APPENDIX A: FURTHER CAD MODELS AND DRAWINGS

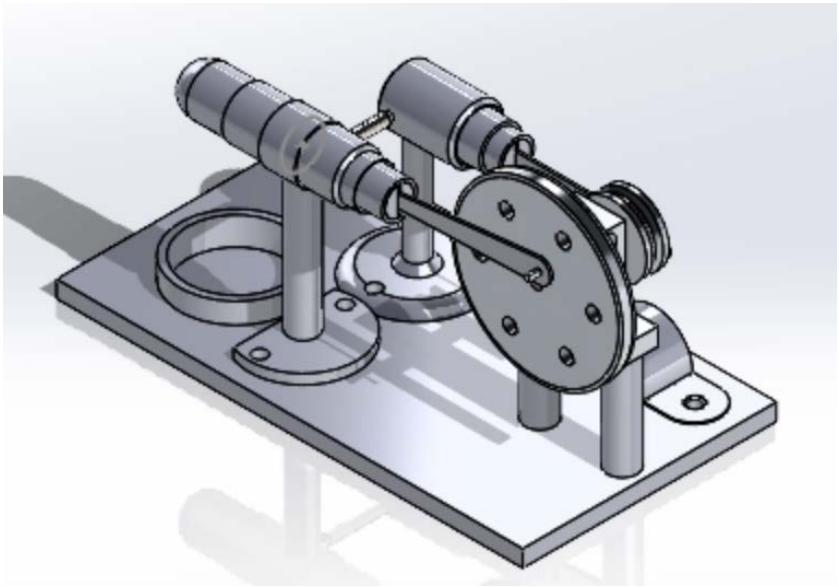


Figure A-1. SolidWorks assembly of the Stirling engine kit.

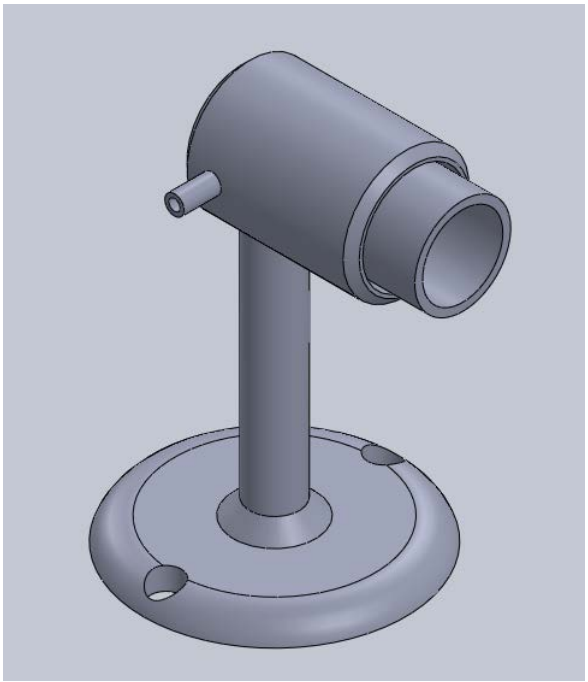


Figure A-2. Cold cylinder and stand subassembly.

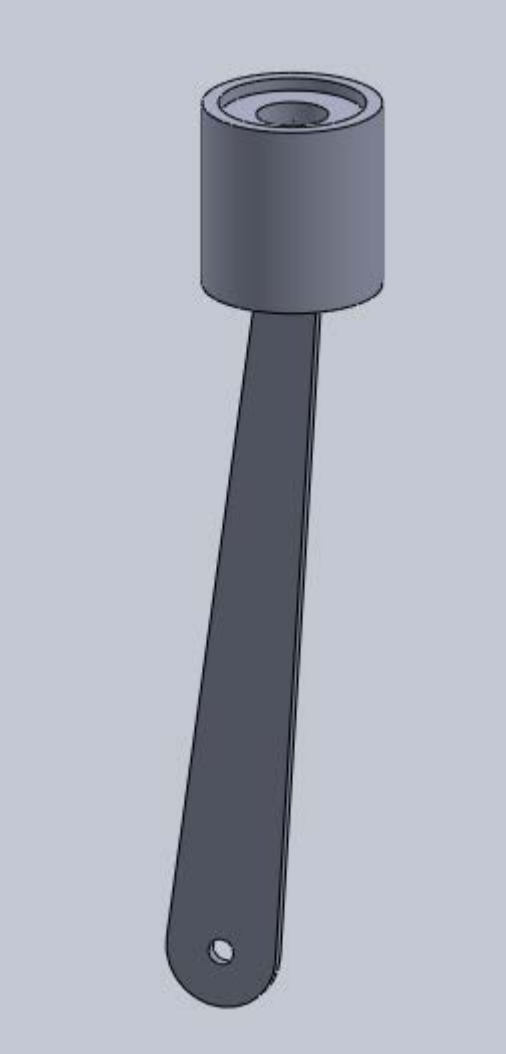


Figure A-3. Piston subassembly.

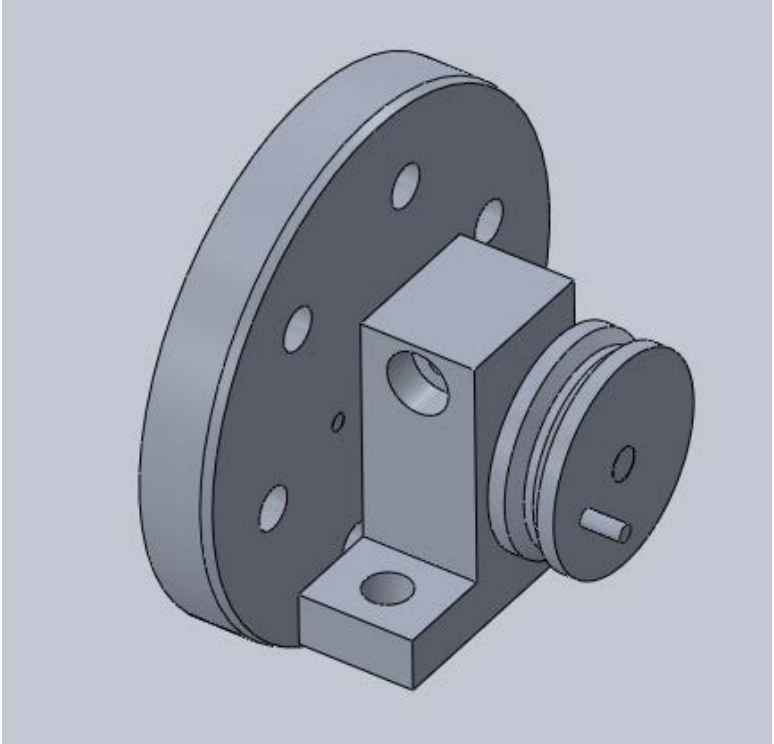


Figure A-4. Flywheel subassembly.

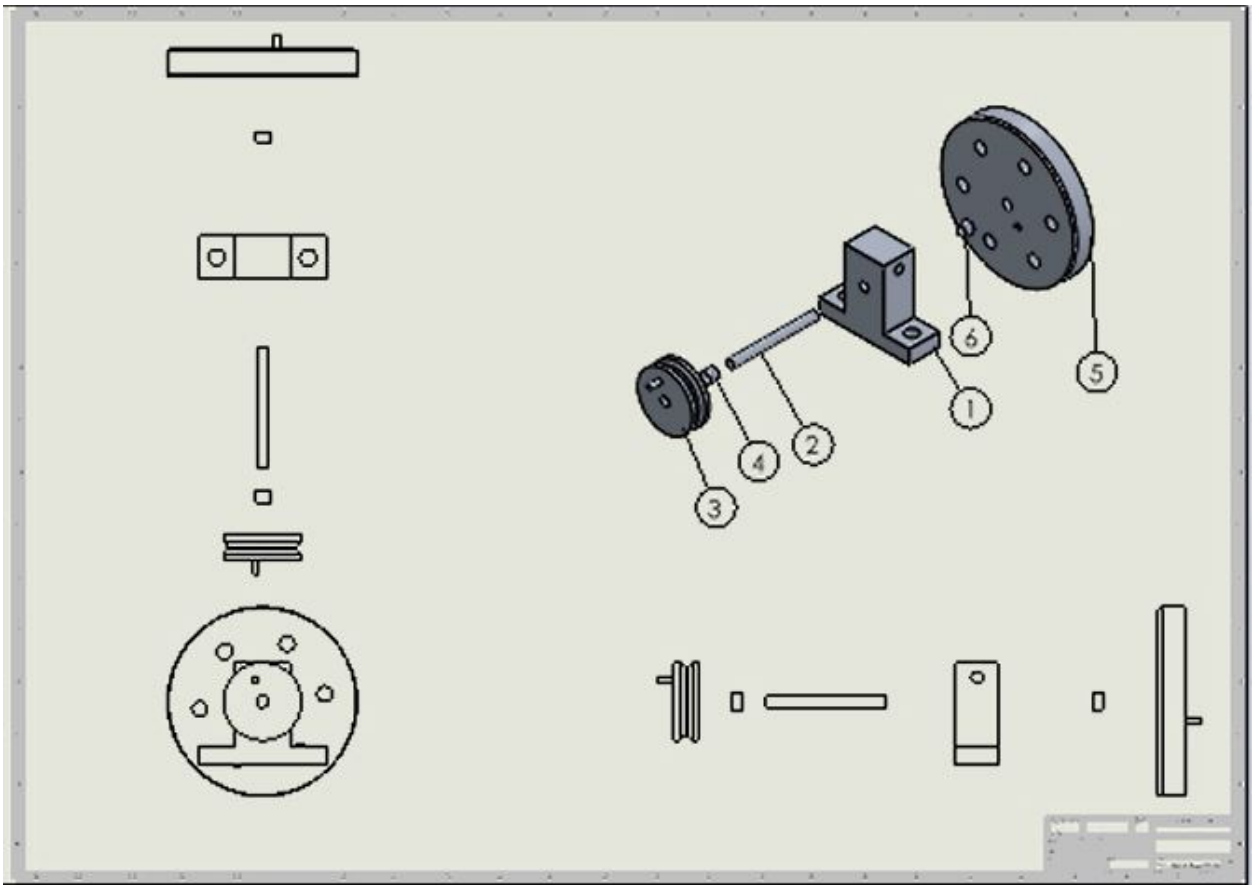


Figure A-5. Drawing of Flywheel subassembly

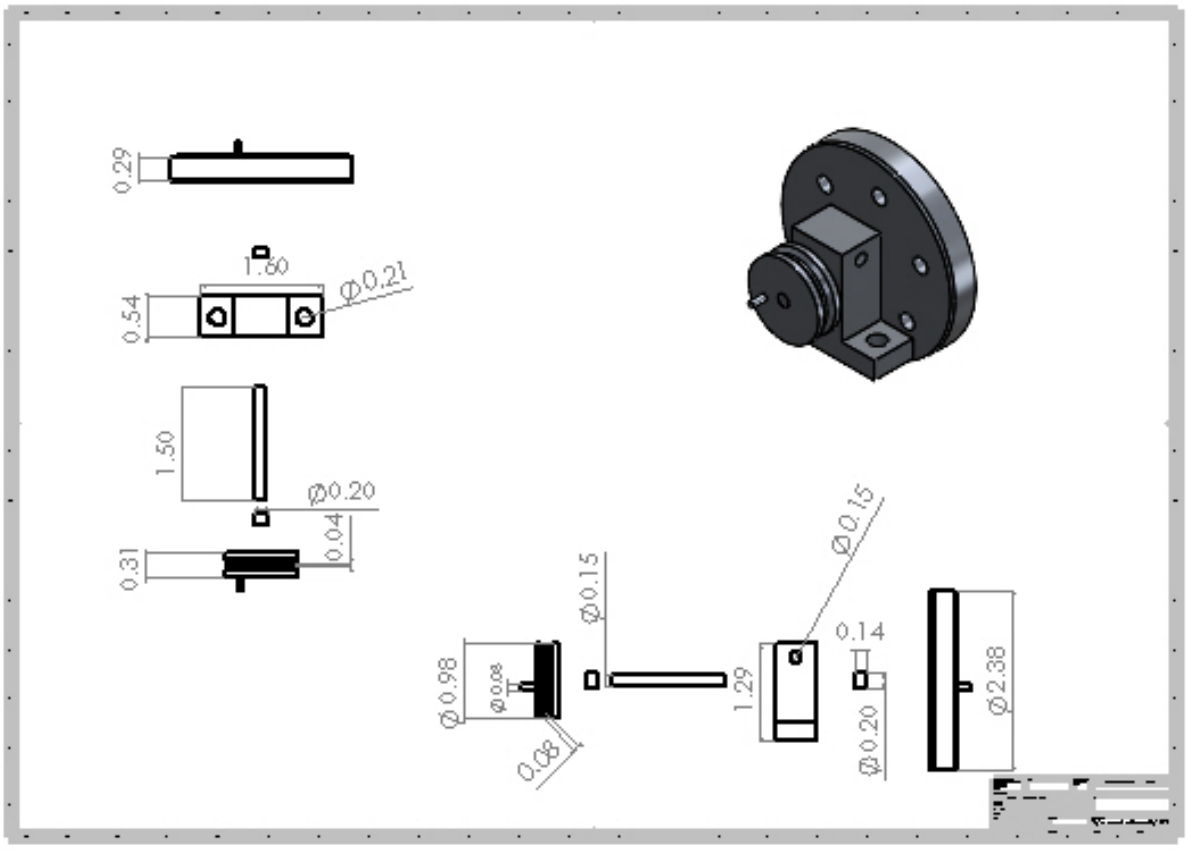


Figure A-6: Dimensioned Flywheel sub-assembly

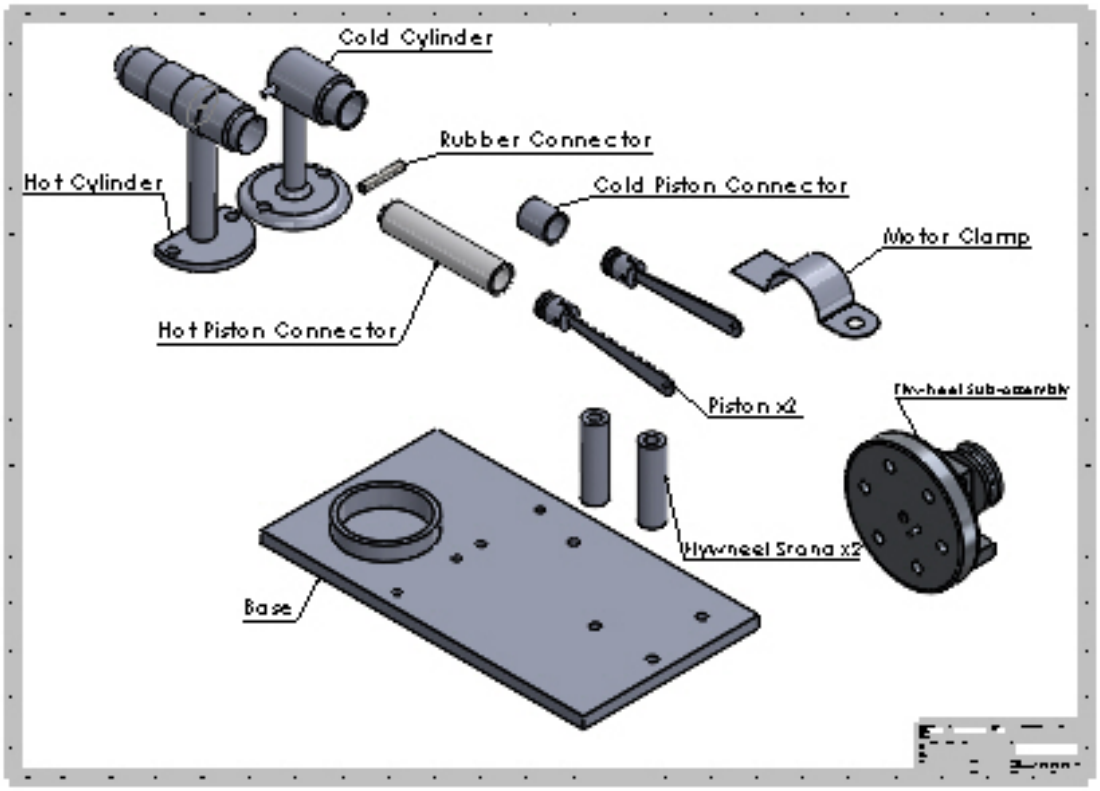
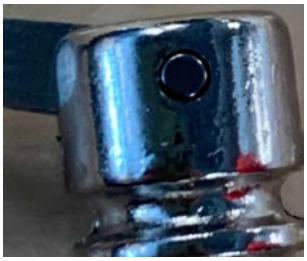
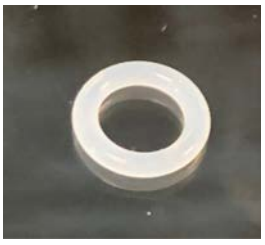
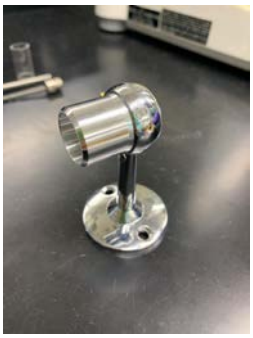
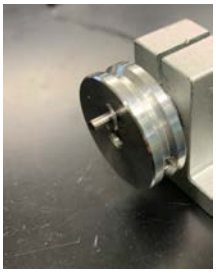
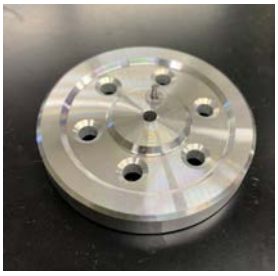


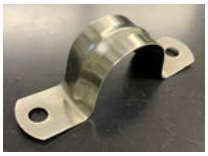
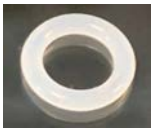
Figure A-7. Full engine assembly.

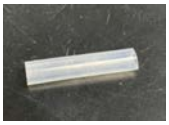
APPENDIX B: BILL OF MATERIALS

Component Number	Subassembly	Name	Picture	Amount
1	Cold Piston	Arm		1
2	Cold Piston	Pin		1
3	Cold Piston	Piston head		1
4	Cold Piston	Dampening O-ring		2
5	Cold Piston	Short Cold Cylinder		1

6	Cold Piston	Long Cold Cylinder		1
7	Cold Piston	Long Cylinder O-ring		1
8	Cold Piston	Cold Cylinder Stand		1
9	Cold Piston	Screw		1
10	Flywheel	Stand Screw		1

11	Flywheel	Flywheel Stand		1
12	Flywheel	Small Flywheel		1
13	Flywheel	Large Flywheel		1
14	Flywheel	Connecting Rod		1
15	Flywheel	Connecting Screw		1
16	Flywheel	Washer between Flywheels and Connecter		1

17	Motor	Motor		1
18	Motor	Motor Flywheel	-	1
19	Motor	Motor Clamp		1
20	Motor	Screw		2
21	Motor	Motor Band		1
22	Hot Piston	Arm		1
23	Hot Piston	Pin		1
24	Hot Piston	Piston		1
25	Hot Piston	Dampening O-ring		2
26	Hot Piston	Piston Connecter		1

27	Hot Piston	Long Cylinder	-	1
28	Hot Piston	Short Cylinder		1
29	Hot Piston	Dampening Cylinder Ring		7
30	Hot Piston	Hot Cylinder Stand		1
31	Hot Piston	Screw	-	2
32	-	Rubber Hot/Cold Connecter		1
33	-	Base		1

APPENDIX C: FURTHER RESULTS OF CALCULATIONS AND MEASUREMENTS

Table C-1 shows the measurements of the weight of the Stirling Engine components. Some components could not be measured individually since the team physically could not take them apart. For these components, the color of the mass box corresponds to all the pieces that were measured together, with the first box containing the mass of these combined components.

Component Name	Mass (g)
Arm	5.71
Pin	
Piston head	
Dampening O-ring	0.07
Short Cold Cylinder	1.27
Long Cold Cylinder	3.19
Long Cylinder O-rings	0.067
Cold Cylinder Stand	48.82
Screw	1.04
Stand Screw	6.97
Flywheel Stand	17.62
Small Flywheel	39.37
Connecting Rod	
Large Flywheel	53.91
Connecting Screw	1.83
Washer between Flywheels and Connecter	0.21
Motor	43.6
Motor Flywheel	0.41
Motor Clamp	6.43
Screw	1.56

Motor Band	0.28
Arm	5.71
Pin	
Piston	
Dampening O-Ring	0.07
Piston Connecter	5.23
Long Cylinder	3.19
Short Cylinder	5.82
Dampening Cylinder Ring	0.469
Hot Cylinder Stand	45.901
Screw	1.04
Rubber Hot/Cold Connecter	0.23
Base	>110

Table C-1. This is the mass measurements of all the components in the Stirling engine.

Table C-2 contains the raw data for the measurements on the original Stirling Engine at differing surrounding temperatures. Notes on potential errors are listed. A heat sink was used in one trial, as indicated in the table.

Outside Temp (F)	Time to start (sec)	Maximum Voltage (V)	Time to Reach Maximum Voltage Time After Start (sec)	Time to Stop After Extinguished (sec)	Notes
77	12.5	4.6	125.5	76	
49.5	65.71	4.3	31.42	93.76	
72.1	15	4.7	84	78	
74.5	25	5	191.43	74.21	
75.3	17.16	4.9	120.17	73.65	
75.2	20.43	4.4	109.57	77.4	- Heat sink used
72.4	7.57	6.4	34.11	-	-Torch used as heat source test -stopped due to unexpected error

Table C-2. The raw data of the measurements on the original engine taken at differing surrounding temperatures.

Table C-3 is the raw data for the measurements on the new Stirling engine at differing surrounding temperatures. Notes on potential errors are listed. A heat sink was used in one trial, as indicated in the table. There was not enough data to analyze and it was not mentioned in the discussion.

Outside Temp (F)	Time to start (sec)	Maximum Voltage (V)	Time to Reach Maximum Voltage Time After Start (sec)	Time to Stop After Extinguished (sec)	Notes
76.1	27.85	5.9	65.77	32	- Heat sink used - Time to stop may have been affected by a bump to flywheel
73.4	26	5.2	83.6	39.73	
72.8	7.31	6.7	31.62	48.59	- Torch used as heat source - Time to stop may have been affected by plugging phone charger into phone

Table C-3. The raw data of the measurements on the new engine taken at differing surrounding temperatures.

Table C-4 is the results for the flywheel speed tests on the original Stirling engine.

Trail	Maximum Voltage (V)	RPM	Notes
1	4.7	10330	
2	4.9	2084	
3	5	7758	
4	4.9	1960	
5	6.3	2581	Torch used for heat source

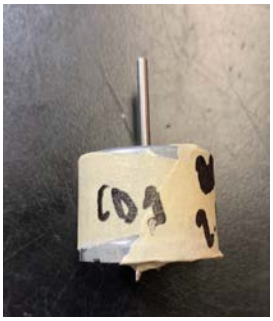
Table C-4. The maximum voltage and rpm measurements on the original engine

Table C-5 is the results for the flywheel speed tests on the new Stirling engine. There was not enough data to analyze and it was not mentioned in the discussion.

Trail	Max Voltage (V)	RPM	Notes
1	5.2	6853	
2	6.7	2409	Torch used for heat source
3	4.6	1659	

Table C-5. The maximum voltage and rpm measurements on the original engine

Table C-6 is the data from the max voltage measurements on the e-waste motors.

Motor	Max Voltage (V)	Picture
CD 1	2.6	
CD 2	2.6	

Toy Car 1	0.8	

Table C-6. The maximum voltage of the e-waste motors.