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

Midterm Report 1

Team Members/Advisors

- Team Members
  - James Whaley – Project Lead/ME Lead
  - Lucas Kratofil – ECE Lead
  - Dean Gonzalez – Financial Advisor/Secretary
  - Itiel Agramonte – Webmaster
  - Tyler Norkus – Webmaster
- Advisors/Technical Contacts
  - Dr. Moore – ME Advisor
  - Dr. Arora – ECE Advisor
  - Van Townsend – QinetiQ Liaison
  - Michael Solomon – QinetiQ Intellectual Property Contact

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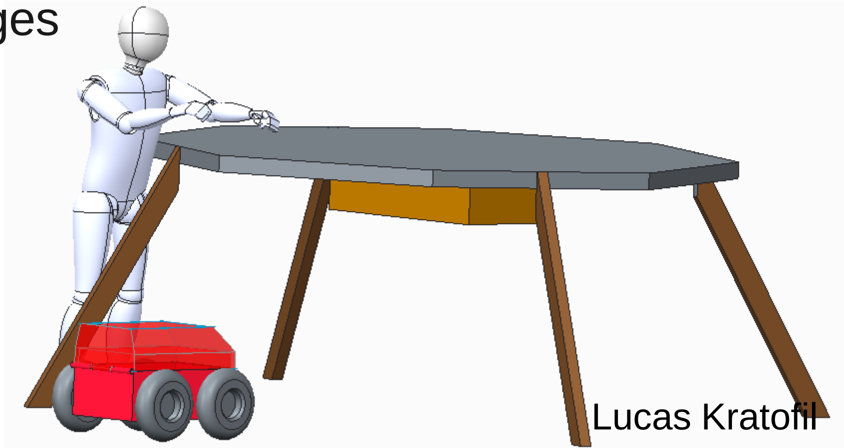
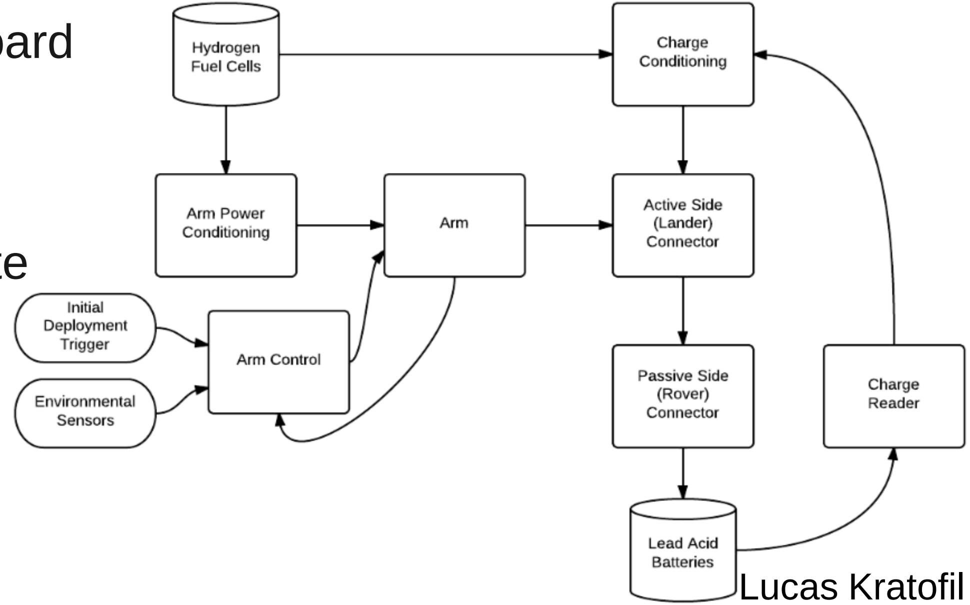
Mission

- NASA has a need for more efficient exploration missions
- Reducing mass increases efficiency
- Design a mission around a stationary lab/fuel station
- A fleet of rovers explores and collects samples
- Deposit samples at the base and recharges
- No need for large, heavy batteries and power generation systems onboard the rovers.



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%



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Design Constraints

- Efficiency
  - >75% Required
  - >90% Preferred
- Mass
  - Rover Connection
    - <2 kg Required
    - <1 kg Preferred
  - Arm
    - 4 kg Required
- Volume

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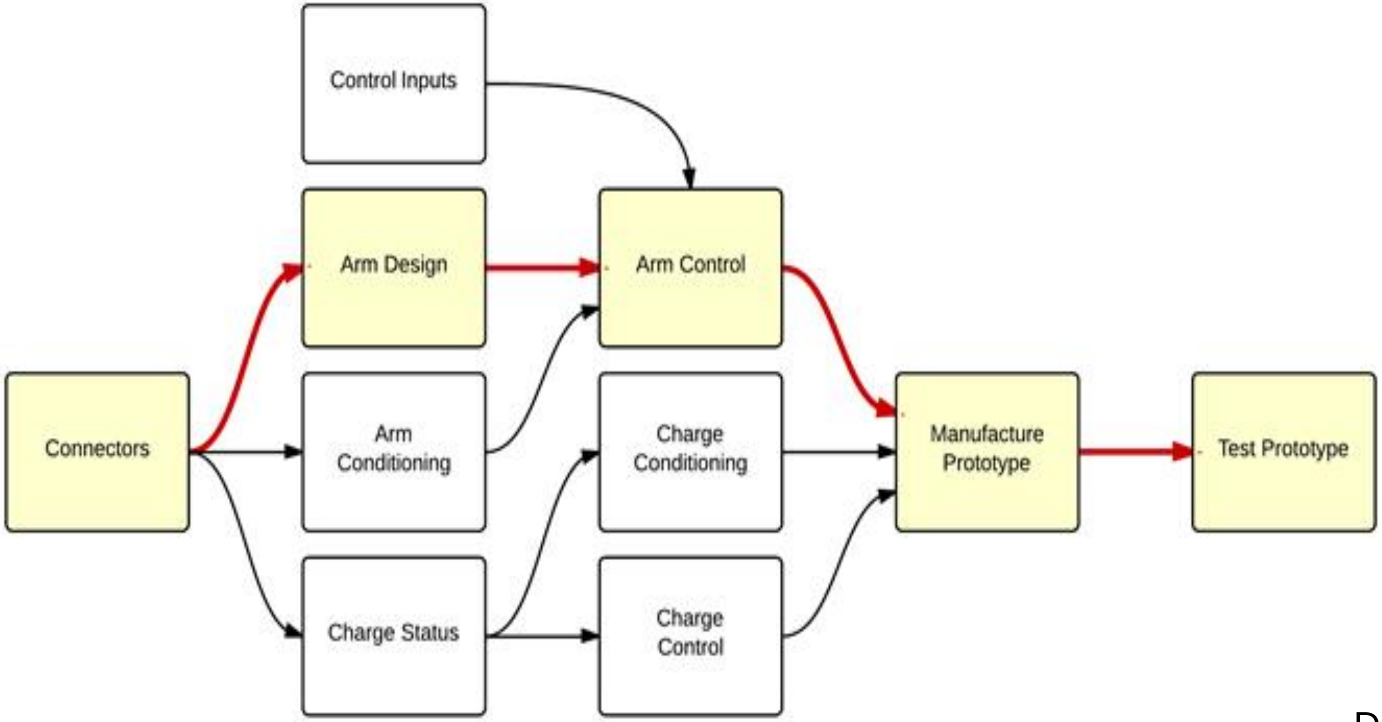
Task Dependencies



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Power Transfer Method

- Contact or Wireless Power Transfer?
  - Contact Power Transfer: Typical Male-Female Plug
  - Types of Wireless Power Transfer:
    - Inductive
    - Laser
    - Microwave
  - Researching Capacitive Power Transfer (CPT) Lead Us to a Unique Solution
    - External Contact with CPT Backup System (Hybrid)
  - Three Power Transfer Options
    - Physical
    - Physical/CPT Hybrid
    - Wireless
  - Ruled out wireless using a Decision Matrix

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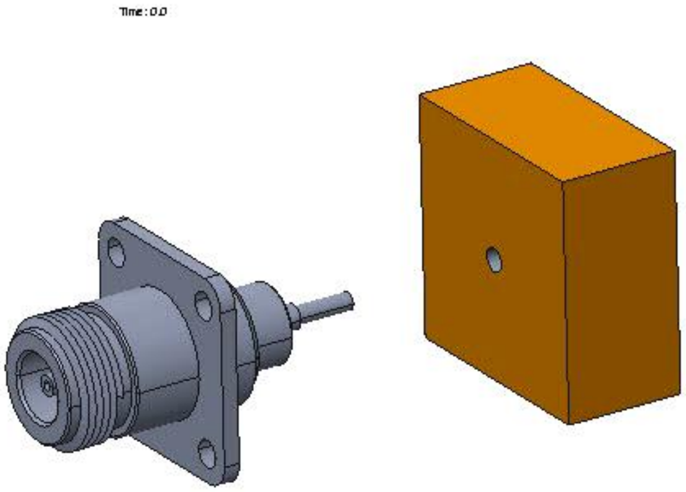
Concept 1: Pin-Socket

- Physical
- Pros
  - Simple
  - Light
  - Symmetric
  - Efficient
- Cons
  - Dust
  - Sophisticated arm control
  - NASA/QinetiQ says to avoid



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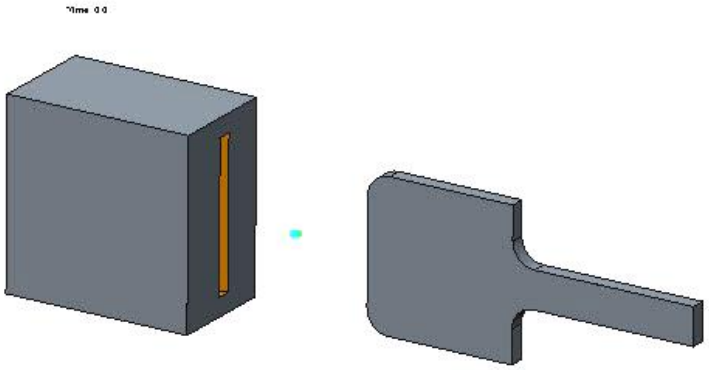
Concept 2: Paddle/Slot

- Physical
- Pros
  - More robust than pin
  - Brushes reduce dust
- Cons
  - Sophisticated arm control
  - Difficult to align paddle with slot



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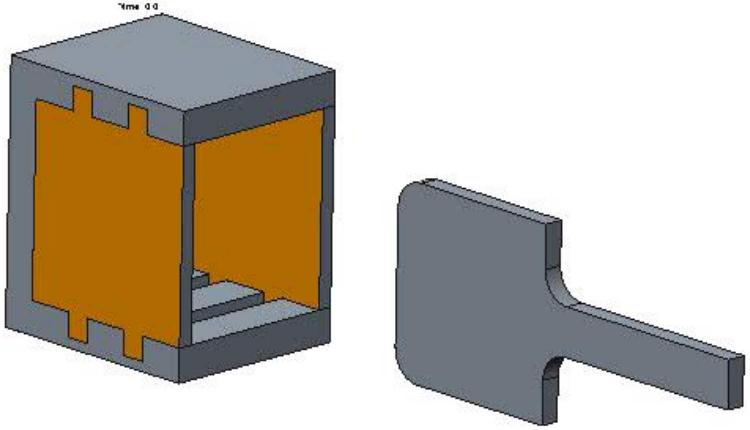
Concept 3: Paddle/Clamp

- Physical
- Pros
  - More robust than pin
  - Remedies alignment difficulties of paddle/slot design
- Cons
  - Sophisticated arm control
  - More moving parts
  - Cavity collects dust



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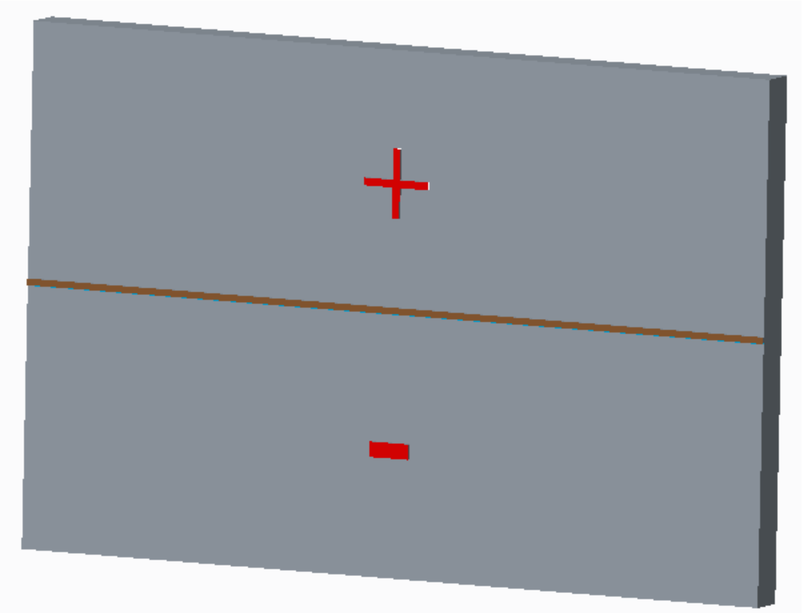
Contact/CPT Hybrid

- Primarily physical contact connection
- Two pairs of plates meet to transfer power
- Physical Obstruction initiates CPT backup
- High frequency power treats the plates as a capacitor
- Power is transferred through the electric field between plates
- 65-90% efficiency depending on conditions



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Concept 4: Blunted-Cone

- Contact-CPT hybrid
- Pros
    - Fully symmetric
    - Resistant to dust
    - Simpler Arm Control
- Cons
    - Difficult to manufacture
    - Requires strict dimensional tolerances

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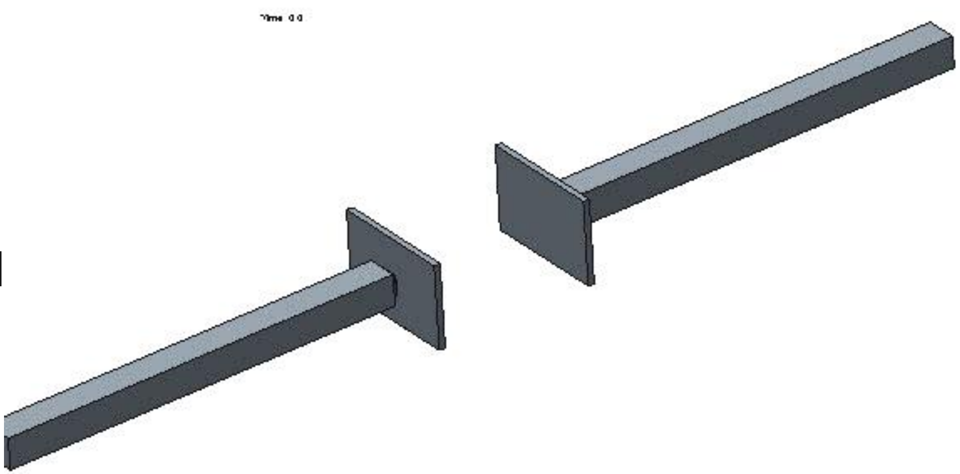
Concept 5: Moving Plate

- Contact-CPT Hybrid
- Pros
  - Resistant to dust
  - Easy to manufacture
- Cons
  - Sophisticated arm control
  - Catches wind
  - Non-Symmetric



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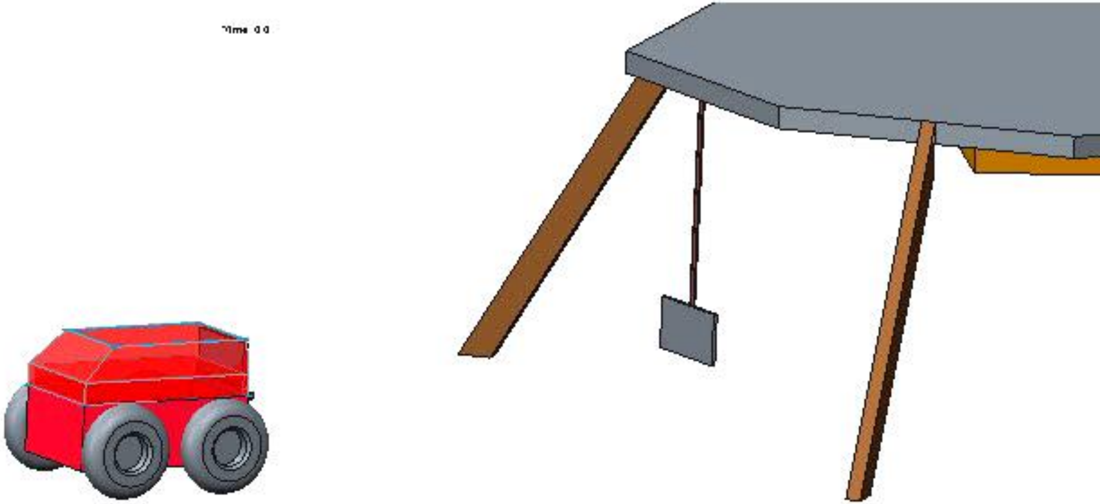
Concept 6: POCCET Station

- Contact-CPT Hybrid Pros
  - Minimal arm control
  - Easy to prototype/test
  - Resistant to dust
- Cons
  - Not symmetric
  - Requires static Martian Surface
  - Catches wind



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Decision Method

- 6 Initial Connector Concepts
- Decision Matrix to weed out dead-ringers
- 4 high-ranking concepts remain
- Qualitative analysis, pros/cons list
- Decision

	Rank	Plug – 1 Pin	Paddle – Single Slot	Paddle - Clamp	Blunted Cone	Roomba Station	Moving Plate
Mass	0.2	8.5	6.5	6	6.5	8	8
Reliability	0.16	7.5	8	8.5	8.5	9	8.5
Volume	0.12	9	8	7	7.5	8	7.5
Robustness	0.12	3.5	7	6.5	8	7	8
Simplicity – Design	0.08	9	8	7	7	8	7
Simplicity - Use	0.12	4	4	5	9	7.5	8.5
Efficiency	0.2	10	10	10	7	7	7
Total	1	51.5	51.5	50	53.5	54.5	54.5

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Design Considerations

- All design decisions are dependent on the connector
- The arm design is the next crucial design decision
- Design specifications include:
    - Material
    - Geometry
    - Movement
- Several considerations taken into account
    - Forces
    - Martian dirt and dust storms
    - Minimize movement
    - Ease of manufacture
    - Reduced Gravity

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Conclusion

- Connector decision has been made
- Next steps
  - In the process of subsequent design decisions
  - More detailed connector design
- Budget proposal for NASA/Qinetiq
- Aggressive schedule to catch up (on-track)

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References

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Questions, Comments?