# The Impossible Now: Limit Telepresence and Robotic Entanglement on Mars

*Kris Paulsen*
(The Ohio State University)
ORCID: https://orcid.org/0009-0000-5623-7574

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**Abstract**

This article investigates the conceptual and aesthetic effects of "limit telepresence" created by communication with Mars. The vast distance between Mars and Earth makes any notion of real-time presence or a stable shared "now" impossible. This scenario exposes the temporal contradictions at the heart of all telepresent encounters, illustrating that "now" is always some version of "then." Looking to artists David Bowen and Minna Långström, who collaborate with NASA engineers and use Martian data in their works, the essay argues that these conditions of spatialized time and temporalized space produce unique aesthetic features that stretch the duration of the instant and demonstrate how telepresence is an experience of the past mistaken for the present.

*Keywords*: Telepresence; NASA; Telerobotics; Robotic Art; Mars; Video Art; Presence; Time; Interplanetary Communication; Human-Machine Interaction; Eye-machine

**Abstract**

Questo articolo indaga gli effetti concettuali ed estetici della "telepresenza-limite" creata dalla comunicazione con Marte. L'enorme distanza tra Marte e la Terra rende impossibile qualsiasi idea di presenza in tempo reale o di un "adesso" condiviso e stabile. Questo scenario mette in luce le contraddizioni temporali che si trovano al cuore di ogni esperienza di telepresenza, mostrando che l'"adesso" è sempre una qualche versione di "allora." Analizzando il lavoro degli artisti David Bowen and Minna Långström, che collaborano con ingegneri della NASA e utilizzano dati provenienti da Marte nelle loro opere, il contributo sostiene che queste condizioni di tempo spazializzato e spazio temporalizzato producano caratteristiche estetiche uniche, che dilatano la durata dell'istante e dimostrano come la telepresenza sia un'esperienza del passato scambiata per esperienza del presente.

*Parole chiave*: Presenza; Tempo; Comunicazione interplanetaria; Interazione umano-macchina; Occhio della macchina

For three months a Martian wind blew in Southern California. Tucked into a corner of Glendale's Brand Library Gallery, dozens of dry stalks of tall grass tilted and swirled in what wall text claimed was the weather of another world. Long stretches of near stillness and uneventful, trembling calm would suddenly break into dramatic twists of collective action. The artist behind this work, David Bowen, planted one hundred twenty-six individual stalks of an unidentified variety of tall grass into small metal and plastic mechanisms that maneuvered the shafts in response to data collected by the Mars Environmental Dynamics Analyzer (MEDA) on NASA's Perseverance Rover.[1] The kinetic sculpture appeared in the exhibition *Blended Worlds: Experiments in Interplanetary Imagination*, organized by NASA's Jet Propulsion Laboratory (JPL) as part of the 2024 edition of The Getty Museum's expansive, multi-site program, *Pacific Standard Time*. The scene was one of strange contradictions. The tangled, root-like ropes of electrical wires appeared both chaotic and overly systematized.

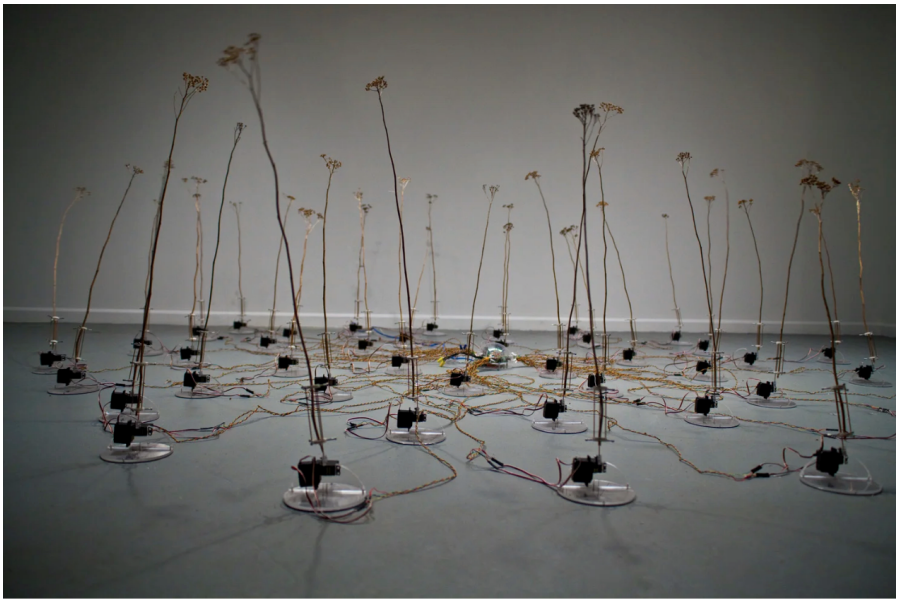

**Figure 1.** *Tele-present Wind (Mars Wind Version)* © David Bowen (2024). Courtesy of the artist.

1 Bowen worked in collaboration with the Jet Propulsion Laboratory and Dr. José A Rodríguez-Mandredi, lead scientist on the Mars Environmental Dynamics Analyzer on Perseverance (Bowen 2024).

The organic, rustic materials rustled noisily in competition with the electric hum and mechanical clicks of their artificial supports. Natural light from adjacent windows dappled an agrarian scene that had no need for it. The modest exhibition space, raucous with the competing soundtracks of the video works playing in other rooms, did not seem grand enough for such a cosmic haunting.

Bowen's *Tele-present Wind (Mars Wind Version)* (2024) (Fig. 1) is an odd spectacle to watch and, moreover, to feel. I visited the installation on multiple occasions in October 2024 and, therefore, experienced at a distance several days of local Martian weather. Each time the ersatz meadow would build from random quiver into sweeping whorls of synchronized movement, I allowed—even encouraged—myself to imagine my body onto the surface of Mars in the same place as our robotic surrogate, Perseverance. In the absence of an actual breeze, the somatic sensations triggered by the dry whisper of the grass were strangely evocative of weather or, at least, the experience of it from indoors. The sudden shift of sound from the parched, shivering vegetation sent involuntary prickles across my skin, triggering that "low-level euphoria" associated with autonomous sensory meridian responses (ASMR).[2] Like most people who surf the constant streams of visual data that flow down to Earth from NASA's many apparatuses on and around Mars, I can call to mind the terrain and environmental conditions that might surround Perseverance in Jezero Crater, or as much as one can claim to do so from video and screen images, those windows that lead to other worlds. Through rover eyes, I've seen dust devils miles wide sprout on distant horizons, tearing up the ground in a riot of rusty debris. They alight across the landscape, tracing the contours of buttes, hilltops, plains, and mountain ranges, bringing movement if not life, per se, to the empty landscapes that surround our lonely robots on their endless sojourns. Perseverance (2020–), Curiosity (2011–), Spirit (2004-2010) and Opportunity (2004-2018) have been prostheses for experiencing this distant world and making it familiar—even ordinary—in the ways they present this endless alien desert in the deluges of media they beam down from the heavens. Through their distant, mechanical bodies, Martian vistas appear like the red rock deserts of the American Southwest and other colonial landscapes that have been photographically framed by geographers, prospectors, and explorers.

2 Dr. Nitin K. Ahuja describes the effect of ASMR (autonomous sensory meridian response) as reliably producing the feeling of "low-grade euphoria in response to specific interpersonal triggers, accompanied by a distinct sensation of 'tingling' in the head and spine (akin to a mild electrical current, some say, or the carbonated bubbles in a glass of champagne)" (2013, 443). The combination of scratchy, dry noises and mechanical hum in a Tele-present Wind elicited something similar in me. Ahuja's connection of ASMR to the sensation of an electrical current is evocative, here, as one might feel connected to the electronic signals broadcast from Mars.

But what is it I actually feel when I remotely experience this wind from another world? Certainly, there is no wind, but movement stands for it by analogy. I am encouraged to imagine a simultaneous experience with Mars when I know this is impossible. The Martian atmosphere is so thin that 100 kph winds might cause but a small breeze.[3] Are the grasses moving to the degree they would move on Mars, or are they converted to an earthly atmosphere? It seems bizarre or ironic that vegetation, a complex form of life—even if dead in this display—serves as the medium for this translation and presumed collapse of here and there. No wind on Mars has ever been registered by the bend of a reed. It is utterly unimaginable occurance without projecting oneself into a fantastical future or unknown (and implausible) deep past when Mars might be teeming with life. There also seems to be a reversal in this scenario as well: someone—or something—on Mars is controlling a machine on Earth, rather than the other way around.

The wall text for Bowen's project claims that the "stalks move in synchrony with the Martian wind, temporarily uniting Glendale with Mars through the dynamic interaction of wind and motion." The idea of synchrony put forward here leans ambiguously on the phrase "tele-present" in the title of the artwork, which, conventionally, indicates a live—or functionally live—auditory, visual, or haptic connection to a distant place, such that one feels present or has remote agency at that site. Telephones, television, and telerobots are just some of the more and less familiar devices that deliver these real-time experiences of connection. Mars is on average, however, one hundred and forty million miles away from Earth, and signals take anywhere from four to over twenty minutes to travel one way between the planets (NASA 2024a). This lag makes any notion of real-time telecommunication impossible, and both casual and expert encounters with Martian data stretch the limits of what we might consider presence in a mediated elsewhere.

Yet, in this essay I want to explore the far edge of presence experienced through remote devices, such as Mars rovers and the sensors that collect and deliver data back to Earth, and examine what it takes to experience embodiment through them, what I call, here, "limit telepresence." The control of Mars-based robots complicates and attenuates our understanding of presence and telepresence, as well as any stable concept of a shared "now." To experience presence at radically distant places through these devices, I will argue, requires stretching the duration of what one considers an instant. In doing so, weird kinds of time emerge that both rely on and produce aesthetic effects. To explore this aspiration and its effects, I will look to the work of both engineers

3 Mars's atmosphere is only about 1% of sea level pressure on Earth. "[T]o a human standing on the surface, this would feel more like a light breeze than a tropical storm" (Mars Education at Arizona State University, n.d.).

and artists, and collaborations in between that aim to inhabit and hold open the strange temporal and spatial dimensions of "limit telepresence."

## 1. Limit Telepresence

In a 1980 article published in the pop literature and science magazine *Omni*, MIT computer scientist Marvin Minsky (1980) famously outlined his concept of telepresence for a general audience. Inspired by the work of science fiction authors like Robert Heinlein, Minsky departs from the terms commonly used by engineers and scientists, such as "teleoperator" or "telefactor," to stress the importance of "feeling" one is present in another place by way of networked sensors, actuators, and displays (47). Interactive computing and real-time physical simulation could transmit one's physical agency into a distant location, allowing for remote sensing and manipulation of an environment. The biggest challenge—and greatest achievement— for telepresence would be, he argues, to provoke the sensation of "being there" (48). Minsky opens his article with an evocative description of a future technology: a suit that simulates the wearer's motions in another place by means of "mechanical hands" (45). "Using this instrument," he muses, "you can 'work' in another room, in another city, in another country or on another planet" (45). While he primarily envisions telerobots working in dangerous and inhospitable places here on Earth—such as nuclear reactors, ocean trenches, and underground mines—off-planet uses appear consistently throughout his essay, from imagining the long-term exploration of the Moon with telerobots rather than human astronauts to the robotic assembly of space stations, and calls out several missed opportunities on recent off-world ventures. He laments that despite recent manned missions to the Moon and a short speed of light delay in signal transmission, no permanent remote-controlled robot was left behind, he laments (49). The Viking missions to Mars (1975), the first to successfully land on the planet, illustrated, Minsky argues, "how much could be done with remote control" and the "pathetic limitations" of the spacecraft NASA sent were (48).[4] Even so, the Viking landers were the first to produce situated, embodied images from the ground of a world no human has yet touched, and paved the way for the rovers that would be more responsive and reactive.

Although most of his article focuses on the work that robotic hands and arms could do, Minsky makes special note of a "telepresence eye" that delivered

4 Minsky laments that the Viking spacecrafts had "pathetic limitations. There was no way to reconfigure the equipment to make use of what was learned; a week of breathless planning was required just to get Viking 2 to turn a stone over" (1980, 48). He acknowledges the near day long delays in data transmission but implies that this will not be a barrier to remote control and telepresence on Mars, as we see later in this essay with drivers embodying Curiosity and Perseverance.

an embodied sense of vision to a remote user, indicating how vital vision is for a sense of presence in this world or others (1980, 50). Theorists of telepresence who followed in Minsky's wake, such as artists Roy Ascott and Eduardo Kac, would broaden the kinds of technology that could deliver telepresent experiences, typically centering a visual experience, be it of text or video images. Writing in the 1980s and early 1990s, Ascott downplayed the role robotics or remote action must have in telepresent scenarios and argued that any use of telematic technologies—which he defines as "the fusion of computers and telecommunications systems" ([1993] 2003d, 258)—could induce an experience of remote presence. Ascott includes a wide variety of media and devices in this list, ranging from "hypermedia" to "teleconferencing." Fascinatingly, he does not stress the real time interaction that "tele" usually implies when attached as a prefix to any technology's name. The television, telephone, telegram are technologies that appear to fold space to provide instantaneous extension of a sense via media: one sees at a distance, hears at a distance, or writes at a distance and the medium delivers those effects to a receiver immediately. Rather, Ascott's interest in the internet and early web, which have the possibility to transmit information immediately but are often experienced at a lag (the email is transmitted and delivered with apparent instantaneity but is read at a delay when the receiver has time) leads him to emphasize asynchrony in telematic technologies.[5] He repeatedly describes the experience of telematic connection as creating an "out of body" experience in which one is "in a timeless sea."[6]

Ascott's emphasis on asynchrony and timelessness seem opposed to a generic description of telepresence, which in the words of Eduardo Kac, another of its early artist-theorists, privileges "real time over real space." (Kac [1993] 2005a, 136). Despite this tidy catch phrase, Kac also allows for asynchrony in his description of the most profound experiences of telepresence, especially with remote controlled robots. His 1997 essay "Live from Mars" records his immediate reactions to seeing images from the Mars Pathfinder of the robot Sojourner situated in the alien landscape. The still images, he writes, are "significant, overcoming real space (119 million miles from Earth) with near real-time contiguousness. Their meaning does not arise from cinematic entertainment but from the raised awareness of the universe we have gained by being collectively telepresent on the Martian surface" ([1997] 2005b, 187). Kac stresses,

5 See for example Ascott's quotation of Jacques Vallée about computer conferencing in "Art and Telematics", especially as he contrasts this kind of immediate but asynchronous connection with images from space: "'In any other medium (and even in the television pictures [of Saturn] we are seeing from Voyager) the sense of time and space is always present. Not so in computer conferencing since we truly link minds wherever they are, and the sense of time is lost rapidly in the group interaction that transcends it'" ([1984] 2003a, 188).

6 These phrases appear repeatedly throughout Ascott's writings on telematics (see [1984] 2003a, [1989] 2003b, [1990] 2003c).

here, the feat of overcoming such a vast distance in "near real-time" to create a "de facto window onto the world" (187). This is a world—more, a "universe," as he states above—that we have "gained," he argues, through our occupation and the situated, embodied views taken from a first-person perspective. At other moments in the essay, however, he notes just how disjointed both time and space were in this remote connection. It took, he records, ten minutes for the data to reach Earth, and another thirty "to process the data stream into images" (188). Kac's elated description of the experience of seeing images beamed from Mars swings between claims of real-time copresence and noting the precise delays of data transfer. Kac writes:

> As the first color images were unveiled—again live on CNN [Cable News Network], approximately one hour after arrival—I was struck with the realization that what I was seeing at that very moment, in the privacy of my own home, was exactly what the surface of the fourth rock from the sun looked like one hour ago! Twenty-one years ago Viking gave us our first glimpses of the red planet. Today, through this near real-time experience, Pathfinder gave us a sense of being telepresent on Mars. While it took the spacecraft seven months to travel to Mars, the near instantaneity—given the relative distance between the planets—of the telecommand, remote response, and image retrieval touched us with a renewed sense of proximity beyond the material limits of physical space. (188)

This passage captures some of the giddiness I, too, feel when looking at NASA's rover images and indulging in the swooning sensation of seeing another world from the kind of situated perspective that typically presupposes a human presence. It illustrates just how hard one must work to square this out-of-joint temporal experience with real-time expectations of telepresence. "Instantaneity" becomes relative. An hour lag is immediacy when reaching toward something as far as Mars. Later in the essay, Kac will briefly suggest that perhaps there are "aesthetic features unique to this telepresence event," specifically citing the strange relativity of space and time (189).

The aesthetic features of limit telepresence are caused by the spatialization of time and temporalization of space. These may also be, however, the features of telepresence itself. At the outer limit, where instant transmission of signals is impossible and the telepresent experience should fall apart due to the frustrating interruptions of signal latency, what emerges is the paradox of all telepresent encounters, the secret hidden at their heart: there is no "now."[7] Lag time is an inherent aspect of telecommunication even if one cannot perceive the delay. Now is always some version of then.

7 Early artistic experiments with satellite transmission of video by Mobile Image (Kit Galloway and Sherrie Rabinowitz) or Nam June Paik brought the inherent latency of communication into the foreground of their work as an aesthetic feature. Their works, which I have written about elsewhere (Paulsen 2017, 2024), dramatize the time it takes to eradicate space.

## 2. The Impossible Now

Kac's 1990 example of the twenty minute one-way signal latency with Mars raises the question of how long the instant can stretch and still be considered a shared "now" of a telepresent encounter. If a command is sent to a rover on Mars it could take close to an hour to receive data on even the smallest action. Commands made from an engineer's now will not reach the robot until sometime in the future; the robot's now, once made known on Earth, is already thoroughly in the past. When we reach so far, the very concept of a "now," of copresence and simultaneity becomes slippery. When actions stretch to the interplanetary scale, past, present, and future become muddled in a "weird time" that challenges the distinctions between them.

Theoretical physicist Carlo Rovelli has explained that it is impossible to share anything like a present or a "now" with something so far away. "Now" is an indexical condition, dependent on context. "The notion of the present refers to things that are close to us, not to anything that is far away" (Rovelli 2018, 43). It is, he writes, "subjective" and "an illusion." Such a realization helps one grasp, moreover, how the perception of a directional "flow" of time, from past through present to future, is a "generalization that does not work" (2016, 60). "The 'present,'" he writes, "does not extend throughout the universe. It is a bubble that surrounds us" (2018, 44). We can easily consider all of Earth as currently in our bubble of now (though this may not have been the case in times past with different modes of communication). The past, he explains, is "all the events that happened before what we witness now." The future, on the other hand, are the events that will occur "after the moment from which we can see the here and now" (2018, 44). The present appears to be an instant shared by everyone, but it does not stretch very far; or, to stretch it far, one must expand the duration of what one calls an instant.

The present, or the "now" I've just referred to, in Rovelli's words, "is an interval that is neither past nor future and still has duration" (2018, 44). This duration is variable relative to the distance of the bodies aiming to share a now. It could be, according to Rovelli's numbers, eight years with Proxima b or millions of years when reaching toward the Andromeda galaxy, and 15 minutes with Mars (2018, 44). All these numbers are the rough estimations of how long it could take for a signal to travel to a location and back. They measure the variable length of an instant.

Telecommunicating with Mars dramatizes this condition of the elongated now. Yet earthlings do not just send pictures and images to Mars; they telecommute, too, driving the semi-autonomous vehicles that have crisscrossed the planet's surface since Sojourner's arrival in 1997. To control the distant rovers, engineers work in and out of time. Given the time delay, it is impossible to drive the rover in real time, even if one accepts the lengthened moment of the

interplanetary now. Whether a quick eight-minute instant or a long forty plus minute delay, receiving feedback on every step of a rover's movement is impractical. Drivers send up batches of commands to execute, a day's worth at a once, and then receive information on the results of those commands after the end of a rover's workday. Teams of drivers work three-month shifts controlling the rovers. During those stints, they adjust their clocks to live and work on Mars time. A Martian sol, or rotation, is roughly forty minutes longer than an Earth day; so, when on duty, drivers add forty minutes to their day. They slowly drift out of sync with the world that surrounds them. At the end of their tour, they are living two full days in Earth's past to attempt to be present in an elusive, stretchy Martian now. And because the drivers and science teams need to have all their commands ready for uplink at the beginning of a rover's workday (8:00 am Mars time), they work the night shift. They become nocturnal Martians living on Earth.

In the 1990s Kac suggested that telepresent encounters with Mars imagery would have "unique aesthetic features" because of the way latency, delay, and asynchrony are inherent in the process. The scheduled data transfers adjusted for Mars times, described above, also imply that the Martian wind David Bowen brought down to Los Angeles for me to feel on October 15, 2024 was not just fifteen or forty minutes old, but a day or more out of sync, stretching not just one hundred and forty million miles but spanning the distance between a day and a sol. To attempt to feel this wind blowing across space and across time is to step into the impossible now of the elongated present.

## 3. Lag Times

The live connections familiar from telephone calls, video conferencing, television broadcasts, and other telematic technologies have habituated users to expect the seamless eradication of distance, even to the Moon and back. Any lagging phone call, however, immediately reminds one of how fragile that sense of connection is. Words pile up, partners' apologies for interruption overlap, until both give up in the communication breakdown. It is difficult, however, for most people to perceive delays of less than a few tenths of a second (Rovelli 2018, 44), and we habitually ignore the near half-second lags that are an inherent condition of our satellite telecommunications technologies.

Nicole Starosielski and Grahm Candy have theorized "the visceral, emotional, and physical" responses users of technology have when they feel their data feeds slowing down, especially regarding systems which they expect to deliver instantaneity" (Graham Candy quoted in Starosielski 2015, 61). Whether characterized by distorted images, out-of-sync sound, or slow loading speeds, Starosielski notes how these delays and glitches make the unseen infrastructure that supports these systems visible. "Lag and distortion are not merely products

of distance" with our terrestrial communications infrastructure, Starosielski writes (62). Rather, they typically indicate "when content is not efficiently transmitted" (56). She calls the effects and affects produced by these delays an "aesthetics of lag" (56).

Neta Alexander picks up Starosielski's term to describe the "phenomenological mode of waiting" produced by buffering and the complications it introduces into "our understanding of immediacy, agency and control in the age of 'connected viewing'" (Alexander 2017, 2). Buffering, she writes, typically produces feelings of "frustration, anger, and sometimes even rage (especially if, and when, one expects transmission always to be seamless)" (13). Both Starosielski and Alexander acknowledge that "'waiting' is a relative term; it can mean something different depending on different expectations and circumstances" (Alexander 2017, 8). One's tolerance for the loading of a webpage in 1995 or 2005 would differ greatly from expectations in 2015 or 2025, just as rural internet users in infrastructurally underdeveloped areas might have different notions of slowness or thresholds for tolerance than those in a large, industrialized city. Alexander connects the displeasures of buffering, however, to the "unpredictable and unknowable length of the disruption" which insulates the aesthetics of lag from effects of nostalgia, intimacy, or artistic pleasure that often accompany creative and experimental uses of noise, glitch, and distortion (13). Alexander, like Starosielski, is only addressing quotidian media encounters, not anything so rarified and exceptional as receiving information from another planet, in which case the primary lag is due to distance and speed of light signal latency. As such, there are distinct differences between their conceptualizations of the aesthetics of lag and all its unpredictable frustrations and Kac's delight in experiencing the elongated time of limit telepresence. While the latency varies in accordance with the relative positions of the planets, it is always known and predictable. It takes time to stretch oneself to inhabit a distant rover. Processing data into human-readable images, too, takes measurable—sometimes long—times, as Kac notes in his calculations of what immediacy means when viewing Mars. Even so, I would like to hang onto Starlosielski and Alexander's concept of the aesthetics of lag to understand what it takes to experience Martian data and to stress that, because the temporalities of delay are known and expected, the elongated instant of limit telepresence activates different aesthetic, affective, and experiential registers than buffering, throttling, or drag in terrestrial communications. Experiences of lag in our commonplace media produce frustration and productively call attention to the formal properties of the infrastructure that undergirds experiences of networked immediacy through formalist experiences of distancing and alienation. The aesthetics of lag in limit telepresence as so evocatively described by Kac, on the other hand, demand that one stretch across space and time to inhabit another world. This takes a patience so extreme that it becomes difficult to parse past, present and future.

## 4. Robotic Entanglements

Writing the instructions to control a rover requires other awkward orientations in addition to living on Mars time. To control the rover, one must anticipate its future. Drivers plan out the rover's maneuvers, foresee each picture it will take in advance, schedule its experiments, and then send up the instructions. Hours later, the team receives the report on how the day went, seeing how the future they programmed manifested in a time now already past. Anticipating obstacles and how to recover from those that were unexpected demands imagining oneself into the rover's body, and mapping oneself into the Martian landscape through 3D displays composed from rover camera images and satellite reconnaissance data. Ethnographer Janet Vertesi has written extensively and compellingly about the ways in which members of the rover teams inhabit these robotic creatures. Writing in 2008 about the Spirit and Opportunity rovers, Vertesi described how drivers plan each of the rover's movements by reconfiguring their own bodies to match the rover's anatomy. Through "intricate associations of talk and gesture," Vertesi writes, a driver "associates her body with the Rover's piece by piece by piece" (2012, 395). Drivers retrain themselves to see the world, for example, through the robot's fisheye lenses, which distort shapes and distances, rather than processing and converting the images to rectangular projections, so as to become "fluent" in the Rover's particular visual world and to work more quickly. Through these physical contortions and mappings, Vertesi explains, the drivers "acquire the robot's own native representations of Mars, as well as its own bodily orientation and apparatus" (397). They "write the Rover onto the human body," Vertesi argues (399). She quotes one of the drivers as claiming, like a mantra, "my body is always the rover" (393). The driver's body must be the rover's future and the rover's past, cycling through the long now that connects the two.

According to Vertesi, operators became strangely, even magically entangled with their off-world machines. Most interesting to her as an ethnographer, Vertesi writes, was the way that drivers "assumed a direct, even causal, somatic association between the robot's experience on Mars and individual bodies" of the drivers on Earth (402). She cites multiple examples of team members experiencing sudden inexplicable injuries or impairments that they soon learned coincided with a rover's malfunction: a frozen right wrist at the same time as Spirit's right front wheel became stuck; a shoulder injury occurring simultaneously with Opportunity's own arm joint issue. While this is an illustration of a remarkable empathic link imagined between humans and robots, it also implies that these human operators, isolated from the dangers of their interplanetary mission by distance and robotic augmentation, imagine their well-being as either affected by the risks to the robots or, conversely, their own embodied conditions put robots in peril. And in the long, amorphous now that stretches between here and Mars it is unclear which event happened first or what might be the directionality of this magical influence.

Filmmaker Minna Långström takes up the mental and physical maneuvers drivers perform to inhabit the mechanical bodies and laggy time of Mars rovers in two related works, a documentary film, *The Other Side of Mars* (2019), and a three-channel multimedia art installation, *Photons of Mars* (2019). They draw upon the same footage and material but present it in very different ways.[8] The documentary, *The Other Side of Mars,* includes first-person narration and talking head interviews with Vertesi, as well as geologist Dawn Sumner, NASA Chief Engineer Rob Manning, and NASA roboticist and rover driver Vandi Verma, who all discuss what it is like to drive and direct a rover. While the documentary is not completely "straight" (for example, it includes some fictional sci-fi elements, such as a steaming hot cup of coffee materialized by a futuristic machine), it aims to evocatively inform viewers of the scientific and engineering feats performed by the rovers and their teams each day, but also captures some of the aesthetic and emotional impulses that affect the choices and operations. For instance, Dr. Sumner describes an image she planned for Curiosity because she thought it would be "inspiring" and affective but did not necessarily have a research justification for its capture. That image, of Curiosity looking back at its own tracks across the sand of "Dingo Gap," a site named after one in Australia where Sumner had done field work, "shows up in more presentations than any other image we have taken in the mission," she explains in *The Other Side of Mars,* "because the camera uplink lead framed it really beautifully, and when people look at that image you feel the absence of humans on Mars." There's something strange in Sumner's description— it is, simultaneously, a manifestation of her meticulously planned choices and full of personal nostalgic resonance and it was a also poignant surprise, and aesthetically moving image created by the robot and its sensors. The scene features dramatic tire tracks cresting over a summit of smooth sand untouched by any being until Curiosity. Sumner states that one "feels the absence of humans" and yet it does so from a situated viewpoint that screams of presence, particularly technologically-aided human presence from the long history of photography. The image bears a record on the ground and in the archive of human action and desire—even if mediated and at a distance— and it does so with artistic and narrative flair. The photograph is a scientific image taken autonomously by a robot, but it is also document that exposes the aesthetic nature of the work these scientists do, and which are constrained by the formal limitations of telepresence as an artistic medium.

Sumner and Curiosity's "Dingo Gap" image shows up a "Top 10" of 2014 essay in the popular contemporary art magazine *Artforum* by science fiction author Kim Stanley Robinson (Robinson 2014) (Fig. 2). The author of the *Mars Trilogy* (1992, 1993, 1996) is just one of the many who have been moved by this particular image. After looking at Viking's images for fifteen years and writing a

8 I am indebted to Lila Lee-Morrison for introducing me to Långström's work.

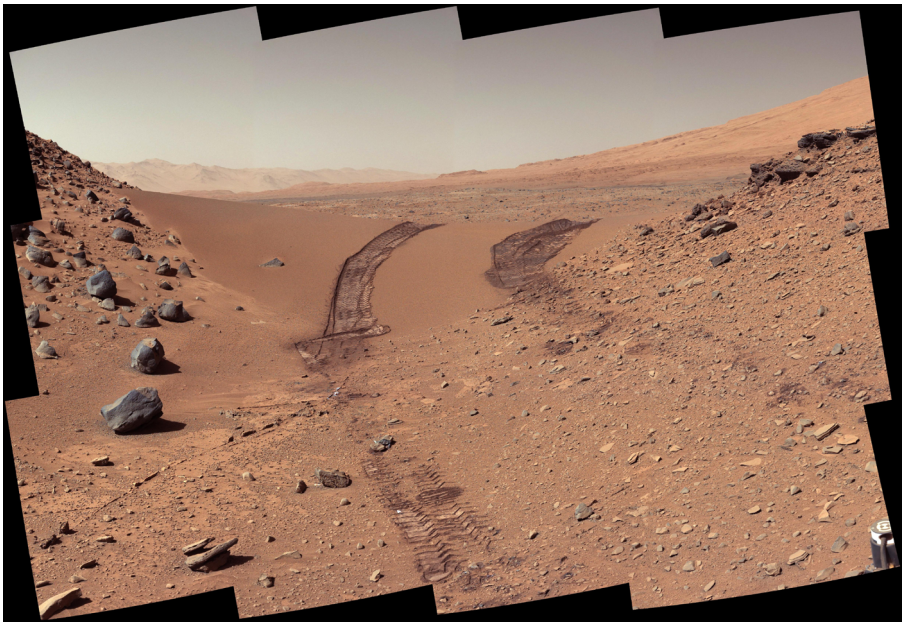

**Figure 2**. *Curiosity's Color View of Martian Dune After Crossing It* (2014). NASA / JPL-Caltech. Public domain.

series of books that revel in evocatively describing what it will be like to inhabit the landscape on Mars, Robinson was transformed by Curiosity's images.[9] He writes: "I was stunned. It was as though I had been nearsighted and color-blind all my life, and then suddenly could see the Red Planet with full sight. And what a beautiful sight it was: a million different textures and tints and colors articulating the ancient volcanoes, crater rims, and canyons…. Someday Mars will become a human space, and when we do inhabit it, there are going to be a lot of very happy artists there" (2014). *In the Other Side of Mars*, Sumner appears as Robinson's happy artist in advance of any inhabitation. A strange circuit in time and space links her past, earthly experiences to a planned image that returns at a lag of a Martian future. Throughout Långström's documentary, the scientists repeatedly imply that to be present on Mars, to connect the here to there, requires engaging with the aesthetic operations of telepresence.

*The Photons of Mars*, Långström's experimental take on the same footage, is a different kind of document than *In the Other Side of Mars*. It does not narrate a series of experiences of maneuvering in the weird Martian now but rather evokes a strange temporality through the formal device of a three-screen projection that enables Långström to create curious conditions of simultaneity and

9 I find it astonishing that Robinson wrote these deeply embodied descriptions of Mars before even seeing the 1997 Pathfinder and Sojourner images.

disjunction across the space-time of the screens. Roboticist and rover driver Vandi Verma is the only character from *The Other Side of Mars* that appears in the near seventeen-minute looped presentation. The video opens with Verma picking her way along a wild suburban footpath that leads through the woods, across a creek, and to the edge of JPL's Pasadena campus. She navigates the terrain easily, making her own decisions. The contrast with the difficulty of guiding a rover is implicit in each thoughtless ascent and casual hop across the rocky stream. The viewer sees the scene and Verma's place within it from multiple viewpoints simultaneously. In the opening shots, she is walking into the distance and toward the viewer, receding on the left and approaching on the right. A babbling creek runs through the middle. The vantage of all three cameras suddenly shifts from embedded views to lofty opposing shots of the road to JPL and an establishing shot of the research campus taken from a distance, framed by the San Gabriel mountains. The arrangement of the first sequence, with shot-reverse-shots on left and right screens with B-roll details in the center, quietly falls away and instead the shot and reverse-shot are disjointed in time. One sees Verma walk into the distance toward JPL on the left, but she never appears on the right. In fact, it is unclear where the right-side shot comes from in both time and space. It is not simultaneous and, moreover, it seems to be the same view as on the left, only rotated 180 degrees, as if one is looking at it in a mirror. This mirror does not show a reflection of now; it displays some other moment in time, before or after, the shot with Verma. It is impossible to know.

*Photons of Mars* hops across sites at JPL—conference rooms, the Mars Yard robot testing area, a 3D driving station—and at each Långström evokes muddled relationships between now and then as well as between here and there. In one sequence, three cameras rest on a conference room table. Metal-clad and fortified, they appear old, as if from the time before plastics and the proliferation of disposable things; but really, they are modern, even futuristic, designed to capture instants and withstand the elements, having long lives in inhospitable circumstances. The scene cuts to a triple view of Mars—a Curiosity "selfie" flanked by two panning images of Marian regolith. The ground drifts vertiginously as the rover holds itself in a steady moment of self-regard. Knowing how drivers work and make choices, this "selfie" marks a human desire for the machine to point one of its cameras at another and to capture its portrait situated in the landscape. Of course, what one sees here is one camera photographing another—the rover's arm camera is looking at the camera situated just off center on the robot's "face." One might imagine the hall of mirrors, the echoing *mise en abyme,* caused by this doubled vision that aligns the robot's with our own.

Throughout the video (Fig. 3), Långström captures but does not explain the temporal relationships between drivers and the rovers. One sequence shows Verma working in the Mars Yard, JPL's proving ground where they use doubles of the rovers to test maneuvers and simulate solutions before sending

commands to Mars. If a rover gets stuck while following the uploaded commands, as Opportunity did in 2011, drivers can test ways of freeing it, seeing what works before risking it in the field. There is a strange temporality in the Mars yard, too, even if the practice seems logical and self-evident. On Earth, engineers test possible futures, send the commands to Mars, and then later receive information on those futures once they are already thoroughly in the past, to move forward and test more futures. Långström shows Verma controlling a rover in the Mars Yard. On the left, Verma's face is framed in the glow of a computer screen; at right, a rover tentatively creeps out from the garage into the Mars Yard. The center frame provides the rover's point of view: a dolly shot of brown soil, sand, and loose rock. The arrangement soon switches: the rover and Verma trade positions, and the center frame shows ground that is clearly from another world—impossibly smooth and untouched. A shot of the rover in the Mars Yard, with its recognizably earthly backdrop, moves in apparent synchrony with the center frame which shows an identical action on Mars. A shovel deploys, scooping and saving a small amount of regolith. The sound of a non-diegetic electric zap bridges a transition to a close-up of Verma's eyes and two views of Mars. Photographic clicks punctuate the hum of mechanical noises and seem to sync with Vanda's blinks. Her body appears to be the rover, as Vertesi observed, and it is easy to imagine Vanda's view stretching through the screen all the way to Mars. This is what our technology allows but not in real time. Långström delivers a fantasy of copresence by illustrating the strange temporal conditions of robotic augmentation and entanglement. In the most curious moment of the video, Curiosity comes upon a remarkable rock: pyramidal-shaped and seemingly alone in a sandy expanse. It is now known as "Jake Matijevic." The occasion of its discovery is a famous one. On the mission's forty-third sol (September 19, 2012), Curiosity's daily drive ended, by chance, in front of this rock. The rover team selected this eccentric object as the target for Curiosity's first use of its contact instruments on a rock (NASA 2024b). The team named the rock after the surface operations chief engineer for the Mars Science Laboratory Project, Jacob Matijevic, who had worked on Curiosity, as well as all the previous Mars rovers, and died just fourteen days after Curiosity landed on Mars. It acts as a tombstone placed on a distant planet millions of years before its namesake was born. In Långström's video it seems to materialize, like that futuristic coffee cup shown earlier in this video and in *The Other Side of Mars*, recomposed of photons sent across time and space. Verma slowly circles and touches the rock, 3D printed from Curiosity's gathered data. "Jake Matijevic" is in the viewer's presence too. It lurks in the installation, ensconced in a vitrine that catches and refracts the reflections of the three video screens. It has moved from Mars to the screen, and then into the viewer's space as if teleported, or an artifact from a future when samples have returned from the Red Planet.

**Figure 3**. The three-channel film installation *Photons of Mars* by Minna Långström (napafilms, 2019), at Kunstfort bij Vijfhuizen's exhibition *Supre:Organism* curated by Miha Turšič of the Waag Society. Photo credit: Minna Långström. Courtesy of the artist.

## 5. Meanwhile

In the case studies of artworks and scientific endeavors above, I sketch the strange temporalities that define encounters with Mars data and which, in their limit cases, point to the condition secretly at the heart of telepresent encounters: that "now" is impossible. As Rovelli explains, the present is a concept that ceases to make sense after a certain threshold of distance. Feeling present by inhabiting a distant body or sensor from afar requires one to grow into lag time, to indulge in the inherent slowness of media sent at the speed of light. By doing so one can see clearly the formal structures and specific aesthetic effects of limit telepresence. Interplanetary temporality undermines the logics— and expectations— of immediacy that define discussions of telepresence and most contemporary media. The understanding that things could be happening simultaneously but in far flung places is, by Benedict Anderson's account, a thoroughly modern idea and narrative invention (Anderson [1983] 2006, 25). Drawing on Anderson's work, media theorist John Durham Peters develops the concept of "meanwhile structures," modern and historical narrative techniques that allowed storytellers in various media to "jump horizontally between scenes," alternately representing actions happening at the same time but in

different locations (Peters 2020, 30). "Antique narrative techniques," he writes in "A Cornucopia of Meanwhiles," "were not capable of cross-cutting, as the film-editing technique is called that takes you instantly from one scene to another—near or far—in a parallel time" (Peters 2020, 30). Modern media, such as the telegraph, telephone, and precise, standardized clock time, allowed for new concepts of the instant and to imagine that space had been eradicated and true simultaneity achieved (Peters 2020, 31). In other historical periods, such elisions of space required magical or divine powers, retrospective confirmation, or advance coordination, Peters explains. None quite achieve the simultaneous power of "meanwhile." But, he writes, soon after the emergence of real-time tele-technologies, Einstein, among others, discovered the finite limits of the speed of light. Media that transmit must always "pay a toll to time," even if it is not easily perceptible (Peters 2020, 36).

Our communications with Mars warp and exceed all Peters's categories, historical and modern. The toll paid to the speed of light is impossible to ignore and takes patience and practice to navigate. As Kac pointed out, the rover's slow images are moving as fast as they possibly can and make one rethink the duration of immediacy and the length of an instant. The inherent way long distance telepresent experiences spatialize time and temporalize space put them in a new aesthetic register and complicate the idea of "meanwhile." When an instant stretches to an hour or a day or more, how do we understand "meanwhile," copresence, and simultaneity? Our technological reach may have exceeded our conceptual grasp, or opened up a new phenomenological means of being entangled with others in space and time. Bowen's and Långström's artworks, and the scientific projects that form their basis, imply that to be present on Mars, to connect the here to there, requires engaging with the aesthetic—not just technical—operations of telepresence. It requires being an artist attuned to the specific formal constraints of an experimental medium. Långström's three-screen arrangement makes cross-cutting unnecessary, as they lay out here and there, now, then, and not yet in an array for the viewers' eyes to move between, creating their own cuts across space and time. The inherent long signal lags that arise in the limit case of attempting to be telepresent—through images, robotics, or any other sensory extension—highlights how latency resides within every telepresent encounter, even if one's equipment or consciousness is not sensitive enough to notice it. Thus, the attempts to be telepresent on Mars, whether through controlling rovers from a lab or experiencing a breeze from one hundred and forty thousand miles (and one sol) away, expose how telepresence, assumed to be the sharing of an instant across space, could also be described as an experience of being simultaneously *now* and *then*, not just *here* and *there*. Telepresence is, thus, more properly, an experience of a past that one often mistakes for the "now."

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