



Australian Rover Challenge - Building Capability Through Competition

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Outline

Australian Rover Challenge - Capability Building through Competition

- Definition
 - Establishment and focus
 - Detail
 - Growth over time
 - ARCh 2025 changes and outcomes
- Impact
 - On systems engineering, robotics, and the Australian space community
- Future
 - ARCh 2026 and beyond





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CHALLENGE**

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Definition

Establishment



Andy Thomas Centre for Space Resources

Enabling long term human presence in deep space

Lunar civil construction & architecture, robotics, space medicine, psychology, law, agriculture



- Established 2020
- Make robotics accessible and develop STEM workforce
 - Enable the growth of multidisciplinary student teams
 - Provide a platform for national collaboration towards innovation
 - Pioneer full-scale planetary simulation missions
 - Promote collaborative learning and friendly competition

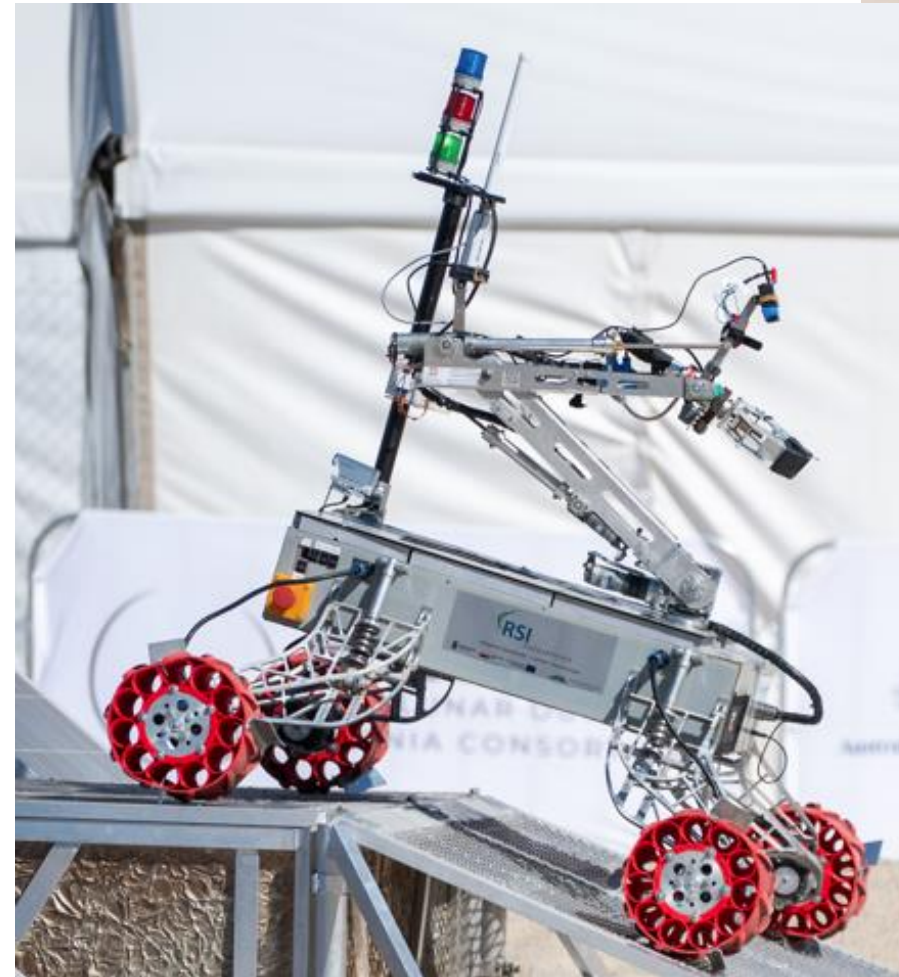
Focus

- Aligned with the Australian Space Agencies' Moon to Mars initiative Trailblazer - the *Roo-ver* project, an Australian-made lunar rover controlled from Earth
- Challenge based on a Lunar robotics scenario with rovers completing four separate tasks over four days
 - Post landing
 - Excavation & construction
 - Space resources
 - Autonomy & mapping



Rover constraints

- Stand-alone, off-the-grid, mobile platforms, controlled from a base station
- Bespoke (not COTS)
- Fix in a 1.6m x 1.6m x 1.6m box at competition start
- Have a mass less than 50kg for some tasks, 60kg for others (depending on payload)
- Cost less than ~\$20,000 (US)
- Conform to appropriate off-Earth constraints (propulsion, GPS, etc.)



History - 2021



- 3 Australian Teams (2 new)
- 120 Participants
- 18m x 15m pitch

History - 2022



- 5 Australian Teams (2 new)
- 150 Participants
- 18m x 15m pitch

History - 2023



- 7 Australian Teams (2 new)
- 1 International Team
- 190 Participants
- 18m x 15m pitch

History - 2024



- 8 Australian Teams (1 new)
- 2 International Teams
- 210 Participants
- 30m x 35m pitch

History - 2025



- 12 Australian Teams (4 new)
- 3 International Teams (+1 demo)
- Over 300 Participants
- Two 30m x 25m pitches side-by-side

Pitches

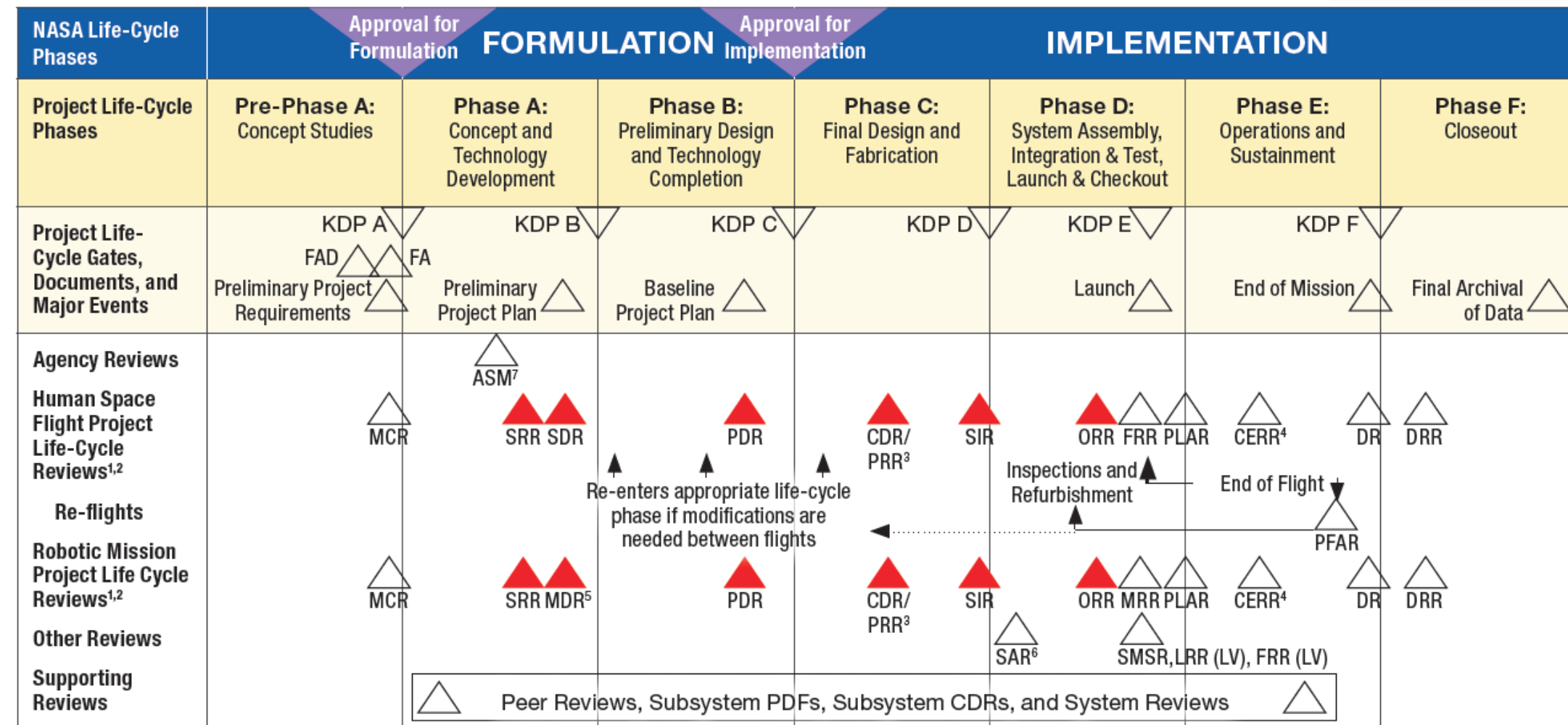
- Two 30m x 25m pitches side-by-side at the university's Roseworthy campus for 2025 and beyond





Tasks - Pre-competition Systems Engineering

- **Critical Design Review**
(30 pts, ~5-months pre-competition)
- **System Acceptance Review & Proof of life video**
(70 pts, ~1-month pre-competition)



(NASA, 2017)

- Judging panel from academia, industry and government
(CSIRO, Caterpillar, Lunar Outpost Oceania, Inovor, others)

Tasks - Post landing

Descend ramp
(5 pts)

Check systems
(15 pts)

Site evaluation
(30 pts)

Read RFID
(10 pts)

Plant maintenance
(20 pts)

Hose connection
(20 pts)



Tasks - Excavation & construction

Descend ramp

(5 pts)

Rock clearing

(30 pts)

**Excavation and
berm**

construction

(30 pts)

Paver

construction

(35 pts)

Tasks - Space resources

Prospect for site identification:

**2 x water,
2 x ilmenite**

(20 pts)

Excavate and process frozen sand (“regolith”) to obtain water
(50 pts)

Presentation
(30 pts)

Tasks - Mapping & autonomous

**Leave start area
autonomously**
(5 pts)

**Navigate
autonomously
and find
landmarks given
approximate
positions**
(30 pts)

**Map arena giving
location of cube
elements**
(40 pts)

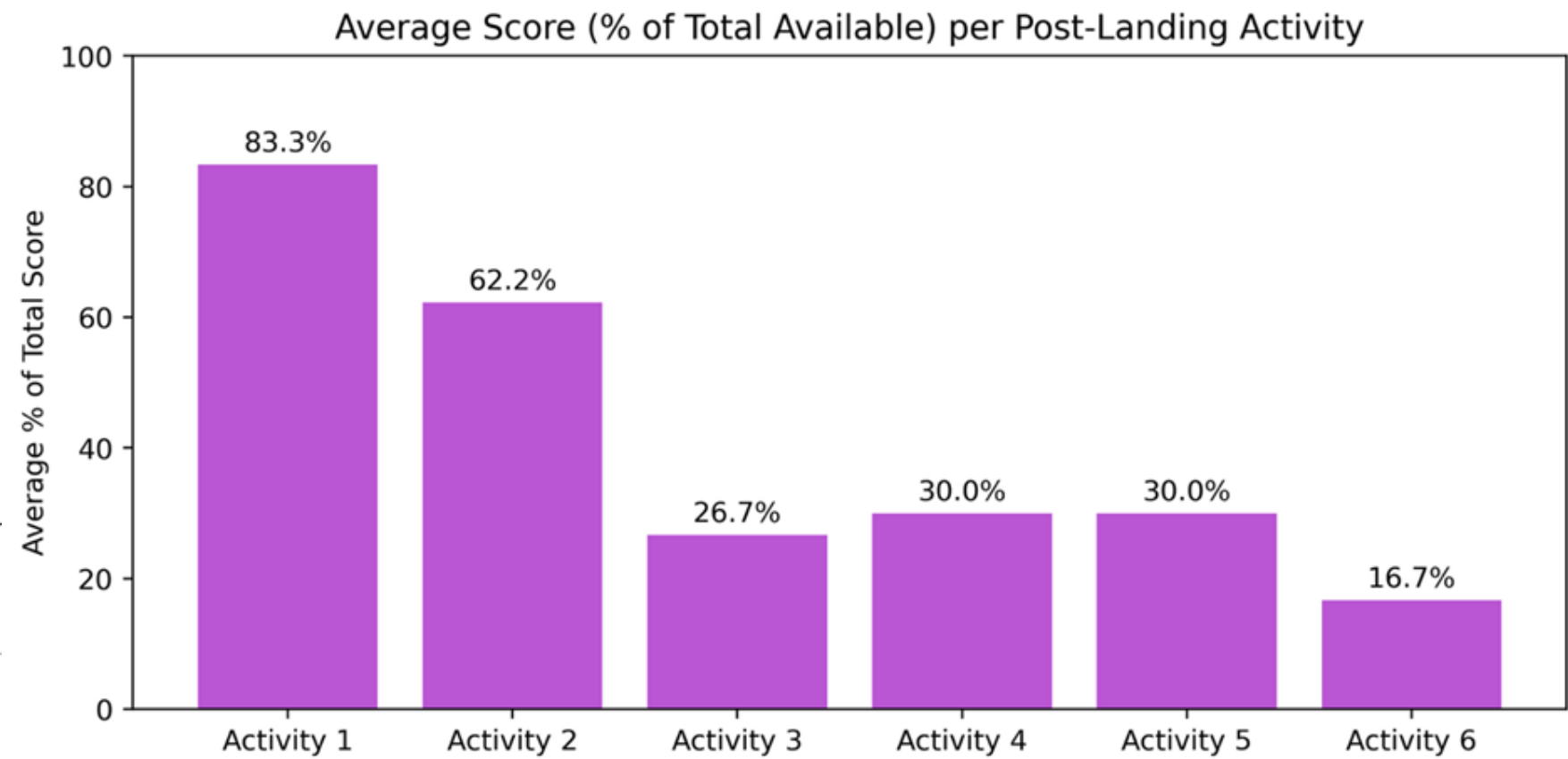
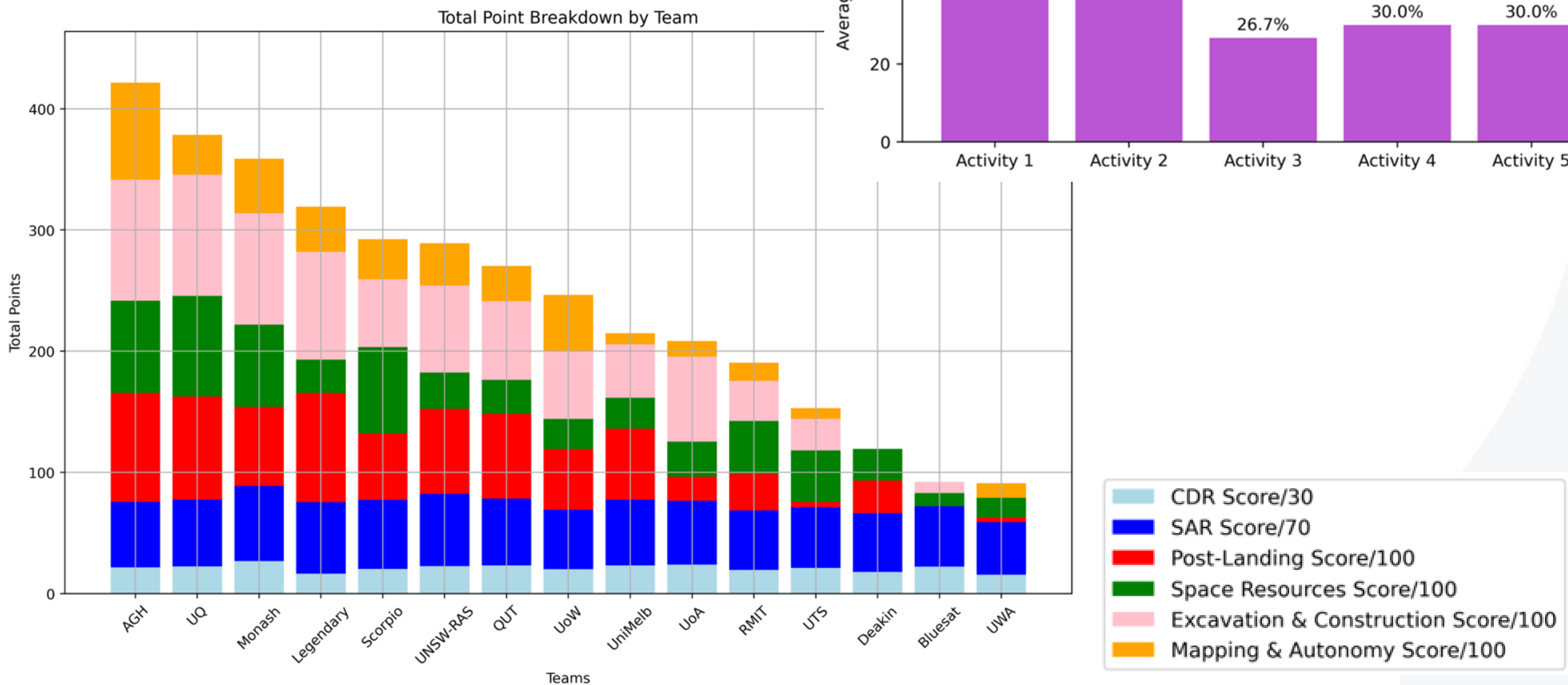
Presentation
(25 pts)

ARCh 2025 changes

- Entry checks for SE reviews
 - More focus on SE
 - All submissions had required elements
- Two fields for simultaneous competition
 - Learnt from Lunabotics 2024
 - Allowed for more entrants
- Open, connected workshop area
 - Promoted collaboration
 - Great for school and public tours
- Updated commentary with roving reporters



ARCh 2025 outcomes



ARCh 2025 outcomes - Lunabotics demonstration






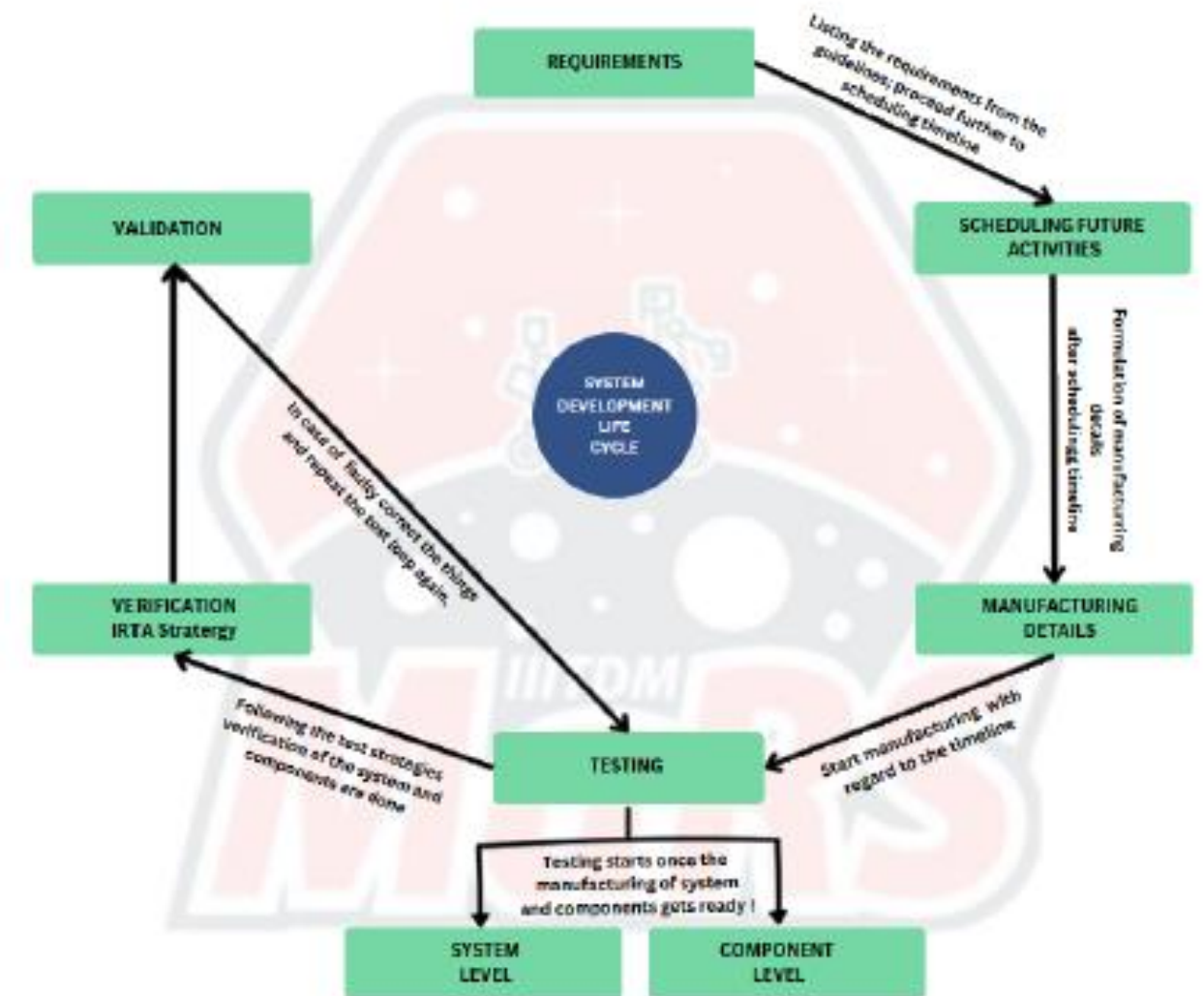
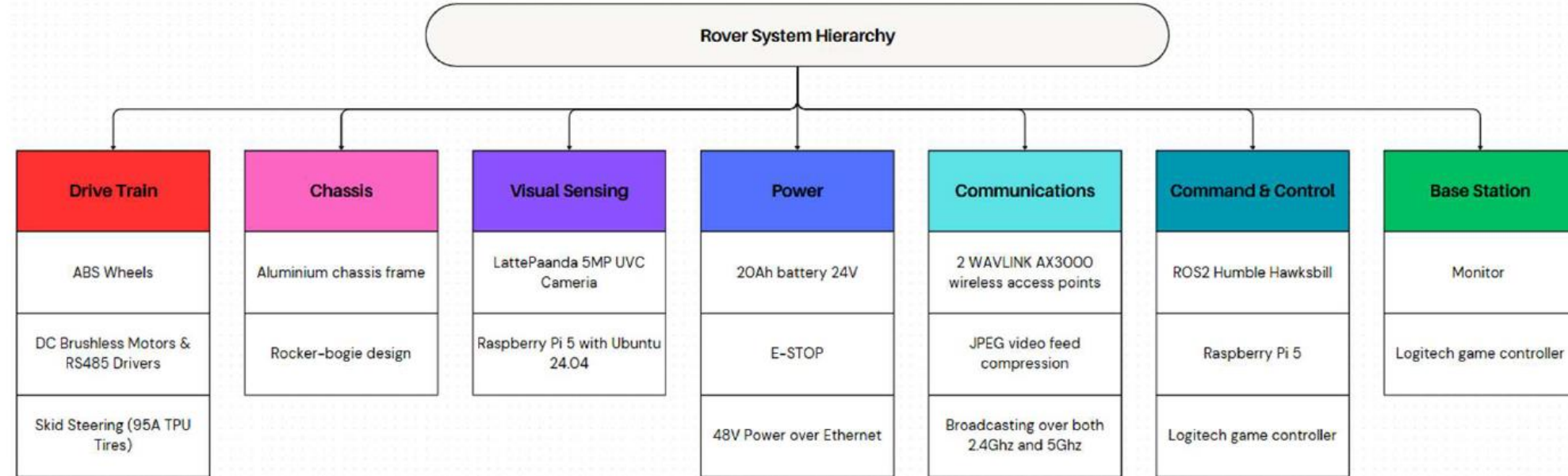
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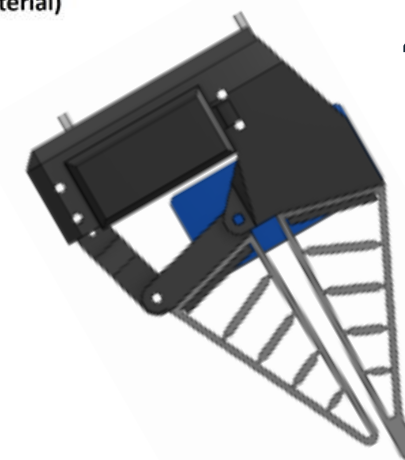
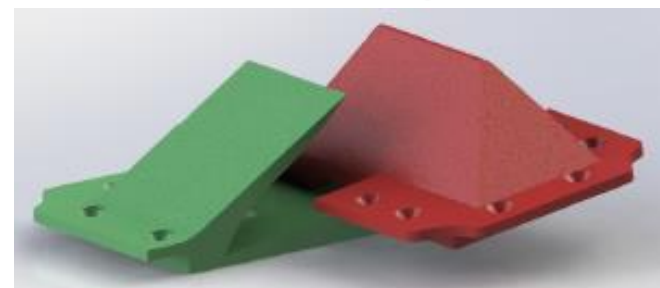
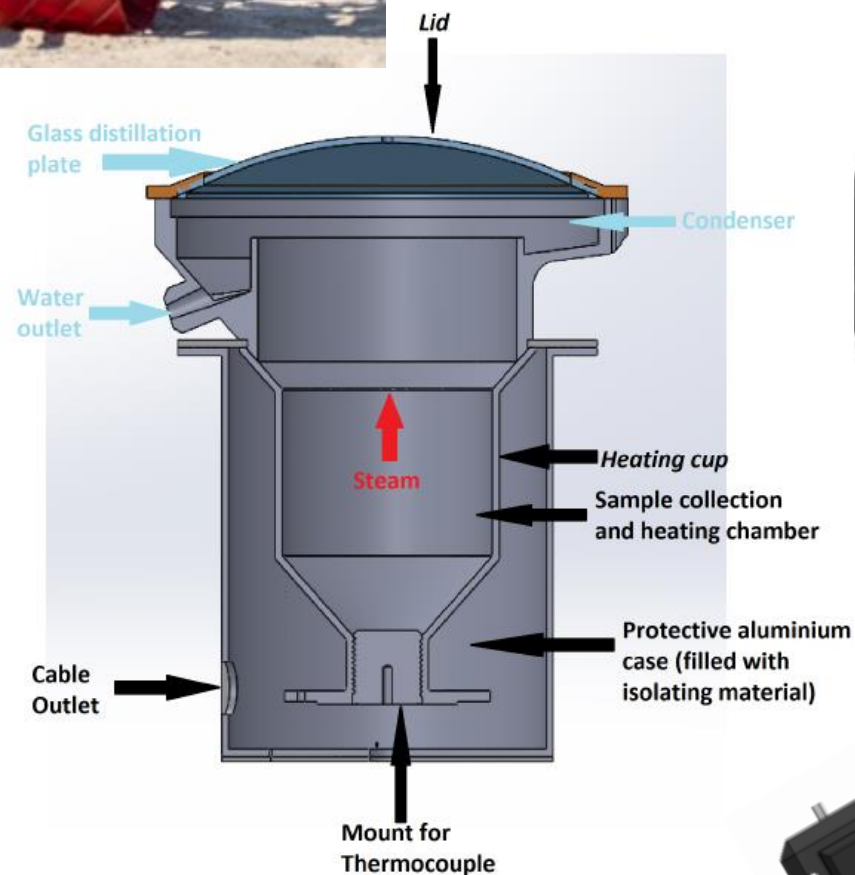
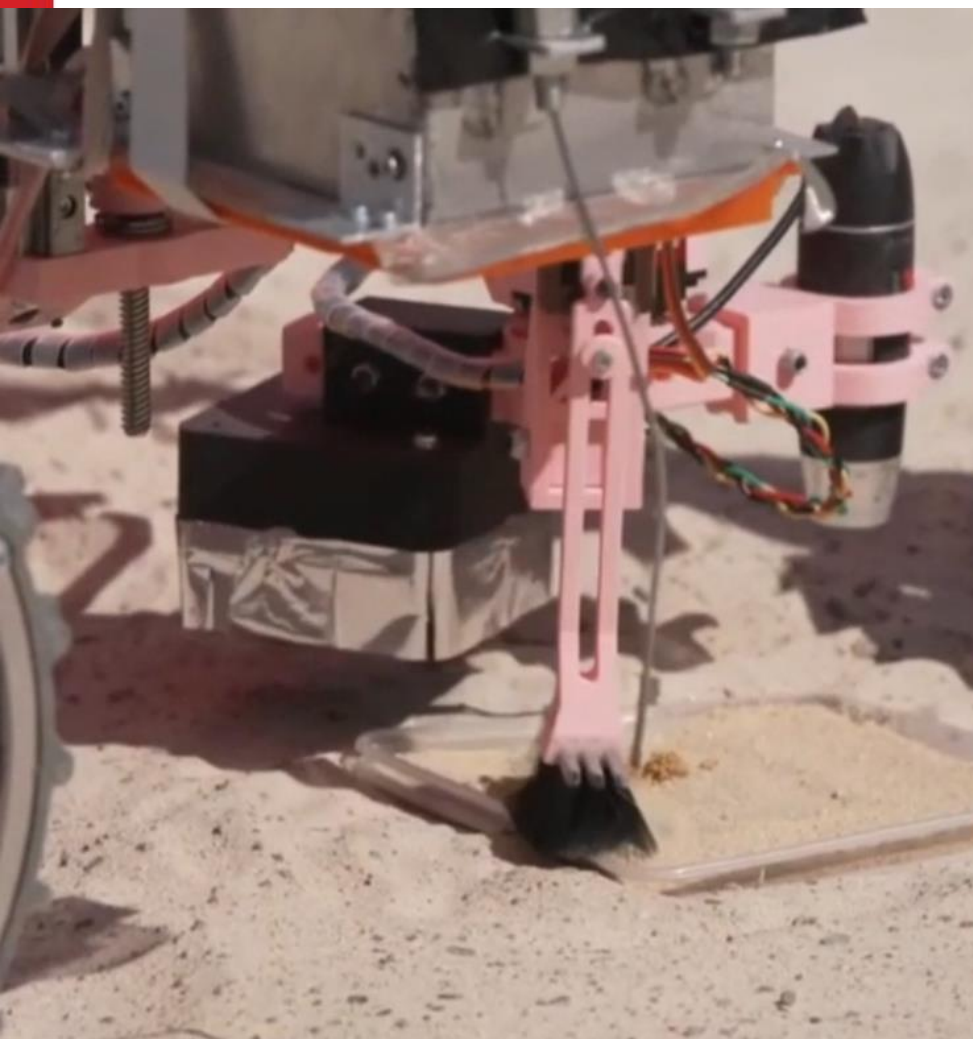
Impact

Impact - Systems Engineering

- Understanding and use of SE has broadened and deepened over time
 - Score improvement
 - 2024 - 50% submissions “failed”
 - 2025 - 13% submissions failed
 - Addition of review entry check allowed assessment on quality
 - 2024 - 50% submissions “failed”
 - 2025 - 13% submissions failed
 - Emerging advanced techniques (digital engineering, model-based systems engineering)
- 
- The diagram illustrates a Drive Train system architecture. It consists of a vertical stack of four components: Drive Train (highlighted in red), ABS Wheels, DC Brushless Motors & RS485 Drivers, and Skid Steering (95A TPU Tires). An arrow points from the top of the stack to the right, indicating a connection to another system.



Impact - Robotics



- Interesting mechanisms and approaches to key lunar missions
 - Robot teaming
 - Resource extraction and processing
 - Infrastructure connection
 - Paving
- Common architecture / structure, but shifting over time (for example 6-wheel rocker-bogie to 4-wheel)

Systematic study coming soon...

Impact - Community

- Chance for students to develop their skills beyond traditional education, working collaboratively on a real-world engineering project within an SE process
- Returning teams (3, 5, 7, 9)
- Culture
 - Trophy building to celebrate journey
 - Teams helping each other even at expense of their competition result
- Connects students to industry and *vice versa*
- Flow through into Australian space industry and beyond





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Future

Plans

- Initiative to align elements and share learning with NASA's Lunabotics Challenge
 - Organisers visited Lunabotics in 2024
 - ARCh demonstration team (QUT) and contributed to Lunabotics SE judging in 2025
 - Further SE sharing session coming in July
- ARCh 2026 plans
 - Introduce parallel Lunabotics demonstration qualifier indoors in the CRATER facility
 - Updating rules to add operational constraints reflecting real-world lunar missions - rewarding efficiency and considering regolith disturbance





Questions and Discussion

<https://set.adelaide.edu.au/atcsr/australian-rover-challenge/>

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References

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Hirshorn, S.R., Voss, L.D. and Bromley, L.K., 2017. NASA systems engineering handbook (No. HQ-E-DAA-TN38707).

Stecklein, J., 2017, July. NASA's Robotic Mining Competition Provides Undergraduates Full Life Cycle Systems Engineering Experience. In *INCOSE International Symposium*, 32, A74.

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