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The “A” in STEAM: PAR as Fifth-Space for Research and Learning in the Arts and Sciences

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An atmospheric moon mourns the death of their robotic paramour and demands sovereignty from Earth's colonial emissaries. This is the plot of "Titan's Romance," the final installment of a series of short, educational science dramas first shared at the Cannon St. Arts Center in Charleston, SC, February 12-14, 2020. The playlets constituted an educational outreach phase of *That which We Call A Rose*, a long-form Practice-as-Research (PAR) project conducted at the College of Charleston (CofC) with funding from NASA's South Carolina Space Grant Consortium, the South Carolina Arts Commission, and CofC's School of the Arts.¹ Here, "Rose" serves as a case study for the consideration of PAR as a viable method for the creation of accessible science narratives within the STEAM (Science, Technology, Engineering, Art, and Mathematics) pedagogical paradigm. When implemented within the STEAM framework, PAR can become a powerful tool in the project of cultivating a diverse community of culturally critical interdisciplinary learners. Interdisciplinary PAR projects, when situated within STEAM curricula, provide the reflective space necessary to re-imagine the intersecting and co-creating cultures of science and art. Arts-science collaborative PAR techniques can make visible the covert institutional and societal euro- and androcentric systems of oppression that pervade the professions and point towards the kinds of changes necessary to realize an equitable socio-scientific culture.² This work begins with K-12 learning; it can be applied to research methods introduced within undergraduate and graduate programs; and it works well when augmented by collaborations among professional artists and scientists working within the university or in the field.

"Rose" is an example of PAR as it might be incorporated into STEAM learning and applications at the K-20 level. The research involves an ongoing process of arts-based, science-oriented inquiry into the cultural dimensions and perspectives of astronomy history and practice. To date, this has been accomplished largely through collaborations among university professors and students, with opportunities for K-8 student participation in the form of two free works-in-progress performances: the first was shared at the 2019 Women's Theatre Festival

(WTF) in Raleigh, NC, and the second was shared at Charleston's Cannon St. Arts Center in February 2020, where students from Charleston County School District's (CCSD) Title 1 schools were bused to the venue. Since the beginning, the vision for "Rose" has been to approach "science as culture, [and] expand the public's notion of who might access that arena as culture-creators empowered to make informed decisions, pursue careers, and benefit from the insights and innovations made possible through a radically inclusive scientific process."³ Inspired by dramaturgical questions raised within the archive of the "Gazetteer of Planetary Nomenclature" ("Gazetteer"), "Rose" explicitly queries andro- and euro-centric hegemonies embedded within 21st century space exploration and invites its audiences to do the same. The "Gazetteer" was our primary source of astronomy data as we devised short plays about four planetary objects that are currently subjects of NASA research: Earth's Moon, Mars, Saturn's moon Titan, and the asteroid Bennu. We had originally envisioned a distributable final product in the form of a touring, interactive, multi-media performance in which student questions would continually spark new research questions that could be pursued within the parameters of the performance itself. The onset of COVID-19 halted the live show's development, but the project has been extended via digital lesson plans and activities on our companion website.⁴ Although we have downscaled during the pandemic, we remain excited by discoveries made about outer space and driven by questions that address tensions among histories of planetary nomenclature, exploration and colonization, and access to authoritative careers in the arts and sciences.

"Rose" probes intersectional histories of planetary nomenclature, conducting research via three main platforms:

1. Live performance creation;
2. Digital dramaturgy, outreach, and audience interface; and
3. Interdisciplinary, undergraduate projects led by faculty, staff, and students.

The 2020 “Rose” performance at the heart of this article was a collection of four 20-minute-long plays for kids (one play per planetary body, with the Moon and Bennu treated for K-2 students and Mars and Titan treated for 5th-8th graders). The plays’ plots feature a crew of 22nd Century Earth explorers on a journey to establish a human colony on Jupiter’s moon Europa. The given circumstances are such that Earth’s climate can no longer sustain human life, and so the themes of environmental responsibility intermingle with a story arc about space exploration. The interactive learning environment of our live works-in-progress involved behind-the-scenes looks at our puppets and masks as well learning stations where they could moonwalk on maps of lunar topography, explore tablet applications involving Saturn’s moons, listen to audio files about the history of lunar topographical nomenclature, touch 3-D prints of Martian rover paths, and see how shadow puppets work. The playlets deployed live action, audience participation, video, and puppetry in their treatment of the climate-conscious, culturally-critical, interplanetary plot.

“Rose” encourages its participants to extend their engagement with theatrical devising techniques and scientific inquiry beyond the experience of seeing a play. Teachers who brought their students to the Cannon St. event were provided with a resource guide and lesson plans intended to be taught before and after the performance. These lesson plans are currently on our website and were broadcast to CCSD K-8th grade teachers during the early COVID-19 pandemic. Students who had attended the live event engaged in hands-on learning activities about theatre-making and scientific research alongside the live, science-oriented theatrical production. The website is intended to be an accessible space for continued exchange. It contains audience feedback tabs, including a page where students can submit examples of their work. In addition, “Rose” strives to create experiences that are accessible to people with diverse physical abilities. 3-D modeling made the lunar craters and Martian rover paths accessible to any blind or visually impaired audience members present at the live sharing, or indeed any

person for whom tactile sensory experience enhances learning. The web interface includes audio clips describing the history of lunar topography, details about Saturn's moon system, and descriptions of our theatre-making process.

This project has created a multitude of K-20 STEAM applications beyond the experience of the performance itself. In addition to K-8 lesson plans, "Rose" provided a platform for cross-disciplinary exploration at the university level during its early development process. Members of an interdisciplinary faculty learning community became excited about this project as a vehicle for a variety of undergraduate research projects. Students from Dr. William Barres' Computing in the Arts class were tasked with creating experimental apps that were used in the pre-show environment to introduce lunar and planetary nomenclature. Education students interested in STEAM were invited to rehearsals and performances to experience the creative process and to explore how they, as future educators, might incorporate science and theatre in lesson planning. Undergraduate devised theatre students as well as MAT (Master of Arts in Teaching) students used the performance to reflect upon the integration of science content in theatre processes. These opportunities arose as a direct result of our PAR framework, which invites cross-disciplinary partnerships.

PAR, when applied to STEAM, holds the potential to spark change in systems of inequity across disciplinary boundaries. STEAM empowers participants with diverse aptitudes and abilities to access science ideas and processes in a meaningful way. When PAR is conducted over a long period of time, as is the case with "Rose," opportunities for sharing and exchange can occur at multiple points throughout the work, fostering a transparency of process in a productive blur of the boundaries that often separate professional research and scholarship from K-20 learning. An extended PAR process such as "Rose" might alternate between questioning, creating, sharing, and a return to questioning; new questions can emerge and new knowledge can be generated for participants involved at any phase of the process. The addition of arts praxes within the STEM model further broadens learners' capacities to imagine themselves in creative, interdisciplinary careers.

This kind of career-oriented imagination is aided when the professionals involved in any PAR project include individuals who represent a number of cultural and social identities. The presence of diverse professional mentors in STEAM projects matters to the development and retention of future generations of practicing artists and scientists. Erika T. Camacho et al. claim that students' learning processes are enhanced in an "environment in which students develop in their ability to see the professoriate, to see themselves in it, and to be able to make choices that foster their career development."⁵ Transparent and participatory research methods and corresponding learning modes across disciplines can help to establish a precedence of practice by diverse players in the minds of K-20 students, and thereby intervene into the white-washed, heteronormative, Euro-American, male science and art narratives that have prevented many youth from imagining themselves as authorities in these fields.

The composition of the "Rose" team is always shifting because of our university situation, but we have consistently been comprised of a mix of scholars, artists, educators, students, and STEM practitioners. The diverse nature of our ensemble contributes to our creative questioning process, and we intentionally seek opportunities for inclusive collaboration. Contributors represent a mix of gender, racial, ethnic, and sexual identities. Most of the playmaking has transpired among CofC theatre students and teachers. Kenya Gadsden, Meagan McMahon, and Noah Ezell, had taken courses in Devised Theatre and/or Feminist Theatre and were curious to apply what they had learned in a PAR project. Erika Gainey, a CofC student who studied theatre and astronomy, served as an invaluable "truth grounder" as she brought her knowledge and enthusiasm for planetary astronomy to our creative project. Rylee Miller, Felise Horne, and Ceili Hesselgrave were recent theatre graduates who designed lights, maps, and sets for the show and pre-show. Local artists Javaron Conyers, Josiah Albright, and Jennifer Bettke were interested in applying their puppetry skills (also introduced in a past CofC class). Emily Pears Caitlyn, Leon Williams, and Nick Brown all had experience with Theatre for Youth which they applied to the devising, performance and educational

outreach aspects of the project. Faculty, staff, and professional collaborators included Jack Wolfe (co-investigator, and expert in augmented reality, virtual reality, and 3-D modeling), Raymon Smith (a robotics engineer who built our functional Mars rover robot), and Dr. Cassandra Runyan (CofC astronomy faculty and SCSG Director).

Representation of diverse social identities is important for equitable professional praxes in the sciences and the arts. The examples in this essay integrate the arts and astronomy, a sub-field of physics, which “has the lowest share of women degree recipients within the broad field of physical sciences.”⁶ According to the *NCSES: Women, Minorities, and Persons with Disabilities in Science and Engineering 2019* report, “Of all science and engineering... degrees awarded in 2016, women earned about half of bachelor’s degrees, 44% of master’s degrees, and 41% of doctorate degrees.”⁷ Among “underrepresented minorities – Hispanics or Latinos, blacks or African Americans, and American Indians or Alaska Natives – [degrees awarded have] increased over the last two decades,” however, “these groups continue to be underrepresented among S&E degree recipients relative to their representation in the overall population.”⁸ Gender inequity exists in the performing arts as well, especially with regard to who has access to narrative-shaping jobs in theatre and film. For example, the League of Professional Theatre Women have been conducting the “Women Count” study of Women Hired Off-Broadway since 2013. The 2017-18 survey shows improvement in the percentages of women hired by Off-Broadway theatres as playwrights and directors (42% and 47% respectively), but numbers still lag with regard to other positions of creative control such as set design (30%), lighting design (23%), sound design (21%), and composers (27%).⁹ Playwright Rebecca Gilman notes, “Even though the number of productions by women of color doubled in the last three years, they still only accounted for 6 percent of productions nationwide.”¹⁰

The surface the Moon is one place where professional inequity has historically been enacted through the planetary nomenclature processes. Features visible to the naked eye constitute the basis for folk tales around the world, and

those visible with the help of a telescope have likewise sparked the poetic and conquest-oriented imaginations of those observers who would name them. Earth-commemorative names of the Moon's topographical features have, until recently, obscured histories of underrepresented minorities' contributions to science and science-oriented culture. The International Astronomical Union's (IAU) rules for naming lunar features stipulate that all craters be named for "[s]cientists, engineers, and explorers, as well as other persons connected with astronomy, planetary, or space research who have made outstanding or fundamental contributions to their field."¹¹ Due to the white, male Euro-centrism endemic in histories of science, this rule implicitly excludes many women, people of color, and/or non-scientists who might otherwise be commemorated on the surface of Earth's nearest neighbor.¹² In "Rose," we addressed the prioritization of science over arts through an interactive map of the Moon that featured QR codes linked to audio stories of craters that had been named for artists and/or women, the names of which had either been changed or were never approved by the IAU. Visitors can still listen to audio clips of poetry by each artist on our website. The gender disparity of lunar nomenclature is visually addressed in artist Bettina Forget's series, "Women with Impact," a collection of graphite and acrylic drawings of lunar craters named for women scientists. Forget's artwork is another example of the application of the "Gazetteer" statistics to raise awareness about gender inequity in the sciences.¹³ Her 32-drawing collection highlights the history of gender exclusion in astronomy, "It creates an atmosphere where you think women aren't contributing."¹⁴ Diverse representation of authority in art and science professions matters to the imagination and realization of a culture in which access to power across all fields is equitable for all people. Accessible and inclusive learning strategies and mentorship at K-20 levels can impact access to professional careers in the sciences and the arts. Diverse representation of people occupying authoritative careers in arts and sciences contributes to a social imagination of the kinds of people who belong in those professional roles. This imagination transpires across a number of cultural domains.

Spaces for Reflection in STEAM and PAR

STEAM has grown in popularity since the Rhode Island School of Design (RISD) began to advocate an educational model that equally values art and science in K-20 learning. The desired outcome is for cross-disciplinary collaborations to flourish beyond the classroom. RISD aims to:

- Transform research policy to place Art + Design at the center of STEM.
- Encourage integration of Art + Design in K-20 education.
- Influence employers to hire artists and designers to drive innovation.¹⁵

The arts must be integral to the whole STEAM process in order for the pedagogy to achieve RISD's holistic goals. Implicit to the idea of the original STEM acronym and pedagogy is a sense of equitable, proximal multidisciplinary: four fields grouped horizontally, no single discipline rising above or singled out from the rest. The addition of the "A" in the center of STEM intentionally prompts STEAM pedagogues to ascribe the same pedagogical, cultural, and professional value to art as to its peer disciplines.

STEAM researchers Verónica A. Segarra et al. observe that STEAM, "has become particularly fruitful in three domains: helping science become accessible and inclusive; clarifying the meaning of scientific concepts and culture; and fostering collaborative works in which scientific and esthetic components are mutually enhanced."¹⁶ Ideally, "STEAM projects recognize the value of art as not simply a vehicle for science content, but as a complementary contribution," to transdisciplinary knowledge generation.¹⁷ A team of interdisciplinary feminist researchers at University of California Davis led by Sara Giordano and Alyssa Ney take an explicitly activist standpoint in their "feminist science shop" project, which resembles collaborative group processes often found within PAR projects as well as STEAM education. Giordano articulates an approach to ensemble building that embraces individual differences and strengths: "I always start group projects through an activist kind of skills inventory to see who is in the room and what skills

we have to move forward... a practice like that centers the fact that we all have something to offer.”¹⁸

An example of the unexpected outcomes made possible as a result of this kind of flexible leadership can be found in the contributions of “Rose” ensemble member Felise Horne, whose artistic research into the historic maps of the Moon and Mars augmented our other research into planetary nomenclature and provided fodder for additional humanities-based research into how these planetary bodies have functioned in a number of cultural imaginations on Earth.

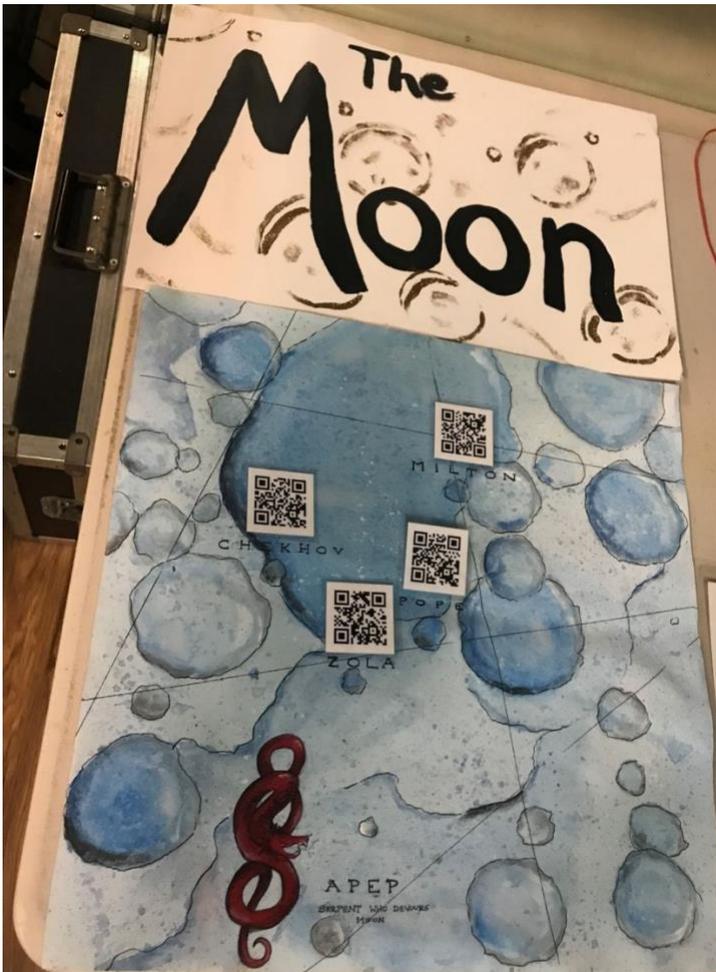


Figure 1: Draft of Moon map with QR codes and folktale concepts, by Felise Horne.

When arts portions of STEAM efforts are framed as research, as they are with the incorporation of PAR, a process may emerge that renders “artistic inquiry an equal research partner.”¹⁹ Performance studies scholar Lynette Hunter proposes

that interdisciplinary laboratory spaces can foster an understanding that the sciences and the arts are parts of a broad cultural spectrum, offering that PAR methods hold the potential to generate a “third space” for which interdisciplinary exchange (conversations among scholars and artists of diverse disciplinary distinctions) and transdisciplinary research (knowledge-generative processes that move ideas across schools of thought) might transpire. She describes her process: “The third space was conceived as a safe lab for rule breaking and novel interdisciplinary exploration, which is defined by neither methodology nor output objectives.”²⁰ The “third space” conjured through interdisciplinary PAR reframes institutional creative research praxes and actively extends such critiques beyond the academy because it introduces arts as a tool for critical questioning that can be applied beyond a single classroom experience.

PAR in STEAM can provide the means to break away from societal patterns of binary thought implied by the acronym, which is unfortunately often interpreted as STEM + arts. The “A”rt in the center of STEM creates an adjacent-yet-porous, at times overlapping, relationship among its peer science disciplines. This contiguous arrangement echoes critical race pedagogue Homi Bhabha’s suggestion that, “[c]ontiguity... explores a third area of life, between the individual and the environment. It is ‘an intermediate area’, a potential space between subject and object in which cultural experience is located.”²¹ In this space, Bhabha argues, familiar concepts might be “de-realized,” made strange in light of their contiguous relationship with other aspects of culture.²² When PAR is incorporated into the arts in STEAM, a *fifth* space for K-20 pedagogy becomes possible. Disciplinary contiguity makes “de-realization” possible via the radical equality of art and science within the acronym. The reflexive space encouraged by PAR allows participants to experience the ways that different knowledges are intertwined through creative questioning led by the collective desires of individuals working together within a multidisciplinary ensemble.

In the fifth space established by arts-science integrative PAR methods, seemingly disparate ideas can grow together in ways that possess novel cognitive

potential and that hold revolutionary social implications. The contiguous arrangement of apparently unrelated objects of study and modes of research invites new perceptions of humanity and nature to be understood. Enlightenment philosopher of science George Berkeley (1685-1753) maintained that perception depended upon co-occurring sensory modalities such as sight, touch, and sound working together to render an understanding of an object or phenomenon.²³ Extrapolating from this natural philosophy, we can surmise that the “Law of Contiguity,” when playfully applied to the acronymical STEAM metaphor, allows for multiple modes of learning to function in simultaneous and equal fashion to render natural and social phenomena perceptible to diverse individual researchers or research communities.

Within this fifth space, questions about access, retention, inclusion, and authority may be asked concurrently with the more familiar labors of art-making and scientific experiment. Questions might be asked about why disciplines such as astronomy and engineering perpetually prove difficult for women and people of color to attain lasting authority in their careers. Strategies for dismantling white male dominance of mainstream theatre and film might be rehearsed. New approaches to socio-scientific problems might emerge that “can produce the kinds of knowledge that exploited groups need and want,” suggests philosopher of science Sandra Harding.²⁴ When the fifth space made possible by PAR within STEAM deliberately resists colonial legacies, we might uncover “how the invisibilized dynamics of settler colonialism mark the organization, governance, curricula, and assessment of compulsory learning... [and] how settler perspectives and worldviews get to count as knowledge and research and how these perspectives... are activated in order to rationalize and maintain unfair social structures.”²⁵ Giordano and Ney add that a critical understanding of STEM fields would benefit “communities who historically have been harmed or excluded from Western sciences (e.g., people of color, women, queer and trans people, disabled people, and poor people).”²⁶ Collaborative STEAM pedagogies that incorporate PAR might address social inequities made invisible by “civilizational” systems of

oppression.²⁷ The active, interdisciplinary processes of query and creation inherent to PAR can present opportunities for artists, scientists, and educators involved with STEAM to deeply consider how we think with and of each other, and also how we might think and behave differently towards one another, our planet. We can extend these ideas to the study of distant places and phenomena, even in outer space.

An excellent example of the kind of cultural conversations that can be sparked through interdisciplinary—and inter-institutional—K.-20 STEAM research is “A Hua He Inoa” (the art of creating Hawaiian names), a project based at Hawai’i’s ‘Imiloa Astronomy Center. This arts-science-humanities collaboration demonstrates how important cultural bridges can manifest through science research performed from an unambiguous position, and when that research also incorporates performance practice in a manner that is contiguous to scientific processes. “A Hua He Inoa” is an interdisciplinary pedagogical project designed collaboratively among ‘ōlelo Hawai’i (Hawaiian language) experts and astronomers who perform their research in Hawai’i. Larry Kimura, founder of the Hawaiian language revitalization movement, saw in the IAU’s astronomical naming process an opportunity to revive traditional Hawaiian naming practices within the context of astronomy. Led by Kimura and together with astronomers working at Hawai’i’s Maunakea Observatories, students at Nāwahīokalani’ōpu’u School (a K-12 Hawaiian language immersion public charter school) applied Hawaiian naming traditions to the task of astronomical nomenclature, and so the asteroids Kamo’oalewa (2016 HO3) and Ka’epaoka’āwela (2015 BZ509) came to be known.²⁸ The naming process involved scientific research, embodied learning about physics concepts, and Hawaiian cultural ritual. ‘Imiloa Executive Director Ka’iu Kimura asserts, “This notion of astronomers working with the local, indigenous community to name discoveries may seem novel to most. But if the research is in and from this place, that relationship should be acknowledged and honored,” adding, “A Hua He Inoa is a critical step towards integrating indigenous perspectives and place-based scientific research.”²⁹

The history and practice of astronomical observation is fraught with conflict. Geographic locations that meet the criteria for high quality observations (including an arid atmosphere that is free from light pollution), are often found in rural regions where the presence of large buildings can interfere with the traditions of the people who are indigenous to these places. Large telescopes located on these remote sites are frequently used by scientists who are foreign to the observatory location and for purposes out of touch with indigenous interests. “A Hua He Inoa” emerged amidst controversy over the development of the Maunakea Observatories’ plans to establish the Thirty Meter Telescope (TMT). The TMT plan has met with strong protests from members of Hawai’i’s indigenous community who are “against the building of a building too big on our sacred mountain.”³⁰ “A Hua He Inoa” indirectly speaks to the controversial construction of the TMT, “[b]ut it does try to address the decades-long dispute over whether astronomers have properly developed and managed observatories on Mauna Kea and other peaks that are sacred to Native Hawaiians.”³¹ “A Hua He Inoa” endeavors to instill a respect for Hawaiian language and culture among scientists who work at Hawai’i’s observatories. According to Ka’iu Kimura, “If they’re using data from Hawai’i, we hope they will see the importance of recognizing the place... There’s already a connection.”³² The project extends research into K-12 education by offering opportunities for input in the nomenclature process from local Hawaiians through collaborations with teachers and students from Hawaiian language schools.

“A Hua He Inoa” is part of a global trend within the astronomy community to acknowledge and intervene into the colonial legacies in which the field is entrenched. Nomenclature has comprised a significant thread of that epistemological shift. Performance scholar Manola K. Gayatri posits PAR as existing in an “unsettled state of its own nomenclature,” and therefore possesses “political potency, especially in the context of the decolonization discourse,” observing that, “the naming of things has been one of the first acts of colonizing and the un-naming of these an important aspect of decolonization.”³³ Some within American indigenous astronomy traditions advocate for a restraint from naming

terrestrial topographies, especially when those names commemorate human accomplishment, “humans are too small, too fleeting and insignificant to have places named for them. The land is eternal; it owns us, we do not own it.”³⁴

“De-realizing” the Solar System: “Rose” as PAR Case Study

The original “Rose” research grant was titled, “‘That which We Call A Rose’: Multi-Media Performance as Inclusive Data Visualization Strategy for Planetary Topographies.” The project intended to engage “audiences with questions pertaining to the human exploration of worlds other than our own through a theatrical treatment of the planetary nomenclature process.”³⁵ The creation of the performance has led to new research questions, and we are closing the loop by incorporating feedback from the Cannon St. event audiences to refine and develop several aspects of the project for wider web distribution.

We have kept planetary nomenclature at the heart of our inquiry throughout our performance research journey. When we began in 2019, the Moon had 9138 named features, Mars had 1910, Titan had 270, and Bennu had none.³⁶ Our process for devising with each planetary body started with a close reading of its topography and nomenclature histories as published in the “Gazetteer.” We paid attention to names of planetary features, landing sites for Earth missions, exploratory histories, and Earth-cultural references. As we allowed ourselves poetic license to follow our own curiosities, we checked in with our research questions having to do with cosmographical traditions of naming and relationships to power and nature embedded in these legacies. We noted the underrepresentation of women, scientists of color, and artists in the Moon’s topographical nomenclature, yet found ourselves devising a play that commented on the detritus left behind by Earth’s explorations, leaving the socioscientific dramaturgical research to be addressed primarily through pre/post show and web-interactive experiences. The research into NASA’s Moon missions led us to ask questions about where Earth’s landers and rovers now reside on the surface of Mars. We devised choreographies inspired by Martian rover paths and improvised tableaux for interactions among humans, robot, and

environment. On Bennu, we established an aviary for Earth's lost birds, performed with puppets made of recyclable material, and dreamed of their safe return.

Perhaps the most difficult planetary body to address theatrically was Saturn's moon Titan. Titan was a primary object of investigation for the Cassini-Huygens Legacy Mission (1997-2017), which sent NASA's Cassini space craft with the European Space Agency's (ESA) Huygens space camera to explore Saturn's moon system. We created "Titan's Romance" to tell the story of the Cassini-Huygens mission to research Saturn's moons. The large moon has now become the future site of NASA's 2027 Dragonfly rover mission to investigate Titan's potential for habitability.³⁷ Titan's topography remains relatively unnamed when compared with closer objects such as Mars or Earth's Moon (objects with longer histories of observation by Earth's astronomers). One of Titan's named features that caught our imagination was Xanadu, a land mass located in close proximity to Shangri-La ("Tibetan mythical land of eternal youth") and Adiri ("Melanesian afterworld where life is easier than on Earth)."³⁸ The historical Huygens camera expired at Xanadu shortly after its landing in 2004. During the initial phases of our devising process, we kept our critical intention to raise dialogue about the orientalist legacies embedded within Titan's nomenclature even as we allowed ourselves freely associate poetic and pop connections among Samuel Taylor Coleridge's "Kubla Khan," Robert Greenwald's film *Xanadu* (1980), and JPL's image library documenting Huygens' landing. We went roller-skating. We did the Hustle. We mapped orbital paths and landing plans in tape, paint, and with our bodies in our rehearsal studio. We deconstructed Coleridge's poem and Shakespeare's *Romeo and Juliet* to depict an ersatz romance between a curious machine and an ineffable planet. After our initial work-in-progress performance at WTF, we discovered that the hegemonic power structures that dominate the histories and praxes of space exploration prove stubbornly difficult to decenter. In the 2019 iteration, Titan, the theatrically embodied character, didn't have many lines of their own, speaking mostly in fragments of Romeo's couplets and Coleridge's poetry. The moon in performance remained abject in the face of

scientific curiosity. We realized that in order to find the balance between enthusiasm for astronomy and critique of its colonial legacies, Titan needed to be depicted as a sovereign entity with the authority to determine their own trajectory in time and space.

We re-imagined Titan using audience feedback from WTF. Our original research questions had led us to explore connections to be found among planetary topographies, colonial histories, and relationships to power. After WTF, the research question became: What is the importance of perceiving the process of planetary nomenclature from the perspective of the land itself? What if Titan could speak for themselves? It became clear that if we were to anthropomorphize a moon as a character, then we must do so in such a way that we did not inadvertently replicate the colonialist tropes embedded in previous scientists' and artists' imaginations of the place. Titan now became a theatricalized figure whose pursuit of autonomy drove our plot. In the next iteration of the play, instead of condensing Titan into a single stage entity, we multiplied Titan to make space for numerous imaginations and interpretations of Titan-the-place while endowing Titan-the-character with agency equivalent to other characters in the play.



Figure 1: Titan (Jennifer Bettke) as disembodied planetary head. Video compiled by Jack Wolfe.

We experimented with Titan's pronouns. Titan speaks using the first-person plural pronoun "we" and is referred to by other characters in the third person (third gender, third space) pronoun "they." By queering Titan's pronouns, we attempted to trouble the binary and gendered cosmographical tropes that have historically imbued land with female-subject associations ("unconquered territory" or "virgin soil," for example) and inscribed white, European, male dominance upon it. Third person pronouns also gave rise to possibilities of performing the multiple aspects of Titan's scientific and mythological histories. The use of "we" and "they," illuminated our humanities-based history of this moon, Titan, so named by John

Herschel (1792-1871) because of its gigantic size. Mythologically, “Titan” does not refer to a single mythological giant, but to an entire pre-Olympian pantheon. Titan refers to many, not one, and so it seemed that the use of “they” was true to the manifold nature of its etymological history as the first of Saturn’s moons to be discovered by Earth’s scientists, as well as to the gender-non-conforming character that we were striving to create.

We realized that we needed to consider Titan’s desires first. We revised the plot so that Titan initiated the action by interrupting the fictional Crew’s activities, instead of introducing the character as an eagerly anticipated object of scientific research for Cassini and Huygens. In the 2020 revision, Titan first appeared on the Crew’s communication screen in the form of a disembodied head, layered over a NASA stock image of Titan (captured by the historic Cassini-Huygens mission). We transformed the actor’s voice into something otherworldly, using basic audio editing tools. The 2020 Titan made a powerful entrance on their own terms, no longer an involuntary object of scientific research, but a celestial body with an explicit agenda: “Send no more emissaries of Earth to Titan. We will continue on our course as sovereign.”³⁹ By adding Titan’s video soliloquys at the beginning and end of the act, we were able to keep much of our original scenario as a flashback, wherein a parallel plot tells the story of two anthropomorphic robots (Cassini and Huygens, themselves representing their historic namesakes), one falling hopelessly in love with Titan, the subject of its research.⁴⁰ The same actor from the video appears as Titan onstage, together with another ensemble member dressed in an identical costume. The pair escort onto the stage a giant, orange papier-mâché globe meant to represent the large, methane-orange moon. As Huygens leaves Cassini and begins to descend towards the moon, the orange sphere opens to reveal a miniature puppet stage, upon which the actors playing Titan and Huygens re-enact our deconstructed balcony scene using hand-held puppets of the space camera and Titan’s dust storms.



Figure 2: *Romeo and Juliet*, 2.2. Javaron Conyers (left) as Huygens. Jennifer Bettke (right) as Titan. Photo by Anna Robertson.

Multiplying Titan allowed us to explore more aspects of the moon's mythological, scientific, and Earth-cultural histories while also imagining a character that was

sovereign, actant, capable of controlling their own borders and shaping their own destiny. By allowing the moon autonomy in a performance in which colonial histories constituted a central theme, we found a way to include an often-marginalized voice in space exploration conversations, that of the planets themselves.

PAR Sustains STEAM, In Class, Onstage and Beyond

We are now revising “Rose” as a series of workbook plays: downloadable, digital scripts that can be used in a variety of formal and informal learning environments, each with linked STEAM activities and lesson plans. Participants will be introduced to each story arc through the website, and then complete Space Passport activities as their individual or collective curiosities lead them. The Space Passport is envisioned as a compilation of hands-on, science-based arts projects intended to enrich student engagement with each play’s script, themes, performance techniques, and science content. Digital media will augment the play participation and Space Passport experiences. A resource guide and lesson plans will be available for teachers to lead students through more complicated aspects of the history of space exploration, climate, and astronomy through theatre-making projects. We are building a workbook play for each of the planetary bodies discussed in the original performances.

The purpose of the workbook play is to get learners to immerse themselves in performance creation while asking themselves the same questions we grappled with as a creative ensemble. For example, one Space Passport activity is to create your own moon. In this project, students imagine a moon and create a papier mâché version of it. The child is asked to consider what the moon looks like, what is its size, shape, color? What features exist on the moon? Then, they consider the process of nomenclature. If they would like to name features, they are encouraged to think about each formation’s scientific and/or cultural significance in order to determine whether or not they should name it. Performing the naming process along

with other interactive features on the website, they ask the same questions our ensemble has asked while replicating aspects of the IAU's nomenclature process.

The long-form PAR nature of this project has allowed us to improvise alongside discoveries released by NASA and in spite of challenges presented by COVID-19. Our research modes have shifted at different phases of the project – from a performance studies essay;⁴¹ to a series of works in progress in 2019-2020; and into our present, reflexive phase of development that is leading us towards an online performance interface and platform for outreach as the primary product of our research. The work is ongoing. Our vision is to continue to develop arts-forward techniques for critical conversations about the solar system, exploration, and climate for innovative, interdisciplinary STEAM experiences.

¹“Titan’s Romance” may be more neatly described under the Performance as Research (PAR) rubric, but here, both the large project and short play are referred to under broader umbrella PAR. See Barton, Bruce, “Wherefore PAR? Discussions on ‘a line of flight’,” in *Performance as Research: Knowledge, Methods, Impact*, Eds. Annette Arlander, Bruce Barton, Melanie Dreyer-Lude, and Ben Spatz (Abingdon, Oxon: Routledge, 2018): 1-19. Barton offers a helpful taxonomy of “artistic research in performance” (4).

² Sandra Harding, *Is Science Multicultural?: Postcolonialisms, Feminisms, and Epistemologies* (Bloomington: Indiana University Press, 1998): 13. Harding outlines five levels of eurocentrism at work in science cultural praxes: overt, covert, institutional, societal, and civilizational or philosophic.

³ Vivian Appler, “That which We Call A Rose”: Multi-Media Performance as Inclusive Data Visualization Strategy for Planetary Topographies,” *South Carolina Space Grant* (2019).

⁴ Visit <http://blogs.cofc.edu/that-which-we-call-a-rose/>.

⁵ Erika T. Camacho, Raquell M. Holmes, and Stephen A. Wirkus, “Transforming the Undergraduate Research Experience Through Sustained Mentoring: Creating

a Strong Support Network and a Collaborative Learning Environment,” *New Directions for Higher Education* 171 (Fall, 2015): 71.

⁶ National Science Foundation. National Center for Science and Engineering Statistics (NCES). *Women, Minorities, and Persons with Disabilities in Science and Engineering*. 8 March 2019.

⁷ *Ibid.*

⁸ *Ibid.*

⁹ Martha Wade Steketee, with Judith Binus, “Women Count IV: Women Hired Off-Broadway 2013-14 through 2017-18,” *League of Professional Theatre Women*, (November 2018): 5.

¹⁰ Rebecca Gilman, “Men still dominate top theater jobs. Here’s how that hurts women,” *Chicago Tribune*, Jan. 7, 2019.

¹¹ *Gazetteer*.

¹² Katherine Kornei, “An Artist Sketches the Giant Gender Gap on the Moon,” *New York Times*, April 27, 2021.

¹³ Special thanks to Ashley Pagnotta for sharing articles about Forget’s work and ‘*A Hua He Inoa* with me.

¹⁴ Forget, Bettina in Kornei, Katherine, “An Artist Sketches the Giant Gender Gap on the Moon,” *New York Times*, April 27, 2021.

¹⁵ “STEM to STEAM,” *Rhode Island School of Design*.
<http://academicaffairs.risd.edu/grants-and-funding/8736-2/stem-to-steam/>.
 Accessed 22 May 2020.

¹⁶ Segarra et al., 2.

¹⁷ Verónica A. Segarra, Barbara Natalizio, Cibele V. Falkenberg, Stephanie Pulford, and Raquell M. Holmes, “STEAM: Using the Arts to Train Well-Rounded and Creative Scientists,” *Journal of Microbiology & Biology Education* 19, no. 1 (2018), 1.

¹⁸ Cruz et al., 288.

¹⁹ Pil Hansen, “Research-based practice: Facilitating transfer across artistic, scholarly, and scientific inquiries,” in *Performance as Research: Knowledge, Methods, Impact*, eds. Annette Arlander, Bruce Barton, Melanie Dreyer-Lude, and Ben Spatz (Abingdon, Oxon: Routledge, 2018), 33.

²⁰ Hansen, 32.

²¹ Homi Bhabha, “Democracy De-realized,” *Diogenes* 50, no. 1 (2003), 32.

²² Bhabha, 29.

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- ²³ Mary Kate Moore, Josha L. Williams, and Nance G. McCarley, “George Berkeley Through History: Multimodal Perception from the 1700s to Present,” *North American Journal of Psychology* 21, no. 2 (June 2019), 2.
- ²⁴ Sandra Harding, “State of the field: Latin American decolonial philosophies of science,” *Studies in History and Philosophy of Science* 78 (2019), 54.
- ²⁵ Eve Tuck, and K. Wayne Yang. “Decolonization is not a metaphor.” *Decolonization: Indigeneity, Education & Society* 1, no. 1, (2012), 2.
- ²⁶ Maya Cruz, Julia Jordan, Stacey Anne Bateria Salinas, Rebecca Jones, Sharena Thomas, Alyssa Ney, and Sara Giordano, “Using the Feminist Science Shop Model for Social Justice: A Case Study in Challenging the Nexus of Racist Policing and Medical Neglect,” *Women’s Studies* 48, no. 3 (2019), 283.
- ²⁷ Harding, *Multicultural?*, 14.
- ²⁸ “Kamo’oalewa” refers to the object having been broken off of another object. “Ka’epaoka’āwela” refers to the asteroid’s relationship to Jupiter that is also mischievous because it is moving in opposition to Jupiter’s orbit. For more, see “A Hua He Inoa,” *Imiloa Astronomy Center of Hawai’i*. www.imiloahawaii.org.
- ²⁹ *Ibid.*
- ³⁰ Noe Noe Wong-Wilson in Urritia, Doris Elin, “At Thirty Meter Telescope protest, native Hawaiian elders leave mountain over coronavirus threat,” *Space.com*. Apr. 2, 2020. www.space.com.
- ³¹ Alexandra Witze, “Hawaiian culture makes its mark on the Solar System: Naming project aims to strengthen Indigenous connections to discoveries made in the state,” *Nature* 565 (January 2019), 278.
- ³² Kimura in Witze, 279.
- ³³ Manola K. Gayatri, “PAR and decolonization: Notemakings from an Indian and South African context,” *Performance as research: Knowledge, Methods, Impact*, eds. Annette Arlander, Bruce Barton, Melanie Dreyer-Lude, and Ben Spatz (Abingdon, Oxon: Routledge, 2018), 170.
- ³⁴ Doug Herman, “Denali and America’s Long History of Using (or Not Using) Indian Names: In restoring the Athabaskan name to the country’s highest mountain, President Obama is among those who have wrestled with the issue,” *Smithsonian Magazine*, Sept. 3, 2015. Smithsonianmag.com.
- ³⁵ *Ibid.*
- ³⁶ International Astronomical Union. “Gazetteer of Planetary Nomenclature.” <https://planetarynames.wr.usgs.gov>. Accessed Feb. 22, 2021. The IAU only names topographical features of scientific interest. As of the composition of this

article, the Moon has 9149 named features, Mars has 1965, Titan has 285, and Benu has 36.

³⁷ Tricia Talbert, “Dragonfly Launch moved to 2027.” *NASA*. NASA.gov. 25 September 2020. Accessed 19 May 2021.

³⁸ *Ibid.*

³⁹ Vivian Appler, Josiah Albright, Jennifer Bettke, Javaron Conyers, Nicholas Brown, Noah Ezell, Kenya Gadsden, Meagan McMahon, and Leon Williams, “That which We Call A Rose,” Charleston, SC, February 14, 2020.

⁴⁰ Giovanni Dominico Cassini (1625-1712) and Christiaan Huygens (1629-1695) were historical astronomers who observed Saturn during the seventeenth century.

⁴¹ See Appler, Vivian, “Titan’s ‘Goodbye Kiss’: Legacy Rockets and the Conquest of Space,” *Global Performance Studies*, 2, no. 2 (2019).