
Bio-Inspired Design for Energy Efficiency

— Hani Alharbi, Kyle Matsuoka, Taylor Mellon, —
Talon Mills

Project Description

To design a ventilation system that increases the energy efficiency of SBS West while bringing the building up to standard code. The design will be added on to the current HVAC system and to be inspired by nature.

Importance: SBS West is inefficient with its energy use and does not meet current standards for ventilation.

Project Sponsor: Jon Heitzinger (Facility Maintenance)

Black Box Model

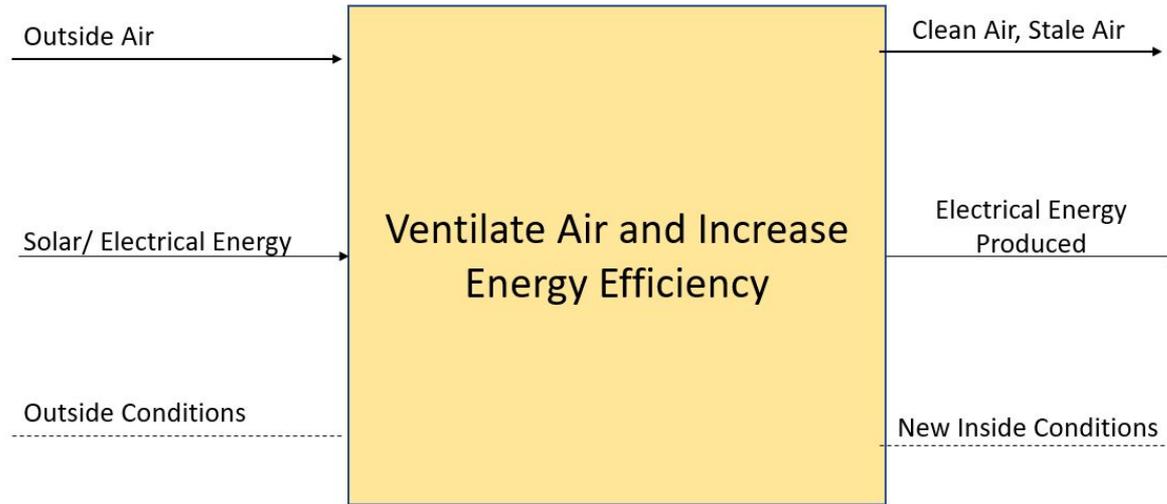


Figure 1: Black Box Model

Hypothesized Functional Model

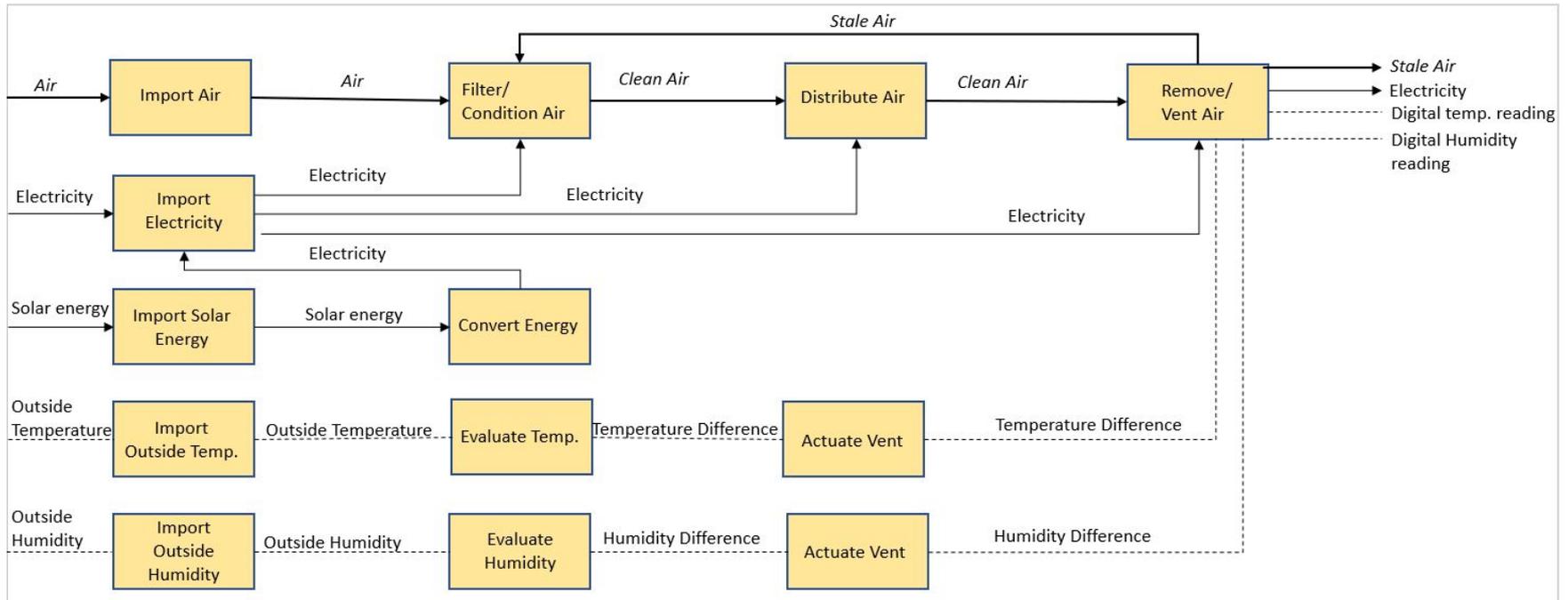


Figure 2: Hypothesized Functional Model

Component Designs

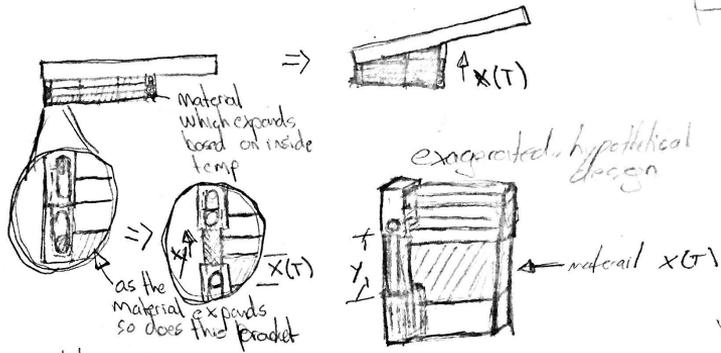


Figure 3: Smart Material Actuation

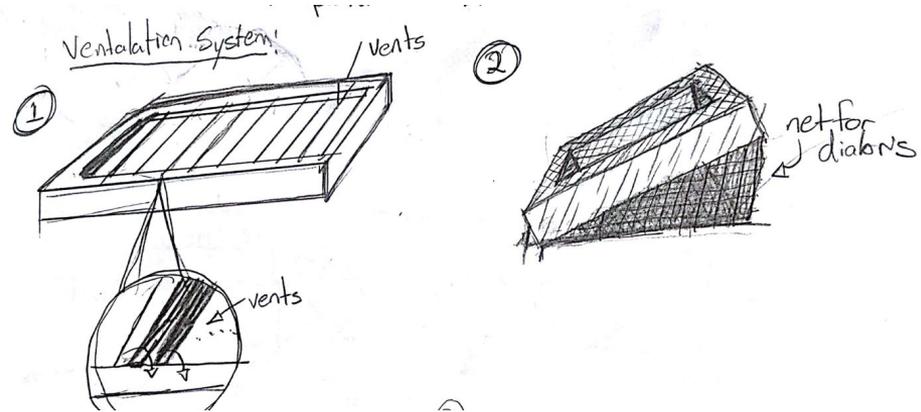


Figure 4: Ventilation Designs

Component Designs

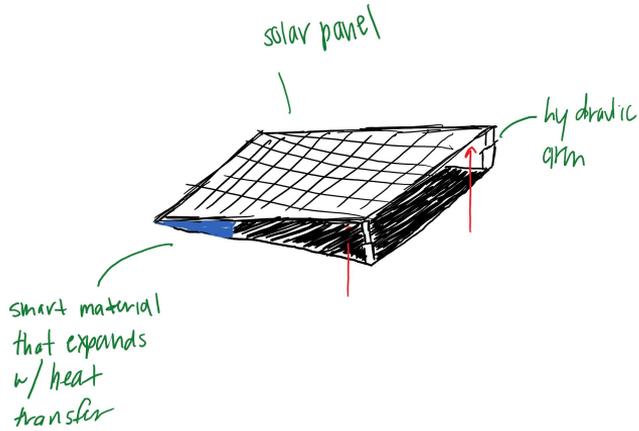


Figure 5: Hydraulic Arm Actuation



Figure 6: Bio-Inspired Fan

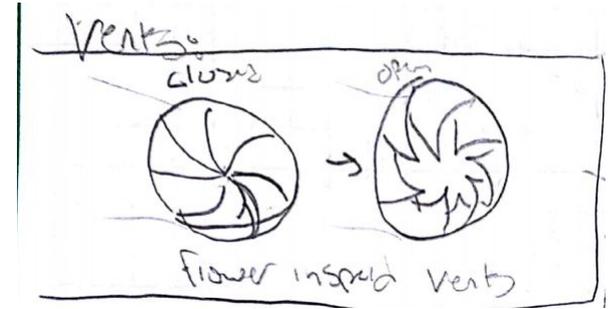


Figure 7: Bio-Inspired Vents

Morph Matrix

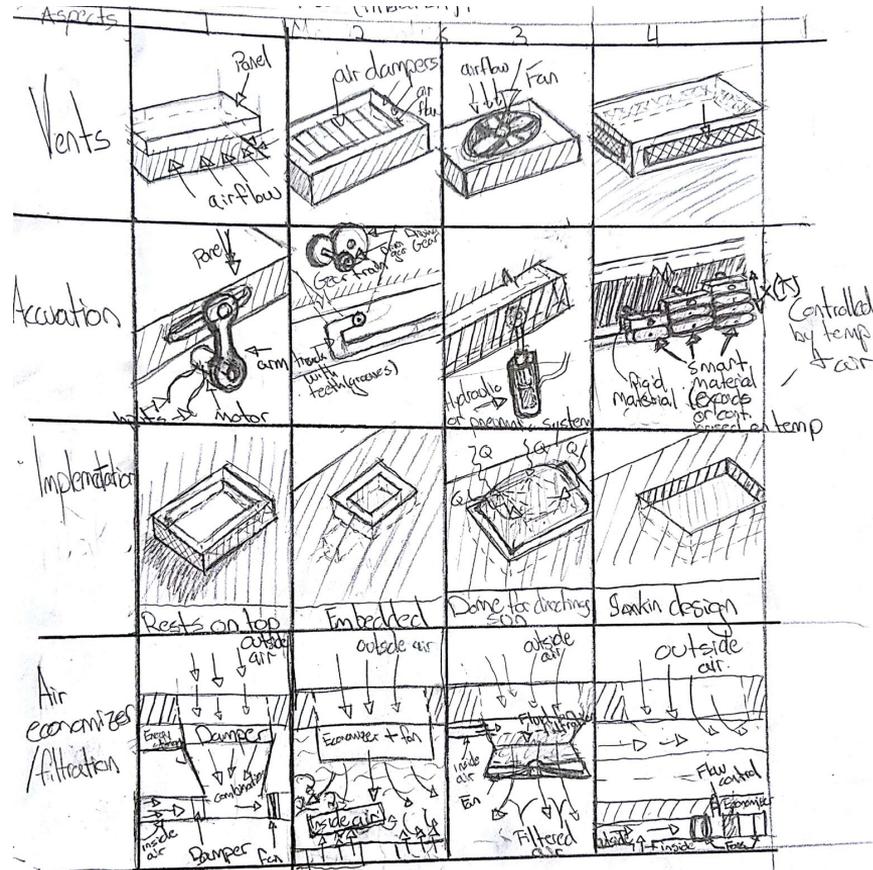


Figure 8: Morph Matrix of Concepts

Designs

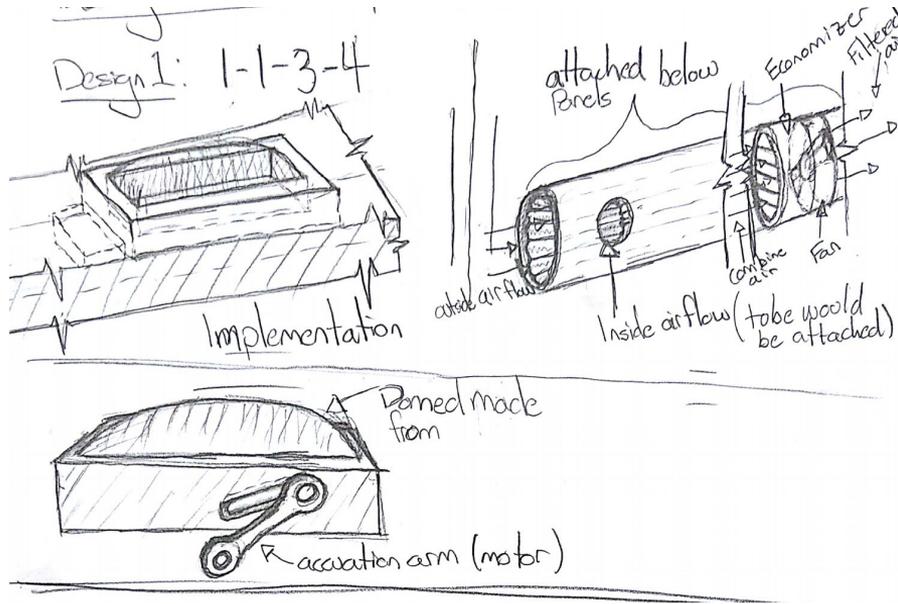


Figure 9: Morph Matrix Design 1

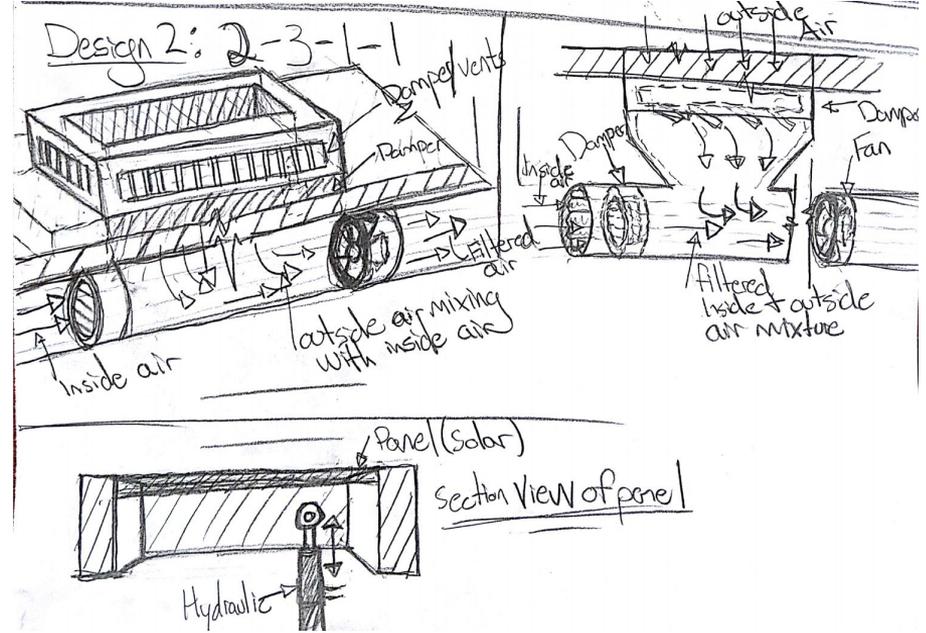


Figure 10: Morph Matrix Design 2

Designs

Design 3:

3-2-4-2

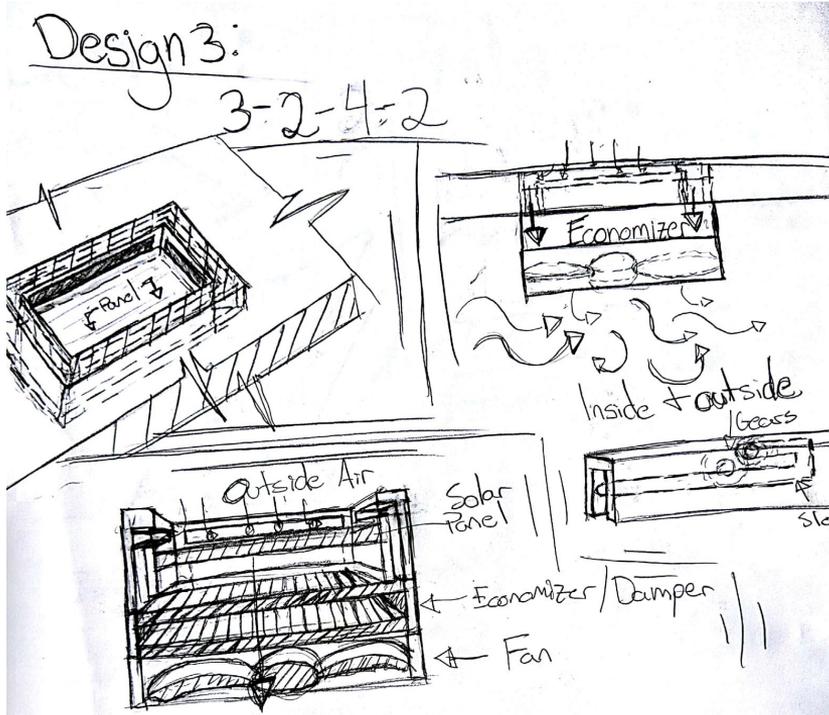


Figure 11: Morph Matrix Design 3

Design 4:

1/2-1/4-1-1

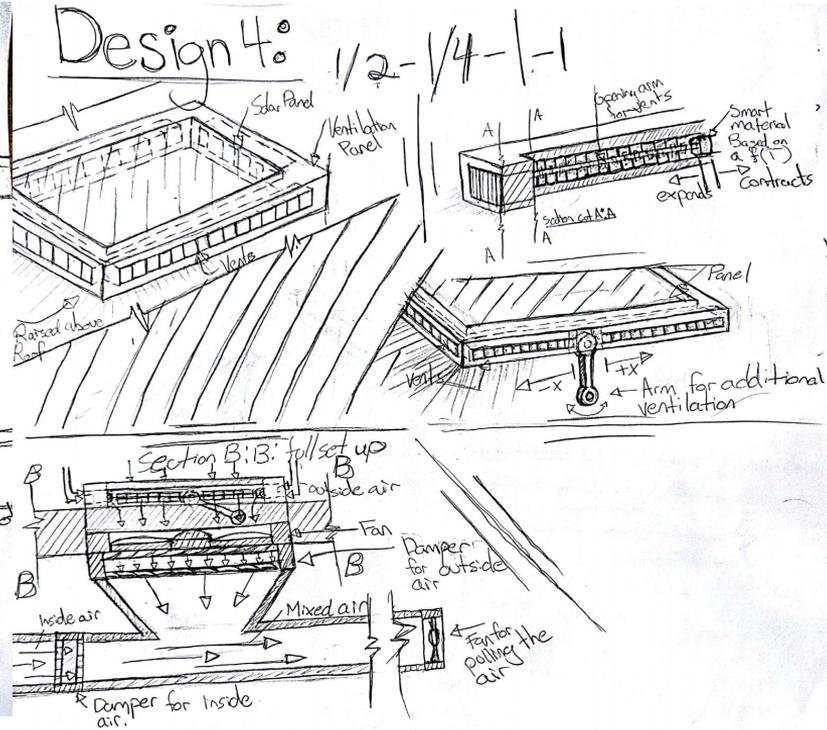


Figure 12: Morph Matrix Design 4

Decision Matrix

		Concept 1			Concept 2			Concept 3			Concept 4	
Customer Needs	Weight (%)	Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score
Must be bio-inspired	0.25	100	25		70	17.5		95	23.75		60	15
Must increase energy efficiency	0.25	95	23.75		90	22.5		0	0		85	21.25
Must have a short pay-off	0.12	20	5		70	17.5		70	17.5		70	17.5
Must provide the same services as current system	0.05	50	12.5		50	12.5		0	0		70	17.5
Must be easy to maintain	0.08	85	21.25		80	20		100	25		75	18.75
Must be space efficient	0.05	90	22.5		95	23.75		100	25		90	22.5
Must not generate excess noise pollution	0.05	95	23.75		100	25		100	25		60	15
Must have adjustable times	0.05	30	7.5		0	0		0	0		70	17.5
Must be safe	0.1	90	22.5		90	22.5		90	22.5		95	23.75
Total	1	655	163.75		645	161.25		555	138.75		675	168.75
		Concept 5			Concept 6			Concept 7			Concept 8	
Customer Needs	Weight (%)	Score	Weighted Score		Score	Weighted Score		Score	Weighted Score		Score	Weighted Score
Must be bio-inspired	0.25	80	20		100	25		100	25		100	25
Must increase energy efficiency	0.25	85	21.25		90	22.5		90	22.5		70	17.5
Must have a short pay-off	0.12	60	15		70	17.5		70	17.5		60	15
Must provide the same services as current system	0.05	50	12.5		70	17.5		70	17.5		50	12.5
Must be easy to maintain	0.08	90	22.5		85	21.25		85	21.25		50	12.5
Must be space efficient	0.05	95	23.75		85	21.25		80	20		90	22.5
Must not generate excess noise pollution	0.05	100	25		80	20		90	22.5		70	17.5
Must have adjustable times	0.05	0	0		0	0		0	0		30	7.5
Must be safe	0.1	95	23.75		90	22.5		95	23.75		85	21.25
Total	1	655	163.75		670	167.5		680	170		605	151.25

Final Design

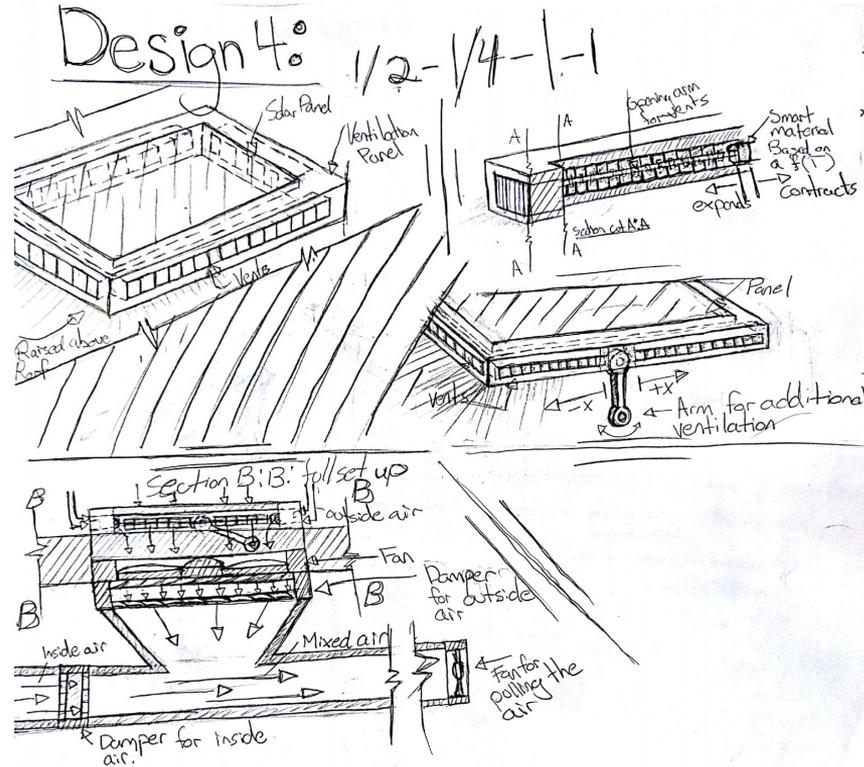
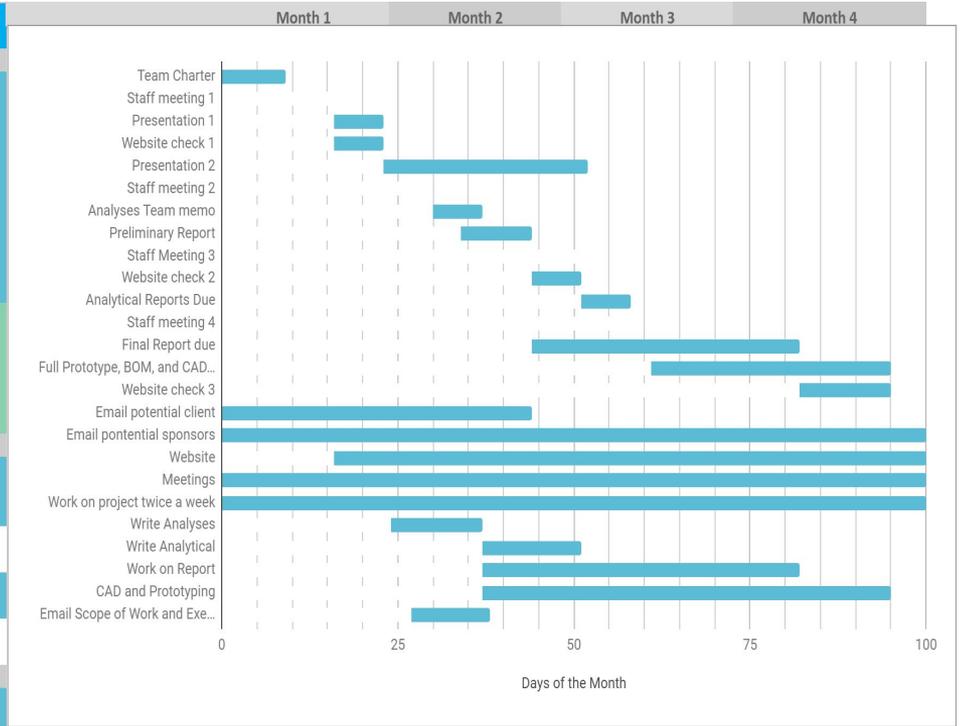


Figure 12: Final Design

Schedule

TASK NAME	START DATE	END DATE	START ON DAY*	DURATION* (WORK DAYS)	TEAM MEMBER	PERCENT COMPLETE
Class						
Team Charter	9/1	9/10	0	9	All	100%
Staff meeting 1	9/17	9/17	16	0	All	100%
Presentation 1	9/17	9/24	16	7	All	100%
Website check 1	9/17	9/24	16	7	Hani	100%
Presentation 2	9/24	10/22	23	29	All	100%
Staff meeting 2	10/1	10/1	30	0	All	100%
Analyses Team memo	10/1	10/8	30	7	Taylor, Talon	100%
Preliminary Report	10/5	10/15	34	10	Kyle	100%
Staff Meeting 3	10/22	10/22	51	0	All	100%
Website check 2	10/15	10/22	44	7	Hani	100%
Analytical Reports Due	10/22	10/29	51	7	All	
Staff meeting 4	10/29	10/29	58	0	All	
Final Report due	10/15	11/22	44	38	All	
Full Prototype, BOM, and CAD package due	11/1	12/5	61	34	Taylor, Talon	
Website check 3	11/22	12/5	82	13	Hani	
Team						
Email potential client	9/1/2018	10/15	0	44	All	100%
Email potential sponsors	9/1	12/10	0	100	Taylor, Kyle	100%
Website	9/17	12/10	16	84	Hani	100%
Meetings	9/1	12/10	0	100	All	65%
Work on project twice a week	9/1	12/10	0	100	All	65%
Write Analyses	9/25	10/8	24	13	Kyle	100%
Write Analytical	10/8	10/22	37	14	Taylor	100%
Work on Report	10/8	11/22	37	45	All	
CAD and Prototyping	10/8	12/5	37	58	Talon	
Client and Sponsor						
Email Scope of Work and Executive Summary	9/28	10/8	27	11	All	100%



Budget

Project Budget: Still waiting on client to give us estimated budget.

Amount Spent to Date: \$0

Anticipated Expenses: Next slide

Project Balance: N/A

Budget: Anticipated Expenses

- 1) **Beta Prototype (low budget): ~\$500 - \$1000**
 - a) Machined parts ~ \$150 - \$200
 - b) 3-D printing ~ \$100 - \$150
 - c) Fasteners ~ \$50 - \$100
 - d) Variable costs ~ \$100 - \$200
- 2) **Scaled Alpha Prototype (medium budget) :~\$1000 - \$1500**
 - a) Machined parts ~ \$250 - \$500
 - b) 3-D printing ~ \$100 - \$150
 - c) Fasteners ~ \$100 - \$200
 - d) Variable costs ~ \$200 - \$400
- 3) **Actual Alpha Prototype (ideal budget) :~\$1500 or greater**
 - a) Machined parts ~ \$500 - \$1500
 - b) 3-D printing ~ \$100 - \$150
 - c) Fasteners ~ \$100 - \$200
 - d) Variable costs ~ \$500 or greater

Questions?