Team 27(ME)/18(ECE): Mars Lander Robot Recharger

Final Presentation

Team Members/Advisors

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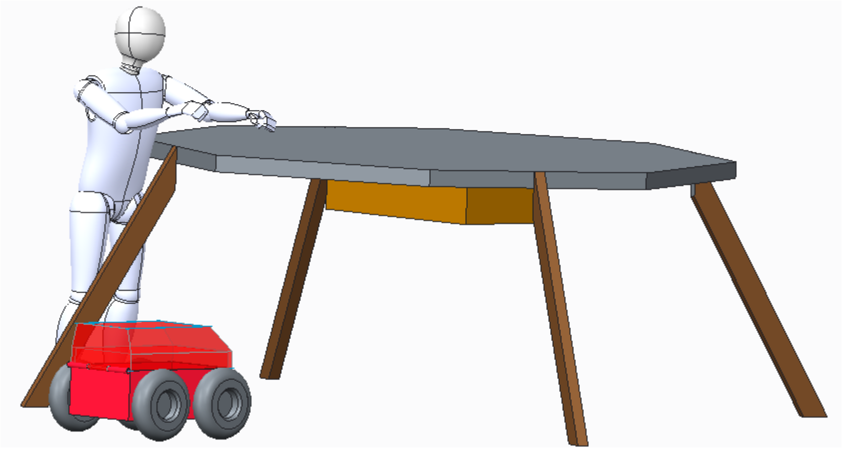
  - Dr. Arora – ECE Advisor
  - Van Townsend – Technical Point of Contact
  - Michael Solomon – Intellectual Property Point of Contact

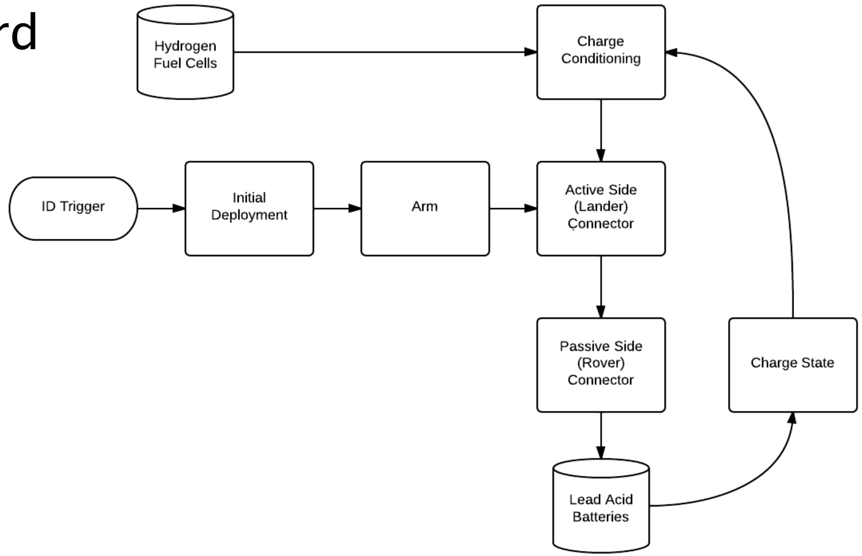
Mission

- There are Martian excavators which will be collecting samples and delivering them for testing.
- In order to decrease the weight of each rover, battery recharging is an external process.
- Our mission is to design the recharging system for the excavators.



Project Scope

- Get power from the stationary lander to the rovers
- Hydrogen fuel cell bank on board the lander
- Two 12V Lead Acid Batteries onboard
- the rovers
- Rovers drive up to be refueled
- Station records current charge state
- Fills batteries to 100%



Budget/Procurement

	Cost (in USD) to Prototype as Designed
Prototyping	
TOTAL COST TO PROTYPE	1099.84
Testing	
TOTAL COST TO TEST	119.27
SHIPPING AND HANDLING CHARGES	250.00
UNFORESEEN EXPENSES	530.89
GRAND TOTAL	**2000.00**

- Procurement began in November.
- Final purchase orders have been placed.

Design Constraints

- Efficiency
  - >75% Required
  - >90% Preferred
- Mass
  - Rover Connection
    - <2 kg Required
    - <1 kg Preferred
  - Arm
    - <4 kg Required
- Charge Time
  - 8 hrs maximum

Connection Designs

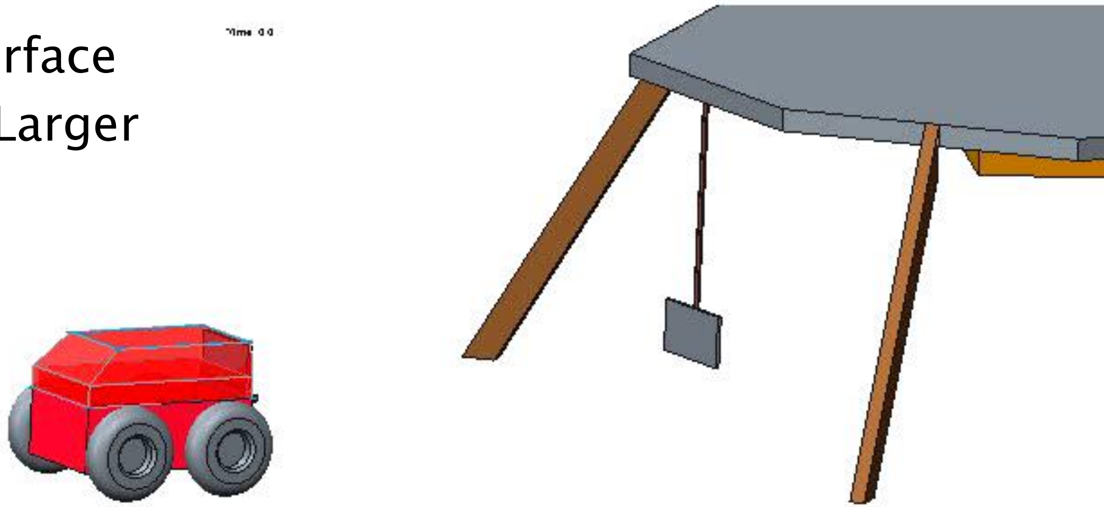
- All design decisions relied on the design and operation of the connection between lander and rover.
- Several decisions had to be made early on.
  - Wireless or Physical?
  - Active or Passive?
  - Shielded or exposed?
- The team went through several design iterations before landing on the final design.

CPT Hybrid Design

- An earlier design relied on a wireless power transfer backup
  - In the event of connection obstruction, power could still be transferred.
  - The connection terminals are treated like the plates of a capacitor.
- Design driven by concerns about dust storms
- Added mass and complexity found to be unjustifiable.

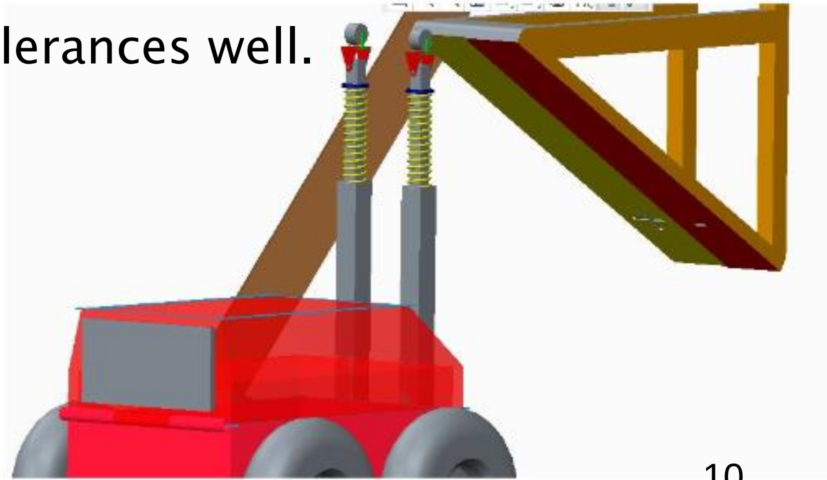
CPT Docking Station

- Contact-CPT Hybrid
- Minimal arm control
- Requires static Martian Surface
- Rover Side plate must be Larger than Lander Side plate



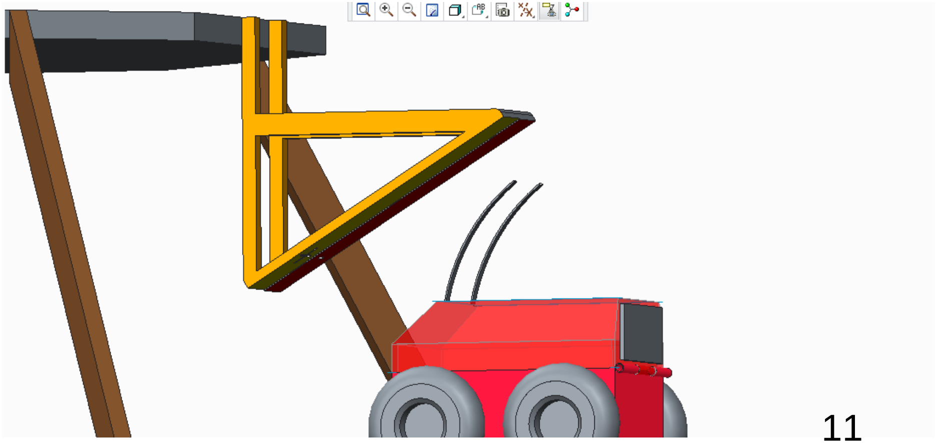
New Concept

- Whole family of designs around an angled plate docking station.
- No more wireless backup.
- First concept involves spring mounted contacts.
- Handles translational and rotational tolerances well.



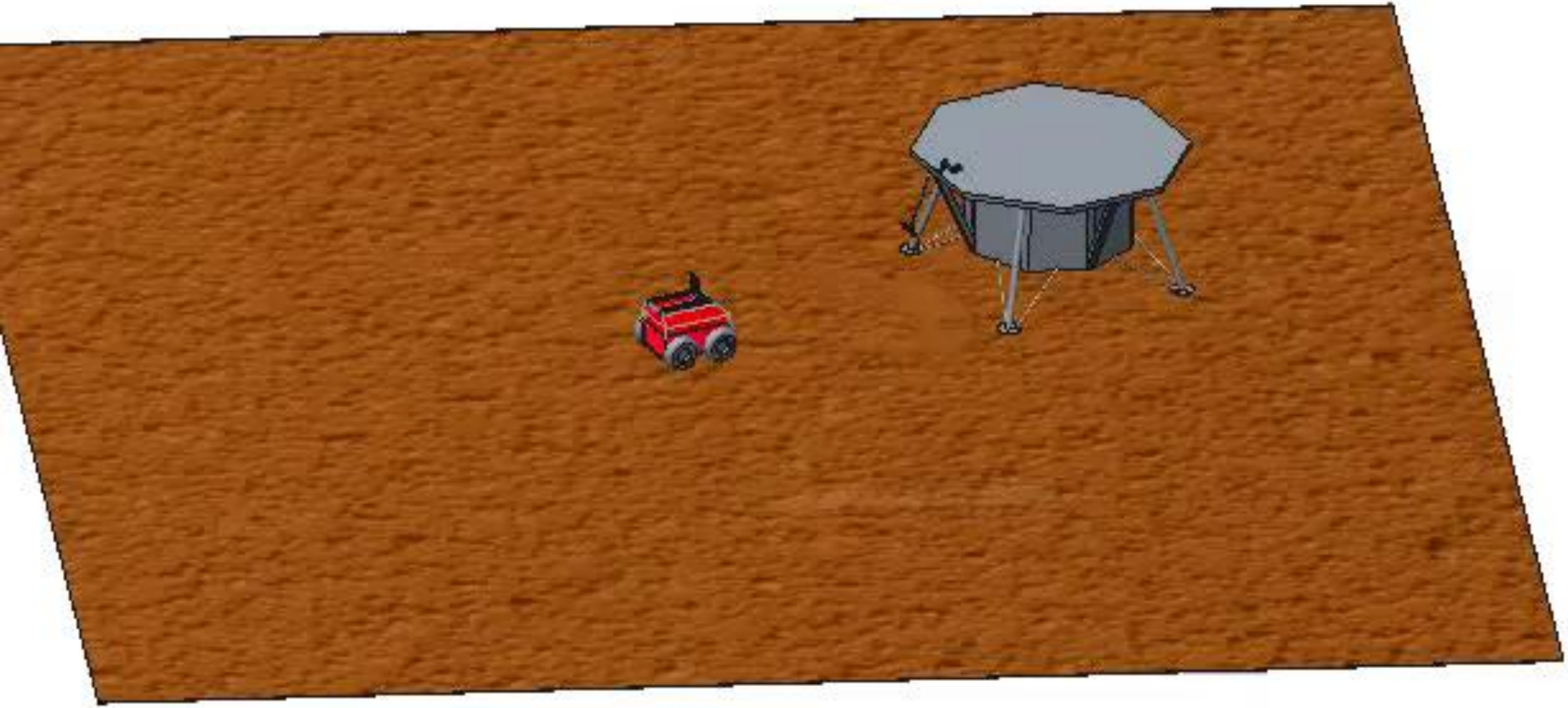
Leaf Spring Concept

- Give the Rover antennae.
- Light, simple, easy to meet ALL required tolerances.
- Very easy to manufacture and test.

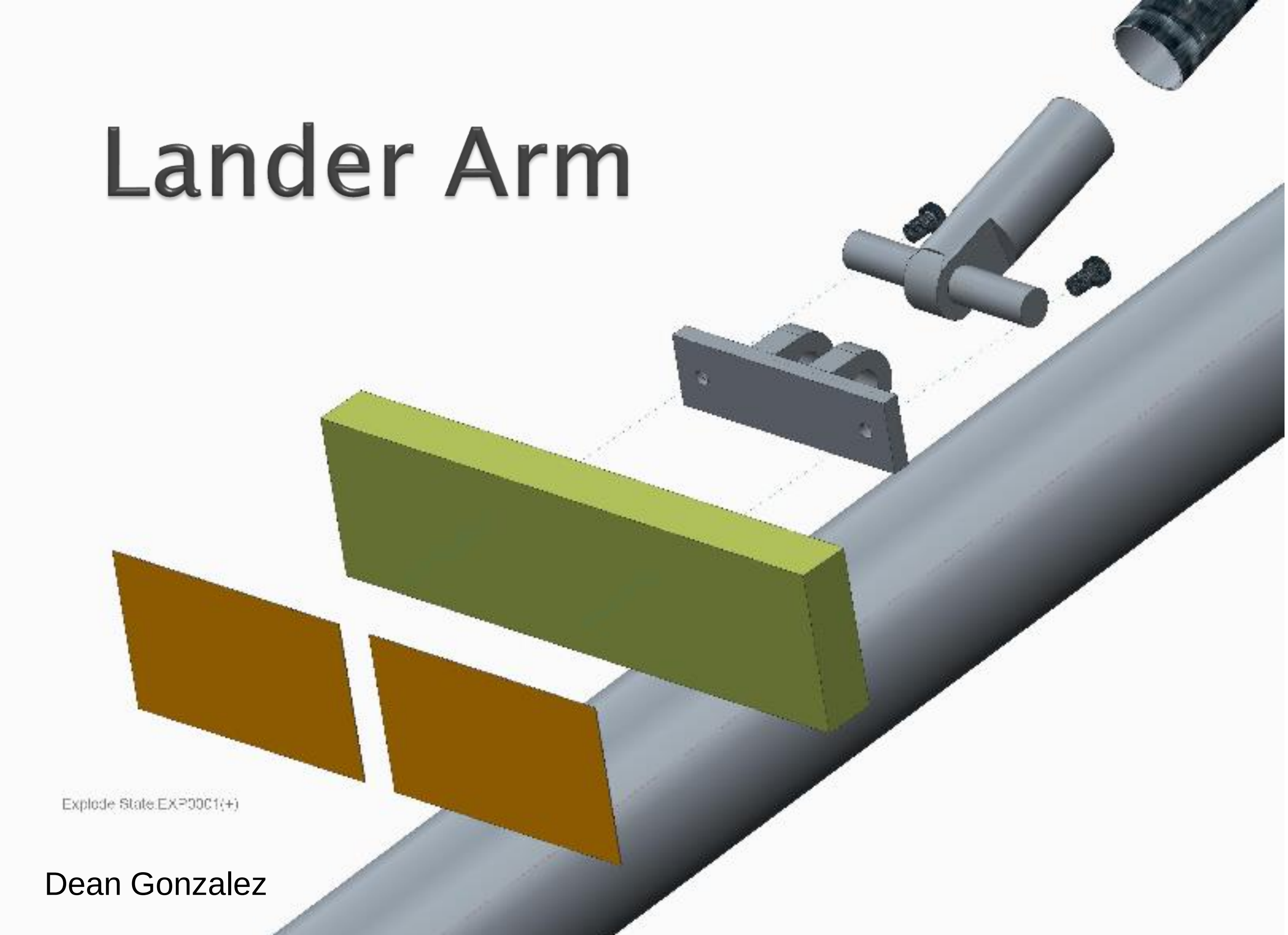


Arm Design

- New arm design concept driven by Passive control method
  - Reduced mass
  - Reduced power consumption
  - Reduced complexity and required arm control
- Arm must be mounted to top of lander deck
- Arm is deployed from initial storage position

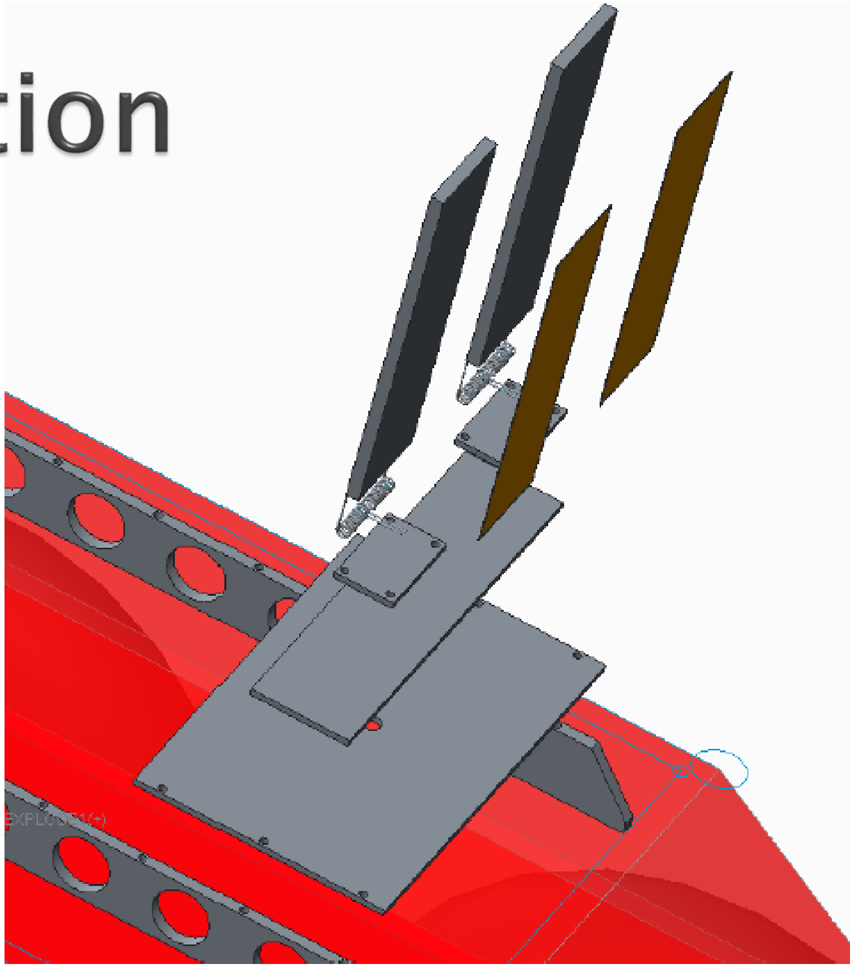


Lander Arm

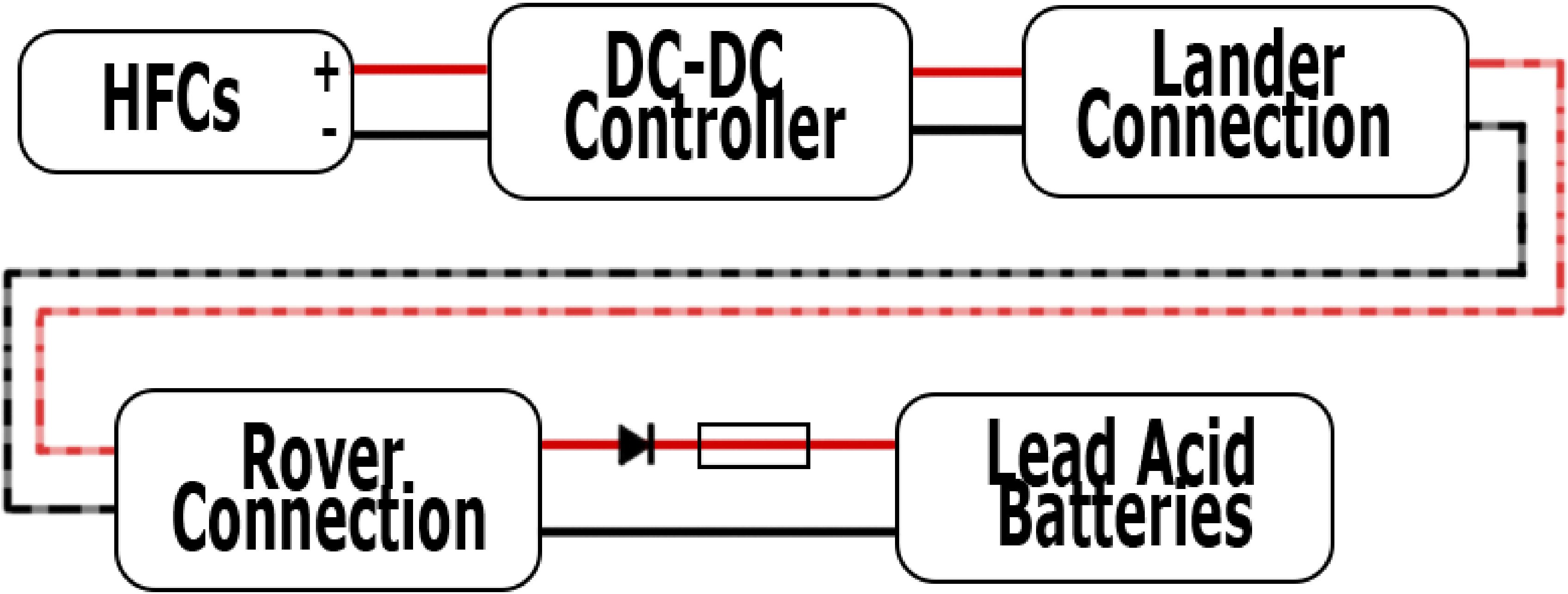


Dean Gonzalez

Rover Connection

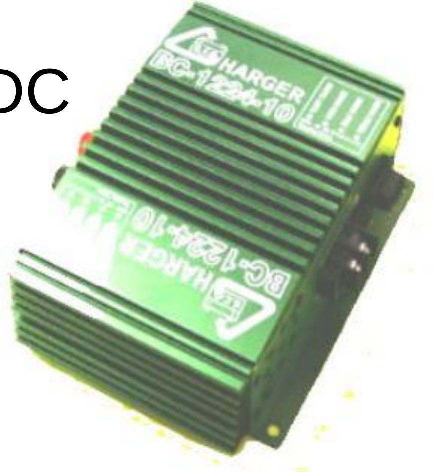


Electrical System

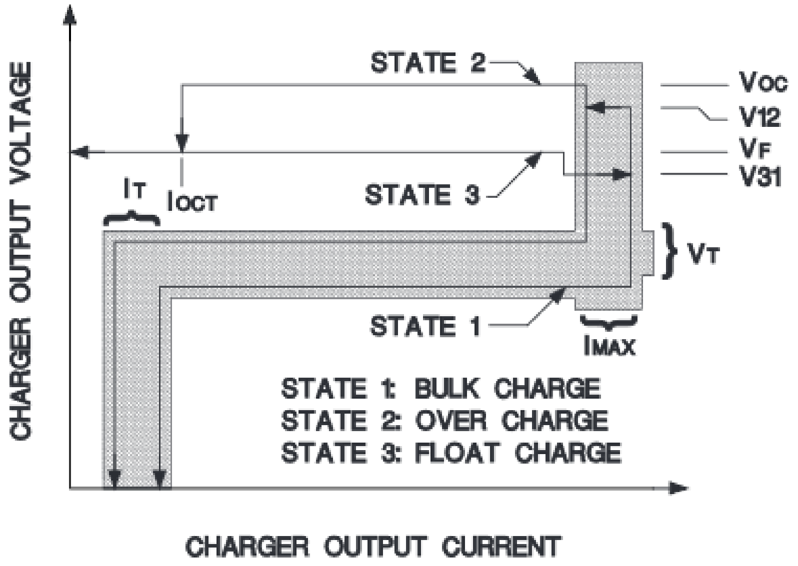


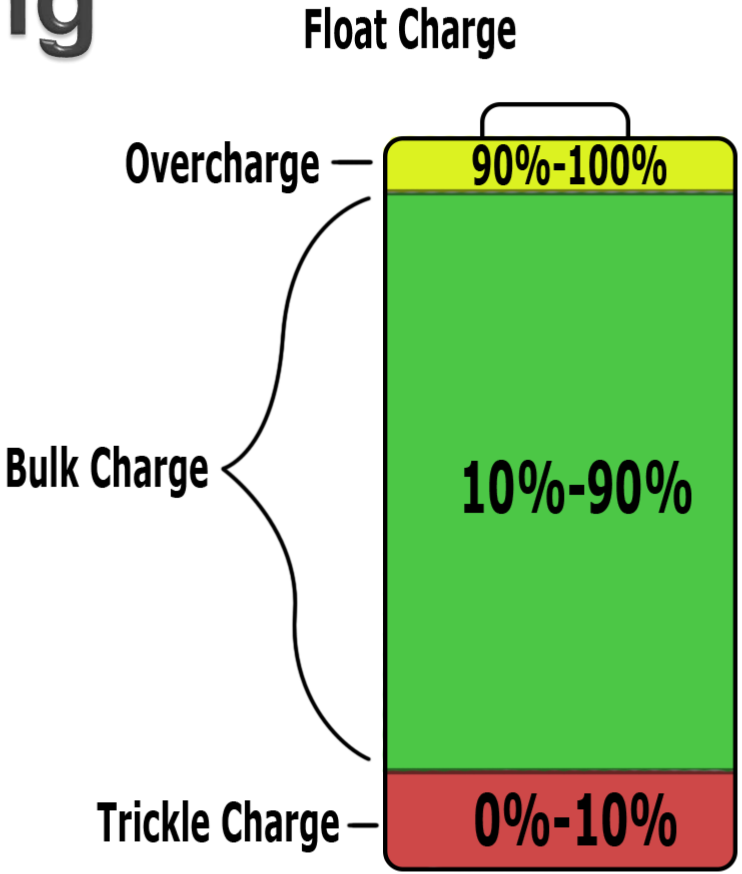
Charge Control

- Power Stream PST-BC2424-10 DC-DC
  - 24-32V input
  - Adjustable output current, up to 10 Amps
  - 4 stage charging algorithm
  - Short Circuit/polarity protection



Four State Charging





Safety and Ergonomics

- QinetiQ has asked for safety systems to protect workers in the Lab.

Risk:

- Possibility for shocks/burns to occur if human hand were to be placed on plate
- Possibility for metal tools to short plates creating a sudden large current that could burn out the lander circuit

Solution:

- First charge stage is current-limited, <100mA.
- Diode at the base of the rover connection.
- Fuse in the rover.

Conclusions/Analysis

- Full arm design completed
  - Simple/Robust/Reliable
  - NASA Approves
- Completed lander and rover connection designs
  - Effective design for the application, efficient, and safe
- Materials selection process
  - Lightweight, within mass constraints of <4kg
  - Low forces/stresses experienced
- Procurement completed
  - Complications encountered with contact

Recommendations for Future Work

- Build final prototype out of correct materials
  - Only have ¼ scale 3D printed visual model
  - Ensure full-size working prototype of arm
  - Test initial deployment is successful
  - NASA should test system using rovers in the lab at acceptable angles of approach and elevation angles

- Test charge circuit (measure efficiency to ensure within requirement of >75%)
  - Test using 50% drained batteries

Acknowledgements

- NASA/Qinetiq Sponsor:
- FSU COE Faculty:
- Team 27 Members

References

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Questions, Comments?