

THE AUSTRALIAN ROVER CHALLENGE – CAPABILITY BUILDING THROUGH COMPETITION.

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Introduction: The Australian Rover Challenge (ARCh) is an annual robotics competition focused on simulated lunar surface operations, founded and run by the Andy Thomas Centre for Space Resources at the University of Adelaide. Each year, university-level teams from Australia and abroad design and build semi-autonomous teleoperated rovers to compete in four days of intensive competition conducting complex, lunar surface-themed missions. Teams are awarded points as they complete engineering design milestones prior to the event, and again as they achieve specific goals during field tasks. This competition, with a focus on locating, extracting, processing resources, and setting up the infrastructure, plays a continuing role in developing Australian space robotics capability.

Competition Aim and Structure: The ARCh was established with the express purpose of building Australia’s space robotics capability, developing systems engineering and technical engineering excellence in a future workforce that has experienced the pressure of a simulated space mission. Students structure their work using a defined systems engineering process (such as that described in the NASA Systems Engineering Handbook [1]), under significant pressure. All while in a supportive environment of like-minded peers and support staff. This approach has proven successful in a similar context with NASA’s Lunabotics competition [2]. ARCh also aims to bring together a community of students, academia, industry and government representatives with interest in this area.

At the event, the teams compete in a new task each day with the breadth of tasks designed to simulate elements of a foundation services and In-Situ Resource Utilisation (ISRU) lunar mission. They include:

- *Post-landing:* Descending from the lander and performing a systems check, damage assessment of infrastructure already deployed on the field, and performing maintenance;
- *Space Resources:* locating, extracting and delivering resources to a set area, and processing them to extract water; and,
- *Excavation & Construction:* Clearing debris, excavating regolith, and deploying dust-mitigating infrastructure;
- *Mapping & Autonomy:* Navigating and mapping the arena autonomously, identifying landmarks as directed.

These tasks mirror requirements proposed by NASA as part of the ARTEMIS Program and the Australian Space Agency’s Moon to Mars Trailblazer “Roo-ver” Initiative [3]. The challenge field is also designed to simulate the lunar surface for that mission, with sand used in place of lunar regolith, and a series of key infrastructure element props created to populate the competition pitch (see Figure 1).



Figure 1: ARCh pitch in 2021 at the city campus (above), compared to ARCh pitch in 2024 at the university’s permanent lunar analogue site (below). In each picture the lunar lander can be seen on the right, with the processing plant on the left.

Growth and Impact: Over its five-year history, the ARCh competition has grown from three teams in the initial challenge, to 15 teams in the 2025 event. In this time, it has maintained its core principles: to enable the growth of multidisciplinary student teams within Australia; to provide a platform for national collaboration towards technological innovation and development within the space industry; to pioneer full scale planetary simulation missions to validate new technologies towards resource utilisation on the Moon and Mars; and to promote collaborative learning and friendly competition for new and growing Australian student teams.

This commitment has delivered a tangible and impactful opportunity for students interested in space-related engineering and science to engage with the same challenges commercial companies face in readying technology and systems for operation in space. It is a chance for students to develop their skills beyond

traditional education offerings, working collaboratively on a sophisticated, real-world engineering project within a defined systems engineering process. While helping to produce rounded engineering graduates for a range of industries, this has specifically boosted the Australian space industry with some many ARCh alumni going on to significant positions in emerging and growing local companies that are connecting with the world.

The iterative nature of ARCh, with all new teams returning in subsequent years along with steady growth, has seen emergence both of common rover architectures, technology, and approaches, leading to rising scores and capability over time. It has also seen genuine innovation from teams as they try novel architecture, technology, and approaches in an attempt to gain ascendancy over their rivals. These commonalities and differences have been closely monitored by the ARCh technical team.

This presentation will introduce the reasons for establishing the ARCh; explain its process, rules, and competition field; and discuss its growth and maturation since inception. It will then talk about the challenge's contributions in the key areas of building national capability in systems engineering and technical engineering excellence for space robotics. It will also introduce key analysis from the wide range of teams competing in ARCh 2025.

References: [1] Hirshon S. R., Voss L. D. and Bromley L. K. (2017) *NASA systems engineering handbook (No. HQ-E-DAA-TN38707)*. [2] Stecklein J. (2017) NASA's Robotic Mining Competition Provides Undergraduates Full Life Cycle Systems Engineering Experience, *INCOSE International Symposium.*, 32, A74. [3] Australian Space Agency (ASA) (2021) *Moon to Mars Initiative: Trailblazer Stage 1 - Grant opportunity guidelines*.