

# Artemis and Ethics Workshop Lessons Learned

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**As NASA lays out its Artemis activities, it expects to set precedents in spaceflight for decades to come. Including ethical and social considerations in Artemis planning will improve the likelihood that the future we create is one where humanity collectively wants to live. NASA's Office of Technology, Policy, and Strategy (OTPS) hosted an Artemis and Ethics Workshop. This workshop was held at NASA's Mary Jackson Headquarters in Washington, DC from April 12<sup>th</sup>-14<sup>th</sup> 2023 and brought together invited experts in social science, humanities, and technical fields to discuss ethical, legal, and social implications (ELSI) of Artemis and human exploration in general. The two key study questions that the workshop aimed to address were: 1) How should NASA consider the ELSI of the Artemis and Moon to Mars efforts?; and 2) What are the key ethical and societal implications that need consideration? After briefly summarizing the formal workshop report, this paper addresses the lessons learned from implementing an interdisciplinary workshop of this nature, and from reflecting on the complexities of societal implications long-term. Issues of breadth vs depth, preparing people to engage across cultures, and allowing for structured brainstorming of specific issues are of particular importance. We also reflect on the limits of a workshop full of experts for addressing these issues and note ways in which other participatory processes or adjustments to policy practices may be worthwhile.**

## I. Introduction

This paper captures lessons learned from a recent workshop to understand the ethical, legal, and societal implications (ELSI) of Artemis and the Moon to Mars effort. NASA's Office of Technology, Policy, and Strategy (OTPS) brought in social science and humanities scholars alongside engineering, science, and policy practitioners to discuss the ethical and societal implications of NASA's future exploration efforts. The scope and interdisciplinary nature of this workshop makes it particularly important to try to capture lessons learned to inform future efforts. One workshop is not sufficient to address all of the ELSI of Artemis, much less all of space exploration activities, and sustained commitment is needed in this type of work in order to make meaningful progress.

We expand on the formal workshop report [1] by exploring lessons learned while organizing the workshop and assessing its results. Section II in this paper describes the rationale for the workshop and Section III gives an overview of the workshop design. Section IV details the observations and insights learned from the workshop research discussions [1]. Following that in Section V is the lessons learned material reflecting on the workshop implementation method, which is new with this paper. We lay out eight types of lessons learned in the conclusion, including content breadth vs depth, schedule, logistics, participant selection, brainstorming scope, adjusting 'culture,' growing relationships, and sharing results. Some of our lessons learned deal explicitly with how to interplay the different cultures of the participants involved, shaping what they talked about, and how to share the discussion. These lessons learned are important because discussing the long-term ethical and societal implications of exploration efforts is deeply complex and learning how best to do that is surely of value.

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## II. Motivation

As NASA lays out its Artemis activities, it expects to set precedents in spaceflight for decades to come. Artemis is a more ambitious program than Apollo, aimed at developing a sustained human presence on and around the lunar surface, in preparation for Mars exploration. Including ethical and social considerations in Artemis planning will improve the likelihood that the future we create is one where humanity collectively wants to live. By understanding how to reflect on these issues as NASA makes decisions related to Artemis, NASA can avoid unintended consequences stemming from cultural perceptions of human exploration of the solar system that may harm society.

The National Aeronautics and Space Act of 1958 states that “activities in space should be devoted to peaceful purposes for the benefit of all [humankind]” [2]. Assessing how NASA’s Moon to Mars work benefits “all humankind” can be complex. NASA has a long tradition of forward-thinking research, including research on the ethical and societal impacts of the Apollo Program in the 1960s [3]. NASA also has a history of exploring potential ethical and societal impacts of astrobiology research, primarily the implications of finding extraterrestrial life [4, 5]. NASA has also enlisted outside thinkers to speculate on the future of humanity [6]. Outside NASA, other U.S. government activities have included research on the ethical and societal aspects of science in general, such as the Human Genome Project. NASA has not, however, systematically addressed the societal and ethical implications of human exploration, including the ongoing Moon to Mars effort.

During Apollo, NASA funded several studies exploring the societal implications of spaceflight, though the efforts were arguably not properly funded or connected to decision-making [3]. NASA’s history office has addressed the topic of societal implications, but always done so in retrospective efforts to evaluate historic exploration [7, 8]. Prior to this workshop, there had not been an event that brought together engineers, scientists, and policy practitioners with social science and humanities scholars in this way.

Recent years have brought several calls for research on the ethical and societal aspects of NASA’s Moon to Mars work. Some of NASA’s international partners highlighted the need for broader engagement at the 2022 Moon to Mars Objectives workshop in London [9]; so did the 2022 summary report from a Lunar Surface Science workshop on Inclusive Lunar Exploration [10]. The latter called for research on how to integrate existing expertise in the social sciences and humanities into NASA decision-making. The National Academies’ recent Planetary Science and Astrobiology Decadal Survey said NASA should study the ethics of planetary in-situ resource utilization [11].

NASA has begun to lay out the framework to answer these calls. In September 2022, the Agency released its latest Moon to Mars Objectives report [12]. These objectives centered some of the rationale for human exploration on benefits including improvements to the human condition, economic growth, and scientific return. These benefits are described in detail in an April 2023 NASA document on the Moon to Mars strategy [13]. Of particular relevance, the Moon to Mars Objectives report had “responsible use” as a recurring tenet (RT-6) of how NASA will explore, stating that NASA will “conduct all activities for the exploration and use of outer space for peaceful purposes consistent with international obligations, and principles for responsible behavior in space” [12]. In the 2023 Architecture Definition Document, NASA stated that “the responsible use of the Moon to Mars architecture may require deeper scrutiny of cultural and societal implications of future exploration” [14].

## III. Workshop Overview

To begin to answer this need, NASA’s Office of Technology, Policy, and Strategy (OTPS) hosted an Artemis and Ethics Workshop. This was the first known structured attempt to look at the future societal implications of NASA’s exploration efforts since the Apollo program. This workshop was held at NASA’s Mary Jackson Headquarters in Washington, DC from April 12<sup>th</sup>-14<sup>th</sup> 2023 and brought together invited experts in social science, humanities, and technical fields to discuss ethical, legal, and social implications (ELSI) of Artemis and human exploration in general. The two key study questions that the workshop aimed to address were: 1) How should NASA consider the ELSI of the Artemis and Moon to Mars efforts?; and 2) What are the key ethical and societal implications that need consideration?

The workshop lasted 2.5 days and covered a specific schedule of topics. Themes for the workshop included past government-funded ethics studies and current issues surrounding Artemis. It also explored who is responsible for making decisions around societal and ethical implications and what options NASA has to address social and ethical concerns surrounding Artemis. OTPS focused the workshop design on studying and framing how to address the long-term ethical and societal aspects of Artemis. Such insights could support NASA’s vision for sustainable and responsible exploration, as robust and transparent ethical dialog helps enable long-term shared visions and public benefit. OTPS also sought to identify best practices for conducting such research, and to map key ethical and societal

issues within Moon to Mars efforts. To prepare for this workshop, OTPS staff studied key literature on space and society and on the ELSI research that the U.S. government has funded over the past decades.

The workshop intentionally solicited a variety of viewpoints on how to approach the key questions and issues and was not meant to produce a consensus perspective. OTPS invited 55 participants across a diverse set of disciplines, and most did not know one another in advance. These participants represented social science, humanities, and technical fields, and included policy actors and scholars, philosophers, historians, sociologists, communications studies scholars, lawyers, engineers, and scientists. Given the past challenges of infusing ethical and societal impacts research into practice [15], 20 of the invitees were NASA civil servants from a variety of offices and programs – not just Artemis – and OTPS asked them to engage from their personal perspectives. These civil servants included early-career staff as well as representatives from key Mission Directorates at NASA Headquarters, notably the Exploration Systems Development Mission Directorate (ESDMD), Space Technology Mission Directorate (STMD), and Science Mission Directorate (SMD). Through this diversity we hoped to explore many facets of how NASA should consider ethical and societal implications.

OTPS focused the content of the workshop on Artemis and the broader Moon to Mars effort, and so excluded other issues facing NASA from analysis. For example, OTPS did not focus on the International Space Station or other activities in Low Earth Orbit (LEO). Nor did OTPS solicit presentations on specific issues such as safety and its associated ethical impacts, instead trying to focus on broader ethical and societal implications. Given that NASA has other organizations responsible for Diversity, Equity, Inclusion and Accessibility (DEIA), OTPS did not solicit dedicated DEIA presentations. DEIA issues of course emerged in discussion from the workshop, given their broad relevance in societal impact.

OTPS also recognized that the workshop would not address all possible criticisms of Artemis and Moon to Mars; it was not intended as a comprehensive examination of the ELSI of Artemis. Given the key research question of how to consider the ELSI of Artemis and Moon to Mars, our primary focus was on processes and identification of possible issues. It was understood that NASA cannot unilaterally resolve every concern, as international law and other spacefaring nations must be included. Rather, NASA seeks to listen and engage with traditional and non-traditional stakeholders.

### **A. Pre-Workshop Activities**

We held a virtual pre-workshop meeting to bring speakers and discussants up to speed on NASA's current Moon to Mars plans in order to promote deeper conversation during the workshop itself. The meeting featured presentations by representatives from the three key Mission Directorates for Moon to Mars activities, the Exploration Systems Development Mission Directorate, the Science Mission Directorate, and the Space Technology Mission Directorate, and provided an overview on the current state of NASA's Moon to Mars objectives. Participants were invited ask questions and make comments on those plans, and organizers identified topical areas for future discussion at the workshop.

### **B. Day One Activities**

The first day of the workshop consisted of a series of presentations aimed at giving participants an overview of the purpose of the workshop and reviewing lessons learned from past ELSI activities in other technology fields, such as nanotechnology and the human genome project. The afternoon included more presentations and two dedicated brainstorming sessions that brought all of the participants together to discuss some of the issues presented earlier in the day. In addition, after the workshop formally concluded for the day, we reserved space at a nearby restaurant for many of the participants to relax and continue to network outside of the formal workshop structure.

In the first brainstorming session, we asked participants to use sticky notes to highlight ELSI of Artemis that they felt were important or that merited deeper conversation at the at the workshop. This approach was seen as having heuristic value in that it could provide a quick map of ethical perspectives and issues from across the varied disciplines. Participants were able to place stickers on notes whose ideas they found salient or agreed with. Including this activity on the first day encouraged participants to start thinking broadly about ELSI, beyond their research area.

In the second brainstorming session, we had groups conduct breakout discussions on four topics that were prominent in the literature: A) environmental issues, B) responsibility for long-term ethical decisions; C) the role of frontier narratives and colonialism; and D) the ethics surrounding the opportunity costs of human spaceflight vs. other NASA activities. The results of this breakout session informed subsequent discussions on potential policy options.

### **C. Day Two Activities**

The second day included a guided tour of the National Air and Space Museum to provide additional context to participants and to encourage networking in a lower-stakes environment. We wanted the tour to be early in the

workshop so that it could impact future discussions but late enough that it could expand upon emerging participant relationships and established topics of interest. An important outcome of the workshop was to build a community around space exploration ELSI. The afternoon included more detailed presentations and two more brainstorming sessions. Following the formal workshop sessions was a happy hour at a nearby rooftop bar, for participants to continue their conversations from the workshop in an informal setting.

The third brainstorming session focused on an issue that would create tension between practitioners on one hand and theoretical science and science scholars on the other. Specifically, this discussion examined the practicality of addressing deeper societal and ethical issues and also opportunities for considering these issues. We wanted to give the technical experts a chance to share some of their concerns with addressing issues that had been previously raised and for all participants to work together to come up with possible solutions to the challenges.

The fourth session was left as an open period during the planning phase. We intentionally built flexibility into these sessions to accommodate the needs of participants and give them time to raise issues that might not have occurred to us while planning. During the workshop, we used the fourth session time to explore the justification for human exploration, including what level of empirical data and understanding would be sufficient for validation. This stemmed from a space scientist saying earlier in the workshop that they are often questioned on why NASA does space exploration with humans in addition to robotic exploration. The scientist said their justifications often fall short with scientific audiences and asked the presenter what they believe would be sufficient. There was much interest in that topic, so we allotted additional time to continue those discussions.

#### D. Day Three Activities

The third and final day was a half day with presentations and a final brainstorming session to allow participants to reflect on everything that they absorbed throughout the previous two days. The fifth brainstorming session was also left as a flexible time during the planning phase of the workshop. We decided to let it be an open, whole-group discussion where participants were encouraged to share any final thoughts and takeaways from the workshop. It was the last planned session during the workshop and ensured everyone got a chance to speak their mind one final time.

### IV. Observations from the Workshop

This workshop marked an initial foray into a topic that NASA has not engaged with historically in a structured way outside of a few selected areas, such as astrobiology and planetary protection. Beginning this conversation around Artemis and Ethics is a significant step toward helping NASA learn how to engage more with ethical and social issues in the future. One outcome of the workshop is the Artemis, Ethics and Society: Synthesis from a Workshop report that OTPS released, describing the ELSI discussed at the workshop as well as the proposed solutions [1]. Note that these observations contain the research results from the workshop – these differ from the lessons learned detailed in section V, which reflect and learn from the process of implementing the workshop.

We drew four main observations from the workshop discussion. A more detailed analysis can be found in the aforementioned report, but a high-level summary is included below [1].

#### A. Observation 1: Participants identified key questions across cross cutting areas.

- a) **Sharing the benefits of space activities:** How should NASA work to the “benefit of all [humankind],” which is part of its mandate under the original Space Act that created NASA? Who is included in that statement and how should they be involved? How can NASA know who benefits from Artemis?
- b) **Reflecting on core values for exploration:** Several asked the question of how we ensure that the values we bring to space are those we want as the basis of future exploration? The principles and goals that organizations use in their practices represent the values that are most likely to shape new engineered systems. It can be difficult to identify these values, especially those held by non-space actors.
- c) **Sustainability:** Defining sustainability on the Moon is a complex challenge, as sustainability discussions in a terrestrial context, with questions of balancing conservation against societal needs, do not necessarily apply. The workshop also cited environmental impacts of space activities (including launches) on Earth.
- d) **Balancing shared access:** Participants identified many operational challenges to prioritizing access to key sites, deconflicting activities, avoiding contamination, and maintaining heritage sites. A recent OTPS analysis [16] explored many of these practical concerns, which feed into broader ethical and societal implications.

- e) **Addressing cultural sensitivities:** Participants identified cultural sensitivities surrounding payloads and activities on the Moon, which is viewed as sacred by many cultures worldwide. This may affect perceptions of increased NASA activity on the Moon for resource utilization and other goals.

**B. Observation 2: Participants mapped out many cultural and practical challenges to identifying and addressing ethical and societal implications of Artemis and Moon to Mars activities.**

- a) **Cultural challenges integrating social science with space engineering.** Social scientists, humanities scholars, and technical staff initially struggled to communicate effectively due to the vastly differing languages of the expertise at play. Many NASA staff lacked a framework to engage on these ethical issues, and some social science and humanities scholars lacked context for how decisions are made internally at NASA. A recommendation from some participants was to increase cross-pollination between the social scientists and NASA Headquarters personnel.
- b) **Cultural challenges toward engineering versus reflection.** NASA and other space organizations have a culture that often prioritizes moving forward efficiently versus more careful reflection and public engagement. Getting space practitioners to focus on long-term societal impacts, versus narrower scientific or technical problems, requires an attempt at culture change.
- c) **Practical challenges in enabling reflection.** Dedicated resources to study the ELSI of Artemis might be drawn from resources needed to accomplish a mission. Some participants also noted that NASA can have many unfunded mandates, despite large budgets for space activities. Dedicating resources or staff time to focus on societal and ethical challenges requires balancing to accomplish NASA's planned missions.
- d) **Practical challenges with diffuse responsibility and control.** Many Artemis ELSI are outside of NASA's full control due to the involvement of international and commercial actors. These ELSI include questions about who might get access to specific lunar surface regions first, and whether those sites are maintained for future generations.
- e) **Practical challenges in anticipating future ethical and societal concerns.** Pressing ethical issues may emerge unexpectedly as a second-order effect of NASA decisions. In light of this, proactive exploration of future ethical and societal issues is needed. For example, a cultural sensitivity about commercial payloads with human remains flying alongside NASA Commercial Lunar Payload Services (CLPS) deliveries is a key example discussed in the report and involves diffuse responsibilities. While NASA has said it would not send human remains to the Moon without consulting U.S. tribal nations, the CLPS initiative's funding of commercial deliveries on private landers has enabled non-NASA payloads, including human remains to become manifested on these private flights. Some cultures see the Moon as having spiritual significance and believe placing human remains on the Moon can disturb the sanctity of the Moon.

**C. Observation 3: A community of researchers working on ELSI is interested in ongoing engagement with NASA and the space community on these topics.**

OTPS brought together many disciplines across social science, humanities, and technical fields. These disciplines haven't worked together before in the context of space exploration. The workshop helped integrate these external disciplines, enabling participants both inside and outside NASA to understand each other's perspectives. Several participants discussed creating their own non-NASA community to build on the discussions at this workshop.

**D. Observation 4: Participants discussed a range of options that NASA and the space community may use to address the ethical implications of Artemis.**

Note that these reflect participants views and are not recommendations from NASA:

- a) The following are examples of methods suggested by participants for how NASA could address ELSI:
  - i. Policy: ELSI expertise can be integrated into existing policy structures such as federal advisory committees, creating incentives for responsible actions, and using public values to determine NASA goals.
  - ii. Management: NASA's internal management can better focus on ethical/societal implications through clarity about the importance of ethical reflection, recognizing societal impacts in systems

- engineering, better utilizing the formal NASA Strategic Plan and Performance reporting processes to capture ethical issues, and budgeting to support ELSI capability.
- iii. Research: NASA can establish a capability to address research questions in this area, and – to access this appropriately – create frameworks to help guide future activity, such as sustainability, stewardship, and equity. The workshop identified participatory assessments with the public and other key stakeholders to create a map of public values as a way to get relevant information to decision-makers.
  - iv. Conversations: This refers to engaging with the public, social science and humanities experts, and under-represented groups as well as those in technical fields. These conversations matter symbolically and practically as a way to exchange ideas and values between NASA and others, and can indirectly shape management and policy.
  - v. Education: There are ways to improve insight on ethical/societal issues for existing space practitioners, students, and the general public.
- b) Participants suggested that key models that NASA and the space community can consider are the U.S. Human Genome Project’s funding of ELSI research and the European Commission research programs for Responsible Innovation.
  - c) Some of the policy options discussed would require no dedicated funding (such as changing decision processes), whereas others, such as public consultations or dedicated research, would. Some combination of these activities seems likely to be of value, but also would come with a tradeoff of impacting already budget-constrained programs and projects at NASA and elsewhere.

## **V. Lessons Learned: Methods and Approaches**

We report on lessons learned that go beyond the content summarized in the formal workshop report [1]. The observations above contain our research insights into the ELSI of Artemis – our lessons learned are not those research results but are rather our insights on reflecting on the process of organizing and writing about the workshop. Facilitating discussions of ethical perspectives represents a cultural shift in the aerospace profession and deals with the uncertain future of how all of human exploration may proceed. As such, capturing lessons learned on how to approach this is of significant value. There were many key lessons learned in the process of planning, executing, and sharing results of the workshop. Our lessons learned can provide insights on the process of thinking about the role of ethics in spaceflight. These lessons learned can inform any future study designers or researchers about best practices and potential pitfalls around holding such a workshop or comparable research effort, and to explore potential alternatives for how to continue such discussions.

### **A. Topic Breadth versus Depth**

By bringing in a diversity of disciplines and having speakers, we made deliberate tradeoffs on the level of depth to be pursued on any specific topic versus covering a broad swath of possible topics. We aimed for breadth, and asked speakers to make their talks accessible to those outside of their disciplinary expertise. We did not know if this approach would work and had concerns about the large scope we were including. Any single topic from the workshop could have easily been worthy of its own multi-day workshop, though for many it would be hard to identify multiple researchers working in the area. We already descope some topics that have been better explored in other literature streams, such as the ethics of safety in exploration [17]. To help make the discussion practical, looking at relevant government efforts to explore these issues (ELSI in the Human Genome Project and Responsible Innovation in the European Commission) seemed wise – but it also added a lot of conceptual territory that participants had to learn about that was separate from the space context. In the end, going for a broad scope worked out, and participants enjoyed the workshop immensely. For others working in this space, think very carefully about what level of depth versus breadth is appropriate.

### **B. Preparing Participants to Break out of their ‘Culture’**

One decision that did help us save time during the workshop was the pre-brief event that we held approximately one month before the actual workshop. It provided crucial information to the invited speakers about NASA’s plans, saving time during the workshop, and helped focus the talks to topics relevant to the Agency’s Moon to Mars plans and policies. For example, we did not have any talks around having people permanently living on one of Jupiter’s

moons which is not in NASA's current or near-term scope. Focusing the talks through the speaker pre-brief helped focus the conversations that stemmed from those talks. However, an additional pre-brief might have been helpful, for the NASA attendees to learn more about ELSI research in general and help them get familiar with the language and frameworks used in that work. It took some time for the NASA participants to understand and fully engage with the social science and humanities scholars. Having an "Ethics 101" pre-brief for engineers and scientists at future workshops could help those participants engage more quickly. This was a direct suggestion from one workshop participant upon learning about the Moon to Mars pre-brief for the speakers. Even more work could be done to proactively think on how to get participants to break out of their own disciplinary and institutional cultures.

We will also note that the burden on us as workshop organizers was more time-consuming than initially expected, largely because we had to continually work efforts to translate across different cultures about the workshop's purpose and nature. Writing of the report involved trying to make a summary of the discussion that would be generally readable to NASA managers and to the social science and humanities scholars. Our executive summary in particular was written with senior executives in mind as the key audience, with the main report having a more varied audience, including those mentioned above as well as working level engineers and scientists. Writing for all of these audiences took more time than planned – the report is scheduled to be released in September 2023, when it was originally planned for a June release.

### **C. Participant Selection**

An intentional and valuable choice in designing the workshop was the decision to invite a wide range of disciplines. The invite list included policy actors and scholars, philosophers, historians, sociologists, communications studies scholars, lawyers, engineers, and scientists. From the NASA side, we made sure to invite both early career staff and senior leaders. From external sources, we focused on inviting attendees who had published research in this area. The result was a diverse group of participants who were willing and eager to engage in topics that they may not be familiar with, while sharing their unique experience with everyone else. One challenge that did arise specifically on the NASA senior leader front was that they were not able to be as fully immersed in the workshop, especially since it was hosted at NASA Headquarters and many other groups had demands on their time.

We also recognize that there are limits from having a workshop draw on experts, compared to having more public or deliberative research method. Many who discuss ethical and societal implications seek to answer whether something has a positive or negative implication – to assert whether it is ethical or not. The inherent nature of many ethical topics is such that they cannot be definitively resolved by one or often even many experts. To approach such implications more fully, approaches that involve broader members of the public or representatives of government are also needed. We were unable, by design, to come up with simple answers to questions like "Is Artemis ethical?" with the workshop.

### **D. Developing Relationships**

A lesson learned in regard to using the workshop to develop relationships came from the design of the brainstorming sessions. That would be to shake up the groups a little more. We used the same groups for all three group brainstorming sessions, hoping that people would be able to connect through those sessions. We did some slight adjustment between sessions two and three but generally the groups stayed the same. If we had done a larger shakeup between sessions three and four, participants would have been able to work with the same group for two sessions, and then new members for the final group session. This would have allowed participants to connect more deeply with some but also get to know more of the other participants. A full shakeup could also help generate new ideas, with new groups of experience coming together. This was also a direct participant suggestion.

Another lesson learned was that having the before-hours, guided tour of the National Air and Space Museum was a large value-added event to the workshop schedule. It was a unique way for participants to engage, helped shake up the workshop by going to a totally different location, and helped add credibility and prestige to the workshop.

### **E. Brainstorming Session Scope**

Brainstorming topics dealt with complex interdisciplinary topics such as environmental responsibility within the Moon to Mars effort, how to remove colonial framing from the language used by space practitioners, and how to share the benefits of space exploration activities. Any one of these topics is hard for a single person to fully understand, and we expected that the group discussions would be interesting explorations of the topics. Since the brainstorming discussions were the most dynamic part of the workshop, there were many lessons learned from those sessions. First was that having more planning into the specific structure of each session helps avoid stress during the sessions. We laid out example questions and context about the brainstorming topics, to guide discussion for participants. This helped the discussion groups to have a way to speak the same language and to brainstorming on the complex topics that we had assigned to them.

This also involved planning on how to moderate and facilitate each session. If staff isn't sure of who is facilitating which part of an activity or how to do so, that can cause delays to the programming and also unnecessary stress as they execute sessions on the fly. A specific area that we did not plan out in great detail that would have benefited from more thorough planning was how the small groups of sessions two, three, and four would share their results with the larger group. While all of the options we tried on the fly were able to communicate many of the key ideas of each group, more efficient options probably existed. Having each group present to the room took up a lot of time, when we shortened each person's time to one minute it was a fun exercise, but some material was lost, and we didn't share results from the final session due to participant fatigue (related to the first lesson learned about workshop duration).

The fourth and fifth brainstorming sessions were left during planning to be open periods of time that we the organizers could adapt to fit the needs of the participants. This had some positives and negatives in how we executed it. On the positive side, such flexibility allowed us to address a question that arose during one of the speaker presentations, which participants were enthusiastic about engaging with, in more detail while not derailing the workshop schedule. However, since we were doing this during the workshop, the sessions were understandably less thought out and so some participants challenged us more on our phrasing and structure of the session. We also had lost some of the momentum of the initial question ask by delaying the discussion by a day. Carving out time to plan an open-ended session as well as the time for the session itself would be a helpful modification to the workshop plan.

In addition, while we captured notes written by each group, we did not have an observer or designated reporter at each discussion table, to whom we could ask questions of later on. We suspect that there were interesting nuances to the brainstorm conversations that we as report authors are unable understand from the written notes alone.

## **F. Schedule**

We targeted a two-and-a-half-day workshop because we felt that would allow for serious discussion and intermingling of views without tripping into the fatigue of a multi-day event. The largest takeaway from the workshop in terms of schedule is that, given the content selected, we should have scheduled it to be a true three-day workshop, if not longer. There were additional speaking topics and brainstorming sessions we could have included because this is such a broad field, and it is the first time NASA has hosted an event like this. But even without additional topics, having the extra time would have made the workshop a little easier on everyone. The days were very long – starting at 8:00 AM and running until 5:00 PM or later on the first two days. By the end of the day, we were running slightly behind schedule, which caused the later afternoons' planned schedules to delay, but the days started out as being scheduled long as well. We wanted to make sure we had adequate time for brainstorming discussion, which also drove our selection of longer days. While participants still overall thoroughly enjoyed the workshop and were engaged throughout, by the end of both afternoon sessions everyone was dragging a little bit and eager to get to the after-events. The long days also did not give workshop staff much time to adjust for real-time updates. Shorter or less compressed days would have been easier on participants and hosts alike.

## **G. Logistics**

The most important lesson learned in the logistics category is that having a good staff to execute the workshop is crucial. Having a project lead and a deputy who both were fully involved in the process and empowered to make decisions on their own helped with delegation of tasks prior to the workshop and with handling challenges that arose during the workshop. One person was able to go off and handle whatever question had arisen while the other continued to moderate the workshop and both were able to trust the other's actions. We also had a number of support personnel who helped with all of the many logistical tasks of running a workshop – moderating sessions, running slides, escorting foreign nationals, and helping with participant concerns. The workshop would not have been successful without all of their help. We also brought in outside expert help with a notetaker and logistics support staff. The notetaker was essential in helping us capture everything that was discussed in a comprehensive manner, and we relied heavily on her notes while writing the workshop report. The logistics support staff had experience running these sorts of workshops and were able to fill in the gaps of our knowledge in everything that should be done for such a workshop.

Light refreshments were provided during the breaks in the morning and afternoon by the logistics support contractor. We knew participants would need a chance to stretch their legs throughout the day and so had breaks scheduled in from the start. The refreshments however turned out to be crucial, helping to reinforce the break time. The snack table became a small social center during the breaks, encouraging people to talk with one another. Having sustenance also helped support participants in the long days. Having the refreshment table was a significant positive contribution to the workshop.

## **H. Sharing Results**



When writing the formal workshop report and while sharing the results internally we had to be careful to clarify what was official NASA position versus what was an opinion stated by a participant. We wanted participants to feel open to sharing any and all ideas but knew that many of them could run counter to NASA priorities and policies. For any organization working on conversations in this area, there can be reputational risk for engaging in this area. NASA decided to lean forward and host this workshop, but as report authors we recognized the potential for people to react to the report in unintended or negative ways. That was why we tried to be as clear as possible as to where an idea came from.

We also found that sharing informal aspects of the workshop – such as reflections from individual participants and conversations on what points seemed to resonate with the social scientists or with NASA colleagues – has been valuable for some colleagues. These informal observations are important to cultivate and collect and to share within an organization. The broad excitement among all parties at the workshop is a testament to the potential of considering these issues in a more systematic way.

## **VI. Conclusion**

Organizing future conversations on the future of Artemis and Moon to Mars conversations is important and having interdisciplinary dialogs on the ELSI of Artemis and the Moon to Mars effort is essential. We summarized some of the important results from the Artemis and Ethics workshop, captured more fully in [1], and then presented lessons learned on how to enable these conversations. We laid out eight types of lessons learned in the conclusion, from content breadth vs depth, schedule, logistics, participant selection, brainstorming scope, adjusting ‘culture,’ growing relationships, and sharing results. Some of the lessons learned are implementation-focused, whereas others are focused on deep cultural issues surrounding space exploration and the many sociotechnical complexities that surround the overall exploration effort.

NASA is formulating future work to explore ethical and societal implications of Artemis and Moon to Mars. Planned future studies on upcoming policy decisions will highlight ethical and societal implications alongside other policy issues. NASA also hopes to formulate a more internationally focused dialog. Expanding the conversation to an international audience would increase the number of issues and perspectives on the table, which likely will raise new challenges for shared discussion. As authors, we would value hearing perspectives from others about how work in this vein could be pursued.

## VII. Supporting Materials

### A. Workshop Agenda

Day 1: April 12, 2023		
Time	Topics for	Presenter(s)
8:00 AM	Welcome Remarks	Ellen Gertsen, Deputy Associate Administrator, OTPS
	Kickoff and Purpose	Dr. Zachary Pirtle, OTPS
8:30 AM	Legal and ethical context for lunar activities	Michelle Hanlon, For All Moonkind
	Recent Calls for Ethical Investigation	Dr. Parvathy Prem, Applied Physics Laboratory
9:30 AM	On Fundamental Narratives for Space	Dr. Natalie Treviño, Open University
		Daniel Hawk, GALXYZ, LLC
10:30 AM	<b>Break</b>	
10:45 AM	Lessons Learned from Ethical, Legal, Society Aspects (ELSA) research in the U.S. Government	Dr. Kelly Smith, Clemson University
		Dr. Shannon Conley, James Madison University
11:45 AM	<b>Lunch Break then return to 2E39</b>	
12:30 PM	Brainstorming Session #1	Full Group Participation
1:45 PM	Environmental Issues and History	Dr. Afreen Siddiqi, MIT
		Dr. Teasel Muir-Harmony, National Air and Space Museum
2:45 PM	<b>Break</b>	
3:00 PM	Ethics of Opportunity Costs in Exploration	Dr. Linda Billings, Consultant
	Past Ethics: 'Responsible' Technologists from Apollo to Artemis	Dr. Mathew Wisnioski, Virginia Tech
4:00 PM	Discussion Session #2	Small Group Participation

Day 2: April 13, 2023		
Time	Topics	Presenter(s)
8:00 AM	Lessons in Implementing "Responsible Innovation"	Dr. René von Schomberg, former EC
	"Participatory Technology Assessment" Research	Dr. Mahmud Farooque, Arizona State University
		Dr. David Tomblin, University of Maryland, College Park
9:00 AM	<b>National Air and Space Museum Guided Tour</b>	
11:30 AM	<b>Lunch Break (then return to 2E39)</b>	
12:30 PM	Brainstorming Session #3 "Can This Be Practical?"	Small Group Participation

1:45 PM	Different Bodies in Moon to Mars	Dr. Sheri Wells-Jensen, Library of Congress
	Global South and Equity Concerns	Daniel Vizuete, FLASCO Ecuador
2:45 PM	<b>Break</b>	
3:00 PM	On Equity	Dr. Erika Nesvold, Just Space Alliance
3:40 PM	Discussion Session #4	Group Participation

<b>Day 3: April 14, 2023</b>		
<b>Time</b>	<b>Topics</b>	<b>Presenter(s)</b>
8:00 AM	How Social Science Can Be Done on NASA Teams	Dr. Janet Vertesi, Princeton University
9:00 AM	Deconstructing Key Myths in Human Spaceflight	Dr. J.S. Johnson-Schwartz
9:30 AM	<b>Break</b>	
9:45 AM	Policy Framings on Environmental Issues	Jessy Kate Schingler, Open Lunar
	Values in Antarctic Research	Dr. Jessica O'Reilly, Indiana University
11:00 AM	Discussion Session #5	Group Participation
12:00 PM	Closing Comments	
12:30 PM	<b>Workshop Ends</b>	

## B. References

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