

“Heat Pipe Demonstration Unit”

Senior Capstone Design- ME476C Concept Gen. & Evaluation Presentation

Kaled Aleweehan
Abdullah Almutairi
Waleed Almutairi
Abdullah Ben Gheyam
Omar Alotaibi

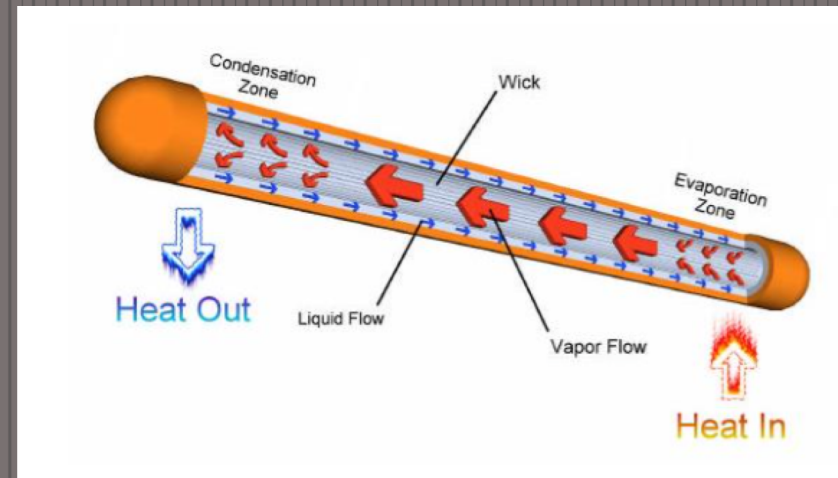


Figure 1: Heat Pipe [1]

Instructor: Dr. David Trevas
07/12/2018

Content:

- **Project Description**
- **Black Box & Decomposition Model**
- **Designs Considered**
- **Design Selected**
 - **Pugh Chart & Decision Matrix**
- **Schedule & Budget**

Project Description:

- What is the project about?
 - Heat pipe demo unit.
- Our sponsor?
 - Dr. David Trevas.
- Our stakeholders?
 - Mechanical engineering students and facilities at NAU.
- Why is it important?
 - Learning the principles of mechanical engineering courses.



Figure 2: NAU [2]

Black Box



Figure 3: Black box

Decomposition Model

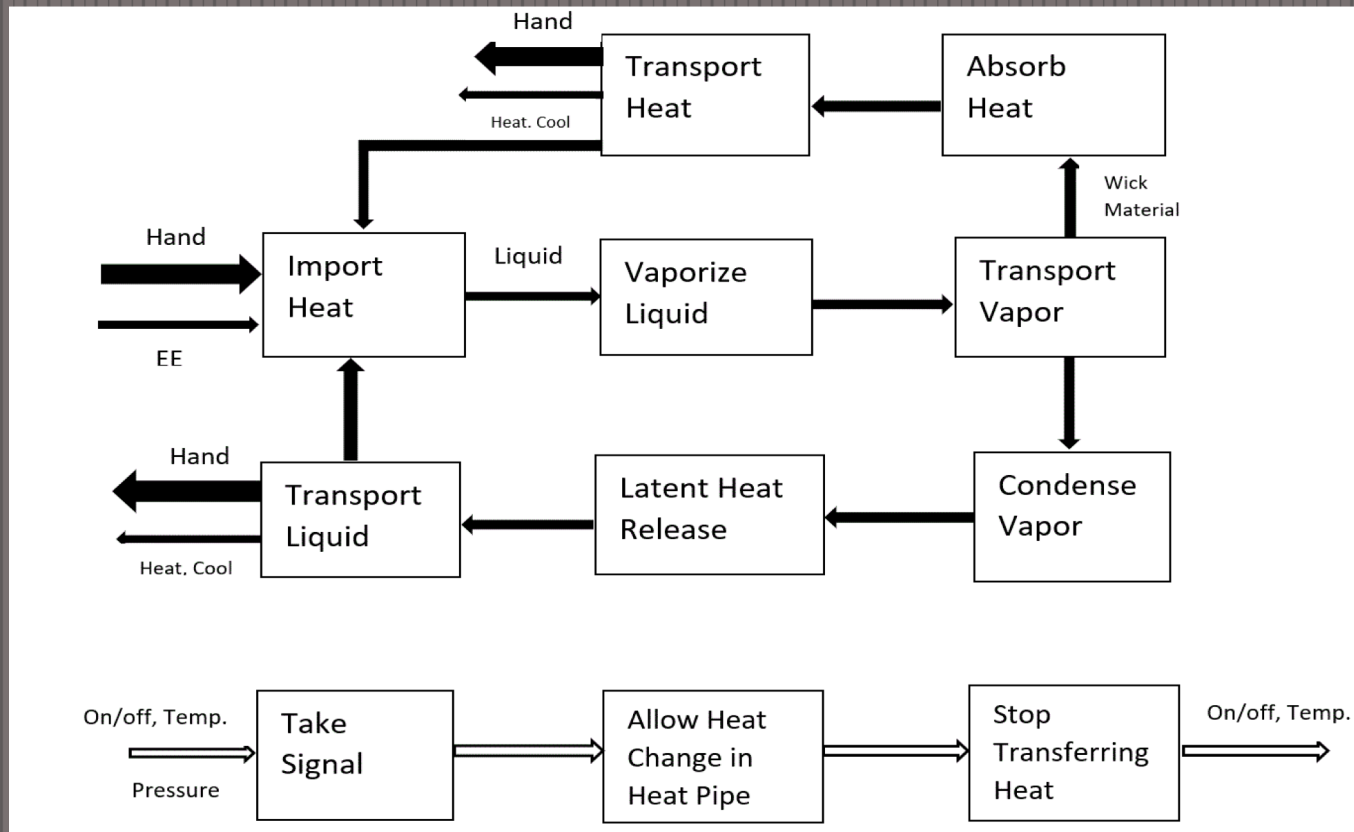


Figure 4: Decomposition Model

Design Considered #1

- **Extruded Heat Sink**
- **Advantages?**
 - Manufacturable
 - Groove
- **Disadvantages?**
 - Limited Dimension
 - Fin height limited $\sim 20x$ fin width

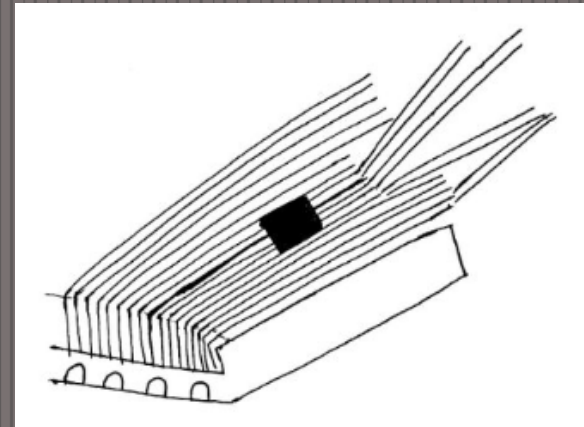


Figure 5: Extruded Heat Sink

Design Considered #2

- **Die Cast Heat Sink**
- Advantages?
 - Low Weight
 - Easily customizable
 - Net shape
- Disadvantages?
 - Lower thermal conductivity
 - Potential for porosity.
 - Commonly, not used with heat pipes

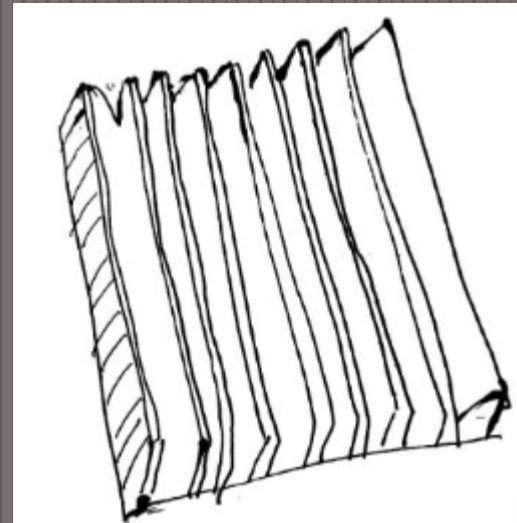


Figure 6: Die Cast Heat Sink

Design Considered #3

- Skived Heat Sink
 - Advantages?
 - Fin and base from solid piece of metal
 - High density fins
 - Flexibility than extrusion
 - Disadvantages?
 - Base maybe thicker than needed
 - Thus higher weight
 - Fins damage easily

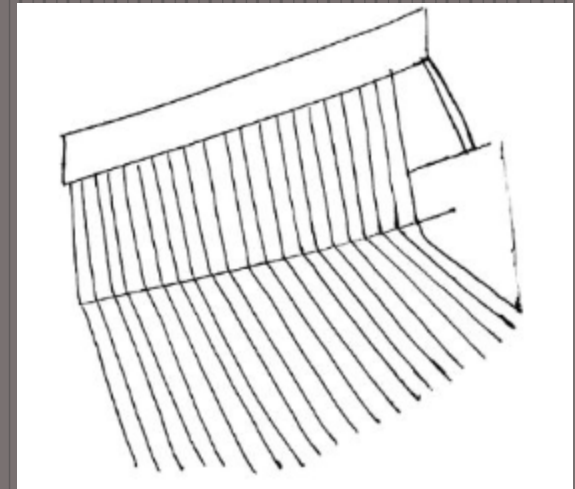


Figure 7: Skived Heat Sink

Pugh Chart

Table 1: Pugh Chart

| Concept Criteria | Design 1 | Design 2 | Design 3 | Design 4 | Design 5 | Design 6 | Design 7 | Design 8 | Design 9 | Design 10 |
|---------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|
| Durability | + | - | S | S | + | - | + | S | D | - |
| Reliability | - | + | + | + | S | - | - | - | D | + |
| Manufacturable | S | - | - | + | S | S | - | S | D | S |
| Safety | S | S | S | S | S | S | S | S | D | S |
| Ease of Assembly | - | + | + | - | - | + | - | + | D | - |
| Variability | - | + | S | + | + | - | + | - | D | - |
| Easy to Measure | - | S | + | + | - | + | + | S | D | S |
| $\Sigma +$ | 1 | 3 | 3 | 4 | 2 | 2 | 3 | 1 | D | 2 |
| $\Sigma -$ | 4 | 2 | 1 | 1 | 2 | 3 | 3 | 2 | D | 2 |
| ΣS | 2 | 2 | 3 | 2 | 3 | 2 | 1 | 4 | D | 3 |

Decision Matrix

Table 2: Decision Matrix

| Weight | | | Design 2 | | Design 3 | | Design 4 | |
|------------------------------|------|----|----------|----|----------|----|----------|--|
| Criterion | | | | | | | | |
| Material Melting Temperature | .235 | 80 | 18.8 | 85 | 19.9 | 95 | 22.3 | |
| Reliability | .214 | 70 | 14.9 | 90 | 19.3 | 80 | 17.1 | |
| Set-up Time | .186 | 85 | 15.8 | 88 | 16.4 | 78 | 14.5 | |
| Size | .248 | 79 | 19.6 | 84 | 20.8 | 95 | 23.6 | |
| Light Weight | .117 | 80 | 9.4 | 85 | 9.9 | 90 | 10.5 | |
| Totals | 1 | | 78.5 | | 86.3 | | 88 | |
| Relative Rank | | | 3 | | 2 | | 1 | |

Design Selected

- Cotton cloth, Inclined setup , and Radial Skived Heat Sink.

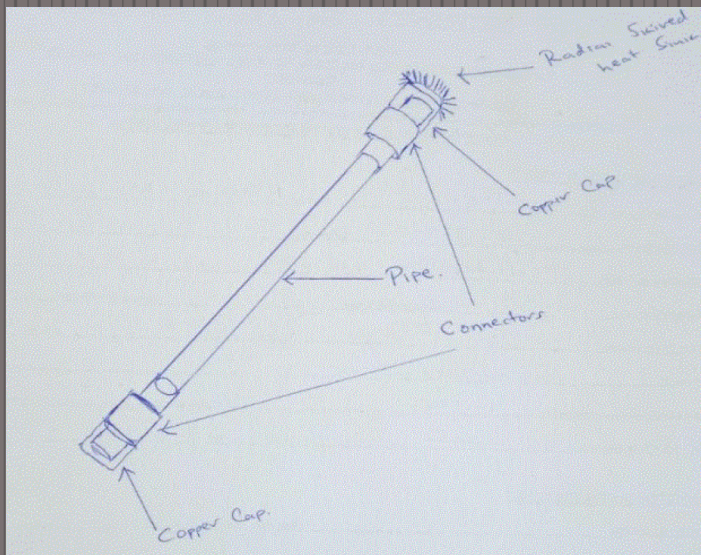


Figure 8: Design Selected

Table 3: Customer Requirements

| Customer Requirement | Description | Weight |
|----------------------|--|--------|
| Durability | How long it is withstanding | 0.16 |
| Accuracy | How accurate it will work | 0.16 |
| Manufacturable | Rate which it could be mass produced | 0.11 |
| Safety | How safe the heat pipe setup is for the end user | 0.13 |
| Ease of Assembly | Able to install the parts | 0.14 |
| Variability | Capable of varying with the situation | 0.17 |
| Easy to Measure | Measuring of the temperature is easy | 0.13 |

Schedule & Budget

Schedule

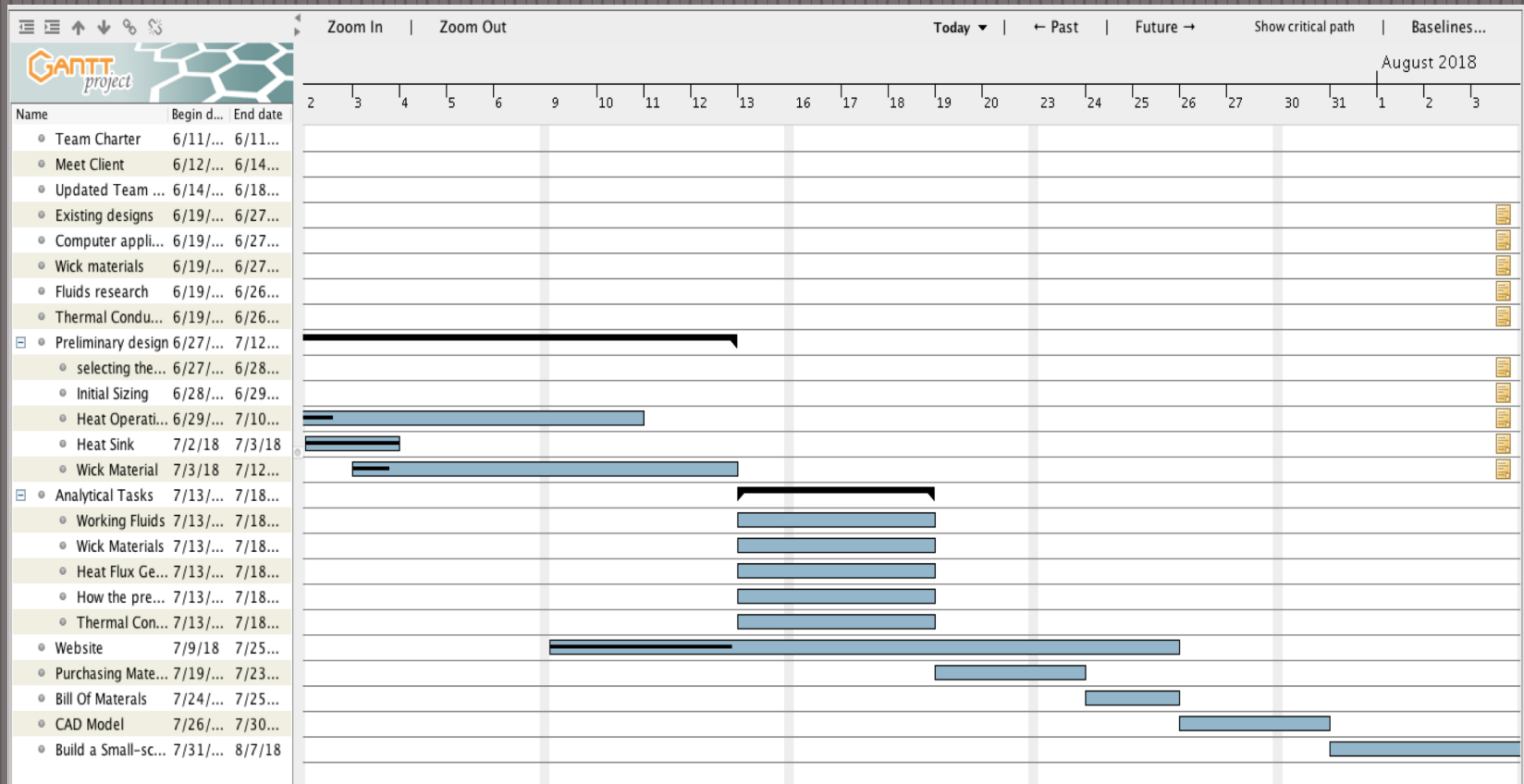
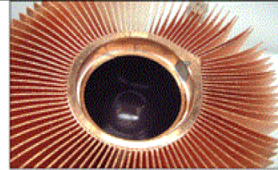






Figure 9: Schedule

Ben Gheyam
Heat Pipe
07/12/18

Budget

Table 4: Budget

| Component Name | Model Number | Picture | Cost | Supplier |
|------------------------|--|--|---------|---------------------------------------|
| Radial Skived Heatsink | Materials: C1000 Copper skived fins, copper base Fan Spec: 1800-3500RPM, 12V, 0.24A Fan Dim: 25*93*93mm, PWM Heatsink & Fan Dim: 68*96*96mm Weight: 714g |  | \$39 | Frostytech [3] |
| Glass tubing | Borosilicate Glass Tubing: 12mm x 12 Inches: Pack 5 Outside diameter: 0.486 inch |  | \$4.40 | OnlineScienceMall [4] |
| Cotton Cloth | 5-sq yards. Wick material |  | \$3.93 | Lowe's [5] |
| Vacuum Pump | Silverline Elite hand vacuum/ pressure pump w/ <u>2 inch</u> compound gauge w/ rubber boot |  | \$49.95 | ToolDiscounter [6] |
| Purified Bottled Water | (16.9 fl. oz., 45 pk.) Working Fluid. |  | \$3.36 | Sam's Club [7] |

Budget Cont....

| | | | | |
|-------------------------|--|--|---|---------------------|
| Copper Heating Elements | 1500-Watt/120-Volt HWD Element |  | \$9.98 | The Home Depot [8] |
| k-type thermocouple | Antunes 4051008 THERMOCOUPLE, TYPE K NO HAZARDS L 4.20in, W 5.70in, H 1.85in, Weight 0.02 lbs |  | \$ 24.90 Qty: 7 Total: \$174.3 | Partstown [9] |
| Copper Cap | 1/2 in. Copper Caps |  | \$5.46 each Qty: 2 Total: \$10.92 | The Home Depot [10] |
| CONNECTOR | 1/2 in. Brass Push-to-Connect Coupling |  | \$7.27 each Qty: 2 Total: \$14.54 | The Home Depot [11] |
| Total: | | | \$310.38 | |

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Thank you - Any questions?

