Human Powered Vehicle

Yousef Alanzi, Evan Bunce, Cody Chenoweth,

Haley Flenner, Brent Ives, Connor Newcomer

October 23rd, 2015

Concept Generation and Selection

NORTHERN ARIZONA UNIVERSITY

ASME SETTING THE STANDARD

Overview

- Introduction
- Criteria
- Analytical Hierarchy Matrix
- Relative Weights of Criteria
- Concept Generation
- Decision Matrix
- Project plan
- Conclusion
- References

Introduction

- There is a need for safe, efficient, reliable transportation for people in underdeveloped countries
- The goal of this project is to reduce transportation costs by designing and building safe, efficient, and reliable human-powered vehicles
- Design objectives include weight, cost, speed, acceleration, and size
- Constraints include a new design and pure human power
- Current competition vehicles are made of metal alloys or composites, or a mixture of both, with a recumbent riding position and minimal aerodynamic effects

Criteria

- Frame
  - Strength
  - Weight
  - Ease of Manufacturing
  - Aesthetics
  - Cost
  - Durability
- Steering
  - Ease of Use
  - Cost
  - Ease of Manufacturing
  - Power Input
- Material
  - Strength
  - Weight
  - Ease of Manufacturing
  - Power Input
- Fairing
  - Strength
  - Weight
  - Ease of Manufacturing
  - Aesthetics
  - Cost
  - Durability
- Power Input
  - Speed
  - Ease of Manufacturing
  - Safety
  - Cost
- Seating Position
  - Ease of Use
  - Cost
  - Ease of Manufacturing
  - Comfort

Analytical Hierarchy Matrix

Framing

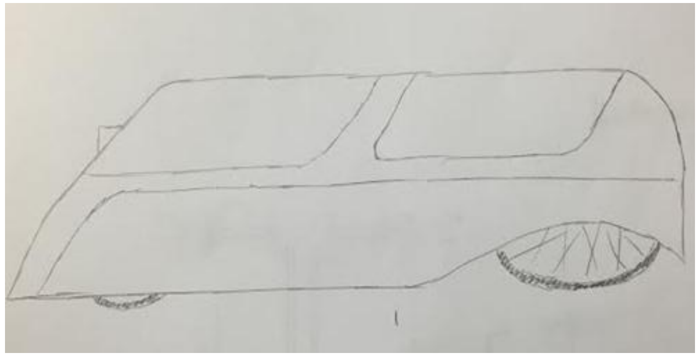
	Strength	Weight	Ease of Manufacturing	Aesthetics	Cost	Durability
Strength	1.000	0.200	1.000	9.000	4.000	2.000
Weight	5.000	1.000	9.000	8.000	9.000	3.000
Ease of Manufacturing	1.000	0.111	1.000	9.000	1.000	4.000
Aesthetics	0.111	0.125	0.111	1.000	0.125	0.125
Cost	0.250	0.111	1.000	8.000	1.000	1.000
Durability	0.500	0.333	0.250	8.000	1.000	1.000
Total	7.861	1.881	12.361	43.000	16.125	11.125

Relative Weights of Framing Criteria

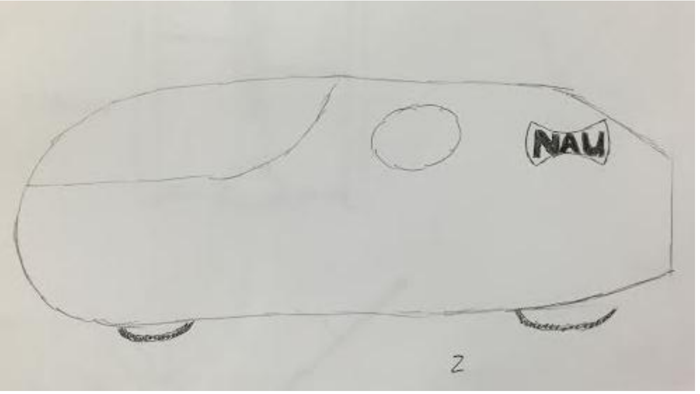
	Strength	Weight	Ease of Manufacturing	Aesthetics	Cost	Durability	**Overall**
Strength	0.127	0.106	0.081	0.209	0.248	0.180	0.159
Weight	0.636	0.532	0.728	0.186	0.558	0.270	0.485
Ease of Manufacturing	0.127	0.059	0.081	0.209	0.062	0.360	0.150
Aesthetics	0.014	0.066	0.009	0.023	0.008	0.011	0.022
Cost	0.032	0.059	0.081	0.186	0.062	0.090	0.085
Durability	0.064	0.177	0.020	0.186	0.062	0.090	0.100

Concept Generation: Fairing

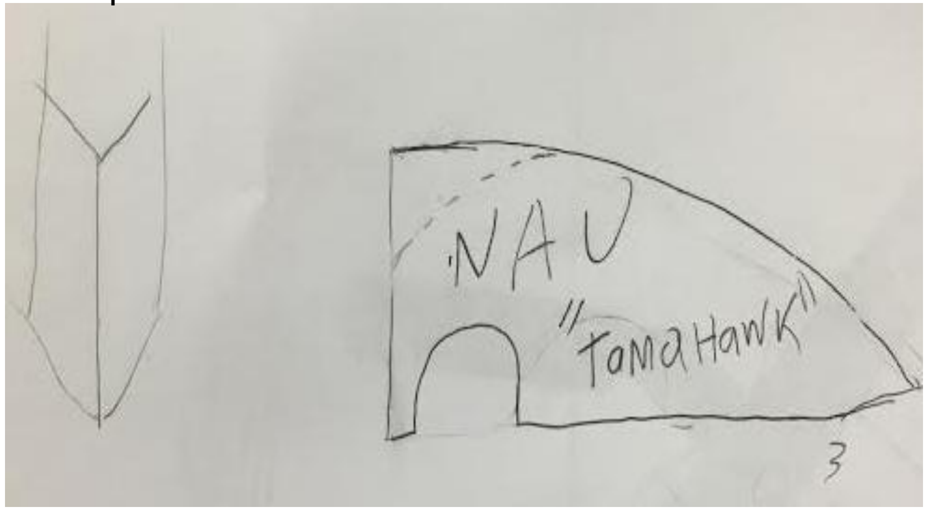
Concept 1



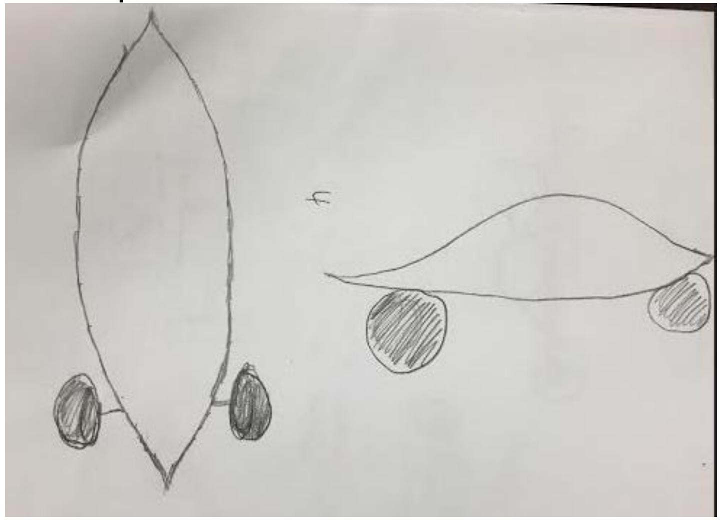
Concept 2



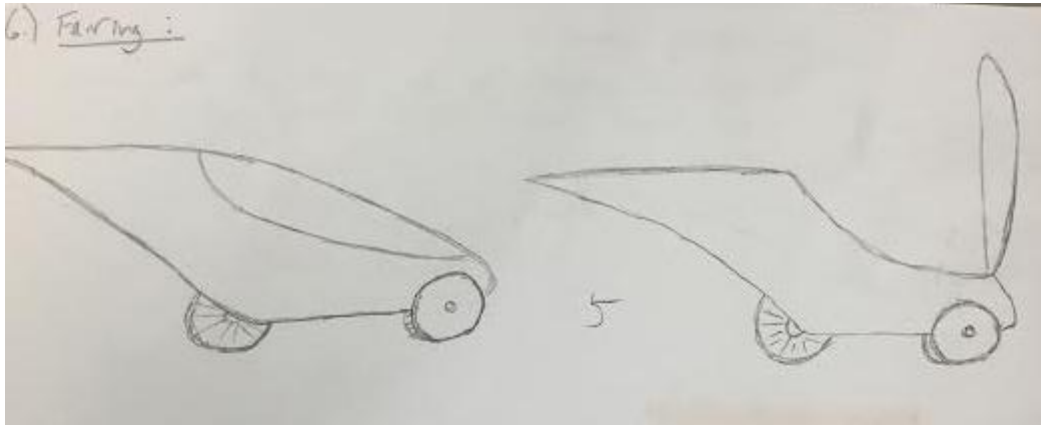
Concept 3



Concept 4



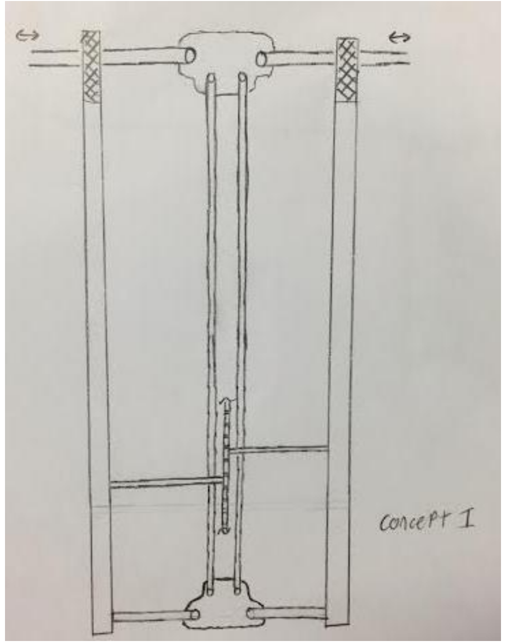
Concept 5



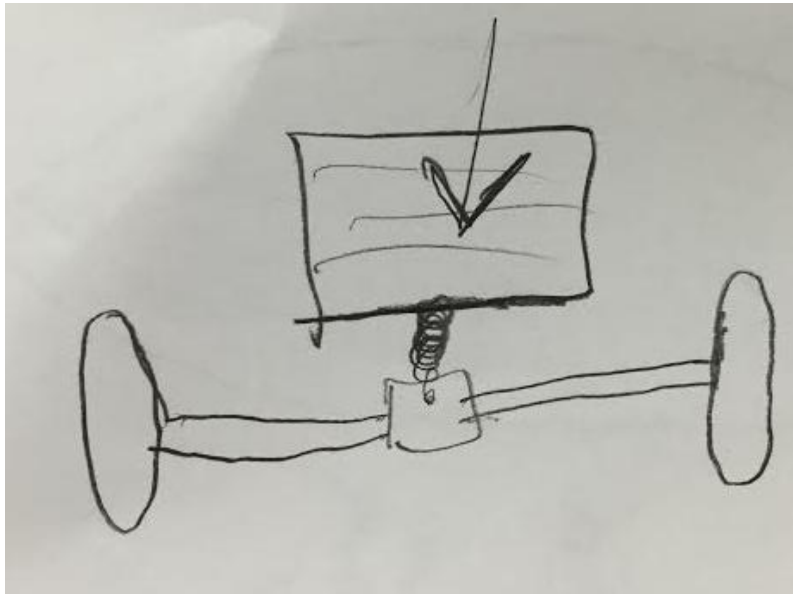
Decision Matrix: Fairing

Fairing	Weight	Efficiency	Ease of Manufacturing	Cost	Durability	**Overall**
Concept 1	4	3	3	2	3	3.164
Concept 2	4	5	3	2	3	4.132
Concept 3	4	1	3	2	3	2.196
Concept 4	4	2	3	2	3	2.680
Concept 5	4	5	3	2	4	4.200

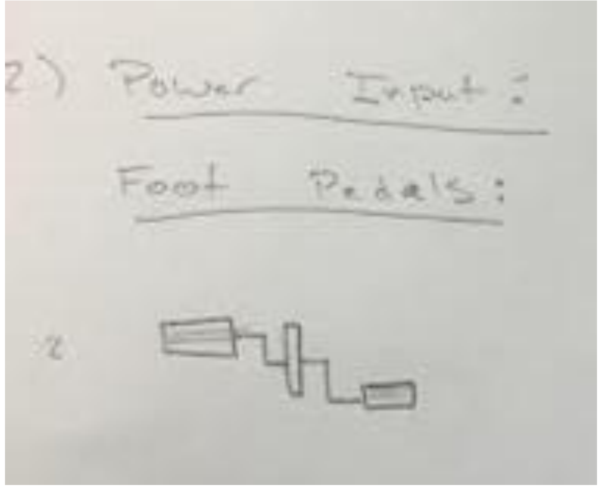
Concept Generation: Power Input



Concept 1

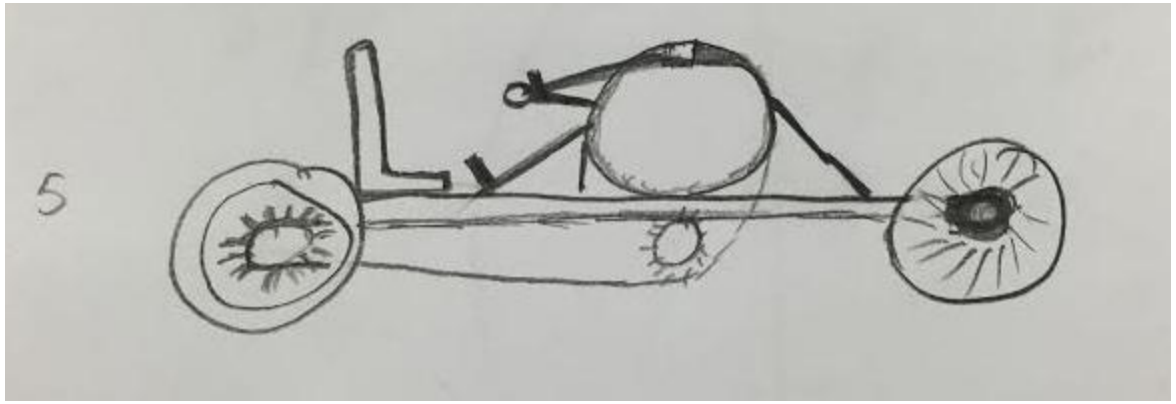


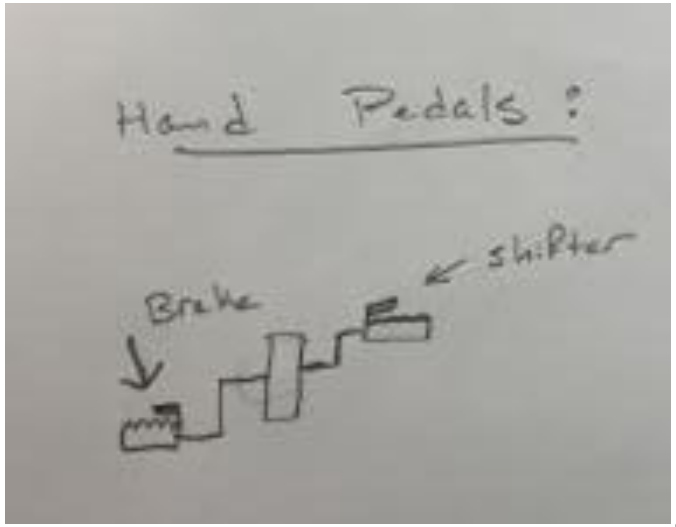
Concept 4



Concept 2

Concept 5



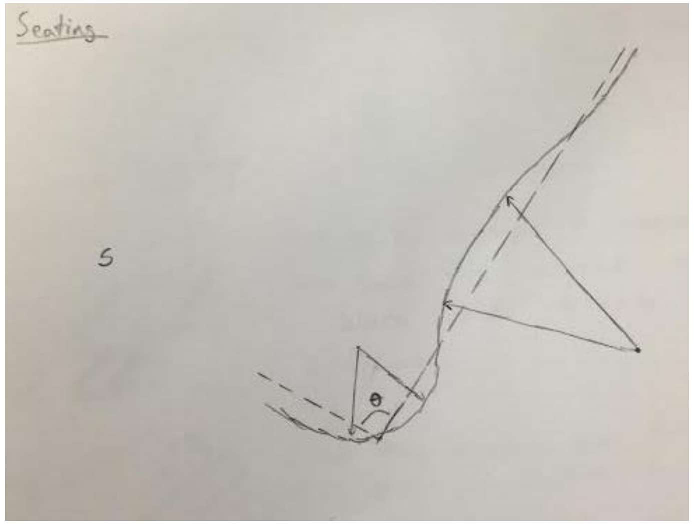


Concept 3

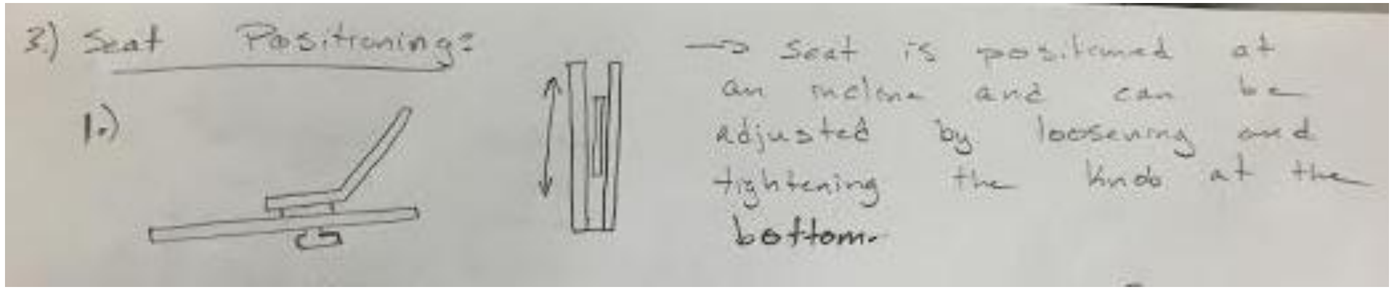
Decision Matrix: Power Input

Power Input	Speed	Ease of manufacturing	Safety	Cost	**Overall**
Concept 1	3	2	3	3	2.815
Concept 2	5	5	5	5	5.000
Concept 3	2	2	2	4	1.834
Concept 4	3	2	4	2	2.454
Concept 5	1	1	1	1	0.815

Concept Generation: Seating

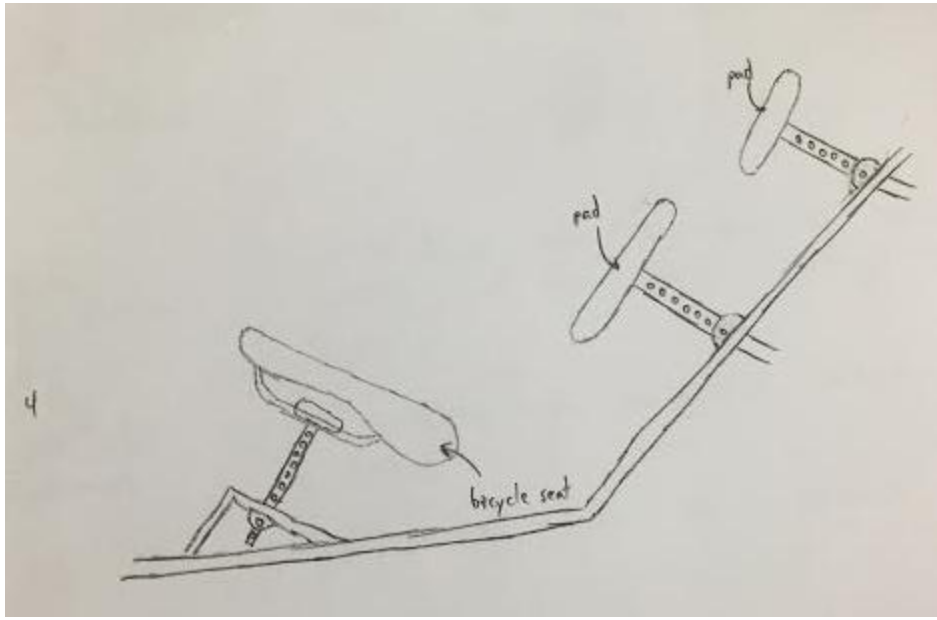


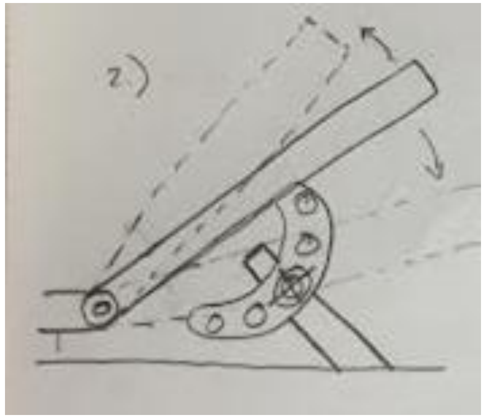
Concept 2



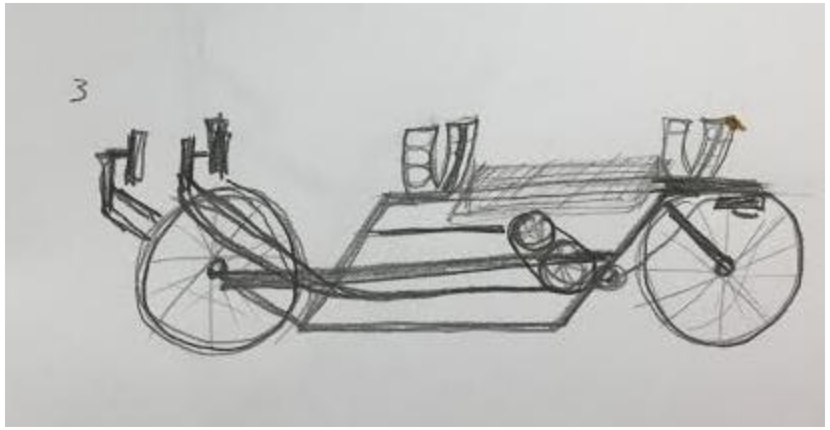
Concept 1

Concept 4





Concept 5

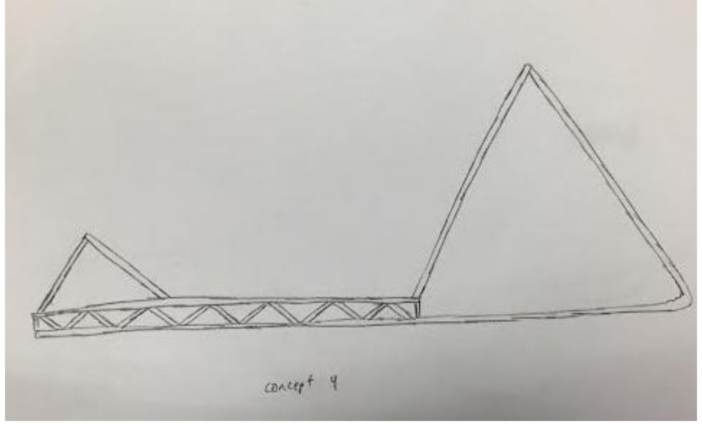


Concept 3

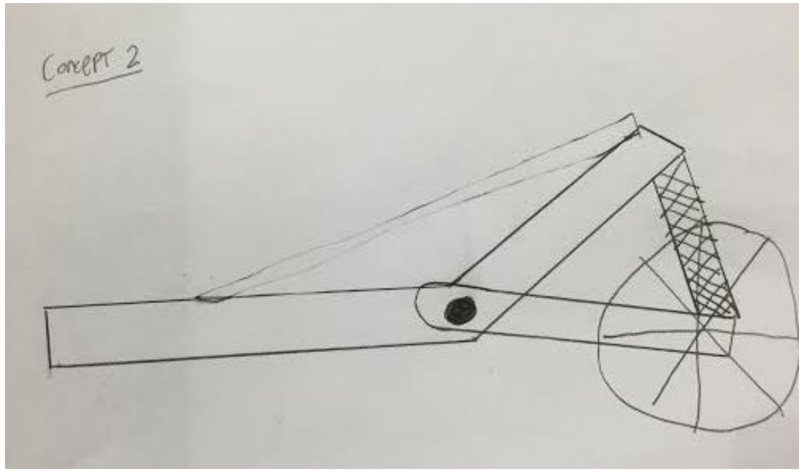
Decision Matrix: Seating

Seating	Ease of Use	Cost	Ease of Manufacturing	Comfort	**Overall**
Concept 1	5	4	4	3	4.401
Concept 2	3	3	3	4	3.188
Concept 3	1	1	1	1	1.001
Concept 4	4	2	2	5	3.721
Concept 5	2	4	4	5	3.025

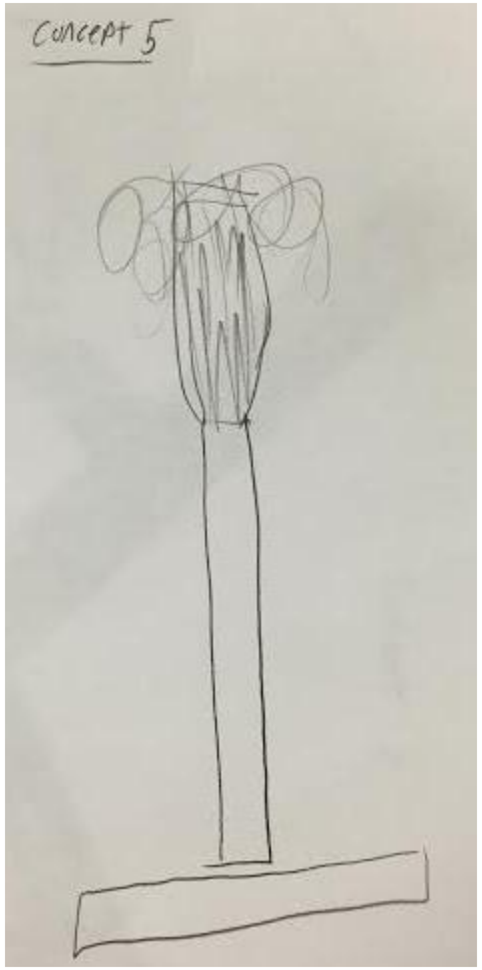
Concept Generation: Frame



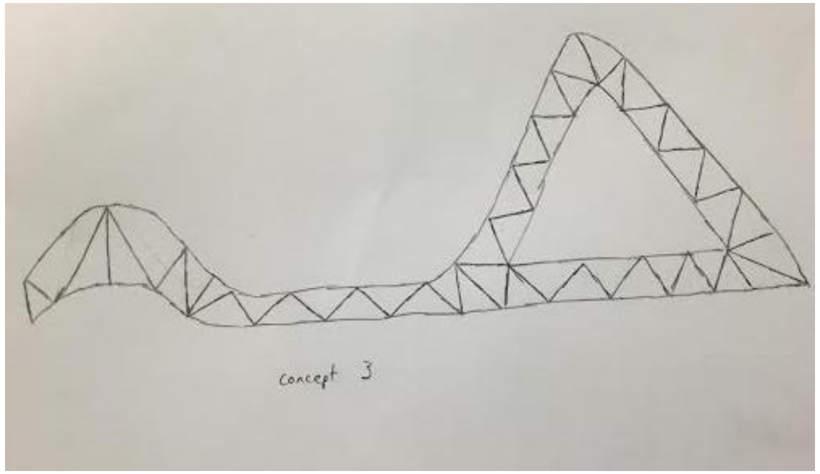
Concept 4



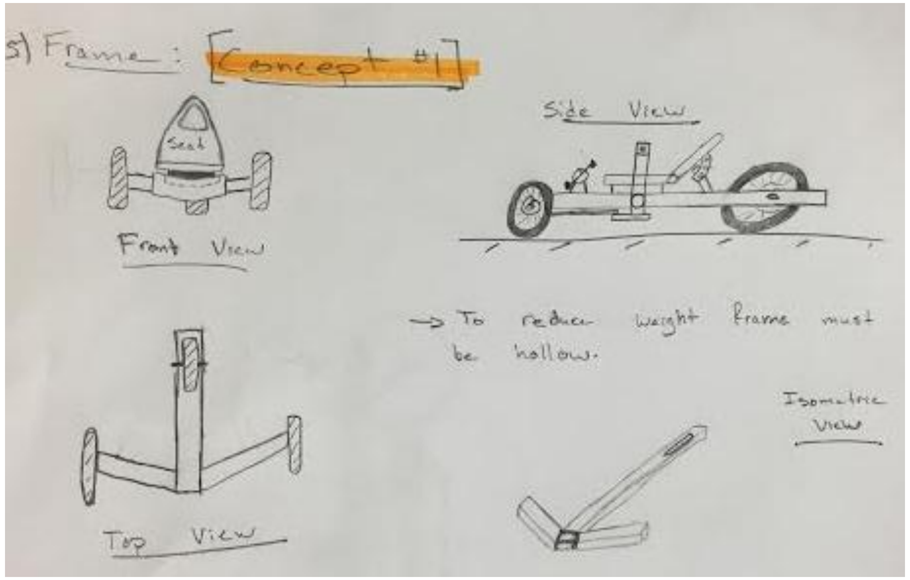
Concept 2



Concept 5



Concept 3

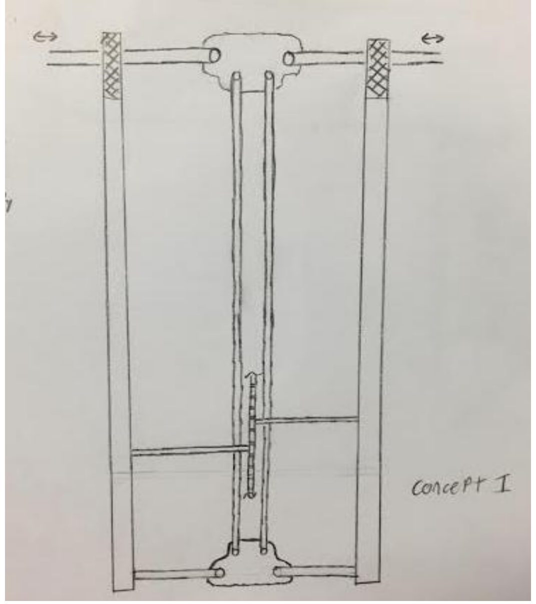


Concept 1

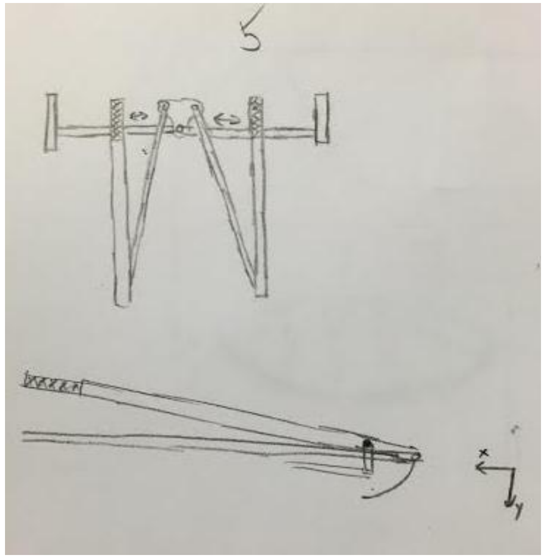
Decision Matrix: Frame

Frame	Strength	Weight	Ease of Manufacturing	Aesthetics	Cost	Durability	**Overall**
Concept 1	2	5	4	3	3	2	3.589
Concept 2	4	4	3	5	5	4	4.827
Concept 3	5	1	1	1	1	3	1.812
Concept 4	3	4	2	5	5	4	4.569
Concept 5	1	2	5	1	3	2	2.802

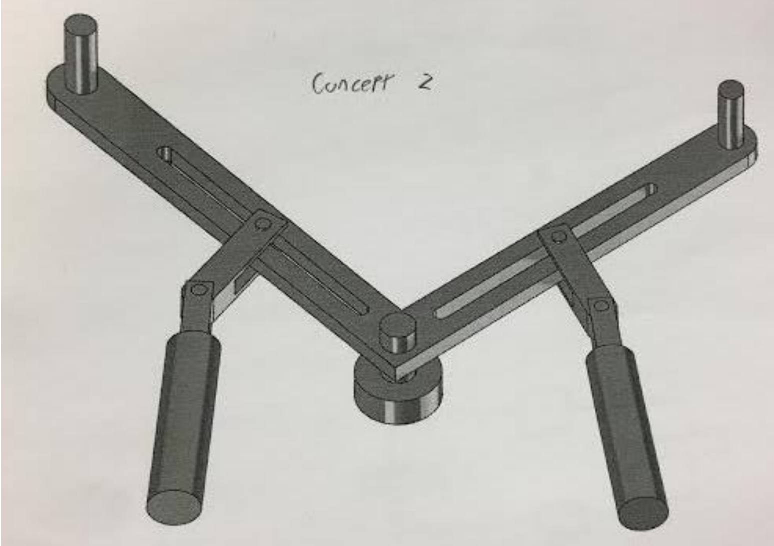
Concept Generation: Steering



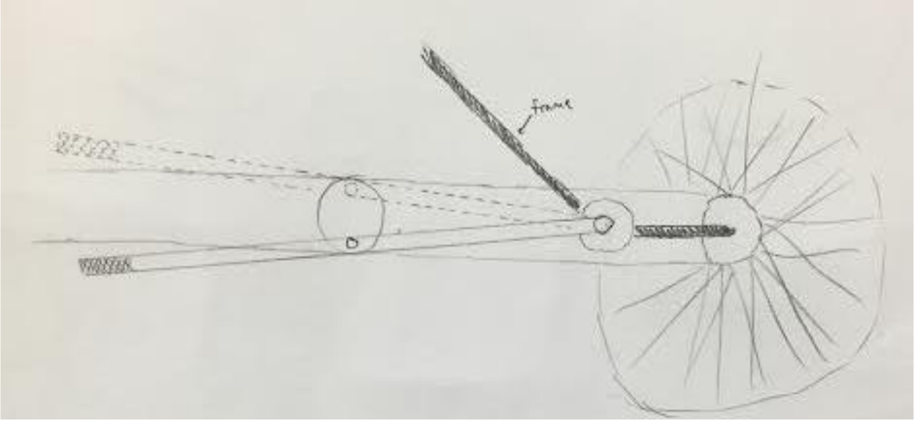
Concept 1

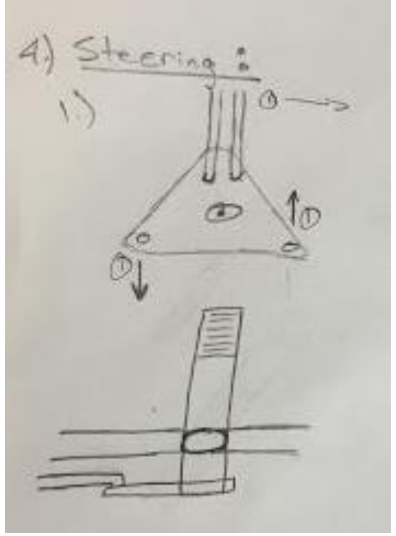


Concept 5

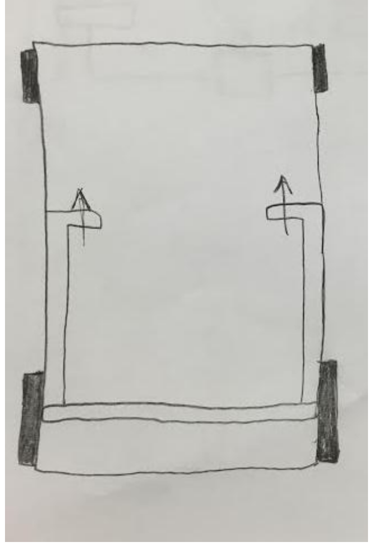


Concept 2





Concept 4



Concept 3

Decision Matrix: Steering

Steering	Ease of use	Cost	Ease of manufacturing	Power input	**Overall**
Concept 1	3	1	1	5	2.905
Concept 2	5	3	3	1	3.797
Concept 3	5	4	4	1	4.031
Concept 4	5	4	4	1	4.031
Concept 5	5	4	5	1	4.216

Concept Generation: Material

www.mountainbike-review.com

www.mountainbike-review.com

www.hobbyking.com

www.mountainbike-review.com

www.endless-sphere.com

Decision Matrix: Material

Material	Strength	Weight	Ease of Manufacturing	Aesthetics	Cost	Durability	**Overall**
Steel	5	1	4	1	3	5	3.261
Aluminum	3	3	3	4	3	4	3.372
Carbon fiber	4	5	2	5	1	4	2.859
Fiberglass	2	4	2	2	3	2	3.121
Wood	1	2	5	3	3	1	2.853

Updated Project Plan

	Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13
Product Specification and Project Plan	Meet with client													
	Problem definition													
	SOTA research													
	Establish objectives/constraints/requirements													
Concept Generation and Selection	Criteria selection													
	Analytical hierarchy matrix													
	Concept generation													
	Decision matrices													
	Concept selection													
Engineering Analysis	Concept simulation													
	Initial analysis/simulated testing													
	Design/model refinement													
	Design review													
Project Proposal	Model synthesis													
	Design review													
	Presentation/report finalization													

Conclusions

- Strength, weight, efficiency, and ease of manufacturing are among the most important design criteria
- The teardrop fairing design of the Pulaski will be retained
- Foot-pedal power alone will be used to propel the vehicle
- The seat will be one piece and adjustable
- A laterally braced backbone frame will be employed
- Steering will be accomplished with two levers, one on each side of the seat
- The frame material will be aluminum
- The project remains on schedule

References

- American Society of Mechanical Engineers . n.d. <https://www.asme.org/about-asme>.
- Dieter, George. Engineering Design: A Materials and Processing Approach. New York: McGraw-Hill, 1983.