FSGC NASA Human Powered Vehicle

Team 509:

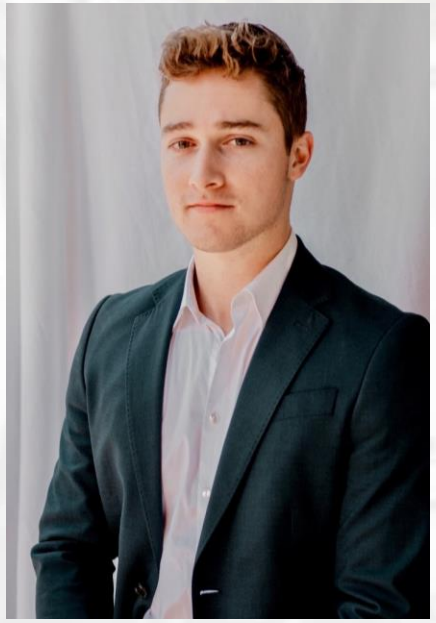
Ryan Floyd, Nicolas Picard,

Ninett Sanchez, Andrew Schlar

Presenters: Nicolas Picard, Ninett Sanchez

Ninett Sanchez

NASA Human Powered Vehicle Team 509



Ryan Floyd
Project and Materials Engineer

Nico Picard
Design Engineer

Ninett Sanchez
Point of Contact and Design Engineer

Andrew Schlar
Team Leader and Design Engineer

Ninett Sanchez

Sponsor and Advisor

Florida Space Grant Consortium

Dr. Shayne McConomy

Special thanks to Dr. Shayne McConomy for advising and mentoring the team

Ninett Sanchez

Objective

The objective is to design and manufacture a human powered vehicle to traverse exoplanetary terrain in a NASA hosted competition.

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Project Background

- Apollo 14 lunar mission complications
- Annual NASA Human Exploration Rover Challenge Competition
- Artemis Moon Program
  - Lunar Mission 2024
  - Sustained Settlement 2028

Apollo 14 Flight Crew [1]

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Competition

Competition Date(s):

- April 15th - 17th, 2021

Location:

- Huntsville, Alabama

Course Details:

- 14 obstacles simulate lunar terrain
- 5 optional tasks, similar to astronaut missions
- 8-minute time limit represents theoretical oxygen supply

Student competitors completing competition challenge [2]

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Project Requirements

Dimensions

- Collapse to fit within 125 cubic feet
- 12-inch ground clearance
- 30° approach, departure, and breakover angles
- Overall width ≤ 5 feet

Input/Output

- 1:1 Steering Ratio
- Maximum turning angle of 20°
- Turning radius ≤ 15 feet
- Pinion between 14-24 teeth
- Cassette between 32-44 teeth

Safety

- Riders secured to vehicle
- Stopping distance ≤ 8 feet (from 10 mph)

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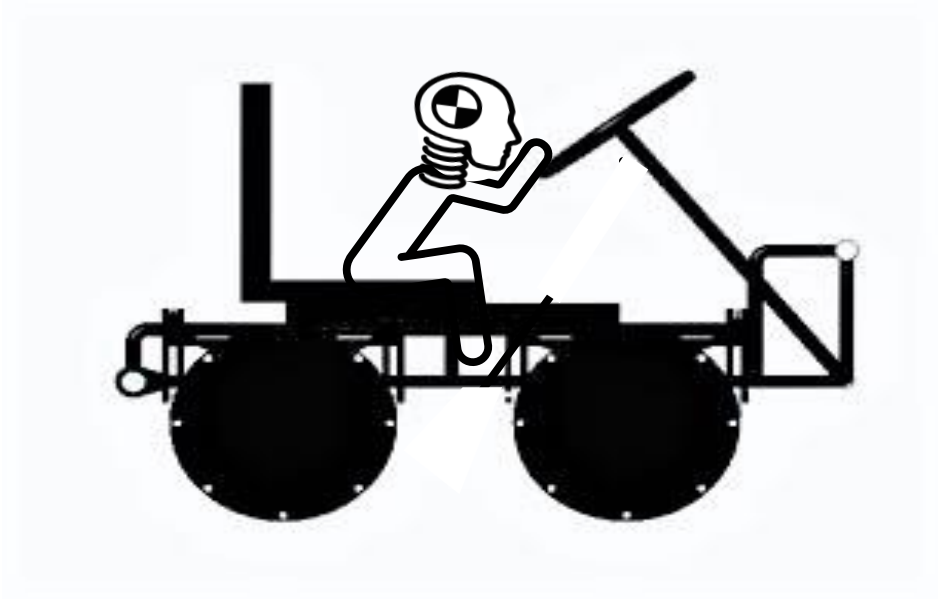
Validation

- ✓ Subsystems and components will be tested individually for their performance prior to competition
- ✓ Design will be fully validated in the field during the competition



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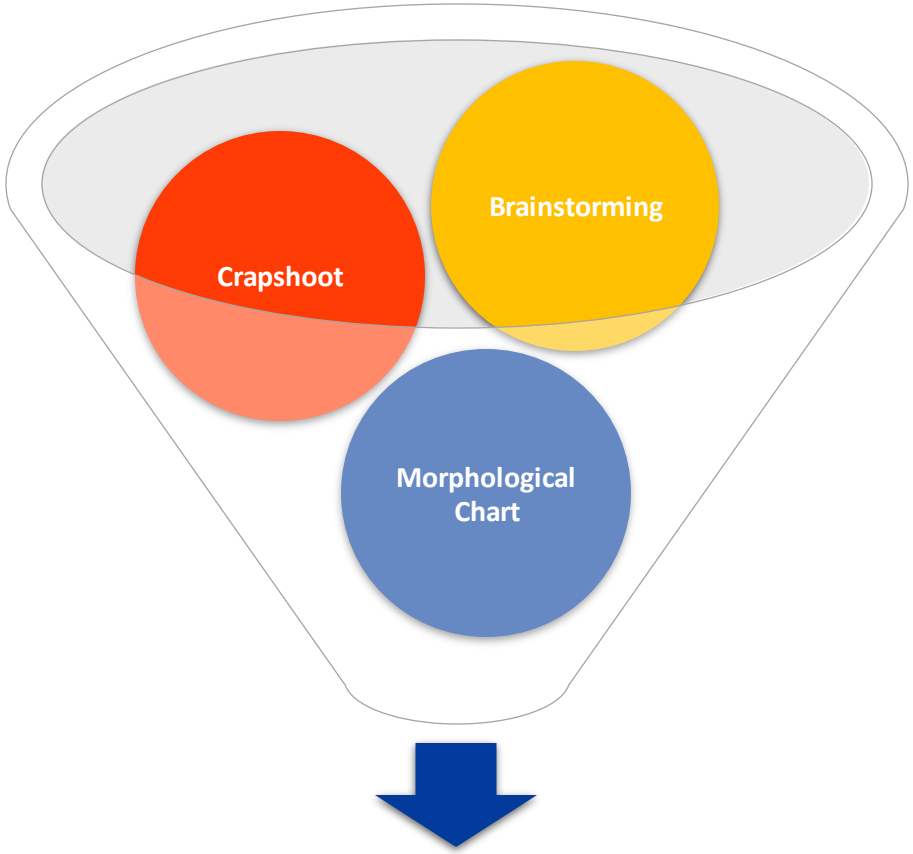
Concept Generation



Medium and High Fidelity

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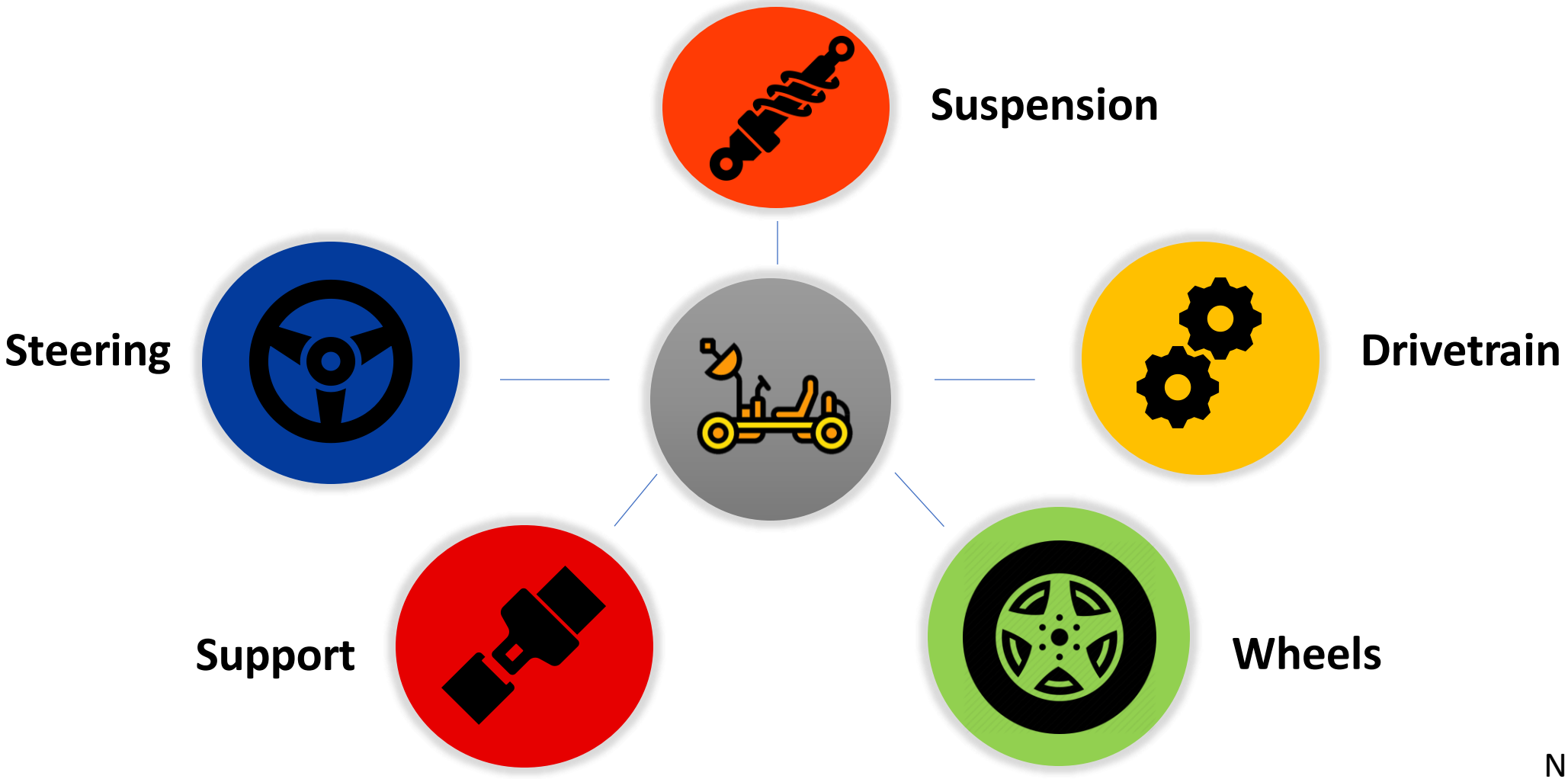
System Concepts



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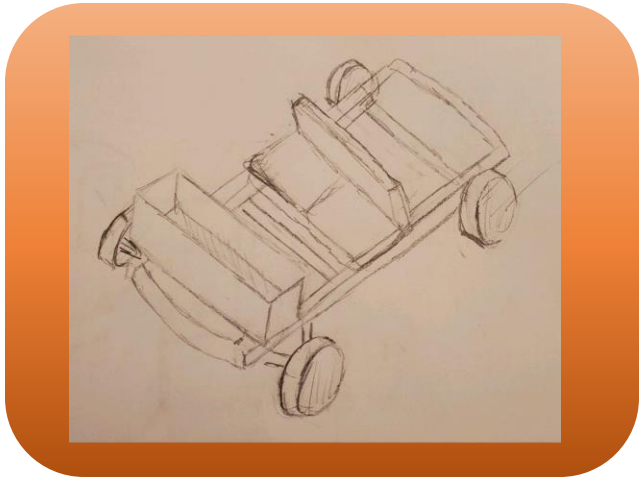
Medium Fidelity

Disk Brakes



Fronk Design

3-Point Seatbelt

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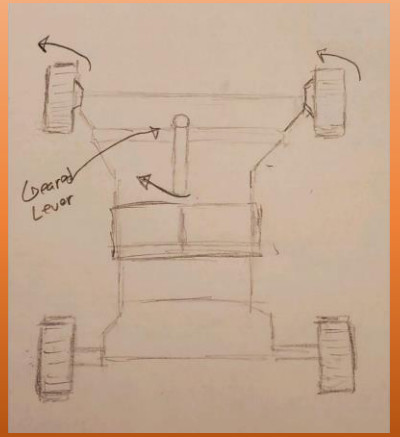
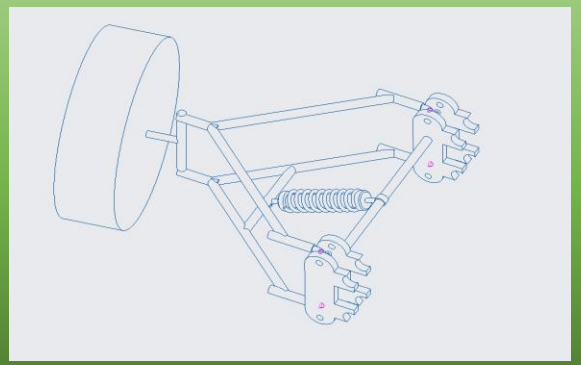
Medium Fidelity


[8]

Sample Gathering Tool



Tiller Steering Mechanism



Double Wishbone Suspension (Front and Rear)

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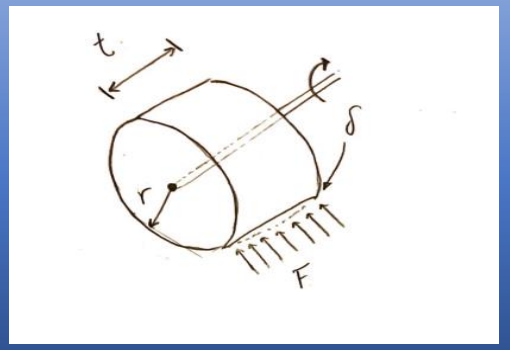
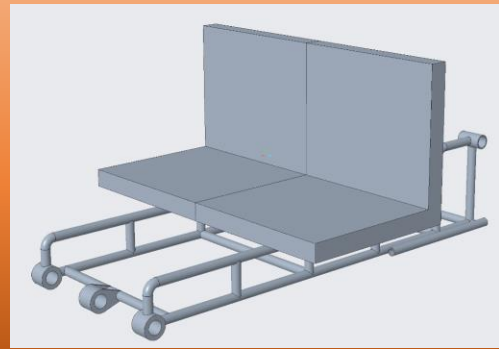
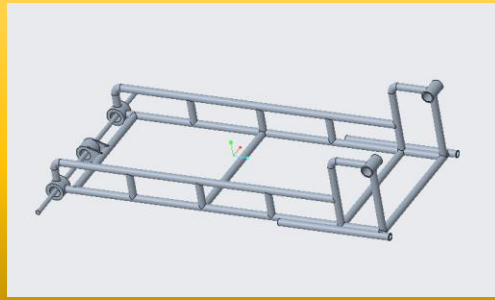
High Fidelity



High Density Rigid Polymer Foam Wheels

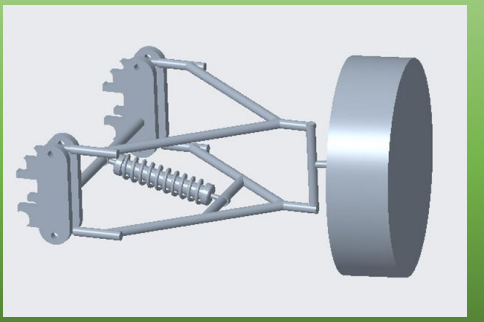
Side-by-Side Seating





Frame from Previous Year's Team 514

Double Wishbone Suspension (Front only)



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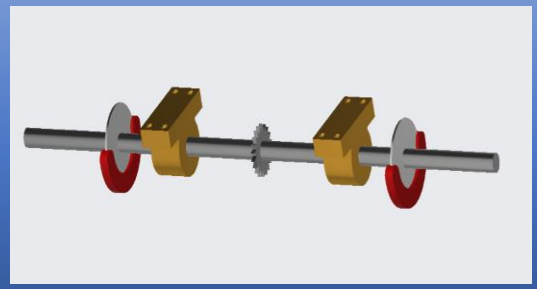
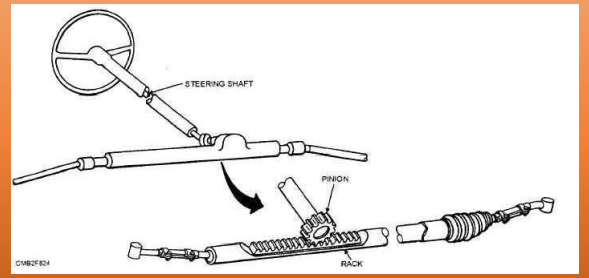
High Fidelity



Rear Axle Powertrain and Disk Brakes



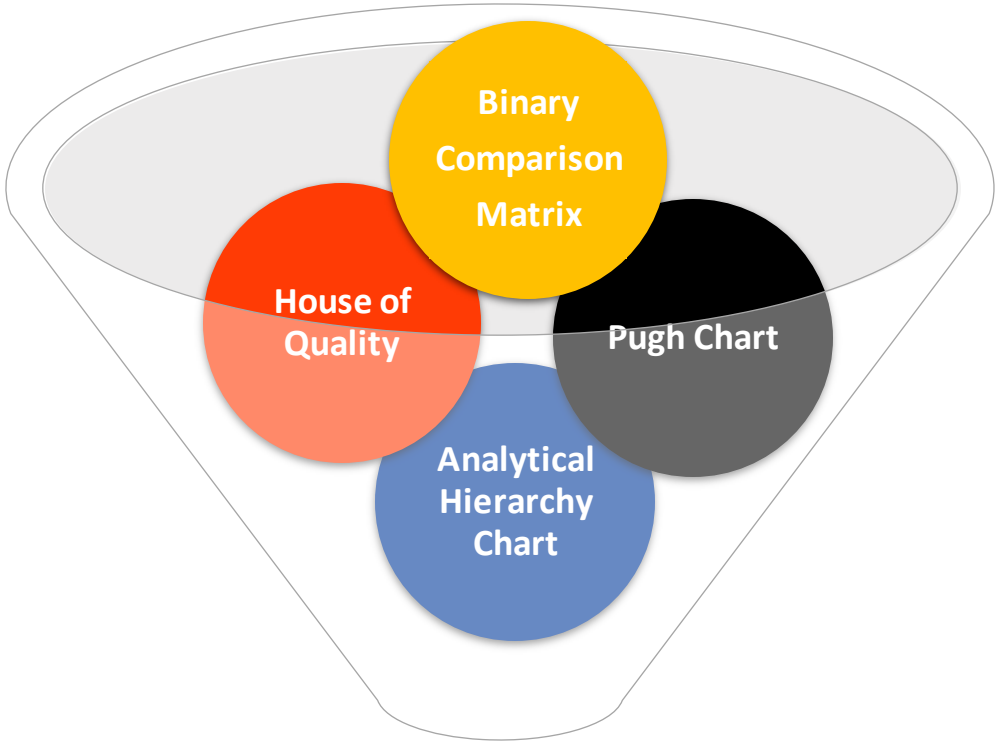
[9]

Rack and Pinion Steering

[10]

2-Point Seatbelt

Concept Selection



Final Selection

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Binary Comparison

Binary Comparison Matrix

House of Quality

Pugh Chart

Analytical Hierarchy Chart

Customer Requirements	Importance Weight Factor
Maintain Functionality	7
Cost Effective	6
Maintain Operator Safety	5
Ease of Production	4
Handle Rough Terrain	2
Rider Size Accommodation	2
Ease of Assembly	2

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House of Quality

Binary Comparison Matrix

House of Quality

Pugh Chart

Analytical Hierarchy Chart

		Engineering Characteristics						
Improvement Direction	↑	↑	↓	↑	↑	↑	↑	↑
Units		N/A	inches	Number of seats	inches	inches*lbf	in	in^3 N/A
Customer Requirements	Importance Weight Factor	Stability	Turning Radius	Seating Accommodation	Ground Clearance	Rover Torque	Stopping Distance	Storage
Handle rough terrain	2	8	4	0	8	4	2	0
Maintain operator safety	5	4	2	8	2	0	2	0
Maintain functionality	7	2	2	0	2	8	8	4
Ease of production	4	0	0	4	4	4	2	2
Rider size accommodation	2	4	0	8	2	2	2	4
Cost effective	6	4	2	2	2	4	0	2
Ease of assembly	2	2	2	4	2	2	0	0
Raw Score (552)		86	48	92	76	112	82	56
Relative Weight (%)		15.58	8.70	16.67	13.76	20.29	14.86	10.14
Rank Order		3	7	2	6	1	4	5

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House of Quality

Binary Comparison Matrix

House of Quality

Pugh Chart

Analytical Hierarchy Chart

		Engineering Characteristics						
Improvement Direction	↑	↑	↓	↑	↑	↑	↑	↑
Units		N/A	inches	Number of seats	inches	inches*lbf	in	in^3 N/A
Customer Requirements	Importance Weight Factor	Stability	Turning Radius	Seating Accommodation	Ground Clearance	Rover Torque	Stopping Distance	Storage
Handle rough terrain	2	8	4	0	8	4	2	0
Maintain operator safety	5	4	2	8	2	0	2	0
Maintain functionality	7	2	2	0	2	8	8	4
Ease of production	4	0	0	4	4	4	2	2
Rider size accommodation	2	4	0	8	2	2	2	4
Cost effective	6	4	2	2	2	4	0	2
Ease of assembly	2	2	2	4	2	2	0	0
Raw Score (552)		86	48	92	76	112	82	56
Relative Weight (%)		15.58	8.70	16.67	13.76	20.29	14.86	10.14
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Nicolas Picard

House of Quality

Binary Comparison Matrix

House of Quality

Pugh Chart

Analytical Hierarchy Chart

		Engineering Characteristics						
Improvement Direction	↑	↑	↓	↑	↑	↑	↑	↑
Units		N/A	inches	Number of seats	inches	inches*lbf	in	in^3 N/A
Customer Requirements	Importance Weight Factor	Stability	Turning Radius	Seating Accommodation	Ground Clearance	Rover Torque	Stopping Distance	Storage
Handle rough terrain	2	8	4	0	8	4	2	0
Maintain operator safety	5	4	2	8	2	0	2	0
Maintain functionality	7	2	2	0	2	8	8	4
Ease of production	4	0	0	4	4	4	2	2
Rider size accommodation	2	4	0	8	2	2	2	4
Cost effective	6	4	2	2	2	4	0	2
Ease of assembly	2	2	2	4	2	2	0	0
Raw Score (552)		86	48	92	76	112	82	56
Relative Weight (%)		15.58	8.70	16.67	13.76	20.29	14.86	10.14
Rank Order		3	7	2	6	1	4	5

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Steering Pugh Chart

Binary Comparison Matrix

House of Quality

Pugh Chart

Analytical Hierarchy Chart

Steering				
	Concepts			
Engineering Characteristics	Rack and pinion Steering from previous year	Tiller Steering Mechanism	Double Wheel Steering	Rear Wheel Steering
Stability	Datum	S	-	-
Turning Radius		-	-	-
Seating Accommodation		S	S	S
Ground Clearance		+	S	S
Drivetrain Torque		S	S	S
Stopping Distance		S	S	S
Storage		S	S	S
# pluses		1	0	0
# minuses		1	2	2

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Suspension Pugh Chart

Binary Comparison Matrix

House of Quality

Pugh Chart

Analytical Hierarchy Chart

Suspension				
	Concepts			
Engineering Characteristics	Double wishbone suspension (front)	No suspension	Double wishbone suspension (front and rear)	MacPherson Strut (front)
Stability	Datum	-	+	-
Turning Radius		S	S	S
Seating Accommodation		S	S	S
Ground Clearance		+	-	S
Rover Torque		-	+	S
Stopping Distance		-	-	S
Storage		S	S	S
# pluses		1	2	0
# minuses		3	2	1

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Frame Pugh Chart

Binary Comparison Matrix

House of Quality

Pugh Chart

Analytical Hierarchy Chart

Frame				
	Concepts			
Engineering Characteristics	Frame from previous year	Elongated and segmented frame from previous year	Single beam, segmented frame	Wooden frame with center fold joint
Stability	Datum	-	-	-
Turning Radius		-	-	-
Seating Accommodation		S	S	S
Ground Clearance		S	S	S
Rover Torque		S	S	S
Stopping Distance		S	S	S
Storage		+	+	-
# pluses		1	1	0
# minuses		2	2	3

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Wheels Pugh Chart

Binary Comparison Matrix

House of Quality

Pugh Chart

Analytical Hierarchy Chart

Wheels				
	Concepts			
Engineering Characteristics	Cork wheels, solid throughout	High density rigid polymer foam wheels	Wooden wheels	Patterned aluminum wheels
Stability	Datum	+	-	-
Turning Radius		S	S	S
Seating Accommodation		S	S	S
Ground Clearance		+	+	+
Rover Torque		S	-	-
Stopping Distance		S	S	S
Storage		S	S	S
# pluses		2	1	1
# minuses		0	1	2

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Analytical Hierarchy Process

Binary Comparison Matrix

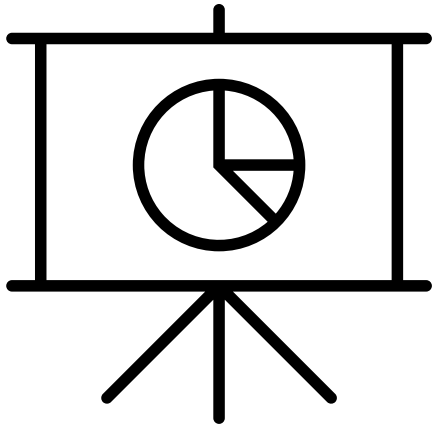
House of Quality

Pugh Chart

Analytical Hierarchy Chart

Evaluation Criteria

Final Concepts



Evaluated Comparison

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Final Selection

- Double wishbone front suspension
- Side-by-side forward facing seating
- Rack and pinion steering
- Rear-axle drive train
- Rear-axle disk brakes

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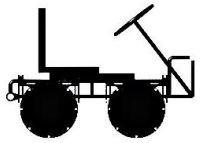
Project Progress



Week 2
Contacted Previous Teams

Week 3
Inventoried Leftover Parts

Week 4
Research and Delegate Subsystems

Week 5
Completed Competition Registration

Week 6
Researched Previous Competitions

Week 7
Force and Strength Calculations

Week 8
CAD Prototyping

Week 9
COE Visit for Detailed Dimensioning

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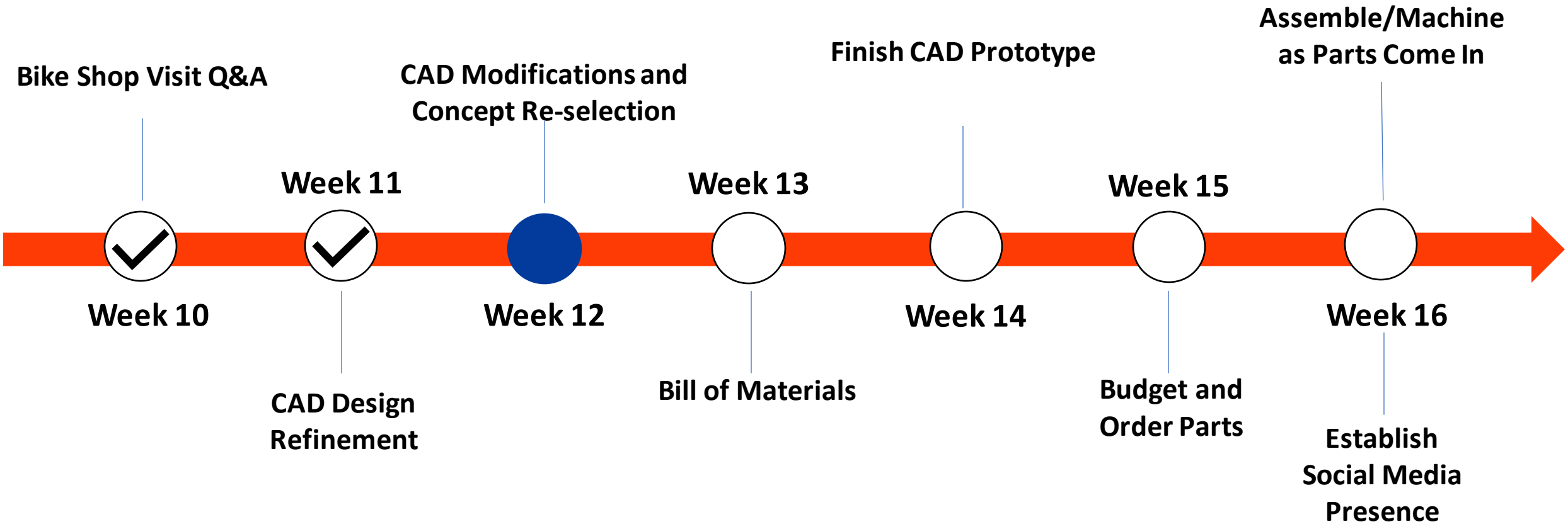
Project Progress



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Acknowledgement

- ✓ Florida Space Grant Consortium
- ✓ Special Thanks to Dr. Shayne McConomy
- ✓ Dr. Patrick Hollis
- ✓ Jessica Meeker

Nicolas Picard

Questions?

FSGC NASA Human Powered Vehicle

Our job is to design and manufacture a human powered vehicle to traverse exoplanetary terrain in a NASA hosted competition.

Feel free to ask us any questions.

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Section Links

Project Background

Competition

Project Requirements

Concept Generation

Concept Selection

Project Progress

Acknowledgements

References

Team 509

References

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Team 509

Backup Slides

Binary Comparison

Binary Comparison Matrix

House of Quality

Pugh Chart

Analytical Hierarchy Chart

	1	2	3	4	5	6	7	8	Total
1. Handle rough terrain	-	0	0	0	0	0	1	1	2
2. Maintain operator safety	1	-	0	1	1	0	1	1	5
3. Maintain functionality	1	1	-	1	1	1	1	1	7
4. Ease of production	1	0	0	-	1	0	1	1	4
5. Rider size accommodation	1	0	0	0	-	0	0	1	2
6. Cost effective	1	1	0	1	1	-	1	1	6
7. Ease of assembly	0	0	0	0	1	0	-	1	2
Total	5	2	0	3	5	1	5	7	-

Team 509