Conceptual Design for the NASA Human Exploration Rover Challenge

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TEAM 17

Agenda

- Background Information on Competition
- Needs Statement and Goal
- Preliminary Failure Analysis
- Design Focus
- Materials Selection Discussion
- Funding
- Future Plans
- Acknowledgements/Bibliography
- Audience Questions

The Competition Basics

Prototype a vehicle that …

- Is human-powered
- Accommodates two people
- Has off-road capabilities
- Is ‘small’ and ‘light’
- Is safe

Needs Statement:

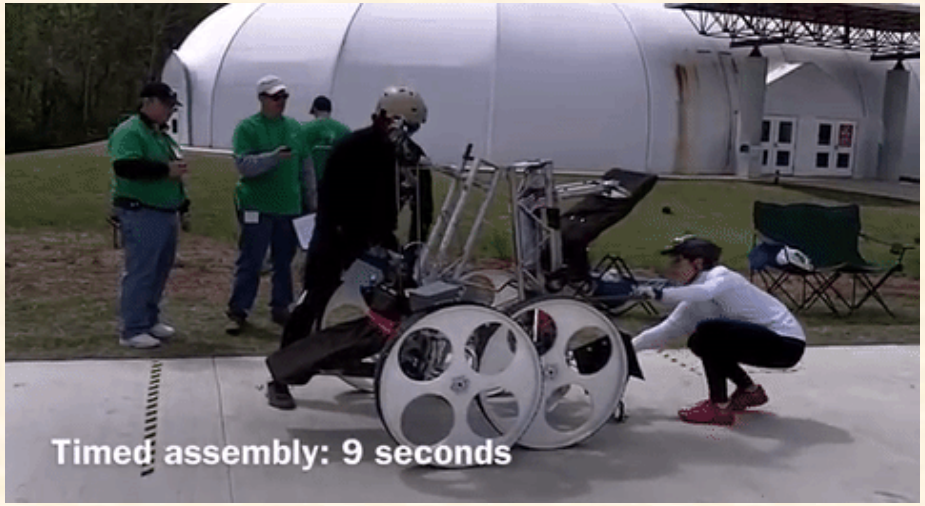
“There needs to be a ground vehicle powered by fit male and female drivers that is capable of competing in the NASA Human Exploration Rover challenge.”

Previous Years Designs

General Designs

- Four-Wheeled vehicles
- Large (~30”) Wheels
- Front-Back driver configuration
- Mid-Chassis folding joint
- Varying Suspension types

SUCCESSES

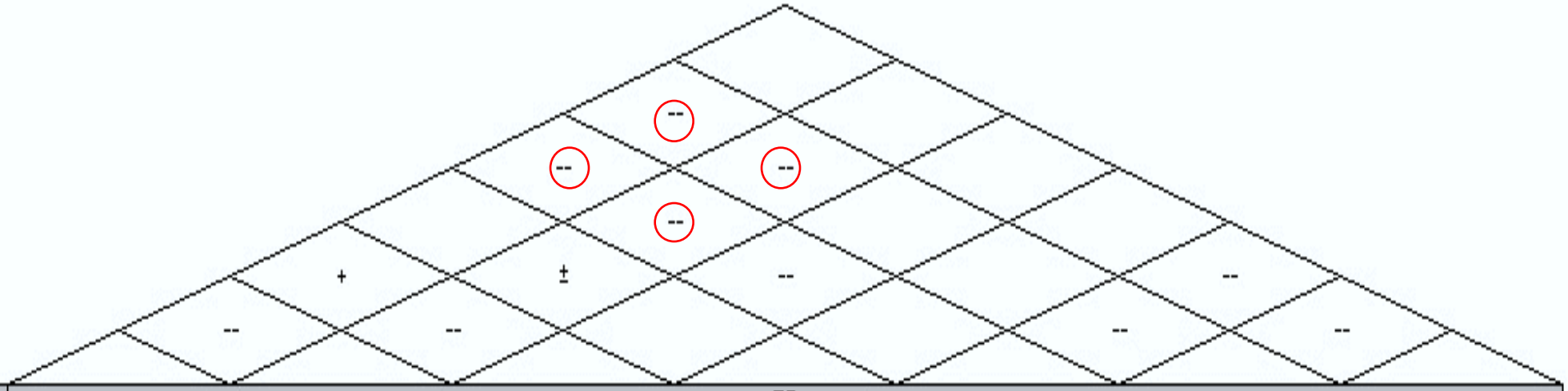


PITFALLS

Failure Assessment

Previous Years Failure Analysis: (0-5 , 5 highest value)			
Issue	Frequency	Severity	Possible Solutions
Power/Torque delivery to wheels insufficient *Most evident Issue*	5	4	Reduce wheel size, increase geared output torque, fundamental power conversion change (RLT), increase normal force on contact
Traction in sand or loose gravel insufficient	5	3	Increase contact patch area, redesign tread material/geometry
Exhaustion of riders	4	4	Strength/Endurance training, Decrease work necessary to power through hills
Drive chain breaking or coming unhinged	2	5	Alternative drivetrain, further attention to chain design, simplify gear system
“Bottoming Out” on hills or bumps	1	5	Decrease wheelbase distance, increase chassis height, increase wheel size

House of Quality



Customer Requirements	CI	EC						
		Frame Strength	Vehicle Weight	Number of Wheels	Wheel Design	Frame Length	Frame Width	Frame Height
Lightweight	6	7	10	7	7	5	5	5
Strong	7	10	7		7	7	5	3
Stable	10			8			7	8
Fast	5		7	7	7		5	
Safe	10	7		5				6
Can traverse obstacles	7	5		7	9	5		
Seats Two Adults	10	7				8	8	
Fits in a 5x5x5 ft box	10					10	10	10
Less than 15 ft Turning Radius	10			5		7	7	
		287	144	256	189	364	410	291

Component Morphology

Design chassis
- Frame style, material, suspension, collapsibility, seat orientation

Design of drivetrain
- Chains, belts, reciprocating lever transmission (HansCycle), shaft drive
- Two-wheel vs. all-wheel drive
- Separate or combined drivetrains for two drivers

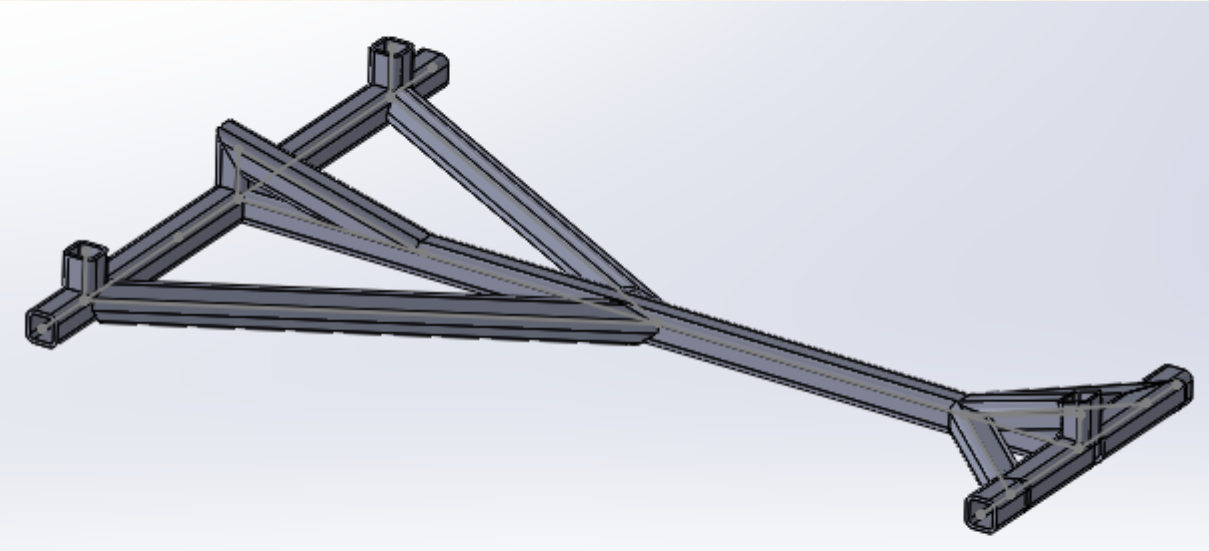
Steering
- Steering wheel, hand levers
- Two-wheel or all-wheel steering

Design of wheels
- Materials, size, shape, tread

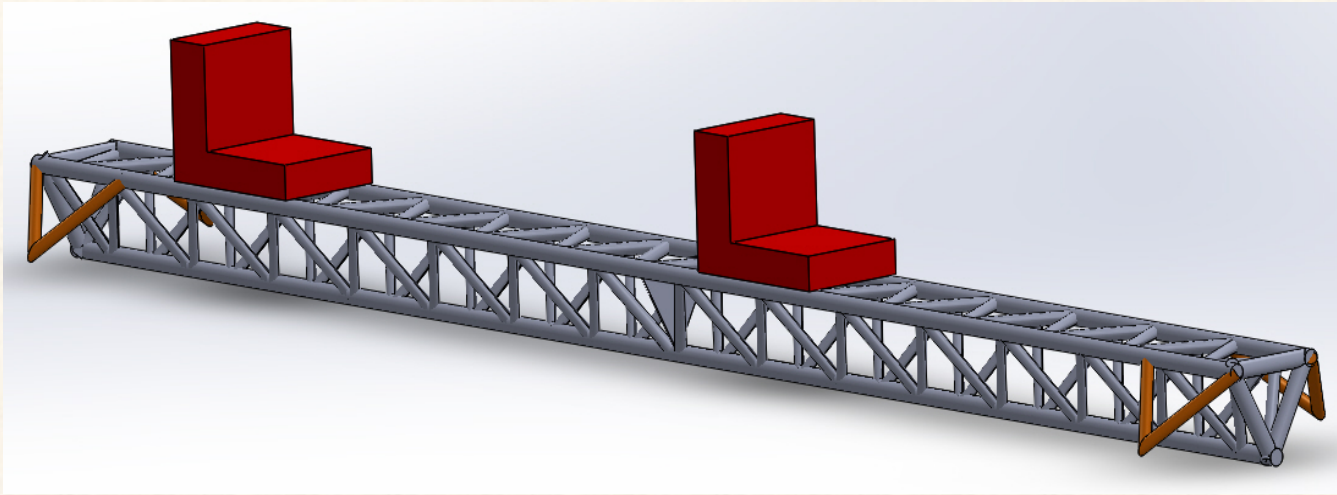
Brakes
- Disc brakes, drum brakes, rim brakes

Chassis Concepts

‘Dune Buggy’ inspired chassis



Chassis Concepts



Purdue Inspired Design

Purdue-Calmet 2016 Rover winning design

Chassis Concepts

Safety

Most important aspect of this project

How we plan on keeping this a priority:

- Assess design flaws
- Stay within competition constraints
- Tool safety
- Goal is safety factor of 4 in design

Material Selection

Desired Characteristics

- Lightweight
- High strength
- Economically efficient
- Safety factor of 4

Possible Materials for Chassis Design include:

- Aluminum (2024, 6061, 7075)
- Mild Steel
- Carbon Fiber

Aluminum Alloy Comparison

2024

- High strength to weight ratio
- Good fatigue resistance

6061

- Lowest strength to weight ratio
- Cheapest of the 3
- Most abundant

7075

- Highest strength to weight ratio
- Most expensive

Mild Steel

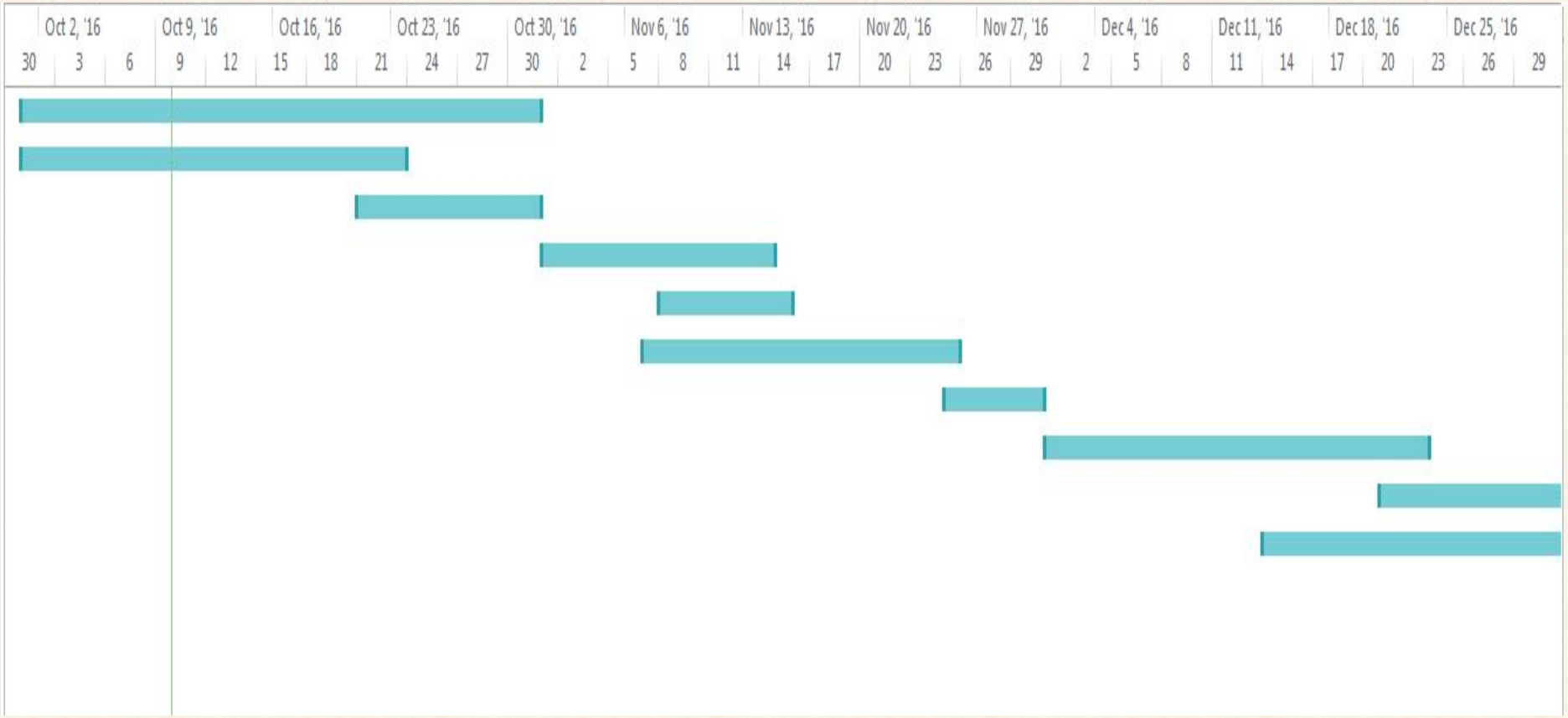
- **Durable** and strong
- Low carbon = less hard, higher weldability
- **Inexpensive**, most commonly used form of steel
- **Heaviest** of the 3 materials being considered
- Different shapes and sizes are attainable
- Most **widely used** in structural applications

Carbon Fiber

- **Highest strength to weight ratio**
- Costly
- Different shapes and sizes are attainable
- Strength depends upon orientation
- Most widely used in aircraft components and structures

Schedule (Gantt Chart)

Task Mode	Task Name	Duration	Start	Finish
	Fundraising	22 days	Sat 10/1/16	Mon 10/31/16
	Conceptual Design	17 days	Sat 10/1/16	Sun 10/23/16
	Part Selection	7 days	Fri 10/21/16	Mon 10/31/16
	Purchasing	10 days	Tue 11/1/16	Mon 11/14/16
	Registration	6 days	Tue 11/8/16	Tue 11/15/16
	Manufacturing	15 days	Mon 11/7/16	Fri 11/25/16
	Revisiting Design	4 days	Fri 11/25/16	Wed 11/30/16
	Finalize Design	17 days	Thu 12/1/16	Fri 12/23/16
	Continue Manufacturi	15 days	Wed 12/21/1	Tue 1/10/17
	Refine Reports	14 days	Wed 12/14/1	Sat 12/31/16
	Tweek Design	14 days	Sun 1/1/17	Wed 1/18/17
	Testing	17 days	Mon 1/9/17	Tue 1/31/17
	Continue Testing	20 days	Wed 2/1/17	Tue 2/28/17



Future Plans

- Chassis: Selection of design
- Drivetrain
- Steering
- Wheels
- Brakes
- Select drivers and begin physical training

Fundraising

- Publix: Request has gone out
- SGA (FAMU and FSU)
- Macy's, JC Penny's, local bike shops
- Fastenal, Grainger, Harbor Freight

References

QUESTIONS?