Controllable Infrasound Source

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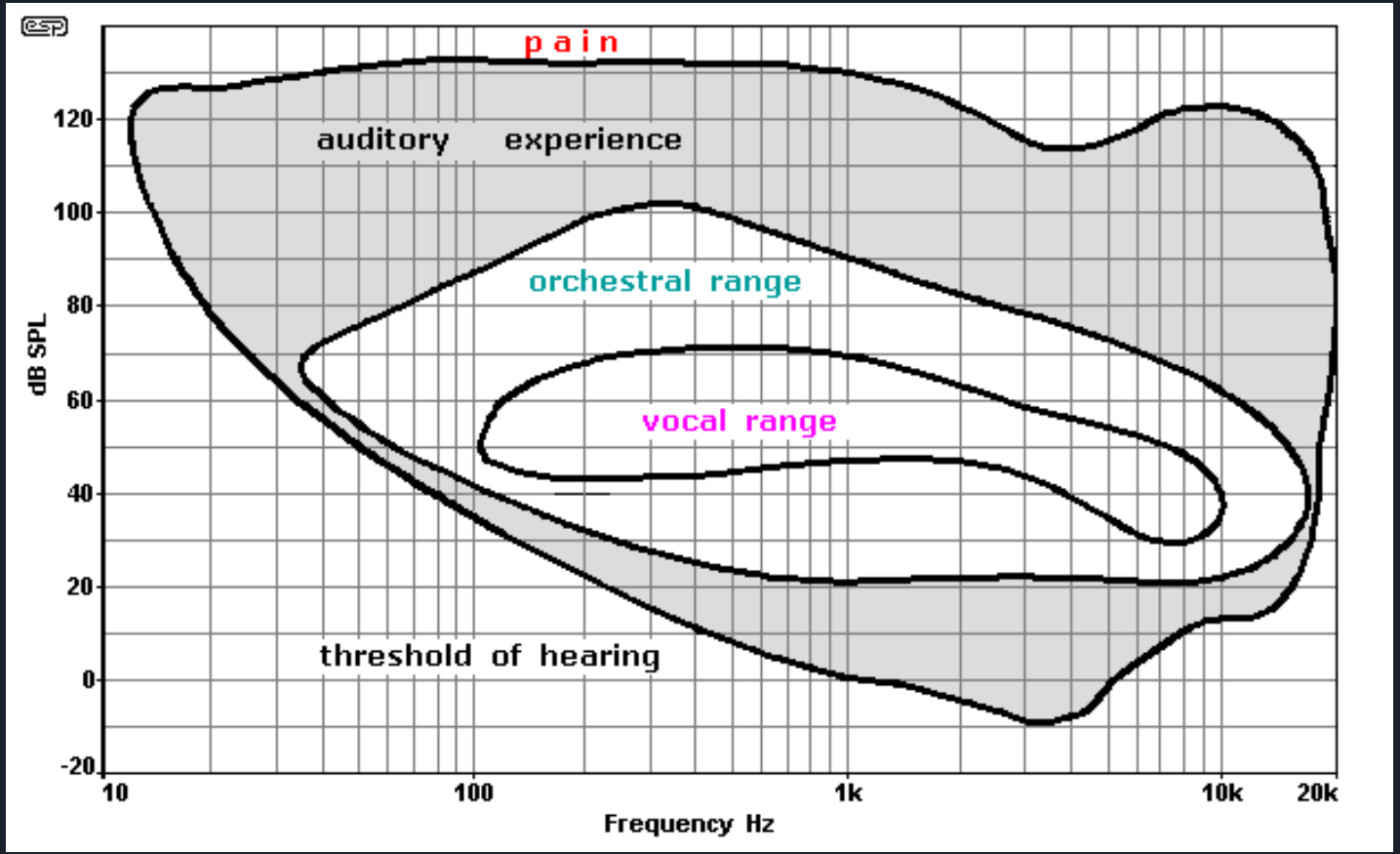
What is Infrasound?

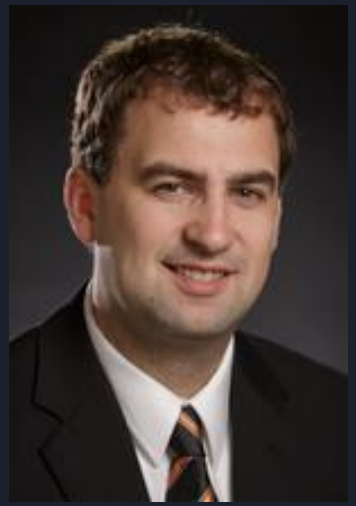
- Frequencies below 20hz
- Human hearing lower limit - 12hz
- Common sources
  - Helicopters
  - Elephant Vocalizations
  - Earthquakes
- Can be detected over large distances



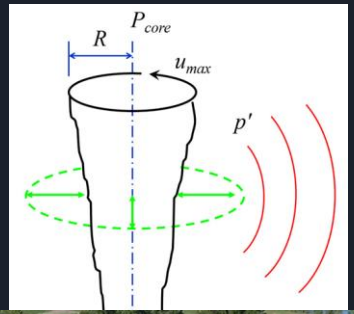
http://people.ece.cornell.edu/land/courses/ece5030/FinalProjects/s2014/kkp37_rjs483/kkp37_rjs483/AudioGram.html

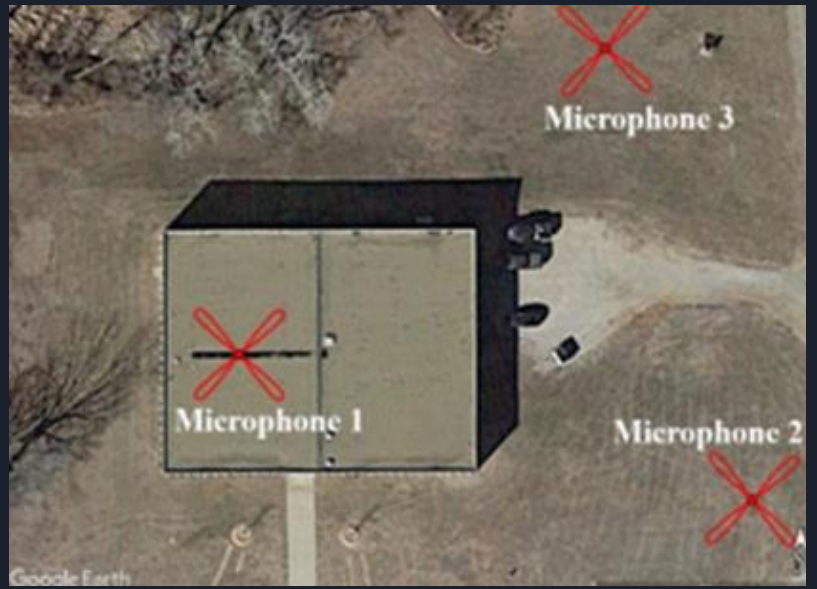
Infrasonic Detection

- Dr. Brian Elbing
  - Research in infrasound possibly emitted by a tornado
- Infrasound microphone array located in the North Campus Lab area



Dr. Brian Elbing, Oklahoma State University





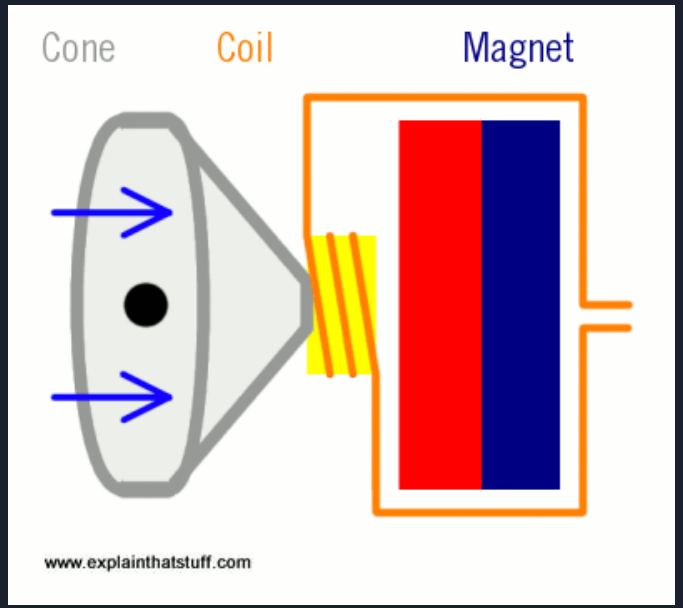
https://www.wired.com/story/a-tornados-secret-sounds/

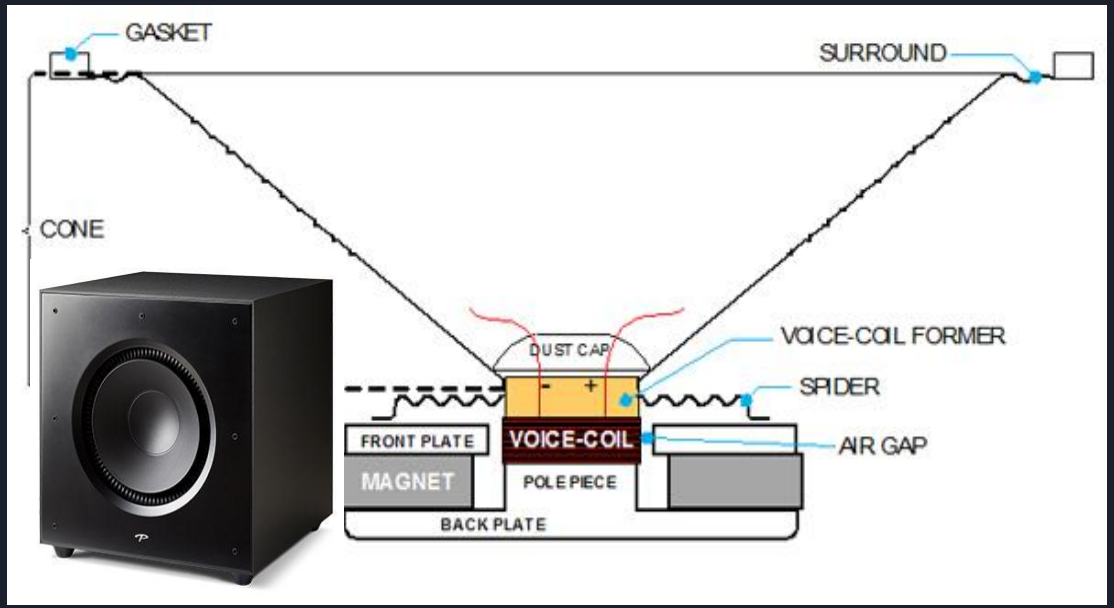
Objective

- To design and construct a **compact**, **mobile** device capable of generating **controllable infrasonic tones**.
  - Used to calibrate infrasonic microphone array to ensure accuracy of collected data

Subwoofers

- Coil in magnetic field - current direction determines cone movement direction
- Placed in enclosure - separates + and - pressure waves
- Not efficient below 20Hz



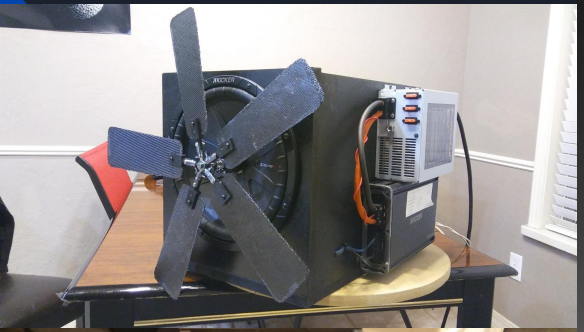


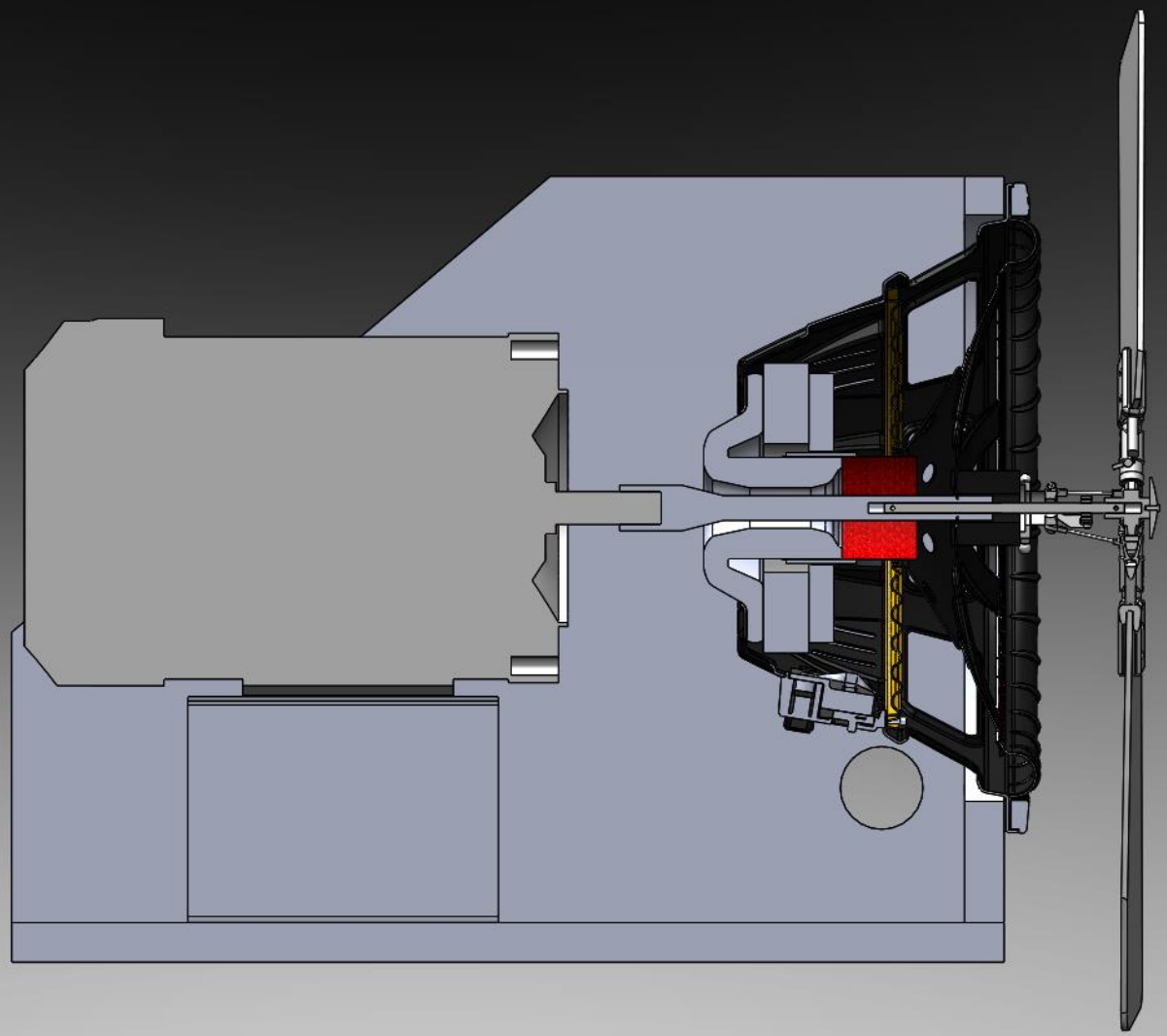
Rotary Subwoofers

- Efficient output from <1Hz to 20Hz
- Fan motor spins blades
- Helicopter rotor head actuates blade pitch
  - Controlled by subwoofer motor
- Baffle separates pressure waves
- Relatively compact

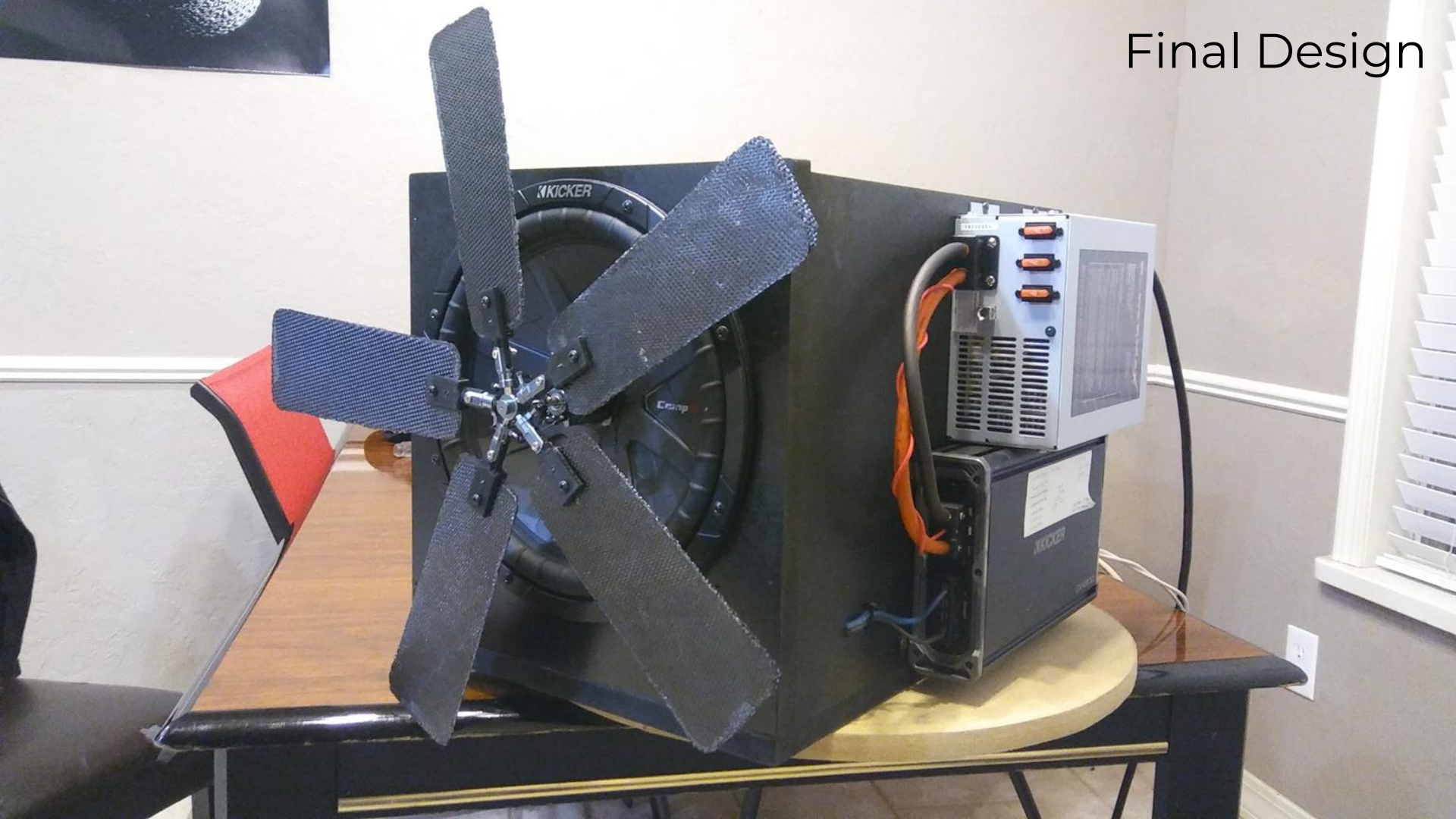
Eminent Technologies TRW-17

Final Design





Final Design



Final Design

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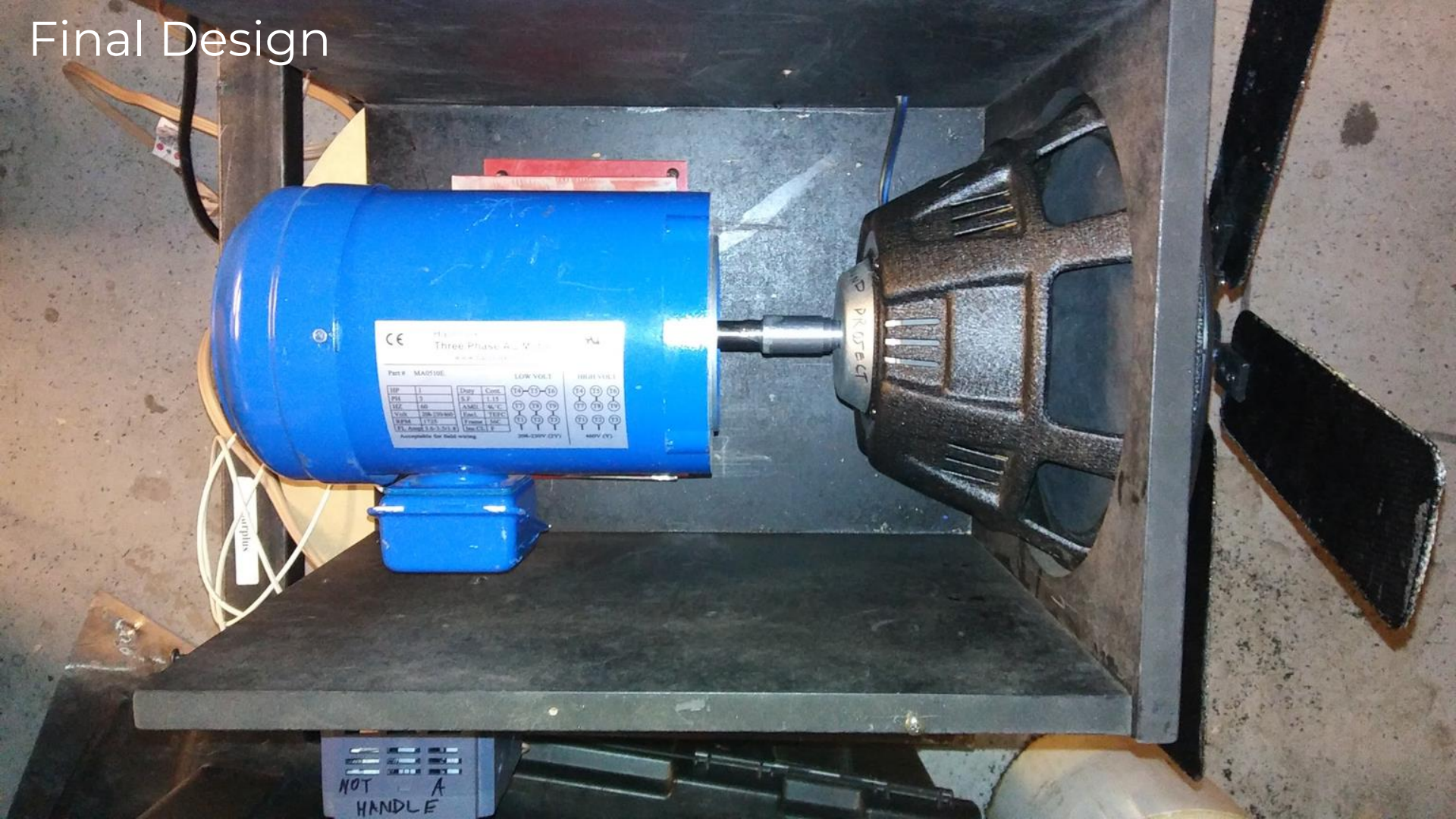


Bill of Materials

Q1	Q2	Q3	Q4	Item	Dwg #	Mfr.	Description	Cost (Best)	Cost (Worst)	Cost (Actual)	Notes	Link
1				Rotary Subwoofer	ROTSUB		Full assembly	$ -	$ -	$ -		
	1			Frame	FRAME	Prop	Frame	$ -	$ -	$ -	MDF	
		1		Fan motor	ACMOTOR		A/C motor; spins fan;	$ 85.00	$ 500.00	$ 146.50	3 phase AC	
		1		Swashplate adapter	SWADAPT	Prop	Mates swash to speaker cone	$ -	$ -	$ -	PLA 3D print	
		1		Rotor head	ROTOR		Controls blade pitch	$ 25.00	$ 115.00	$ 27.75	5 blade	Link
			1	Swashplate	SWASH		Connected to voice coil	$ -	$ -	$ -		
			1	Bearing	ROTABEAR			$ -	$ -	$ -		
				2mm screw	SCRW2x20		2x20mm screw for rotorhead	$ 8.00	$ 10.00	$ -	Extra	Link
			5	Ball link end	BALLINK			$ 9.00	$ 12.00	$ -	Extra	Link
		1		Sub motor	SUBMOTOR	Kicker	subwoofer magnet/voicecoil/spider	$ -	$ -	$ -	CompR 12	
		1		Amplifier	AMP	Kicker	Drives sub motor	$ -	$ -	$ -	Remove high pass, set low pass to 20hz 24dB/oct on CXA1200.1 - Matt Spinks	
		1		DC power supply	12VPSU		Powers amp	$ 100.00	$ 250.00	$ 146.00	Provides power to amp from wall	
		1		Shaft	SHAFT	Prop	Motor to rotorhead shaft	$ -	$ -	$ -	Machined aluminum	
		1		Motor controller	ACCONT		3 phase A/C motor freq. controller	$ 80.00	$ 250.00	$ 153.70	GE/Fuji AF-300 Micro-Saver II	Link
		1		Hardware kit	HWKIT	Prop.	Additional assembly hardware	$ -	$ -	$ -		
			4	Motor bolt	MOTBOLT		Secures motor to stand	$ 4.00	$ 10.00	$ 8.00	5/16" screws	
			4	Motor washer	MOTWASH		Secures motor to stand	$ 2.00	$ 5.00	$ 4.00		
			4	Motor nut	MOTNUT		Secures motor to stand	$ 2.00	$ 5.00	$ 5.00		
			24	Wood screw	RFS2		Frame screw	$ -	$ -	$ -	Holds to frame - motor stand, VFD, amp, DC PSU, subwoofer	
		1		Stand	STAND	Prop.	Base everything attaches to	$ -	$ -	$ -	Welded steel frame; piping?	
		5		Blade	BLADE	Prop.	Fan blade	$ 35.00	$ 105.00	$ -	1/16" Aluminum? 3/32" Acrylic/PC?; CNC cut; **Carbon fiber, 4 layers**	
		5		Blade adapter	BLADAPT	Prop.	Connects blade to rotor head	$ -	$ -	$ -	3D print PLA	
1				Baffle	BAFFLE	Prop.	For enclosure/testing	$ 20.00	$ 70.00	$ 42.00	Truck bed enclosure vs. building	
							Totals	$ 370.00	$ 1,332.00	$ 532.95		

Sourced Materials

Subwoofer - Kicker CompR 12”

Sourced Materials

Subwoofer amplifier - *Modified* Kicker CXA1200.1

Amplifier power supply - 75A DC power supply

Sourced Materials

R/C helicopter rotorhead

Sourced Materials

3-phase A/C motor

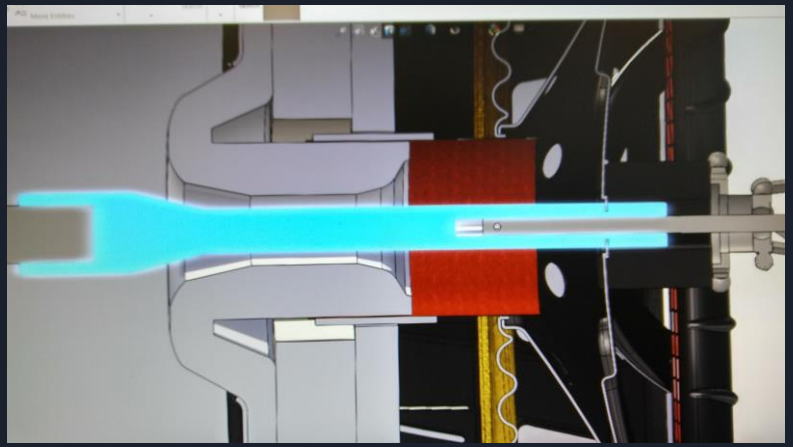
VFD Controller

Design Needs

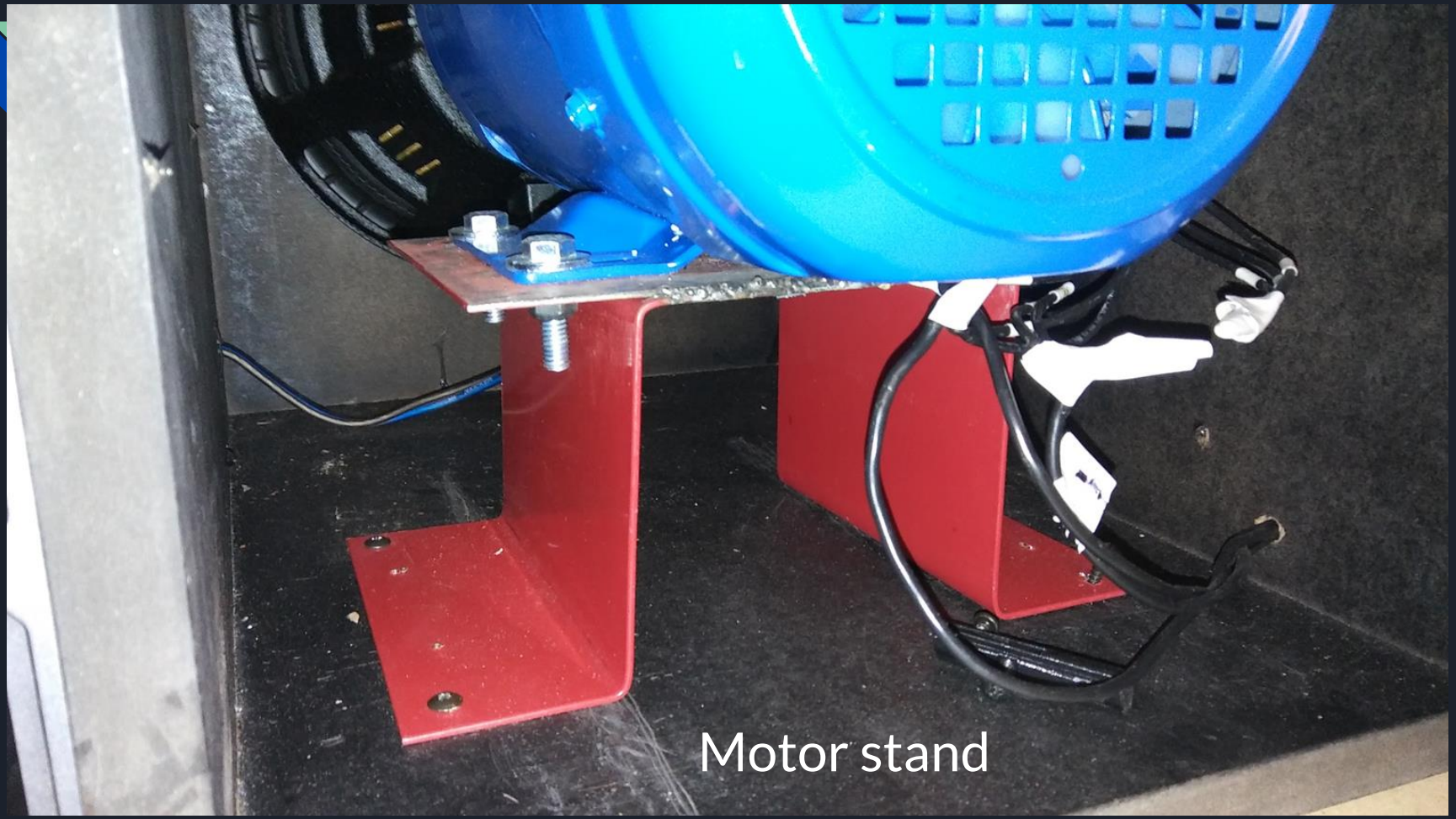
Design Needs

Design Needs

Coupling shaft



Design Needs



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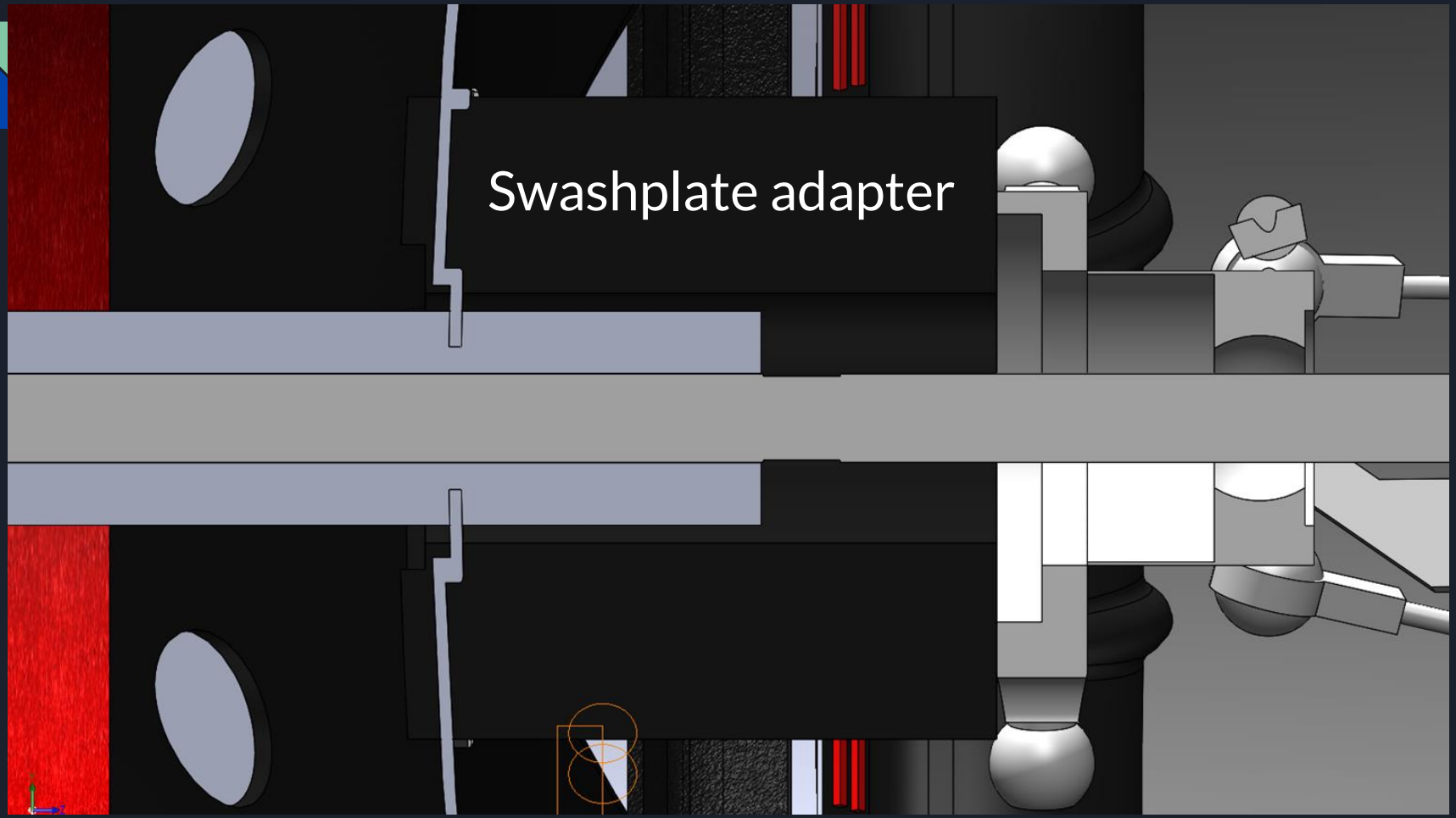
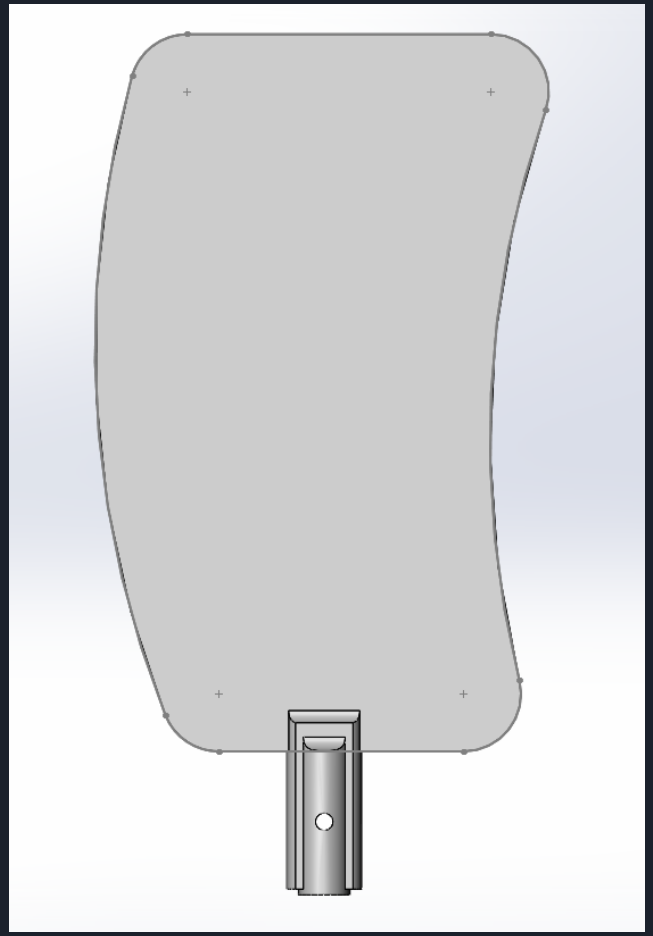
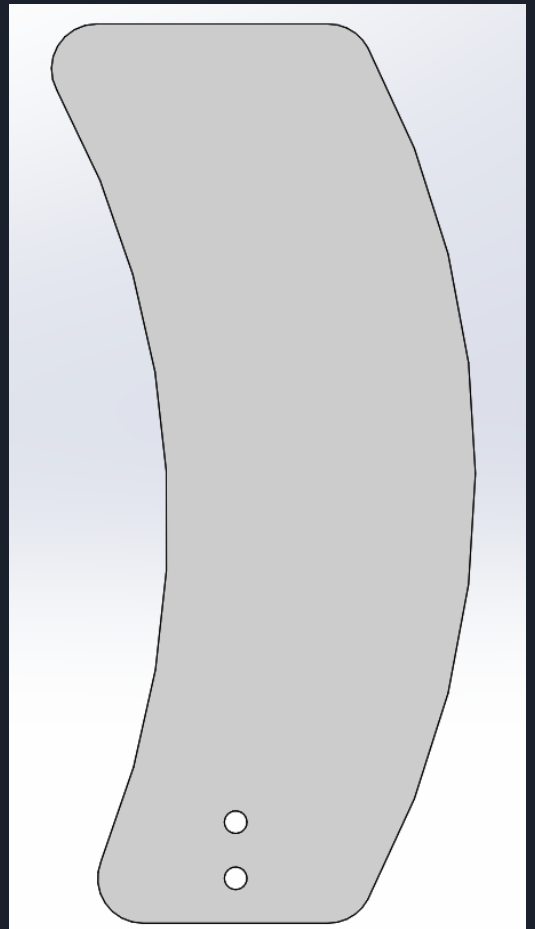
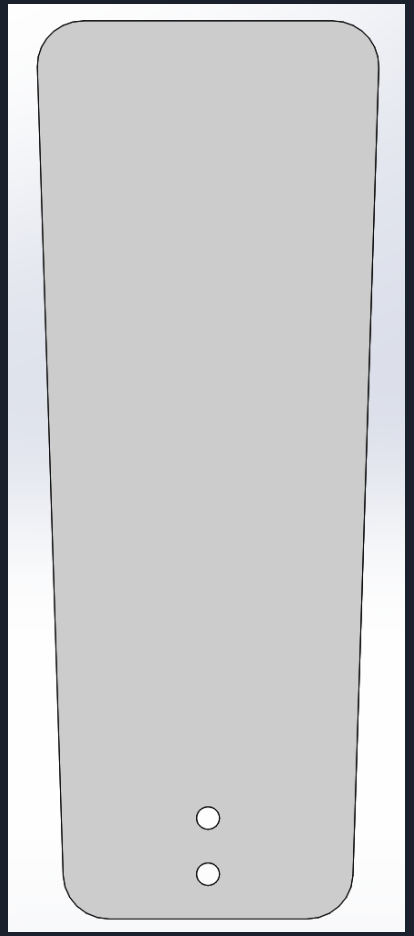


Design Alternatives

Blade







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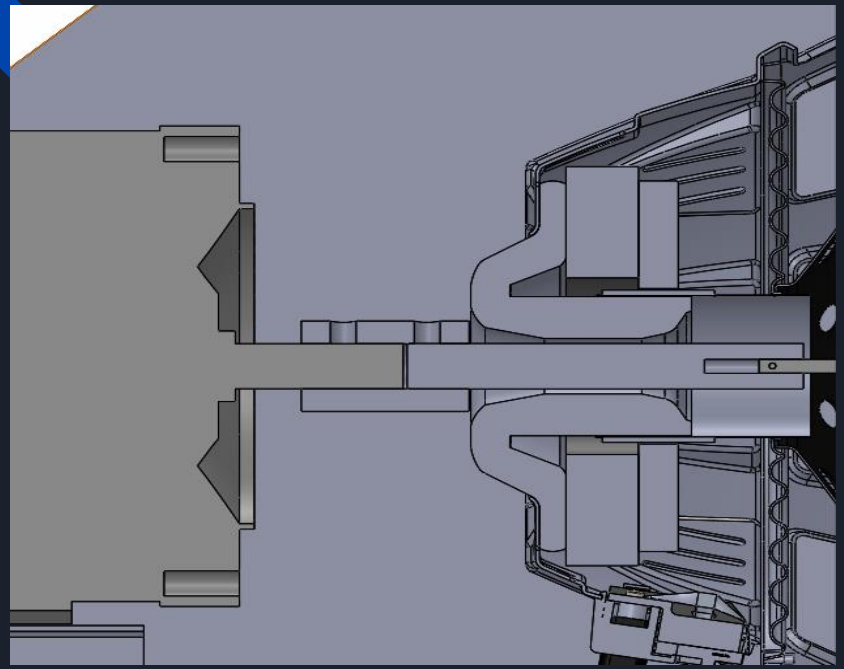
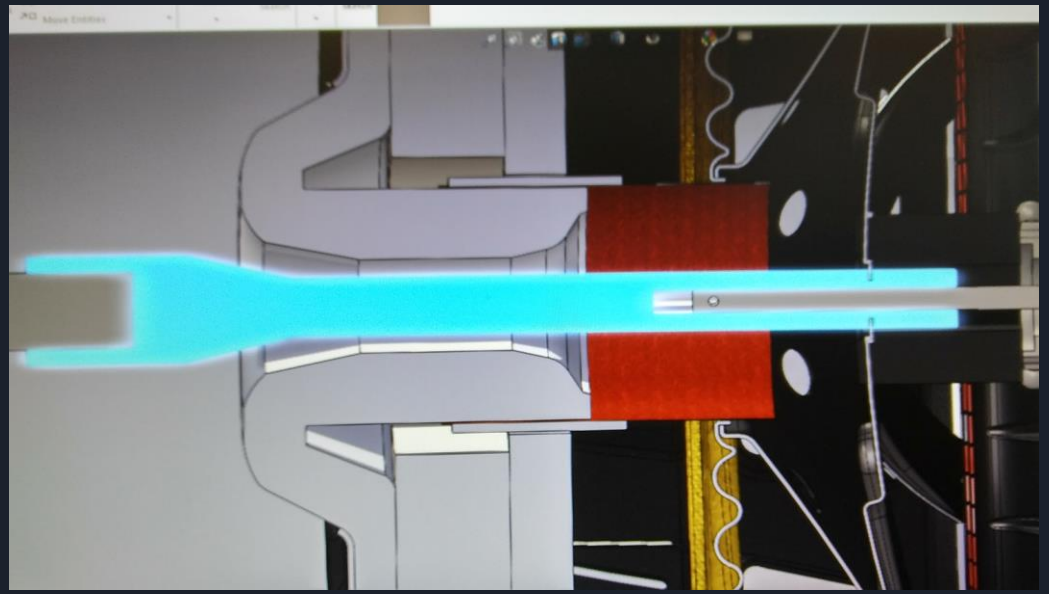
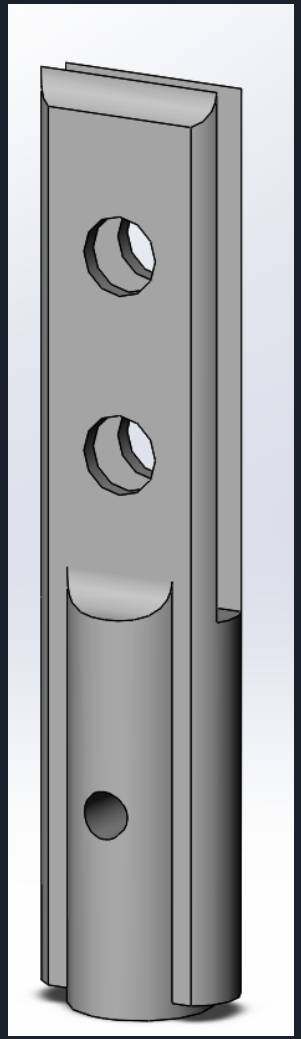


Shaft



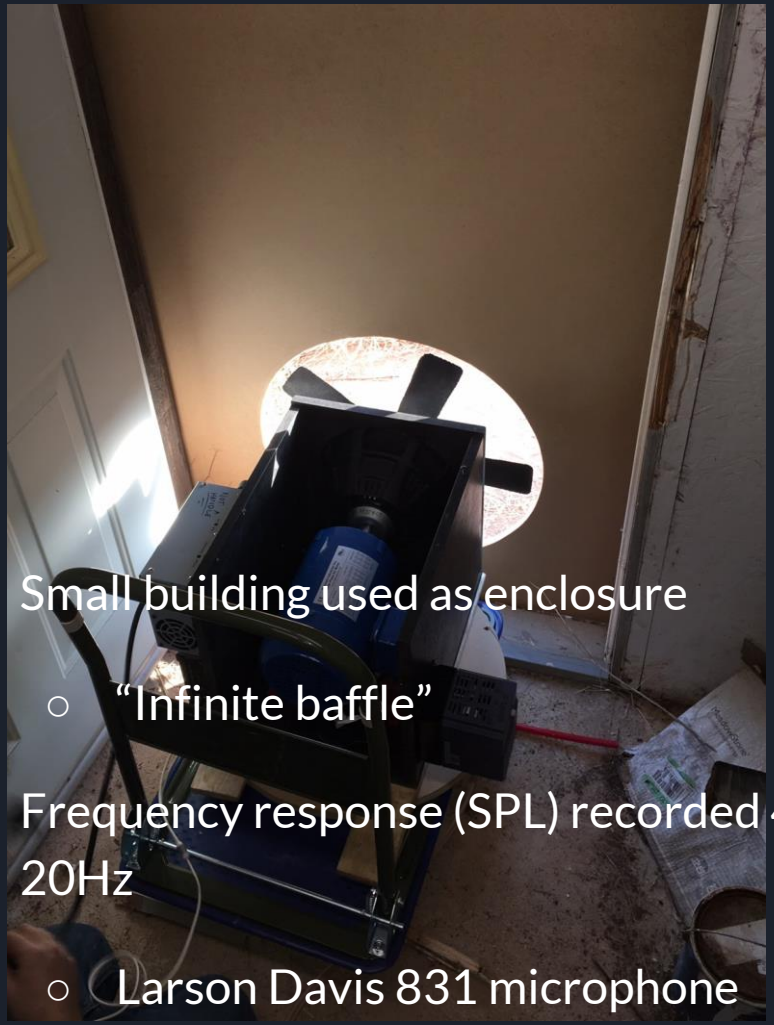
Design Alternatives

Blade adapter




625'
Map
Google
2D
Zoom
Imagery ©2018 Google, Map data ©2018 Google
United States
Terms
Send feedback
50 ft

Test Setup



Small building used as enclosure

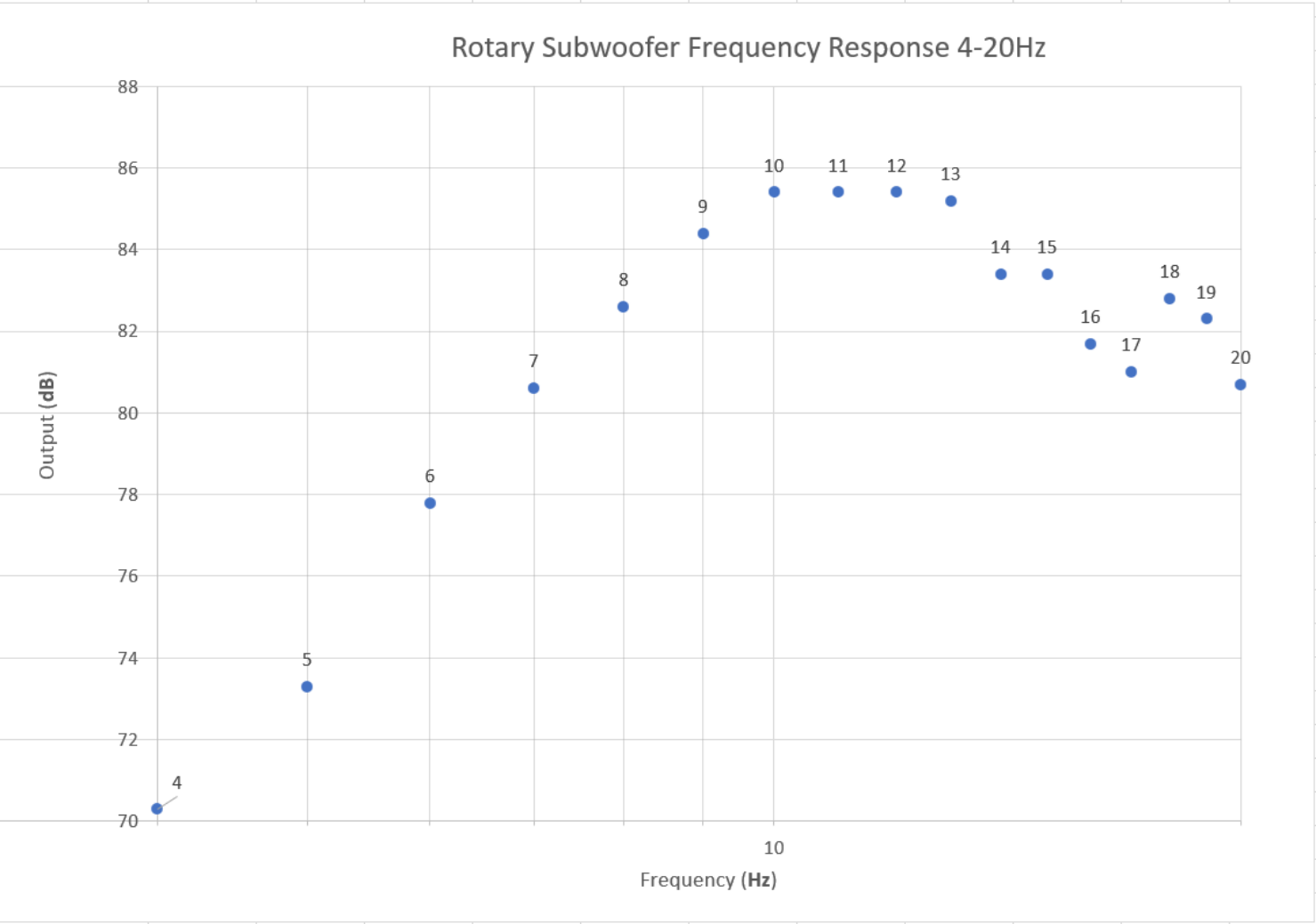
- “Infinite baffle”

Frequency response (SPL) recorded 4-20Hz

- Larson Davis 831 microphone

Results

- Microphone ~20ft axial distance
- Amp gain halfway
- Motor @ 300 rpm



References

[1] Olson, Harry F, (1967). “Music, Physics and Engineering,” Dover Publications, 1967. ISBN 0-486-21769-8.

[2] M. Simon, “A Tornado's Secret Sounds Could Reveal Where It'll Strike,” Wired, 08-May-2018. [Online]. Available: https://www.wired.com/story/a-tornados-secret-sounds/. [Accessed: 03-Dec-2018].