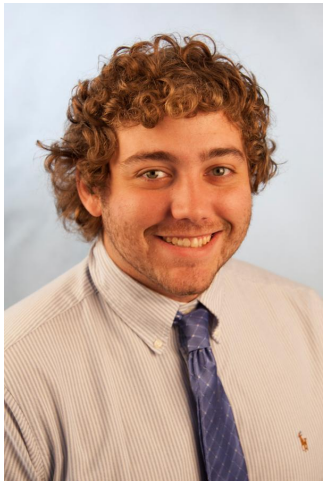
Unison Industries Forced Air-Cooled Heat Sink

Dustin Birchall, Tyler Pilet, and Jeffery Rutledge

02/27/2018

Team 19



Dustin Birchall
Lead ME

Parker Harding
Team Leader

Tyler Pilet
Lead FEA Engineer

Lucas Pye
Recorder

Jeffery Rutledge
Financial Advisor

Project Recap

Dustin Birchall

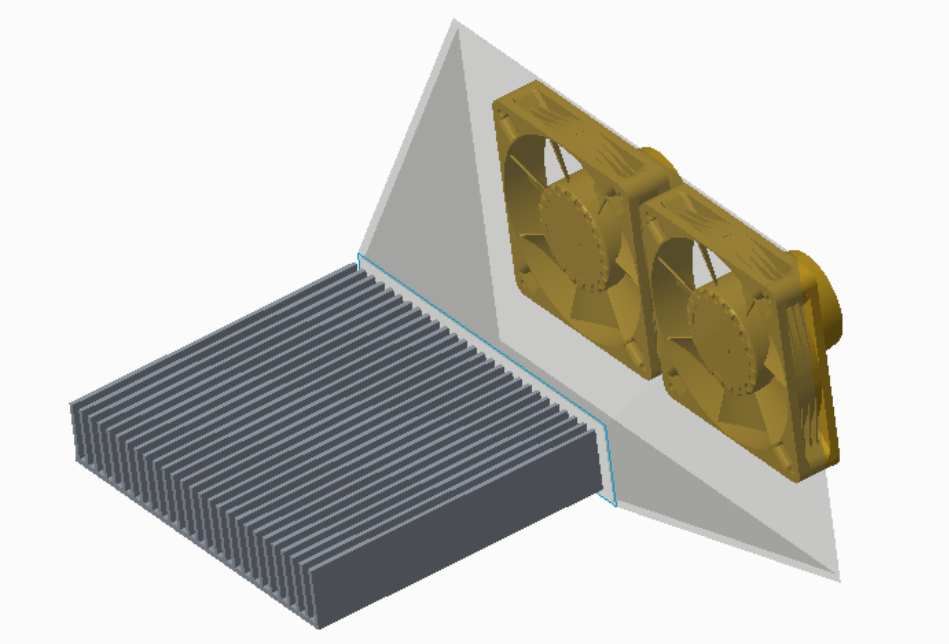
Project Recap

- Team 19 is tasked with developing a forced air, lightweight heat sink that must be able to dissipate 300W of heat and maintain a temperature of 135°C max (preferably lower).
- A full-bridge rectifier, which changes AC to DC, is our heat source. It is necessary to cool this device, as overheating results in electrical failure for the aircraft.
- Objectives:
  - Design and construct a Heatsink to keep the aircraft's circuitry below an operating temperature of 135°C
  - Lightweight
  - Physically small in size
  - Remove Heat
  - Minimize use of our $2000 budget
  - Efficiently organize 24 Semiconductors in sets divisible by 3

Dustin Birchall

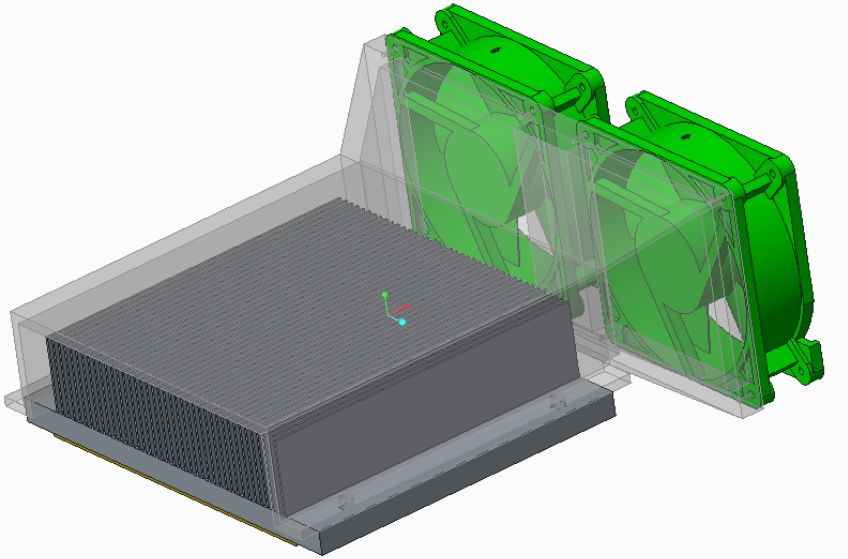
Old Design

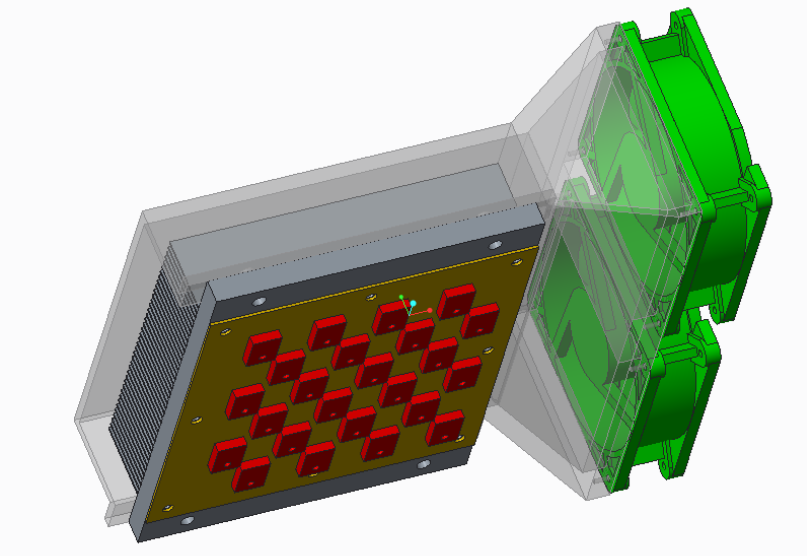
- Where we left off with Design Review 3
- Ideas that were certain:
  - Duct
  - 2 Fans
  - Rectangular Fins
- Possible ideas:
  - Graphite plate
- Find a way to mount fans



Dustin Birchall

Updated Design



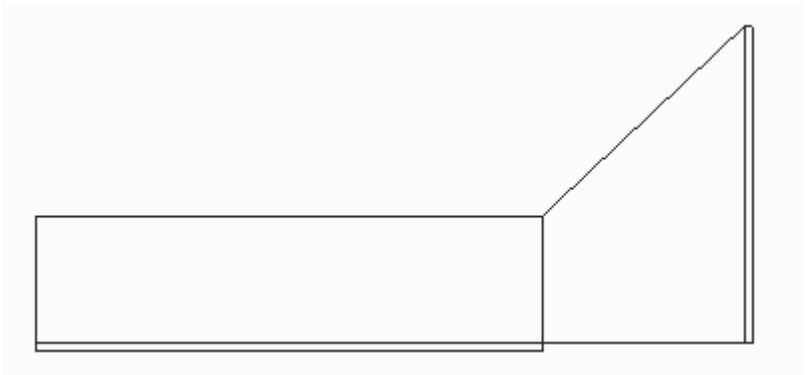


- A duct forcing air through entire length of channels of the heatsink.
- Graphite plate to help distribute heat evenly.

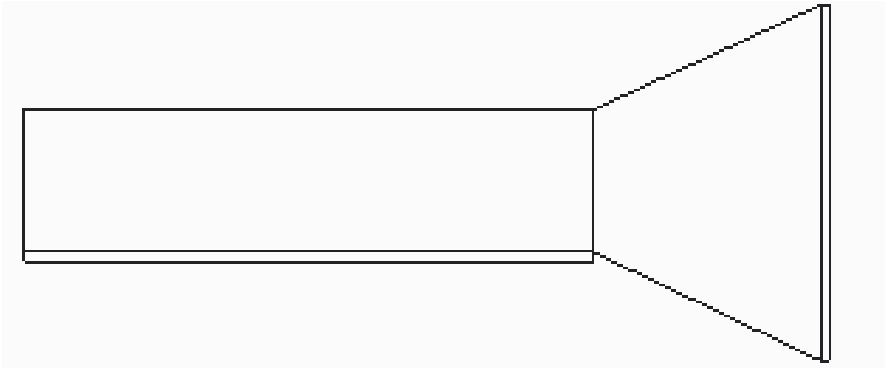
Dustin Birchall

Issues

- When we attempted to order our updated design, we were told of ways to make some of the parts cheaper and easier to fabricate.
- For our heatsink fin dimensions, we originally had a spacing of .133 in.
  - We changed the dimension to be .125 in, a standard size
  - Saved a couple hundred dollars
- Next for the duct, we had to alter how it constrained the air,
  - We were told by Parker Services that they fabricate the ducts a certain way so we altered our design so that they could easily make ours.



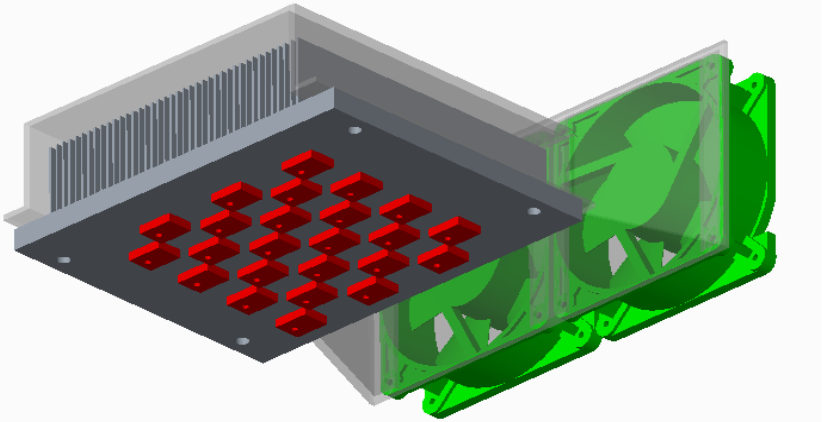
Updated duct design

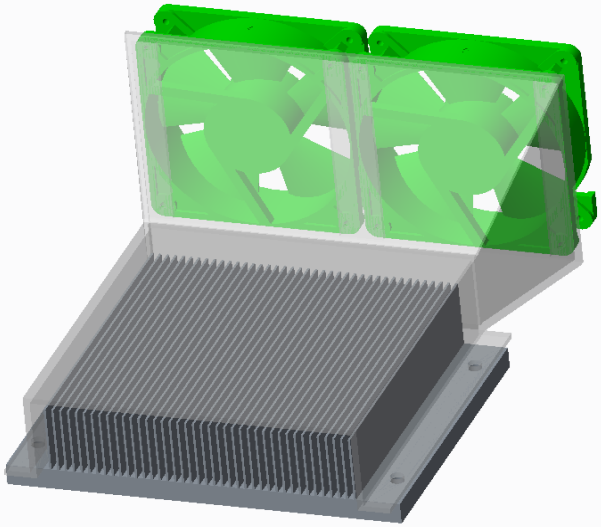


Old duct design

Dustin Birchall

Finalized Design





Dustin Birchall

Ordering

Jeffery Rutledge

Aquisitions

- Allied Electronics
  - 30 resistors to act as semiconductors
- Parker Services
  - Sheet metal for fan duct
- Already in Possession
  - Wiring for resistors and fans
  - Screws for resistors
  - Thermal camera
- Ordered
  - 2 Heat Sinks
- To be Ordered
  - 2 Fans
  - ~30 Thermal pads

Jeffery Rutledge

Mersen

CURRENCY		TERMS				SHIPPING TERMS		
USD		Cash–In–Advance				Freight Pre–pay and Add		
Line #	Mersen Part #	Description	Customer Part #		QTY	UoM	UNIT PRICE(EA)	
1	QUOTEITEM	MF178T13A53AF40D			1	EA	329.67	
					3	EA	217.58	
					5	EA	217.58	

Mersen Quote

PROS:

- R-Theta tool
- Cheap price
- Many designs to choose from

CONS:

- Lead Time: 10 weeks
- Not customizable
- Difficult to mount fan duct onto design

Jeffery Rutledge

COE Machine Shop

- COE Machine Shop
  - Unable to cut the fins
  - Possibly buy new tool to machine it

New Tool: End Mill

- Problems with Machining
  - New tool would break easily
  - Long time to machine the heatsink
  - Machinist didn't want to machine it

Jeffery Rutledge

Velocity Machine Works

- Velocity Machine Works
  - Can make our heatsink
  - Came up with a new fin dimensions to ⅛ inches
  - Lead time: 1 month
  - PO Made by Neil Coker

Terms			F.O.B.		Delivery	Valid thru
Net 30			Tallahassee		3 weeks	3/02/2018
Quantity	**Runs**	**Part Number**	**Rev**	**Description**	**Price/Unit**	**Extension**
1	1	Heatsink	1	Heatsink	1,396.88	1,396.88
3	1	Heatsink	1	Heatsink	1,173.96	3,521.88
1	1	Heatsink 3.175		Heatsink 3.175	959.38	959.38
3	1	Heatsink 3.175		Heatsink 3.175	736.46	2,209.38
						8,694.08

First revision of Quote

Terms			F.O.B.		Delivery	Valid thru
Net 30			Tallahassee		45 Days ARO	3/03/2018
Quantity	**Runs**	**Part Number**	**Rev**	**Description**	**Price/Unit**	**Extension**
2	1	Heatsink 3.175		Heatsink 3.175	792.19	1,584.38
						1,584.38

Second revision of Quote

Jeffery Rutledge

Budget

- Total Budget: $2,000
- Current running total spent: $1,783.42
- Current running total left: $216.58
- What is left to price:
  - Thermal pads: ~$50.00

Budget for Team 19

Website	Purchase	Quantity	Cost	Running Total Cost	Running Total Budget
https://www.alliedelec.com/caddock-mp915-20-0-1-/70089556/	Resistors	30	$52.20	$52.20	$1,947.80
https://www.mcmaster.com/#fans/=1bdtg5n	Fans	2	$146.84	$199.04	$1,800.96
https://www.velocitymachineworks.com/	Machine Work	2	$1,584.38	$1,783.42	$216.58

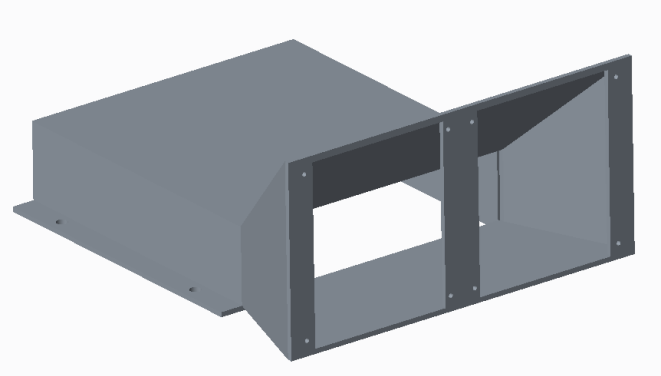
Jeffery Rutledge

Future Work

Tyler Pilet

Future Work

- A duct was required, as the fans are larger than our heat sink's height. The flow needed to be guided through the fins.
- Parker Services, Lucas's employer, donated sheet metal and equipment to produce a duct for our team.
- The duct will be manufactured after fans are received. The lead time a singular day.

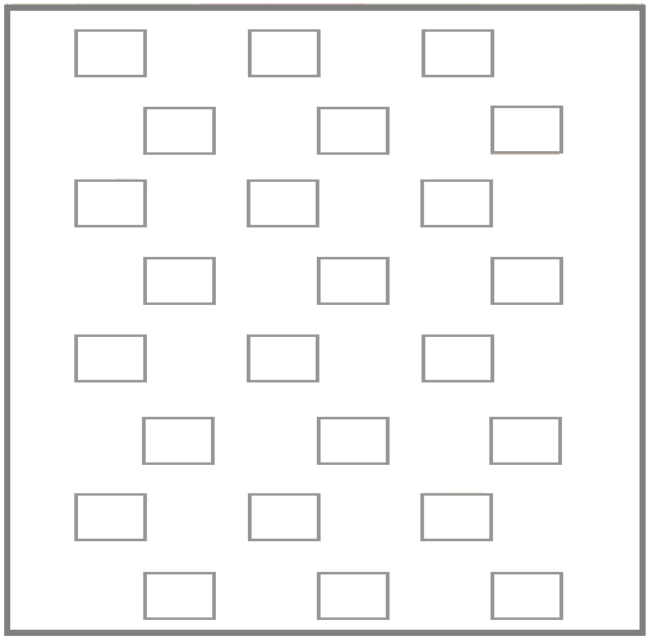


A CAD model of our proposed duct.

Tyler Pilet

Testing and Optimization

- In order to determine the resistance and voltage needed, ***V = I*R*** and ***P = I*V*** were combined and rearranged to produce ***V = (P*R)^0.5***
- The 12.5 W heat dissipation of the semiconductors will be simulated by 20 ohm resistors run at 15.8 VDC.
- The 24 resistors will be placed in a staggered pattern.

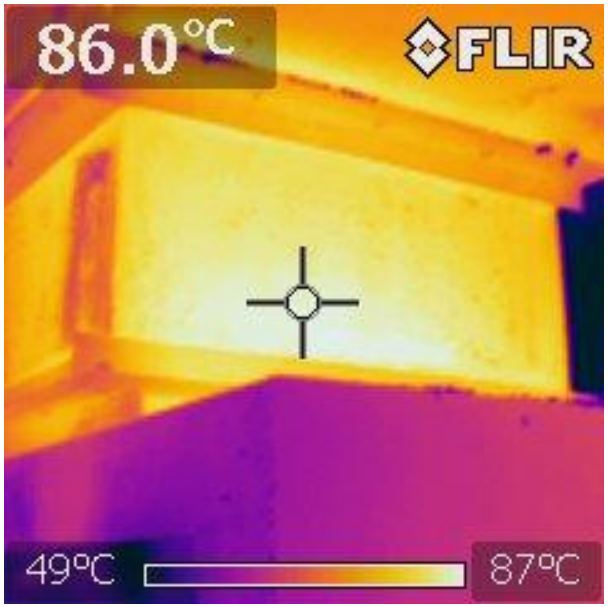


A drawing displaying the semiconductor locations.

Tyler Pilet

Testing and Optimization (Cont.)

- The experiment will take place at room temperature.
- Once the system reaches steady-state temperatures, the ambient temperature will be recorded with a thermistor and thermal imaging camera will be used to determine cold spot on the fins.
- k-Type thermocouple pads will be used to verify the thermal image, inlet, and outlet conditions.
- Using the thermal image, cold spots on fins will be determined, and material will be milled off to reduce weight.



A sample thermal image taken last month with Dr. Juan Ordonez.

Tyler Pilet

QUESTIONS?