Optimized Rim for Spring Mesh Tire

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ABSTRACT

The current Mars Science Laboratory (MSL) rover wheels are a rigid, thin-shelled, aluminum design which are susceptible to punctures and cracking from sharp rocks and soft soil. Solutions are currently being developed for the rovers for future Mars exploration missions, including Mars 2020 and Mars Sample Return. NASA Glenn Research Center engineers have proposed an alternative compliant tire created out of a metallic spring mesh that would increase the life of the wheel while providing added traction. The objective of this project is to develop a suitable tire rim prototype as support for the compliant spring mesh tire design. The tire rim must meet all requirements set by NASA including: rigidly constrain the spring mesh at a specified geometry, transmit driving torque, and resist projected forces and torques associated with the rover's operations. The developed design is verified with stress, fatigue, and buckling analysis through finite element modeling. A physical prototype is to be fabricated and tested at NASA Glenn Research Center in the Simulated Lunar Operations (SLOPE) facility.

BACKGROUND

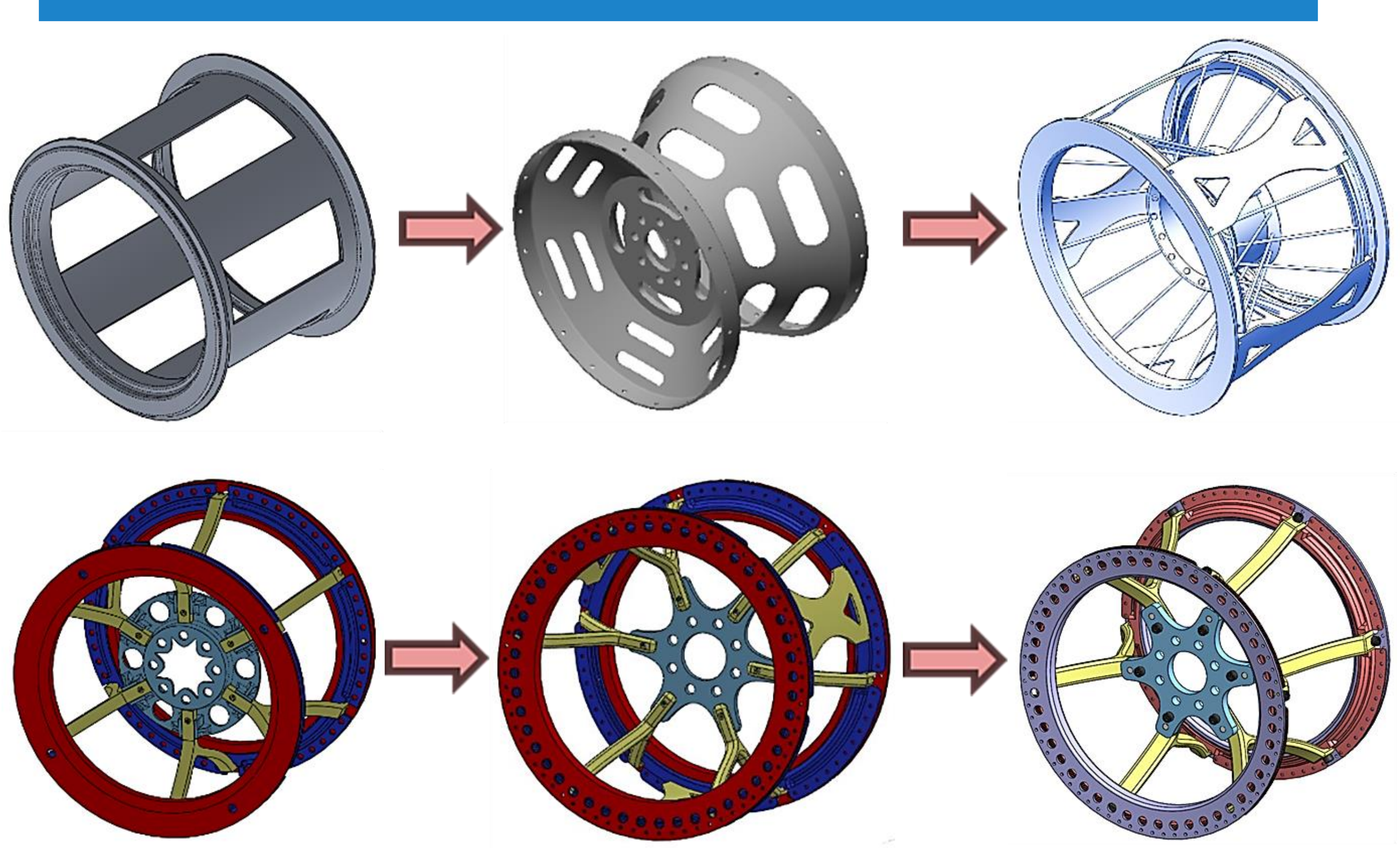
Curiosity Rover Tire

- Rigid, punctured, risk of entrapment

Spring Mesh Tire

- Better traction, resists puncture, low risk of entrapment

DESIGN PROCESS



OBJECTIVES

Importance (1=most)	Engineering Characteristic	Unit of Measure	Marginal Value	Ideal Value
2	**Mass**	**kg**	**3.0**	**2.0**
3	High Endurance	pass/fail*	Pass with minimal damage	Pass with no damage
5	Support Impact Load	N	7000	11000
3	**Coaxial torque transmitted**	**N-m**	**350**	**680**
3	Transverse torque resisted	N-m	360	500
1	**Material Choice**	**N/A**	**Metallic/ Composite**	**Metallic**
4	Minimal Parts	# of components	5	2
5	Standardize Fasteners	# of different fasteners	3	2
4	Manufacturing Method	N/A	Machine/ Welding	Machined
3	Wheel Geometry	in	7.81W x 10.41 D	7.81W x 10.41 D

FINAL DESIGN

Mass

– 2.2kg (4.86lbs.)

Materials

– Al 7075-T6, Stainless Steel 304, Black Oxide Alloy Steel and Ti-6AL-4V

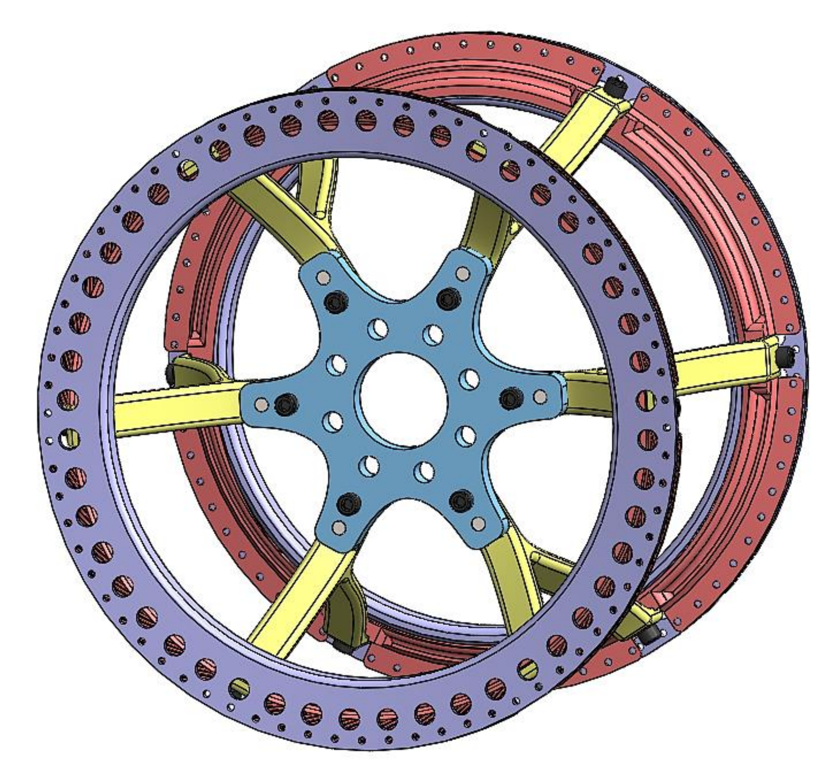
Notable Features

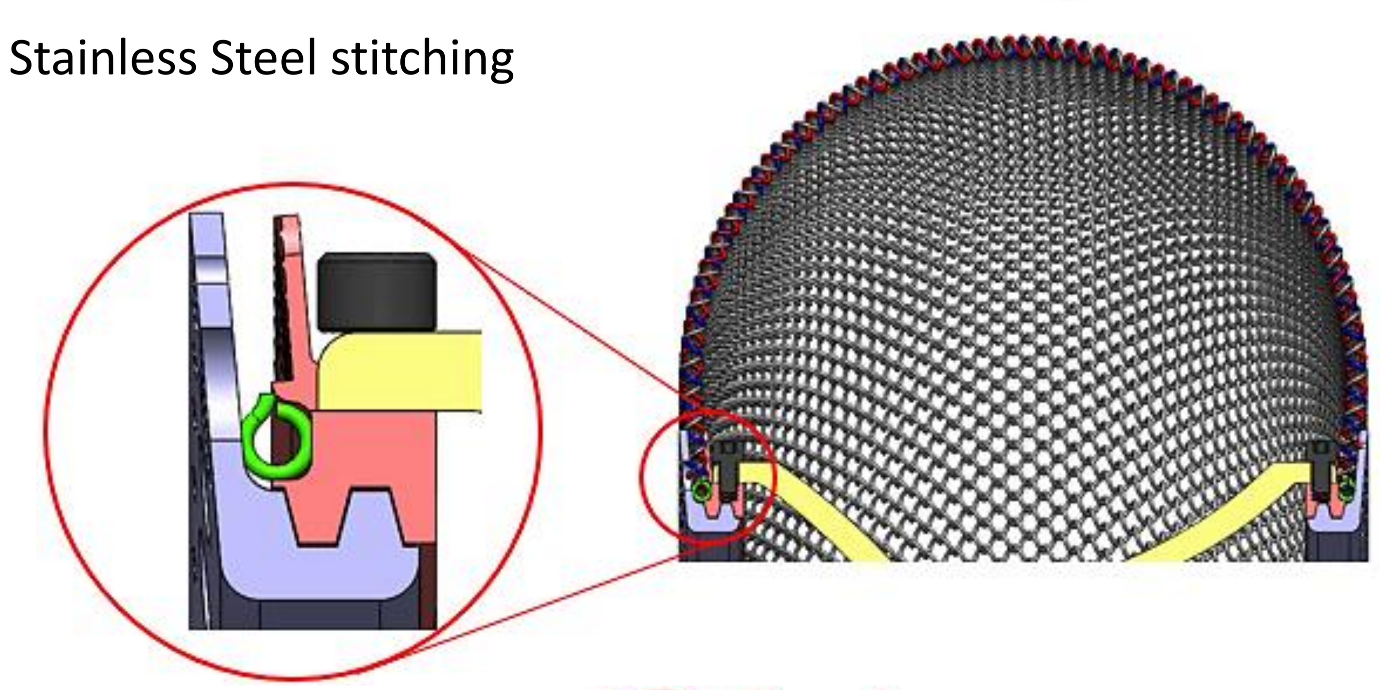
– Twist Lock (ACME 9.77-3 G2)

– Helical Grooved Plates

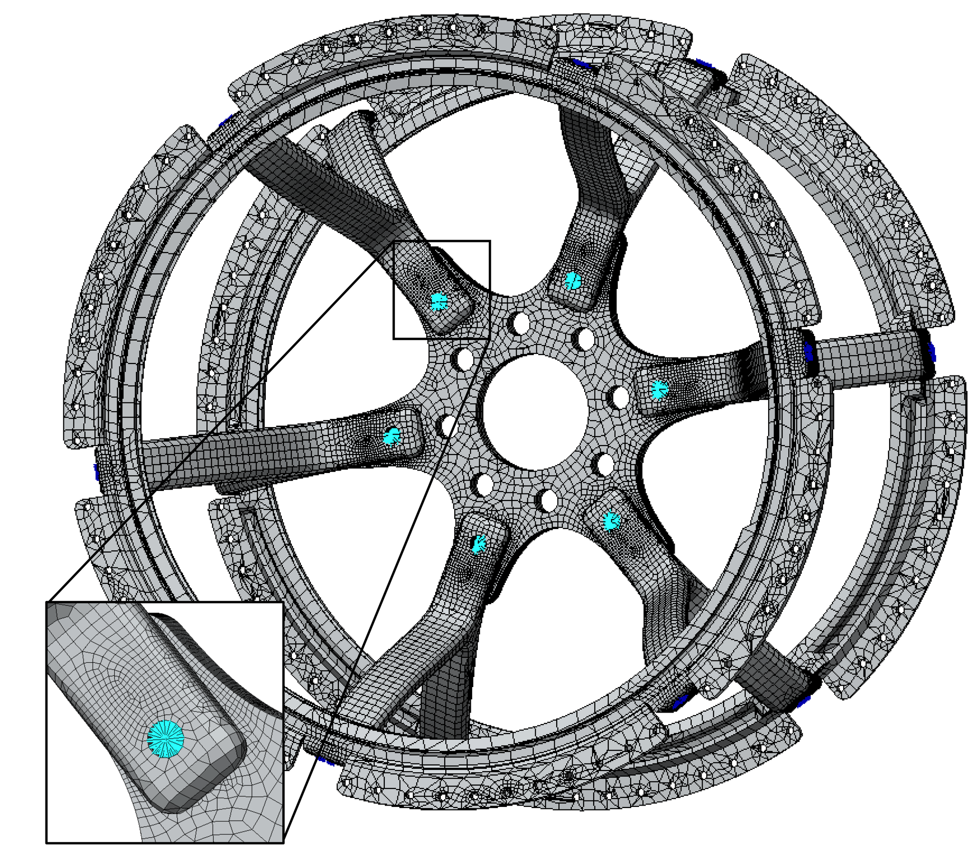
– Bead Lock

– Stainless Steel stitching

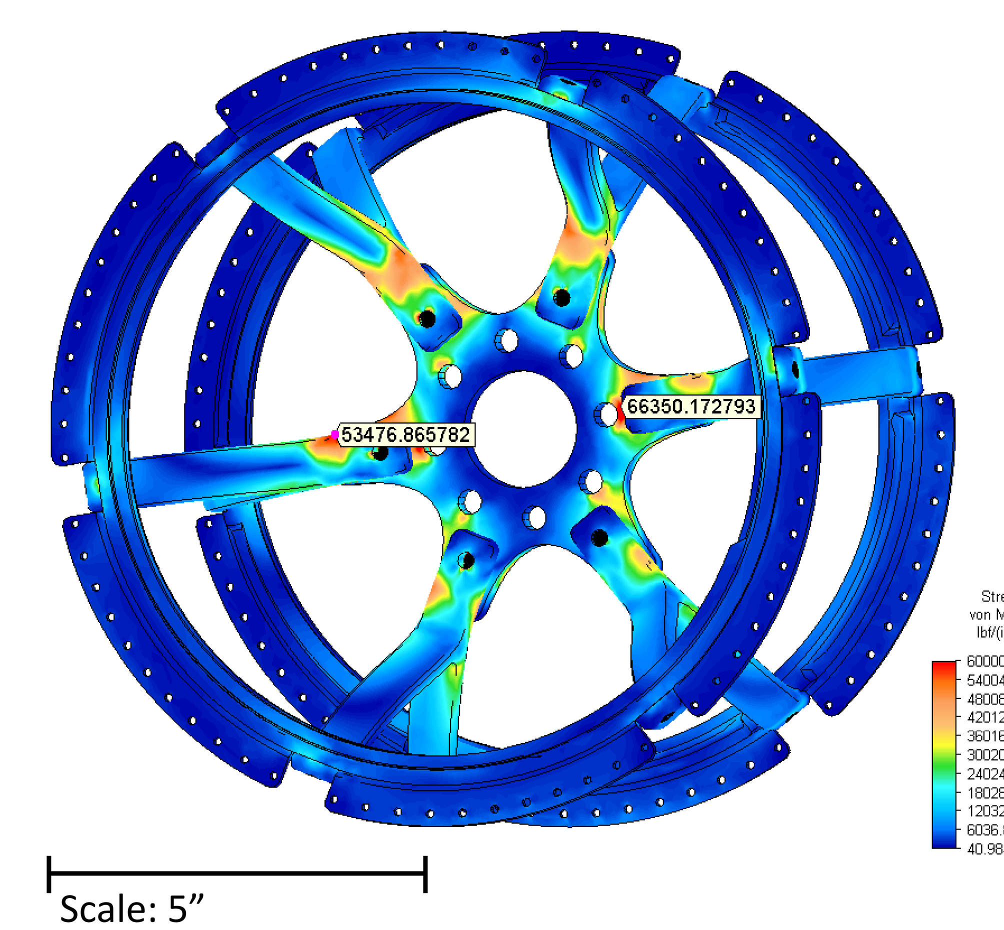




FINITE ELEMENT ANALYSIS



- Al-7075
- 438099 Elements
- Brick (Mid-Side Nodes)
  - 0.1” TYP
  - 0.03-0.05” Refinements
- Constraints:
  - Pins (Fixed)
  - Bolt (Truss)
  - Sliding Contact



- σ_{max}=66.3 ksi ($<S_y$=73.2 ksi)
- Ideal Value Loading:
  - Transverse torque
  - Coaxial torque
  - Axial assembly force
  - Force of weight

CONCLUSIONS/FUTURE WORK

- Met highest priority project requirements
- Modeled force behavior in rim and mesh
- Prototype in progress
- Exploration of SMA springs
- Rigid tires vs spring mesh tires