SUBMISSION TYPE
Symposium

TITLE
Moon 2024: Translating Research to Practice for Upcoming Artemis Lunar Exploration

SHORTENED TITLE
Moon 2024: Translating Research to Practice

ABSTRACT
The United States has committed to NASA landing the first woman and the next man on the Moon by 2024. I/O psychologists and other experts have been focused on preparing future space crews for the exciting missions that will help achieve this goal. In this symposium, presenters will translate their research to practice, making specific recommendations for the upcoming space quest.

PRESS PARAGRAPH
The Artemis program: NASA's plan to land the first woman and the next man on the Moon by 2024. To achieve this bold goal, advances in technological, biological, and psychological fields must be made. This symposium highlights the contributions of I/O psychologists to successful space exploration by translating research to practice with specific recommendations for the upcoming space quest. Specifically, researchers will share insights related to crew composition, group living, and overall team dynamics. Ultimately, the audience will be left wondering, what insights can be made from *your* research that will help put American astronauts on the surface of the Moon for the first time since 1972?

WORD COUNT
5,317

Re-Pairing Teams for the Moon

Brennan Antone[1], Leslie DeChurch[1], Suzanne Bell[2,3], & Noshir Contractor[1]
[1]Northwestern University [2]DePaul University [3]KBR/NASA Johnson Space Center

The next era of space exploration has US Astronauts heading back to the Moon in the 2020s. Fifty years after the first American planted the flag, astronauts will return to the Moon not to do “what is hard” as President Kennedy challenged the nation in his 1962 speech, but to develop the capability to do what is currently impossible: A mission to Mars. The moon missions will set up a deep space gateway and a testing ground for technologies of all kinds, from reusable landers to repairable teams. One immediate challenge is crew composition.

NASA leverages sophisticated computer models for many of its physical systems. We develop and leverage a sophisticated model of a human social system that can be used to compose the crew: CREWS (Crew Recommender for Effective Work in Space). CREWS is the result of five years of validation in NASA analog facilities. In this talk, we share three sets of findings. First, we will elaborate the model, its underlying logic, and the key variables supported by genetic algorithms as mattering most for crew compatibility. Second, we present cross-validation results determining the efficacy of the model parameterized on a subset of crews to accurately predict what happens in new crews. Third, we share a novel experiment conducted in NASA’s Human Exploration Research Analog (HERA) that takes the CREWS model, the four crew members, and the mission schedule and runs the model to identify potentially problematic pairings of crew members on task assignments and recommend “re-pairing” strategies that can be implemented in the mission to repair - and optimize - crew functioning and performance.

HERA simulates the social isolation, confinement, and communication delay that astronauts experience during long duration deep space missions. During these missions, crew members experienced acute and chronic sleep loss, a lack of privacy, and communication delays up to 5 minutes one way outside the habitat. These physical conditions affect individuals' social proclivities. We have been collecting data in HERA since 2015. The first four crews participated in Campaign 3, a 30-day isolation mission to an asteroid. Four additional crews participated in Campaign 4, a 45-day isolation mission to an asteroid. We are currently three quarters of the way through Campaign 5 (C5), which includes four 45-day isolation missions.

CREWS is an agent-based model (ABM) we developed using data collected from HERA which predicts team relations over time for space crews. We take a networks-oriented approach in viewing a crew in terms of a set of changing interpersonal relations of four types: task affect (Who do you work well with?), hindrance (Who makes tasks difficult to complete?), leadership (Who do you provide leadership to?), and followership (Who do you rely on for leadership?). ABM allows us to jointly account for the many sets of factors affecting relation over time. Modeling allow us to consider the effects of hundreds of variables, and to fit a model based on data collected in the most similar possible context and team, an analog space crew.

The CREWS model includes four kinds of inputs. We include ***team composition effects,*** resulting from individual differences between team members such as complementarity in personality and demographic faultlines. We also model the effects of salient ***contextual features*** specific to long-duration space exploration, including time spent in isolation, communication delays with mission control, and sleep deprivation. We include ***task scheduling factors*** such as task interdependence, cumulative workload, and other task attributes. The ABM predicts how each individual task completed over the course of the 30 to 45-day mission impacts the crews. Lastly, we include ***network patterns*** to capture the configural effects of social relations, such as subgrouping and tie strength that constitute the social context affecting the ongoing development of crew interpersonal relationships.

We rely on empirical data, collected in the HERA analogs, in order to calibrate the effects in our model. These 8 crews from Campaigns 3 and 4 were used to parameterize and cross-validate the model. By using cross-validation, we are able to test the ability of our model to generalize to make predictions about crews outside of those that were used to calibrate it.

In Campaign 5 we are testing the efficacy of the model to predict and repair crew functioning by re-pairing the task assignments of crew members. We begin by using our model along with the task schedule to forecast the emergence of potentially problematic crew dynamics. Then we use the model to identify how changes in crew assignment to various tasks ("re-pairing" them) can be used to repair dysfunctional crew dynamics. To demonstrate the efficacy of the model's scheduling-based recommendations, we conducted an experiment in HERA. We identify key tasks requiring repeated interaction and task our ABM with recommending, out of a four-person crew, which dyads to partner in order to optimize the quality of crew relations during the mission. The model predicts the best and worst case, and we implement both scenarios in each crew and test if our predictions are borne out.

We share findings from an unprecedented effort to model human teams and inform staffing practices in space missions. ABM, such as ours, can not only be applied descriptively to understand team process, but also be applied in practice to provide actionable recommendations relating to team process. Once an ABM is developed, it can be used to conduct computer simulations of what would happen in different scenarios: What if a team member was replaced? Or a different team entirely was sent on a mission? What if task scheduling or assignments were altered slightly? With an ABM, it is possible to not only ask these hypothetical scenarios, but also get results from them near-instantly and at no additional cost. Just like we would study real-world teams in long distance space exploration (LDSE) analogs, we can now begin to examine *in* *silico* teams and how they behave according to our models. This provides an unprecedented test of exactly how ABMs can help monitor and improve team process for teams set to launch to the moon.