Human Powered Vehicle (HPV)

13 November 2018

ASME
SETTING THE STANDARD

FAMU-FSU
COLLEGE OF
ENGINEERING

TEAM MEMBERS

Tyler Schilf	Tristan Enriquez	Jacob Thomas	Kyler Marchetta
			
Project Manager	Steering Engineer	Powertrain Engineer	Ergonomics Engineer
			

Project Review

ASME HPVC

FAMU-FSU COLLEGE OF ENGINEERING

Competition Objectives

Design

- Methodology
- Testing and Analysis
- Safety
- Aesthetics

Speed

- Timed race
- Top speed
- Men and Women

Endurance

- Agility, Utility and Durability
- Obstacles
- Inclines and Declines
- Tight turning

Mission Objective:

Produce a vehicle for the Human Powered Vehicle Competition (HPVC) that a rider will mechanically power and control through their input force.

Project Budget: **$2,000**

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- Testing and Analysis
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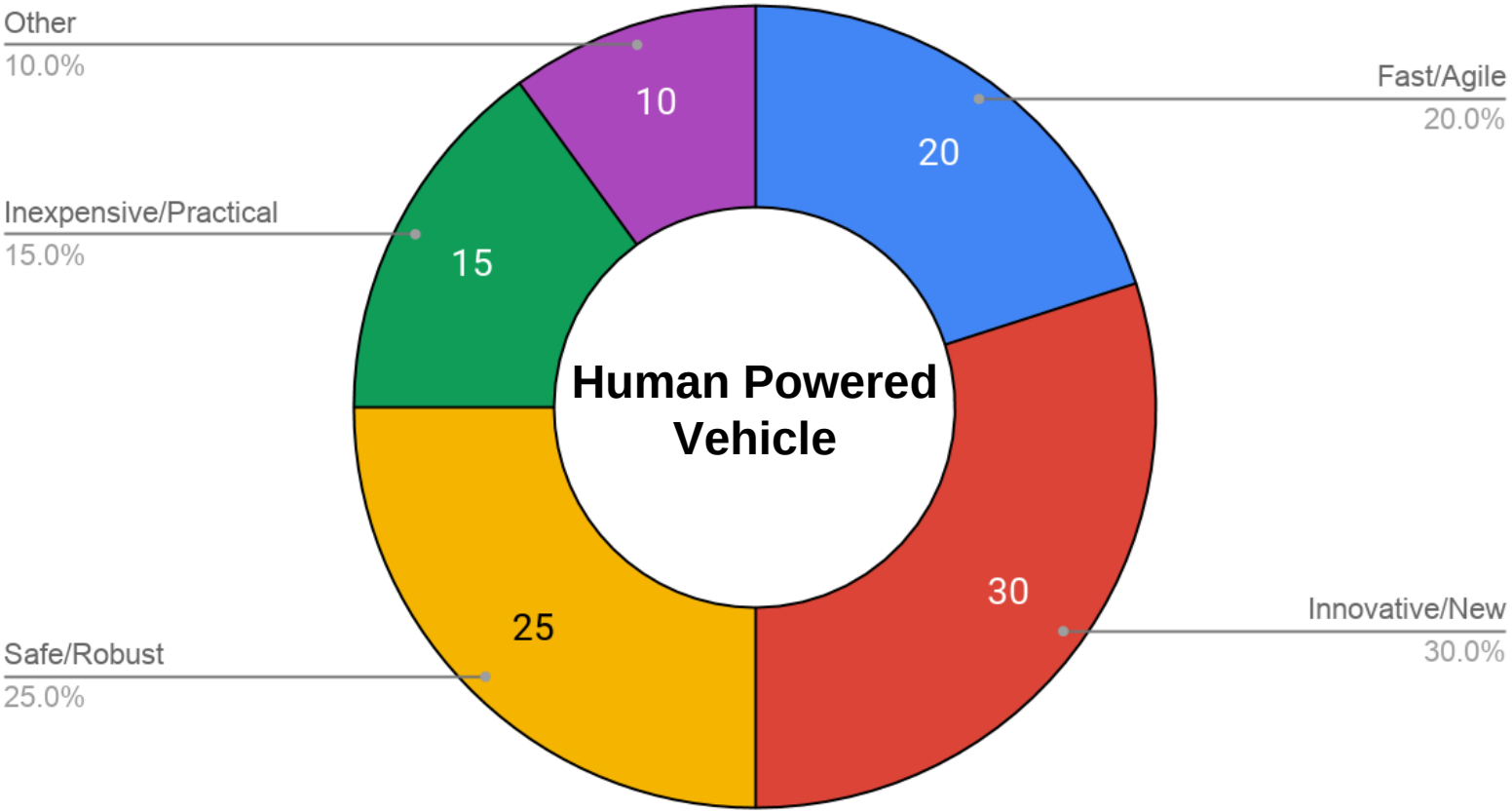
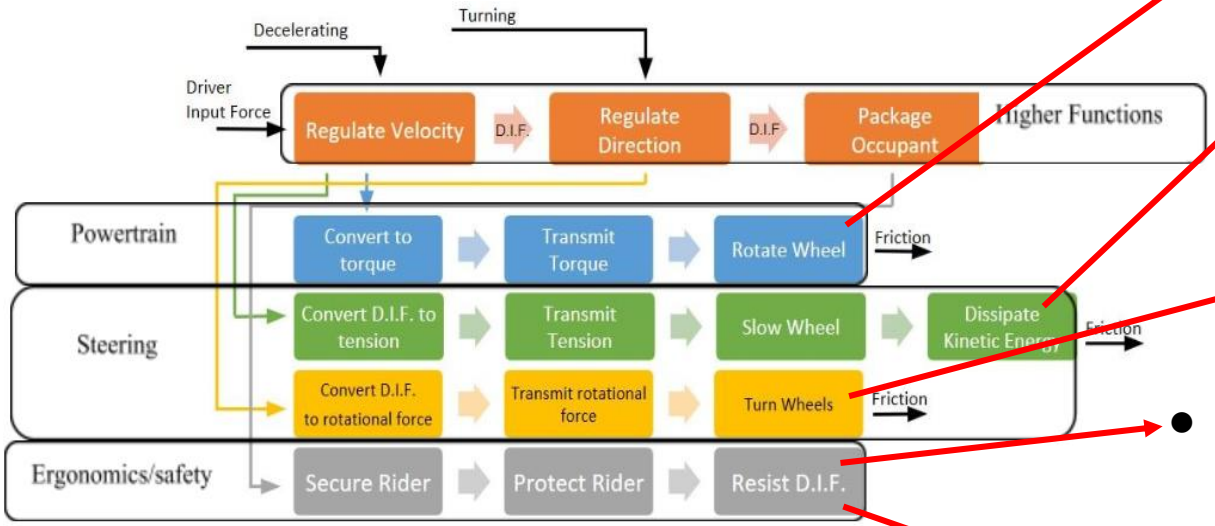
Customer Needs



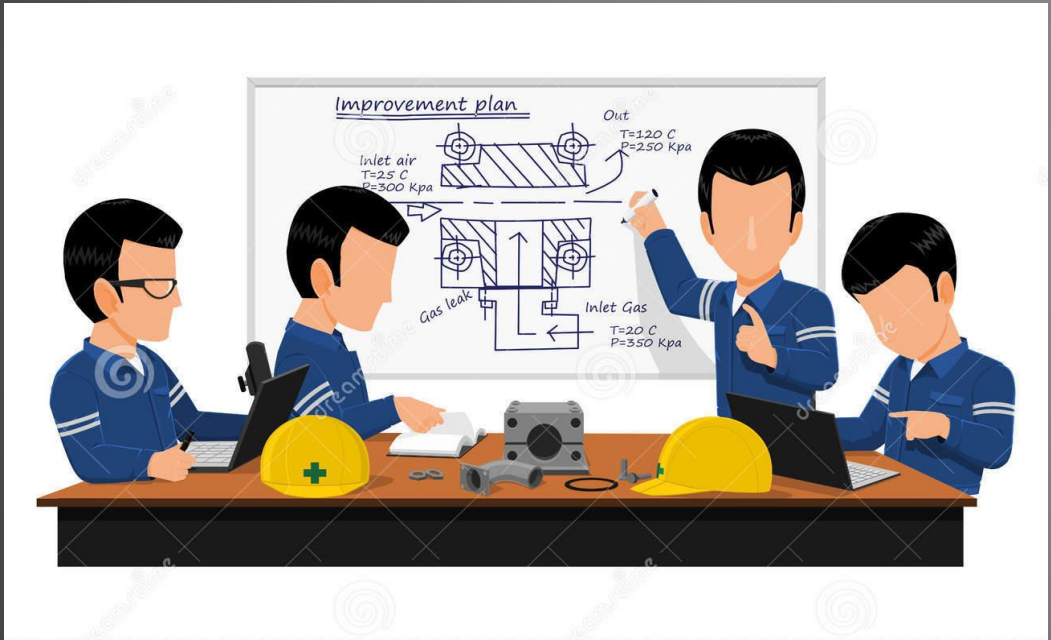
Functional Breakdown



Targets/Metrics

- Top speed of 40 km/h
- Brake in 4 m at a speed of 25 km/h
- Turning radius of 6.0 m
- Supports 2670 N applied to top roll protection system (rps) in the event of a rollover
- Supports 1330 N applied to roll bar at shoulder height

Concept Generation



Concept Generation

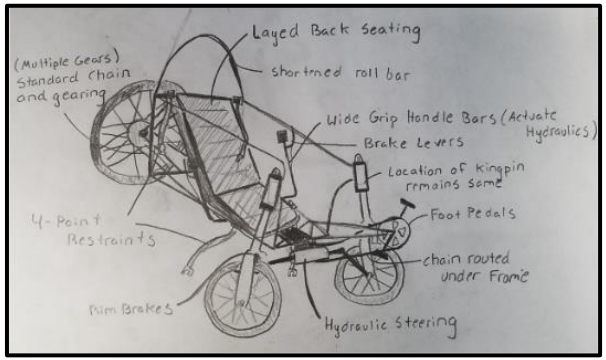


Figure 1: Concept 42

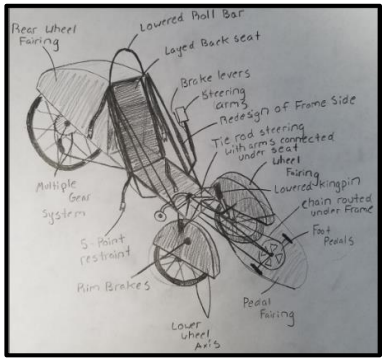


Figure 2: Concept #85

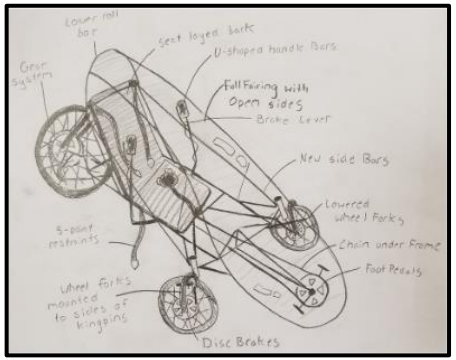


Figure 3: Concept #92

Concept #42

-Push/Pull lever actuate rim brakes
-Hydraulic Steering
-No fairing

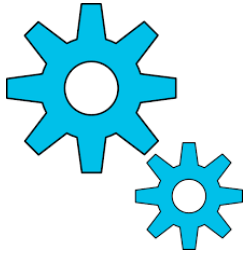
Concept #85

-Hand lever steering
-Brake lever on handle actuate rim brakes
-Nose, front, and rear wheel fairings

Concept #92

-Hand lever steering
-Brake lever on handle actuates disc brake
-Full fairing with open sides

Concept Generation



The next three most plausible concepts for comparison..

Concept #24
- Disc brakes
- Partial Fairing
- Tie rod steering
- 3 point safety harness

Concept #58
- Direct tie rod steering
- Belt and CVT
- Car strap restraint
- Leaf spring suspension
- Disc Brakes

Concept #87
- Rack and pinion steering
- Steering column with wheel
- Partial fairing
- Hand lever brake actuation

Concept Selection

House of Quality Chart (HOQ)

HOUSE OF QUALITY																			
		Engineering Characteristics																	
Units		MPa	m/s	m	m	kg	m^2	W	W	Cd	m	m	N	N	N	s	deg	USD	N/A	m^3
Customer Requirements	Importance Weight Factor	Strength	Speed	Braking Distance	Turning Radius	Weight	Foot Print Area	Cruisng Power on 0% Grade	Cruising Power > 0% Grade	Drag Coefficient	Height	Length	Brake Force	Pedal Force	Steering Force	Enter/Exit Time	Rider Position	Cost	Complexity	Rider Cabin Space
Protects Rider/Robust	9	9	0	9	9	1	0	0	0	0	3	0	1	0	1	1	3	1	3	1
Turns Quickly	7	0	1	1	9	9	3	0	0	1	3	3	1	0	9	0	1	0	1	0
Is lightweight	5	3	9	9	3	9	1	3	9	0	1	1	0	3	3	0	0	9	3	0
Visually Appealing	1	1	0	0	0	0	0	0	0	3	3	3	0	0	0	1	9	3	9	3
Comfortability	5	1	0	0	0	0	1	1	1	3	3	3	3	3	3	3	5	3	3	9
Affordability	2	9	3	3	0	3	0	0	0	9	0	0	0	1	0	0	0	9	9	0
High Top Speed	5	0	9	0	0	9	0	3	3	9	1	1	0	3	1	0	1	9	3	0
Low Drag	1	0	9	0	1	0	9	9	3	9	3	3	0	1	0	3	1	9	9	3
Brakes Quickly	8	0	1	9	1	9	1	0	0	3	1	1	9	0	0	0	0	9	9	0
Easily Maintained	2	0	0	0	0	3	0	0	0	3	0	0	0	0	0	0	0	9	9	1
Raw Score (1153)		120	120	211	168	246	48	44	68	127	87	60	103	48	107	28	74	234	205	62
Relative Weight %		5.556	5.556	9.769	7.778	11.389	2.222	2.037	3.148	5.880	4.028	2.778	4.769	2.222	4.954	1.296	3.426	10.833	9.491	2.870
Rank Order		7	7	3	5	1	16	18	13	6	11	15	10	16	9	19	12	2	4	14

Table 1: House of Quality

House of Quality Chart (HOQ)

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Table 1: House of Quality

Figure 4: GT20 Recumbent Trike

Initial Pugh Chart

Six concepts compared to the GT20

"A carefully engineered, lightweight frame, low rolling resistance tires, and an efficient drivetrain..."

	Datum Comparison	Design Concepts Numbers					
Engineering Characteristics	Green Speed GT20	42	85	92	87	58	24
Weight	Datum	-	-	-	-	-	-
Cost	Datum	-	+	+	-	-	+
Braking Distance	Datum	-	-	S	-	S	S
Complexity	Datum	-	+	S	-	-	S
Turning Radius	Datum	+	S	S	+	S	S
Total (+)		1	2	1	1	0	1
Total (-)		4	2	1	4	3	1

Table 2: Initial Pugh Chart

Figure 4: GT20 Recumbent Trike

Initial Pugh Chart

Six concepts compared to the GT20

	Datum Comparison	Design Concepts Numbers					
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Braking Distance	Datum	-	-	S	-	S	S
Complexity	Datum	-	+	S	-	-	S
Turning Radius	Datum	+	S	S	+	S	S
Total (+)		1	2	1	1	0	1
Total (-)		4	2	1	4	3	1

Table 2: Initial Pugh Chart

Figure 4: GT20 Recumbent Trike

Initial Pugh Chart

Six concepts compared to the GT20

New Datum

	Datum Comparison	Design Concepts Numbers					
Engineering Characteristics	Green Speed GT20	42	85	92	87	58	24
Weight	Datum	-	-	-	-	-	-
Cost	Datum	-	+	+	-	-	+
Braking Distance	Datum	-	-	S	-	S	S
Complexity	Datum	-	+	S	-	-	S
Turning Radius	Datum	+	S	S	+	S	S
Total (+)		1	2	1	1	0	1
Total (-)		4	2	1	4	3	1

Table 2: Initial Pugh Chart

Final Pugh Chart

	Datum Comparison	Design Concepts Numbers	
Engineering Characteristics	24	85	92
Weight	Datum	-	-
Cost	Datum	S	-
Braking Distance	Datum	-	S
Complexity	Datum	-	-
Turning Radius	Datum	S	S
Total (+)		0	0
Total (-)		3	3

Table 3: Final Pugh Chart

Final Pugh Chart

Cost is Heavily Weighted (number 2 from HOQ)

	Datum Comparison	Design Concepts Numbers	
Engineering Characteristics	24	85	92
Weight	Datum	-	-
Cost	Datum	S	-
Braking Distance	Datum	-	S
Complexity	Datum	-	-
Turning Radius	Datum	S	S
Total (+)		0	0
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Complexity	Datum	-	-
Turning Radius	Datum	S	S
Total (+)		0	0
Total (-)		3	3

Table 3: Final Pugh Chart

Analytical Hierarchy Process (Concepts 24 and 85)

Table 4: Weight Matrix

	Weight	Cost	Braking Distance	Complexity	Turning Radius	Criteria Weights
Weight	0.045	0.021	0.059	0.161	0.032	0.064
Cost	0.225	0.107	0.176	0.226	0.045	0.156
Braking Distance	0.405	0.321	0.529	0.290	0.674	0.444
Complexity	0.009	0.015	0.059	0.032	0.025	0.028
Turning Radius	0.315	0.535	0.176	0.290	0.225	0.308
Totals	1.000	1.000	1.000	1.000	1.000	1.000

Table 5: Alternative Design Weight Matrix

Final Rating Matrix		
	Disc Brakes	Rim Brakes
Weight	0.83	0.17
Cost	0.1	0.9
Turning	0.75	0.25
Braking	0.88	0.13
Complexity	0.17	0.83

Table 6: AHP Decision Results

Results	
Concept	Alternative Value
Concept 24	0.48
Concept 85	0.52

Analytical Hierarchy Process (Concepts 24 and 85)

Table 4: Weight Matrix

	Weight	Cost	Braking Distance	Complexity	Turning Radius	Criteria Weights
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B =

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Weight	0.83	0.17
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Complexity	0.17	0.83

A = ^{T}

Table 6: AHP Decision Results

Results	
Concept	Alternative Value
Concept 24	0.48
Concept 85	0.52

$A^T B =$

Final Decision (Concept 85)

Features:

- 5-Point Restraint
- 10 speed transmission
- Wide Grip Handlebar Steering
- Laid Back Rider Position
- Minimal Fairings
- Adjustable Pedal Mount
- Front Wheel Rim Brakes

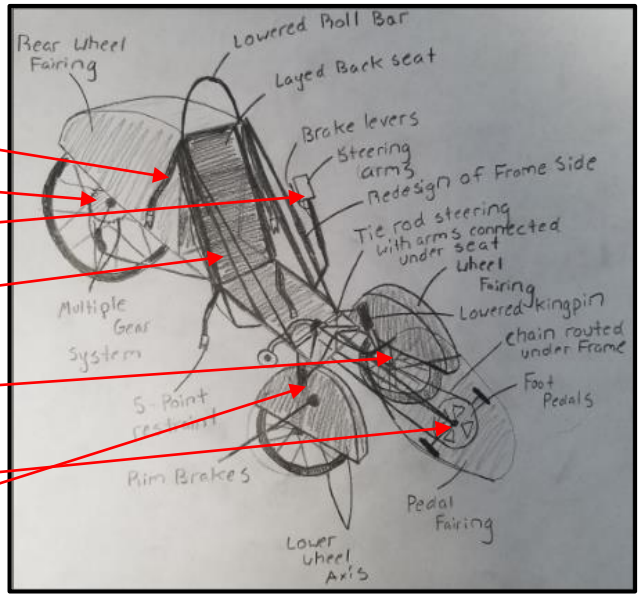
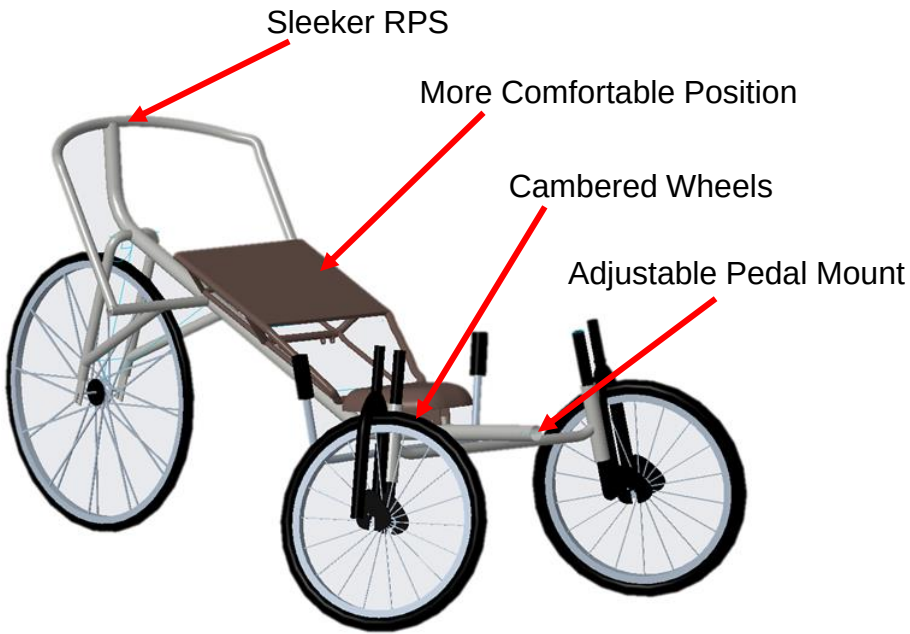


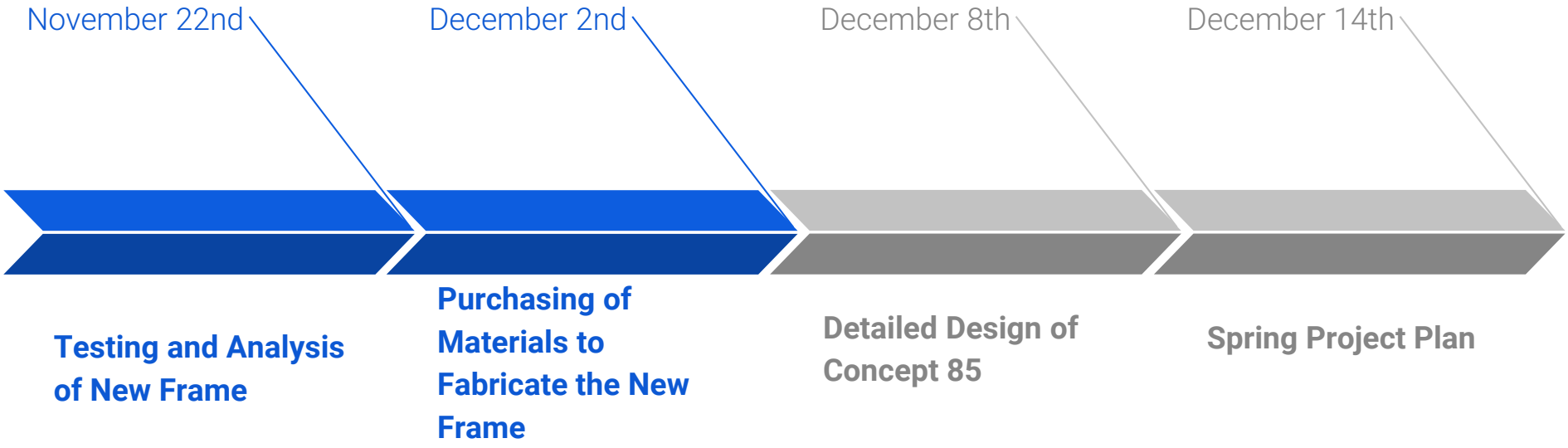
Figure 5: Rough Conceptual Sketch

Old Frame

New Frame



Looking Ahead...



References

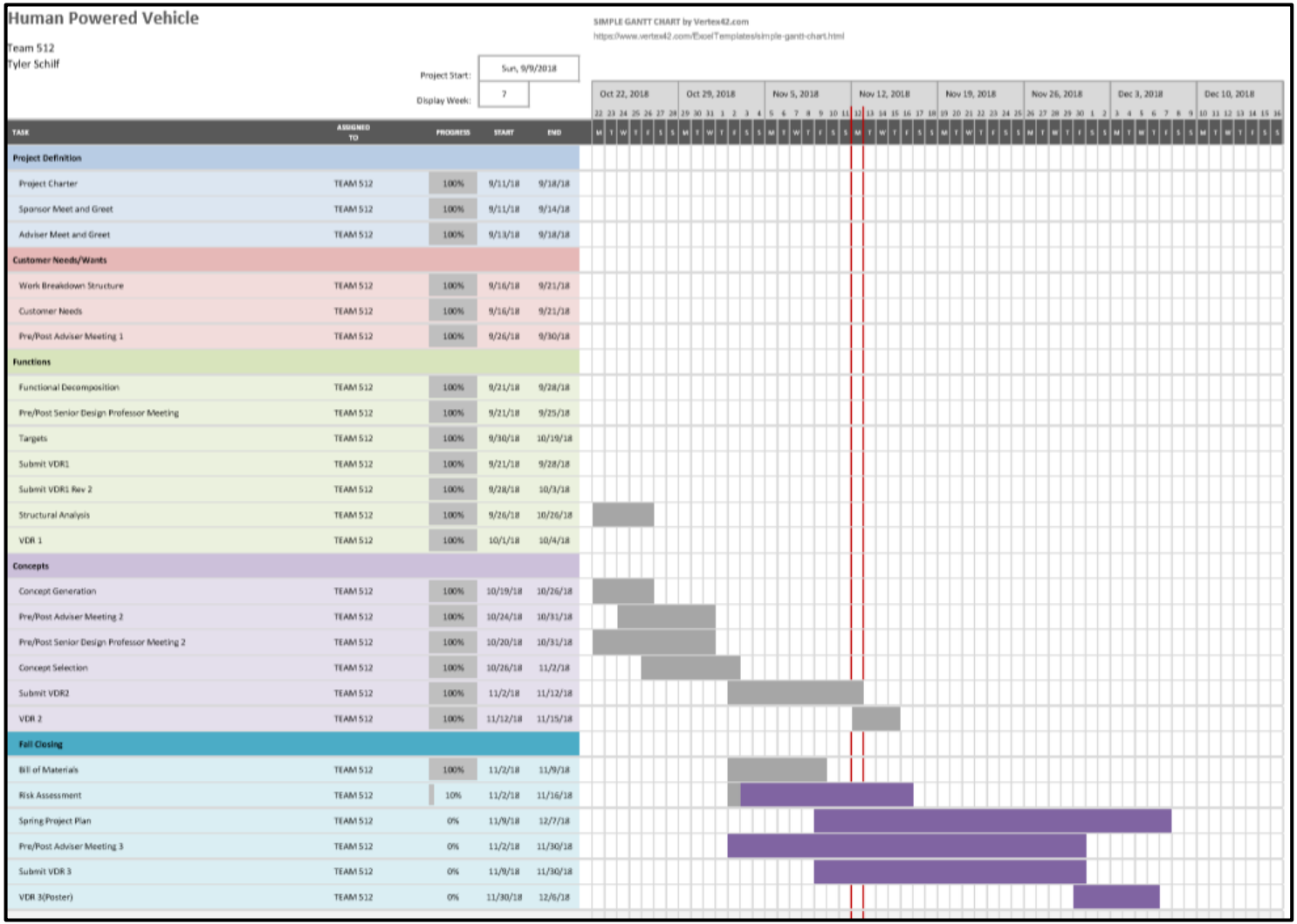
1. ASME (2018). *Rules for the 2018 Human Powered Vehicle Challenge.* Retrieved from: https://www.asme.org/events/competitions/human-powered-vehicle-challenge-(hpvc)
2. Backcountry Recumbent Bicycles. (2018) Retrieved from: http://www.backcountryrecumbentcycles.com/shop/greenspeed-gt20/
3. Bauer, B., Bohne, E., Lanier, P., MacDonnell, G., & Rodriguez, M. (2017). *Virtual Design Review 4 Team 20*. Retrieved from: https://ww2.eng.famu.fsu.edu/me/senior_design/2018/team20/4thVDR.pdf

Questions?

Tyler Schilf	Tristan Enriquez	Jacob Thomas	Kyler Marchetta
			
Project Manager	Steering Engineer	Powertrain Engineer	Ergonomics Engineer
			


ROSE-HULMAN

Project Timeline



Human Powered Vehicle

Team 512
Tyler Schilf

SIMPLE GANTT CHART by Vertex42.com
https://www.vertex42.com/ExcelTemplates/simple-gantt-chart.html

Project Start: Sun, 9/9/2018
Display Week: 7

TASK	ASSIGNED TO	PROGRESS	START	END
Project Definition				
Project Charter	TEAM 512	100%	9/11/18	9/18/18
Sponsor Meet and Greet	TEAM 512	100%	9/11/18	9/14/18
Adviser Meet and Greet	TEAM 512	100%	9/13/18	9/18/18
Customer Needs/Wants				
Work Breakdown Structure	TEAM 512	100%	9/16/18	9/21/18
Customer Needs	TEAM 512	100%	9/16/18	9/21/18
Pre/Post Adviser Meeting 1	TEAM 512	100%	9/26/18	9/30/18
Functions				
Functional Decomposition	TEAM 512	100%	9/21/18	9/28/18
Pre/Post Senior Design Professor Meeting	TEAM 512	100%	9/21/18	9/25/18
Targets	TEAM 512	100%	9/30/18	10/19/18
Submit VDR1	TEAM 512	100%	9/21/18	9/28/18
Submit VDR1 Rev 2	TEAM 512	100%	9/28/18	10/3/18
Structural Analysis	TEAM 512	100%	9/26/18	10/26/18
VDR 1	TEAM 512	100%	10/1/18	10/4/18
Concepts				
Concept Generation	TEAM 512	100%	10/19/18	10/26/18
Pre/Post Adviser Meeting 2	TEAM 512	100%	10/24/18	10/31/18
Pre/Post Senior Design Professor Meeting 2	TEAM 512	100%	10/20/18	10/31/18
Concept Selection	TEAM 512	100%	10/26/18	11/2/18
Submit VDR2	TEAM 512	100%	11/2/18	11/12/18
VDR 2	TEAM 512	100%	11/12/18	11/15/18
Fall Closing				
Bill of Materials	TEAM 512	100%	11/2/18	11/9/18
Risk Assessment	TEAM 512	10%	11/2/18	11/16/18
Spring Project Plan	TEAM 512	0%	11/9/18	12/7/18
Pre/Post Adviser Meeting 3	TEAM 512	0%	11/2/18	11/30/18
Submit VDR 3	TEAM 512	0%	11/9/18	11/30/18
VDR 3(Poster)	TEAM 512	0%	11/30/18	12/6/18