THE AUSTRALIAN ROVER CHALLENGE (ARCH) : BRINGING COMPETITION TO LUNAR ROVER SIMULATION MISSIONS. D. Ricardo[1,2], J. Culton[1], M. Davies[1], L. Holden[1] and H. Lourey[1], [1]The University of Adelaide, [2]Swinburne University of Technology (dricardo@swin.edu.au, daniel.ricardo@adelaide.edu.au).

Australian Rover Challenge (ARCh) is an international robotics competition held by the University of Adelaide, where university students from across Australia and around the globe compete to perform a series of tasks on a simulated Lunar analog facility, using semi-autonomous rovers that they have designed and built themselves. The aim of this project is to challenge tertiary students to demonstrate a fully-functional foundation services rover capable of remote operation, autonomy, regolith manipulation and ISRU, in line with Australia's commitment to support NASA's Moon to Mars program through the Trailblazer mission [1]. The ARCh aims to address the four strategic space pillars outlined in the Australian Space Agency 2019 - 2028 Civil Space Strategy by inspiring the next generation of the Australian space workforce to 'learn-by-doing' through a hands-on simulated mission to the Moon [2]. The ARCh complements an existing series of rover challenges globally which simulate rover missions on the surface of Mars.

Lunar analog arena: From 2021 to 2023, the ARCh took place annually in on a temporary lunar surface constructed in the heart of the University of Adelaide main campus in South Australia. Recently from 21 to 24 March, 2024 the ARCh took place on a dedicated 35 x 35 meter analog facility built at the Roseworthy campus. Due to the large scale of the arena and human footraffic, the arena was built using a dense base of sandy loam to create large hills, topped with a surface of fine-grained sand. The field contained approximately $500\,\mathrm{tonne}$ of material to a depth of approximately $30\,\mathrm{cm}$, consisting of flat-expanses, three large $1.5\,\mathrm{m}$ tall hills with slopes up to $40°$, and fake foam boulders up to $50\,\mathrm{cm}$ in diameter that can be easily moved. In addition, four bespoke 'props' were made and placed across the field, including a lander, communications tower, solar array, and space resource processing plant, shown together in Figure 1. These props serve dual purposes, as both visual aids that engage audiences and younger students, and critical infrastructure that are incorporated into the challenge ruleset, like all rovers deploying of the $1.2\,\mathrm{m}^2$ lander platform and ramp to begin the challenge. As part of the Mapping & Autonomous task, the field has also been scanned to centi-meter accuracy using lidar provided by CSIRO.

Figure 1: **View of challenge arena infront of Barr Smith library on main campus with props including; processing plant, solar array, communication tower, rover and lander from left to right. Also on the arena are fiducial markers, coloured blocks and fake rock obstacles as a rover completes the Mapping & Autonomous Task.**

Challenge Tasks: A total of 500 points are available to teams, comprised of up to 100 points for each of the four challenge tasks and an additional 100 for written deliverables including a Critical Design Review (CDR) and System Acceptance Review (SAR). The theme of the challenge tasks are to emulate the activities that a lunar rover would be expected to perform as part of a foundation services mission to prepare a surface base, in preparation for human astronauts. Each task tests a rover's capability to perform indivudal activities with a focus on demonstrating different capabilty, from navigating difficultt terrain, interacitng with the environment using a robotic arm, performing in-situ resource evaluation, excavation and extraction, constructing artifical features, and semi- or fully-autonomous traversal and mapping. During a task, teams control the rover remotely from a sealed base-station shown in Figure 2, simulating operating a lunar rover from Earth. Currently, no simulated time-delay or packet bandwith limitations are enforced.

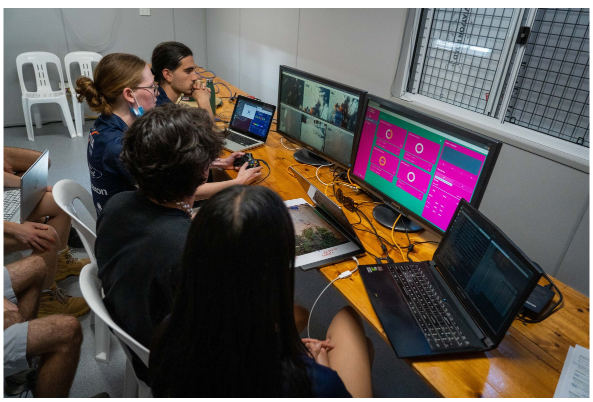

Figure 2: Students controlling rover within base-station

Post Landing Task: Rovers must navigate difficult terrain, search and localize where previously landed supply caches (props) are located, and perform a series of tasks using a robotic arm typing on a keyboard, pressing buttons, moving joysticks and joining modular propellane hose connections.

Space Resources Task: Rovers must perform *in-situ* resource prospecting to quantify the concetration of water-ice and imenite in two separate deposits, then excavate and extract water from the icy regolith to hand to judges. Students present their findings during a presentation.

Excavation & Construction: Rovers must excavate, transport and deposit up to $10\,\mathrm{kg}$ of dry regolith from one location to another, clear rocks between $1\,\mathrm{kg}$ to $10\,\mathrm{kg}$, and construct a $1.1\,\mathrm{m}^2$ dust mitigating feature using individual pavers built by the team.

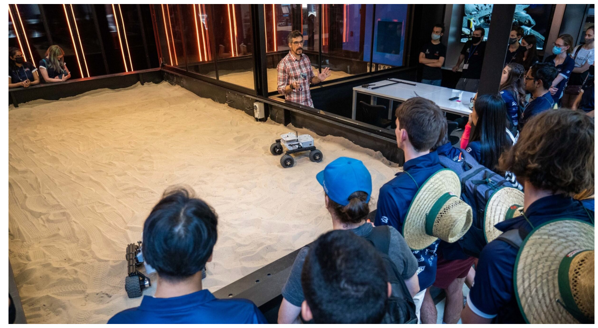

Figure 3: Students visiting the EXTERRES laboratory

Mapping & Autonomous Task: Rovers must semi- or fully-autonomously navigate the arena to designated landmarks, like fiducial markers, blocks or props whilst avoiding obstacles, then provide judges with a detailed map of each landmarks' location.

Impact & Future work: Since the inagural event in 2021, more than 11 new Australian teams comprising several hundred students across several faculties, not just engineering, have been created specifically to compete in the ARCh with plans to compete overseas. Not only does each team conduct outreach education to primary and secondary schools in their local comunity to promote STEM educaton, participation in ARCh has resulted in multiple dedicated undergraduate and postgraduate research projcts, internships and full-time employment. Alongside ARCh, the University of Adelaide has also developed the Extraterrestrial Environmental Simulation (EXTERRES) laboratory as a state-of-the-art facility specifically designed to simulate off-Earth environments including a $2.3\,\mathrm{m}^3$ regolith thermal vacuum chamber and $27\,\mathrm{m}^2$ regolth pit, shown in Figure 3 being presented to ARCh student participants.

Conclusions: The Australian Rover Challenge aims to provide a platform for teritary students to showcase their talent and innovation towards developing planetary rovers to compete under simulated lunar mission conditions. Since inception, the challenge has had a significant positive impact in both the future Australian workforce, domestic space industry, and as more international participants attent and compete, is fostering strong relationships and friendships among students and industry partners.

References [1] Australian Government , Grant Opportunity Guidelines Moon to Mars Initiative: Trailblazer Stage 1, Technical report (2021). [2] Department of Industry Innovation and Science (2019), 24.