

# Meeting #8

## Agenda

Frigus – Meeting 8

10/24/2016

EP324A – ME conference room

3:30 am – 4:30 pm

### Introduction:

- JT takes minutes

### Previous Action items:

- Caleb – Agenda, MathModel, Models
- JT – Minutes, Slides, Machine shop capabilities ( meet with bill)
- Connor –Wiki page, Experimentation, Binder, Models, Schedule

### Discussion:

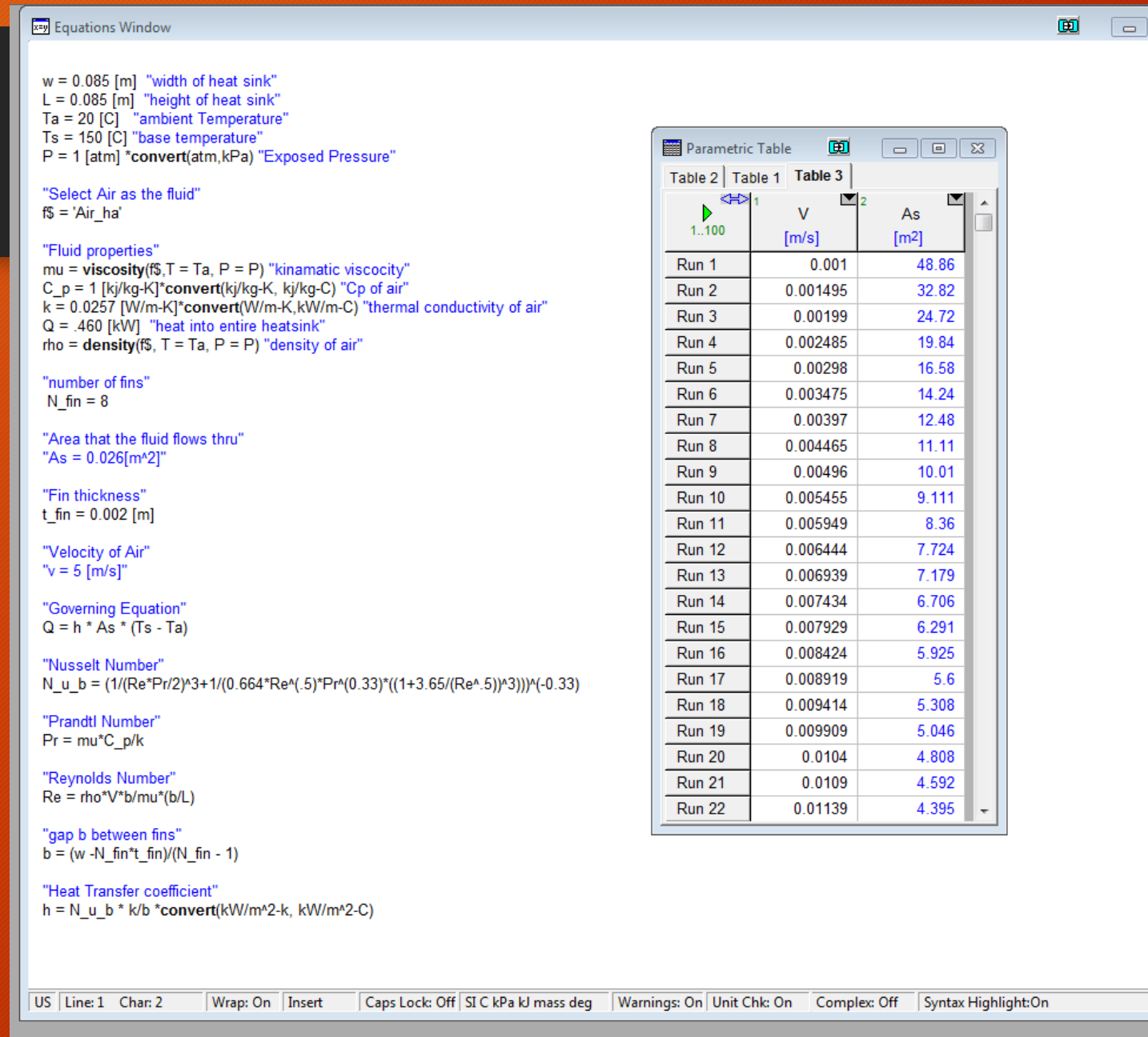
- Team – Progress Report
- Simulations – file type, changes, dimensions
- Math model – Ideas, changes, error
- Machine specifications - Come up with a Machinable part
- Wikipage begun- Tomorrow Class workshop on how to make the page better
- Preliminary Experimental Methods
- New ideas? Changes
- Attachment ideas

### Action Items:

- Assign weekly tasks

# Math Model

- There are some complications
- Caleb will explain



Equations Window

w = 0.085 [m] "width of heat sink"  
L = 0.085 [m] "height of heat sink"  
Ta = 20 [C] "ambient Temperature"  
Ts = 150 [C] "base temperature"  
P = 1 [atm] \*convert(atm,kPa) "Exposed Pressure"

"Select Air as the fluid"  
f\$ = 'Air\_ha'

"Fluid properties"  
mu = viscosity(f\$, T = Ta, P = P) "kinematic viscosity"  
C\_p = 1 [kJ/kg-K] \*convert(kj/kg-K, kj/kg-C) "Cp of air"  
k = 0.0257 [W/m-K] \*convert(W/m-K, kW/m-C) "thermal conductivity of air"  
Q = .460 [kW] "heat into entire heatsink"  
rho = density(f\$, T = Ta, P = P) "density of air"

"number of fins"  
N\_fin = 8

"Area that the fluid flows thru"  
As = 0.026[m^2]

"Fin thickness"  
t\_fin = 0.002 [m]

"Velocity of Air"  
v = 5 [m/s]

"Governing Equation"  
Q = h \* As \* (Ts - Ta)

"Nusselt Number"  
$$N_{u_b} = (1/(Re*Pr/2)^{.33} + 1/(0.664*Re^{.5}*Pr^{.33}*((1+3.65/(Re^{.5}))^{.33})))^{-.33}$$

"Prandtl Number"  
Pr = mu\*C\_p/k

"Reynolds Number"  
Re = rho\*v\*b/mu\*(b/L)

"gap b between fins"  
b = (w - N\_fin\*t\_fin)/(N\_fin - 1)

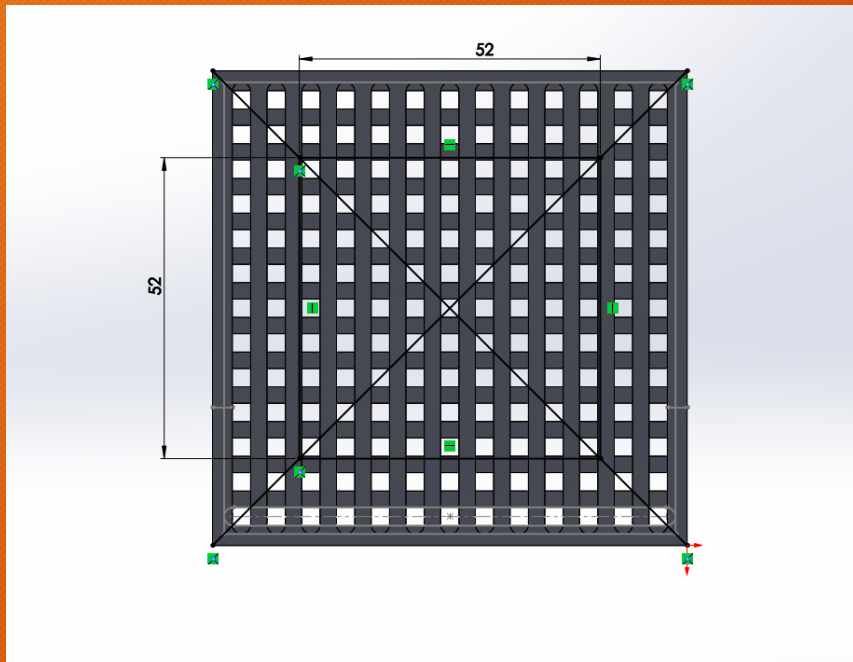
"Heat Transfer coefficient"  
h = N\_u\_b \* k/b \*convert(kW/m^2-k, kW/m^2-C)

Parametric Table

	V [m/s]	As [m^2]
Run 1	0.001	48.86
Run 2	0.001495	32.82
Run 3	0.00199	24.72
Run 4	0.002485	19.84
Run 5	0.00298	16.58
Run 6	0.003475	14.24
Run 7	0.00397	12.48
Run 8	0.004465	11.11
Run 9	0.00496	10.01
Run 10	0.005455	9.111
Run 11	0.005949	8.36
Run 12	0.006444	7.724
Run 13	0.006939	7.179
Run 14	0.007434	6.706
Run 15	0.007929	6.291
Run 16	0.008424	5.925
Run 17	0.008919	5.6
Run 18	0.009414	5.308
Run 19	0.009909	5.046
Run 20	0.0104	4.808
Run 21	0.0109	4.592
Run 22	0.01139	4.395

US | Line: 1 Char: 2 | Wrap: On | Insert | Caps Lock: Off | SI C kPa kJ mass deg | Warnings: On | Unit Chk: On | Complex: Off | Syntax Highlight: On

# Machine shop meeting with bill



- Smallest mill cutter currently in shop ( $1/8$  in  $\approx 3.175$  mm)  
But we will be cutting slightly larger than the head
- The thinnest the walls of the fin can be is 2 mm but suggested to over shoot to 3 mm in case of metal shaving getting caught on the head
- The deepest the fin can be with the  $1/8$  in head is  $.6$  in = 15.4 mm
- 85 mm block will fit into the clamps on the mill and cnc mill fine
- we will be using the cnc mill to cut out our block
- Assuming aluminum

# Shop training status

- Conner-Good on every thing except (mill and lathe need some one else) and can Use CNC Mill and lathe with grad mentor
- JT-good on every thing and can use CNC mill and lathe with grad school mentor
- Caleb- good on basic equipment (no mill, no lathe)

# 3D Printing



- Printed Preliminary 3D Model
- Will work as stand-in for board for Preliminary Experimentation

# Wiki Page

## Unified Liquid Cooling Heat Solution

The objective of this Senior Design project is to design a thermal management system for a multi-kilowatt, multi-phase, power converter based around a unified thermal core with liquid cooling. This will require that the semiconductor transistor dies to be removed from the normal packaging found in a commercial device to maximize heat transfer to the thermal core and into the coolant. This hot coolant then will be passed through a radiator and thermoelectric generator to the ambient environment, allowing the recovery of otherwise lost heat energy to power control systems

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- 2 Project Goals
- 3 Cad Design
- 4 Team Members
- 5 Document Archive

### Problem Statement

 [edit]

The objective of this Senior Design project is to design a thermal management system for a multi-kilowatt, multi-phase, power converter based around a unified thermal core with liquid cooling. – Rachel Peterson

The first phase of the process will be designing a heat sink to fit within the constraints for the thermal and physical properties defined by board configuration and MOSFET placement.

The second phase will be focused around testing for the purpose of refining heat dissipation, functionality, and efficiency.


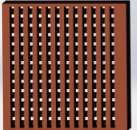
### Project Goals

 [edit]

Our Project Goals are to Complete a robust heat removal system to fit within the constraints required by the project. We will design the heat sink to be able attach securely to the MOSFETS with a pressure of at least 10 PSI. The current goal is to explore natural convection if this is not feasible forced convection will be explored. We hope to be able to manufacture the sink in house.

### Cad Design

 [edit]

Solidworks Render	Example Photograph for CAD Modeling
	


### Team Members

 [edit]

Member	Discipline
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- Began Preliminary design of Wikipage
- Tomorrow we will be having a workshop day for the Wikipage and hope to have it fully up and running shortly after that.

### Unified Liquid Cooling Heat Solution Team



From Left to Right: Connor Trulock, James Sutton, and Caleb Jo

**Sponsor** University of Idaho Mechanical Engineering Department

**Team Name** Fngus

**Team Members**

- James Sutton
- Connor Trulock
- Caleb Jo

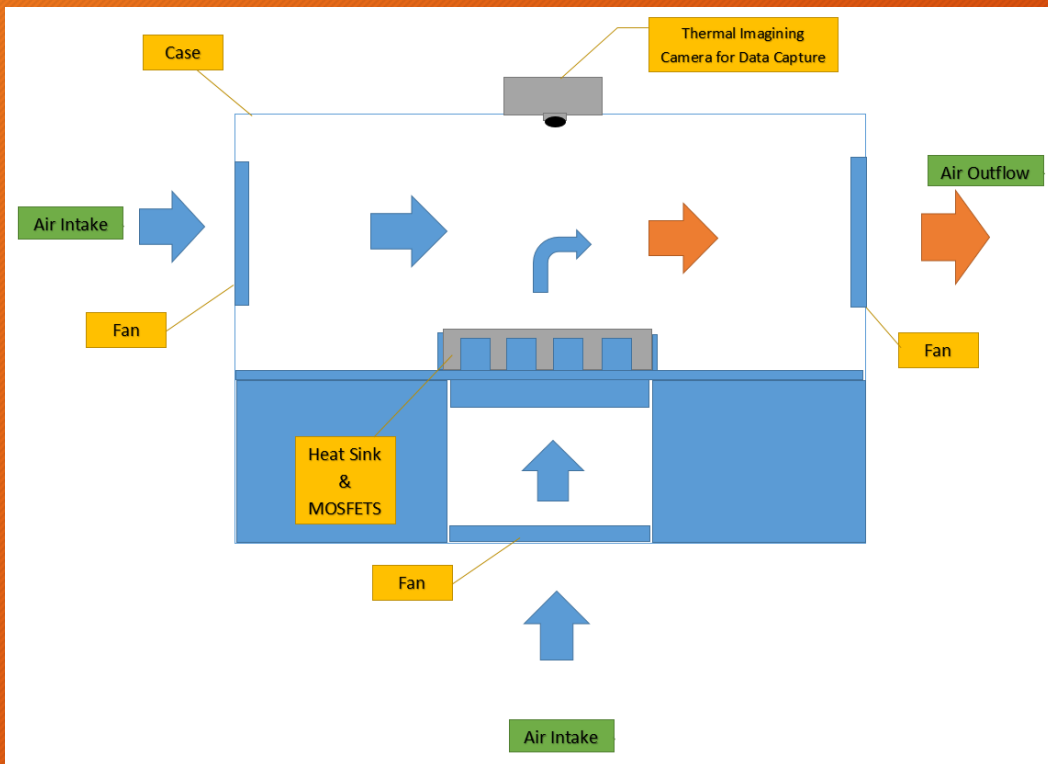
**Faculty Advisors**

- Herb Hess
- Steven Beyerlein
- Tau Xing

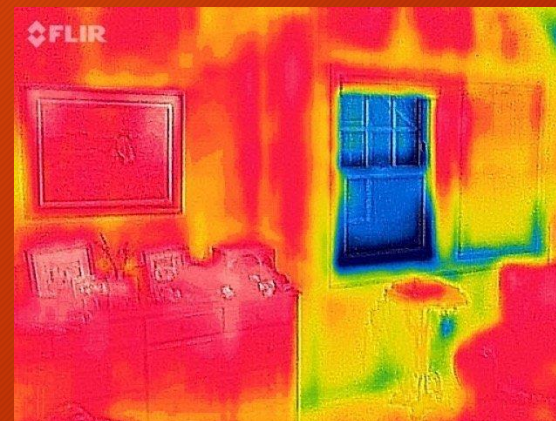
**Mentor** Rachel Peterson

**Duration** Fall 2016 - Spring 2017

# Experimentation



- Looked at Preliminary testing methods
- Will use a mix of thermocouples and Thermal Imaging Equipment
- The person to contact in the ME department is Kamal Kumar





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