Design of a Less Deafening Hair Dryer

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Presentation Overview

- Project Scope
- Solving the Problem
- Current Concept
- Current Progress and Upcoming Plans
- Gantt Chart

Project Scope

- Fall 2015 Objectives
  - Finalize Concept Design
- Spring 2015 Objectives
  - Produce Business Model for Product
  - Construct a Fully Functional Prototype

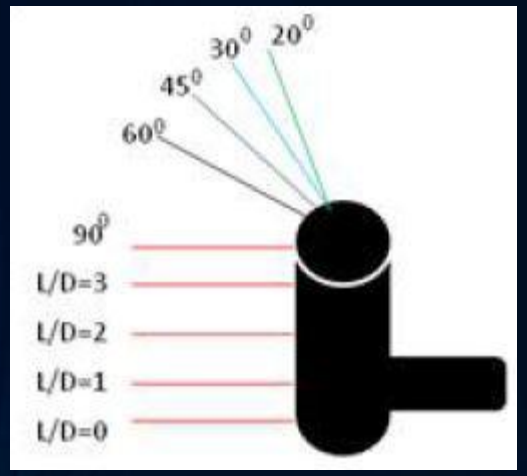
What's the Problem??

- **Hair Dryers are just TOO LOUD!**
  - 60 dB < Sound Pressure Level < 95 dB
  - Free Jet Flow --> Turbulence
  - Creates unwanted and annoying noise in households and grooming businesses
- **Goal: Design and Build a Quieter Hair Dryer**

Where's the Problem?

- **Primary Sources**
  - Intake
  - Nozzle Exit
- **Additional Sources of Concern**
  - Within the Nozzle
  - Front and Rear Grill Covers
  - Air Filter

KEY

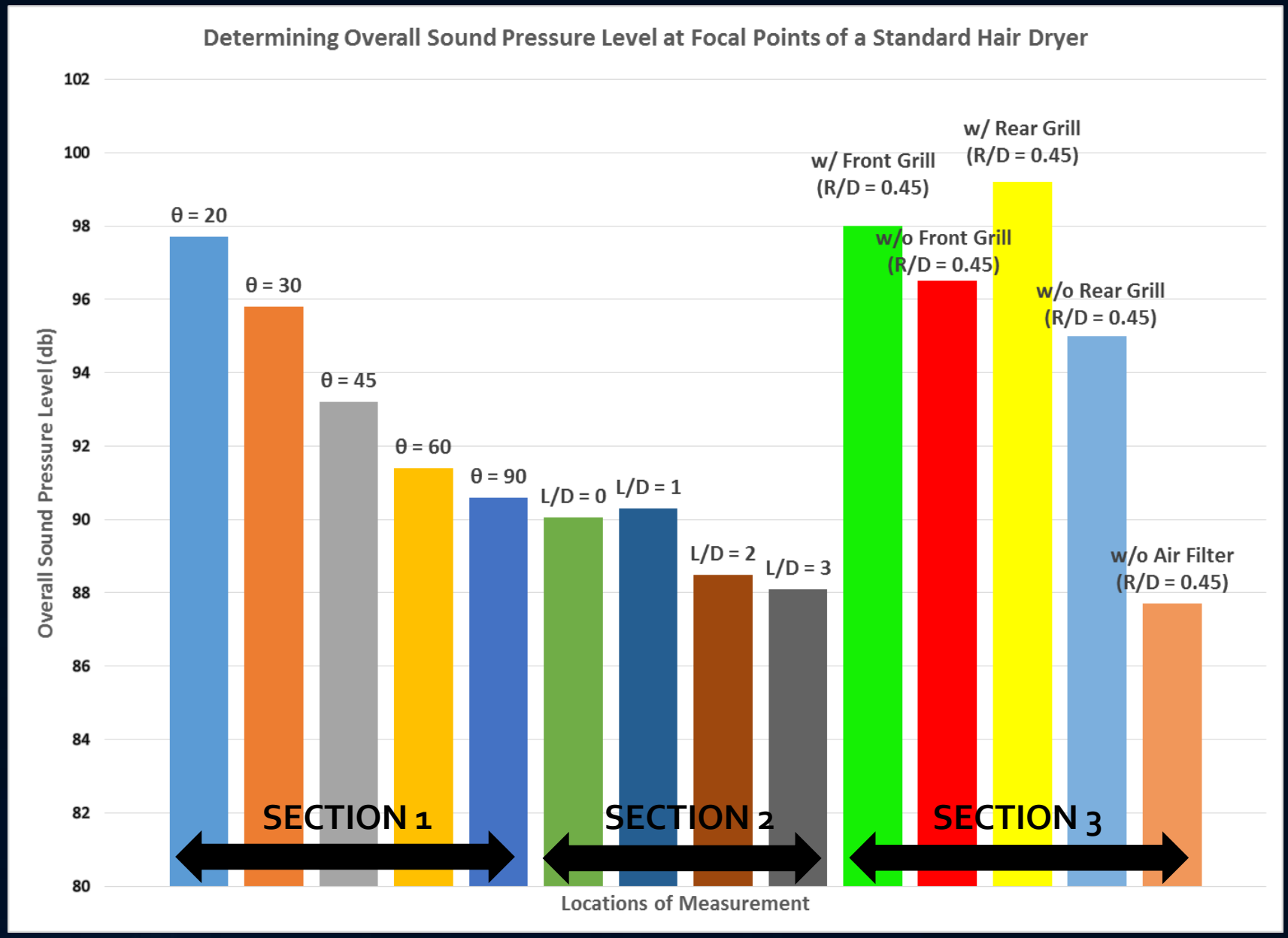


θ = Angle between the axis of the jet and the plane of the hair dryer

L/D = Distance of the microphone location from the inlet

R/D = Distance between the hair dryer exit and its user

D = Diameter of 2 inches



Note: Testing data above based on outside source

How to Fix the Problem?

- **Fan**
  - Incorporate Centrifugal Design
  - Apply Cambered Airfoil Shaped Blades
- **Intake and Exit**
  - Design Front Rear Grill-Cover with Streamline Spokes
  - Mount Sound Absorption Material
  - Shape Edge of Nozzle-Exit

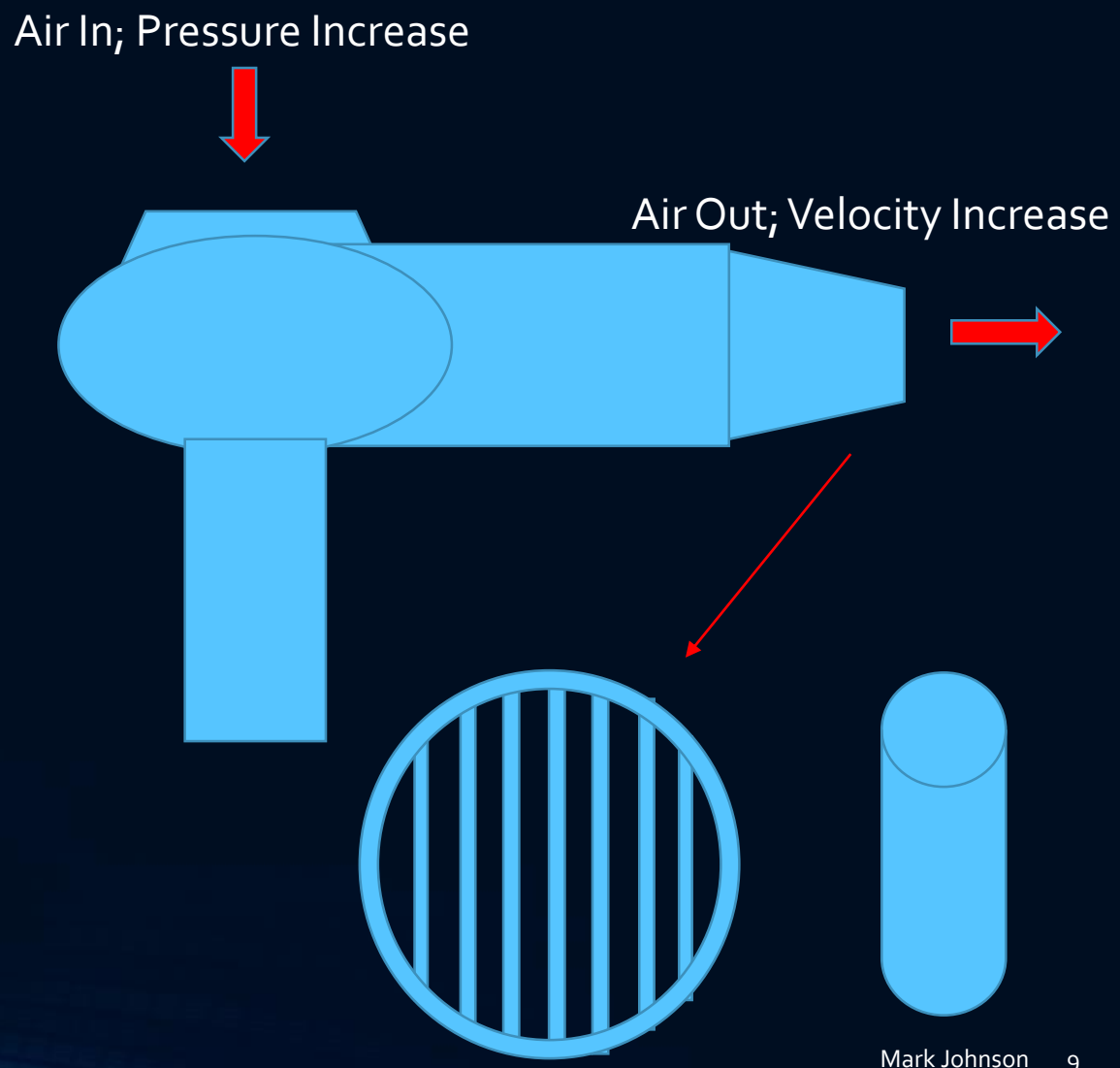
Why Fix it this Way?

Centrifugal Types

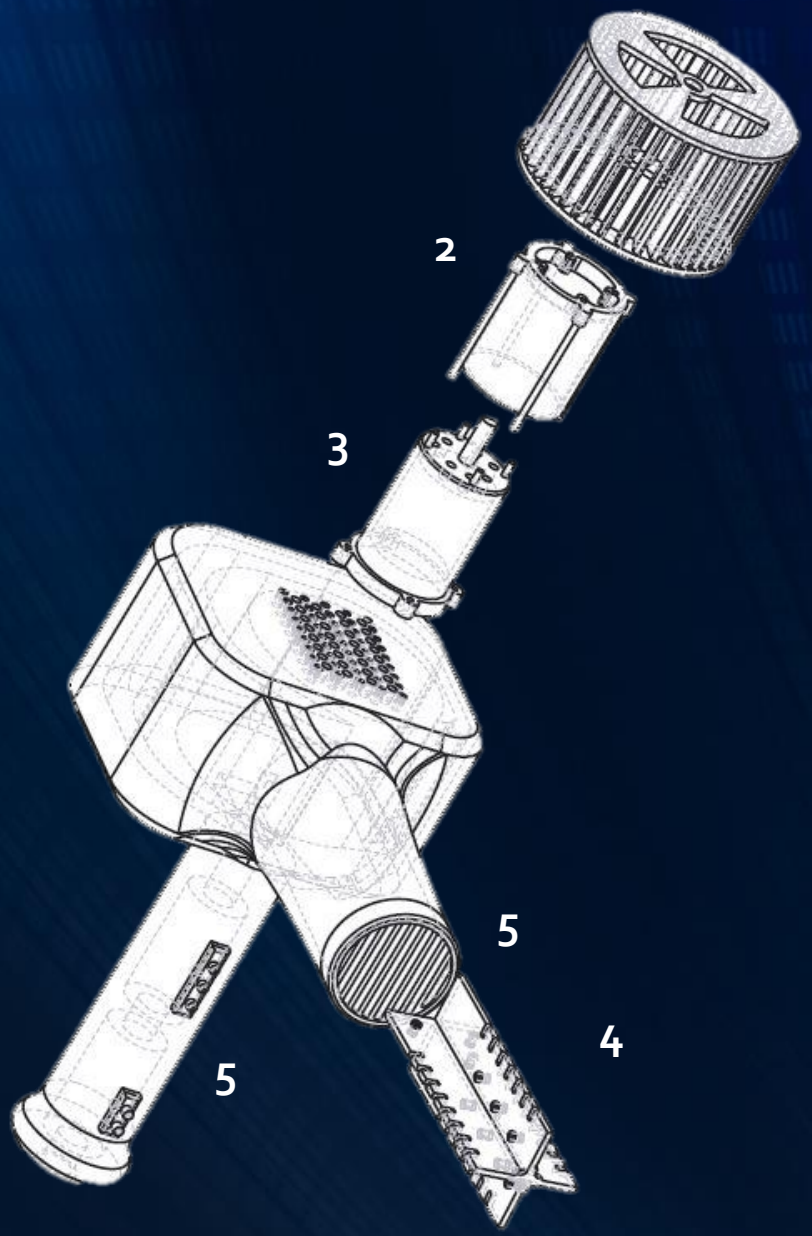
- **Centrifugal Fans with an Airfoil Blade Design**
  - High Pressure
  - Requires the least amount fan power input
  - Use of airfoil blade design with ~ 10 to 16 blades creates lowest amount of broadband noise
  - Covered by housing which greatly reduces noise
  - When installed in a hair dryer, air is pulled in from the top of the hair dryer as opposed to the side; away from user's ear during operation
  - Can be made inexpensively with plastic and aluminum parts

Why Fix it this Way?

- **Intake and Exit**
  - Designing the air-exiting section of the hair dryer as a nozzle versus a diffuser will increase velocity of air
  - The shape of the spokes for the grill cover should enhance streamlining of air from the nozzle to reduce turbulence
  - Applying sound absorption liner near both the intake and exit of hair for sound reduction



Current Concept



1 (Type: Centrifugal Fan)

- Decision: "Airfoil Blade" – Low noise output and efficient flow output

2 (Type: DC Brushless Motor Casing)

- Decision: Physical vibration damped material

3 (Type: DC Brushless Motor)

- Decision: Weighs less than AC, quieter than brushed

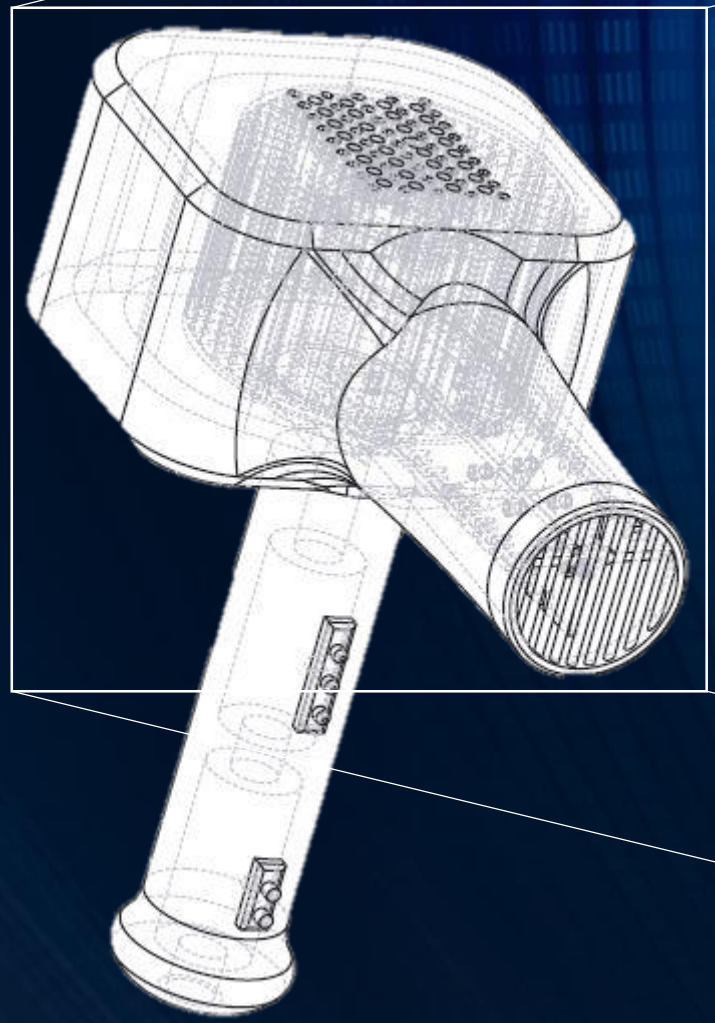
4 (Type: Heating Element)

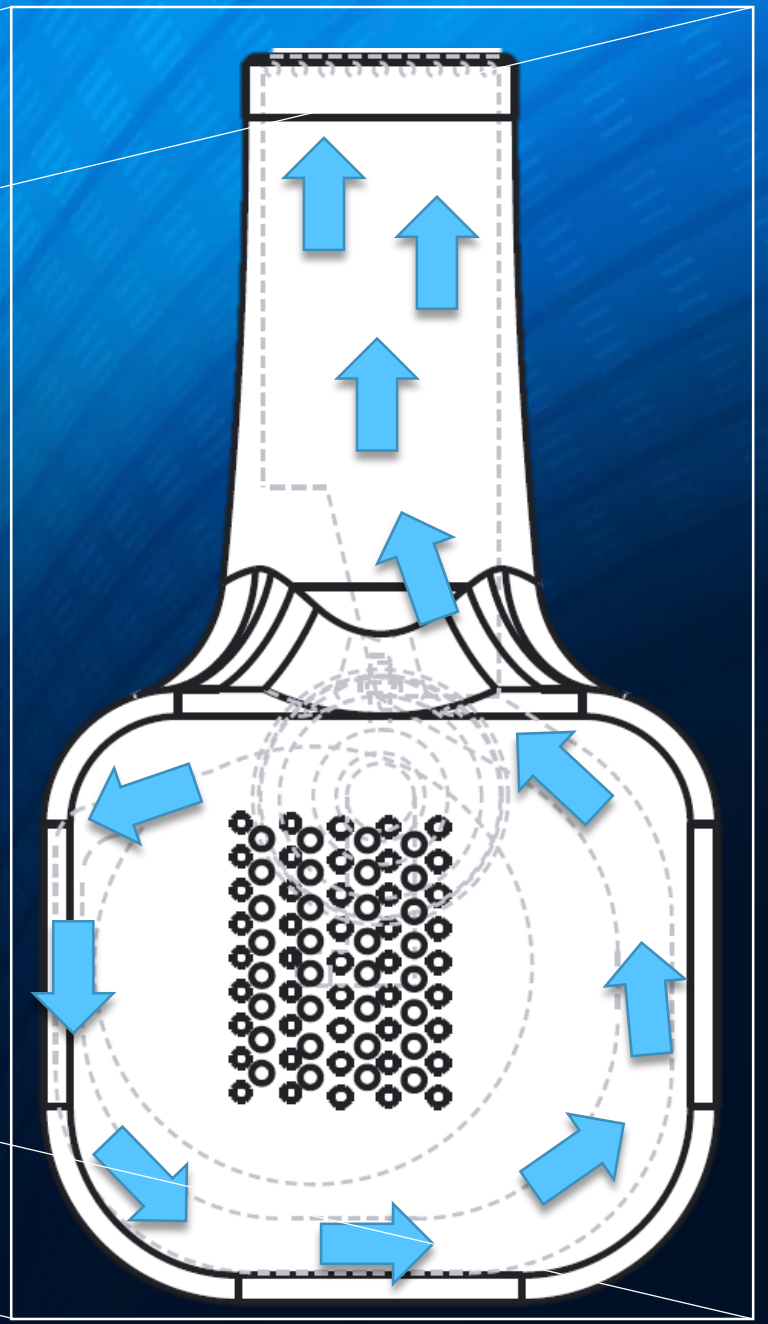
- Decision: "+ Geometry" – Produce heat and with less restriction for airflow as possible

5 (Type: Exterior Design – Switches, Outflow)

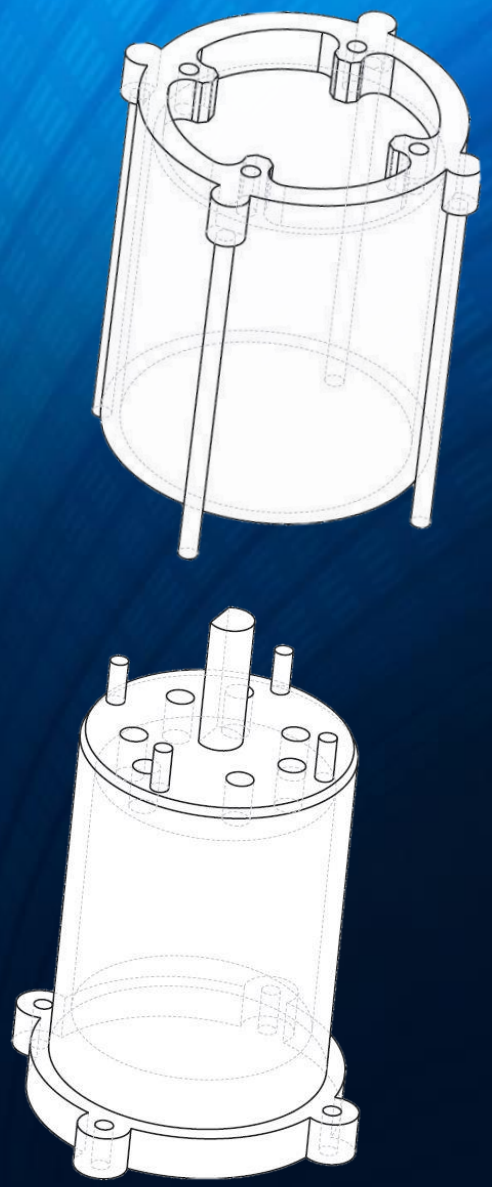
- Decision: "Circular Rods" – Increase flow rate compared to other geometric shape
- Decision "Switches" – Function parameters

Current Concept





Current Concept



Reverse Engineering of Quiet Hair Dryer

Centrix Quiet Q-Zone - $80

- Rubber vibration dampers between casing
- Centrifugal fan design
- Forward curved wheel blades
- Intake on both top and bottom
- Brushed DC motor
- High setting ≈ 71 dB

Sound Intensity Mapping

Equipment:

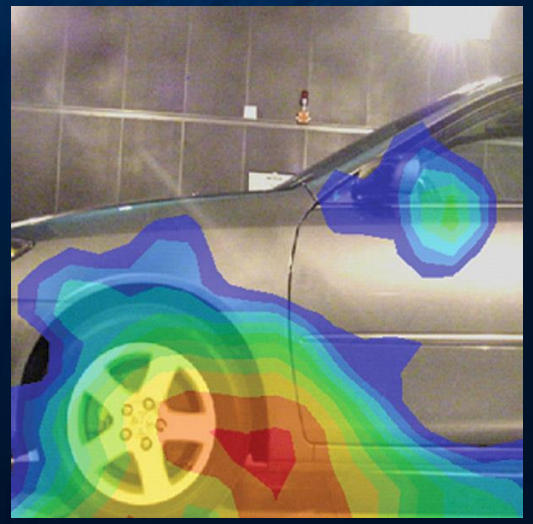
Brüel & Kjær's Type 3599 Sound Intensity Probe Kit

$$Sound\ Intensity = \frac{Sound\ Power}{Area}$$

Reasons for doing this:

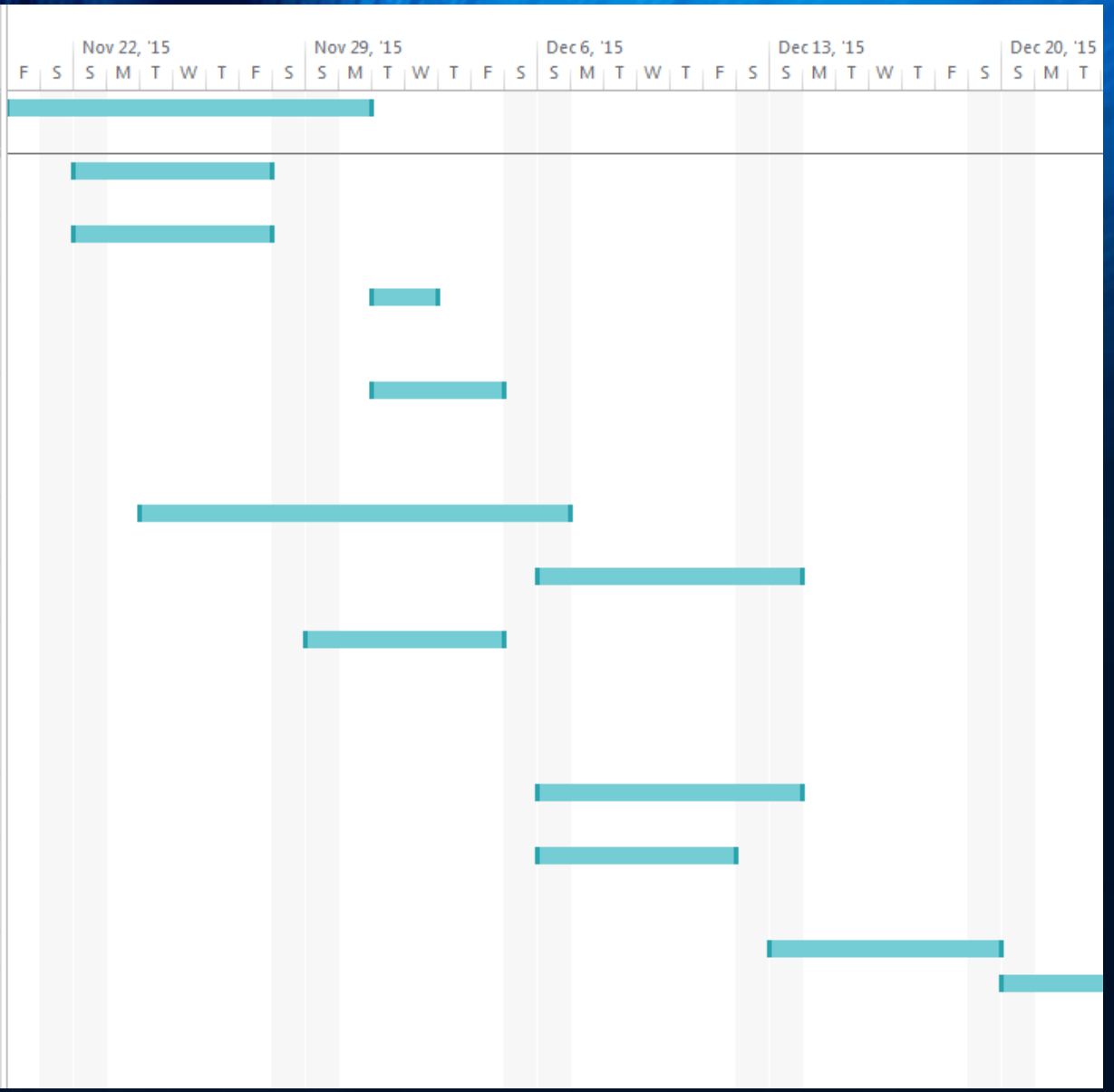
- Determine Sound Power
- Locating Noise Sources
- Perform Sound Insulations Tests

Create contour map of sound sources



Gantt Chart

% Co	Task Mode	Task Name	Duration	Start	Finish
0%		Purchase Brushless DC Motor	7 days	Fri 11/20/15	Mon 11/30/1
0%		Fine Tune Diameter of Nozzle	6 days	Sun 11/22/15	Fri 11/27/15
0%		Fine Tune Sizing of Grill Cover	6 days	Sun 11/22/15	Fri 11/27/15
0%		Measure Dimensions of Motor	2 days	Tue 12/1/15	Wed 12/2/15
0%		Scale Fan Connection Slot to Diameter of Motor Shaft	4 days	Tue 12/1/15	Fri 12/4/15
0%		Design Airfoil Dimensions	10 days	Tue 11/24/15	Sun 12/6/15
0%		3-D Print Airfoil Fan Blade Design	7 days	Sun 12/6/15	Sun 12/13/15
0%		Scale Centrifugal Housing to Overall Length of Airfoil Blades and Height of Motor	6 days	Sun 11/29/15	Fri 12/4/15
0%		3-D Print Centrifugal Housing	7 days	Sun 12/6/15	Sun 12/13/15
0%		Scale Nozzle to Centrifugal Housing Dimensions	6 days	Sun 12/6/15	Fri 12/11/15
0%		3-D Print Nozzle	7 days	Sun 12/13/15	Sat 12/19/15
0%		Purchase Heating Element with respect to inner diameter of nozzle	9 days	Sun 12/20/15	Wed 12/30/15



Questions?

References

- http://hebergement.u-psud.fr/projetsdephysiquestatistique/m1/projet_jt.html
- Akehmetov, B, and Gupta, S, and Ahuja, K; "Noise Source Ranking of a Hair Dryer.", AIAA
- http://www.brd-nonoise.com/RequestDetails.aspx
- http://www.mne.psu.edu/lamancusa/me458/11_fan.pdf

Appendix - HOQ

		ENGINEERING CHARACTERISTICS							
Customer Requirements	CI	Air Supply Source	Air Flow Rate	Convert Electricity to Heat	Temp Control	User Protection	Electric Supply	Motor	Material Selection
Quiet	10	10	6	0	0	0	0	6	3
Dries Effectively	10	10	10	10	10	0	3	6	0
Ease of Use	6	0	3	6	3	0	0	0	0
Operates Safely	10	6	0	3	3	10	6	6	0
Lightweight	6	3	0	0	0	0	0	3	10
Ergonomic	3	0	3	0	3	0	0	0	3
Variable Heat Settings	6	0	0	10	10	0	0	0	0
Variable Speed Settings	6	6	10	0	0	0	3	10	0
Affordable	3	6	0	0	0	3	3	6	3
SCORE		332	247	226	217	109	117	294	108
Relative Weight		20%	15%	14%	13%	7%	8%	18%	7%
Rank		1	3	4	5	7	6	2	7