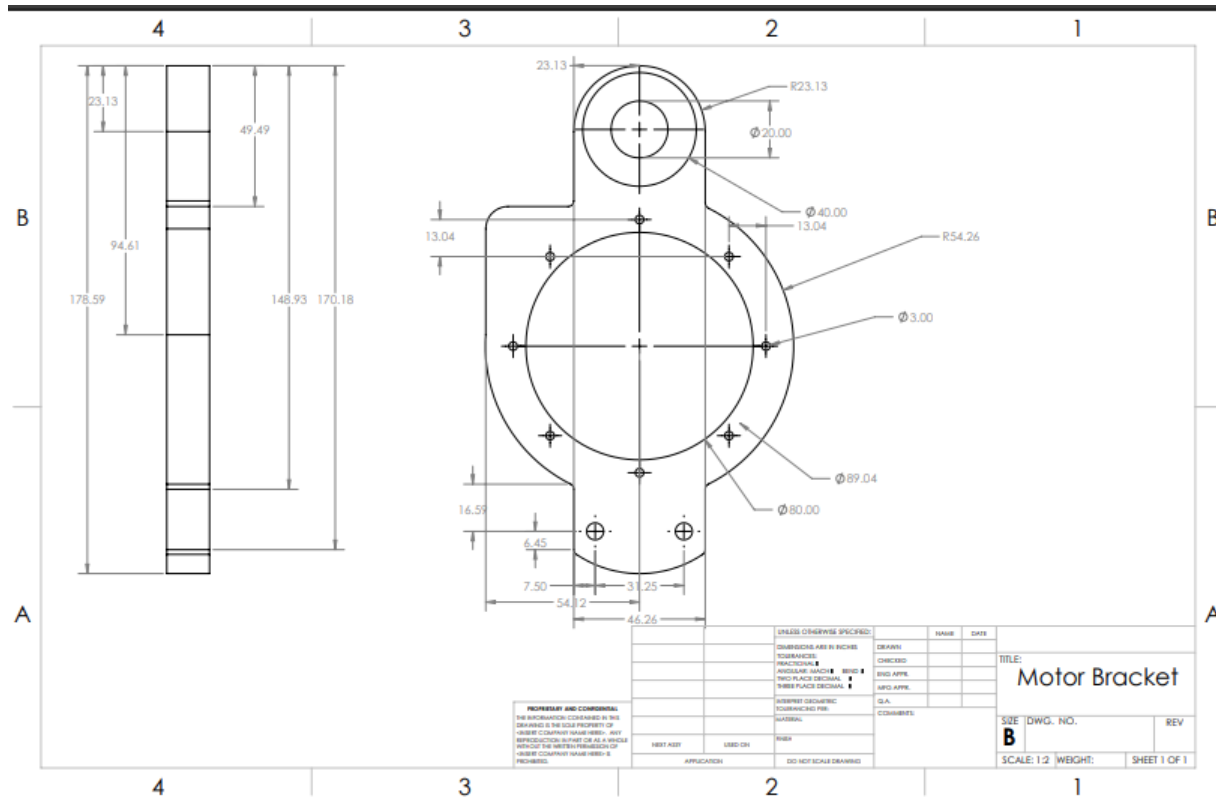
  

CHECKED		TITLE:
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		
INTERPRET GEOMETRIC TOLERANCING PER:		SIZE DWG. NO. REV
MATERIAL		<b>A</b> Full Build
FINISH		SCALE: 1:16 WEIGHT: SHEET 1 OF 1
NEXT ASSY	USED ON	
APPLICATION	DO NOT SCALE DRAWING	

# Design Efforts – Drawings



# Design Efforts – Drawings



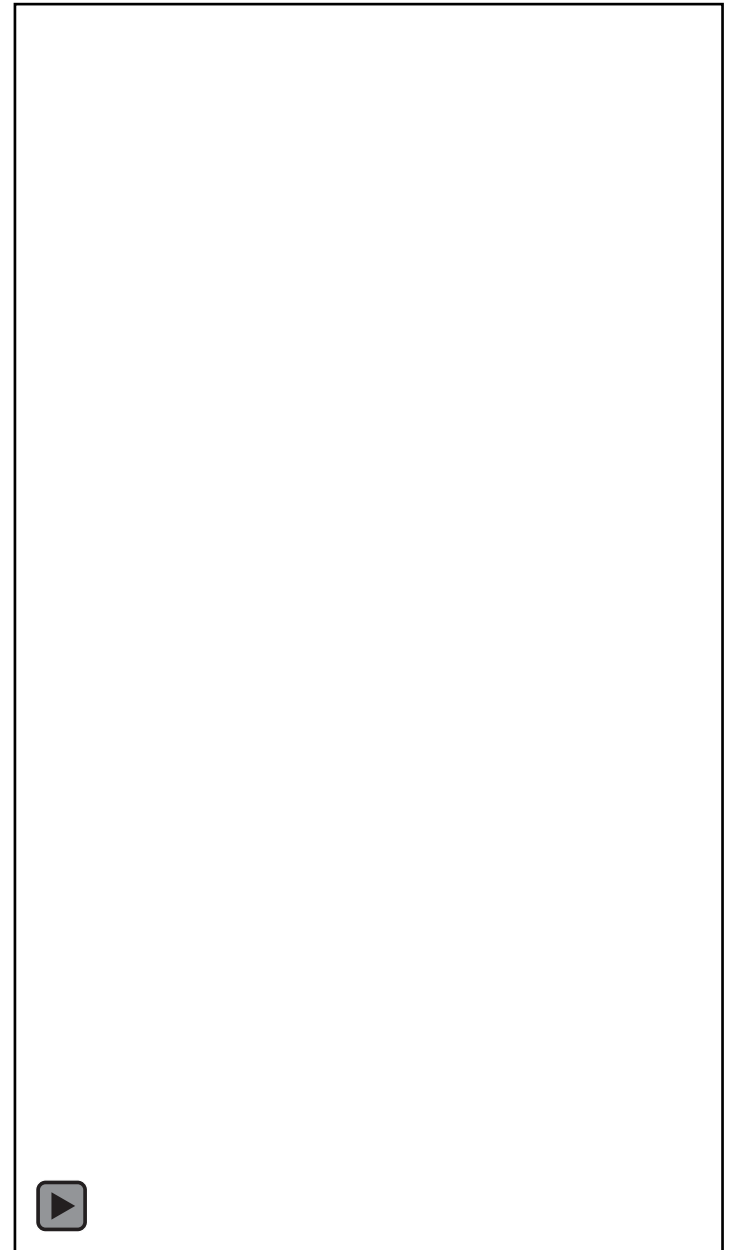
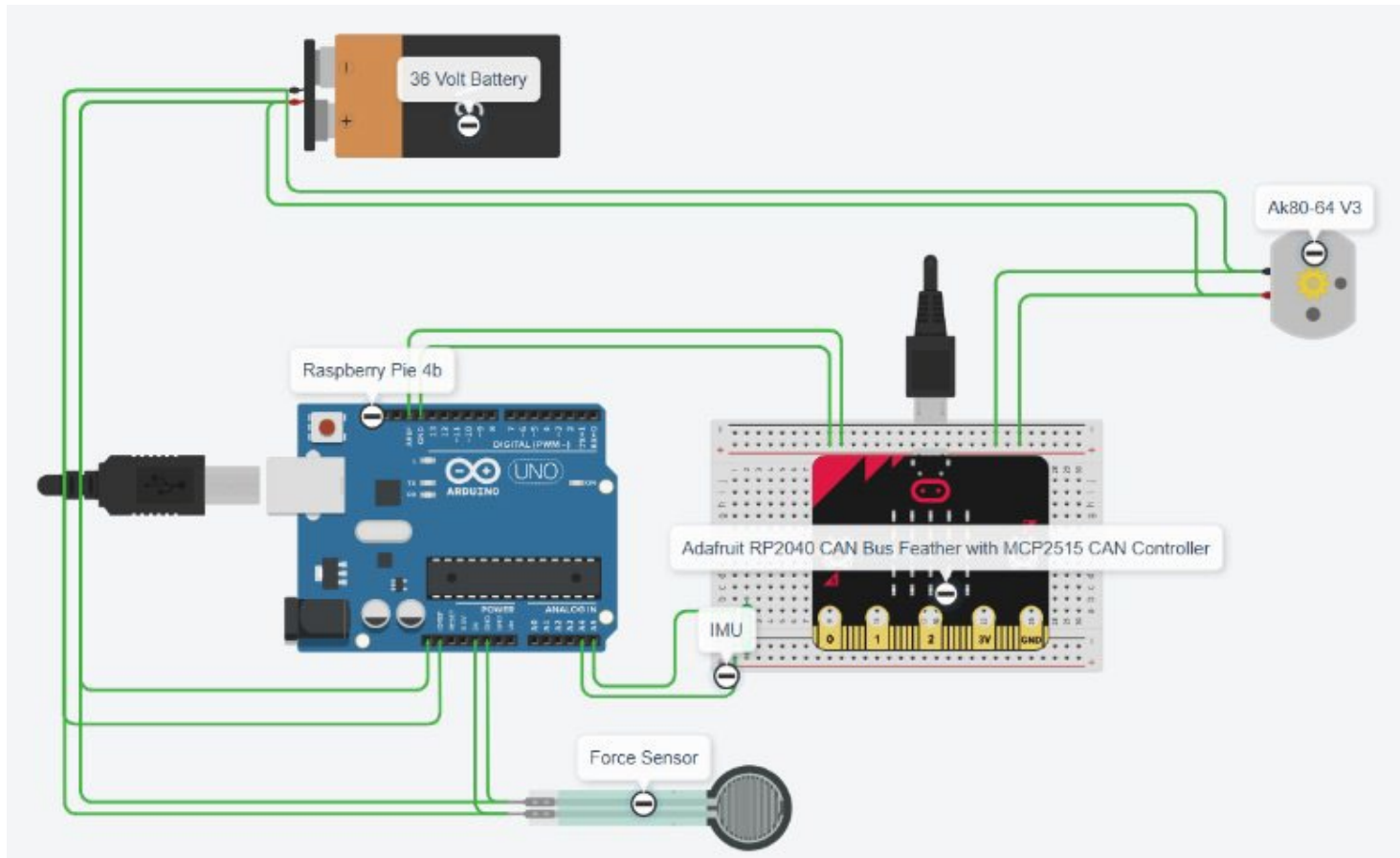
# Design Efforts - Electrical

```
1  /* V1 1/30/26
2  |      Adding switch case to evaluate motor set position function
3  |      Changed the counter for can read to be >7 not >8
4  */
5
6  // I2C Communication
7  #include <Wire.h>
8  #define SDA_WI (D0) //TX
9  #define SCL_WI (D1) //RX
10 #define ADDR_1 (8) //peripheral address
11 #define ADDR_0 (64) //peripheral address
12 uint8_t state = 0x00;
13
14 // CANBUS Communication
15 #include <Adafruit_MCP2515.h>
16 #define CS_PIN (D19) // From schematic: \Users\Dante\Documents\Arduino\libraries\Adafruit_MCP2515\src\Adafruit_MCP2515.h
17 #define CAN_BAUDRATE (1e6)
18 #define MTR_ADDR (0x01) //0x68 for v3 motor, 0x01 for v1 motor
19 #define MTR_FREQ (100)
20 #define CAN_LEN (8)
21 Adafruit_MCP2515 mcp(CS_PIN);
22 uint8_t can_recv[CAN_LEN];
23 uint8_t can_send[CAN_LEN];
24 uint8_t set_pos[CAN_LEN] = {0,0,0,0,0,0,1};
25 uint32_t mtr_cmd = 0x0;
26
27 uint cur_time = micros();
28
29 char x = 0;
30
31 void setup() {
32   Serial.begin(115200);
33
34   // set Wire 0 (ADD_0) to send data
35   Serial.println("Establishing I2C bus 1: REQUEST BUS"); Serial.print(' ');
36   Wire.begin(ADDR_0); // join i2c bus (join as peripheral because we have an address)
37   Wire.onRequest(requestEvent); // register event
38
39   // set Wire 1 (ADD_1) to receive data
40   Serial.println("Establishing I2C bus 2: RECV BUS"); Serial.print(' ');
41   Wire1.setSDA(SDA_WI);
42   Wire1.setSCL(SCL_WI);
43   Wire1.begin(ADDR_1); // join i2c bus with address #8
44   Wire1.onReceive(receiveEvent); // register event
45
46   // Set up Can bus
47   Serial.println("Establishing CAN BUS"); Serial.print(' ');
48   if (!mcp.begin(CAN_BAUDRATE)) {
49     Serial.println("Error initializing MCP2515.");
50     while(1) delay(10);
51   }
52   Serial.println("MCP2515 chip found");
53   cur_time = micros();
54 }
55
```

```
56 void loop() {
57   int peak_time = micros();
58   if ((peak_time - cur_time) > 1e5 / MTR_FREQ){
59     // Send communication to motor
60     cur_time = peak_time;
61
62     // Interpret data - byte 0 (first byte) is the "state"
63     switch(state){
64     case 0x01: // Motor on (direct control of motor from RPI)
65       mtr_cmd = 0x00 | MTR_ADDR; // command 7 for v1 and 8 for v3
66       CAN_Send(mtr_cmd, &can_send[0], 8);
67       break;
68     case 0x02: // set position
69       mtr_cmd = 0x80 | MTR_ADDR; // should give us 0x808
70       CAN_Send(mtr_cmd, &set_pos[0],8);
71       break;
72     default:
73       break;
74     }
75
76     //Serial.println(" sent packet");
77
78     int packetSize = mcp.parsePacket();
79
80     if (packetSize) {
81       // received a packet
82       //Serial.println("Received ");
83       //Serial.println("packet with id 0x");
84       //Serial.println(mcp.packetId(), HEX);
85
86       if (mcp.packetRtr()) {
87         Serial.print(" and requested length "); Serial.print(' ');
88         Serial.println(mcp.packetDlc()); Serial.print(' ');
89       } else {
90         Serial.print(" Received "); Serial.print(' ');
91         //Serial.println(packetSize);
92         // only print packet data for non-RTR packets
93         byte i = 0;
94         while (mcp.available()) { // extract data from buffer
95           can_recv[i] = mcp.read();
96           Serial.print(can_recv[i], HEX); Serial.print(' ');
97           i++;
98           if(i >= CAN_LEN){
99             break;
100          }
101        }
102        Serial.println("");
103      }
104    } else {
105      // don't do anything
106    }
107
108   }
109 }
110
111 void CAN_Send(uint32_t cmd_id, uint8_t *data_addr, int len){
112   mcp.beginPacket(cmd_id, len, false);
113   Serial.print("Command "); Serial.print(cmd_id, HEX); Serial.print(' ');
114   for(byte i = 0; i < len; i++){
115     Serial.print(*(data_addr+i), HEX); Serial.print(' ');
116     mcp.write(*(data_addr+i));
117   }
118   mcp.endPacket();
119   Serial.println("");
120 }
121
122 // function that executes whenever data is requested by master
123 // this function is registered as an event, see setup()
124 void requestEvent() {
125   Wire.write(can_recv, 8); // respond with message of 8 bytes
126   // as expected by master
127 }
128
129 void receiveEvent(int howMany){
130   int i = 0;
131   Serial.print("from rpi "); Serial.print(' ');
132   while(Wire1.available()) // loop through all but the last
133   {
134     char c = Wire1.read(); // receive byte as a character
135     Serial.print(c,HEX); Serial.print(' ');
136     if (i == 0){
137       state = c;
138     } else if (i > 0){
139       can_send[i-1] = c; // -1 because must start at index 0.
140     }
141     i = i+1;
142   }
143   Serial.println("");
144 }
145
```

---

# Design Efforts - Electrical



# Purchasing Plan - Budget

Hip Prosthetic Bill of Materials

Category	Item No	Description	Primary Vendor	Unit Price	Quantity	Make/Buy	Manufacturer	Lead Time	Part Status
Main Assembly	1	<a href="#">AK80-64 KV80 Motor</a>	CubeMars	\$ 911.77	1	Buy	CubeMars		In-Hand
Main Assembly	2	<a href="#">Angular Contact Bearing</a>	MiMotion	\$ 10.83	3	Buy	Timken	3-4 Weeks	In-Hand
Main Assembly	3	<a href="#">1030L Gear</a>	Zoro	\$ 200.00	1	Buy	Boston Gears	2-3 Weeks	In-Hand
Main Assembly	4	<a href="#">1030R Gear</a>	Zoro	\$ 195.00	1	Buy	Boston Gears	2-3 Weeks	In-Hand
Main Assembly	5	Upper Shaft	NAU Machine Shop	Custom	1	Buy			In-Hand
Main Assembly	6	Lower Shaft	NAU Machine Shop	Custom	1	Buy			In-Hand
Main Assembly	7	<a href="#">Retaining Ring</a>	DSR	\$ -	2	Buy	Hillman	1 Week	In-Hand
Main Assembly	8	Shaft Key	Amazon		2	Buy		3-4 Weeks	Ordered
Main Assembly	9	Frame (Motor Side)	McMaster-Carr	\$ 46.01	1	Make		3-4 Weeks	In-Hand
Main Assembly	10	Frame (Bearing Side)	McMaster-Carr	\$ 31.55	1	Make		3-4 Weeks	In-Hand
Main Assembly	11	Mounting Bracket	McMaster-Carr	\$ 21.83	1	Buy		3-4 Weeks	In-Hand
Main Assembly	12	Base Plate	McMaster-Carr	\$ 16.02	1	Make		3-4 Weeks	In-Hand
Main Assembly	13	<a href="#">Male Pyramid Adapter</a>	Ebay	\$ 25.00	1	Buy		N/A	In-Hand
Main Assembly	14	Structure Enforcing Bar	McMaster-Carr		1	Make		3-4 Weeks	In-Hand
Hardware	15	M6-1x25 Bolt	HomeDepot	\$ 3.75	4	Buy	Everbilt	1 Week	In-Hand
Hardware	16	M6-1x20 Connector Bolt	Amazon	\$ 0.89	2	Buy	ACCU	10 days	In-Hand
Hardware	17	M3x12 Socket Cap Head Screw	Amazon	\$ 0.23	8	Buy	ACCU	10 days	In-Hand
Hardware	18	M4x10 Socket Cap Head Screw	Amazon	\$ 0.24	6	Buy	ACCU	10 days	In-Hand
Hardware	19	M6x15 Countersunk Screw	Amazon	\$ 0.84	2	Buy	ACCU	10 days	In-Hand
Hardware	20	M3x20 Countersunk Screw	Amazon	\$ 0.68	4	Buy	ACCU	10 days	In-Hand
Electronics	21	<a href="#">Power Supply 1 60 V, 5A</a>	Amazon	\$ 71.99	1	Buy	Jesverty	5 days	In-Hand
Electronics	23	<a href="#">Adafruit CAN Controller</a>	Adafruit	\$ 19.95	1	Buy	Adafruit	2-3 Weeks	In-Hand
Electronics	24	<a href="#">MicroSD Card</a>	Adafruit	\$ 13.69	2	Buy	Adafruit	2-3 Weeks	In-Hand
Electronics	25	Buck Converter	Amazon	\$ 15.99	1	Buy	YABOANG	1 Week	In-Hand
Electronics	26	<a href="#">Breadboard Jumper Wire</a>	Amazon	\$ 10.99	1	Buy	TODOELEC	5 days	In-Hand
Electronics	27	<a href="#">IMU Sensor</a>	Adafruit	\$ 6.99	2	Buy	HiLetgo	5 days	In-Hand
Electronics	28	<a href="#">USB-C to USB-C</a>	Amazon	\$ 5.00	1	Buy	Orseoose	5 days	In-Hand
Electronics	29	<a href="#">USB to USB-C</a>	Amazon	\$ 7.99	1	Buy	Basesailor	5 days	In-Hand
Electronics	30	<a href="#">RUBIK Link V2.0</a>	CubeMars	\$ 40.00	1	Make	CubeMars		In-Hand
Electronics	31	CAN Bus HAT	Waveshare	\$ 39.99	1	Buy	Waveshare		In-Hand
Electronics	32	36V Battery	Amazon	\$ 32.83	1	Buy	Amazon		In-Hand
Electronics	33	Battery Adapter	Amazon	\$ 5.82	1	Buy	Amazon		In-Hand
Electronics	34	Adapter	NAU Surplus	\$ 3.21	1	Buy	N/A		In-Hand
Electronics	35	Micro HDMI cable	BestBuy	\$ 31.81	1	Buy	Best Buy		In-Hand

<b>Total Parts:</b>	60
<b>Total Purchased:</b>	100%
<b>Total In-Hand:</b>	97%

**Expenses** \$ 2,718.11  
**Available Balance** \$ 1,781.89

# Purchasing- Manufacturing Plan

**Hip Prosthetic Bill of Materials [MANUFACTURING]**

Item No	Description	Primary Vendor	Location	Quantity	Machinist	Process	Time Spent (Hr)	Estimated Tim	Progress %	Part Status
9	Frame (Motor Side)	McMaster-Carr	NAU Machine Shop	1	Matt	Mill	0	4	0%	Ordered
10	Frame (Bearing Side)	McMaster-Carr	NAU Machine Shop	1	Matt	Mill	8	4	80%	In-Hand
12	Base Plate	McMaster-Carr	NAU Machine Shop	1	Matt/Aiden	Mill	5	3	90%	In-Hand
14	Structure Enforcing Bar	McMaster-Carr	NAU Machine Shop	1	Victoria	Lathe	4	2	100%	In-Hand
5	Upper Shaft	NAU Machine Shop	NAU Machine Shop	1	Quinn	Lathe	4	3	100%	In-Hand
6	Lower Shaft	NAU Machine Shop	NAU Machine Shop	1	Victoria	Lathe	5	3.5	80%	In-Hand
11	Mounting Bracket	McMaster-Carr	NAU Machine Shop	1	Aiden	Mill	5	1	0%	In-Hand
3	1030L Gear	Zoro	East Valley Precision Machining	1	East Valley	Wire EDM Cutting	0	1	0%	Ordered

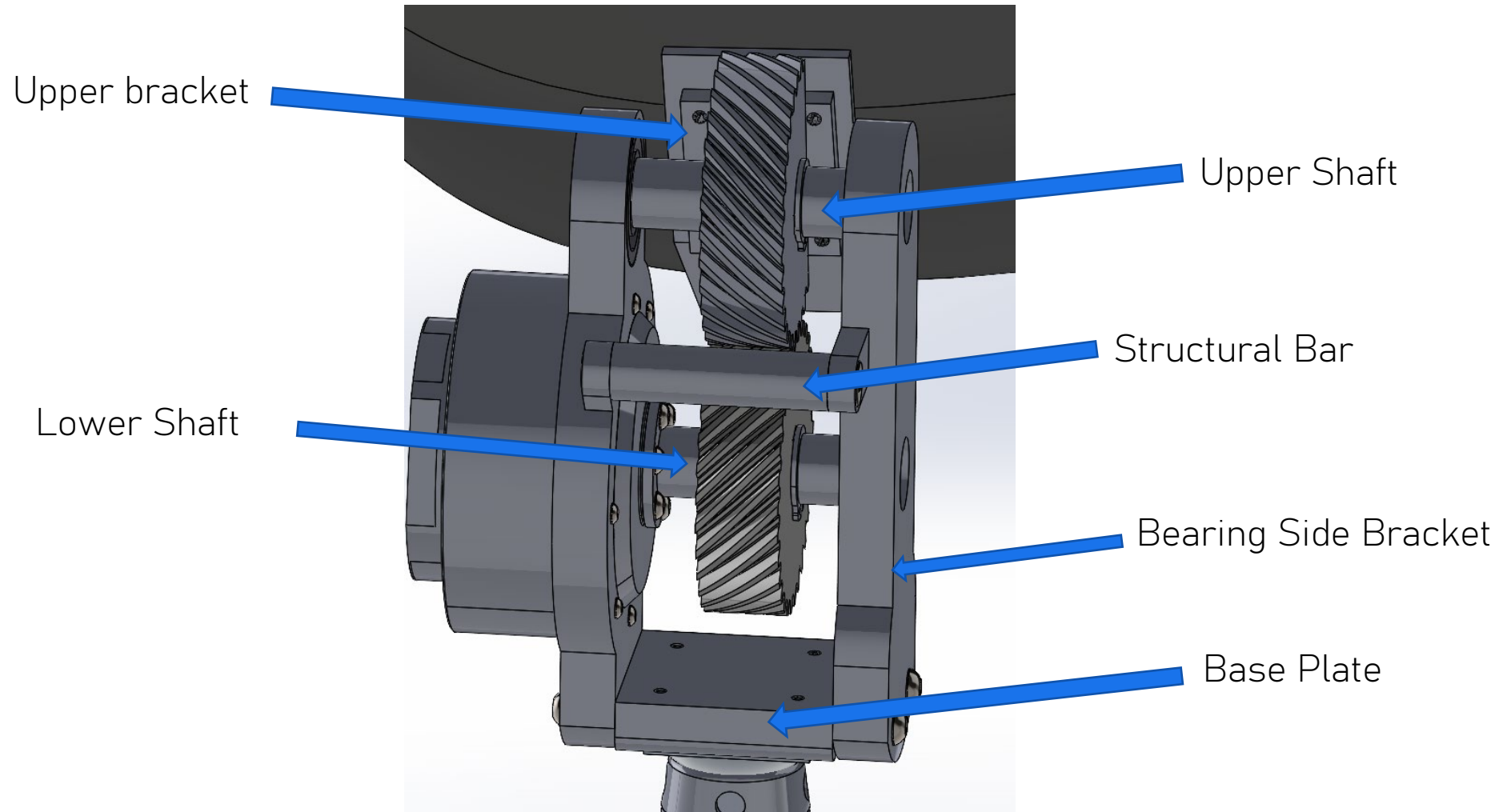
<b>Total Parts:</b>	<b>8</b>
<b>Total Time Spent:</b>	<b>31</b>
<b>Total Progress:</b>	<b>84%</b>

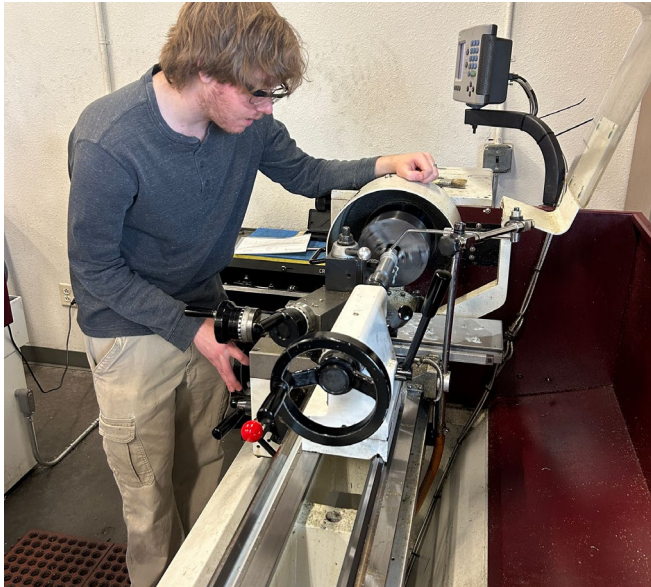
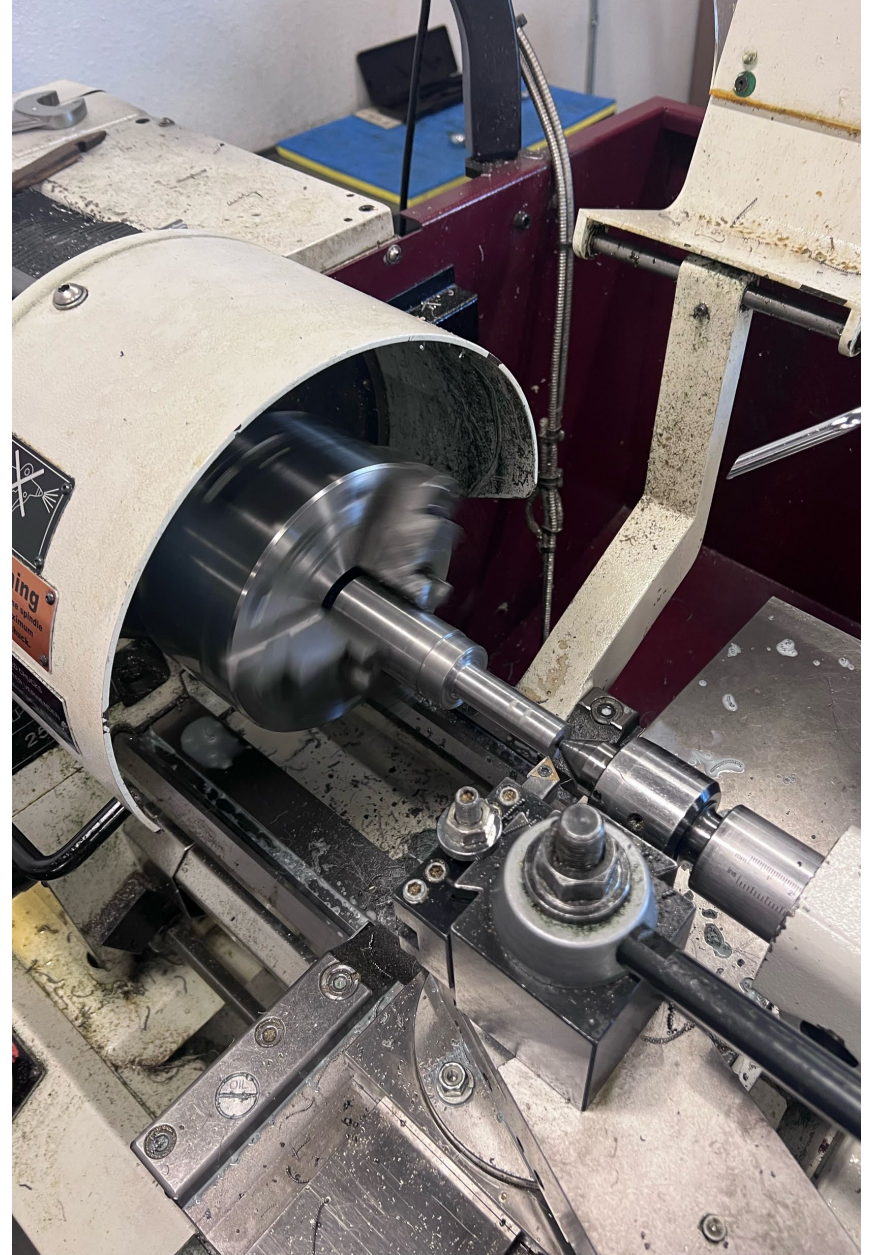
$$\text{Total progress} = \frac{\sum \text{Time spent}}{\sum \text{Time spent} + \sum \text{Estimated remaining time}}$$

31 hours spent, estimated 6 remaining

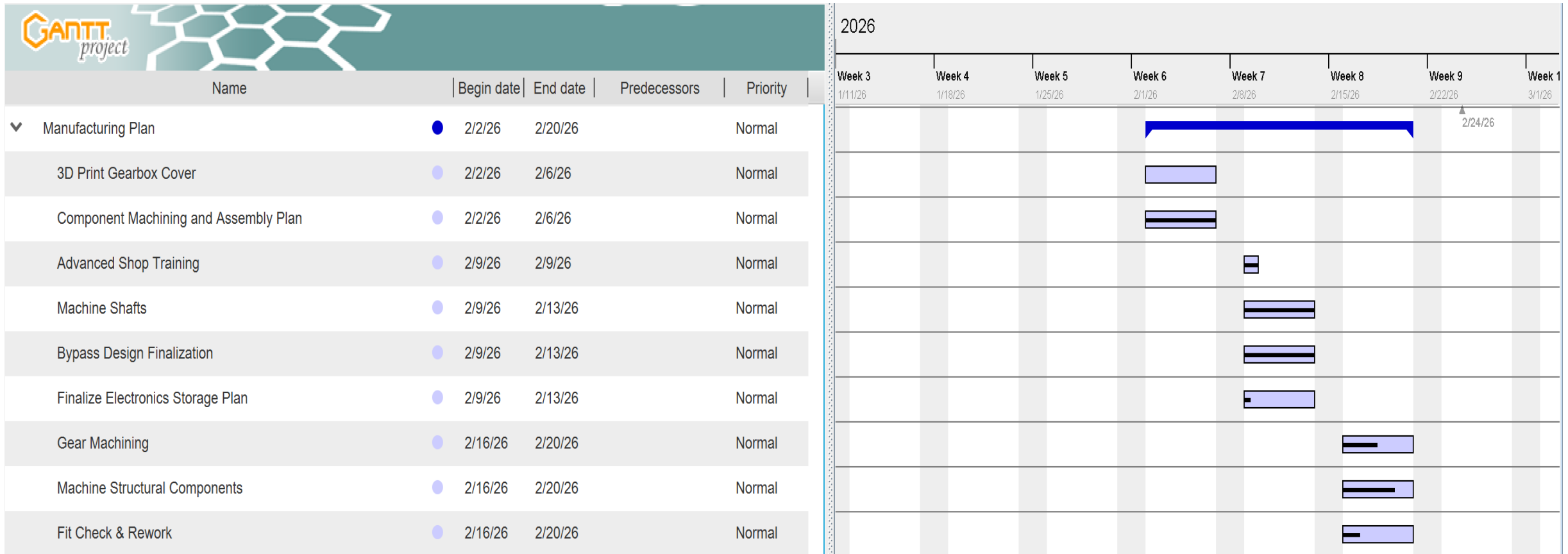
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# Physical Hardware Demonstration

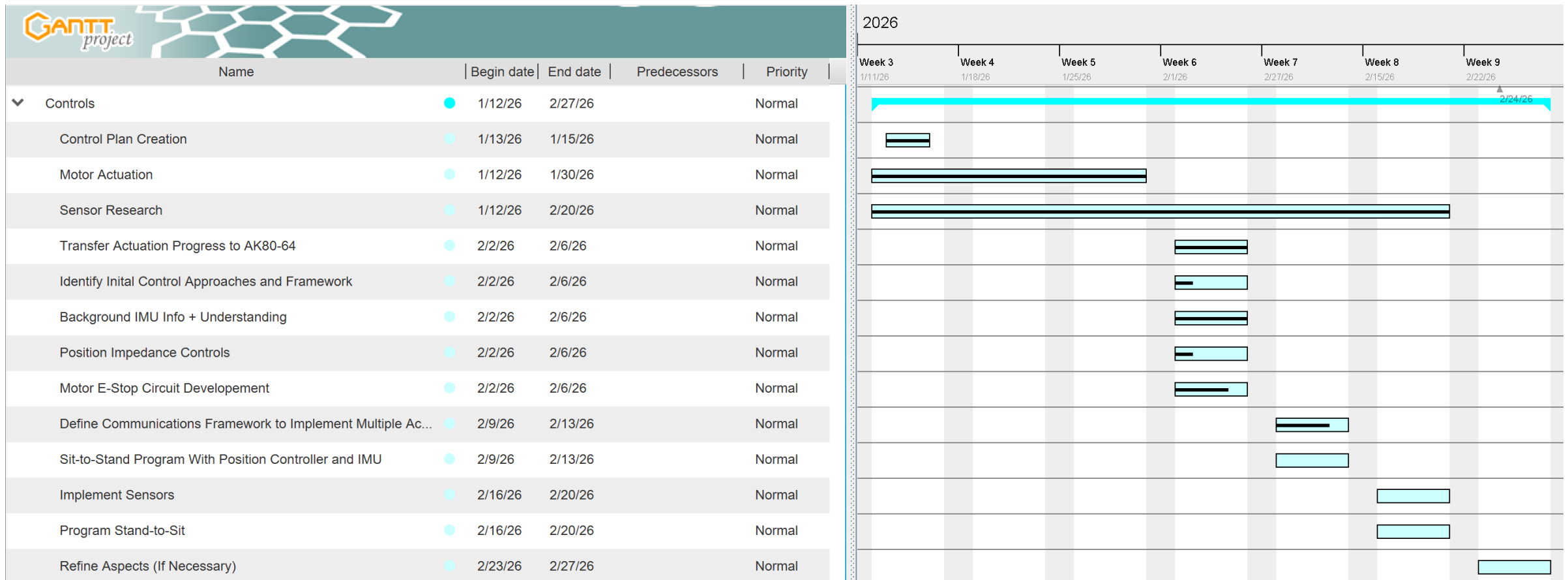




# Gantt Chart



# Gantt Chart





# Next Steps

- Finalize covering design
- Finalize material sourcing for testing
  - Attachment plate
- Assemble bypass for testing
- Integrate sensors in electrical testing
- Finalize control code for activities
- Electrical component storage

IRB approved conditionally!

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Thank you

