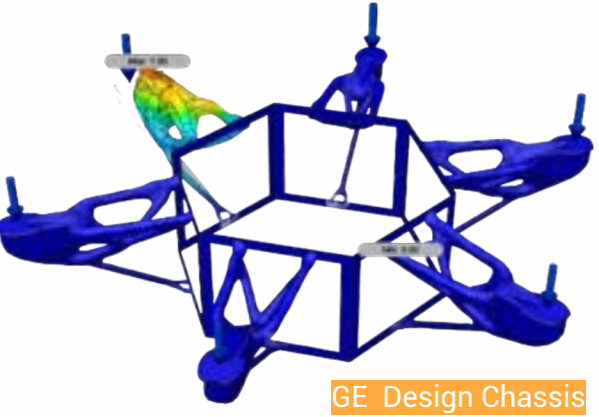
Mars Science Helicopter: Mass Optimization

Autonomy For Manufacturing And Construction



GE Design Chassis

Arm Generative Design Iterations

Top Cover Design Iterations

Synopsis

Design elements to optimize mass requirements for the Mars Science Helicopter

- Mission Requirements
  - Operate under specific temperature ranges, survive launch forces, 7-minute flight time, 30 m/s flight speed
- Design Criteria
  - ~4 Meter Diameter (with arms) and ~1 Meter Diameter (Chassis)
  - 18kg mass and payload mass of 2kg
  - Foldable Design

Research Objective

- Develop a Mars helicopter chassis optimized for
  - Mass
  - Vibrational Forces
  - Thermal Issues
- Develop with new manufacturing concepts such as
  - Generative Design
  - Metal 3D Printing
  - Carbon Fiber
- Validate design through digital twin simulations
  - Omniverse
  - Ansys

Research Approach

- Use generative design to create lightweight, efficient drone structures for enhanced performance and rapid design iterations.
- Apply thermal optimization through custom CFD API for Fusion 360 to ensure the mechanical structure withstands extreme temperature fluctuations during the mission.
- Utilize finite element analysis to address mechanical and vibrational issues, ensuring system robustness in demanding environments.

Research Results and Products

- Derived JPL Design Requirements
  - Chassis Size Range
  - Max Weight
- Finished standard chassis design and optimization as a reference point for testing against generative design iterations
  - Isogrid Design
  - Tube Truss Design

Commercialization and/or Societal Impact Opportunities

- **Application:** Decrease spacecraft iteration time and cost
- **Key Values:** Generative design, optimization, analysis
- **Potential Customers:** Space industry, automotive industry

Team Names & Collaborators

ARCS Students:

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Faculty:

Prof. Amiel Hartman, ME; Dr. Bingbing Li, MSE; Dr. Ashley Geng, ECE

Collaborators:

Dr. Greg Agnes, JPL; Dr. Larry Matthies, JPL

Citations

Johnson, W., Withrow-Maser, S., Young, L., Malpica, C., Koning, W. J., Kuang, W., ... & Grip, H. F. (2020). Mars science helicopter conceptual design (No. ARC-E-DAA-TN78199).

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