HPV Child Size Exhibition

TEAM #21SPR06 – ASME HPV

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Project Review

Figure 1 - NAU 2014 HPV [1]

Updated Project
-Safety
-Inspire and Intrigue
Benchmarking
Review

Figure 2 - Queensland Recumbent Gekko FXS [2]

Benchmarking

Figure 3 – Lightning F-40 [3]

Figure 4 – Technic by TryTrike [4]

Figure 5 – 2014 NAU HPV [1]

Benchmarking

Lightning F-40 [3]

- 4130 Chromoly steel tubing
- 33 lbs
- Fairing ✓
- Hydraulic disc brakes
- Fastest production bicycle
- Safe night riding with transparent headlight window

Technic [4]

- Weather protection
- 99 lbs
- Fairing ✓
- Mechanic drum brakes
- Strong driver cage
- Rearview mirrors
- Cargo space available

2014 NAU HPV [1]

- Driver cage
- Tadpole trike design
- Fairing ✕
- Drive cage protection
- Seat adjustability

Black Box Decomposition

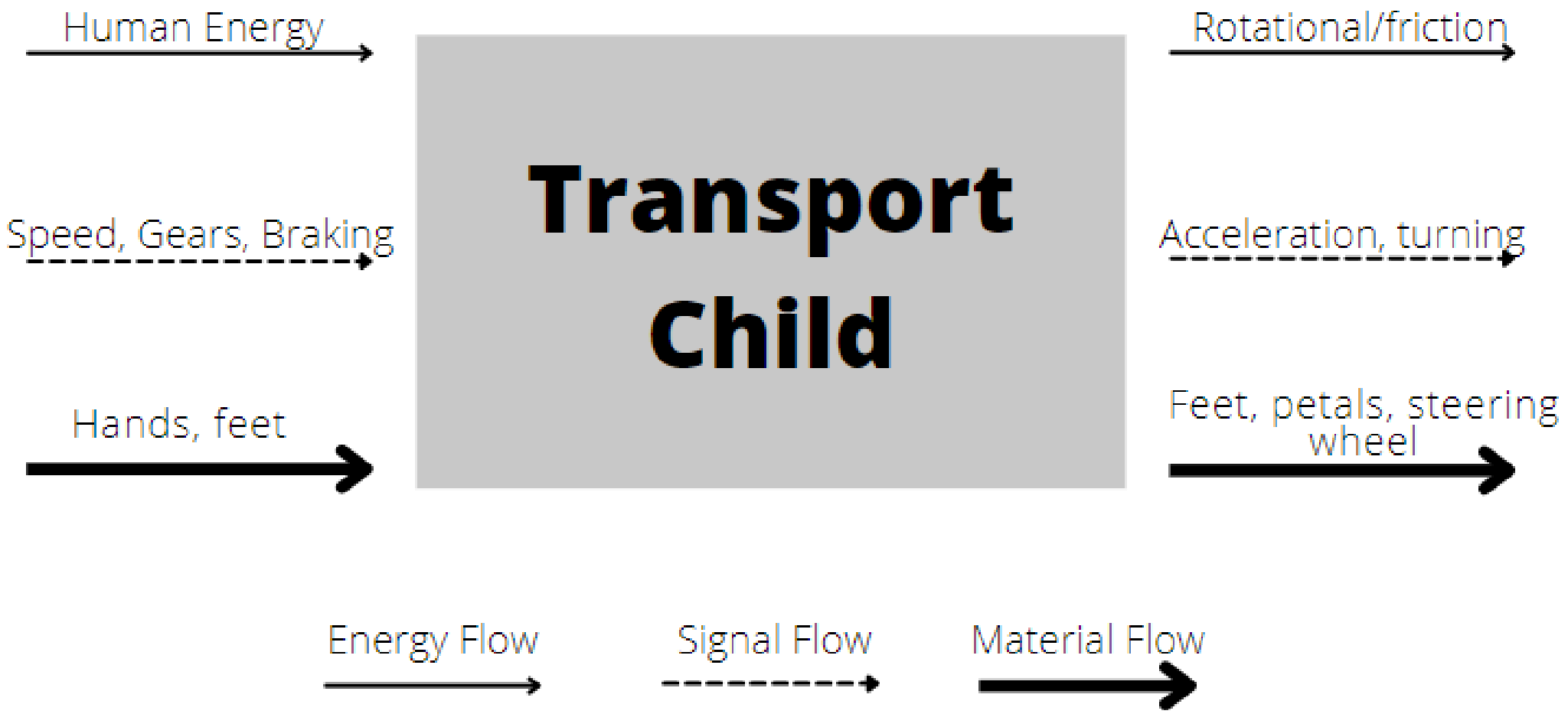

Figure 6 - Black Box Model

Black Box Decomposition

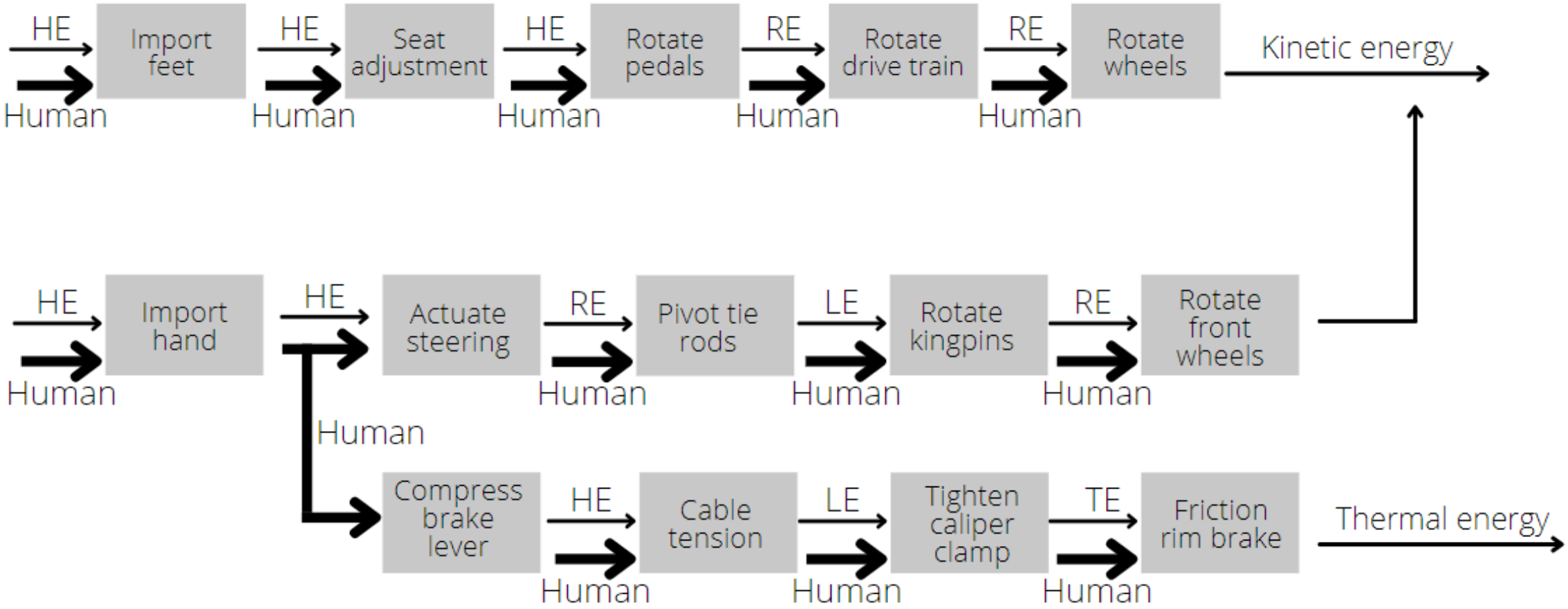

Figure 7 - Functional Decomposition

Concept Generation

Rank	Customer Requirements	Engineering Requirements
1	Safety	Braking Distance (m)
5	Ease of Operation	Limit Actuating Systems
2	Stability	Minimum of 3 wheels
3	Operation Age (5-13 years old)	Seat to Pedal Distance (cm)
4	Educational	Volume (m^3)
6	Transportable	Center of Mass
		Gear Ratios
		Turning Radius (m)

Table 1: Updated Cr's and ER's

Generation Outline

- Used updated CR's & ER's and Subsystem decomposition to generate concepts
- Evaluated each Individual Subsystems
  1. Braking (Caliper, Cantilever, Hydraulic)
  2. Steering (Direct/Indirect)
  3. Roll Cage (Material Type)
  4. Drive Chain (Chain, Shaft & FWD, RWD, etc.)
  5. Fairing
- Evaluated Combability of overall system
  - Example: 2 Front Wheels with direct steering and FWD = [highly problematic]

Concept Generation

Wheel Design

- Two Front Wheels: Better Steering, Worse Drivetrain Power
- Two Rear Wheels: Better Drivetrain Power, Worse Steering

Roll Cage Design:

- Idea 1: Better Protection, Heavier
- Idea 2: Lighter, Less Protection
- Idea 3: Least Protection, Lightest Design

Figure 8: Rear Wheels [6]

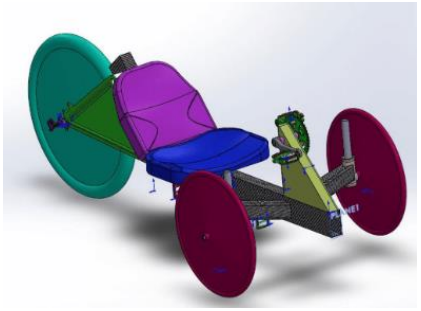

Figure 9: Front Wheels [7]

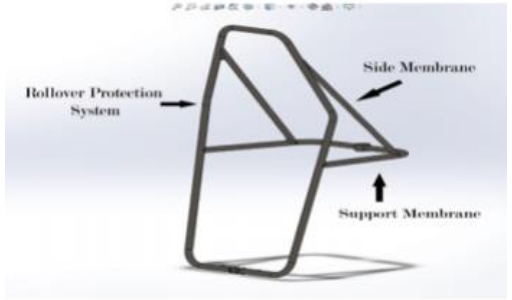

Figure 10: Roll cage Design 1 [10]

Figure 11: Roll cage Design 2 [9]

Figure 12: Roll cage Design 3 [8]

Concept Evaluation

Created a Pugh chart for each major subsystem including:

- Layout
- Steering
- Drivetrain
- Frame material
- Faring
- Ergonomics
- Braking
- Roll cage

Adjusted Design to fit new CR's for child size HPV

- Safety > Performance
- Ease of operation
- 3+ wheels
- Intrigue elementary children

		2 Wheels *			3 Wheels		4 Wheels
Criteria	Weight %	Upright	Prone	Recumbant	Delta	Tadpole	Quad
Stabilty/ safety	25.0%	5	4	3	6	9	10
Performance	15.0%	7	6	6	5	6	3
Weight	10.0%	9	9	7	5	5	2
Ease of operation	20.0%	6	2	4	8	9	7
Braking	15.0%	6	3	5	7	7	6
Aerodynamics	5.0%	8	9	7	6	6	3
Complexity	10.0%	8	7	6	5	5	3
Total	1	6.5	4.8	4.85	6.2	7.3	5.9

Table 2: Layout Pugh Chart

Concept Evaluation

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	
Faring	Tear drop	Kamm tail	Ellipse	U-shape	None
	7.39	5.79	6.42	5.98	6.71
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	

Table 3: Concept Evaluation

Rank	Customer Requirements	Engineering Requirements
1	Safety	Braking Distance (m)
5	Ease of Operation	Limit Actuating Systems
2	Stability	Minimum of 3 wheels
3	Operation Age (5-13 years old)	Seat to Pedal Distance (cm)
4	Educational	Volume (m^3)
6	Transportable	Center of Mass
		Gear Ratios
		Turning Radius (m)

Table 1: Updated Cr's and ER's

Concept Evaluation

Figure 13: Mobo delta [11]

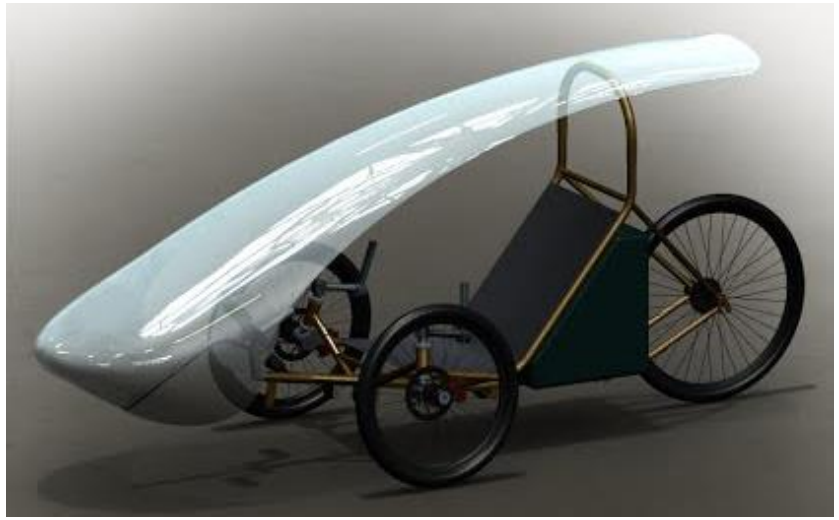

Figure 14: C.S.U HPVC [12]

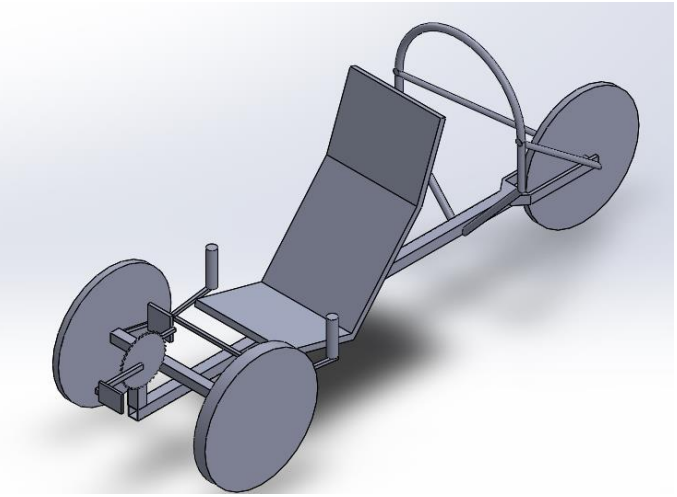

Figure 15: SolidWorks draft [13]

Concept 1
- Delta layout
- RWD In-direct steering
- Caliper Brakes
- Steel frame
- FWD direct driven
- No fairing
- Adjustable frame

Concept 2
- Tadpole layout
- Direct steering
- Partial fairing
- Disk brakes
- 4-point roll cage
- RWD chain driven
- 135 degree BCA angle

Rough CAD model
- Tadpole layout
- Indirect steering
- RWD chain driven
- Caliper brakes
- 4-point roll cage
- - 15 degree HOA
- 140 degree BCA

Budget Planning

Bill of Materials	
Items	**Cost**
6061 Aluminum Tubing	$215
Crank	$90
Brakes	$90
Chains	$15
Wheels X 3	$240
Tires	$90
LED's (Braking/Turning)	$15
Fairing	$120
Total	$875

Table 5 : Bill of Materials [5]

- Prototyping
- SolidWorks Simulation
- No competition costs
- Extra Parts

Conclusion

Current Design:

- Recumbent
- Tadpole Trike (Two front)
- Indirect Steering
- Teardrop Fairing
- Chain Drivetrain
- Caliper Brakes
- Aluminum 6061 Frame Material
- 4 Point Roll Cage

End Goals to keep in mind for Child Size HPV:

- SAFETY over performance
- Inspiring Design
- Sturdy

Looking Forward:

- Detailed SolidWorks Assembly
- SolidWorks Simulation Testing
- Prototyping
- Website

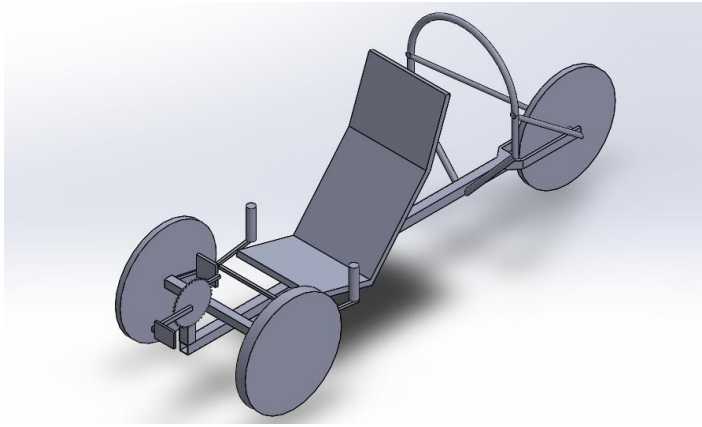

Figure 15: SolidWorks draft [13]

Questions?

Resources

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