

Advancing Inclusion, Diversity, Equity, and Accessibility in the Lunar and Planetary Exploration Community through Mission Control Software. Dr. Melissa Battler, Dr. Andrew Macdonald, Dr. Matt Cross, Kaizad Raimalwala, Veronica Chatrath, ¹Mission Control Space Services Inc., 162 Elm St. West, Ottawa, ON Canada, melissa@missioncontrolspaceservices.com.

Introduction and Problem Statement: The field of planetary science and exploration, and its community, are continually evolving. However, there are still barriers to participation when it comes to equity, diversity, and inclusivity (EDI). These barriers have existed in the field historically, and have currently not been resolved, resulting in the planetary science and exploration workforce not truly representing the current demographic of those seeking to participate, limiting the ability to develop new ideas and move the field forward. This longstanding problem creates a divide among those in the discipline, making it increasingly difficult to further the field, as various members and researchers face challenges in carrying out their work. If this divide is not addressed, the planetary science and exploration community is at a risk of both further alienating underrepresented highly qualified personnel (HQP) and missing opportunities for inclusion.

We currently stand at a unique point in history, with the dawn of the commercial lunar exploration era on the horizon. An unprecedented number of teams will soon have access to real-time lunar data, and with these missions come opportunities to advance inclusion, diversity, equity, and accessibility in the planetary exploration community and beyond. Mission Control would like to introduce our Mission Control Software platform, which reduces barriers to planetary mission participation.

interface with robotic systems and payloads. Our web-based application allows anyone with an internet connection to drive a rover, operate science instruments, interact with tools, visualize data products, and more. Our software development kit makes it easier for spacecraft teams to integrate their systems and enable end-to-end data connectivity.

By allowing for easy connection to our software, we are expanding access to many more voices and participants. For example, geography and travel restrictions are no longer a barrier, as our software allows for distributed teams to operate a mission or instrument from anywhere in the world with an internet connection. Additionally, a multitude of distributed science team members can view and annotate imagery, to facilitate real-time tactical discussions and rapid decision-making. By allowing increased accessibility, we also allow for increased equity, diversity, and inclusion, letting more individuals be a part of science missions.

Our design philosophy starts with providing accessibility to anyone with an internet connection. As we move forward, we continue to design our software to align with accessibility and EDI values in mind, seeking input from users in the lunar and planetary exploration community. In designing future iterations of our interface, we will consider how the user's experiences such as gender, culture, discipline, and sensory needs can inform more accessible human-machine interactions. For example, user interface design can take into account needs from a wide range of audiences, such as individuals with colour deficiency.

An additional use-case of our software is for education and outreach. As part of all our ongoing projects, we love to give people of all ages and backgrounds an opportunity to immerse themselves in planetary rover operations through our interactive, inquiry-based educational program, Mission Control Academy. We've enabled hundreds of students on four continents to get a feel for what it is like to operate a real space mission, by teaching them how to plan a mission, and then letting them remotely tele-operate our rover to conduct a science mission in an analogue environment, such as our on-site indoor lunar terrain. We recently did an outreach event for a group of high school students in Northern Ontario, as seen in Figure 2. The students were first given a presentation on planetary robotics and exploration, and then had the chance to remotely operate a rover from their classroom, with only a computer and internet access. Mission Control Academy can be



Figure 1: Depiction of Mission Control's cloud-based Mission Control Software (MCS) platform.

Accessibility: We're excited to demonstrate our core product to the space exploration community, our cloud-based Mission Control Software platform. For missions in space, and for testing and analogue missions on Earth, our platform makes it easy for operators to

conducted by any classroom (or group of students) with an internet connection, anywhere in the world, including remote Arctic communities, and underserved groups and communities (Figure 3).



Figure 2: A high school student tele-operating a rover using our Mission Control Software as part of an outreach event.

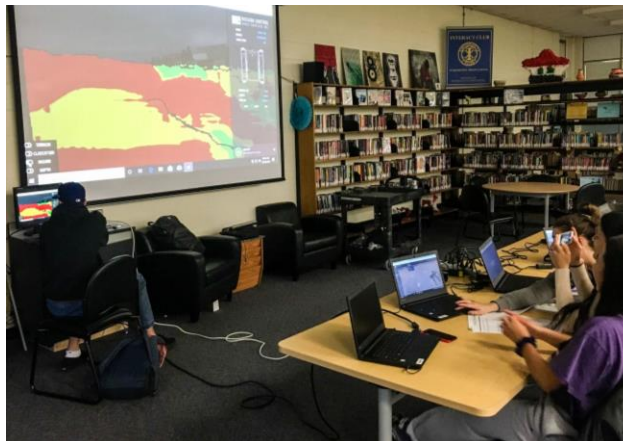


Figure 3: A group of high school students remotely operating a rover using our Mission Control Software as part of a Mission Control Academy session.

Next Steps: We are excited to participate in the United Arab Emirates' upcoming Emirates Lunar Mission (ELM), and we acknowledge the Canadian Space Agency's financial support of our participation in this mission. At the end of 2022, ELM is set to launch to the surface of the Moon, and we will have an opportunity to demonstrate our terrain classifier that will be integrated on an ispace lander, which will be the first demonstration of Deep Learning algorithms on the Moon. Our terrain classifier will process images

from the Rashid micro-rover, and return the results down to Earth, where the data products will be used to support advanced navigation techniques and scientific research.

Our MCS platform will enable science operations for our team joining remotely, with just a secure internet connection and a laptop. We truly believe that space is a field that should be accessible by all.