NASA HUMAN EXPLORATION ROVER CHALLENGE

Cosmic Javelinas

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BACKGROUND

NASA Human Exploration Rover Challenge: The team will participate in both TSGC Design Challenge and Human Exploration Rover Challenge. Challenge includes a total of 10 obstacles with an 8-minute limit

HPV Division: Teams design and build human-powered rovers to overcome various terrains.

Obstacles & Terrain

Obstacles in competition test the strength and adaptability of the rover. The course includes obstacles with steep inclines/drops, steering capability, and different types of terrain(sand, gravel, etc.)

Figure 1: Uneven terrain with alternating terrain elevations

Figure 2: Ascending and descending terrain; ramps.

Figure 3: Heavily reliant on steering capability

Figure 4: Traversing through gravel/pebble terrain

OBJECTIVES

Construct a human-powered rover to complete the 10 obstacles in under 8 minutes. Goals to achieve are:

- Total weight of the rover under 130 pounds
- Turning radius under ten feet
- Braking system can hold drivers on 30-degree incline
- 12-inch ground clearance to appendages of drivers
- Maximum Dimensions: 5 feet $LxWxH$

SAFETY

Safety features included in the design:

- Three-point harness for each driver
- No sharp or rough edges
- Low center of gravity
- Reclined seating

DECISION MATRIX

Morph Chart	1	2	3	4	5
Frame	I-Frame	Double-I	Square	Car Frame	X - Frame
Frame Material	Chromoly-Steel	Aluminum	Lithium Aluminum		
Suspension	Multi-Link	Leaf Spring	Double Wishbone	Solid Axle	Macpherson
Seats	Bucket	Car	Curved	Flat	
Wheels	3-Spiral	4-Spiral	4-Spoke	5-Spoke	One-Piece

Reasons

I-Frame: Easy to weld

Frame Material: Lightweight

Seats: Safety

Wheels: Weight, Rigidity

Suspension: Great handling

DESIGN

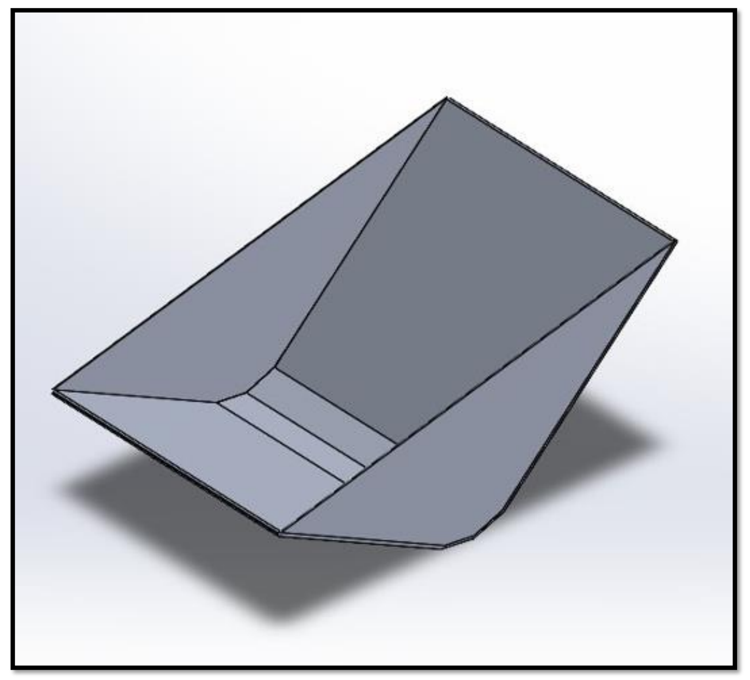

Figure 5: Second seat concept

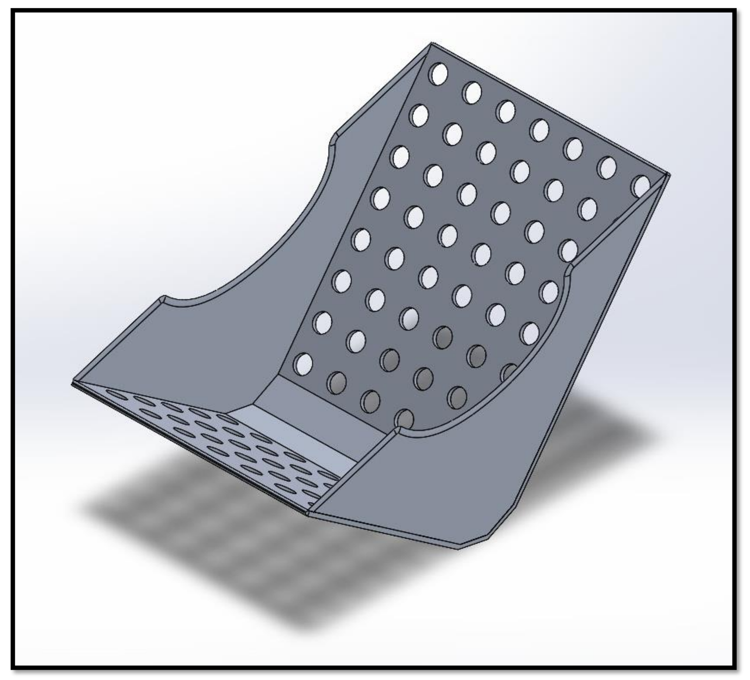

Figure 6: Current seat design

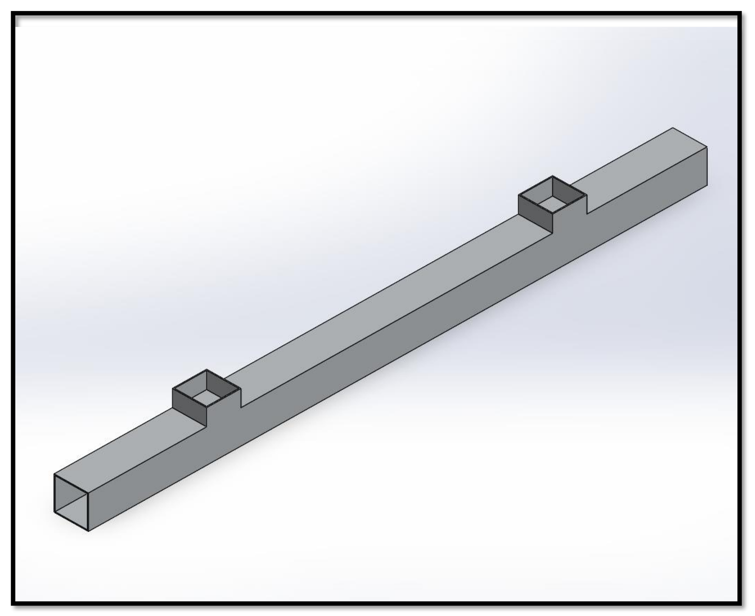

Figure 7: Second frame concept

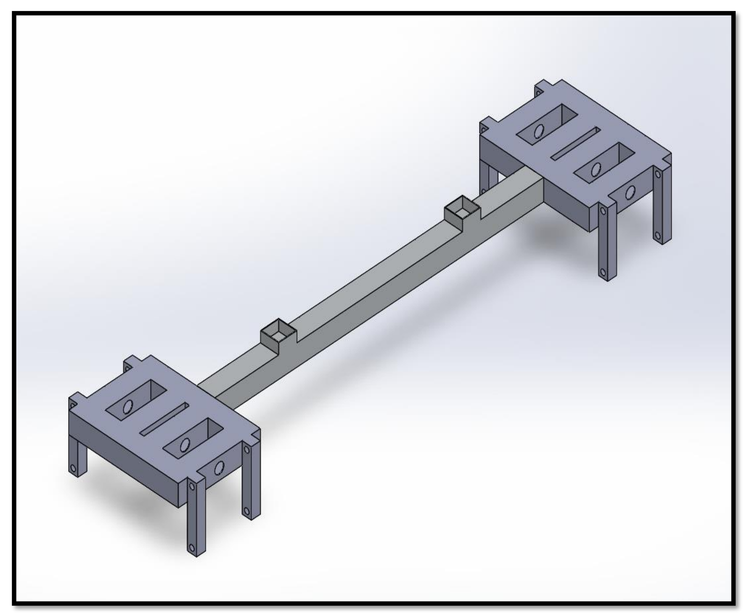

Figure 8: Current frame design

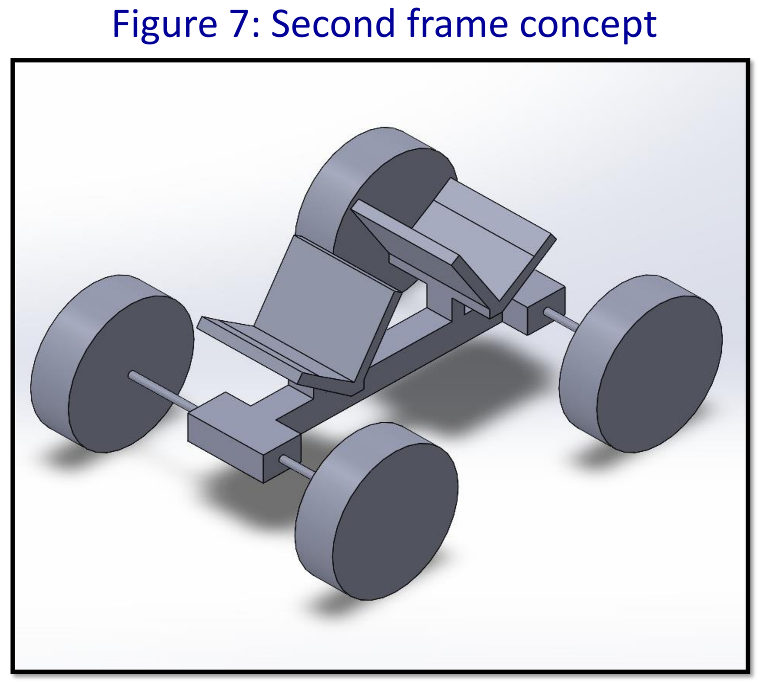

Figure 9: First rover concept

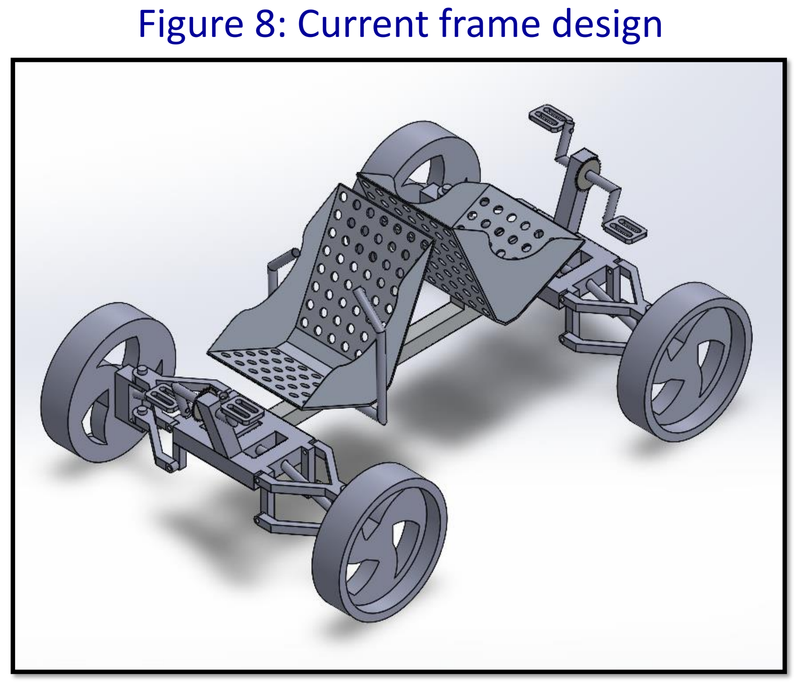

Figure 10: Current rover design

CALCULATIONS

$$R = \frac{L}{\sin(\theta)} \qquad r = \frac{L}{\tan(\theta)}$$

Steering Angle (°)	Steering Angle (Rads)	Wheel Base (ft)	Front Wheel	Turning Radius (ft)	Rear Wheel	Turning Radius (ft)	Notes
20	0.34906585	3.5	R =	10.2333154	r =	9.616170968	Special Case
21	0.366519143	3.5	R =	9.766498384	r =	9.117811726	Good case
22	0.383972435	3.5	R =	9.343135069	r =	8.662803987	Good case
23	0.401425728	3.5	R =	8.957566328	r =	8.24548328	Good case
24	0.41887902	3.5	R =	8.605076675	r =	7.861128709	decent case
25	0.436332313	3.5	R =	8.281705541	r =	7.505774222	decent case
26	0.453785606	3.5	R =	7.984102114	r =	7.176063446	acceptable case

Table 1: Turning radius

$$G.R. = \frac{t_{in}}{t_{out}} = \frac{N_{in}}{N_{out}} = \frac{T_{in}}{T_{out}}$$

Sprocket Teeth	Sprocket Teeth	Gear Ratio	Rotaional speed	Rotational Speed	Torque	Torque
t-in	t-out	G.R.	N-out (RPM)	N-in (RPM)	T-in (Nm)	T-out (Nm)
60	30	2	120	60	60	30

Table 2: Gear ratio

SIMULATIONS

- Fixed points where control arms and frame meet
- 155 lbs. of force on front seat
- 190 lbs. of force on back seat
- 200 lbs. of force on the backs of the seats
- 250 lbs. of force on the poles of the pedals

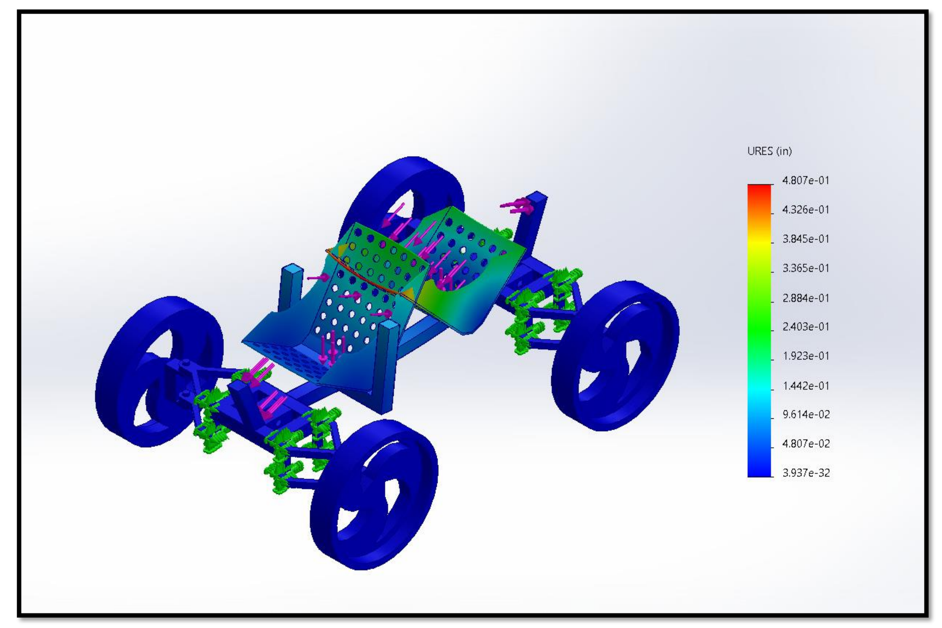

Figure 11: Displacement diagram

DESIGN SPECIFICATIONS

- Length - 61.03 inches
- Width - 44 inches
- Height - 28.65 inches
- Total weight - 91.22 lbs.
- Seat angled by 30 degrees
- Drivetrain has 2:1 ratio for more power
- Reverse gearing so person in rear seat still pedals forward

CONCLUSION

TRL 3

•Analytical and experimental critical function and/or characteristic proof-of-concept

Technical Readiness Level (TRL) – 3. The proposed objectives have been met based off calculations and HERC guidelines. Successfully building the rover and undergoing proper testing are close. Current goals achieved: total weight under 130 pounds, turning radius under ten feet, 12-inch ground clearance.

FUTURE PLANS

- Alter overall length to satisfy length objective.
- Further calculations to improve the rover components
- Gathering the required supplies and materials for the rover
- Properly welding all components
- Testing and trial runs shall be conducted
- Modify components from test results and second opinions

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NASA Mentor: George Salazar, P.E., ESEP, LSMIEEE

Past Student: Jared Garcia

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