

HPVC Final Presentation

TEAM #21SPR06 – ASME HPVC

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11/19/21

Project Description



Figure 1 - Client - Perry Wood
(Machine Shop Faculty Manager)

1. Child Sized Recumbent Tricycle
 - Adjustability
 - Safety
2. Final Steps
 - Finish the drive train
 - Brake Testing
 - Painting
 - Electronics

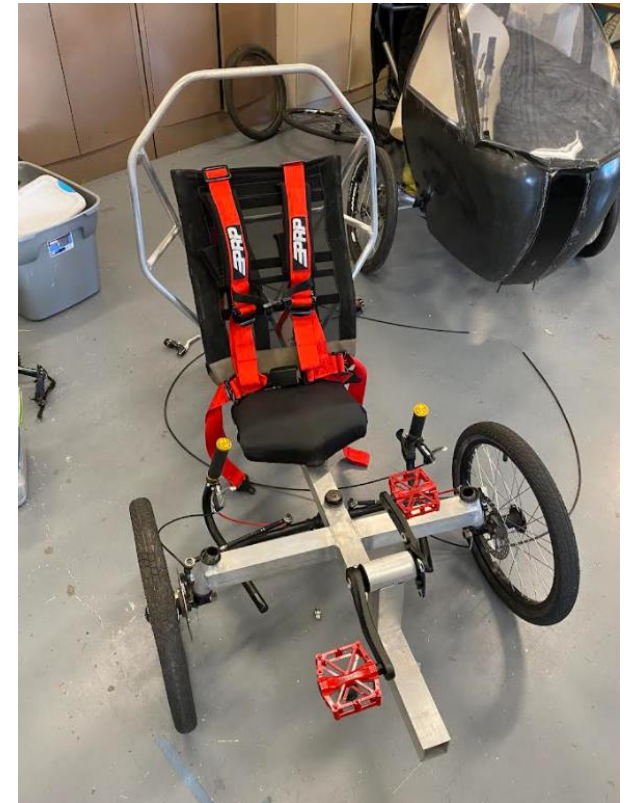


Figure 2 - Current HPV

Table 1: Customer Requirements

RANK	CUSTOMER REQUIREMENTS (CR'S)	DESCRIPTIONS
1	Safety	Includes roll cage integration and secure seating.
2	Stability	HPV will not tip over through a sharp turn. Will also ride upright at slow speeds.
3	Operation age (5-13 years of age)	HPV can be driven by Kindergarteners through 8 th graders.
4	Educational	Includes components that students can visually learn from.
5	Ease of operation	Low difficulty to operate. Includes foot pedals/brakes and hand steering.
6	Transportable	Lightweight to transport over long commutes. Can fit in a truck bed to transport places where it cannot drive.
7	Rollover protection	3- or 4-point roll-cage to ensure safety in the case of an operator accident that tips the HPV.
8	Manufacturability	Materials used are compatible and feasible to manufacture within a college students' budget.

Requirements & Specifications

Requirements & Specifications

Table 2: Engineering Requirements

BRAKING DISTANCE (WITHIN 8 METERS)	COST UNDER \$1,600
MINIMUM OF 3 WHEELS	GEAR RATIO (4:1 typically seen in bicycles)
SEAT-TO-PEDAL DISTANCE (50 CM ADJUSTABILITY RANGE)	TURN RADIUS (within 8 meters)
VOLUME (TO FIT IN A 6.5' X 5.5' TRUCK BED)	TENSILE STRENGTH (250-560MPa)
Weight (no more than 45 kg)	

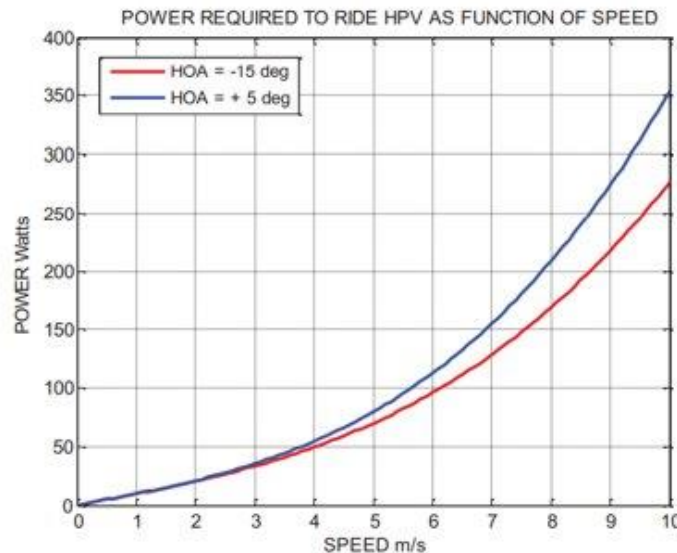
Decision Making (Research)

Aluminum 6061 alloy

- Zinc is major alloying element
- Requires heat treatment after welding
- Fracture toughness
- Corrosion resistance
- Less susceptible to stress-corrosion-cracking (SCC)
- 1/3 the density of steel (0.098 lb/in³)
- Lightweight

Ergonomics

- Tadpole Trike Design
- HOA: -15 degrees



Roll Cage Design

- 4pt, 5pt, or 6pt cage
- Structure Outline
- [Main Hoop, Support Hoop, links, supports etc.]
- Structural Design [No broken or fractured structure links]

Decision Making

Table 3: Pugh ratings

Concept	1	2	3	4	5
Layout	Tadpole	Delta	4-Wheel		
(Pugh rating)	7.3	6.2	5.9		
Steering	Direct	In-direct	Tilt*	FW	RW
	5.3	6.7	3.95	7.75	5.25
Drive	Chain	Shaft	Direct	FW	RW
	7.7	4.85	5.7	5.5	7.65
Frame material	Aluminum 7075 alloy	Carbon fiber	4130 Chromoly	Aluminum 6061 alloy	
	6.45	6.6	6.7	7.1	
Ergonomics	HOA -15 degrees	HOA 5 degrees	BCA 135 degrees	BCA 110 degrees	
	7.54	5.6	6.6	5.6	
Braking	Rim Caliper	Rim Cantilever	Drum	Disk	
	7.4	7.3	6.5	7.3	
Rollcage	2-point	4 point	3 point	Full-body	
	4.4	4.9	4.4	4.5	

Design Decisions Influenced by Manufacturing

- Roll Cage
- Front Arms/Head Tubes
- Crank Set Mounting
- Steering
- Break and Seat Tabs
- Fasteners
- Notching



Figure 3 – 4-point roll cage

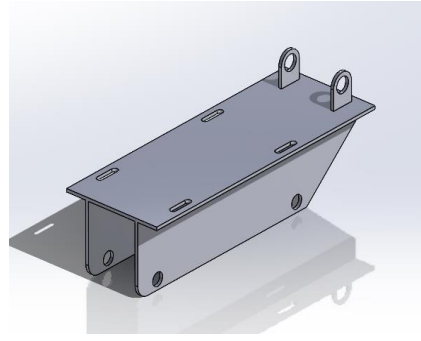


Figure 4 – Seat bracket

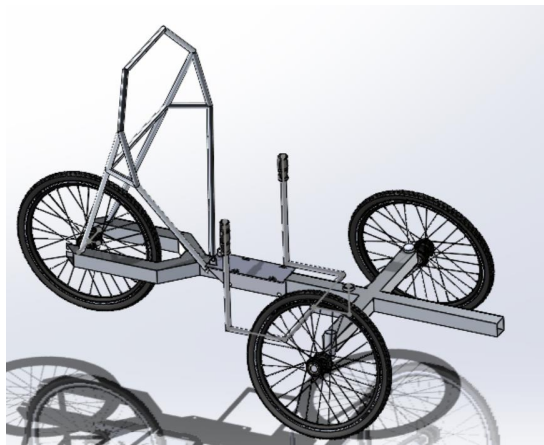


Figure 5 – Final CAD Frame



Figure 6 – Rolling Design

Design Solution

4-point roll cage

6061 aluminum alloy

Tadpole tricycle (Rear wheel drive)

Ackerman steering

Adjustable seat

Three-wheel disc braking

Utilized recycled parts

CAD Progression

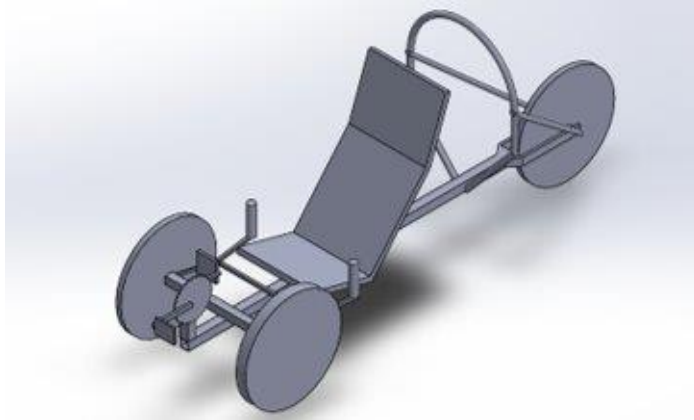


Figure 7 – Initial CAD Model

- Rough conceptual layout



Figure 8 – Midpoint CAD model

- Added Camber angle
- Improved on CAD practices

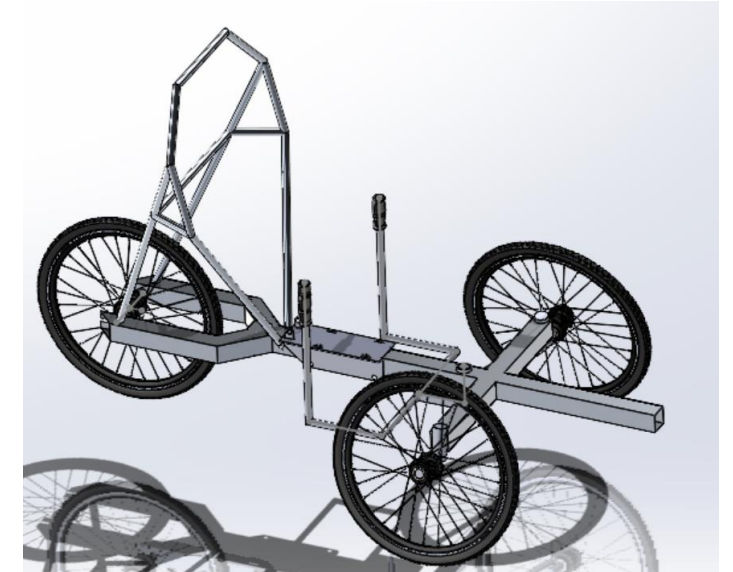


Figure 9– Final CAD Model

- Drastically shorten frame
- Update Steering to match
- Adjusted cage to meet bender constraints

Manufacturing



Figure 10 – Rear Fork Assembly



Figure 11 – Trent Welding



Figure 12 – Steering



Figure 13 – Seat

- TIG Welder
- Lathe
- Horizontal/Vertical band saw
- Vertical mill
- Jig saw
- Pneumatic pipe bender
- Hydraulic press
- Oxyacetylene torch
- Misc. hand tools

Table 4: Testing Status of Engineering Requirements

Engineering Requirement	Status
Braking distance (<8m)	Pending test
Cost under \$1,600	Met (~\$600)
Minimum of 3 wheels	Met (Trike)
Highest gear ratio (4:1)	Met (4:1)
Seat-to-pedal distance (50 cm adjustability)	Met (50cm)
Turn radius (<8m)	Met (1.7m center)
Tensile strength (250-560mpa)	Met (290MPa)
Volume (Must fit in a 6.5' x 5.5' bed)	Met (6' x 3')
Weight (<45 kg)	Met (~11.5 kg)



Figure 14 – Turn radius test

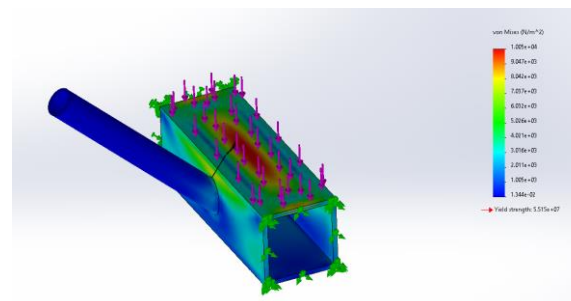


Figure 16 – Material strength

Testing



Figure 15 – Volume

Budget

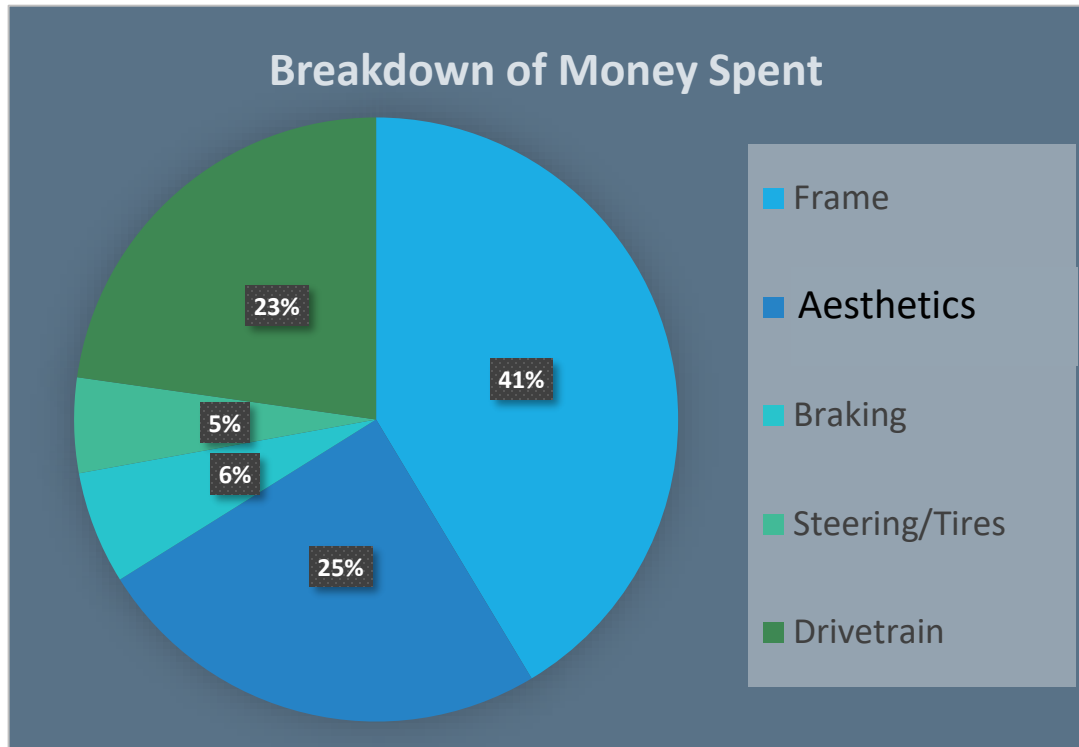


Figure 17 – Budget distribution

Total Budget: \$1,600

Team Spent: \$579.93

Remaining: \$1,020.07 (~65%)

- All major system parts have been purchased
- Further purchases for adjustment and tweaking parts may be needed, but not planned

Updated BOM

Table 5: Bill of materials and items purchased

Purchased	PO#	Vendor	Item	Quantity/Size	Total Costs	Totals
						\$1,600.00
9/3/21		1 Mayorgas	2"x 2" Hollow Square	10ft	\$73.72	\$1,526.28
9/3/21		1 Mayorgas	1.75" Round Tube	20ft	\$42.58	\$1,483.70
9/29/21		2 OnlineMetals	1.5" Hollow Tube	2ft	\$44.10	\$1,439.60
9/29/21		2 Amazon	Hall Effect Sensor	1x6pc	\$12.91	\$1,426.69
10/15/21		3 Amazon	Wire Brush Stainless Steel Wire Scratch Brush for Cleaning Rust	1x1pc	\$13.05	\$1,413.64
10/15/21		3 Amazon	OVIMAG Super Strong Neodymium Disc Magnets	1x5pc	\$9.23	\$1,404.41
10/15/21		3 Amazon	24PCS Sand Paper Variety Pack Sandpaper	1x24pc	\$5.43	\$1,398.98
10/15/21		3 Amazon	Rust-Oleum 7582838A2 Professional Primer Spray	1x2pcs	\$15.18	\$1,383.80
10/15/21		3 Amazon	Rust-Oleum 249127 Painter's Touch 2X Ultra Cover	1x1pc	\$7.90	\$1,375.90
10/15/21		3 Amazon	K01706 Krylon Spray Paint, Gold	1x1pc	\$15.62	\$1,360.28
10/15/21		3 Amazon	Rust-Oleum 271920 Gloss Cherry Red	1x4pcs	\$6.82	\$1,353.46
10/15/21		3 Amazon	Amazon Basics 9 Volt Everyday Alkaline Battery	1x1pc	\$7.58	\$1,345.88
10/15/21		3 Amazon	Mybecca Upholstery Foam Cushion Sheet High Density	1x1pc	\$32.61	\$1,313.27
10/15/21		3 Amazon	emma kites Black Ripstop Nylon Fabric	1x1pc	\$9.73	\$1,303.54
10/15/21		3 Amazon	Gorilla Super Glue with Brush & Nozzle	1x1pc	\$6.49	\$1,297.05
10/15/21		3 Amazon	Battery Powered LED Strip Lights, 24-Keys Remote Controlled	1x1pc	\$18.37	\$1,278.68
10/25/21		4 HomeCo	CDX Plywood.75"x2'x4'	1x1pc	\$19.40	\$1,259.28
10/25/21		4 Amazon	0.75" Lerox Tool	1x1pc	\$10.37	\$1,248.91
11/3/21		5 Amazon	4 Pack 20 Inch Bike Tubes with 2 Tire Levers	1x4pcs	\$16.19	\$1,232.72
11/3/21		5 Amazon	hooee Universal Bicycle Brake Cable Housing Kit for Mountain Bi	1x1pc	\$10.86	\$1,221.86
11/3/21		5 Amazon	TOPCABIN Bicycle Grips,Double Lock on Locking Bicycle Handleb	1x2pcs	\$11.80	\$1,210.06
11/3/21		5 Amazon	Sunlite Alloy Double MTN Lever	1x1pc	\$22.35	\$1,187.71
11/3/21		5 Amazon	AHEYHOM Bike Pedals 9/16 MTB Mountain Bike Peda	1x2pcs	\$13.04	\$1,174.67
11/3/21		5 Amazon	GANOPPER 170mm Crankset 32T	1x1pc	\$59.80	\$1,114.87
11/12/21		6 Amazon	Vbest life BB386 24mm Mountain Road Bike Press Fit Bearing	2x1pc	\$52.40	\$1,062.47
11/12/21		6 Amazon	ELEGOO UNO Project Super Starter Kit with Tutorial	1x1pc	\$42.40	\$1,020.07
					579.93	\$1,020.07

Items Reused:

- Wheels
- Gear Shifter
- Derailer
- Headsets
- Spindle/ Steering components
- LCD screen
- 2" OD Tubing
- 0.125" Plate metal
- Seat backrest
- Majority of braking system

Future Work

Table 6: Future action items

Task	Equipment – Member(s) in Charge
Implement drivetrain	Common shop hand tools – Preston + Trent
Weld brake tabs	Horizontal Band Saw, TIG Welder – Abel + Trent
Complete remaining testing procedures	Markers – All, Volunteers
Paint trike	Spray paint, tape – All
Implement electronics	Light strip, Arduino, speedometer – Martin
All final deliverables (report, website, CAD/BOM, manual, poster)	SolidWorks, MS Teams, WinSCP – All
Client handoff	Perry Wood – All



Where it started...



Where it's at

Questions?