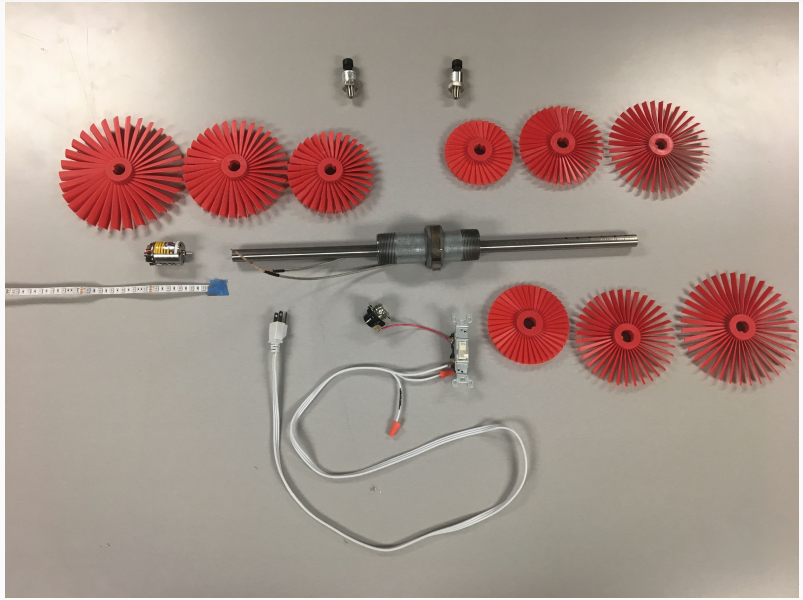
Thermodynamics Demo Unit 1B

Erich Gemballa - Manager
Gavin Geiger - Treasurer
Hamad Almutairi - Secretary
Abdullah Abdulghafour- Web-admin

Project Description

Gavin
Thermo Demo Unit 1B
July 10,2018

The purpose of this project is to design and manufacture an operational Brayton Cycle for educational purposes in an introductory thermodynamic class.



Project Description

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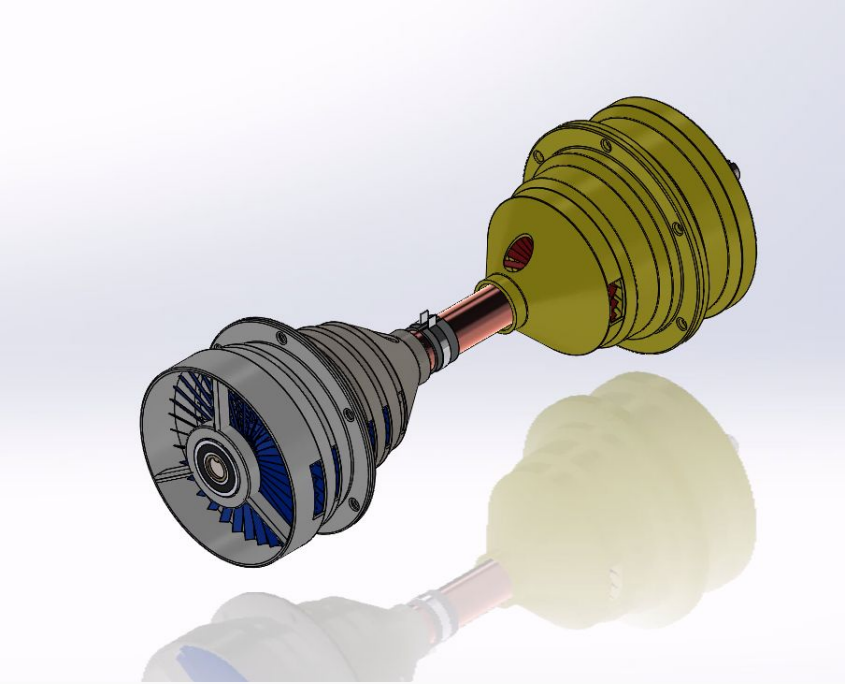
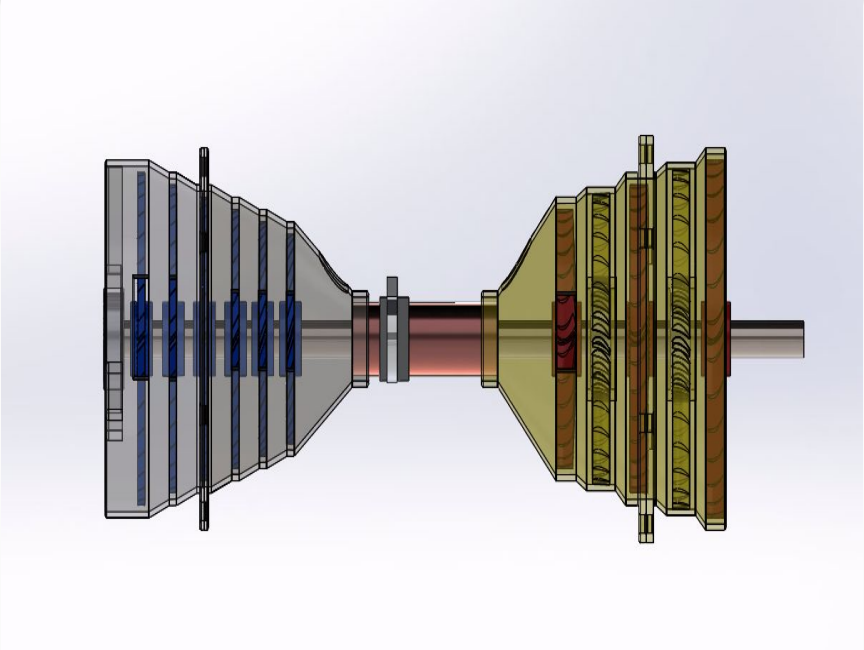
July 10,2018





Updates

Blade Design

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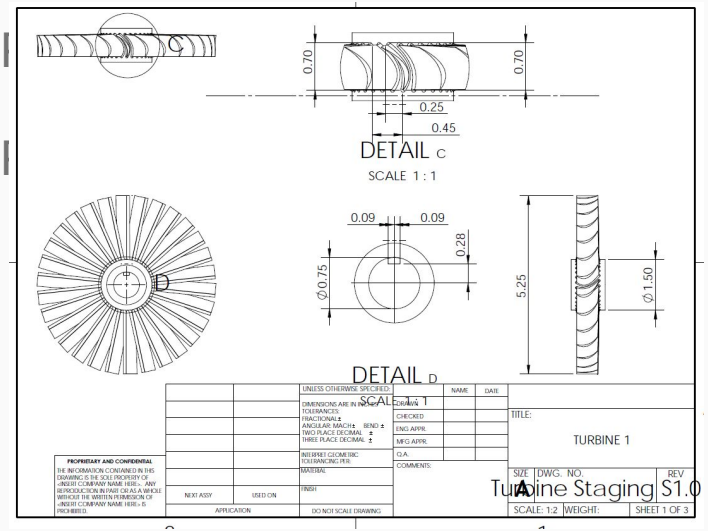
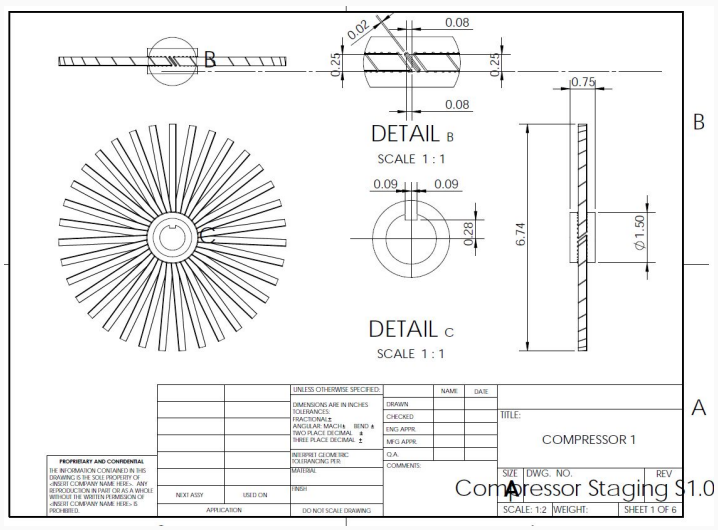


Turbine 1



Compressor 1

Updates

Casing Design

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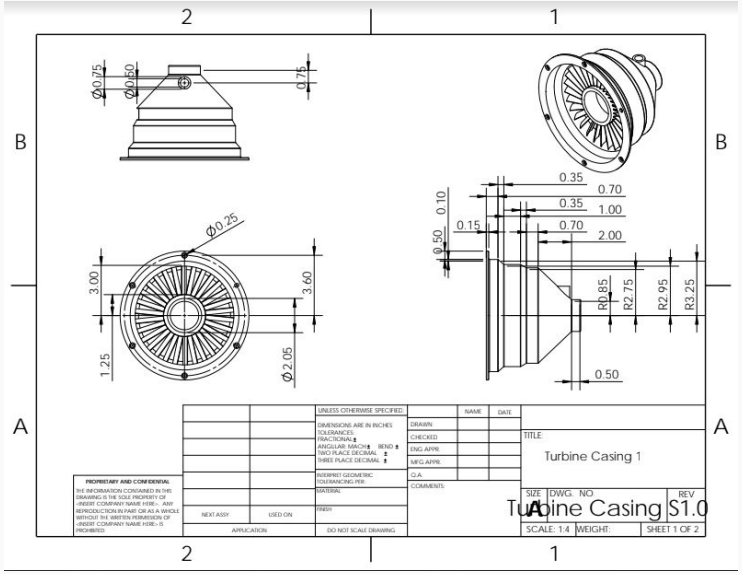
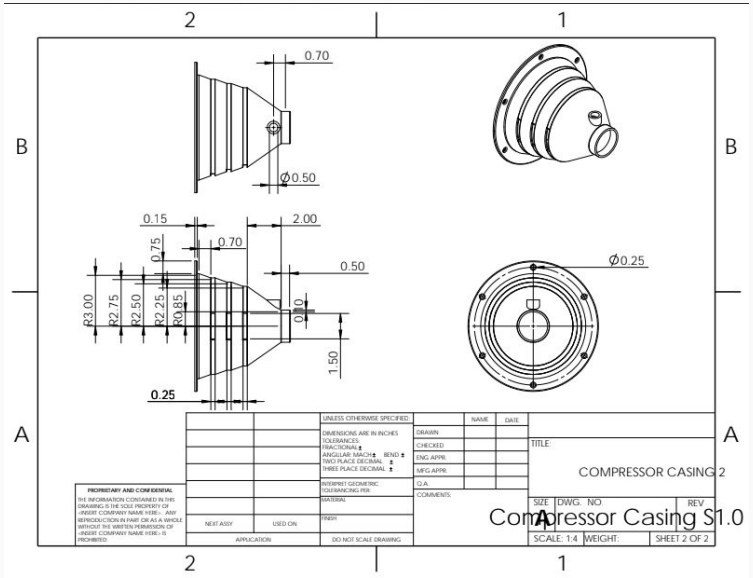


Turbine Casing 1



Compressor Casing 2

Updates

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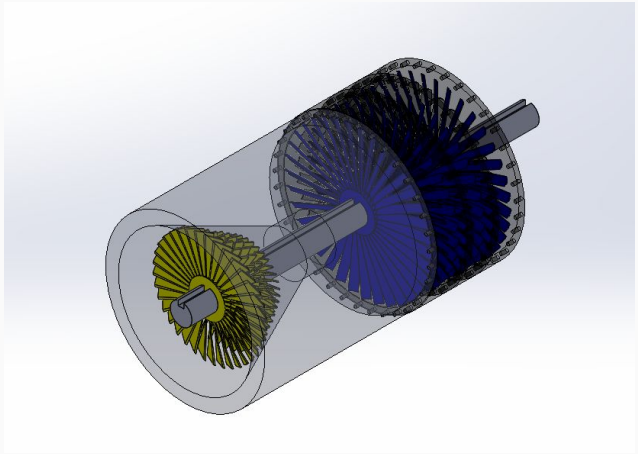
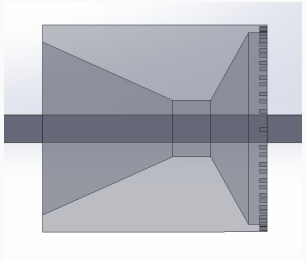
Design Changes

Change to heating band size from ½” to 1”

Casing Design Changes





Updates

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Manufacturing Plan

Blade & Cycle		
Print	**Purchase**	**Assemble**
Prototype 1 Stage	Radial Ball Bearing	Casing
Print 9 Stages of Blades	Bolts for Casing	Ball bearing casing for stator
Bearing Casing		
Turbine Casing		
Compressor Casing		

Heating Element		
Print	**Purchase**	**Assemble**
	Collar heater	Wiring Schematic for wall
	Thermal Fuse	Safe wiring casing
	Heat Sink	Outer casing insulation
	Light Switch	
	Aluminum Casing	
	Wiring	

Pressure System		
Print	**Purchase**	**Assemble**
	Pressure Transducer	P-v & T-s Diagram
	Wiring for DAQ	Data Acquisition
		Labview Display

Power System		
Print	**Purchase**	**Assemble**
Reduction Hub	LED strip	Power Check
	RGB Wire	Motor to LED wires
	DC Brushless Motor	Reduction Hub to motor

Ignition System & Cart		
Print	**Purchase**	**Assemble**
	Air Compressor	Air Diffuser
	Tubing	Air Introduction into system
	Air Compressor Adaptors	Low load usage system
	Valve	Power System into wall
	Cart	Main Power cable
	Plywood Standing	
	Surge Protector	

Updates

Analytical Reports
Power & Heat

Erich & Hamad
Thermo Demo Unit 1B
July 10,2018

Power System

2.93 Watt needed

5 Ω DC Motor
Torque Resistance:
21.1 mNm/A

$$P = i \cdot V$$

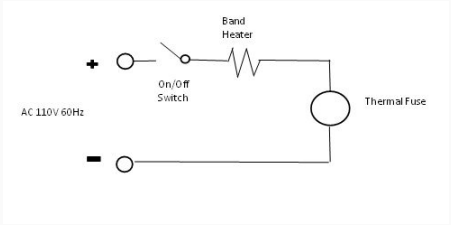
$$i = \frac{24\ Volt}{2.93\ Watt} = 0.122\ Amps$$

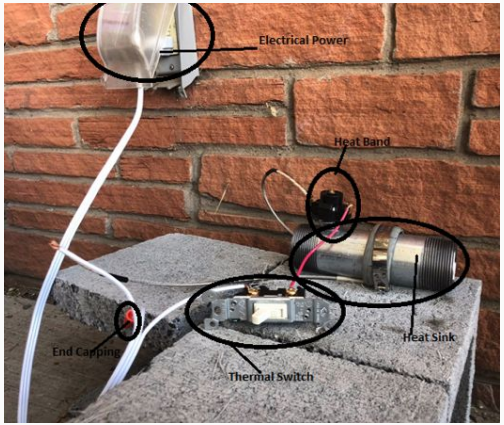
$$V = i \cdot R + K_e \cdot \omega$$

$$\omega = \frac{24\ Volts - (0.122\ Amps)(5\ \Omega)}{21.1\ mNm/A} = 110.85\ rad/s$$

110.85 rad/s = 1058 RPM

Heating System





Updates

Analytical Reports
Pressure & Casing

Gavin & Abdullah
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July 10,2018

Pressure System

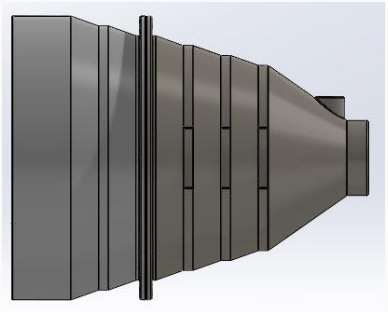
Pressure transducer (Range: 250 psi)

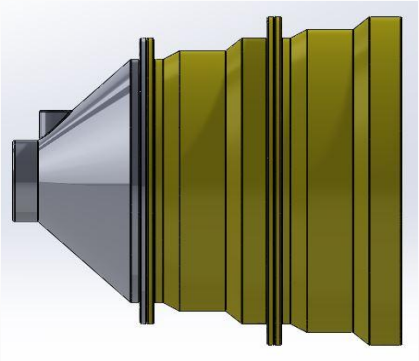
Casing System

- Bernoulli's equation

PLA 3D filament

Visibility options





Moving forward

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Testing Procedures
&
Procedures of Operation

Power Test
- Tools: Multimeter
- Procedure:
  - Measure motor resistance for quality assurance
  - Measure voltage and current generated from motor

Heat Test
- Tools: Thermocouple
  - Multimeter
- Procedure: Check heating element temperature is below 240° F
  - Check thermal fuse is operational with multimeter
  - Check Aluminum Shroud is safe to touch with thermocouple

Pressure Test
- Tools: Multimeter
  - Computer
- Procedure:
  - Measure Voltage generated from pressure transducer
  - Check all wires are connected and communicating to computer

Speed Test
- Tools: Stroboscope
- Procedure:
  - Measure rotational speed of shaft
  - RPM not exceeding 1500 for safe operation

Ignition Procedures
- Plug in main power cable
- Begin Air Compressor to 60 psi
- Release Valve to Turbine Section
- Turn Valve to Compressor Diffuser

Heating Element Operation
- After Ignition is completed and running
- Turn on heating system
- Safe Run Time: 20 minute, continuous

Temperature Acquisition Operation
- After LED system is continuously operating
- Plug in Temperature position one
  - Acquire Data
- Plug in Temperature position two
  - Acquire Data

Pressure Acquisition Operation
- Plug in Pressure position one
  - Acquire Data
- Plug in Pressure position two
  - Acquire Data

Shut Off Procedure
- Turn off Heating system
- Turn off Power System
- Allow system to run until no movement
- Unplug main power cable

Moving forward

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Roles & Responsibilities

Erich Gemballa: Print & Power Output Lead

Gavin Geiger: Casing & Ignition Lead

Hamad Almutairi: Heat Exchanger Operator Lead

Abdullah Abdulghafour: Pressure Data Lead

Moving Forward

GANTT

Abdullah
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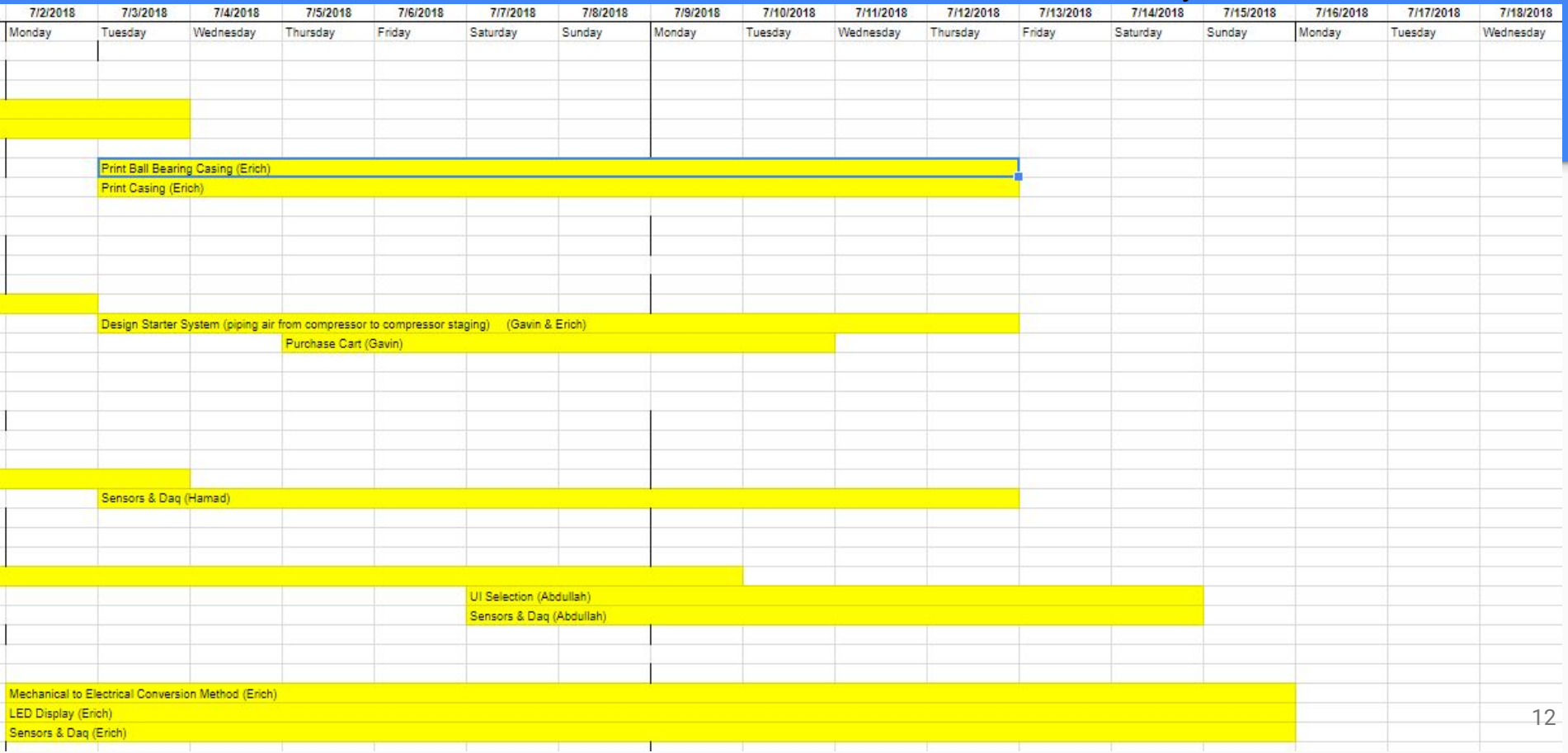

Moving Forward

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Tasks for Team Members	Task Completed	Tasks in Progress	Tasks to Complete
3D Print (Erich)	Ball Bearing Casing Designed CAD	Printing Bearing Casing Printing Turbine Casing Printing Compressor Casing	Updates (Pending)
	CAD update		
	Keyed Shaft purchased		
	Blade Staging Printed (9)		
Casing (Gavin)	Case Shape designed	Purchasing Bolts Plywood Construction Purchasing Cart	Assemble Casing System
	Material Selected		
Heating System (Hamad)	Heat Band purchased	Assemble safe housing and wiring	Thermal Insulation
	Thermal Fuse Purchased		Wire Management with cart
	Heat band power input built		
	Power Switch assembled		
Pressure System (Abdullah)	Pressure Transducer purchased	p-V & T-s diagram for power output ranging from 50 - 100 Watt	UI Selection for display and operation
		Purchase Wire for pressure systems	Labview Acquisition
Work Output System (Erich)	LED strip purchased	Purchase RGB Wiring	LED Display Housing
	Brushless Motor Selected	Assemble Wiring system	Power Check System
	Motor hub designed and currently printing		
Ignition System (Gavin)	Air Compressor acquired	Purchasing Tubing Purchasing Valve	Implementation of air compressor to model
		Designing Air Diffuser	

Budget

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	Vendor	Part #	Part Name	Qty	Description	Cost Per Unit	Total Cost + Tax
Structural/ Data Collection	McMaster-Carr.com	1	Keyed Shaft	1	3/4" Dia, 2 ft long Keyed Shaft	$ 47.50	$ 41.68
	HomCo	2	Ball Bearings	3	Radial Bearings	$ 4.95	$ 14.85
	Home Depot	3	Pressure Transducer	2	Pressure Collection	$ 49.00	$ 119.98
	Home Depot	4	Pressure Transducer Wire	2	Wiring for Transducer		
	Home Depot	5	Thermocouple Wire	2		$ 4.00	
	Home Depot	6	Duct Tubing	1	Sleeve Over Heating Section	$ 10.48	$ 10.48
	TransducersDirect.com	7	Bolts	12	1/4" Diameter, 1" long	$ 0.63	$ 7.56
		8	Nuts	12	1/4" Locking Nuts	$ 1.18	$ 14.16
		9	Washers	12	1/4" Diameter	$ 0.10	$ 1.18
	Home Depot	10	Wires				
		11	Wire End Caps			$ 2.58	$ 2.58
					Total	$ 120.42	$ 212.47
Heat	Home Depot	12	Heat Sink	1	1.5" x 5" Steel Pipe	$ 5.99	$ 6.93
	Tempco	13	Band Heater	1	Collar Heater	$ 32.30	$ 45.09
	Grainger	14	Thermal Fuse	1	Temperature Regulator	$ 17.60	$ 29.57
	Home Depot	15	Switch	1	Emergency Shutoff Switch	$ 0.69	$ 0.83
	Home Depot	16	Thermal Tape	1	Thermal Tape for Insulation	$ 4.98	$ 4.98
					Total	$ 61.56	$ 87.40
Compressor	CPOOutlets.com	17	Air Compressor	1	6 gal 150 PSI Compressor	$ 89.00	$ 96.90
	Home Depot	18	Recoil Hose	1	25 ft Compressor Hose	$ 14.98	$ 16.10
	Home Depot	19	Ball Valve	1	Compressor Connector	$ 8.98	$ 9.70
					Total	$ 112.96	$ 122.70
Power		20	Brushless DC Generator	1	Power Generation	$ 20.00	$ 20.00
	SolidApollo.com	21	LED Light Strip	1	Light Strip	$ 14.00	$ 15.00
					Total	$ 34.00	$ 35.00
3D Prints	NAU	22	Comp Casing 1	1	3D Print	$ 15.00	$ -
		23	Comp Casing 2	1	3D Print	$ 15.00	$ -
		24	Turbine Casing 1	1	3D Print	$ 20.00	$ -
		25	Turbine Casing 2	1	3D Print	$ 20.00	$ -
		26	Comp Blade 1	1	3D Print	$ 10.00	$ -
		27	Comp Blade 2	1	3D Print	$ 10.00	$ -
		28	Comp Blade 3	1	3D Print	$ 10.00	$ -
		29	Comp Blade 4	1	3D Print	$ 10.00	$ -
		30	Comp Blade 5	1	3D Print	$ 10.00	$ -
		31	Comp Blade 6	1	3D Print	$ 10.00	$ -
		32	Turbine Blade 1	1	3D Print	$ 10.00	$ -
		33	Turbine Blade 2	1	3D Print	$ 10.00	$ -
		34	Turbine Blade 3	1	3D Print	$ 10.00	$ -
					Total	$ 160.00	$ -
					Project Total	$ 488.94	$ 457.57

Hardware Review 2

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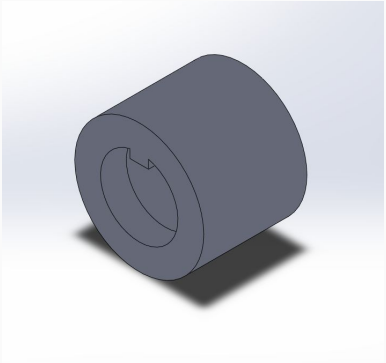
Heating & Power Display

Heating

Power



Hardware Review 2

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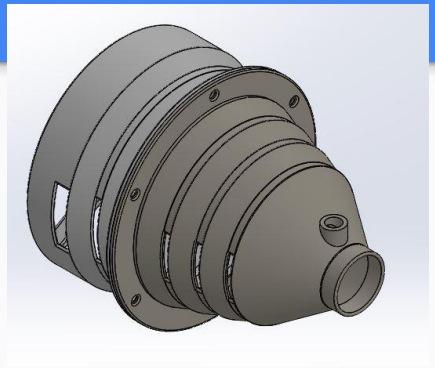
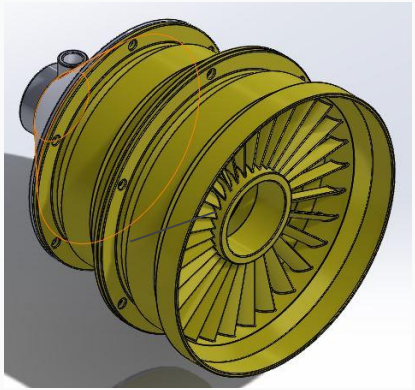
Casing, Ignition & Pressure Display

Casing





Ignition

Pressure Display