MCAD
SUSTAINABLE DESIGN PROGRAM
MINNEAPOLIS COLLEGE OF ART AND DESIGN

PAX
FLAIR
FAN

PEDESTAL FAN REDESIGN

FINAL PRESENTATION

THE FOLLOWING ARE PROPOSED IDEAS FOR OVERALL IMPROVEMENT AND A BREAKDOWN OF OUR WINNING REDESIGN.

Client: Pax Scientific

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Collaborative Product Design Fall 2020

PAX
FLAIR
FAN

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INTRODUCTION

The MCAD Collaborative Product Design class worked to assess and provide sustainability solutions in consultation with PAX Scientific on their PAX Flair Fan design to increase efficiency, reduce waste, and rethink fan usage as a whole.

RECAP OF EXPLORATION

Week 1: Disassemble and assess the product.
Week 2: Establish design priorities.
Week 3: Explore potential materials.
Week 4: Research material effectiveness.
Week 5: Establish energy priorities.
Week 6: Make the product persuasive to users.
Week 7: Rate and finalize potential solutions.
Week 8: Present design recommendations.

FLAIR PEDESTAL FAN SYSTEM MAP **(WITH IMPACTS)**

DESIGN SCOPE

LCA BOUNDARY
The boundary of the LCA is from ready–to–use materials to customer use. The LCA does not include the impact of extracting raw materials such as gases to make plastic pellets. The assumption that the manufa will purchase pla pellets to mold plastic componen

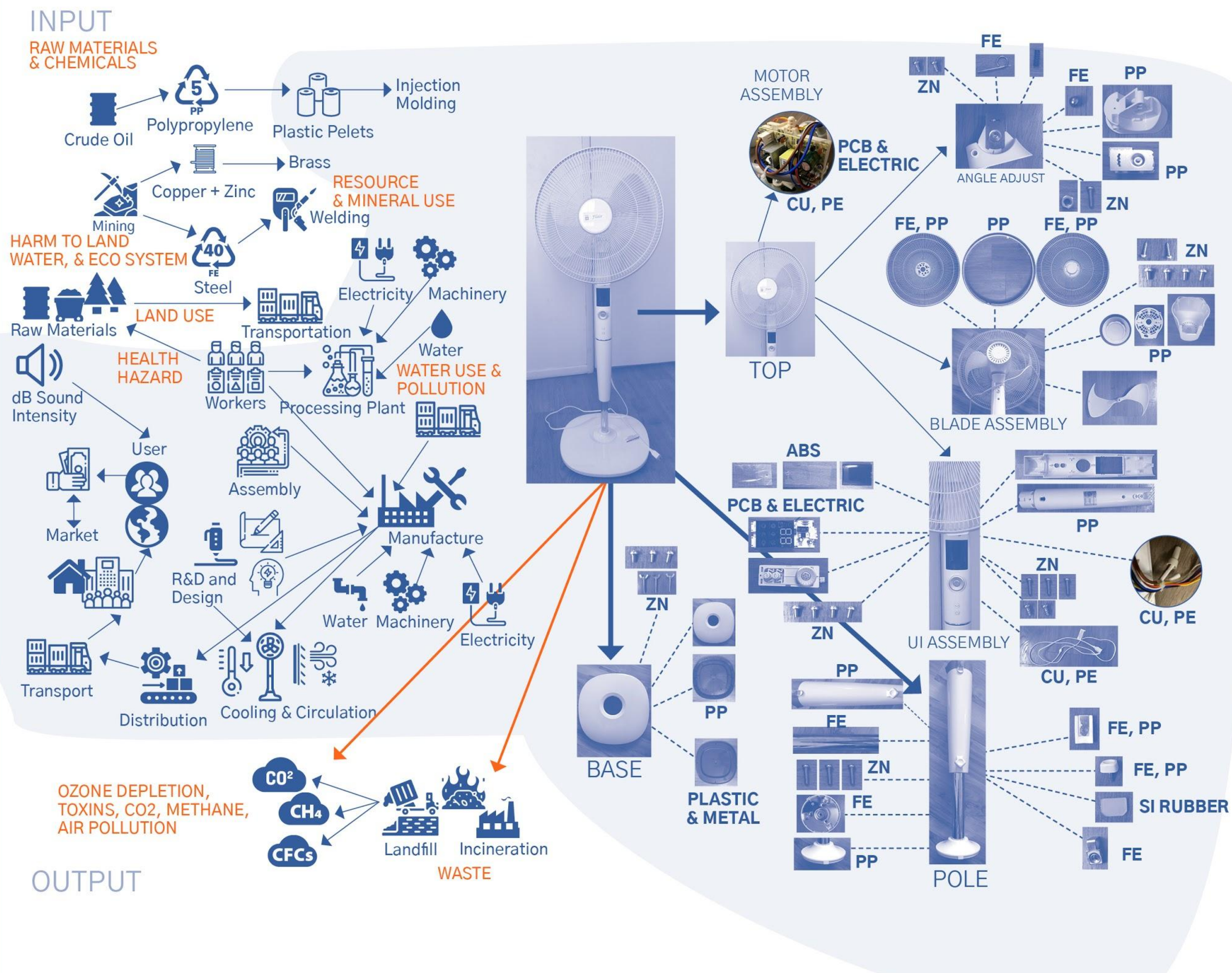
MEASURING IMPACT

THIS EQUATION MEASURES THE SUCCESSFULNESS OF DIFFERENT DESIGN CONCEPTS.

Imvironmental Impact
(Okala MPTS)

Energy Usage
(KWH)

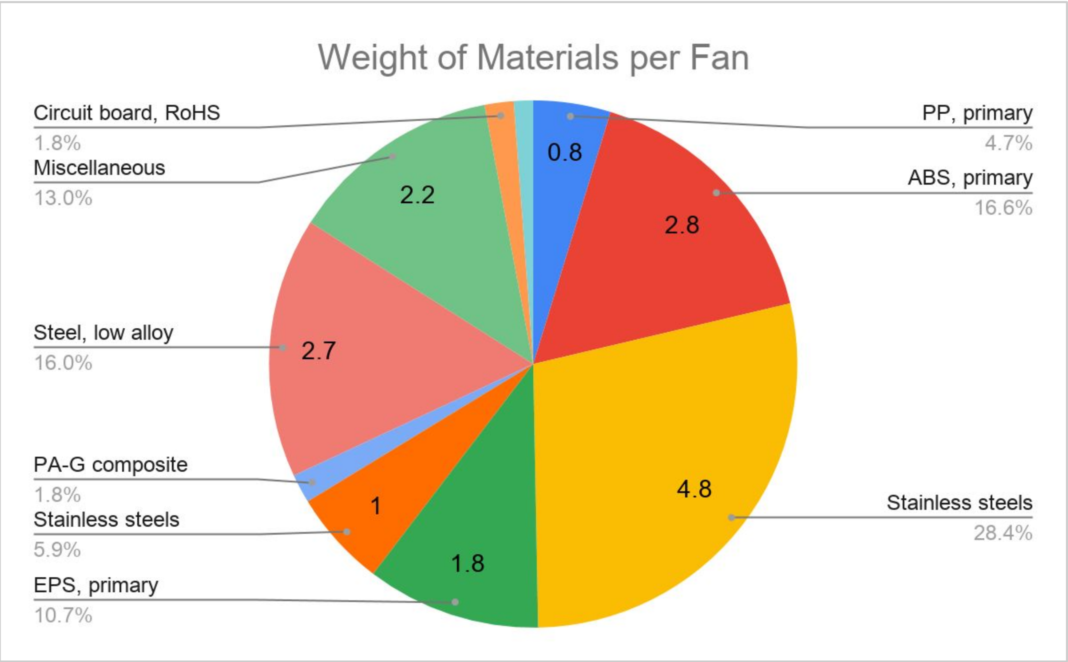
Useful Time
(Year)



IMPACTS SHOWN IN RED

BILL OF MATERIALS

After the pedestal fan is disassembled, components are grouped by their material compositions. Stainless steels have the highest percentage by weight, followed by ABS and low alloy steel.

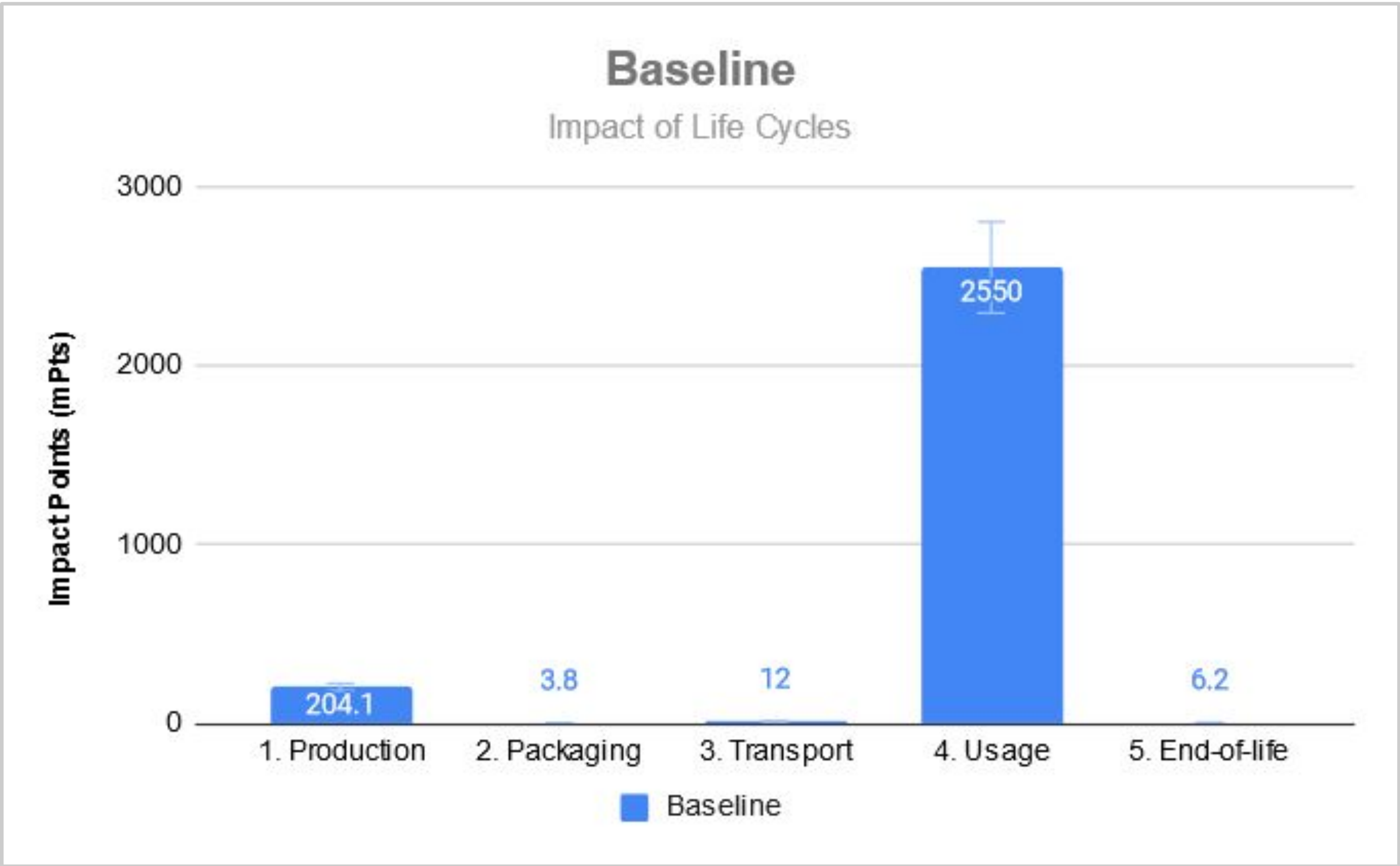


Group by Components	Material	Weight (lb)
Base enclosure	PP, primary	0.8
Enclosure (base, pole, and top), height adjust, and blade stopper	ABS, primary	2.8
Base weight	Stainless steels	4.8
Base weight	EPS, primary	1.8
Pole enclosure, base weight, screws, height adjust, angle adjust	Stainless steels	1.0
Pole height adjust stopper	Silicone	0.0
Blade	PA-G composite	0.3
Blade enclosure	Steel, low alloy	2.7
Top blade enclosure joint lock, protective sheets, screen cover	PC, primary	0.0
Top motor assembly (various materials)	Miscellaneous	2.2
Electronics	Circuit board, RoHS	0.3
Wire insulator	B-PVC, primary	0.2

ASSESSING ENERGY EFFICIENCY

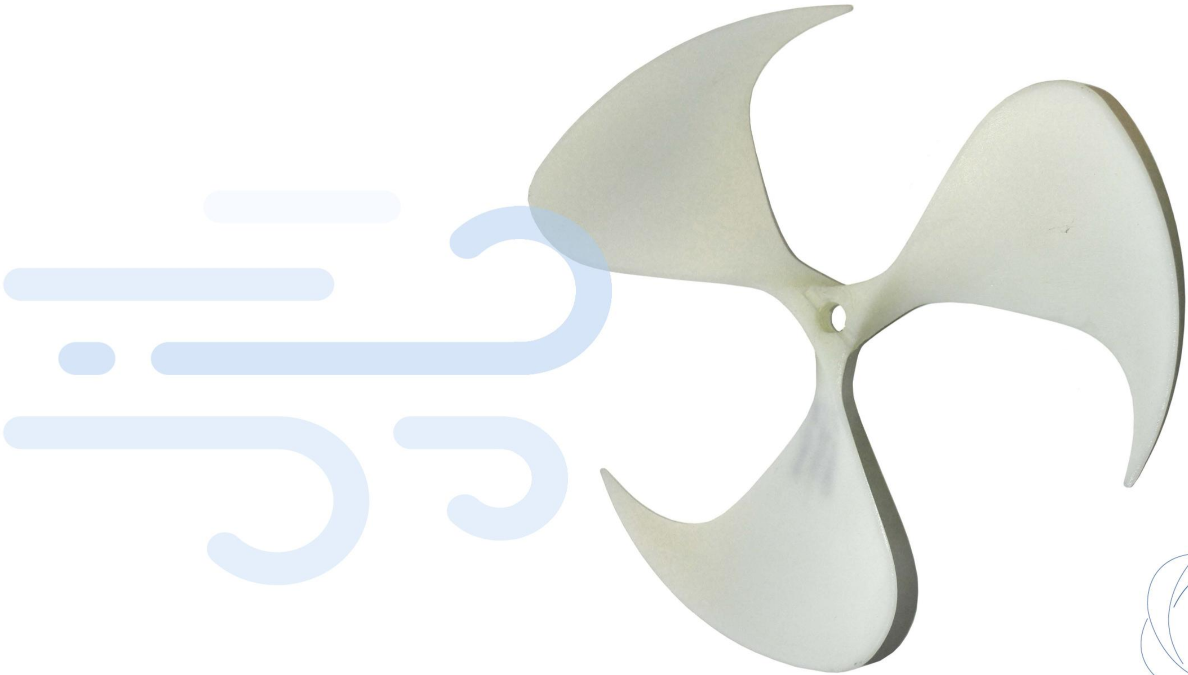
TOP USERS OF ENERGY:

1. **In life – Motor:** The power consumption of the fan increases with the usage time.The power consumption mainly comes from the DC motor that turns the fan blade.
2. **Embodied energy – Metal:** Metal has a high embodied energy due to the impact of the processes of mining, refining, and producing.
3. **Inert energy – Electronics:** Electronics require an intricate construction of relatively high impact materials like metals.



FUNCTIONAL UNIT

Assumptions and calculations during assessment and redesign:



PAX
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FAN

Usage: **50,000 Hours** minimum
11.4 Years if operates 24/7 for half a year
7.6 Years if operates 24/7 for three quarters of a year

Environmental Impact (Okala mPts) PER / **Energy Use (kWh)** PER / **Year (year)**

DECISION MATRIX

We narrowed down our top ideas to the 6 following ideas:

1. Use bamboo for all possible materials in unit.
2. Retrofit Blade Option to allow existing fans to remain in use with increased efficiency.
3. Informationalization – Offer 3D model of blade for user to print their own as Product-Service Systems offering.
4. Gamification – Improve user engagement and brand awareness.
5. Modularity – keep the motor/cage the same on all models and offer alternative bases for table top, pedestal, clamp, etc..
6. Simplifying parts and features – Reduce functions for efficiency and reduced material use.

	Priority 1	Priority 2	Priority 3	Priority 4	Priority 5	Cost	Usability	Desirability	Repairability, Replaceability	Feasibility	Total Score
Weight	4	5	3	4	2	4	4	3	5	3	...
Idea 1	5	1	3	4	3	1	1	3	2	3	**83**
Idea 2	**5**	**5**	**5**	**5**	**5**	**5**	**1**	**1**	**3**	**2**	**132**
Idea 3	**5**	**5**	**5**	**5**	**5**	**1**	**2**	**1**	**3**	**1**	**120**
Idea 4	1	5	1	1	1	1	5	4	1	4	**79**
Idea 5	**3**	**1**	**4**	**4**	**3**	**5**	**4**	**4**	**3**	**4**	**114**
Idea 6	4	2	3	4	2	4	4	2	3	5	**108**

Scoring Key:

5 = Best in the market. Significant improvement over existing design. Paradigm shifting.
4 = Great but no paradigm shift.
3 = Statistically significant. Measurable impact.
2 = Slightly better than existing design.
1 = Lateral change.

Weight Key:

The priorities are weighed based on cradle to cradle concepts and the four system conditions in the Natural Step. The highest weight (most important) is 5, and the lowest weight (least important) is 1.

- Priority 1: 4, meet cradle to cradle and system conditions 1 through 3
- Priority 2: 5, energy usage has the highest impact
- Priority 3: 3, insignificant compared to energy usage
- Priority 4: 4, a limited factor when fan usage is required
- Priority 5: 2, reduce cost at production stage, impact occurs mostly in usage stage
- Cost: 4, must be affordable, satisfy system condition 4
- Usability: 4, must be easy to use
- Desirability: 3, a limited factor when fan usage is required
- Repairability/Replaceability: 5, key factor in system condition 2
- Feasibility: 3, not a dominant factor on customers' experience

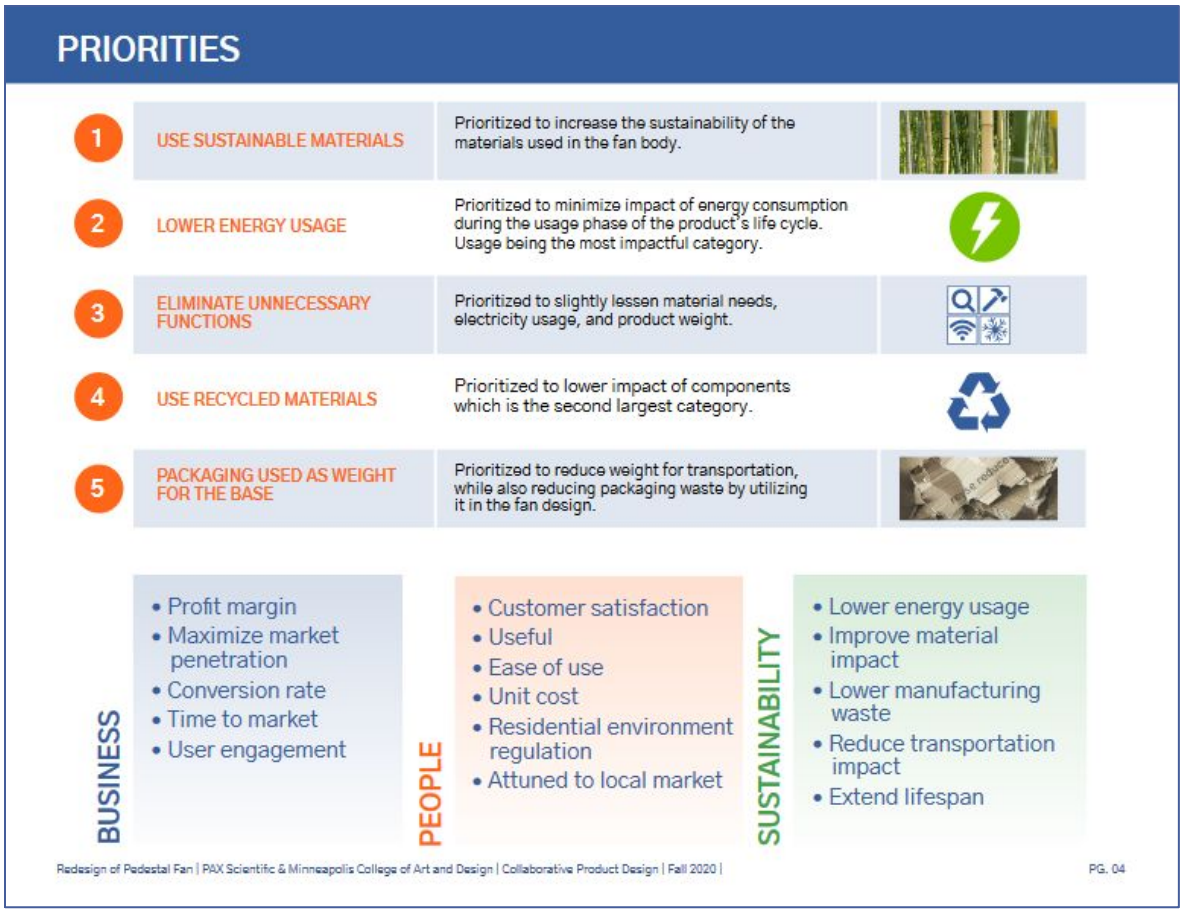
TOP 3 IDEAS: NARROW BEST SOLUTIONS

1. **Retrofit Kit:** Blade rendering, how-to instructions/videos/network for fix-it people, Informationalization (provide 3D model for sale for users to print on their own)

2. **Base Model** : Bamboo, reduced functions (including a list of basic features) simple modular bases

3. **High End Model:** Information sharing, gamification, bamboo, advanced modular bases, app Interface

Top ideas used the following priorities for redesign:



BAMBOO AS MAIN UNIT MATERIAL

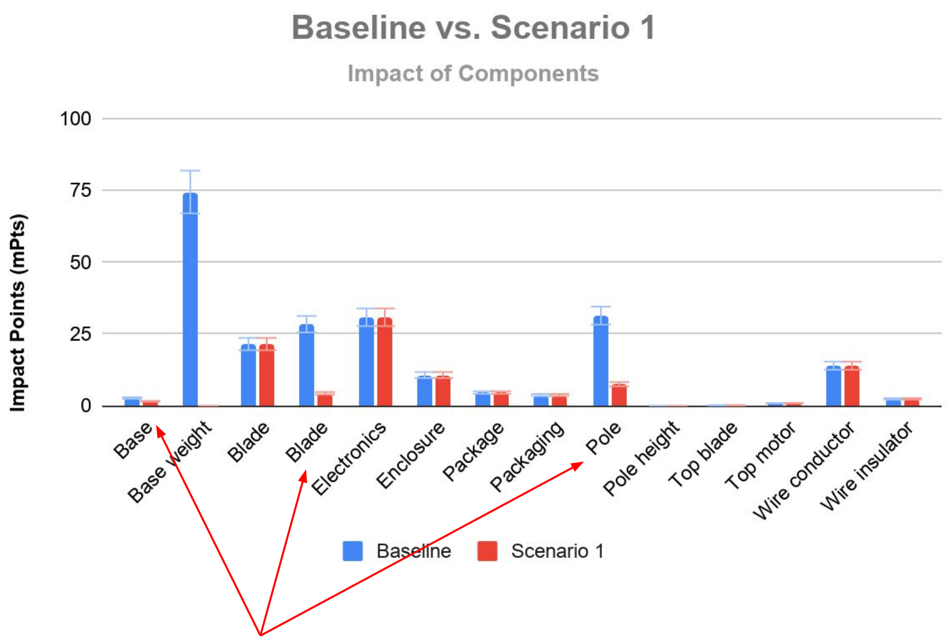
Summary of Changes

- Steel in the base, pole, and blade enclosure was removed.
- Bamboo was used to replace plastic in the base, pole, and blade enclosure.
- The weight of bamboo is similar and hence assumed to be equal to that of plastic (ABS and PP)

Outcome

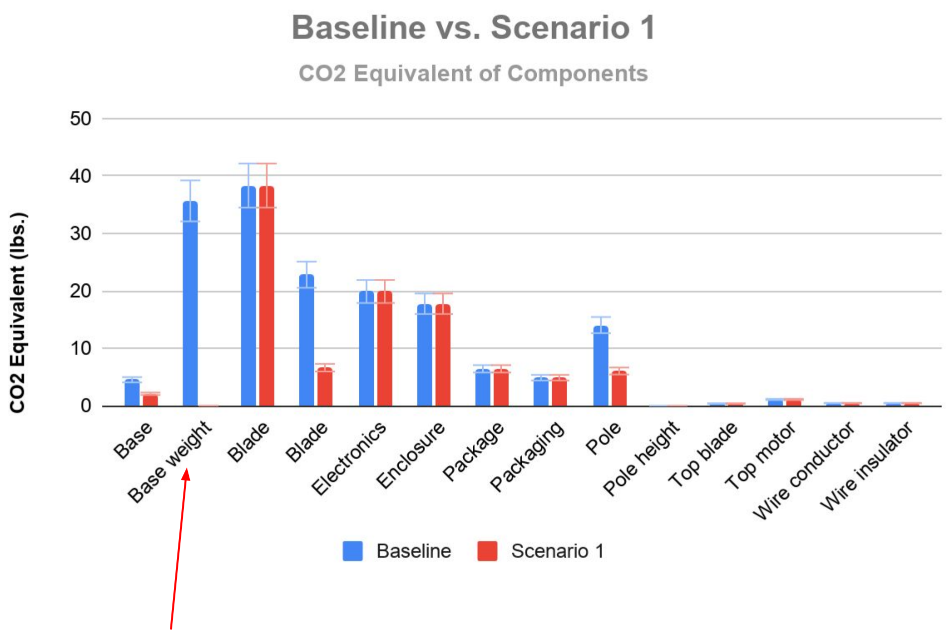
- Using bamboo yields a combined **<u>55% reduction</u>** in environmental impact and CO_2 emission in all product life cycle except the usage phase.

(Environmental Impact)



Bamboo replaces the plastic and steel in the base enclosure, the pole enclosure, the motor enclosure, and the blade enclosure.

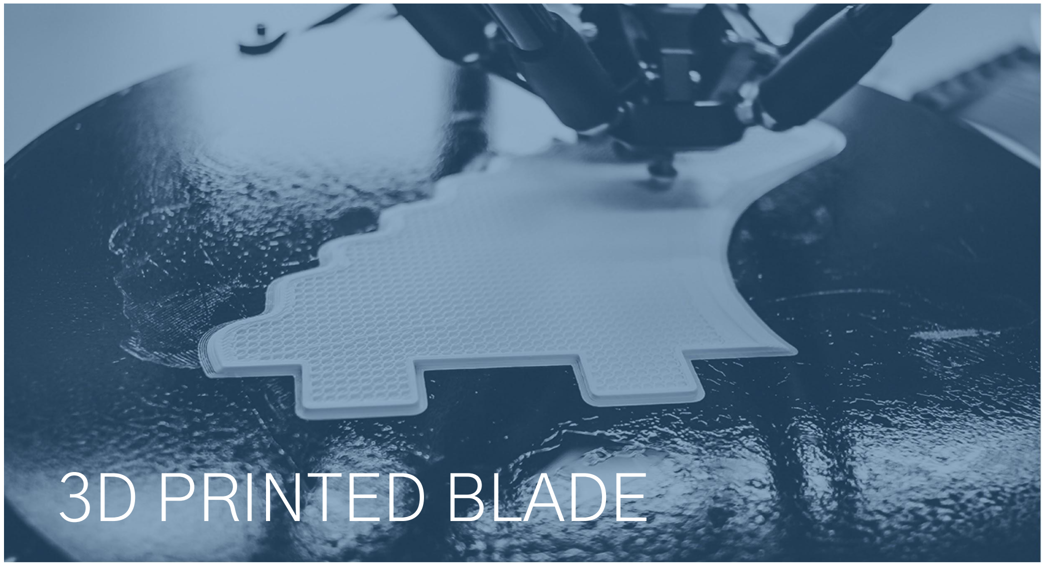
(CO_2 Equivalent)



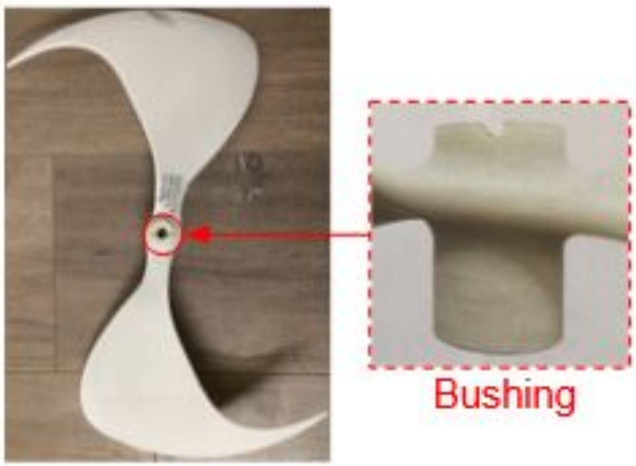
The base weight is removed. The redesigns did not require the use of the base weight. *See slides on modularity for more info.*

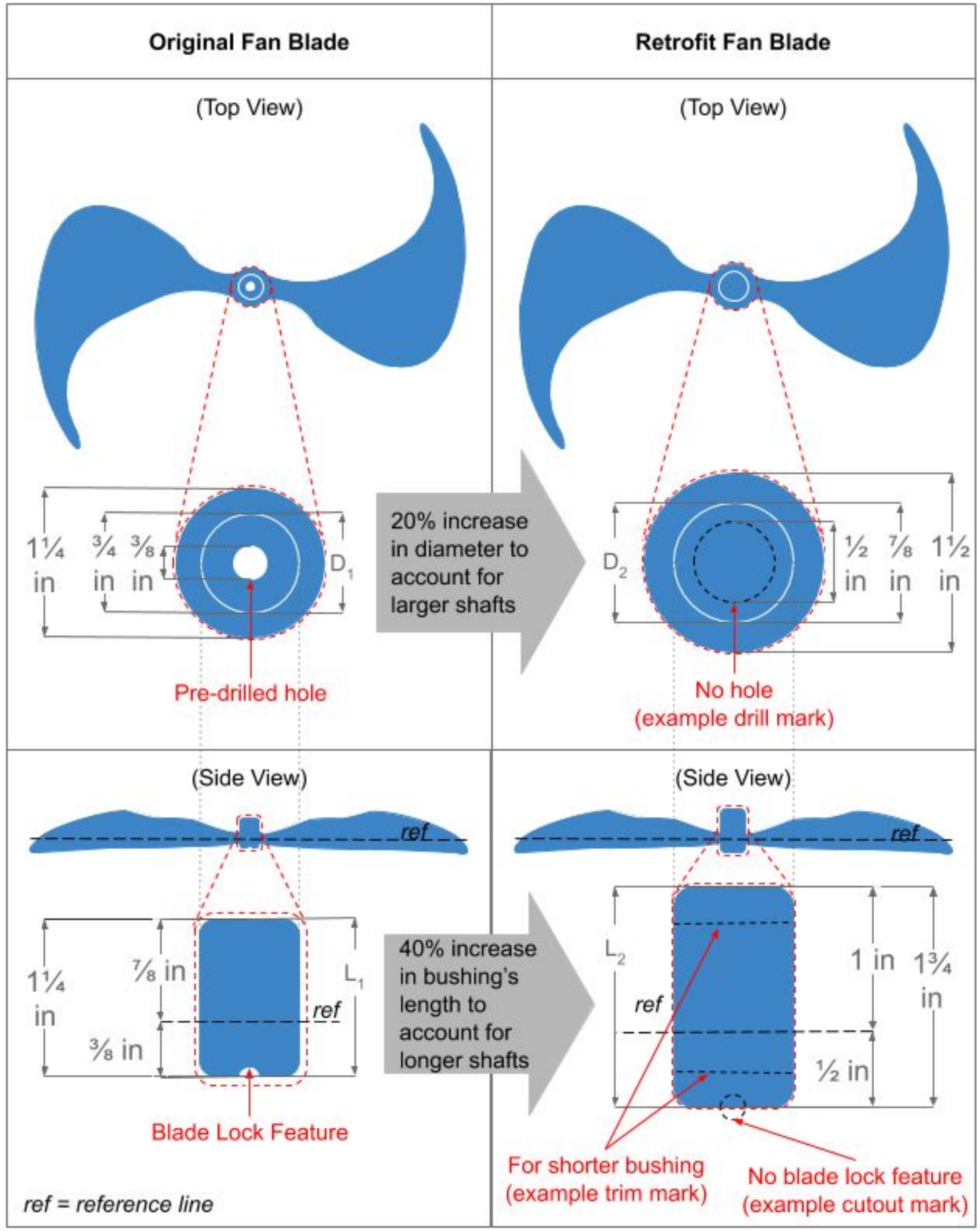
CONCEPT 1 – RETROFIT KIT AND INFORMATIONALIZATION

RETROFIT WITH
PAX MOTOR/BLADE



Enable Retrofitting by Oversizing the Bushing

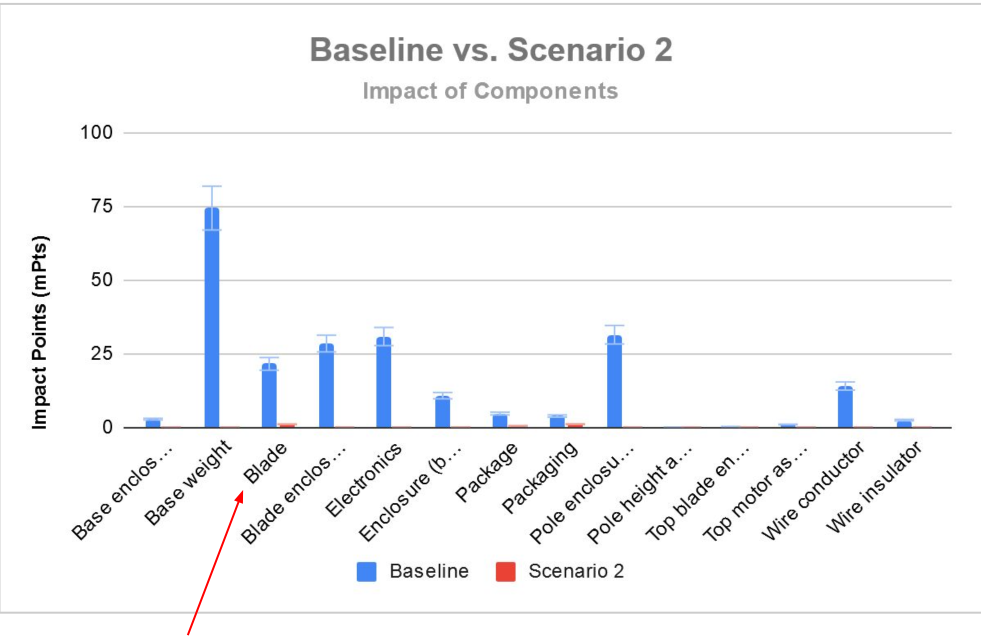




LIFE CYCLE ANALYSIS OF RETROFIT OPTIONS

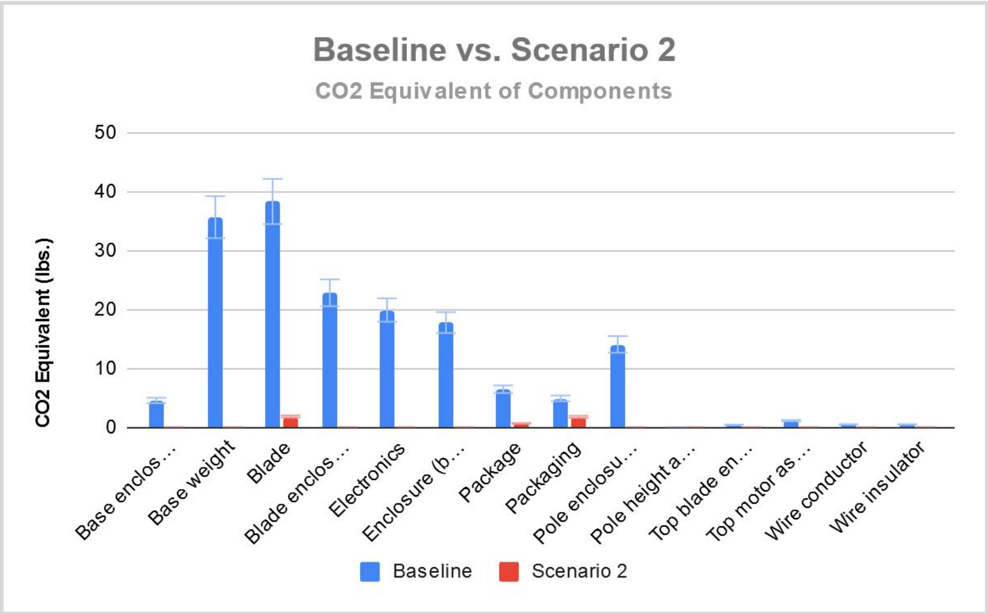
Components	Weight in the Original Design	Weight in the Retrofit Option	Net Weight	Percent Change
Top, Blade	0.3 lb	0.4 lb	+0.1 lb	+33%
Packaging	5.0 lbs	1.8 lbs	-3.2 lbs	-64%
All others	16.7 lbs	0 lb	-16.7 lbs	-100%
Total	22.0 lbs	2.2 lbs	-19.8 lbs	-90%

(Environmental Impact)



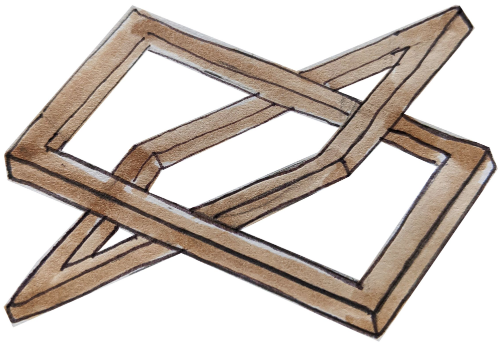
The difference in impact points between the baseline blade and retrofit blad is reflected in the production via 3D printing and molding.

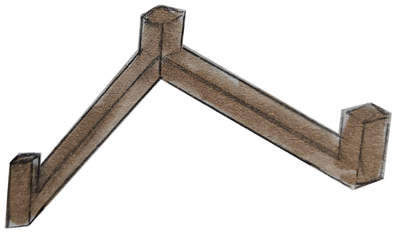
(CO_2 Equivalent)

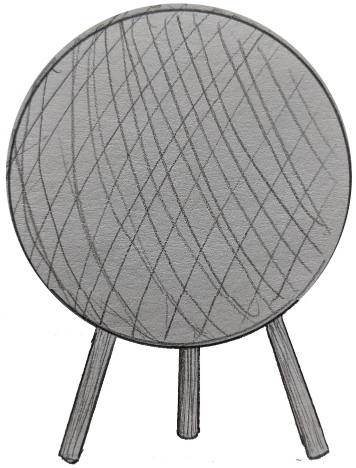


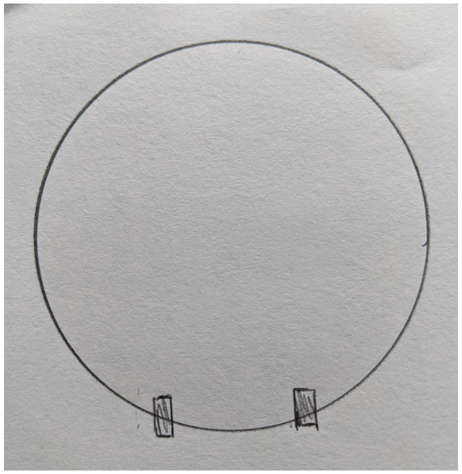
90% of material weight is removed hence **98% reduction** in environmental impact and CO_2 emission in all product life cycle except the usage phase.

SIMPLIFIED PARTS AND FEATURES



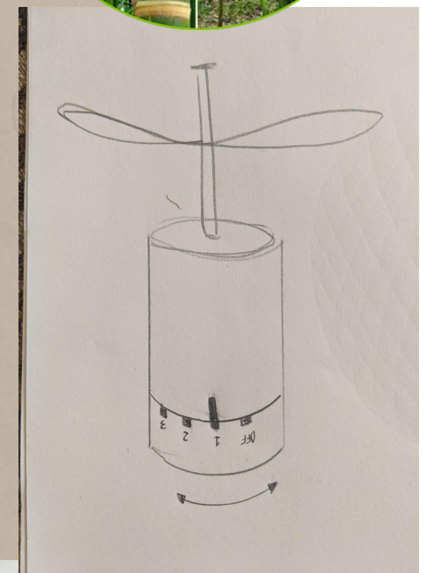






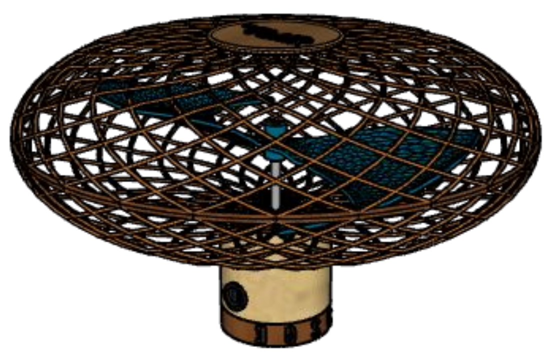
BASE MODEL

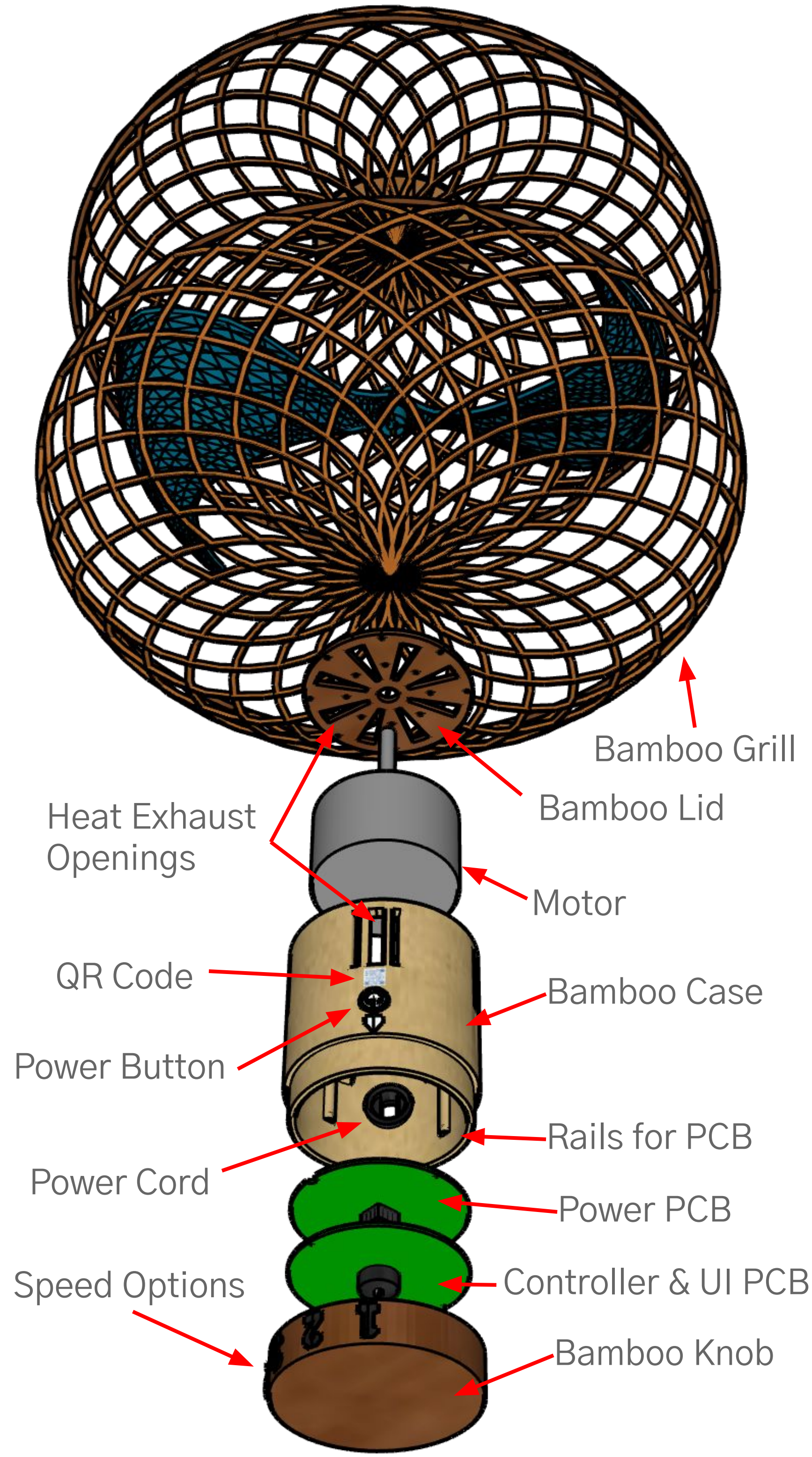
This model includes: Bamboo, reduced functions, simple modular bases



INSPIRATION

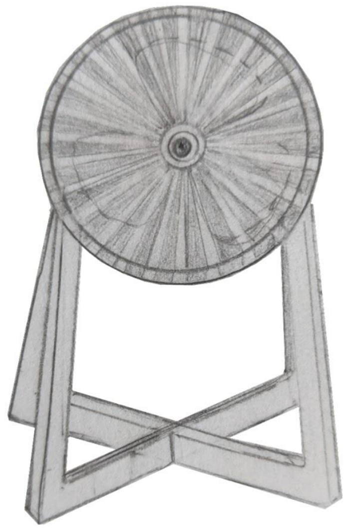
BASE 3D MODEL





CONCEPT 3 – HIGH END MODEL

This model includes: Bamboo, optional functions, Information sharing, gamification, advanced modular bases, app interface



Modification of PCBs and Wiring Harness

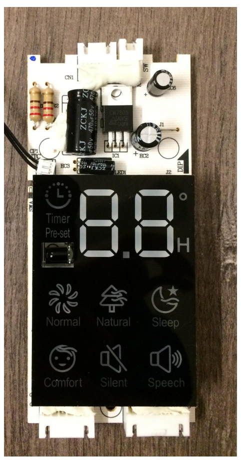
BASELINE

Circuit Board	Dimensions	Area
Controller and Screen	4 ¾ in x 2 in	9.5 in^2
Knob	4 ¾ in x 1 ⅞ in	8.9 in^2
Power	3 ½ in x 2 in	7 in^2

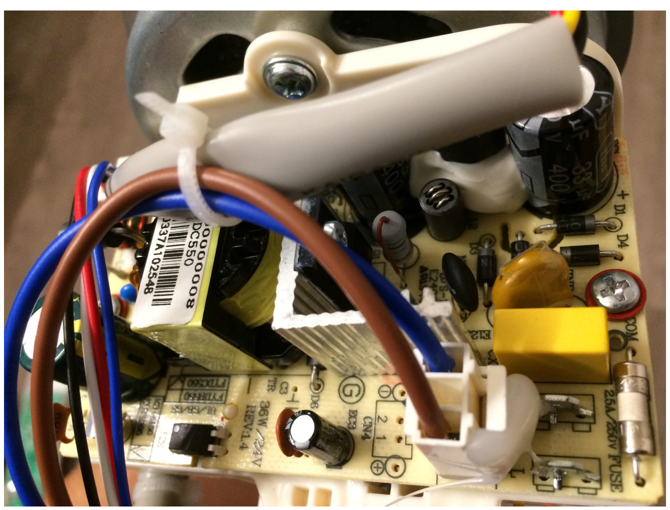
REDESIGN

Circuit Board	Dimensions	Area
Controller and Knob	Diameter: 3 ½ in	9.6 in^2
Power	Diameter: 3 ½ in	9.6 in^2

Knob PCB



Controller & Screen PCB

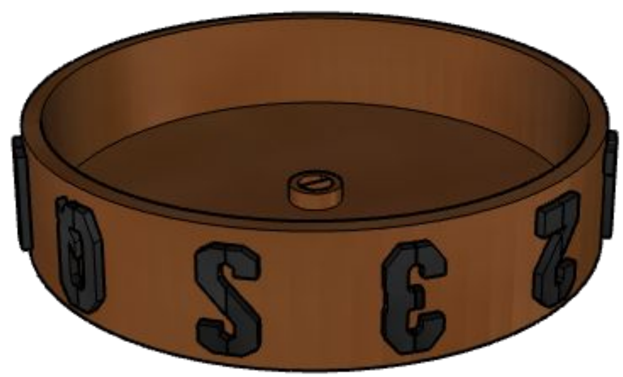


Power PCB

Power PCB

SketchUp

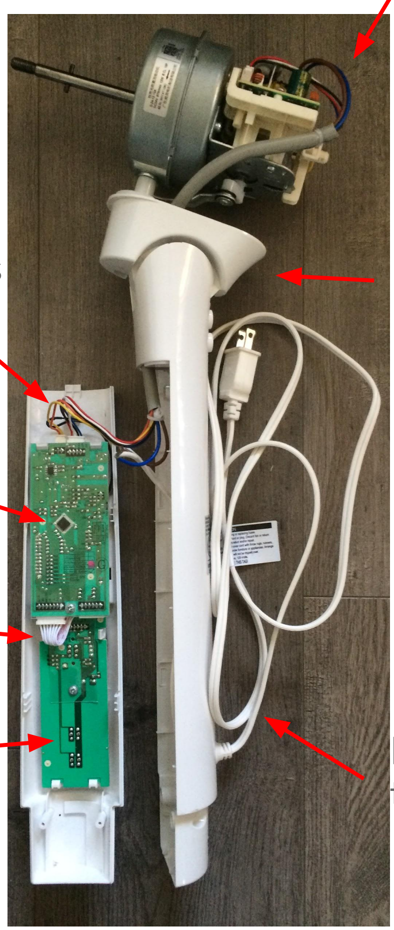
Controller & Knob PCB



Knob for speed control

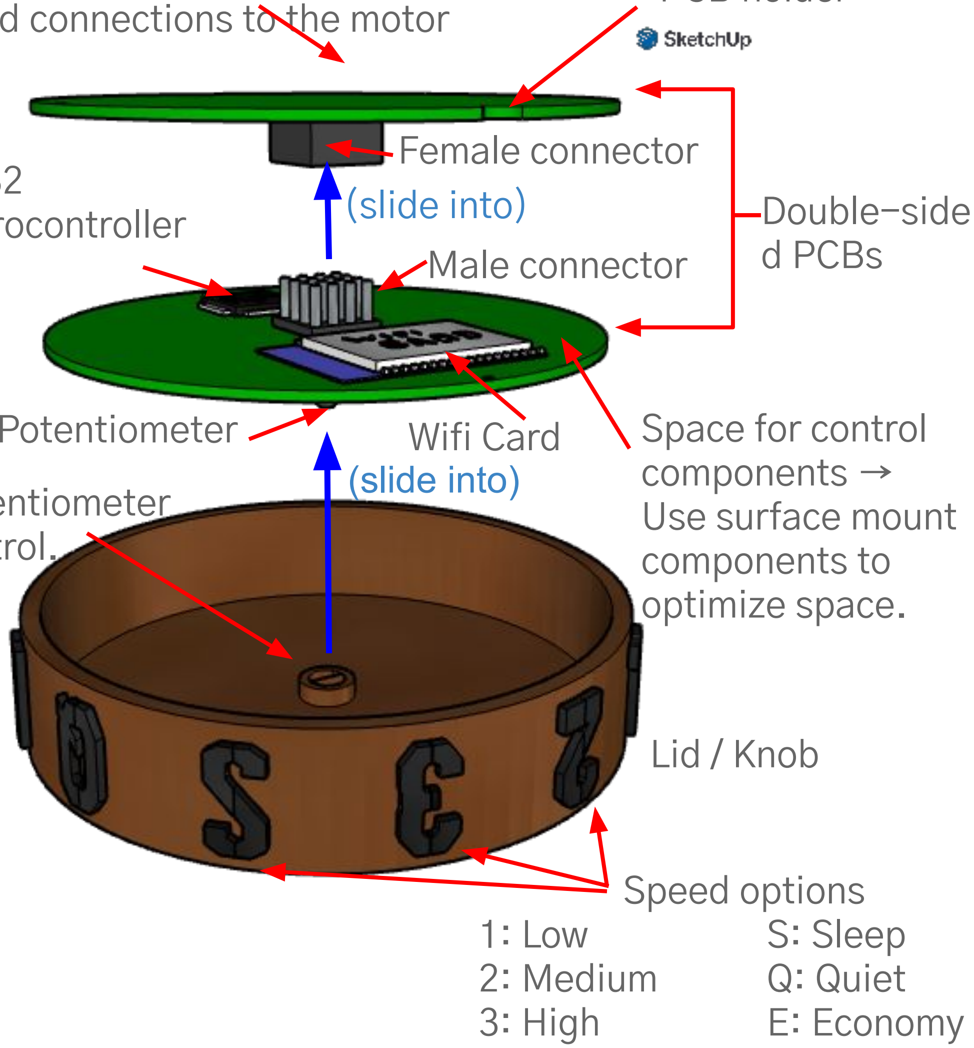
Anatomy of PCBs and Wiring Harness

BASELINE



<u>PCBs are far apart</u>
<u>→ Require more wiring.</u>

REDESIGN

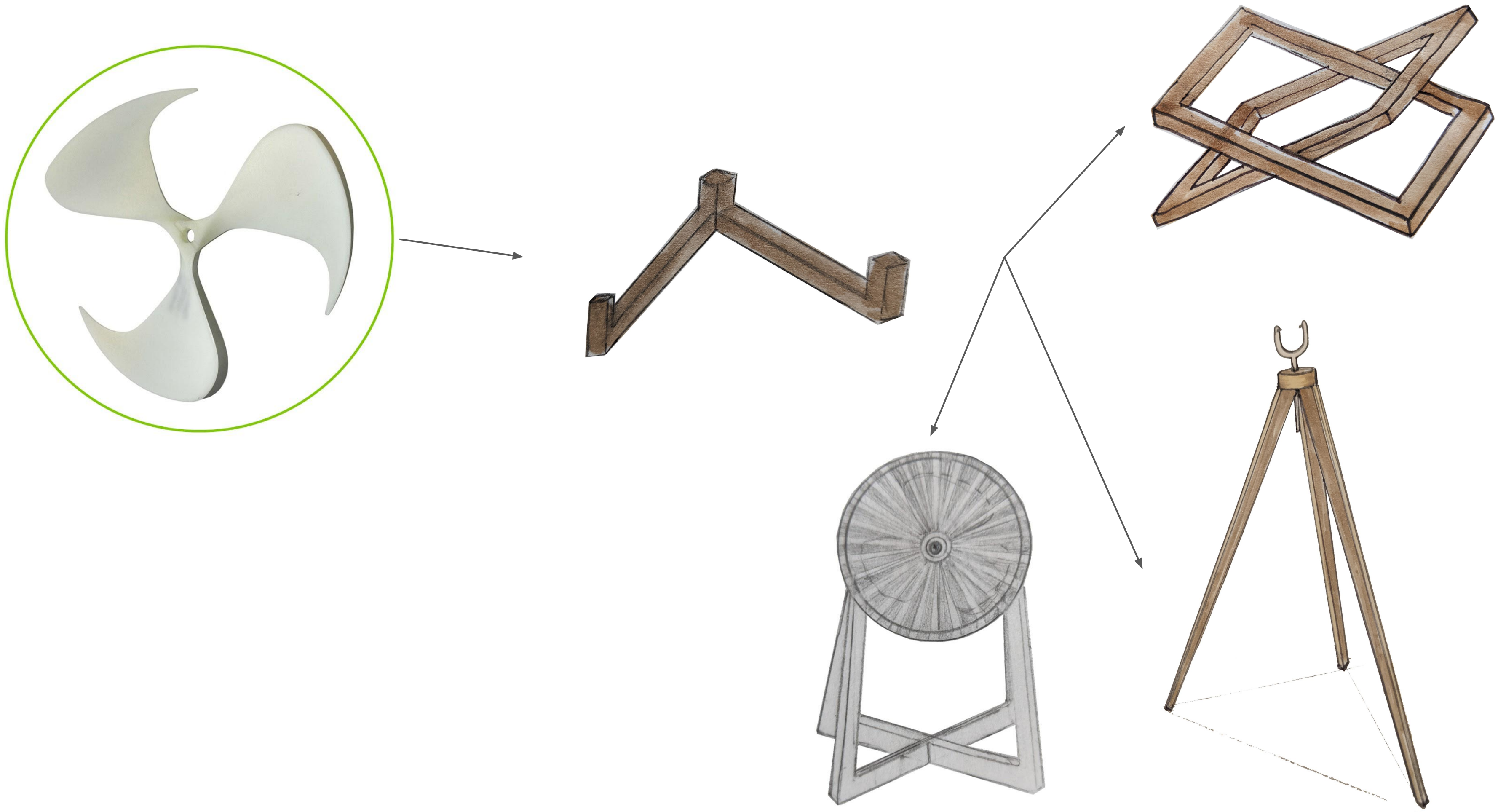


<u>PCBs are plugged into each other</u>
<u>→ Reduce wiring.</u>

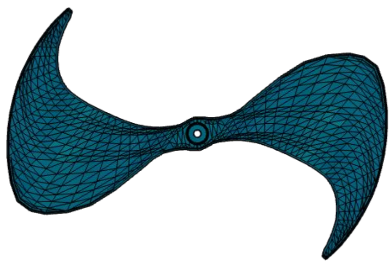
INCORPORATE MODULARITY

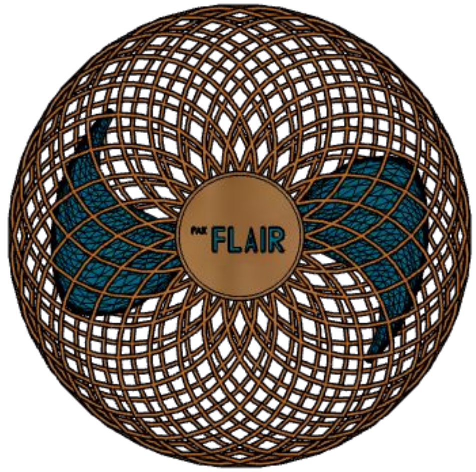
Incorporating modularity allows for replaceable parts, user selections of desired features, and incorporation of economy of scale to reach multiple price points and user needs within variable markets.

The motor/cage remains the same on all models and includes the **offering of alternative bases** for table top, pedestal, clamp, etc.) as well as modified routing of wires and placement of PCBs for added/removed functions and/or features.

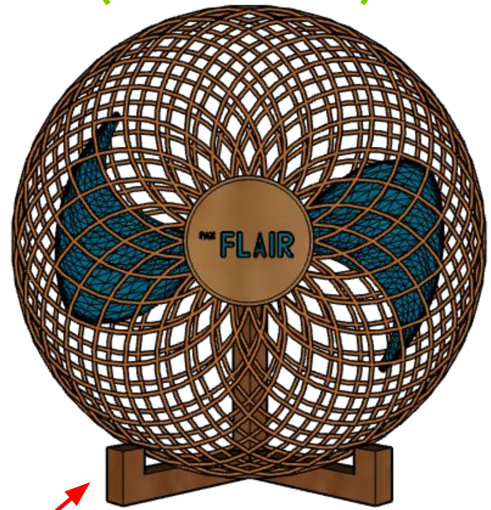


MODULARITY 3D MODEL OPTION 1

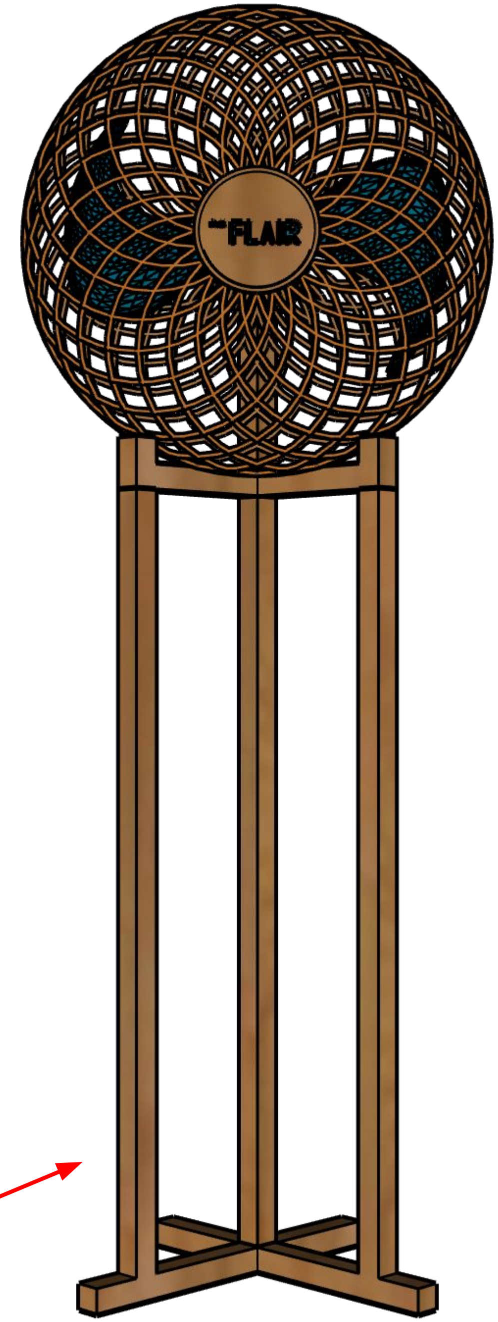




(Front View)

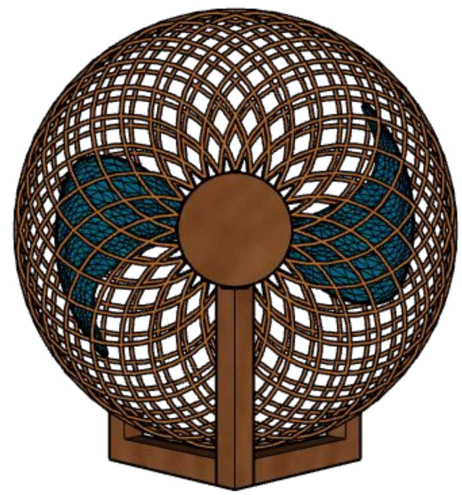


(Front View)



Basic stand to keep the fan in upright position. The stand can be placed on any flat surfaces (table, floor, counter, etc.). Customer can also build their own basic stand.

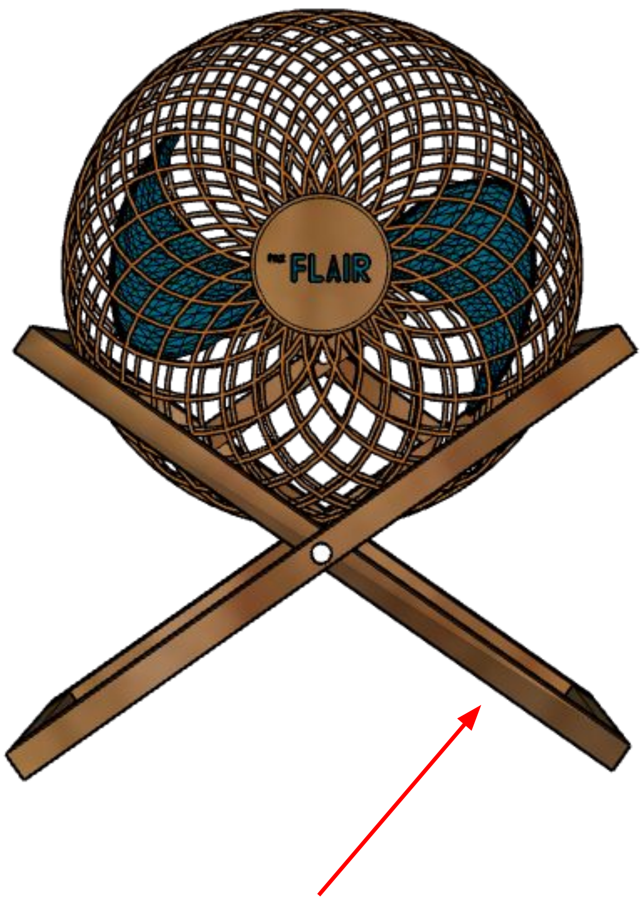
(Back View)



Stand extension based on customers' preference on the height of the fan. Customer can also build their own stand extension.

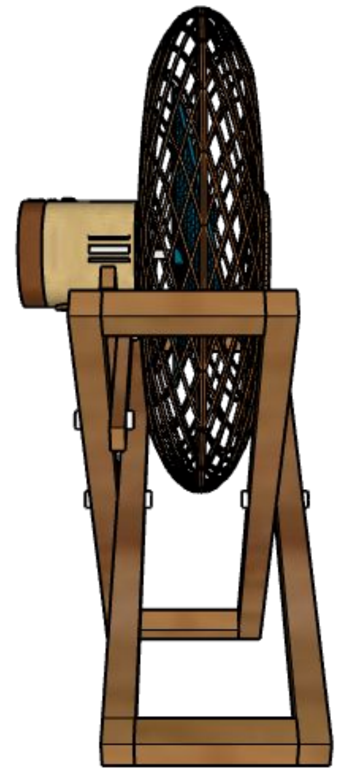
MODULARITY 3D MODEL OPTION 2

(Front View)



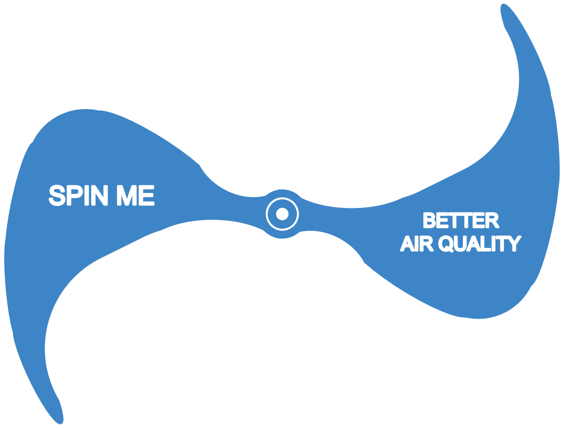
(Back View)

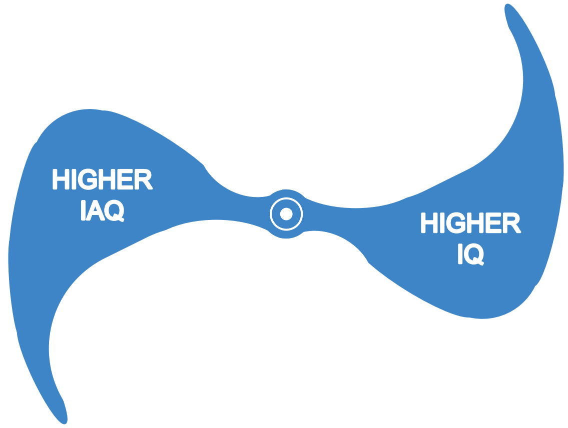
(Side View)

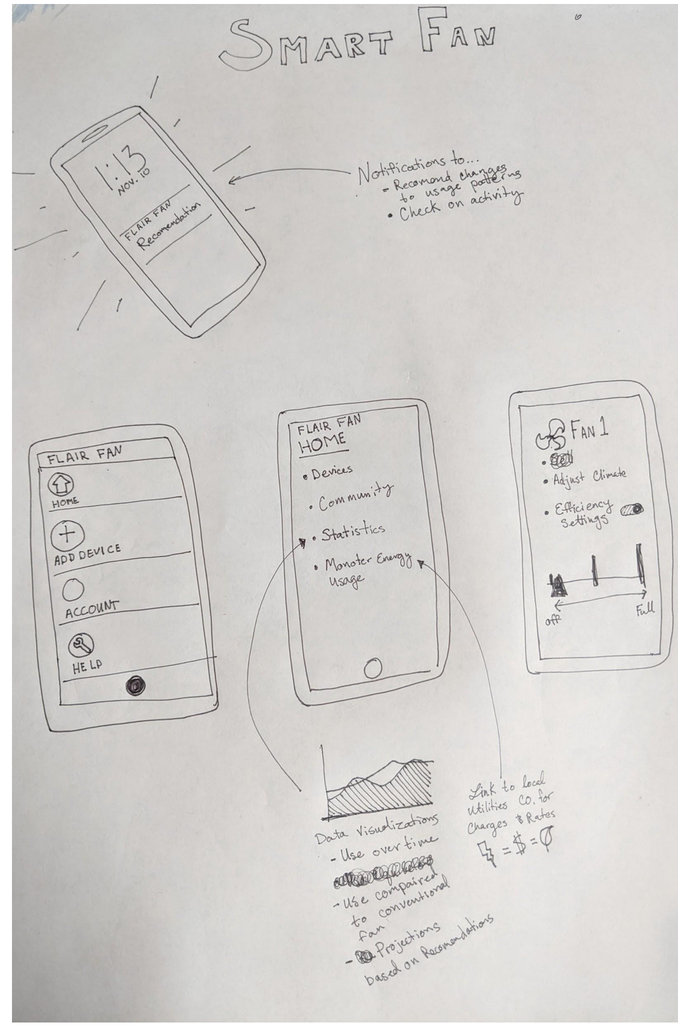


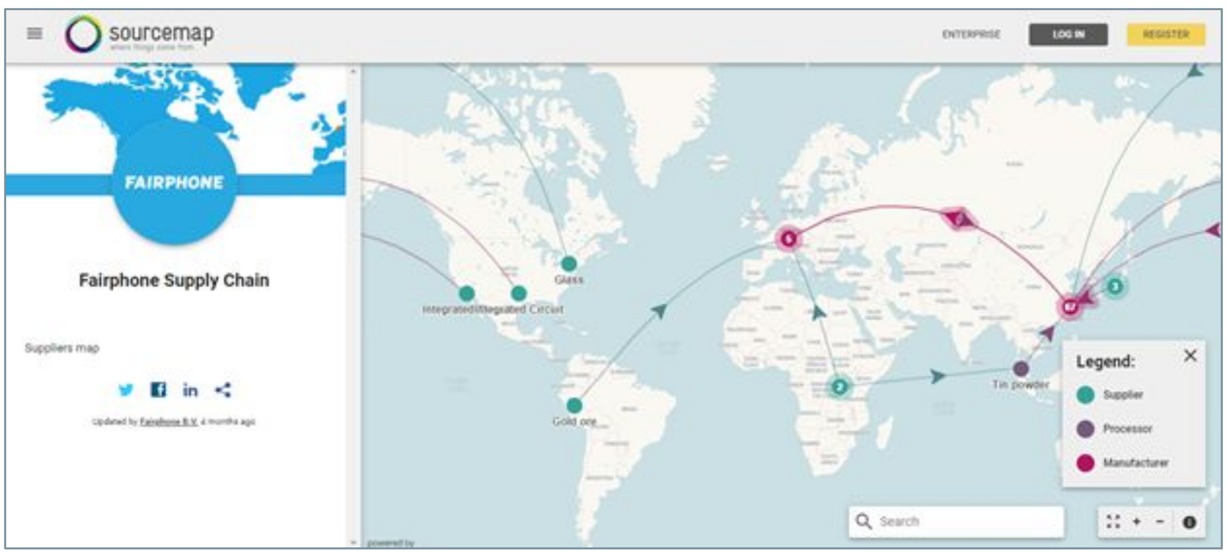
Easy to build short range adjustable stand.

Influencing human behavior through product/service characteristics.

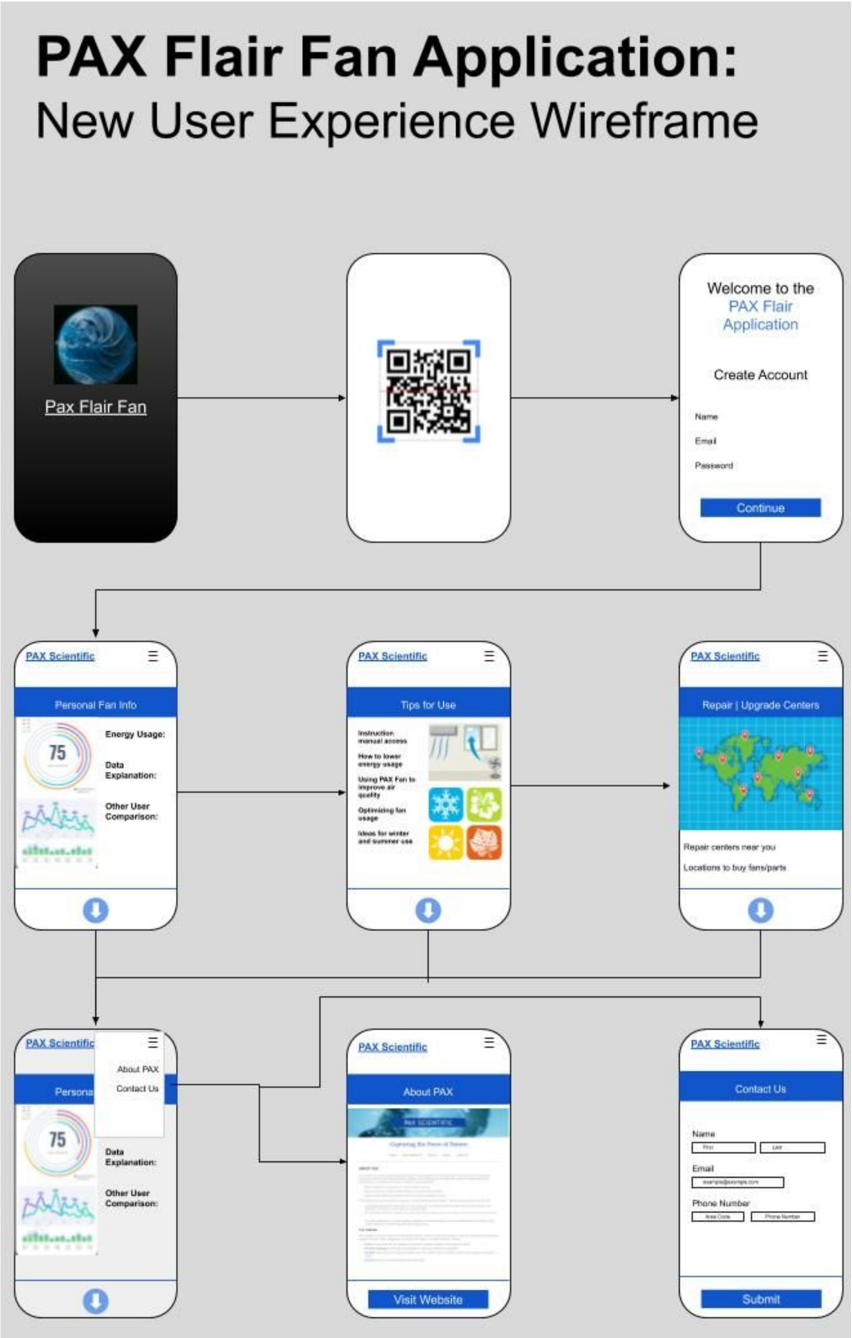






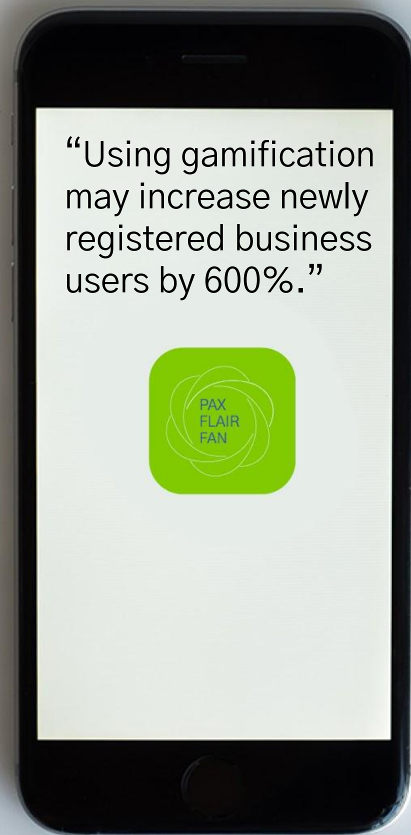


Establish a Materials Map to show where materials were sourced using Open Sourcemap at https://open.sourcemap.com/



User interface application for tracking energy usage, accessing instruction manual, repair network, etc.

GAMIFICATION

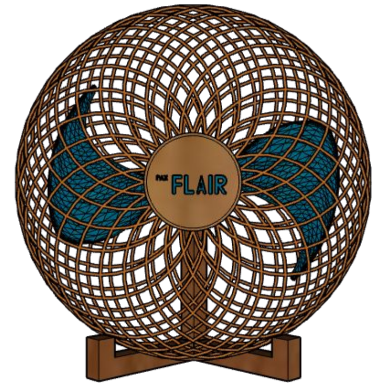


PAX Scientific: https://paxscientific.com/

Generate static QR code:
https://www.qrcode-tiger.com/

THE BASELINE VERSUS THE FINAL REDESIGN HIGHLIGHTS

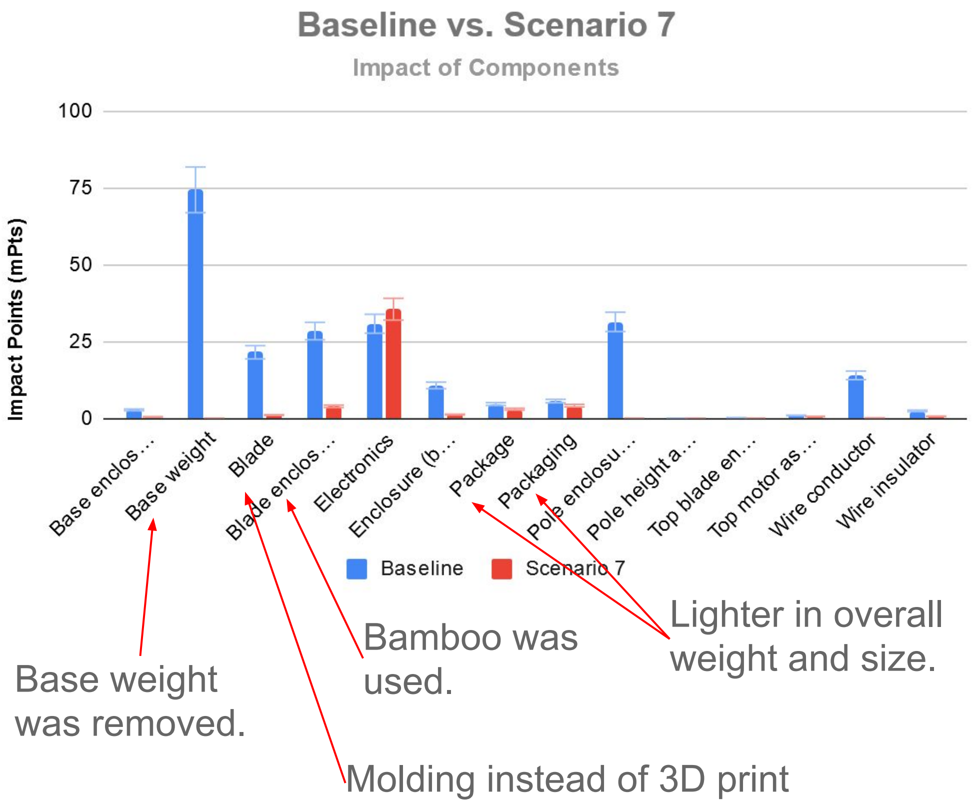
BASELINE	REDESIGN
Features	
Tilling	No tilling.
Height Adjust	Available as an add-on
Oscillation	No oscillation
LED screen	No LED screen
Functions	
26 speed options (1 - 26)	3 speed options (1, 2, 3)
5 modes	3 modes (S, Q, E)
	QR code
	Gamification
	Remote control
	Control via smart phones
Dimensions	
H 50in x W 18in x D 18in	H 19in x W 21in x D 10in
17 lbs	8 lbs



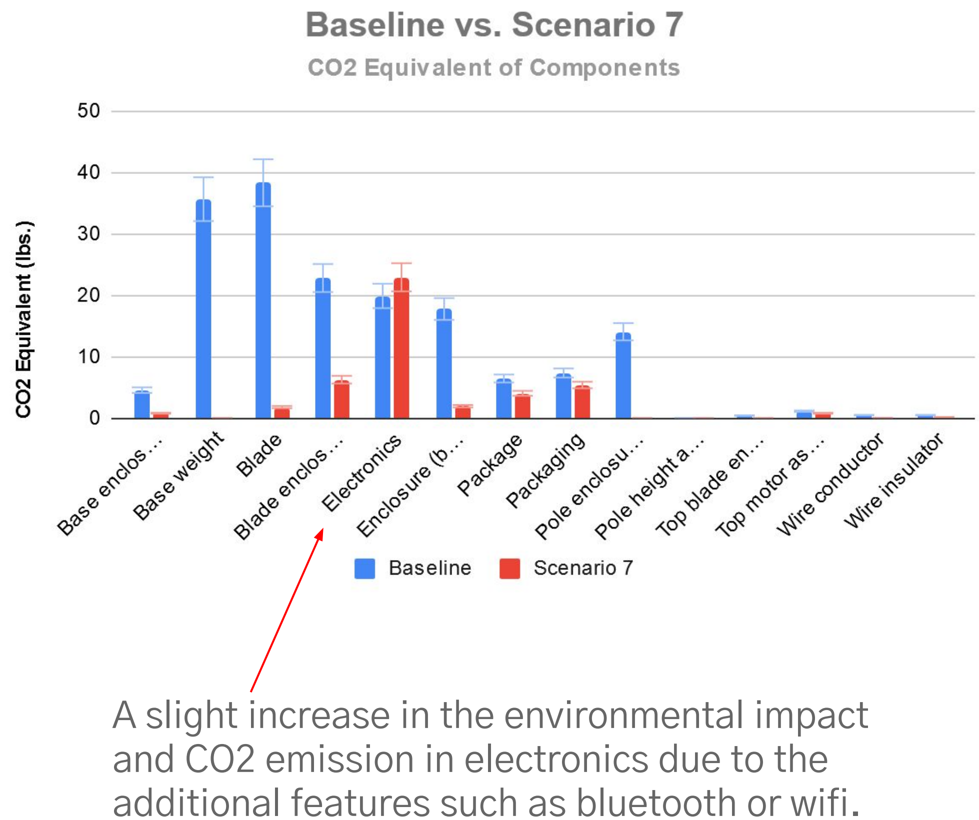
CONCLUSION

LIFE CYCLE ANALYSIS OF THE FINAL REDESIGN

(Environmental Impact)



(CO_2 Equivalent)



The final redesign of the fan results in a **77% reduction** in environmental impact and CO_2 emission in all product life cycle except the usage phase.

SOURCES

The Natural Step

www.thenaturalstep.org/

cradletocradle

www.cradletocradle.com/

The Engineering ToolBox
Home www.EngineeringToolBox.com

SketchUp

www.sketchup.com/

Thank You