The Pole Patrol Final Build

The objective for this project was to design, manufacture, and test a device that provides the ability to easily manage music and phone calls without the consumer pulling out their phone or taking off their gloves. With the team's final build this was accomplished in many ways. The product has the media controls to pause, play, skip to the next track, go to the previous track, and turn the volume up or down. These functions help the user to ski while easily controlling his/her music. The phone remains safely stored, and the user's hands can stay warm in their gloves. The product is shown in Figure 1.

Figure 1: Finished Product ski pole handle on pole.

The product passed every performance measure except for the ability to answer and accept phone calls and to send text messages. Table A1 in Appendix A shows the performance measures with the pass and fail statuses, according to the tests performed. For performance measure 1, the device was tested with 15 individuals. To teach and for the person to connect and use the device it took around 55 seconds. For performance measure 6 the device was thrown high in the air, more than 25 ft, and hit the ground and analyzed. For performance measure 7, the housing and the device were held under a steady stream of water for 10 seconds and then tested again to see if the device worked properly. For performance measure 8, the device was put into a freezer for 6 hours, taken out, and tested for functionality.

Appendix B shows the Wiring Diagram for the electronics portion, the drawings for the housing, buttons for the device, and the assembly of all the components.

Appendix C shows the design team's notes for the recommended manufacturing methods, including an adjusted bill of materials for mass production.

Appendix D shows the bill of materials and the costs of manufacturing for the design as it stands right now with labor costs.

This product is not yet on the market and allows flexibility with the pricing. The team estimates that the manufacturer could start selling this product for $80 per unit and the retail price of the product is estimated at $160 a unit. However, if the manufacturers pursue injection molding, as discussed in Appendix C, along with addition of other improvements such as access to smart assistants like Siri, both manufacturers and retailers could raise selling price, lower cost of manufacturing, and increase profit margins significantly.

After testing the product against the performance measures and interviewing the ski community, a product that is both desirable and transferable has been created. The handle has large buttons so that the user can press them with gloves on, thus fulfilling the objective of allowing the user to control their music while skiing without taking their gloves off. This allows the user to keep their phone in their pocket where it is safe and to not have cold hands while changing their music. The product passed most performance measures and has shown to be a robust design even in non ideal operating conditions. The ergonomics of this product have shown that it is comfortable to the average person's hand and is easy to hold and to use. The design is simple with only 5 buttons and is intuitive to connect to and use. This is a great product and has the potential to do very well in the market.

Appendix A: Performance Measures

Table A1: Performance Measures

#	Performance Measure	Unit	Lower Bound	Ideal	Upper Bound	Actual	Pass/ Fail
1	Time to train someone to use device	s	-	60	180	**55**	**Pass**
2	Cost to manufacture	$	-	30	50	**24.37**	**Pass**
3	Device usable without removing gloves	Binary	N	Y	Y	**Y**	**Pass**
4	Battery Consumption in 8 hrs time (Full Day Ski Day)	mWh	-	10	25	**0.5**	**Pass**
5	Number of buttons the device has	#	3	4	5	**5**	**Pass**
6	Height the device can be dropped from	ft	15	20	-	**25+**	**Pass**
7	Water resistant under stream	sec	1	10	-	**10**	**Pass**
8	Temperature Test	°F	-25°	0°	100°	**Pass**	**Pass**
9	Device can control music	Binary	Y	Y	Y	**Y**	**Pass**
10	Device can answer and reject phone calls	Binary	N	Y	Y	**N**	**Fail**

11	Device allows the user to text without removing gloves	Binary	N	Y	Y	**N**	**Fail**
12	The size of the device	in^3	3.5	7.5	12	**5.449**	**Pass**
13	Distance the device can send signals	ft	10	50	-	**405**	**Pass**
14	Bluetooth Connection Time when starting an initial connection	s	-	30	60	**2**	**Pass**
15	The number of uses the device has	#	1	4	-	**2**	**Pass**

Appendix B: Drawing Package

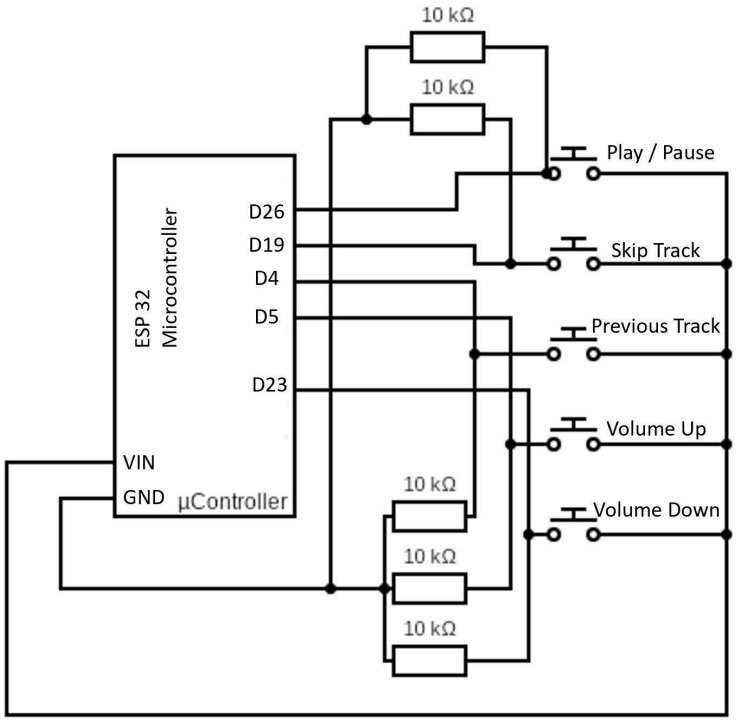


Figure B1. Electronics design

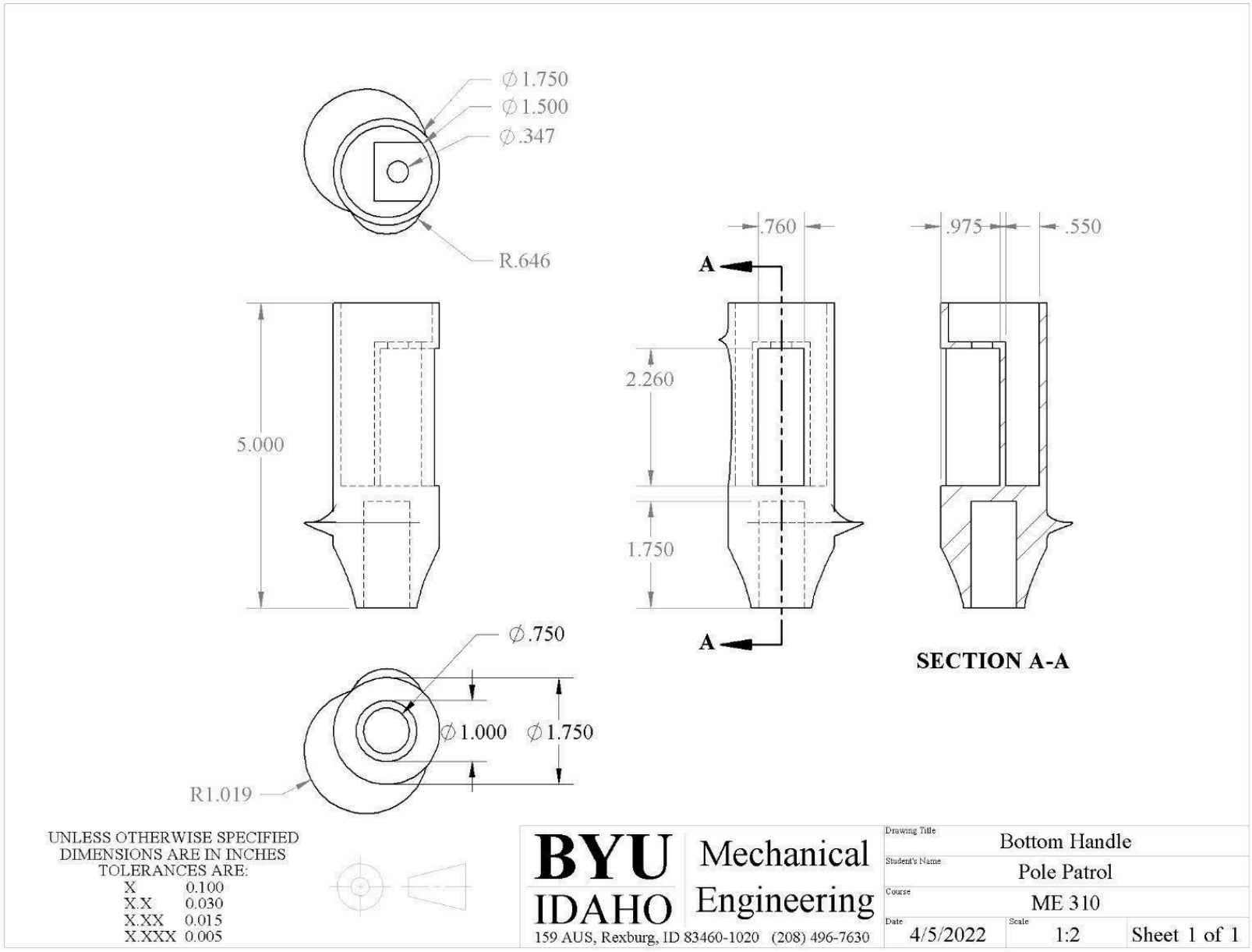


Figure B2. Button handle drawing

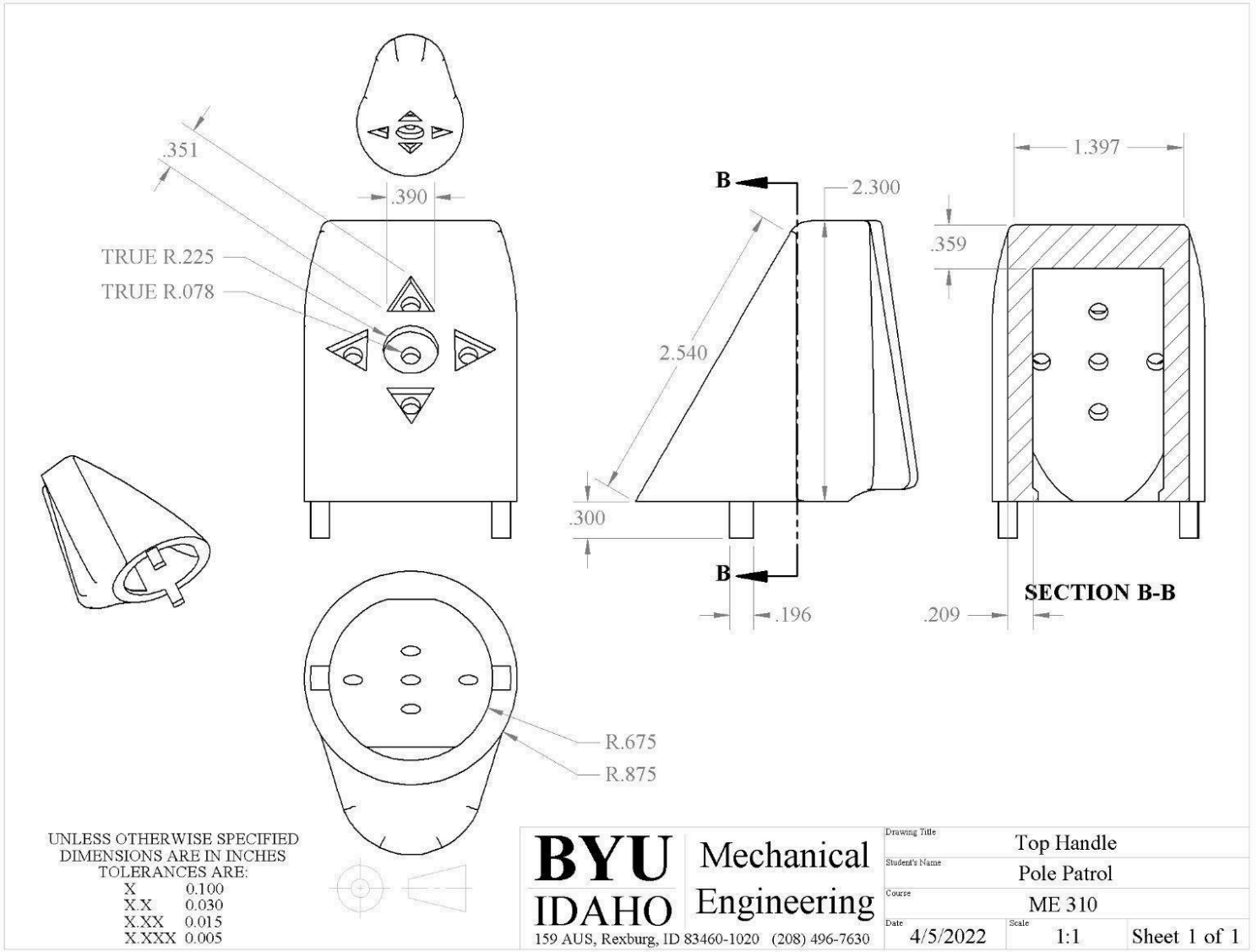
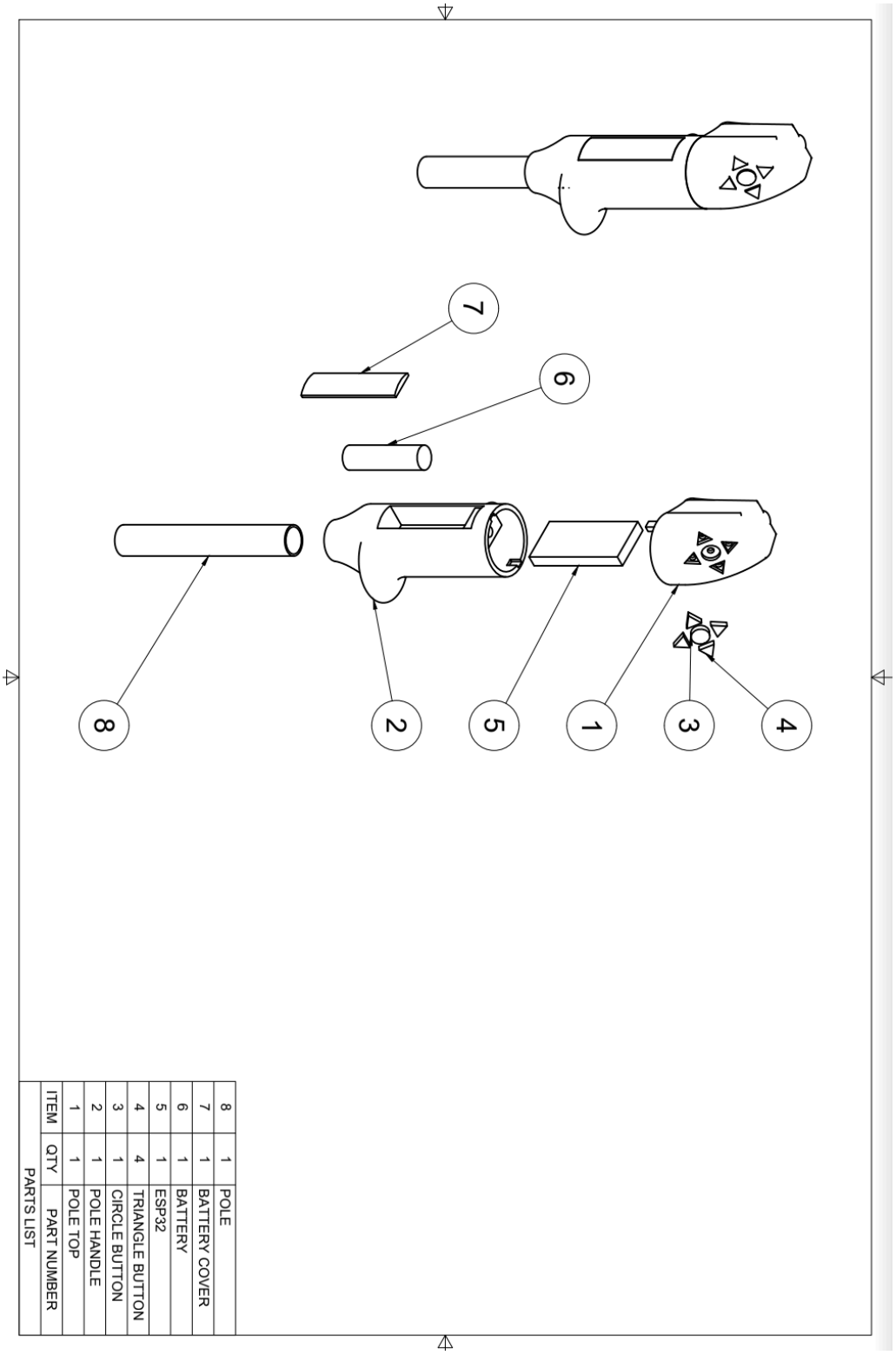


Figure B3. Top handle drawing



PARTS LIST

ITEM	QTY	PART NUMBER
8	1	POLE
7	1	BATTERY COVER
6	1	BATTERY
5	1	ESP32
4	4	TRIANGLE BUTTON
3	1	CIRCLE BUTTON
2	1	POLE HANDLE
1	1	POLE TOP

Figure B4. Ski pole handle assembly drawing

Appendix C: Manufacturing Notes

To manufacture the electronics portion of the project an ESP32 microcontroller is first soldered to a protoboard. The buttons and pulldown resistors are wired according to Figure(wiring diagram). The battery is connected to ground and 3.3V.

Recommended manufacturing process

While 3D printing works fantastically for prototyping, we would recommend instead a co-molded injection molded part. The first mold would give us the main body out of a more rigid and durable plastic while the second would give us the grips made out of either a softer rubber or silicone material to increase grip strength and add a little bounce to it.

The following are just some of the advantages of injection molding:

- Much faster cycle times (18.5hrs down to <3min)
- Better cross sectional strength
- More complete automation
- Reduced material cost
- Less post processing
- Ability to easily change material and color
- Ability to add grips in the same process of a different material

Below is an unofficial, modified BOM with the estimated cost changes associated with injection molding

****Modified items are marked with asterisk
For official BOM see appendix D****

#	Description	Qty	Make or Buy	Approved Vendor	Unit Price	Total Price
1	Micro-controller	1	Buy	Teyleten Robot	$7.33	$7.33
2	Buttons	5	Buy	wmycong	$0.15	$0.75
3	Battery	1	Buy	Amazon	$3.00	$3.00
4	On/Off switch	1	Buy	Sumkyle	$0.45	$0.45
6	Ski pole	1	Buy	Goodwill	$8.40	$8.40
7	**Injection molded	1	Make	-	$0.07	$0.07*

	housing**					
8	10k resistors	5	Buy	Amazon	$0.25	$1.25
9	22 AWG wire	25 in	Buy	Radio Shack	$0.02/in	$0.45
					Total Cost	**$21.7***

*Reduction in >$6.00 per part.

In addition to a reduction in material costs we estimate a significant reduction in labor costs as well. The only increased cost would be the singular upfront cost of the tool which has been estimated and approved by Brother Kinghorn as ~$75,000. However, across a million parts the cost is quite negligible.

Appendix D: Bill of Materials and Cost Analysis

Bill of Materials

Product: Ski Pole Handle
BOM Revision: D
Revision Date & Notes: 04/05/2022

#	Description	Qty	Make or Buy	Reference Figure	Approved Vendor	Unit Price	Total Price
1	Micro-controller	1	Buy		Teyleten Robot	$7.33	$7.33
2	Buttons	5	Buy		wmycong	$0.15	$0.75
3	Battery	1	Buy		Amazon	$3.00	$3.00
4	On/Off switch	1	Buy		Sumkyle	$0.45	$0.45
6	Ski pole	1	Buy		Goodwill	$8.40	$8.40
7	Housing (polycarb 3d printer filament)	1	Make		3D XTECH	$6.25	$6.25

8	10k resistors	5	Buy		Amazon	$0.25	$1.25
9	22 AWG wire	25 in	Buy		Radio Shack	$0.02/in	$0.45
						Total Material Cost	**$27.88**

Labor Cost Analysis

Labor type	Price per unit	# of units	Total Cost
3D Printing	$1.00/hr	18.5hrs	$18.50
Soldering	$15.00/hr	0.5hrs	$7.50
		Total Labor Cost	**$26.00**

Total Build Cost: $53.88