DESIGN OF A QUIETER HAIR DRYER

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Presentation Overview

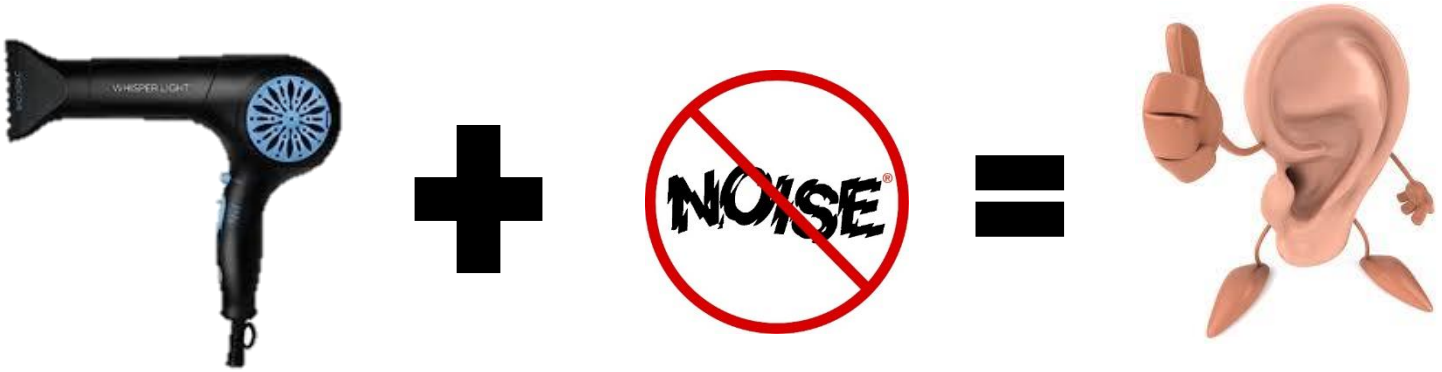
- Project Scope
- Performance Analysis
- Noise Source Contributions
- Design Modification Plans
- Entrepreneurial Progress
- Gantt Chart

Current Problem

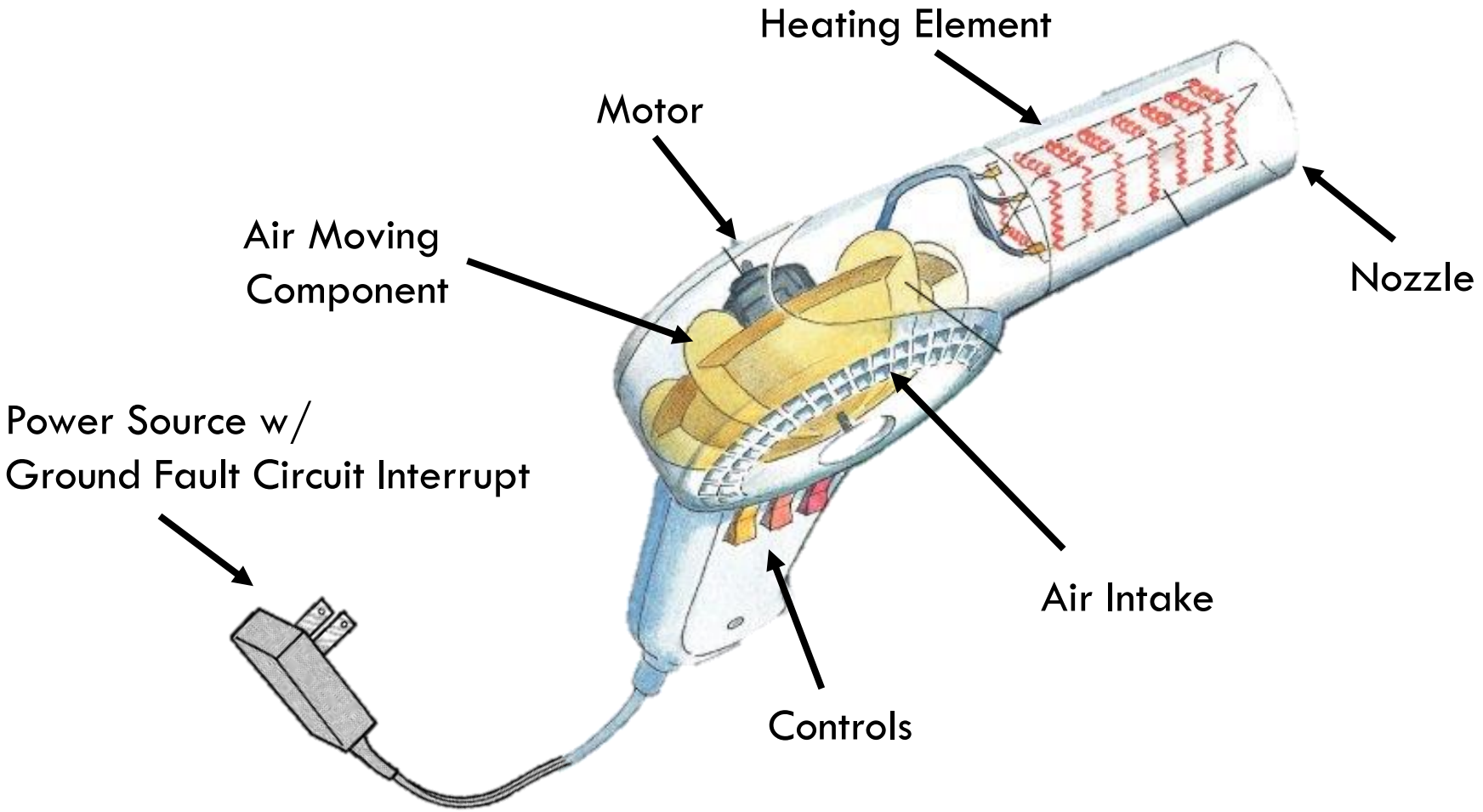
- Hair dryers can be very loud
- Causes unwanted noise in areas meant to be peaceful
  - Pet Grooming
  - Salons
  - Household Bathrooms
  - Brands that aren't loud are very expensive; up to $250+

Project Scope

- Our project scope is to make repeatable and measureable noise reduction improvements to a centrifugal type hand-held hair dryer through enhancements in design aspects, while maintaining performance within 10% of the maximum.



Hair Dryer Components



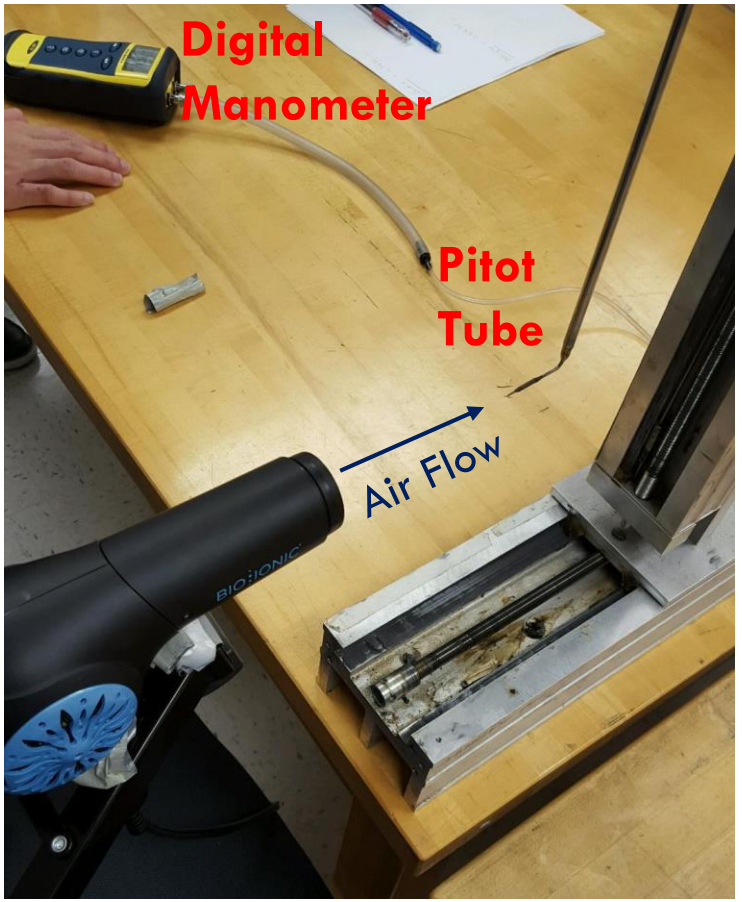
Noise-Flow Tradeoff

- Making alterations to suppress noise results in decreased flow
  - Examples include: lower fan speed and baffles on intake
- Determine tradeoffs that reduce noise while maintaining flow
- Measure base flow rate and noise before modifications
- Correlate flow and noise analysis

Performance Testing Setup

- Performance based on rate of heat output $\dot{Q}$
  - Mass flow rate
  - Temperature change
- $\dot{Q} = \dot{m} * C_p * \Delta T$
- **Pitot-Tube** to determine velocity profile of jet
- **Infrared Thermometer** to measure temperature of different locations from nozzle

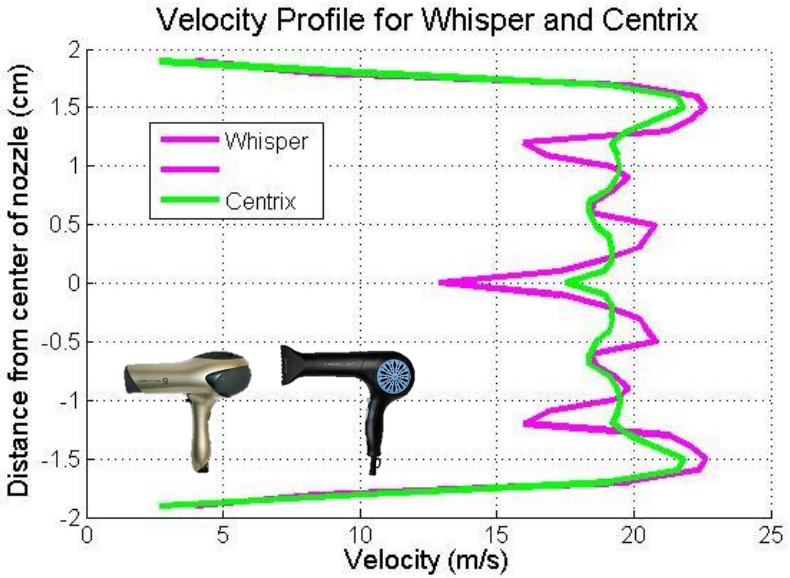
Temperature measurements w/ infrared thermometer

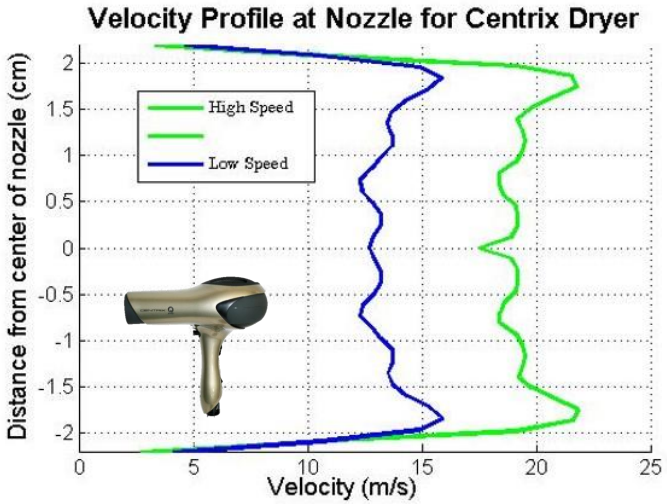


Velocity measurement setup
w/ Pitot-tube

Performance Testing Analysis

- Integrate velocity profile to determine volumetric flow rate
  - $Q = \int_0^r v(r)\, 2\,\pi\, r\, dr$
- Assumed negligible density and temperature changes in profile
  - $\dot{m} = Q * \rho$
  - $\rho = 1.225\ \frac{kg}{m^3}$





- Determining ΔT
  - Record surface temperature before and after heat application
- Calculate rate of heat transfer
  - $\dot{Q} = \dot{m} * C_p * \Delta T$

Hair Dryer Performance Comparison

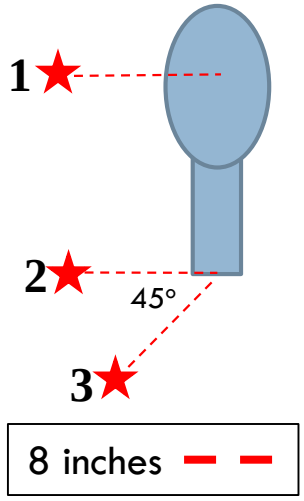
	Centrix Q-Zone		Whisper Light	
	High	Low	High	Low
Power Rating	$1500\ W$		$1400\ W$	
Temperature 6 in. from nozzle	$55^o\ C$ $131^o\ F$	$41^o\ C$ $106\ ^o\ F$	$65^o\ C$ $150^o\ F$	$50^o\ C$ $122\ ^o\ F$
Volume Flow Rate	$0.0284\ \frac{m^3}{s}$ $60\ cfm$	$0.0201\ \frac{m^3}{s}$ $39\ cfm$	$0.0226\ \frac{m^3}{s}$ $50\ cfm$	$0.0142\ \frac{m^3}{s}$ $30\ cfm$
Motor RPM	514	360	730	520
Heating Rate ($\dot{Q}$)	**1190 W**	**495 W**	***1227W***	**508 W**

Table comparing performance characteristics of two dryers

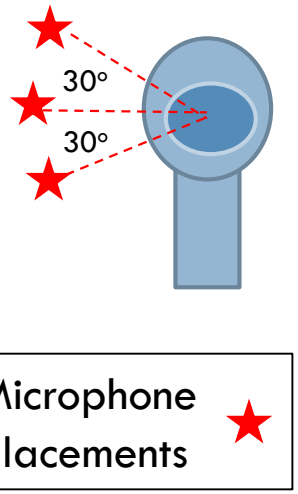
*cfm = cubic foot per minute

Microphone Testing Schematic

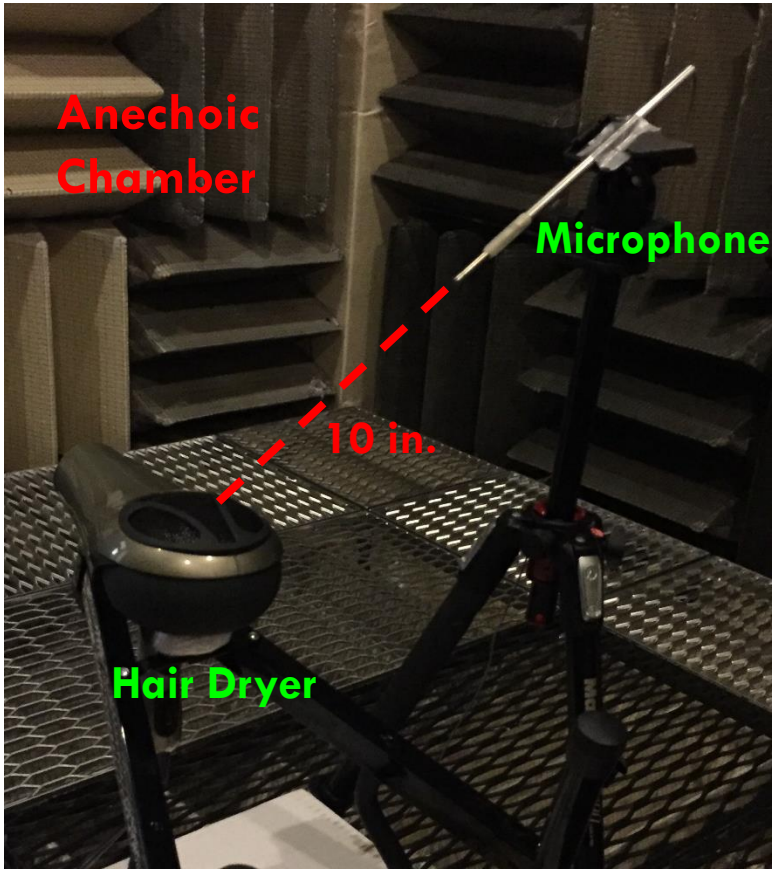
Top View



Front View



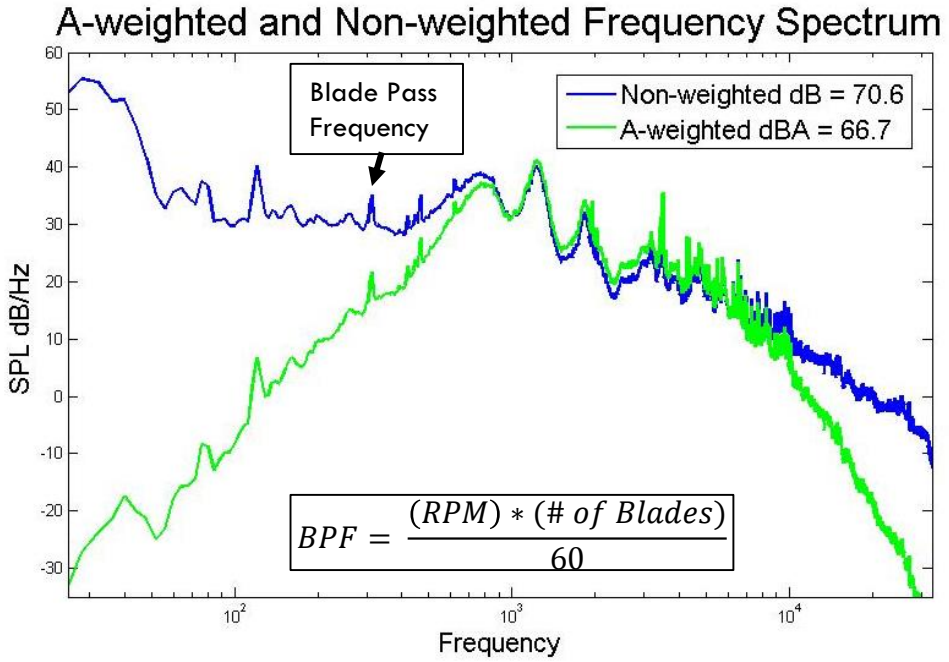
- Measurements take around the device at locations above, level and below
- All measurements taken 10 inches away from nozzle center or top of the intake



Microphone testing setup in anechoic chamber

Noise Analysis Overview

- Goal is to determine noise sources then determine the greatest contributor
- Human hearing is most sensitive between 1-2 kHz
- A-weighted filter models human hearing
- Design aims are to push noise to lower frequencies to take advantage of A-filter



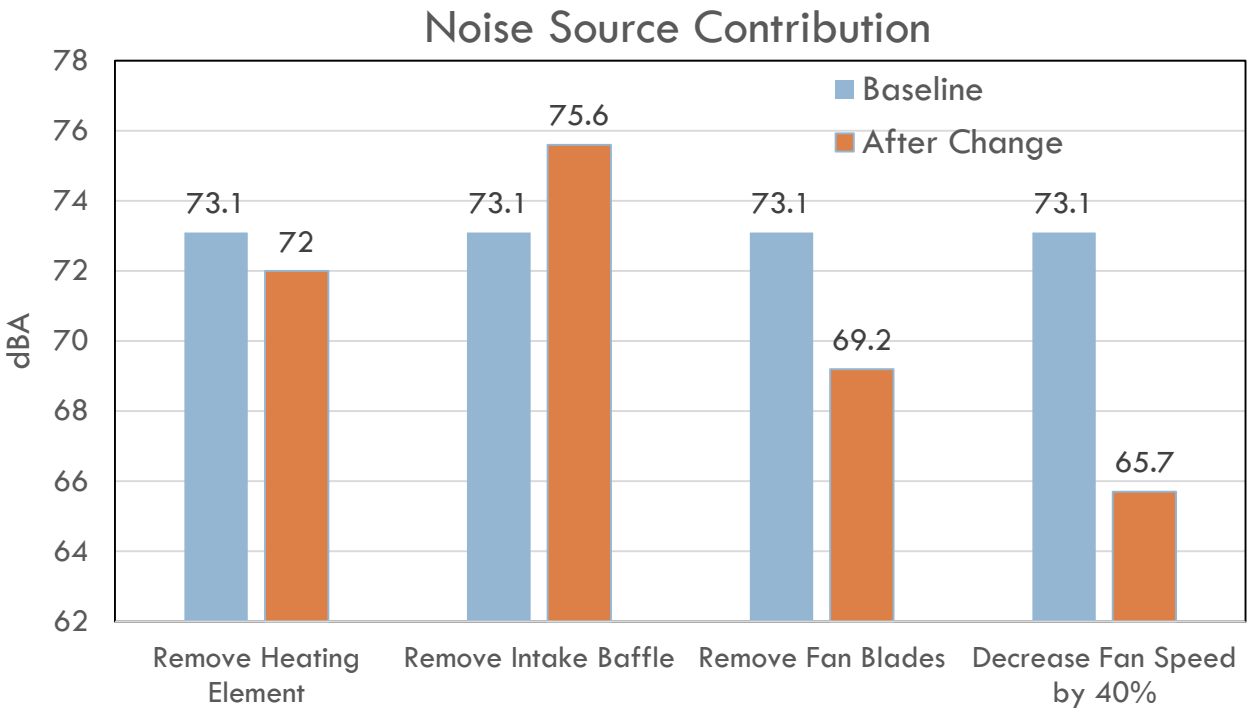
Frequency spectrum at side of intake for low speed showing behavior of A-weighting filter

- Examine noise contribution of various design aspects
  - Heating Element
  - Intake Covers
  - Fan Speed

Noise Source Contributions

Heating element removed from flow path

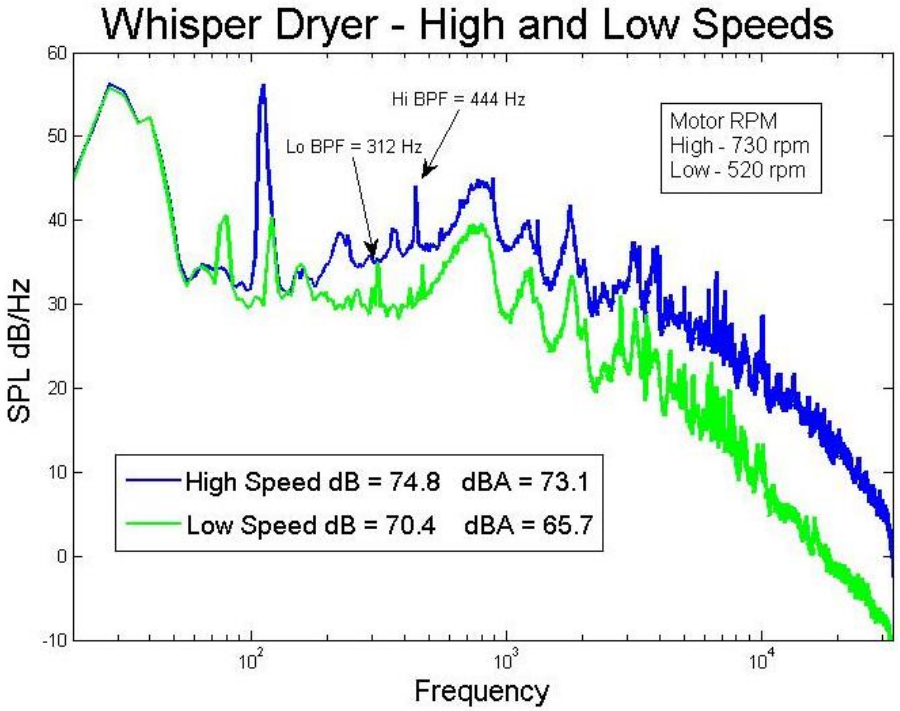
Intake baffle removed from flow path



- Heating element noise is minimal
- Baffles are necessary and must be used efficiently
- Fan speed is largest contributor

Fan speed is largest noise contributor

- A 40% increase in fan speed results in a SPL increase of 6-8 dBA
- By far the greatest reduction observed in measurements
- Must effectively balance flow and performance



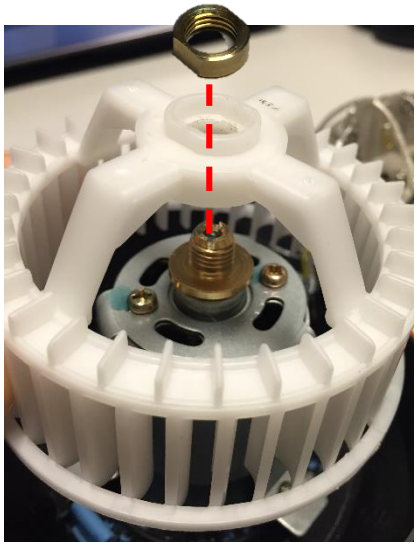
Frequency spectrum at side of nozzle for high and low speed settings

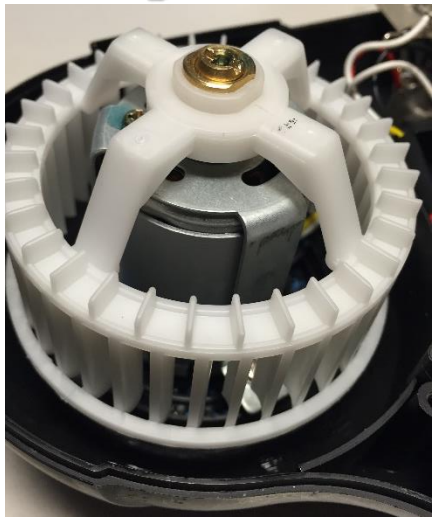
- Conclusion: Maximum benefit will come from improvements to the fan system and blades

How to modify the fan

- Whisper Light chosen for modifications
  - Simple fan attachment mount
  - Louder of the two hair dryers

- Modifications
  - Reduce the number of blades
    - To decrease BPF
  - Increase blade size and surface area
    - To maintain volume flow
  - Add serrations to blades trailing edge
    - Break up packet of air leaving blades



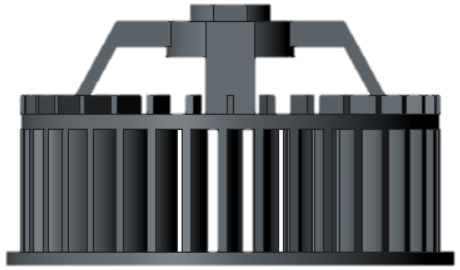


Showing how the fan attaches to the motor

Fan design

Current fan features	
# of blades	36
Blade height	0.935 in.
Outer Diameter	3.05 in.

- Current fan is a "bucket" type design



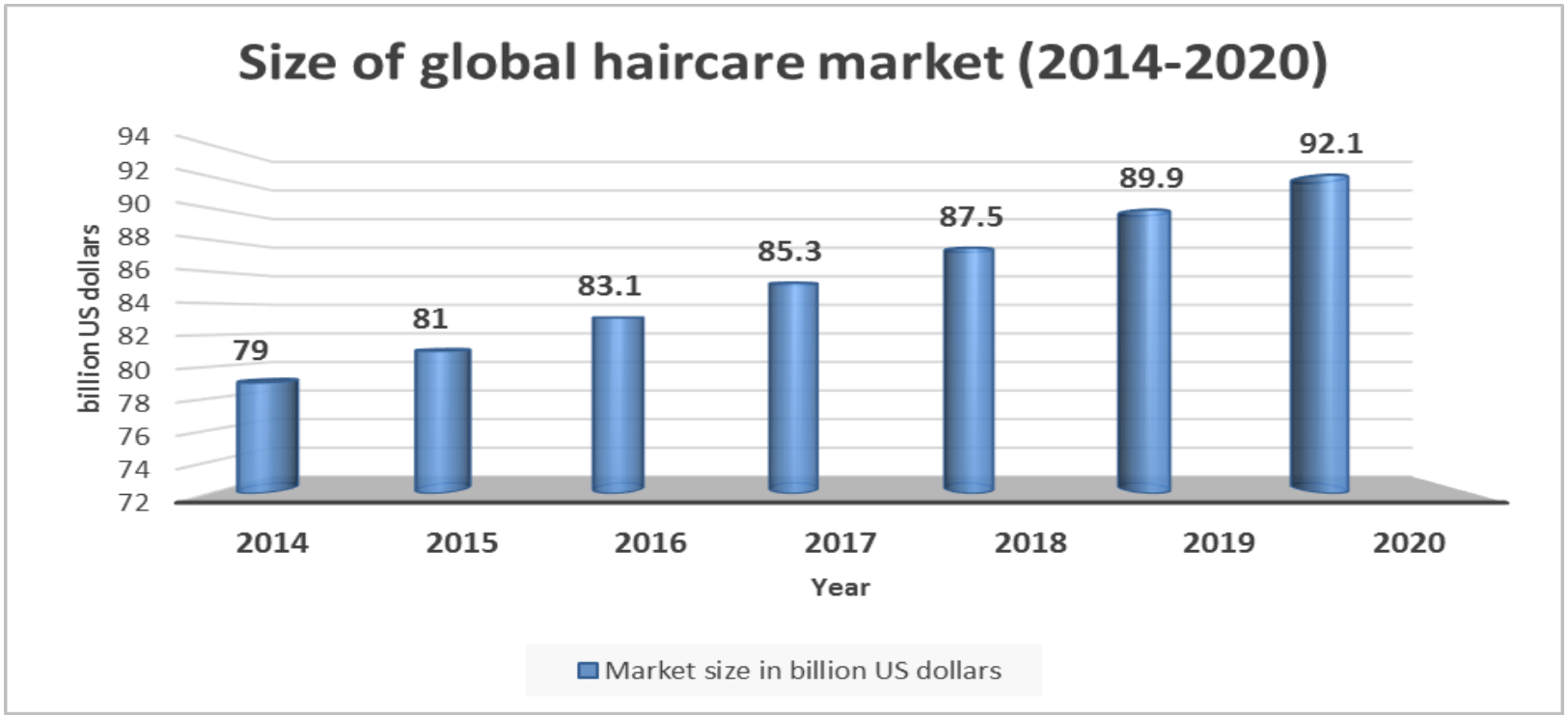
- 3D printed replica of current fan
  - 1st iteration came out rough but was not designed for 3D printing
- Plan is to 3D print modified designs
  - Looking into more sophisticated methods
- Ensure new fans fit the mount and in the housing
- Use centrifugal fans design references and tools to ensure efficient designs

Entrepreneurial Progress

- Global Market
- Potential Customer Survey
- Business Model Canvas
- Engineering Shark Tank

Global Hair Products Market

- The hair care market is only going to grow
  - Shampoos, Conditioners, Relaxers, Gels, Hair Straighteners,…
  - Most importantly Hairdryers!
- Great time to introduce a product to the market

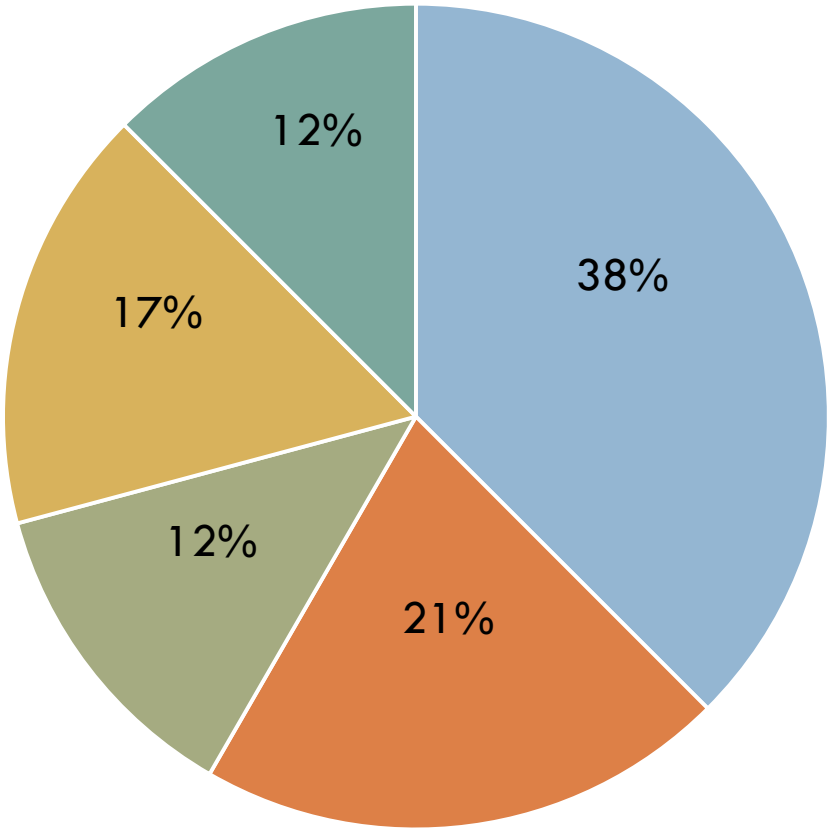


Hair Styles of Today

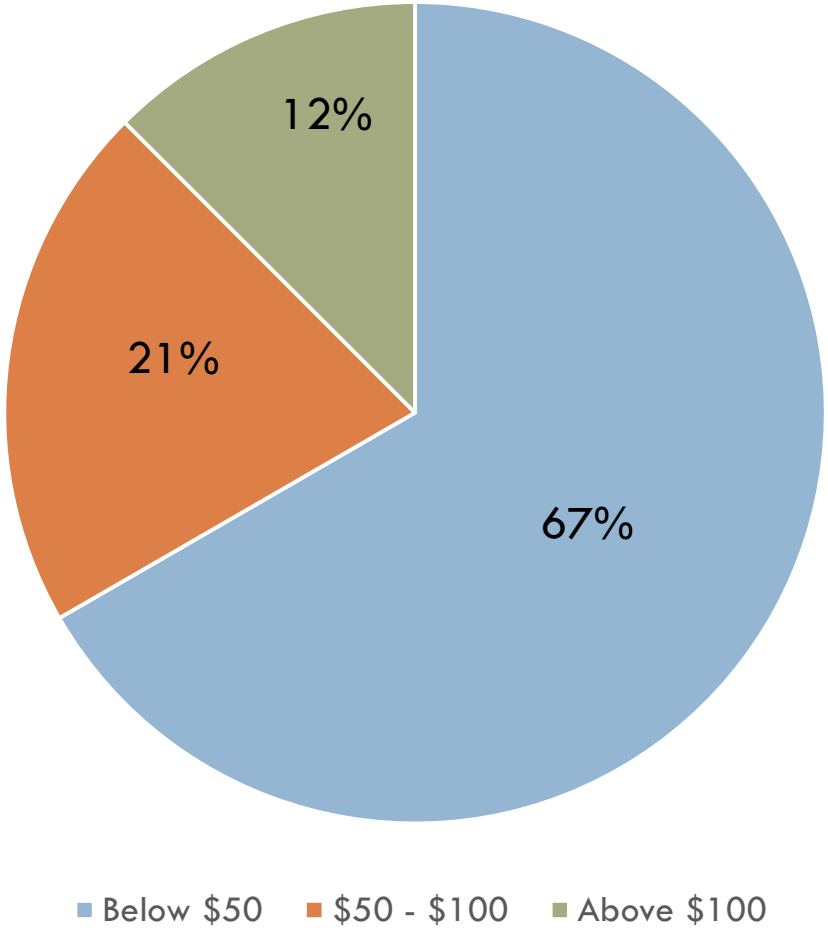
- Mostly women have been consumers
  - We expect them to purchase hairdryers
- Men are now becoming consumers
  - To Complete the look a hairdryer is needed
- Pet groomers are also consumers
  - Pets with long and short hair
  - Animals are sensitive to loud sounds

Understanding Customers

Desired Customer Improvements

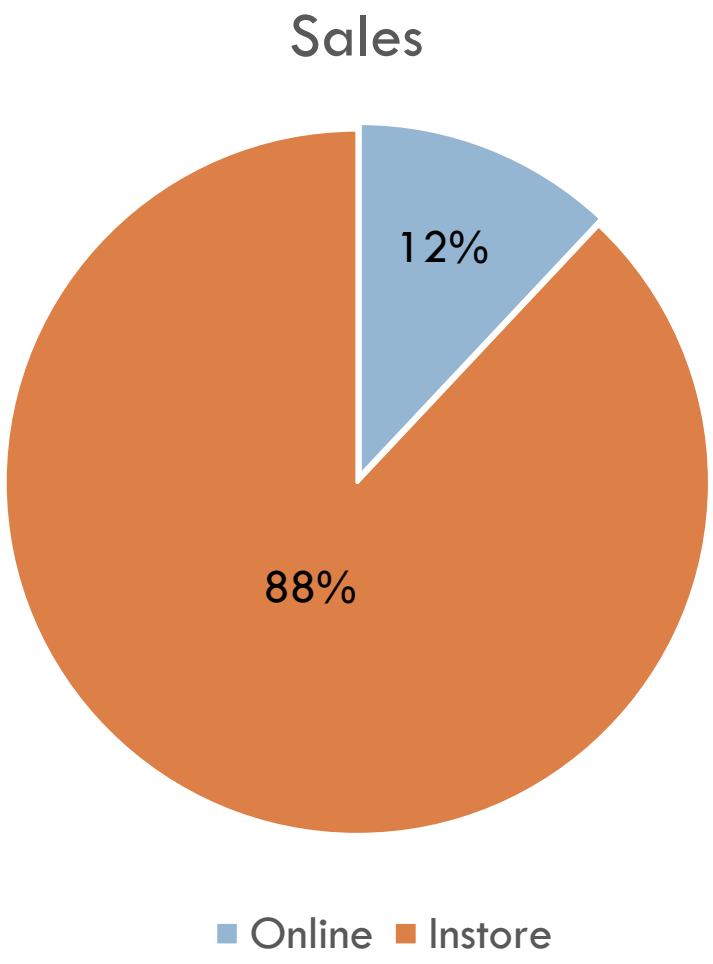


Desired Pricings



Marketing…A Great Product Sells Itself

- To be a viable seller in a market full of competitors
  - It needs to have proven results
  - A wow factor that isn't just for show
  - Must set itself apart from the rest
- We aren't Anheuser Busch
  - Can't afford to spend millions on commercials
  - Not popular enough to do promotions



Business Model Canvas

The Business Model Canvas

Team or Company Name: Hushdryer

Date: 02/16/15

[X] Primary Canvas
[ ] Alternative Canvas

Key Partners

Funders
- FAMU & FSU College of Engineering Senior Design
- Dr. Devine (Sponsor)

Advisors
- Dr. Cattafesta - Acoustics & Permission Access
- Dr. Gupta & Shih (Coordinators) - Mechanical & Electrical

Testing
- Aero-Propulsion Mechatronics & Energy Building

Vendors
- High Performance Material Institute
- 3D Printing on Gaines st.

Key Activities

- R&D to improve on current hairdryers
- Good sales team
- Upfront in Retail Stores
- Online Shipping & Delivery Accessibility

Key Resources

3D Printing Shop
- Tallahassee, Fl

Helpful Staff
- FAMU-FSU COE

High quality hair dryer parts (outsourced)

Value Proposition

Product
- High performing yet quiet hairdryer
- 3D printed blades for high durability
- Reliable DC motor for longevity
- Three colors, purple, blue, green

Customer Relationships

Purchasing
- By self (Online based, Pre-caution prior to FAQs)
- By engagement (Retail Stores, One-on-One Assistance with FAQs)

Channels

- Retail Stores (In-Person)
- Online Stores (Amazon)
- Online Website

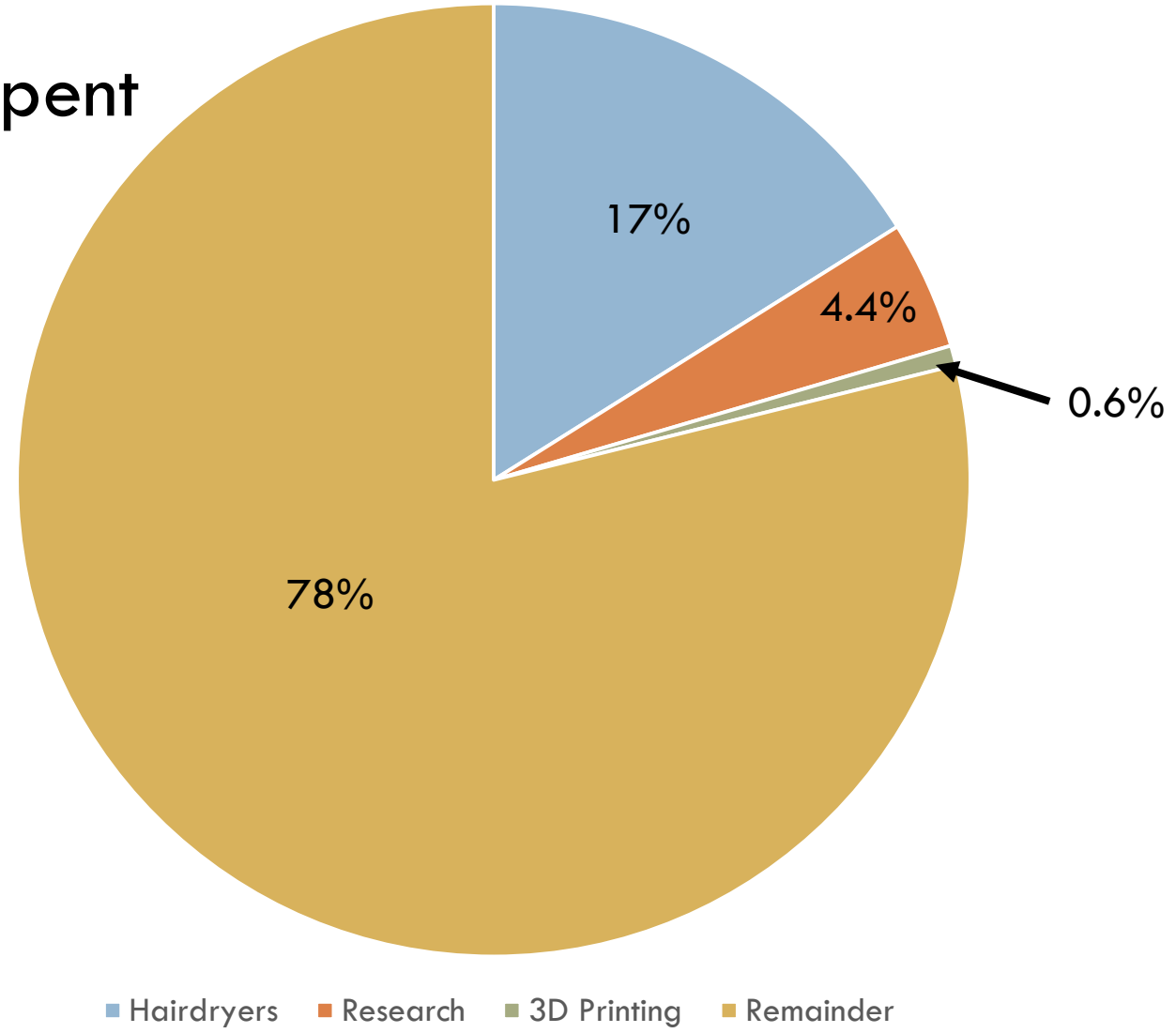
Customer Segments

Individual
- Independent Customers

Professional
- Hair Salons
- Pet Grooming
- Painters

Financial Status

- Total amount spent
  - $328.72
- Total left
  - $1171.28

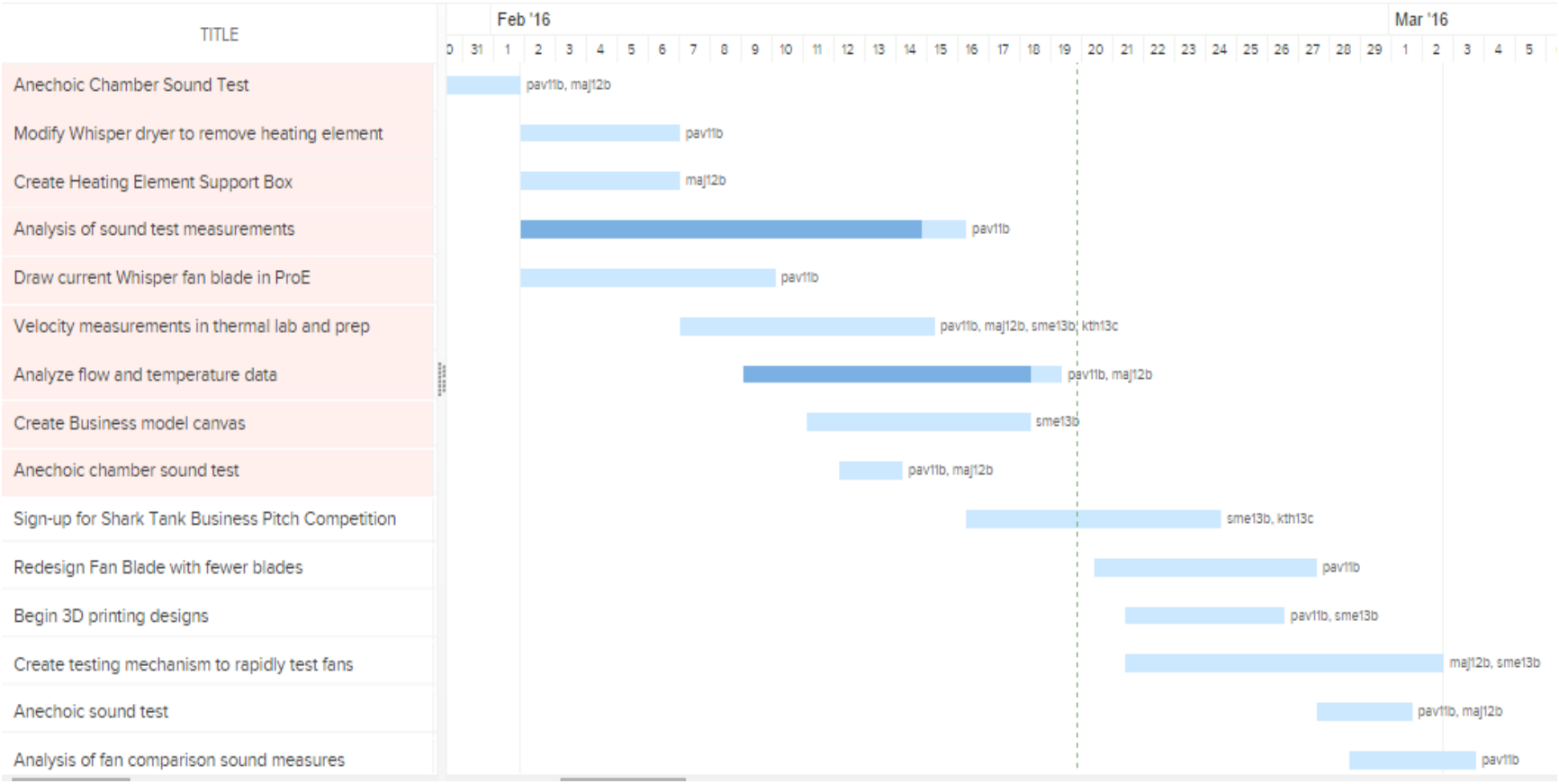


Engineering Shark Tank

- A Business Pitch Competition for Technology Innovations
  - 1st $1,250
  - 2nd $750
  - People's Choice $500
- A panel of 7 Judges
  - Faculty of FAMU-FSU COE
  - Alumni
  - Entrepreneurs
- Takes place on Thursday, April 14, 2016

Future plans/Gantt Chart

Shawn Eckert



Questions?
Thank you