COSMOS AS A JOURNAL

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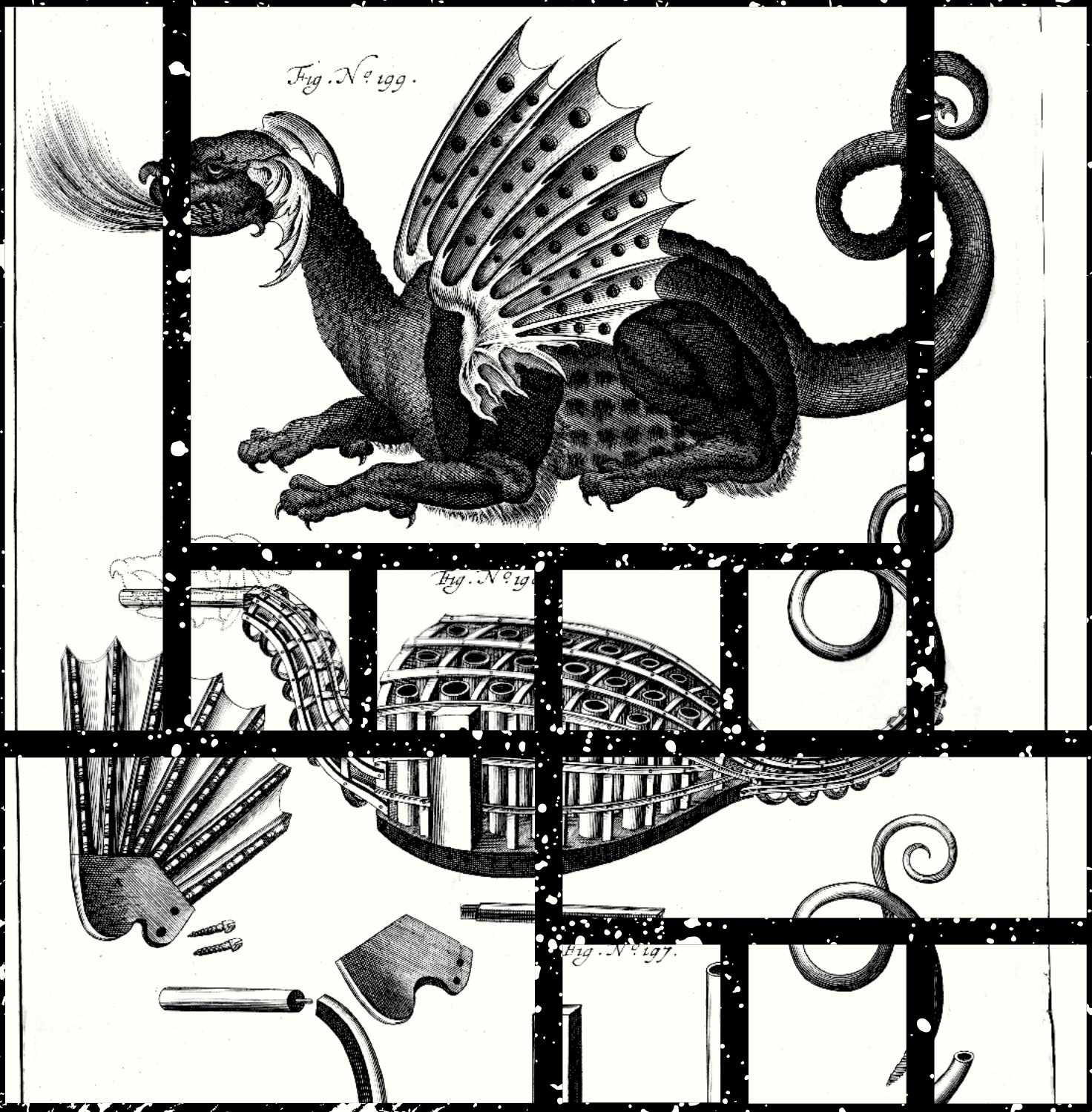

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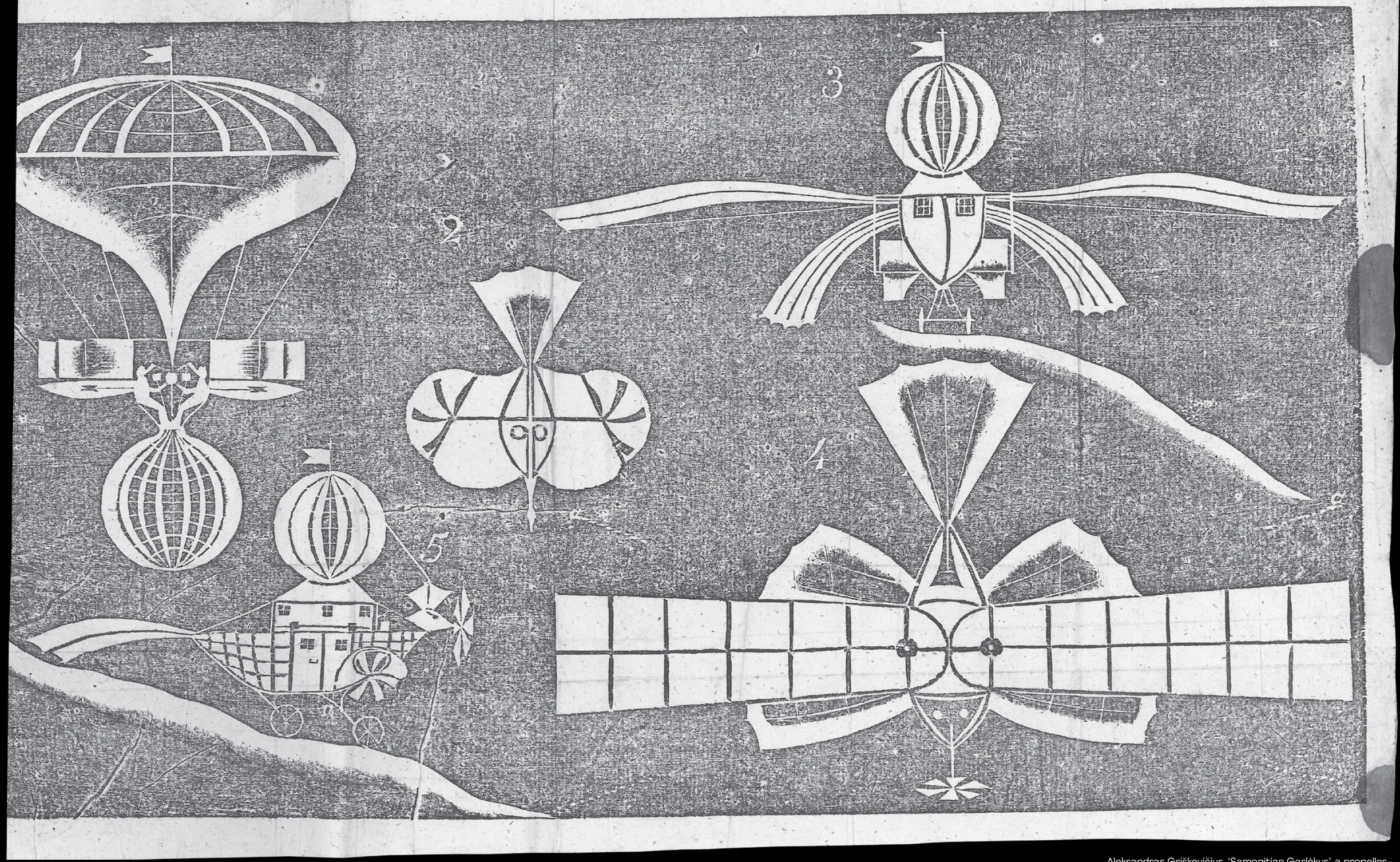

Aleksandras Griškevičius, 'Samogitian Garlėkys', a propeller-propelled steam machine with horizontal wings, 1851. Courtesy Lithuanian Museum of Ethnocosmology

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Cosmos as a Journal Editorial

Julijonas Urbonas

Imagine you found yourself somewhere far in the vacuum of outer space with nothing but this journal, only to discover that you don't need to breathe, eat and keep warm to stay alive. Floating naked in cosmic weightlessness and holding the paper in your hands or legs (there is no ground anyway), how would you read it? Most likely this familiar terrestrial thing would all of a sudden become both the most alien and intimate object you ever encountered or even imagined. Confused and space-sick you'd drop the journal, and soon find out that it was you toward which it would be falling (it is because you're heavier and hence exert more gravitational pull). Well, to be more precise, you would both fall toward each other until meeting and connecting into a unique journal-cum-human celestial body. That would be true cosmic reading!

The truth is, outer space is not that far from this conjecture. Most of the time, if not always, space is imaginary. Very few human beings have had access to it, but even if you had, you could not experience it with naked eyes, ears, noses, tongues and fingertips. Everything you experience about space is mediated via technology. Whether that is a radio telescope, robotic rover, space suit, cinematic special effects, extraterrestrial ice cream or an astro-painting generated by artificial intelligence – all of it is the outcome of somebody's imagination. That is why the cosmos always reflects humans, along with their cultural, political, ethical biases and aesthetic preferences. And that is why, for example, we've got more images rather than smells or sounds from up there, which echoes the ocularcentrism of Western culture's preoccupation with sight. The word imagination itself is self-explanatory.

This is one of the reasons I decided to devote this issue of ** as a Journal* to the expanded notions of cosmic *imag*ination such as taste-imagining (*Jane Levi*), smell-imagining (*Claire Isabel Webb* and *Milda Dainovskytė*), sound-imagining (*Daniel Gilfillan*, me and *Gailė Griciūtė*), tactile-imagining (*Eleanor S. Armstrong* and *Akvilė Terminaitė*), kinaesthetic-imagining (*Rob La Frenais*' interview with *Kitsou Dubois*). Another reason – that perhaps explains why I am the guest editor of this issue in the first place – is the recent establishment of the Lithuanian Space Agency, an extraterrestrial cultural organisation that researches cosmic imagination and gravitational aesthetics, and which represented Lithuania at the Venice Architecture Biennale in 2021 (more on this can be found in my article). Partially, I founded it to spark a critical discourse about the Lithuanian cosmic culture and imagination. If we do not include premodern mythological 'terraforming' (*Radvilė Racėnaitė*) that could be traced back to thousands of years, a more recent (modern) cosmic history of Lithuania spans over four centuries and it involves *Kazimieras Simonavičius*' first in the history of space ideas for multi-stage rockets in 1650; the establishment of one of the oldest astronomical observatories in Europe in 1753; the first successful attempt to grow plants 'from seed to seed' in space in 1982 (*Goda Raibytė*'s interview with *Danguolė Švegždienė*); the establishment of the Lithuanian Aerospace Association in 2009; and, most recently, the launch of several Lithuanian nanosatellites. However, when it comes to the public discussion of space culture here, it is frequently monopolised by technologists and businessmen. It is almost absent, as if culture terminates at the Karman line – a borderline that lies at an altitude of one hundred kilometres above sea level, often defined as the boundary between the Earth's atmosphere and outer space. This is not unique to Lithuania and may apply to many other if not all countries. However, the so-called Second Space Age we live in now has been showing signs of an increasing interest in arts and culture from space agencies, as well as an interest in space within the arts community. Perhaps it is just a matter of time until we have an art residency on the International Space Station or even on the surface of the Moon.

On the other hand, maybe there is no need to go to space to experience it, to encounter the extreme otherworldliness, to cosmically imagine. Extraterrestrial life has been simulated on Earth in remote areas – usually with a Lunar or Martian looking environment – for half a century, yet mostly, if not exclusively, with a scientific or military agenda. Basically, it is about several painstakingly singled out human beings spending lots of time in a cramped space. How would such a make-believe practice change if instead it was about speculating upon interplanetary (or even exoplanetary) cultural life and art? It is one of the questions that space artists try to answer or stage, implicitly or explicitly. When it comes to space art, there is no single nor finite definition of the cosmos but the multiverse at its finest. Every artist produces their own cosmologies. *Nahum*, for example, does so with something that no governmental space agency would dare employ; illusionism, hypnosis and music are his vehicles into the cosmos. Another example, *Fred Scharmen*, does not describe himself as an artist, yet he poetically blends the astroscientific with fictional writing, myth and autobiography, triggering mental spatiotemporal warps. Me, as yet another example, use (or abuse) astronaut training machinery for producing new sonic cosmologies, or mating robotic telescopes with distillery to stage an alchemical deconstruction of moonshine. The latter is featured in one of the inserts scattered in the publication of eight 'cosmically virgin' projects – unrealised projects by *Andy Gracie*, *Emilio Chapela*, *Joseph Popper*, *Nelly Ben Hayoun-Stépanian*, *Nicole L'Huillier*, *Sitraka Rakotoniaina*, *Xin Liu*, and me that remain floating in the vastness of imagination, yet grounded (or yet to be) by the traction of harsh terrestrial reality.

Maybe there is no need to travel at all to access outer space. You are already there, in this very journal-cum-cosmos. Text, and language in general, can make you experience things that would otherwise be impossible pragmatically, logistically, and in terms of linguistic relativity. A follower of the latter hypothesis would say that one can become an extraterrestrial by simply learning an alien language (*Daniel Oberhaus*). Or learn Lithuanian. We, Lithuanians, use the term 'cosmos' (in Lithuanian 'kosmosas') quite often, but instead of defining something that is above our heads, we rather refer to something inside our heads – something that is very confusing or hard to accept. One could say our language is our space programme, reminding us that the cosmos is always about humans and Earth, however you want to escape it.

Let the language of the journal find the cosmos within all of us.

The Very First Space Programme of the Lithuanian Space Agency: A Planet Made of Human Bodies

Julijonas Urbonas

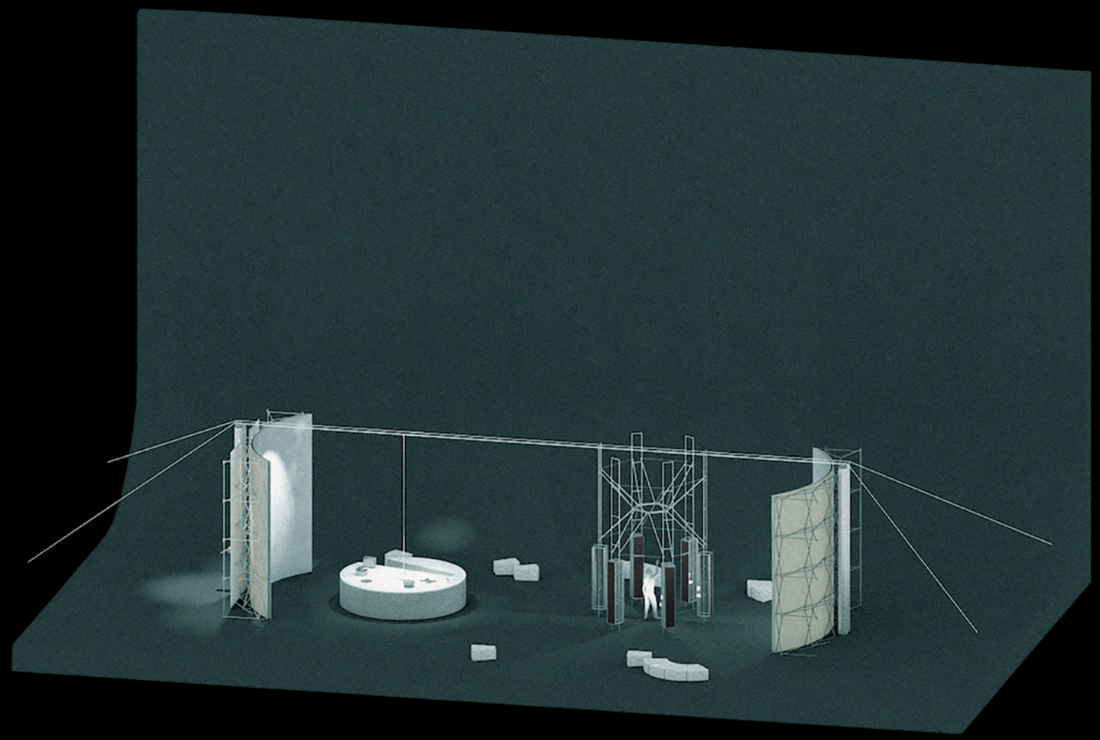
Screenshots showing the formation process of *Planet of People*, an astrophysical simulation of a celestial body from the scanned bodies at the Biennale Architettura 2021, Venice © Julijonas Urbonas and Studio Pointer*. Courtesy Lithuanian Space Agency

Installation view of the Lithuanian Space Agency's laboratory by Julijonas Urbonas at the Biennale Architettura 2021, Venice. Photo: Aistė Valiūtė & Daumantas Plechavičius. Courtesy Lithuanian Space Agency

The 3D human scanner was custom engineered to suit/fit the diversity of body shapes, (dis)abilities, mobilities and age. Photo: Aistė Valiūtė & Daumantas Plechavičius. Courtesy Lithuanian Space Agency

The Lithuanian Space Agency's seating at the Biennale Architettura 2021, Venice; © Julijonas Urbonas and Isora x Lozuraitytė Studio. Photo: Aistė Valiūtė & Daumantas Plechavičius. Courtesy Lithuanian Space Agency

According to the LSA architects Isora x Lozuraitytė Studio, 'the main aim of the visual layer was to create unrecognisable evidence of known technology'. For this purpose, the architects addressed current material urgencies and used an unusual-looking material borrowed from the largest plastic manufacturer in the Baltic States and one of the leading plastic recycling companies in Europe. This material has been recycled several times and now, as part of the LSA, is just in another stage of its continuous circulation. Its mass represents a critical perspective on human-made shifting geology and the stratum of material flows and traces that humans are leaving behind as a species. The entangled structure and ironic ornamentation resembles human guts and engages in an interplay with Planet of People, which consists of entangled human bodies. Conceptually referring to the idea of humans as post-fossil, this sinuous material was moulded into torus-shaped seating elements.



An axonometric render of the Lithuanian Space Agency's laboratory at the Biennale Architettura 2021, Venice. © Julijonas Urbonas and Isora x Lozuraityte Studio. Courtesy Lithuanian Space Agency

'The Agency's body is designed and organised by its operatives – the revolving table, the torus-shaped seating elements and the scanner – along a linear spine which works as an infrastructural supplier at both of its ends forking into a Y-form tethering. The structure is supported by two pairs pairs of 6m tall stainless steel tubular poles at both ends that serve as a 'gate' marking the entrance into the agency's traveling realms' – Ona Lozuraitytė and Petras Išora.

Julijonas Urbonas is an artist, designer, researcher, engineer, lecturer, and Founder of the Lithuanian Space Agency. He is the former prorector of arts at Vilnius Academy of Arts and the CEO of an amusement park in Klaipeda. For more than a decade, he has been working between critical design, amusement park engineering, performative architecture, choreography, kinetic art and sci-fi and has been developing various critical tools for negotiating gravity: from a killer roller coaster to an artificial planet made entirely of human bodies. As part of his research, he has coined the term 'gravitational aesthetics', which involves manipulating gravity to create experiences that push the body and imagination to the extreme. His work has been exhibited internationally and has received numerous awards, including the Award of Distinction in Interactive Art, Prix Ars Electronica 2010. His works have been acquired by private and museum collections.

What happens to imagination once it leaves Earth? Crossing the Kármán line, the boundary between the Earth's atmosphere and outer space, it becomes disoriented. After all, imagination has evolved in the Earth's ecosystem, held by gravity and human care. Catapulted up there, imagination is confronted with the hostility of outer space, otherworldliness at its most acute. How can we attune imagination to such a departure from our terrestrial origins?

Even though the arts, science, fiction and religion – to name a few – have often been reimagined from the perspective of the cosmos (with the prefix 'astro' marking such a departure from terrestrial thinking), most of these domains of thinking and making suffer from a certain degree of Earth sickness. For example, faced with humanity's survival, too often they simply search for a shelter in the cosmos that is merely a replica of Earth and is based on current human conditions or our recent history. The ground is lifted up, turned upside down, suspended in mid-air, and yet the sensual, psychological and social planes are often, if not always, left earthbound. The majority of space programmes around the world manifest such a terrestrial conservatism, often underpinned by material and (astro)ecological exploitation, colonialism and warfare. The moment of history we live in has been recently labelled as the 'Second Space Age', characterised by the emergence of an outer space economy, the (private) commercialisation of space, an increase in space debris, interplanetary biocontamination and the establishment of the astro-anthropocene.

Being concerned with such a crisis of cosmic imagination, I established the Lithuanian Space Agency (LSA); an astro-disciplinary initiative that aims to create a truly extraterrestrial imagination. A think-tank-cum-space-logistics-company, the LSA has been researching and developing poetic logistics to establish alternative ways of being and imagining together both on and beyond Earth. Acknowledging the cosmos as the site of radical other-worldliness, the agency focuses on how we can get closer to the unearthly while also shifting the perspectives on humanity to those of an alien. However, being aware of the near, if not total, impossibility of its mission and the cold indifference of the universe, the LSA believes that the only way to access the cosmic is through our capacity to imagine cosmically, employing techniques of pretence, make-believe and simulation as vehicles to multiple cosmoses. This plural term lies at the core of the LSA's ethos: the cosmos is a multiverse with an infinite number of realities, including some that will never be accessible to us earthlings. As such, the LSA combines knowledge and tools from a multitude of scientific or artistic disciplines, but does not limit itself to disciplinary approaches and looks into ways to unlearn terrestrial thinking.

The conceptual background of the LSA is largely based on my decade-long artistic research into what I call gravitational aesthetics. Looking into gravity's impact upon us, our thinking and imagination, I have developed a set of gravity-defying creative tools to tap into unprecedented sensual, psychological and social domains. Embedding the tools into the combination of fields such as design choreography, vehicular poetics, amusement park engineering, performative architecture, art and sci-fi, I have designed experiences that push the body and imagination to their extremes. The most recent materialisation of this practice is the project *Planet of People*, a scientific and artistic feasibility study of an artificial planet made of human bodies. *Planet of People* is a quasi-real, multimodal fiction based on scientific feasibility studies as well as various narrative devices that combine digital animation, set design, interactive art, fiction writing, sci-fi music etc. The project has been transferred to the LSA to advance its complex intellectual grounding, which spans astro-aesthetics, the eschatological imagination, the astro-anthropocene, extraterrestrial anthropocentrism and terraforming.

An extra-terrestrial strip dance or back to stardust

The LSA invites you to conduct a thought experiment: let's forget our earthly origins and the definition of scale, consider your body as a celestial body. Strip yourself of all social, racial, cultural, sexual, political and even biological constructs. Such earthly attributes dissolve whilst suspended in space, detached from systems of judgement and classification prevailing on Earth. Now, catapult your body into outer space. Depending on particular astrophysical circumstances, your body might meet galactic cosmic rays, solar wind particles, micrometeorite impacts, slowly disintegrating into tiny bits and coming back where they came from. All of us are made of cosmic dust after all, hence we are no different from stones, sand dunes and asteroids.

A planet from human bodies

What if we catapult more bodies, many, many more, say, the whole sextillion (1036)? Let's consider a more concrete location in outer space: one of the Lagrange points. These are locations in space where gravitational forces and the orbital motion of two celestial bodies like Earth-Sun or Earth-Moon balance each other. Being weightless, super cold vacuums that are pitch black (some of them), these points are perhaps the closest analogues to what could be considered as nothingness. A cloud of the human bodies would float there freely until their weak gravities (any object with mass has gravitational force) pull them towards each other, slowly coalescing into a blob. This meat asteroid would start to decompose, releasing enough heat to boil and liquidise its core. Plumes of hot meat and bubbles of trapped gases would periodically rise through the asteroid crust and erupt volcanically from the surface, eventually calming and freezing human landscapes all the way through.

A human being at the scale of a planet

Would it be a dead 'Planet of People'? The naked, unprotected human bodies would die long before meeting other floating astro-mates after all. However, such a contemplation is rather terrestrially biased – life and death in outer space are no different from each other, speculative astrobiology would say. What 'life' would be for such beings is something that we can only speculate on or cannot probably comprehend until we become them. What if we consider this huge blob of human biomass as a new living being? The organic matter or what is left of it would be bombarded by space radiation and solar winds, damaging or transforming DNA, provoking mutations and extra-terrestrial evolution. All which would lead to the formation of a life form the size of a planet or at least human panspermia.

A colony of astro-cyborgs

Actually, there is quite a well known cyborgian conjecture that proposes a no less radical take on the definition of 'life' in outer space. Originally the term 'cyborg' was coined to define a modified human who could survive the hostile environment of outer space. What would a population of cyborgs suspended in the nothingness of the cosmos do there? What would their life look like? If there is no longer a need for breathing, eating, sleeping and defecating, would phenomena such as culture, art, architecture, and love exist?

An inversion of Vitruvian architecture

One of the core issues that has given birth to the field of architecture was gravity. What happens to architecture if gravity disappears? What if the other core issue – human beings – disappear as well? Architecture becomes disoriented in outer space. Even more confusing is the idea of the human becoming architecture. The fundamental spatial definitions such as 'up' and 'down', or 'vertical' and 'horizontal' no longer make sense. What does an upright posture mean when legs lose their footing? Heads and butts become equal. The cosmos is indifferent: the human body is the same as space debris, a comet, a star, or a human brick to be used for constructing a new celestial structure.

A monument to humanity out of humanity

What could such a thought experiment mean here and now? Let's get down, back to Earth. It feels apocalyptical. Pandemics, climate change, deadly asteroids, atomic war, aliens – those are only some of the possible scenarios. But the scenarios for saving humankind are considerably fewer: the colonisation of other planets, space stations, and cryoanabiosis (suspended animation by freezing). The 'black swan' theory says that such events can happen unexpectedly and suddenly. In the worst-case scenario, if we have to come to terms with the end of our planet and history, what human legacy, apart from space debris, will we leave in the Universe? One could consider analogues, such as the golden phonograph record, on which are recorded images and sounds portraying Earth's life and culture, sent in the space probe Voyager. However, nothing can be a substitute for a human being. If placed in certain locations of outer space, it could be frozen and preserved for millions of years. Human astro-fossil. Or is it a manifestation of anthropocentrism at its finest?

An architectural fiction or an expanded notion of sci-fi

Lithuanian Space Agency: Planet of People was chosen to represent Lithuania at the Biennale Architettura in Venice in 2021.

As an interactive architectural fiction, the pavilion invited the public to become co-architects of a planet made out of human bodies. It was a sort of expanded form of architectural narrative, powered by deployable structural engineering, kinetic furniture design, speculative material science, extraterrestrial choreography, interactive arts, astroscientific research and corporate vocabulary – all in tandem to provoke a critical form of cosmic imagination.

At the entrance to the pavilion, visitors were greeted by a printer which automatically printed a metre-long ticket featuring information about the project and a unique queuing number for the 3D human scanner. The ticket also functioned as a booklet, a sort of pocket info-wall, and turned the visitor into a poster holder. In the pavilion were four major components. The whole installation anchored itself on two large reflective walls that bracketed the project within the church in which it was based – thereby referring to the quasi-fictional nature of the project – and sustaining itself physically and aesthetically without damaging the venue's sensitive surfaces. Within this structure was a revolving table and a custom engineered 3D scanner. The table functioned as both a reception desk and an archive of the Lithuanian Space Agency, with a number scale models referring to selected projects of mine that gave birth to the establishment of the LSA. The 3D scanner, meanwhile, scanned visitors' bodies and transposed their 3D models into an astrophysical simulation, where they could see how their bodies – in interaction with other bodies – could form a new celestial body. It invited the public to catapult themselves into a multitude of different timelines that were displayed on special screens. All of these simulations were sped up, representing different spatiotemporal circumstances. For example, on one of them visitors could see themselves being assigned an individual orbital motion, floating in the emptiness of space. Each of our bodies are unique in shape, centre of gravity and other physical characteristics – all of which make up a unique choreographic presence in space. Realising they have such an extraterrestrial presence, participants slowly started loosening up, stripping themselves from Earthly preoccupations and biases, and imagining what their body could do up there that it cannot do here on Earth. It's a sort of mirror that shows an extraterrestrial reflection of yourself. In another – the most sped up – simulation visitors could see themselves bumping up against other bodies and connecting with them to form unique spatial configurations. The simulation provided participants with an unprecedented contact dance that is only possible in the absence of gravity. Have you ever tried huddling up with other bodies in an armpit-heel-chin-chin-forefinger configuration while considering the very act of connecting with other people as a means of planetary architecture?

In the space, visitors also found a number of ring-slice-shaped seats made of plastic that had been recycled thousands of times, which may be considered as a kind of plastic poo because of its deteriorated quality. Conceptually, it refers to the origins of the material (as well as that of the human) as a post-fossil. It's also unique in its imaginary quality – it is hard to tell what it is and where it comes from – is it an unearthly brain, intestines, faeces?

To summarise, all of the elements in the exhibition – from the queue ticket, the typography based on a human skeleton, the kinetic furniture, and the astrophysical animation to the publication of the agency's first annual report – played in tandem as an expanded form of architecture to create an evocative empathetic bridge between the public and the other-worldliness of the cosmos.

Upon leaving the space, the visitors' sky-ward pointed heads bent downwards, realising that the cosmos is not only up there, but here within us.

The Lithuanian Space Agency's revolving archive featuring prototypes of Julijonas Urbonas' previous projects, merchandise display, and a reception desk that accommodates the LSA's assistants. Biennale Architettura 2021, Venice. Photo: Darius Petrulaitis © Julijonas Urbonas and Isora x Lozuraityte Studio. Courtesy Lithuanian Space Agency

Justinas Vaitiekūnas, *Kosminis derlius* (Cosmic Harvest), 2009

Julijonas Urbonas and Gailė Griciūtė talk about their collaboration on —extraterrestrial sound

Julijonas Urbonas, *Honey, Moon!*, as part of the New Opera Action festival, Contemporary Art Centre, Vilnius, 2018. Photo: Aistė Valiūtė & Daumantas Plechavičius

Gailė Griciūtė is a Lithuanian composer and sound artist. She graduated from the Sibelius Academy of Music in Helsinki, Finland and Lithuanian Academy of Music and Theater, and was also a guest student at the Städelschule in Frankfurt am Main.
Gailė is a member of the performance collective Eye Gymnastics. The group's works have been shown at various festivals in Lithuania and Germany. Some of the festivals and concert series where Gailė Griciūtė's sound and art projects were presented include Ahead, Jauna muzika, Soundscape, NOA, Estonia (Vilnius), Counterflows (Glasgow), Sound Art Festival (Kaliningrad), Unsound (Krakow), Labor Sonor (Berlin), Tectonics (Tel Aviv), Atmospherics (Haus Der Kunst, Munich).

Julijonas Urbonas:

In 2018, I was commissioned by Operomanija, a Lithuanian production house for new musical theatre, to direct and design the set for the opera *Honey, Moon!*. Collaborating with composer Gailė Griciūtė, librettist Gabrielė Labanauskaitė-Diena and others, I turned the opera into something between a participative performance and a live sculptural installation. Scattered across the 1000 sq. m exhibition hall of the Contemporary Art Centre in Vilnius were seven revolving platforms on which twelve performers – vocalists and instrumentalists – were strapped and performing. Covered with custom designed fabrics by illustrator Célestin Krier, the platforms looked like extraterrestrial landscapes, yet on closer inspection those semi-transparent textiles revealed various conglomerates of narrators, singers, a flautist, a clarinettist, a violinist, a cellist, a pianist, and a synthesiser player. The public was invited to walk around the constellation of sets and explore the play between micro, macro, and cosmic scales, encouraging the confusion between what could be considered as human and planet. For me, it was a true space opera dedicated to honey, the Moon, honeymoons... *Honey, Moon!*

Could you please say something about the creative process of composing the music for the opera 'Honey, Moon!'? What was driving your sonic imagination? How did you approach the cosmic aspect of it? What were the challenges besides the mobilised listenership and the vertigo experienced by the performers?

Gailė Griciūtė:

As I was writing the music I was thinking about there being two layers to the story: the personal intimate journey versus the cosmic journey on a bigger scale. I used different sound sources: field recordings, modular synthesisers, a chamber music ensemble and speech and was navigating between very delicate sonic gestures and an overall immersive and meditative sonic experience, where small, subtle movements merged into a constantly moving steady state.

It was a challenge for performers to play while being in motion and to hear themselves together with the amplification of sounds, which

travelled in space; it required very attentive listening and physical mobilisation. In general, all of the participants served the purpose of creating some kind of bigger organism – the sense of being an individual had to be let go of. The musicians were covered with painted fabric and the gestures of movement created by playing their instruments formed a collection of curiously moving sculptures.

JU:

When I talk about the conditions of space and the 'cosmic' in my artistic practice, I usually refer to altered states of gravity, such as weightlessness, artificial gravity, hypergravity, etc. Looking from that perspective, the piano that I developed for the opera could be seen as a hypergravitational simulator for the sound of a piano. Later, I advanced this idea so that the piano could work as a separate and independent installation, and the first occasion in which it was tested was the solo show 'Planet of People' at Galerija Vartai. It was staged as a three-month performance-experiment or high-g sound training with weekly concerts of yours in which we were increasing the speed of the platform and contemplating the effects of altered gravity on both the piano player and the composer, the instrument and the sound, the music and the listenership. Capable of producing 3g (three times greater than that of Earth's gravity), the centrifuge became a hypergravitational sound-stage. In addition to this, the centrifugal force of spinning produced unique gravitational fields that varied at different points in relation to both the player and the piano. The force increased when further away from the spinning axis. Thus, the fingers on the keyboard, for example, felt a weaker pull than the head or the back. Furthermore, the movement of the playing hands were affected by the complex Coriolis forces as were the piano strings. The constantly changing orientation of the instrument affected the way the sound was transmitted. I like to think that all of these unique physical and mental conditions gave birth to what can be called an extraterrestrial sound.

What was it like to ride, play and compose the *Hypergravitational piano*?

GG:

For that composition I used fragments from the opera *Honey, Moon!*, excerpts from prepared piano parts. My experience with the moving platform was very subtle, it did not change the way I played in a visually effective or dramatic way. But I didn't feel as stable in the way my fingers made contact with the keys, and the way I controlled my body weight, which resulted in a certain tension in my hands and that, of course, affected the sound. The composition that I wrote for the moving prepared piano had certain patterns and quite an open form; I had the freedom to experiment and choose the material. The physical conditions made an impact on my choices of course, but they also conditioned the precision of execution.

JU:

I consider the *Hypergravitational piano* piece as a soundtrack for both the exhibition and the project *Planet of People* in general. There is something eerie in the music as if the piano was possessed by a spirit. Or maybe I am too biased by the hauntological music I was listening to a lot during the development of the project?

GG:

I guess we inspired each other during the process. It started with the opera *Honey, Moon!* as the compositional material was taken from there. *Hypergravitational piano* is a composition for prepared piano, which I use in my practice a lot, as a tool to get in between the well tempered notes on the piano – it also serves as a component of the unpredictability, which I find important in the compositional process. So in this particular piece I was playing with the idea of using the instrument to get somewhere else. Repetitive passages also have a tendency to create a type of non-linear narrative, a sense of a sonic landscape and an immersive, atmospheric experience. I was also interested to feel how the use of preparation with magnets on iron strings, hit by a felt hammer, controlled by wooden keys and the flesh of fingers would complement 3D images of scanned bodies.

JU:

What effect have such projects had on your later sound art/musical practice if any?

GG:

I am a performer and a composer and so, for me, it is interesting to think about the performer's role, musicianship and individuality in the context of a large composition involving many individuals. I search for ways to leave freedom for the performers to make choices and to sharpen the process of contemplative listening and creating one attentive experience of a sonic whole. My recent work, *A Body Of Water*, commissioned by the Lithuanian Composers Union and Gaida Festival to be premiered by the Lithuanian National Symphony Orchestra involves different aspects of freedom for the performers to make individual choices, while also remaining part of a directed sound mass.

JU:

Actually, I quite often find myself being not just inspired by certain music, but guided, even manipulated to such a degree that I could consider some of my projects as a scenography or a stage for those musical compositions. Thus, my practice is like making a movie by starting with the soundtrack.

If you were commissioned to produce a score for a sci-fi space film before the script was even conceived, how would you begin composing?

GG:

I am inspired by so many different things and very often I like to think about sound composition as sculpture, considering form in time, and shapes and different textures, merging and transforming.

I am inspired by environmental sounds, certain states of mind, and melodies inherent in human speech. But in this case, I think I would try to clear my mind of thoughts and take the ideas that emerge from there as a starting point. Another very important element in my practice is failure: I embrace it and use it to guide me out-of-bounds.

Julijonas Urbonas, *Honey, Moon!*, as part of the New Opera Action festival, Contemporary Art Centre, Vilnius, 2018. Photo: Aistė Valiūtė & Daumantas Plechavičius

Julijonas Urbonas, *Honey, Moon!*, as part of the New Opera Action festival, Contemporary Art Centre, Vilnius, 2018. Photo: Aistė Valiūtė & Daumantas Plechavičius

Julijonas Urbonas, *Hypergravitational Piano*, Galerija Vartai, Vilnius, 2018. Photo: Aistė Valiūtė & Daumantas Plechavičius

Comet Composition/ Alien Materiality: Resilience, Attunement, and our Sonic Imagination

Daniel Gilfillan

Daniel Gilfillan is Associate Professor of German Studies and a Senior Global Futures Scholar in the Julie Ann Wrigley Global Futures Laboratory at Arizona State University. He is the author of *Pieces of Sound: German Experimental Radio* (Minnesota, 2009), and has published widely on German/Austrian radio- and sound art. He is currently working on a book project titled *The Unsung Planet: Resilience, Resonance and Our Sonic Imagination*.

The European Space Agency's Rosetta mission, launched in March 2004, made an intriguing discovery in August 2014 on its approach to a comet orbiting Jupiter known as 67P/Churyumov-Gerasimenko (67P/C-G, for short). Focused on efforts to soft land a robotic landing module named Philae on the comet, the Rosetta space probe's magnetometer picked up a low-frequency range of electromagnetic waves inaudible to the human ear. After increasing the frequencies 10,000 times to allow for human reception, the resultant sound composition picked up by the spacecraft's instruments could easily be imagined as the vocalisation of some new sentient life form wending its way through the oceanic vacuum of outer space. While these sounds are theorised to be the result of oscillations in the magnetic field around the comet as it interacts with the solar wind, the imaginative potential provided by this discovery offers one unique way to think about how knowledge is produced irrespective of human intervention. This celestial body and its song point to the importance of sound for analysis of phenomena external to human-based experience. In disclosing the possibility of compositional sound originating outside human experience, this sonic discovery points to a whole new set of questions and understandings about how the world and universe work and interrelate. Whether we think of these electromagnetic frequencies as a random set of oscillations dispersing into the vast emptiness of outer space, or whether we interpret them as patterns of communication occurring outside of human spatial and perceptual awareness, they provide a fascinating set of possibilities toward understanding both the limitations of human sound perception, and the limitlessness of nonhuman and object-based sound production.

Sound has played a unique role within space exploration through its use in representing an idea of humankind and life on Earth for an unknown, but imagined, interstellar audience. Now in its 44th year, NASA's Voyager mission launched twin spacecraft in August and September 1977 for purposes of detailed flyby studies of Jupiter and Saturn and their two largest moons, Io and Titan. After successfully extending the mission of Voyager 2 to include pioneering studies of Neptune and Uranus, both spacecraft officially embarked in 1990 on their current mission of exploring interstellar space beyond our own solar system. That both Voyager spacecraft carry a golden phonograph containing images, music and sounds showcasing the diversity of life on Earth provides an interesting counterpoint to the low-frequency sonic output of comet 67P/C-G.

Accompanying the assortment of genre-based and traditional music from around the globe, these golden records also include acoustic ecological sounds produced by the Earth's complex interwoven system of spheres – the biosphere, hydrosphere, lithosphere, atmosphere, and cryosphere. Alongside bird and whale song, cricket chirps and frog calls, and the sounds of thunderstorms, earthquakes, wind and rain, we also hear the sounds of the Anthropocene. These sounds range from human biological to human cultural sounds, revealing for an extraterrestrial listener what the golden records' curator Carl Sagan and his team of collaborators believed to be uniquely human sounds: the beat of the human heart, laughter, the sounds of mother and child, the diversity of the globe's languages captured in 55 greetings to the universe, and the ingenuity of human invention and human advancement with the sounds of early tools: Morse Code, a horse and cart, automobile, train, and aircraft. This sound archive of human life and civilisation on Earth is very much an imaginative product of human agency, an idea that denotes the capacity of human beings to act within any given environment or network of relationships, and one that commonly takes humans' relationships with nonhuman counterparts (e.g., animals and plants) for granted. In the arrangement of sounds chosen for inclusion on the Voyager golden record we can clearly see the importance placed on how these sounds contextualize and support human agency as the central player in the development of knowledge. Rather than being understood as providing other models of experience, the sounds of the Earth's interwoven system of spheres serve as ambient background material for humankind's continued pursuit of that knowledge.

While these human-produced sounds are far from the only types of sound that exist in the Anthropocene, they do tend to drown out the numerous other sounds produced by the remaining animals, plants, and non-human lifeforms that also inhabit Earth's complex network of interconnected spheres. The examples of the Voyager records and the low-frequency song of the comet can help us to understand the importance of sound for these complex networks by highlighting these notions of human and nonhuman agency. Their relationship hinges on whether or not humans engage these networks from a position of authority, control and regulation or from a position of attunement arising from a shared understanding of a moral and ethical responsibility for the mutual benefit of all of the Earth's inhabitants. At the core of such complex systems' sets of adaptive capacities is the multifaceted process of resilience, which carries along with it an equally ephemeral notion of risk and its potential either to support or threaten flexibility within such systems. Resilience represents the capacity of an ecosystem to absorb and/or recover from a disturbance (natural storms, wildlife depletion, human population growth, economic development, etc.) without causing a threshold shift into a different stable state of existence. This notion of stability indicates the system may have weathered the disturbance, but it has also lost one or more beneficial agents from the prior state, to which it is difficult to return.[1] In their volume *Resilience Thinking* Brian Walker and David Salt point to the practices of optimisation and efficiency within ecosystem management for our inability to create and maintain sustainable systems without 'drastic losses in resilience.' In their discussion of optimisation Walker and Salt reference an approach that:

> aims to get a system into some particular 'optimal state,' and then hold it there. That state, it is believed, will deliver maximum sustained benefit. It is sometimes recognized that the optimal state may vary under different conditions, and the approach is then to find the optimal path for the state of the system. This approach is sometimes referred to as a maximum sustainable yield or optimal sustainable yield paradigm.[2]

These models rely on a formula of natural resource and wildlife management to ensure that a maximum level of harvest (timber, fish catch, etc.) is attained without leading to depletion of the resources in question. But what these models do not account for are those elements of intrinsic and unquantifiable value that Walker and Salt term 'ecosystem

services' – 'the life support, regenerative, and cleansing services that nature provides,' as well as 'the values placed on beauty or on the existence of species for their own sakes.'[3] The presence or absence of sound forms an integral component of these ecosystem services, and serves as a marker for discovering nonhuman agents and the sonic and other knowledges they produce. When taken in the context of our Anthropocene 'moment' these concurrent processes of resilience and risk so crucial for adaptability often become more about optimising toward an idea of an ideal or peak resilience and minimising the importance of risk and precariousness so that humans may continue to thrive within the rapidly less sustainable ecosystem. Without the risk and the potential for disturbance and without an acknowledgment of the importance that complexity plays within and across such systems, then sustainability becomes less about the transformative capacity of the system, and more about a rigidity of optimal outcomes that overlooks the flexibility of the system's numerous actors.

In veering away from the value of complexity needed for adaptability, we lose sight of and sound of other models of experience that should enhance and accompany our perception of our own model of experience. The song produced by comet 67P/C-G throws into stark relief the importance for thinking otherwise about the significance we place on human thought, human experience, and human action in articulating the hyper-objective scale and deep time of our many complex sustainability issues (e.g. climate change, biodiversity and species extinction, water scarcity and food security) and for engaging responses to these issues in some way. The alien materiality of the comet's composition, the long trajectory it participates in across space and time, and the low frequency waves it produces across that traverse all call attention to the limits of our knowledge, and the limits of our experience. When expanded beyond the specifics of comet 67P/C-G, the sonic realm allows us to rethink the very limits of human resilience alongside the nonhuman. The delicate set of entanglements we share with plants, animals, geologies and atmospheres, and with other humans, necessitates that we also continually open our sonic imaginations to those entanglements within and beyond the human.

Sound in all of its forms, whether as hearing and listening, as musicality, as echo and reverb, as language and voice, as communication, or as representation, has always been a crucial component in humankind's effort to know. As both a medium and a perceptual modality, sound carries within it a whole range of possible knowledges. Spatial, ideational, affective, temporal, experiential, scientific, acoustic, and/or speculative threads may reside within any sound wave to be heard by the multiple possible recipients of that sound wave with the right biology or technology available for hearing it. Sound is thus always compositional in its production and its reception, drawing discrete but momentary connections between its points of origination and its points of arrival, whereupon it once again triggers a compositional move dependent on the cognitive, instinctual, biosemiotic, and physical abilities and needs of its varying recipients. Seen in this way, the comet and its song are also important for their ability to unsettle long-held understandings about how the world and the universe work as a product of the human compulsion for creating information, producing knowledge, and building archives meant to contain and valorise them. Their sound-based alignments provoke numerous phenomenological questions ranging from humankind's unique position within the universe, to the changing nature and value of non-human, non-sentient, and non-biological agency for engaging complex environmental and existential problems, and, for that matter, to a critical reframing of the Anthropocene concept beyond the definitional and metaphoric roles it has come to encompass.

The Rosetta mission lasted a period of 150 months and 27 days, from its launch on 3 March 2004 to the official mission completion on 30 September 2016 with a controlled descent to the comet surface and the loss of its signal upon impact. In contrast, comet 67P/C-G originates from the Kuiper belt, an extremely cold region of the outer solar system containing bodies believed to be primitive remnants from the early phases of the solar system.[4] In the relatively short human rendezvous with 67P/C-G the ingredients of risk and precariousness are central to the encounter but become disguised as routine elements to narrate the power of human technical ingenuity vis-à-vis the unpredictability of the comet's lithic imagination.[5] Risk perception also exists in this realm of the imaginary, as a visualisation of potential threats and benefits to any one system's sustainability, while precariousness arises within the momentariness of the encounter, setting the perception of risk into performative action alongside the non-scriptable uncertainties bound up by the comet's very existence. Without a human technical solution, the inaudibility of the low-frequency electromagnetic waves produced by the comet's orbit through space would have inscribed the encounter as one involving the impossibility of sound, as belonging to a realm where sound doesn't or shouldn't occur. Yet even with the technical solution and the discovery that sound is possible, our human capacity to attach meaning to the event still resides within that imaginary. Perhaps this helps form a truer definition of resilience, wherein risk and precariousness act as imagined and immeasurable performance variables given the spatiotemporal uniqueness of the encounter. And perhaps the value of the precarious moment provides us with some response or counter to the selfish conceit and accompanying hedonism that an Anthropocene thinking foregrounds by making us confront the very limitations of how we produce a knowledge that doesn't include, in some way, the value of the imaginary, and the value of our sonic imaginations.

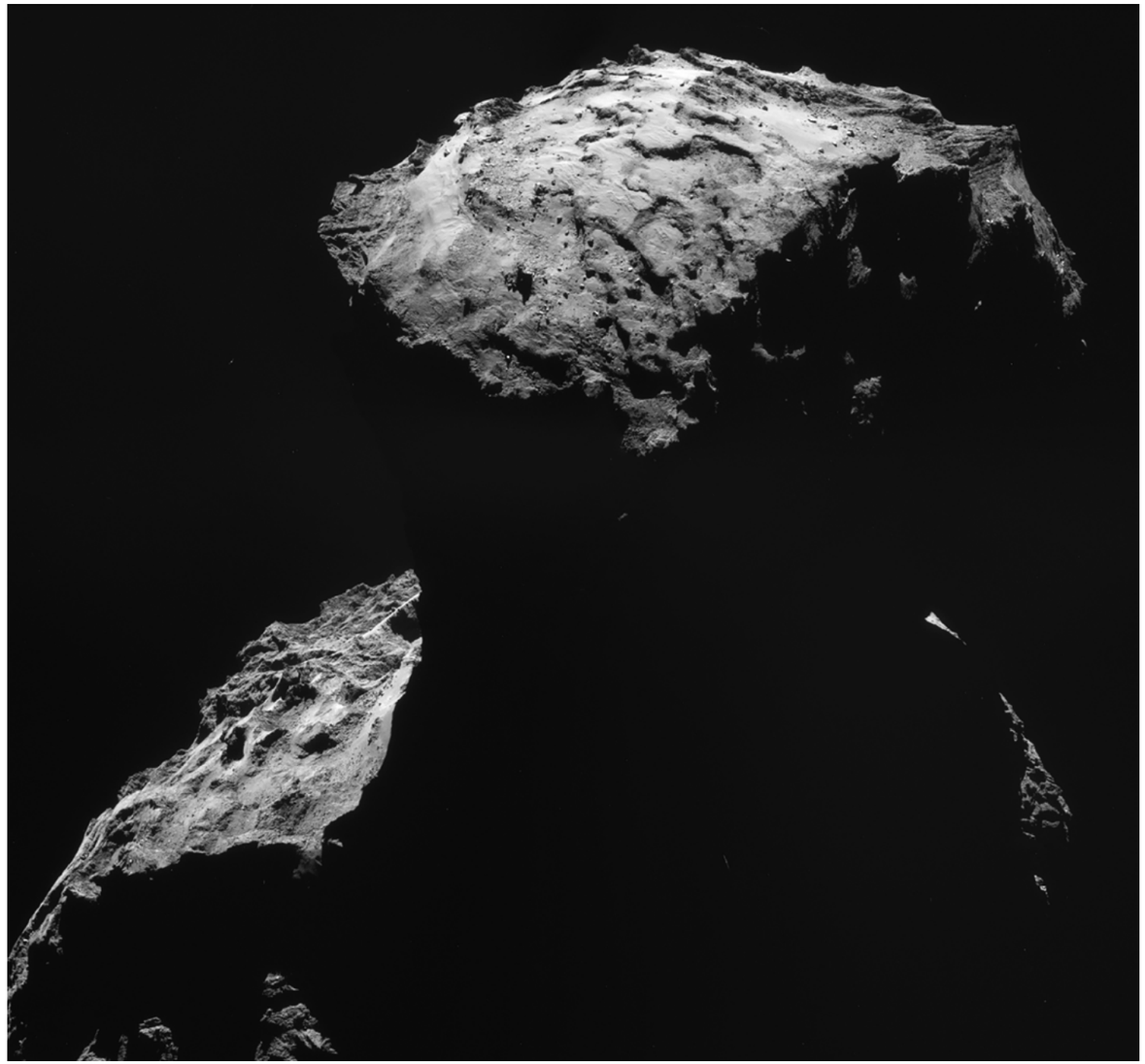
Endnotes

1 Brian Walker and David Salt, *Resilience Thinking: Sustaining Ecosystems and People in a Changing World*, Washington, DC Island Press, 2006, pp.36–38.

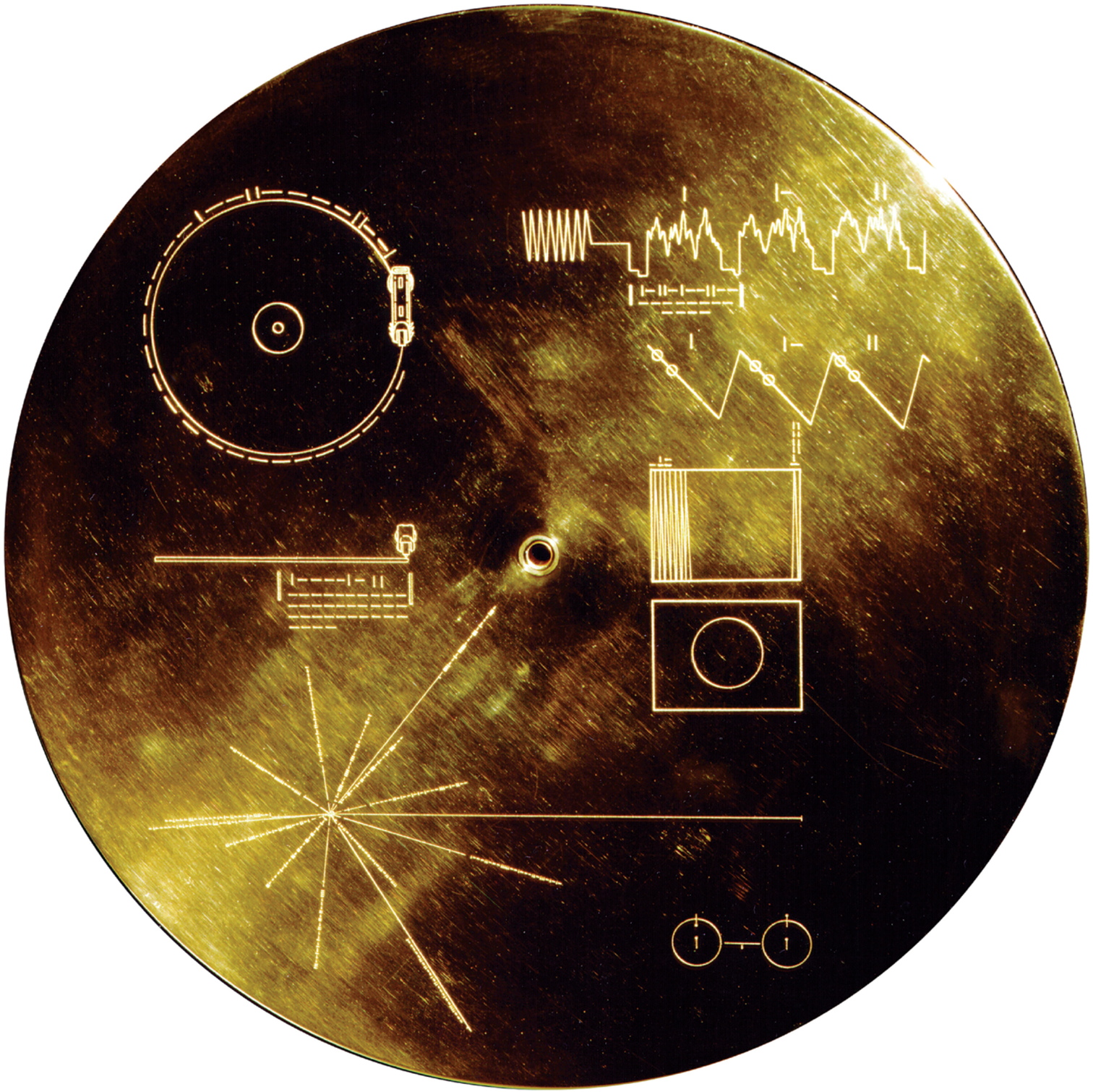
2 ibid, pp.6–7.

3 ibid, p.7.

4 For an interesting multimedia timeline animation plotting the orbital arc of the Rosetta spacecraft and detailing milestones from the mission, see 'Where Is Rosetta?', ESA Science & Technology, http://sci.esa.int/where_is_rosetta/,ccessed 8 April 2018..

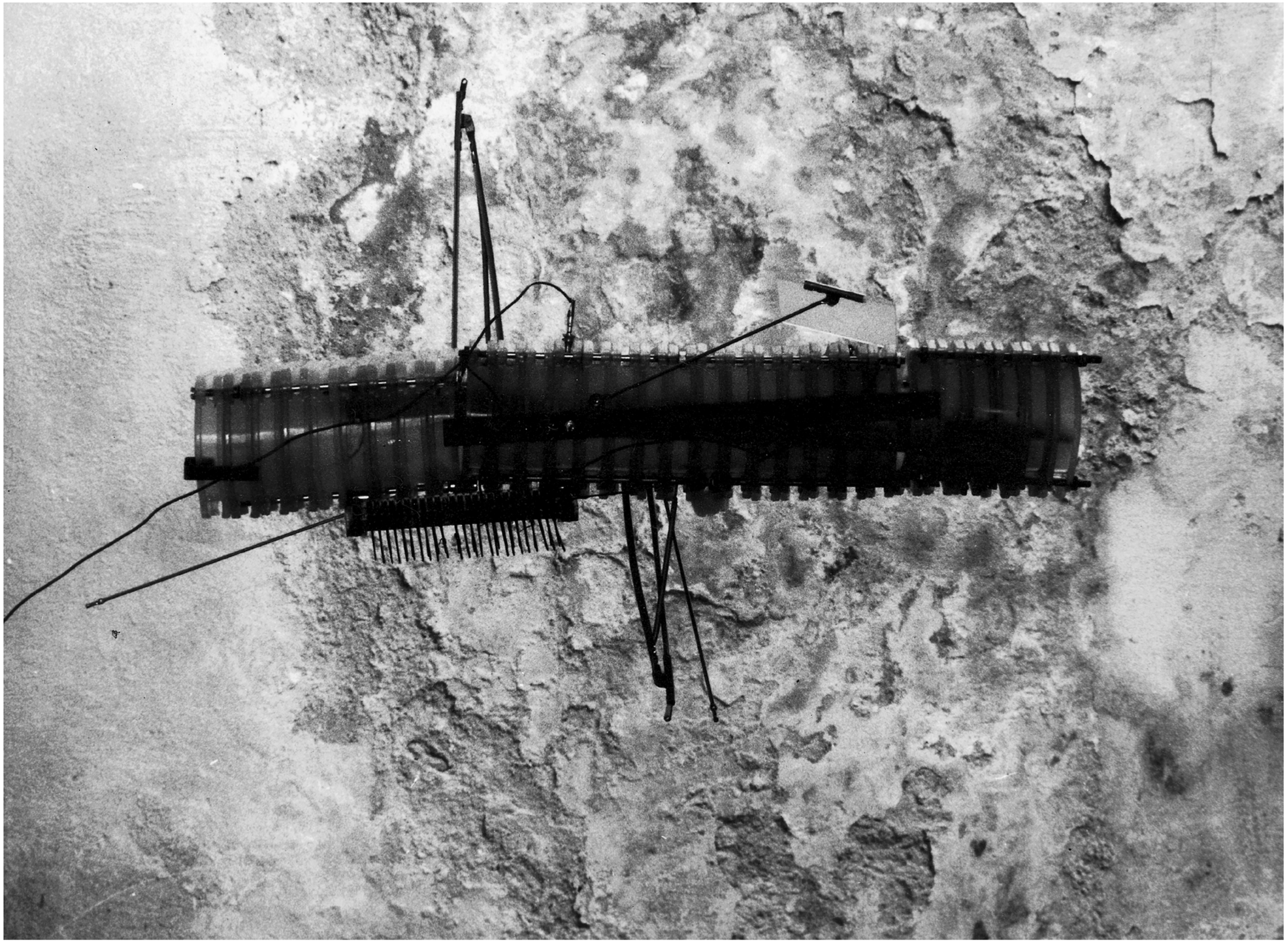


5 Mosaic of four images taken by the spacecraft Rosetta's navigation camera (NAVCAM) on 19 September 2014 at 28.6 km (17.8 mi) from the centre of comet 67P/Churyumov–Gerasimenko.



Cover of the Voyager Golden Record.

This gold aluminium cover was designed to protect the Voyager 1 and 2 ‘Sounds of Earth’ gold-plated records from micrometeorite bombardment, but also serves a double purpose in providing the finder a key to playing the record. The explanatory diagram appears on both the inner and outer surfaces of the cover, as the outer diagram will be eroded in time. Flying aboard Voyagers 1 and 2 are identical ‘golden’ records, carrying the story of Earth far into deep space. The 12 inch gold-plated copper discs contain greetings in 60 languages, samples of music from different cultures and eras, and natural and man-made sounds from Earth. They also contain electronic information that an advanced technological civilisation could convert into diagrams and photographs. Currently, both Voyager probes are sailing adrift in the black sea of interplanetary space, flying towards the outmost border of our solar system.



Audrius Bučas and Valdas Ozarinskas, *Tarakonas (aka Architektonas)* (Cockroach – aka Architecton), 1989. Courtesy Valdas Ozarinskas Foundation

Otherworldly Journeys

Nahum

Nahum's oeuvre goes deep into the human experience by challenging our perceptions through unusual perspectives. Navigating between the real and the imaginary, his work produces events that reframe the way we understand the world: 'I am interested in that point where reality touches the impossible.' He often employs outer space technologies, illusionism, hypnosis and music to guide audiences into otherworldly journeys to raise critical dialogues about the politics of existence. Nahum's multidisciplinary work orchestrates a wide range of media including performance, installation, video, music, drawing and storytelling.

Nahum is the Founding Director of KOSMICA, a global institute founded in 2011 with the mission to establish a platform for critical, cultural and poetic discourse on our relationship with outer space and the impact of space activities here on Earth. The Institute develops initiatives that bridge art and humanities, the space sector and wider society.

Nahum served as the Chair for the Committee for the Cultural Utilisation of Space (ITACCUS), at the International Astronautical Federation (IAF) in Paris. In 2014, he was the first artist to be awarded the Young Space Leader and Karman Fellowship in 2021 for his unique cultural contributions to astronautics and space exploration. Born in Mexico City, he lives and works in Berlin.

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As you are holding this text and listening to the sound of my voice, you start feeling relaxed. Take three deep breaths... Breathe in... hold it for a second... now breathe out and as you do allow all your tension to flow out of your body, and again. Breathe in... hold it for a second... now breathe out and as that warm breath leaves your mouth you can feel the tension flowing away from you. Let's do it once more. Breathe in... hold it for a second... now breathe out allowing your shoulders to drop as you do. I want you to draw your attention to your eyes, feel how your eyelids are getting heavier and heavier. Relax your jaw and allow your mouth to fall freely and comfortably open. As you relax the tiny muscles around your mouth, you can feel your whole face more and more relaxed. Now, visualise this feeling of relaxation slowly spreading all over your face and head. Slowly, this bubble of relaxation starts covering your neck, your chest, your arms… As you experience these sensations you allow yourself to go into a trance...

Now gently wake up and open your eyes.

Unfortunately, I am not going to hypnotise you this time. I use these words to begin an intimate and personal journey. With these words I have hypnotised over a thousand people around the world in countries as diverse as Brazil, Japan, Sweden, Canada, Mexico, amongst others. In these hypnosis sessions I introduce false memories in the minds of an audience. Once they wake up, they remember something new: walking on the Moon.

Once I got on to the Moon I started to drift and boundaries between dream and memory are very fuzzy for me.

On 16 July 1969, the world witnessed the landing of man on the Moon. In the coming years, 12 men walked on the lunar surface. Armstrong famously uttered 'That's one small step for man, one giant leap for mankind.' And indeed, he was talking about men as not a single woman was given the opportunity to be part of the Apollo missions. Today we know this wasn't because of a shortage of well prepared and qualified women that were ready to undertake such challenge, but instead because of what seems to have been an actual NASA policy, as the letter overleaf reveals.

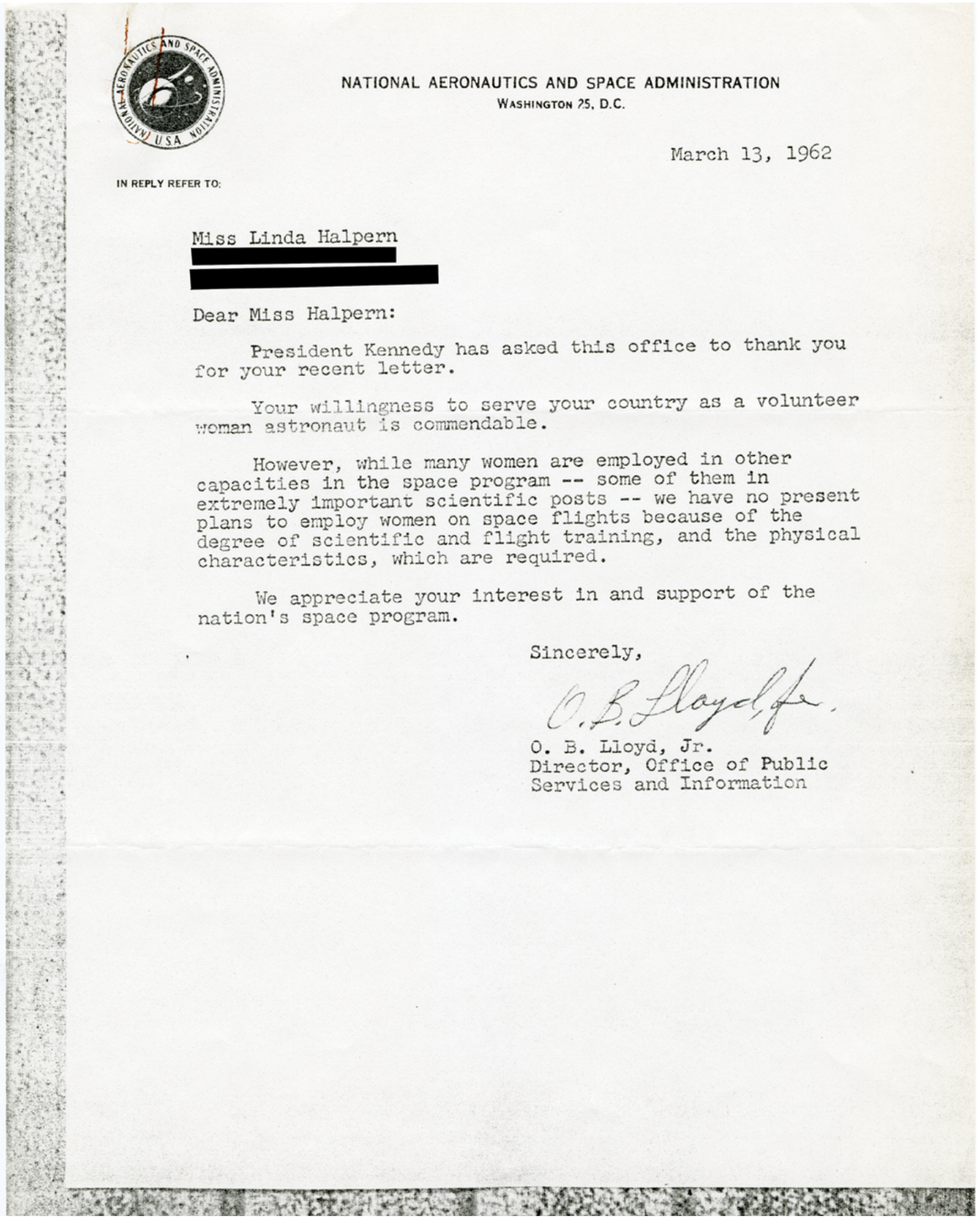
Instead, NASA sent a group of well trained fighter jet pilots that came back to Earth as philosophers. As a thought experiment, let's imagine what it would have been like to have a different crew? What impact would have been made by a woman astronaut walking on the Moon back in the early 1970s? How many people would have been empowered by such an image? What other ways of seeing the Moon have we missed?

The sky was just a vivid hazy blue, such an intense blue. As it touched the horizon it was sort of a pinkish yellow but as it rose up it was just the most intense beautiful crystalline blue that I have ever seen.

Today we can argue that while things have changed in the space sector, those changes are still not sufficient. Today, only about 10% of astronauts are women and the space sector still remains largely conservative. Let's remember that the history of space exploration is dominated by affluent and industrialised nations, often tied to military and economic imperatives. In turn, space activities and their narratives have further cemented the imperial and economic dominance of these superpowers, reinforcing existing belief systems, gender politics, racial and colonial orders. This legacy leaves little room for cultural diversity in space activities. By examining the origins of these norms we can explain why this sector struggles to create an inclusive environment that can reflect the diversity that exists here on our planetary home.

With the growth of the commercialisation of space by private companies, also called New Space, the space sector is moving in new directions. These companies are often led by billionaires, who claim to be guiding humanity into a better future (while avoiding paying their fair share of taxes), bringing a new layer of exclusivity to space travel. Space will now be accessible to those that can afford it. This alienates the public image of space travel as a luxury leisure pursuit available to only the most wealthy individuals. Certainly, seeing the richest people of Earth floating and smiling in tiny capsules undermines and vilifies the intrinsic value of space exploration. These companies seek to have launches as often as possible to become profitable. With the current space technology, propulsion systems and rocket fuel, daily space travel seems more of a threat to the planet than a benefit. According to a NASA study back in 2011, the consequences of having 1000 rocket launches per year could raise the polar surface temperatures by 1 degree centigrade.

Many of us have been deeply influenced by the 'overview effect'; a noble concept coined by space philosopher Frank White. It refers to a cognitive shift experienced by some astronauts during space flight while viewing Earth from afar. In this new awareness astronauts experience a sense of wholeness, fragility and a profound appreciation of the beauty of



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON 25, D.C.

March 13, 1962

IN REPLY REFER TO:

Miss Linda Halpern
[redacted]

Dear Miss Halpern:

President Kennedy has asked this office to thank you for your recent letter.

Your willingness to serve your country as a volunteer woman astronaut is commendable.

However, while many women are employed in other capacities in the space program -- some of them in extremely important scientific posts -- we have no present plans to employ women on space flights because of the degree of scientific and flight training, and the physical characteristics, which are required.

We appreciate your interest in and support of the nation's space program.

Sincerely,

O. B. Lloyd, Jr.
Director, Office of Public Services and Information

Image of Linda Halpern's letter with her address redacted. Image: National Air and Space Museum Archives, NASM-9A12464
https://www.si.edu/Termsofuse

Earth. Today this type of clarity is used as a punchline to promote space travel for all, but until new alternatives to rockets and fuels are developed, it is problematic as a prospect. After all, we are already in space! How incredible would it be to develop something like a 'roundview effect'. A regained sense of wonder by looking at the horizon and experiencing the daily dance of the Sun from side to side, the feeling of our feet being pushed towards the core of the planet and the realisation that we inhabit one of the most beautiful and intriguing places in the universe.

And when I was looking at Earth, I wanted to embrace it.

But perhaps, the greatest failure in this new era of space exploration is the lack of bold new visions (going to Mars doesn't count) that would enable us to fantasise and expand our wonder about the cosmos. Let's remember that first and foremost, space exploration has its origins in the visions of artists. Before space travel was possible, artists from different disciplines were already imagining humanity beyond Earth's orbit with paintings, music, films and otherworldly stories. These cultural works inspired both scientists and engineers that made space travel possible. Today, as the space sector grows, the importance of imagination and creativity become even more evident. Artists can directly contribute to shape the new technologies that will revolutionise space exploration.

When envisioning the future of our societies, space becomes a critical territory that must be inhabited artistically as well as scientifically. Artists have not stopped envisioning a myriad of models for exploring the universe in both critical and poetic ways. These imaginaries conjured by artists have the potential to make an enormous impact on the future of space exploration, from exploring space without rockets to new models for planetary personhood.

I saw two kinds of gods dressed in white and wearing Indian clothes. They were giants and I thought I was projecting myself as the goddess of man and woman.

It's been over seven years since I started taking people to the Moon using hypnosis in theatres around the world. In recent years I have been performing these journeys with various groups of space professionals and these sessions have been equally revealing to me. I recall a couple of years ago the case of a space mission designer from the European Space Agency. While he was in the trance state nothing seemed out of place. He looked like most people do when they are under hypnosis, calm and unexpressive. There were 20 other scientists and engineers in the room, which was a sterile white space with low ceilings inside a science facility in Strasbourg – very different from the flamboyant and classy theatres I like to perform in. After relaxing the group and focusing their attention on the sound of my voice, I asked them to search for their first memory that connected them to space. Afterwards, they had to imagine a speculative mission around this memory. Then, they came out of the trance state and started writing a fantastical space mission that they were to perform in a theatrical way in front of everyone. At some point, it was the turn of the ESA space mission designer. He was a hardcore engineer with postdocs, published papers and a good reputation in the space sector. From the brief conversation I had with him he seemed secular and scientific. But at this moment something was different. He switched off the lights in the room and took his iPad out which displayed a fullscreen photo of himself. In the darkness we saw his face floating around the room while he was talking about Jupiter. His voice started to crack and he confessed that when he was a kid he experienced a kind of astral-travel to this planet. He said that it was real and that he still remembers the exact point he visited on Jupiter. Since then he has been determined to go back to this place and is committed to spending the rest of his life working towards that goal. He had never shared this experience with anyone before and felt exposed for revealing such a magical event that had guided his entire scientific life.

I was like ah! I have to go back to Earth, damn! It's really nice up here and I was enjoying the beauty.

For the last decade I have attended every single one of the annual International Astronautical Congress; the big gathering for space professionals across the world. As well as attending the plenaries and chairing the sessions about culture and art in space, I make sure to take some time to simply observe the thousands of people that gather there. I perceive them as a bunch of dreamers – they work for space and they dream about space. Yes, they come from STEM education backgrounds but they could be designing coffee machines, and instead they want to do things away from this planet. Many of them have forgotten how incredible and magical their job is due to spreadsheets, politics and just everyday life. Hopefully, artists will continue to fuel visions for a kinder and bolder space exploration sector, but also remind us how much we need to acknowledge and embrace fantasy today.

I feel I must have been sleeping in some moments, I am not sure.

Photos courtesy of Nahum Studios

On Extraterrestrial Relativism

Daniel Oberhaus

Daniel Oberhaus is a science writer in New York City whose work primarily focuses on space exploration and the future of energy. He was previously a staff writer at Wired magazine and has published journalism and essays in *The Atlantic*, *The Guardian*, *VICE*, *The Baffler*, *Nautilus*, and other publications. He received BA degrees in English and Philosophy from Arizona State University and worked as a Fulbright scholar in New Delhi, India. His first book, *Extraterrestrial Languages*, was published by MIT Press in 2019. It explores the art, science, and philosophy of interstellar communication with the aim of creating a framework for overcoming the practical and theoretical challenges of communicating with an alien intelligence.

The prospect of interstellar communication with an extraterrestrial intelligence has enchanted humans for centuries, but our species has developed the technical capacity to act on this dream only in the past few decades. More recently still, the general perception of the Search for Extraterrestrial Intelligence, or SETI, has changed from a fringe pursuit by wayward astronomers into a legitimate scientific enterprise. Today, SETI is backed by massive budgets and venerable institutions. But the legitimation of SETI only pushes us closer to two questions that have haunted the Search from its earliest days: (1) why haven't we found evidence of extraterrestrial intelligence and (2) will we be able to understand one another if we make contact with ET?

Both of these questions ought to be considered through the lens of relativism. While relativism cannot judge whether continuing SETI is worthwhile or will ultimately be successful, it *can* suggest new pathways for studying the problems of interstellar communication between two intelligent species. Interstellar communication is just one of many goals of SETI and is not the sole criterion for judging its success. For example, merely detecting the presence of a non-communicating intelligence on a planet around another star – perhaps by discovering certain compounds associated with industrialisation in its atmosphere – would fundamentally change our understanding of the universe.

Receiving an intentional message from an extraterrestrial intelligence would certainly be the most extraordinary result of the Search. Indeed, this possibility is a major motivating factor for many, if not most, SETI scientists in the world. Thus, it is worthwhile to focus our attention on the primary problems with intentionally exchanging meaningful information across vast distances of time and space: scientific, linguistic, and cultural relativism.

Scientific Relativism and the Fermi Paradox

In 1950, the physicist Enrico Fermi posed a simple question that has rankled generations of alien hunters ever since: Where are they? The Earth is the only planet we know that hosts life, intelligent or otherwise. But there are billions of stars in our galaxy and billions of galaxies in our universe and we now know that most of these stars host planets. Some fractions of those planets appear to have conditions amenable to life as we know it. The odds seem to favour a universe teeming with life and it's reasonable to expect that at least some of the alien lifeforms out there are intelligent. This is the crux of Fermi's paradox: It seems as though life should be abundant in the universe and yet we can't find even the slightest hint that we're not totally alone.

There have been many attempts to theoretically resolve Fermi's paradox. Solutions range from the pessimistic (perhaps intelligent life is abundant, but tends to destroy itself after reaching a certain level of technological maturity) to the fanciful (perhaps intelligent life conceals its location due to some danger lurking in the cosmos). One of the most compelling explanations invokes relativism: Perhaps intelligent life in the universe is abundant and communicative, but our technologies are based on a scientific understanding of the world that prevents us from recognising interstellar conversations.

Scientific relativism is a subspecies of epistemic relativism and is based on the idea that the interpretation of a given datum is bound by existing cultural, theoretical, or technological frameworks. While science is usually treated as the process of learning some ground truth about the 'real' world, the facts must be integrated into a theory about how the world works. In other words, there is no pure 'fact,' but multiple ways to correctly interpret a datum in different contexts. This idea was popularised by the philosopher Thomas Kuhn, who put forth the concept of scientific paradigms, which are perhaps best understood as shared understandings of the world by groups of scientists that allow them to meaningfully communicate and make progress. In this sense, a scientific paradigm is a way of defining the world rather than exploring a world that exists independent of that paradigm.

We can clearly see the impact of scientific paradigms in the history of physics. The slow march from Newtonian physics to relativity and quantum mechanics has fundamentally changed the way that physicists think about the world. Of course, you can still get by with Newton's classical mechanics, but there is a limit to what is explainable within this paradigm. Einstein's theories of relativity expanded our understanding of the world, but so did the quantum theories of Neils Bohr and Max Planck. Without these theories, technologies like GPS, computer chips, or LEDs wouldn't exist.

And yet, even these theories aren't the whole picture. Einstein's relativity is great at describing the world at very large scales while quantum mechanics is best suited for describing the infinitesimal. Neither theory can be easily transposed to other scales and a unifying framework has eluded generations of physicists. Does this mean that one or all of these theories must be wrong? Not at all. Quantum mechanics didn't negate Newtonian physics. It just expanded the world of scientific discourse.

This has several important implications for interstellar communication. Given the age of the Universe (~13 billion years), the relatively young age of Earth (~4 billion years), and the extremely young age of *homo sapiens* (~200,000 years), any extraterrestrial intelligence we communicate with is highly likely to be a significantly older – and by extension, more scientifically advanced – species. So even if we are observing the same universe as an extraterrestrial intelligence, the scientific paradigms we use to make sense of that universe may be radically different.

Our scientific understanding of the world influences our ability to control it. This is why we have mastered the art of heavier than air flight but have yet to develop gravity-based propulsion systems. (Indeed, with our limited understanding of gravity we can't yet say whether such a device would even be possible.) This is important in the context of interstellar communication because we may not yet — or perhaps ever — have an understanding of the physical world that allows us to develop the technologies that enables us to converse with an extraterrestrial intelligence. Indeed, today's primary SETI instrument is the radio telescope, which operates in a portion of the electromagnetic

spectrum we've had access to for about a century. It seems probable that radio communication will turn out to be a relatively primitive communications technology. In that case, it's like we are trying to detect telegrams from the cosmos when most extraterrestrial intelligence has already upgraded to broadband.

Linguistic Relativism and Interstellar Communication

Let us suppose that our extraterrestrial correspondents do in fact communicate with radio messages and the reason we haven't heard from them is because they are listening for a message from us. If we decide to engage in an extraterrestrial messaging campaign, this raises a new intractable challenge: What language shall we use to establish basic conversation?

Language helps convey information between two parties, but there are many different modes of transmission, rules for exchange (i.e., grammar), and shared vocabularies. In the context of interstellar communication, any cosmic communiqué from Earth must be encoded in radio or light waves. But what should we say and how should we say it? Perhaps we can build a custom language for interstellar communication based on pictograms where patterns of radio signals represent different concepts. Or maybe we should send patterned radio bursts that represent numerical concepts like Pi or Euler's number that would presumably be recognisable to any scientifically literate species. If we sent a message in a natural language like English, Greek, or Mandarin, would ET ever be able to decipher it?

Each of these ideas has been seriously proposed as the basis of an interstellar message. But the last suggestion – writing a message in a natural human language – seems absurd. It's worth examining why. We have good reason to suspect that an extraterrestrial will not speak English or any other language found on Earth. The reason is that the emergence of English or any of the hundreds of other natural languages on Earth is effectively a random accident. These languages were shaped by our planet's idiosyncratic history and we wouldn't expect the same languages to evolve anywhere else in the universe. But does that mean an alien wouldn't be able to understand them?

Under certain assumptions, it is perfectly reasonable to assume that an extraterrestrial intelligence would be able to decode a human language with the proper assistance. Consider our remarkable ability to bridge language barriers on Earth. We are perfectly capable of translating between, say, English and French to facilitate communication. We can even translate among cultures with no shared linguistic heritage. The reason this is possible at all is because both native English and French speakers share the same cognitive hardware. Although the exact physiological origins of language are still under investigation, there is an emerging consensus that our capacity for language is built into the very structure of the brain. The evidently embodied natured of language supports the theory of a 'universal grammar,' which explains why human children are capable of acquiring any natural language and why a Russian speaker can learn to understand a speaker of Urdu. It also sets hard limits on the design of interstellar messages.

If we send an extraterrestrial intelligence a message written in a natural language, we are presupposing that their brain is sufficiently similar to our own to make translation possible. But if the extraterrestrial has a radically different cognitive structure, this translation would be impossible. If the alien brain does not have a functionally equivalent 'language module' to our own, its language would violate our universal grammar. This would make decoding our message more akin to discovering new scientific laws than translation.

Given the rather large assumptions we must make about the nature of extraterrestrial intelligence to justify sending a natural language message, perhaps it is desirable to look for a more objective linguistic basis for interstellar communication. Languages based on science and maths seem like natural candidates since they don't appear to be a product of human culture and physiology. If an octopus were capable of performing science experiments, we'd expect them to discover the same laws of physics as we have. But to paraphrase Wittgenstein, if a lion could speak we wouldn't understand a word.

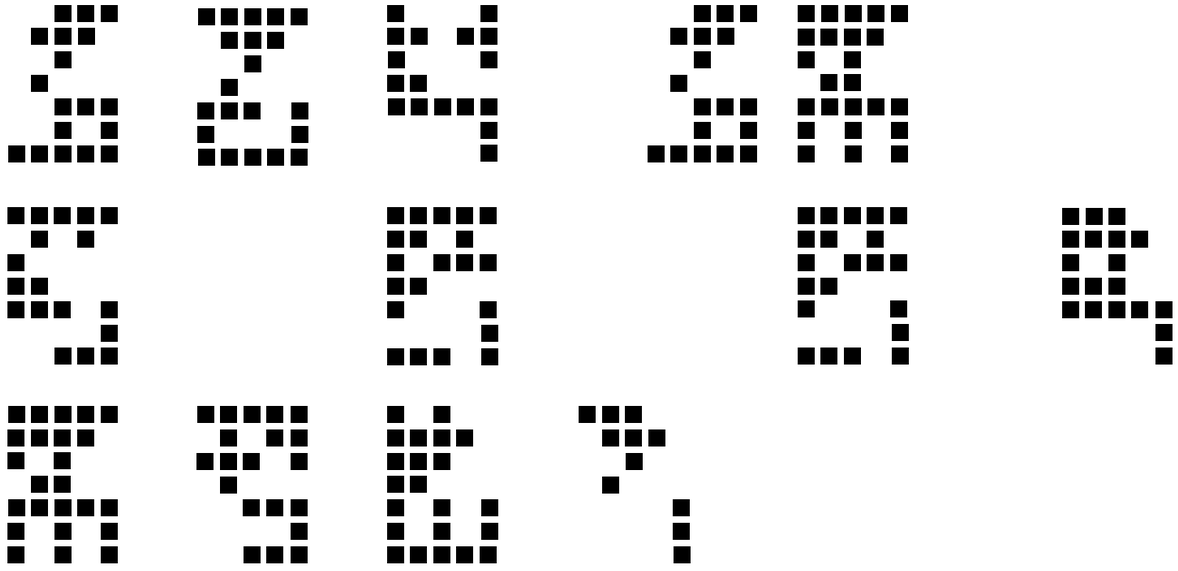
Yet as we saw above, even something as apparently objective as science is still distorted by relativism. The same may be true for math, which may be regarded as the 'language of science.' It ultimately depends on how you feel about the ontological status of mathematics. Is it something that exists independent of our minds such that mathematical truths are discovered much like one might discover a new species? Or is it more accurate to say that mathematics is something we create, a language used to describe the world once it has been filtered by our all-too-human cognition?

If mathematics exists independently of the human mind, we could expect any extraterrestrial intelligence to be familiar with our mathematical concepts. They may know more about mathematics than we do, but we can at least be comforted knowing we are reading from the same book. But if our mathematics is shaped by the capabilities and limitations of the human mind, a message written in a mathematical language would face the same challenges as one written in a natural human language.

Although we are accustomed to thinking of mathematics as something that exists independently of our minds, the ontological status of mathematics is still contested. The reason we tend to think of mathematics as something that exists independent of us is because it seems to correspond so well with physical reality, an uncanny congruence that has puzzled scientists from Galileo to Einstein. One alternative explanation for this 'unreasonable effectiveness of mathematics in the natural sciences' is that maths is always filtered through our embodied cognition. As human beings, there are limits to our sensory perception and cognition and these limits shape how we see the world. Perhaps the reason our mathematics corresponds so well with our world is because it is subject to these same limitations. An extraterrestrial with different physical and cognitive limitations would in a sense be inhabiting a different world and may have a very different mathematics that describes it.

Cultural Relativism and Designing a Message for ET

Suppose that we do have the same mathematics as an extraterrestrial intelligence and we use this shared understanding as the basis for an interstellar language. Can we say anything meaningful about life on Earth or what it means to be human? Or are we destined to only swap mathematical axioms? On Earth, cultural relativism is the idea that one culture's values should not be evaluated based on the values of another culture. This is particularly important in the context of communication – both interstellar and terrestrial – to ensure that a message is not misinterpreted due to cultural differences. While many cultures on Earth share at least some values, such as ethical prohibitions against killing, there are vanishingly few universal values. And even these



In 1999 an interstellar message was broadcast in the direction of four stars. This transmission took place at the Evpatoria radio telescope dish in Ukraine. With its 70 meter dish and a 150kW transmitter at 6cm, Evpatoria was one of the most powerful deep space radar at the time. The message was sent using unique characters made by small bitmaps of 5 x 7 pixels. The concept of the message was based on the work of two Canadian physicists, Stephane Dumas and Dr Yvan Dutil.

ostensibly universal values may be context dependent – for example, cultures that prohibit homicide may still condone killing during war.

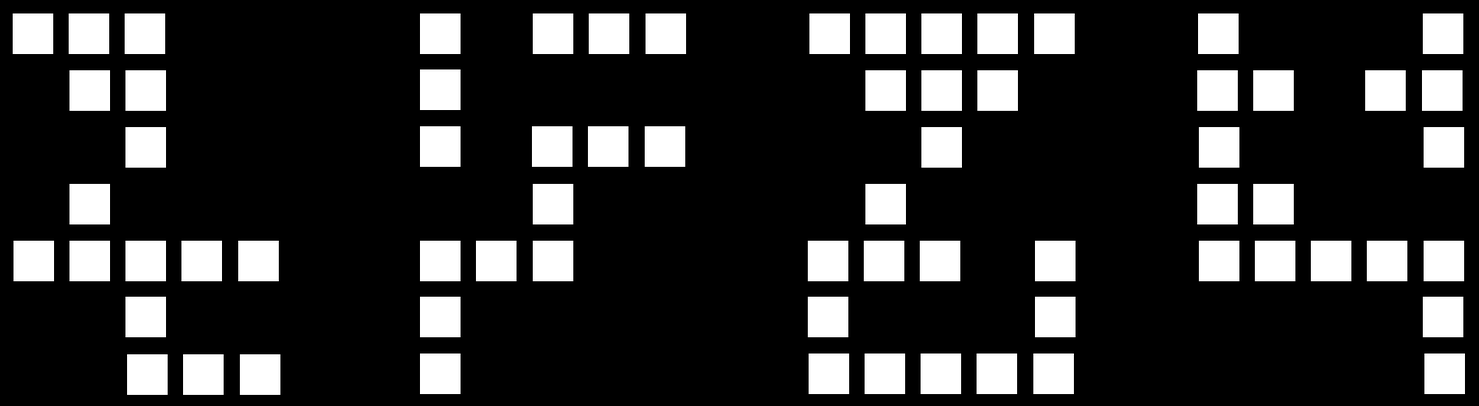
Cultural relativism is a massive challenge for interstellar communication. Since we cannot know anything about the extraterrestrial civilisation in advance, we must be extremely cautious about the assumptions we are making when crafting the content of a message or interpreting a message received from space. Perhaps we receive a message from an extraterrestrial intelligence that functions as a hivemind where individuals are subservient to the macro-organism. This may create very perverse value frameworks for a culture accustomed to individual sovereignty. Or what if a race of superintelligent extraterrestrials rears extraterrestrials of human-level intelligence on their planet as food, much as we raise cattle for beef on Earth? These scenarios may make it incredibly difficult to find a shared basis of understanding. Our implicit and explicit cultural and personal values shape our interpretation of the world in profound and often imperceptible ways.

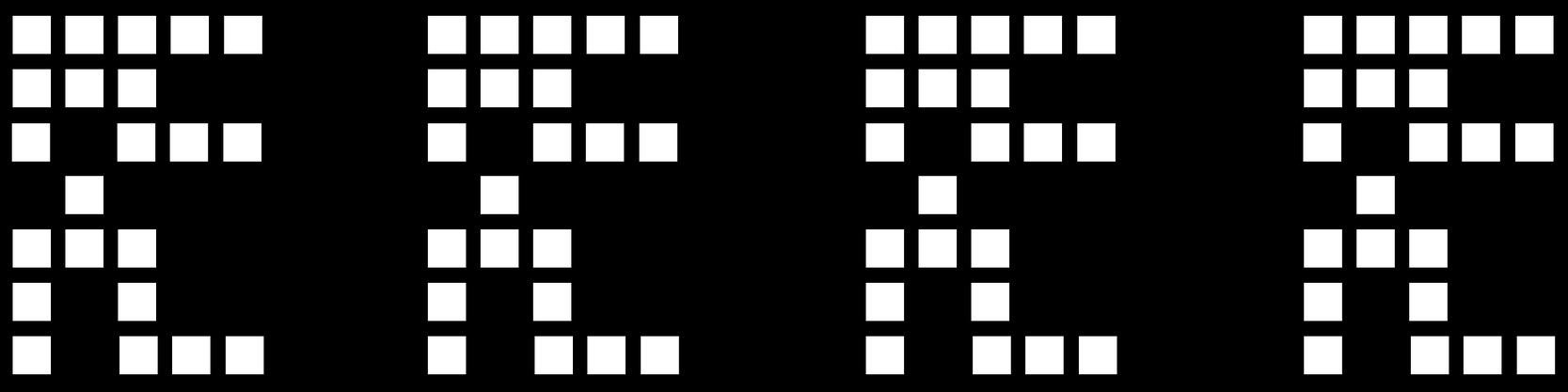
Earthlings are faced with a further challenge when designing a message for interstellar communication due to the wide variety of cultures on the planet. Interstellar communication is fundamentally different from everyday conversation because it occurs between species instead of individuals. Furthermore, the conversation may occur over thousands of years due to the distances between the transmitter and receiver. The civilisation that sends a message may change a lot over the millennia and be very different from the one that receives a reply. We can see the challenges of communicating across time on our own planet in the context of deciphering ancient languages such as the Egyptian hieroglyphs. If it weren't for the discovery of the Rosetta Stone we may never have been able to read the messages of ancient Egypt, even though it was written by the same species on the same planet only 4000 years ago. The problems are magnified in the context of interstellar communication, which may involve much larger time scales and radically different intelligent species.

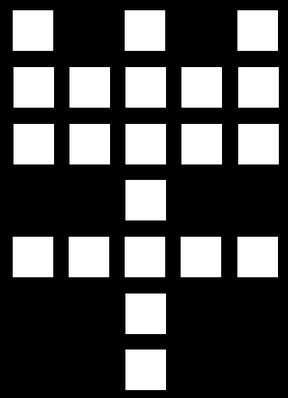
These factors require careful consideration about how the values of *humans as a species*, rather than the values of a particular culture in a particular time period, are to be conveyed in an extraterrestrial message. In the past, messages that have been sent into space from Earth have had a significant Western bias, which would hardly give the recipient an accurate picture of the diversity of life on Earth. Similarly, it will be challenging to determine whether any extraterrestrial message received on Earth speaks on behalf of an entire planet or only its dominant culture.

Is There Hope for Interstellar Communication?

The challenges that scientific, linguistic, and cultural relativism pose for extraterrestrial communication are immense. But they are not insurmountable. In fact, engaging with the challenges of extraterrestrial relativism poses a unique opportunity for Earthlings to learn more about the universe and ourselves, *even if we never make contact with an alien intelligence*. Addressing these issues forces us to critically examine everything from science and technology to our language and cultural values. We must identify the preconceptions that haunt our most cherished beliefs and explicitly state all that we take for granted. We must adopt an extraterrestrial mindset, which means searching for universals in the strongest sense of the term. This is the only path to truly understanding what it means to be human. Even if we never make contact with ET, the Search may still lead us to amazing discoveries.







United in a Common Vertigo

Rob La Frenais
interviews Kitsou Dubois

In 1990, Kitsou Dubois, choreographer and researcher in dance, became the first artist to experience weightlessness in parabolic flight with the French Space Agency (CNES). Since then, Kitsou has flown on a series of 21 parabolic flights. Over the years, she has been able to include on these flights about 15 dancers and acrobats working with her on her choreographic creations with various space agencies including the Yuri Gagarin Cosmonaut Training Centre at Star City, Russia (with The Arts Catalyst in the UK and Projekt Atol in Slovenia) and the European Space Agency at Novespace in Bordeaux (with Imperial College London and The Arts Catalyst) and again with the French Space Agency, where she was in residence with the Space Observatory of CNES and finally with the European Space Agency. In addition to parabolic flights, she works with dancers and acrobats in other environments where the sensation of gravity has been altered, such as in water and virtual reality set-ups, and regularly collaborates with researchers in science and technology. From stage choreographies to video installations, documentary films to exhibitions or hybrid productions, Kitsou uses her experience and knowledge of weightlessness to explore movement, the sensation of time, the relation to matter, the relation to others and the poetry and perception of an environment where all familiar references seem to have been transformed.

Dr Rob La Frenais is an experienced independent curator, writer and lecturer, working internationally with artists on new commissions. He believes in being directly engaged with the artist's working process as far as possible, while actively widening the context within which the artist can work. From 1997 to 2014 he was curator of The Arts Catalyst where, along with director Nicola Triscott he developed an ambitious art/science programme. His last exhibition with the Arts Catalyst was 'Republic of the Moon'. As an independent curator he led a major project by Tomás Saraceno in White Sands, New Mexico and was the curator of 'Exoplanet Lot' in the Lot Valley in France. He was a visiting professor at Srishti Institute, Bangalore, and a visiting curator at FACT Liverpool, and the National Taiwan Museum of Fine Art, where he curated 'No Such Thing As Gravity'. He writes regularly for *Art Monthly*, UK and *makery.info* France. He was the first curator to enter zero gravity at Star City in 1999.

The parabolic flight is a diving aircraft which simulates free fall for around 25 to30 seconds between 10 to 20 times. It is the only way to experience extended weightlessness in the Earth's atmosphere. It was previously only used for astronaut/cosmonaut training or scientific research, before Kitsou Dubois pioneered its use for art as well as science. She continues to bring to audiences around the world the experience of zero gravity through her evocative performances and installations.

Rob La Frenais:
I wanted to ask about your view on space, how it sounds, how it feels, how it touches, how it reads. I was just catching up on your recent work and noticed you use the term 'bodily empathy' in your installations and performances. Can you say more about this?

Kitsou Dubois:
I create immersive situations with both my performances and video installations to create an empathy between the bodies of the dancers/acrobats and the spectators. Time is slowed down and infinite; we do not know where the movement begins and where it ends. It is as if we are suspended from what is going to happen… the space we inhabit is expansive and it is moving thanks to the interplay of images and light that blur our outlook. Dancers and spectators are united in a common vertigo.

RLF:
You were originally inspired by Gaston Bachelard in your work. Have you found any more philosophical influences in your long career as a weightless choreographer and dancer?

KD:
Yes, José Gil, a Portuguese philosopher and also the work of Alain Berthoz, a neurophysiologist specialising in particular in the 'sense of movement'.

RLF:
Can you say something about your last experience of flying with the European Space Agency in 2009, where you used cameras to create a new installation?

KD:
Yes, at the time what we did was a true prototype. We used tiny cameras in this flight and we adapted circus equipment for the aeroplane: a wheel fixed to the ground, a stick fixed to a joystick, which was the equipment for the show. We brought on board a 3D stereoscopic capture prototype, wide-angle fixed cameras, and a fisheye lens handled by a cameraman who was strapped down in the aircraft. This device was very innovative and therefore complex to perform. To do this, we built a model of our space in the plane in order to test all the constraints connected with stereoscopy in the cockpit. This 3D stereoscopic device gave birth to the installation *Perspectives, Time to See*.

RLF:
You also developed the use of wearable body sensors.

KD:
I was using experimental technologies as early as 2003, mainly those used in industry, which had been diverted from their initial functions, adapted and made available from research experiments in science, and later art. In the early 2000s, sensory sensors were very fragile. There were many constraints to adapt them to the bodies of dancers or acrobats: friction, support, and the dynamics of movement often damaged the device. The installation was tedious and required constant welding and repairs. These constraints forced us to choose precisely which sensors, for which movements, for which types of sounds and which creative objectives. This is how, depending on the themes and the qualities of movement in action in the performances, we used various sensors: flexion sensors on the elbow and knee joints, pressure sensors under the feet or on a Wiwi games platform, sensors with magnetic fields on the shoulder blades, or Myoware sensors, which record muscle power on the

forearms. From flexion (the medical term for bending an arm or leg) to pressure to muscle strength – we were able to analyse the sound impact on new qualities of movement, in order to refine the choreographic and musical choices we made.

RLF:

With the performances you do, particularly the circus performances, how do you draw audiences into the feeling that they are in space?

KD:

With the 3D stereoscopic images I created video installations inside or around the space in which viewers move. I invented immersive spaces that bring into play situations analogous to 3D immersion, like cropped images of dancers projected on a wall, similar in size to the audience without a picture frame. They seem to move throughout the front space of the room. With the circus, I shifted the focus to the figure of the circus performer. Rather than favouring the landing on land, I put the accent on the course of movement between the starting and the landing, in order to obscure the apparatus and to only see the aerial acrobat deploying all directions of the suspended space. We had 3D cameras in the plane, but due to a lack of finance, the audiences on the ground wore 3D glasses, as a way to experience this feeling in an immersive situation. We filmed the dancers in 3D and projected the image on the wall at the Maison Européenne de la Photographie. The images of the dancers were exactly the same size as the people in the audience. They moved the way you would move in space, which enhanced the immersive experience. You didn't actually see the inside of the plane, it was all black, with the silhouettes of the dancers in zero gravity on a black background.

Research and experimentation in weightlessness: Parabolic Flight 2009 with the Space Observatory of CNES (National Centre for Space Studies). Photo: Loïc Parent

RLF:

I see you are participating in a research project and symposium organised by Annick Bureaud as part of the 'All Women Crew' activities, 'Which Bodie(s) in/for Space'?

KD:

Yes, it's about the complexity of our body, the fact that when we are on Earth we only take care of it when we are unwell and we are totally lost in social media etc. The fact is that when we experience weightlessness we are more aware of our bodies. It's part of the paradox of being inside a matrix where we lose our point of support. The title is: 'Modified Body in Microgravity: Complexity and Paradoxes'. The absence of gravity modifies the sensation of the body. The supports become virtual, the body dilates. It oscillates between a type of hyper-sensitivity and a loss of sensitivity. There is nothing more; no gravity, no support, nothing but the body and a sensation of infinite movement. Paradoxical sensations arise between emptiness and fullness, absence and presence, loss and anchoring, pleasure and fear, speed and slowness. The experience of microgravity creates an immersive matrix-like sensation while being in an environmental disorder due to the loss of reference marks. As a choreographer and dance researcher, I revisit the fundamental gestures of dance from this experience of another space-time. Its representation on Earth questions the practices of creation (experimentation in flight, in water, on circus apparatus, with sensory sensors), choreographic writing (linked to the states of the body), the scenic space (immersion in the image and in the sound) and the shift of

artistic forms (from dance to circus, through both video installations and in-situ.

RLF:
There's also a political aspect to this symposium. When we first met back in the late 1990s, you were having problems in getting access to Zero Gravity flights as the space agencies were all dominated by men. They didn't take you seriously because you were a woman.

KD:
Yes, because I was a woman, I was a dancer and because I was French. Now the situation is different. Thanks to the support of Gerard Azoulay of the Space Observatory of CNES (Centre National D'Etudes Spatiales) I managed to enter this male-dominated environment. Now the question is of the artistic act in parabolic flights. The scientists think that the cultural sector has lots of money, and the cultural sector thinks that the scientific world has lots of money, so they don't understand each other. Above all, it is a matter of politics. The big difference nowadays is that if you have the money you can get on board a parabolic flight quickly, whereas before you had to wait three or four years.

RLF:
We also see this in the new commercial space tourism with Blue Origin and SpaceX, aimed at billionaires. I have another question about artists working in zero gravity. Before, we had a problem persuading space agencies of the legitimacy of artistic uses of parabolic flights. Now, can we justify the burning of fossil fuels for artistic purposes in the face of climate catastrophe?

KD:
In the past, what mattered was that we helped the researchers and scientists, and worked together to make discoveries. Now you can just buy a flight, the utility for the scientists in the artistic work is lost; it's absolutely useless. The idea is to keep on making discoveries for both the artists and the scientists. I'm not doing the work in weightlessness for fun. I've been doing it for a long time and it really matters to me. I find it sad that the billionaires that went into space recently were shown doing silly things in space. It's not the same thing, obviously. It does matter to me, a lot.

RLF:
So, you think that the research outputs justify making those flights?

KD:
Yes, I think so; in conducting this research we make advances for society. It's very difficult, but I would fight for it! Because changing our point of view as earthlings leads us to discover ourselves differently and to revisit our relationship to time and space.

RLF:
Now I want to talk about gravity. One of the things we discovered through the flights that The Arts Catalyst organised in Star City in Russia in the 2000s was that there were at least four sorts of gravity for 25 seconds, zero gravity, double gravity etc. in a parabolic flight. This is opposed to continuous zero gravity or free fall that you would experience on the International Space Station. Have you considered using that environment, for example working with astronauts on their missions?

KD:
Yes, it would change everything to be able to work in that environment, to stay a long time as opposed to the 25 seconds I have had. It's really different and would concern questions of adaptability. We had a few projects that we started with astronauts to develop a theory of gestures. It's really, really complicated and we were never able to realise those projects – I was very disappointed. I would love to be able to work in this way, but it's a very closed circuit environment. It's very difficult.

RLF:
Who was the astronaut you were trying to work with?

KD:
He was a French engineer on the Columbus station. He was an engineer by training, so he wasn't really interested in a project on gesture on the station; not really the right type. That was a long time ago. Unfortunately, had it been Thomas Pesquet maybe it would have worked. However, this astronaut was a typical engineer and was not really interested, actually, which was why the project didn't go through.

RLF:
What are your thoughts for the future? Where would you like to go next with this subject? I know you have been working with weightlessness since 1990. You are constantly developing new ways of dealing with this experience. If you had the resources, money, time, collaboration possibilities, what would be the ideal development? How might you use the new technologies and virtual environments that have become ubiquitous during the pandemic?

KD:
Well, I'm about to bring out a book – *Kitsou Dubois, Danser De L'apesenteur* – which will be presented at the symposium 'Which Bodie(s) in/for Space?' I'm also developing a new piece for two dancers with sensors on their body that produce sound and light. It produces a universe in the performance space which is really fluid, with perpetual movement for light and sound. On the stage there is a white backdrop, a screen and a white floor as well. The dancers have sensors, and as they dance the audience feels the complexity of what it is to 'stop'. In weightlessness, it's really difficult to stop. There are two parts to the performance; in the first, nothing is said, in the second, there are some explanations which are given to the audience about the technologies that are being used. They are therefore able to take another look at the piece.

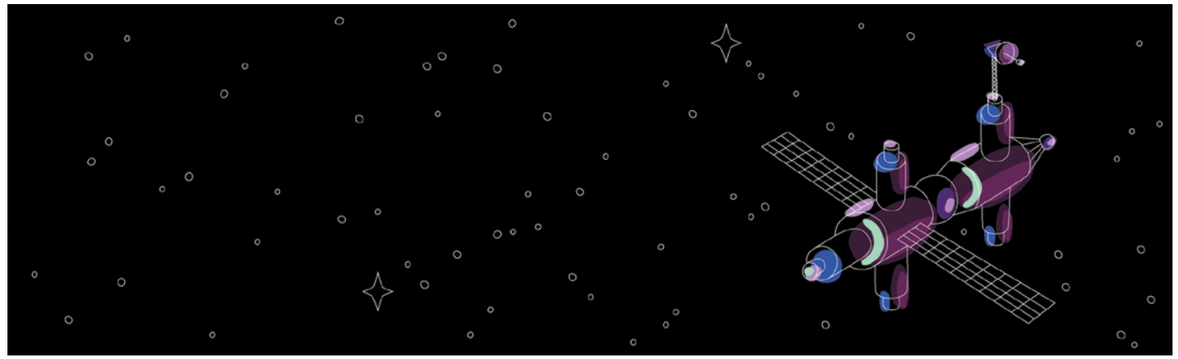
RLF:
If you had another opportunity to do a parabolic flight, what areas of work and what new ideas would you prioritise?

KD:
If I had the opportunity for another flight, I would like to work on the concept of 'melee' with one or two pairs of dancers, what possible displacements, what possible intertwinings, what spaces between bodies can we set up without getting lost? How can we find ourselves when we have moved away from each other and above all how is the bodily relationship established in an exchange of continual flow between two bodies – how can we find autonomy for each of the partners, how can we enhance the listening between two people in zero gravity?

Écoute/Expansion, essai sur le cirque et les technologies by Ki Productions (touring 2021/2022). Production at Théâtre de Rungis as part of La Biennale de danse du Val-de-Marne. Photo: Diane Delehaye

Intimacies with(in) the Space Station

Text by Eleanor S. Armstrong
and Akvilė Terminaitė
Memory-vignettes by
Eleanor S. Armstrong
Illustrations by
Akvilė Terminaitė



EXO-MOAN Studio, led by Akvilė Terminatė and Eleanor S. Armstrong, uses design thinking to imagine interplanetary sex tech futures and informal sex education.

Playful curiosity is the catalyst for Akvilė Terminatė's research-led design practice that draws from social and cognitive sciences and maker culture. Her work invites the audience to rediscover their own childlike wonder and natural ability to create rich alternative narratives and new ways of seeing and knowing. Her background in museum education provides a rich foundation for a collaborative approach that negotiates the intersection between product interface and interaction design. Akvilė is interested in the topics of relationships, intimacy and care in speculative futures.

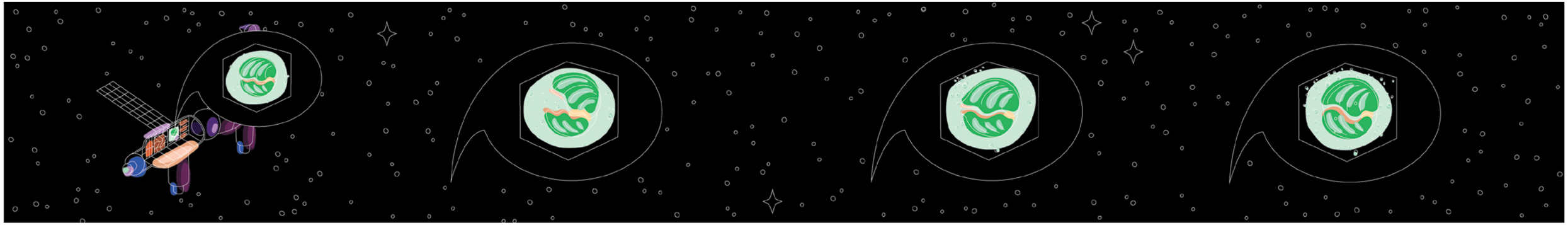
Dr Eleanor S. Armstrong is a Postdoctoral Fellow at the University of Delaware, where she researches the terrestrial geographies of outer space. Her work focuses critical queer, feminist approaches to space sciences; including their representation in cultural institutions; their interaction with local communities and environments proximate to research sites; and ideas of intimacy, care, pleasure, and consent in space.

Observing ends. We leave the shift to go to watch the stars ourselves, Koko and I. Down the concrete stairs at the rural observatory, holding onto the cold bannister. Out the door into the balmy darkness. We cross the complex on the well-worn paths, down the lane to the field. We take the footpath, holding hands, one in front of the other. Warm together, our fingers interlock to make sure we don't lose each other in the inky openness. There are roots and branches on the ground that we used hushed tones to warn each other about; as if we must keep our presence a secret from the night itself. My other hand skims the air beside me – where the tops of the plants in the field reach up and tickle my fingers, brushing themselves into my experience of the night. The lights from our cabins illuminate the end of our journey greeting us home as we grab jumpers and beers; and deposit books, notes, and worries from the day. Then onwards, to the stars. Our path runs between the cabins, and into the woods. Slowly, slowly, down the steps. Gently, gently, around the trees. We grab each other for support – hands, arms, bodies used to stabilise our journey down to the lake. The very last stretch is wooden steps. A slick wooden rail, clammy with dew and mosses, runs down the side. Koko goes first down the steps, arm bent up at the elbow across his chest, fingers outstretched and joined to mine at his shoulder. Our hands have cooled; plunged into the depths of the night they've taken on the quiet coldness of the early hours of the morning. Our fingers entwined together to share their remaining warmth.

We reach the pontoon, stretching out into the lake, which opens to the night sky. The stars fill the expanse – as far as I can see in all directions above they glow. The flat, still surface reflects them back to us – stars all the way down from the horizon to where I place my now shoeless feet on the water. We sit, curled one into another on the edge of the wooden boards, alone, far from everyone in the cabins. Perhaps the most perfectly isolated I've ever felt. I run my fingers across the boards tracing the rings and lines of the wooden slats, experiencing their rough grooves and channels, little bumps and growths while we talk. My feet pat the water. The lake is still warm, balmy in the cool night. I swing my legs, caressing the top of the water with my toes; or tapping it with the balls of my feet. I generate gentle ripples as we share secrets and embrace, movements through the resistance of the liquid that I feel to make sure this is not a dream. The ripples warp the stars reflected back to the sky – their wobbling and waving is sharply different to the stoic slow turning of the constellations through the unending rotation of the Earth. It's 4am. We've watched the milky wash of our galaxy rotate through the sky, when there's a movement across the lake – a rapidly moving light. I think it's something I've made in my skimming of the water but looking up it's there as well. We've seen the space station, passing overhead in orbit, their remote isolation far away from other people's – echoing ours as we sit out, sleepily, on the lake.

COSMOS AS A JOURNAL

What is 'remoteness'? People physically apart through the pandemic. Engagement from a distance. Separation. Alone Together. Being remote, isolated, apart has been an experience that our global society – ironically collectively – has had in the pandemic. As a prompt in Touchy-Feely Tech's sex tech hackathon that we (the authors, Akvilė and Eleanor), participated in earlier in the year, 'remoteness' initiated thinking about partnered intimacies at a distance: sex toys that could be remotely



controlled or collectively operated; ways to mitigate the physical absence of touch from others that characterised many people's experience during the pandemic; repurposing the things are already in one's immediate surroundings for these needs.

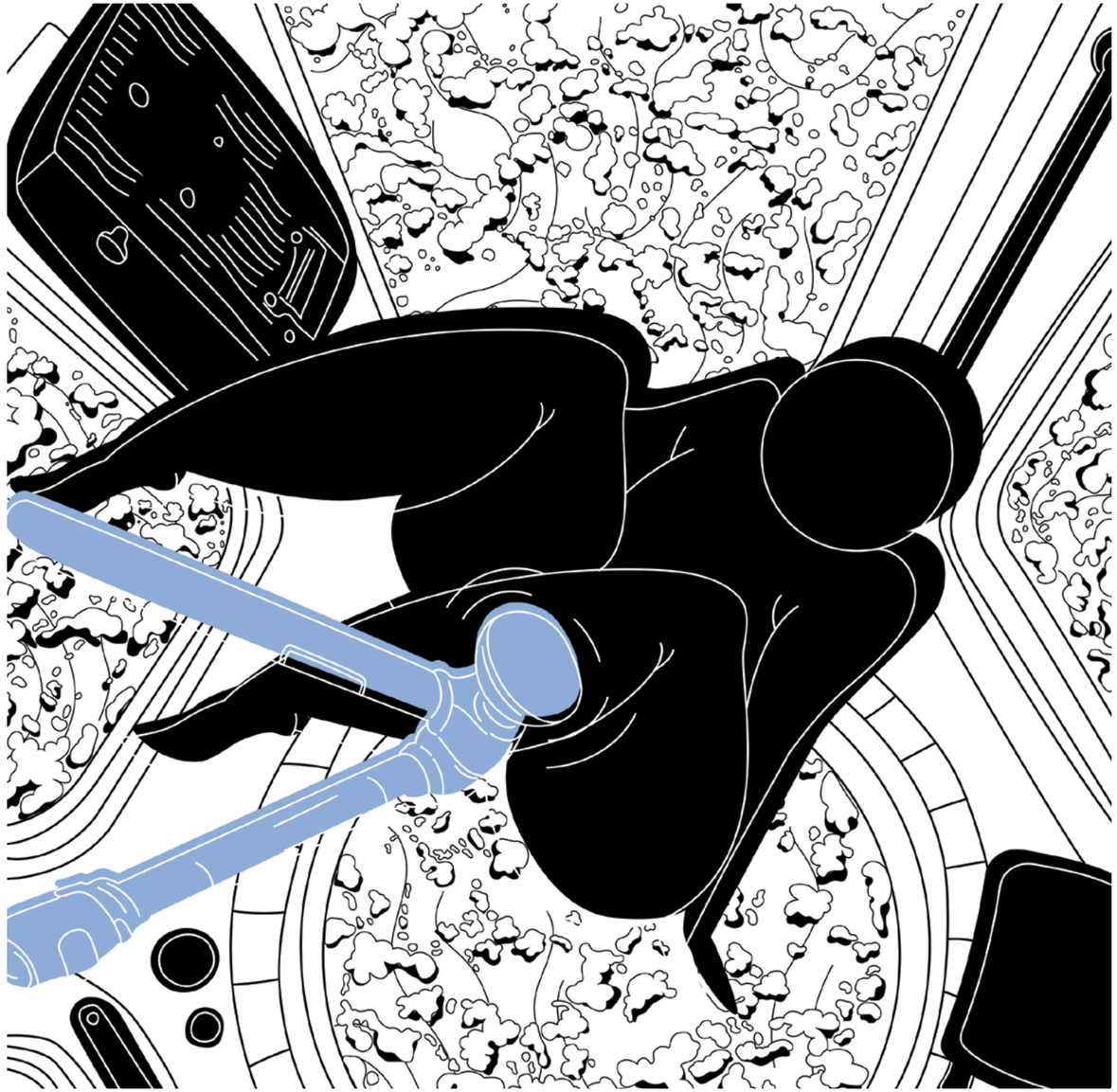
We were already interested in thinking about sex in space. Taking people who are isolated extensively – astronauts on the International Space Station (ISS) – our intervention in the hackathon saw us think about subverting the conventional uses of materials already part of the ISS to foreground intimacies and pleasure in this remote environment. We were stimulated by touch points that ranged from illustrations of tentacle-aliens in Ruby Rare's *Sex Ed: A guide for Adults*, to cyborgian space-embraces in Kate Devlin's *Turned On*, to the call in Sara Hendren's *What Can a Body Do?* to reimagine and repurpose everyday items and to build from non-specialist materials that we already have access to. We responded to Douglas Adams' sighing doors in *The Hitchhiker's Guide to the Galaxy*, and sensual hybridity between technology and humans in Janelle Monae's *Dirty Computer: Emotion Picture*.

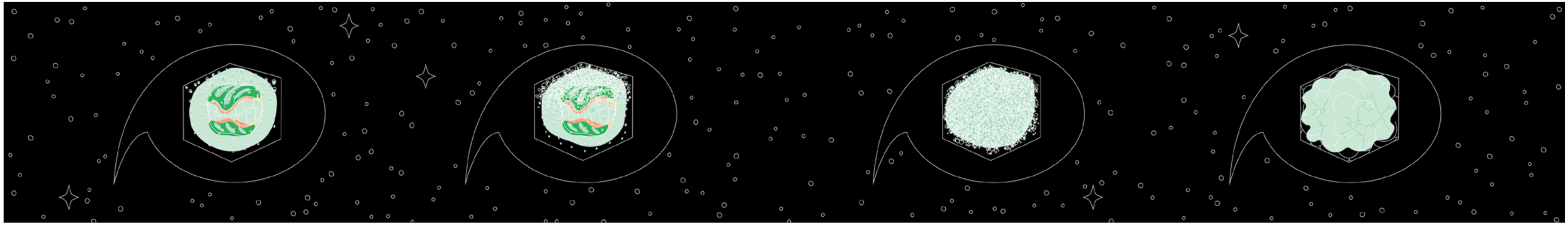
Stimulated by a selection of 'everyday' images taken on the ISS in 2020 by the collaboration of Paolo Nespoli and Roland Miller, we looked at the materials onboard and thought about how these might be reimagined in service of intimacy and pleasure of the astronauts onboard. A rounded head of a moveable arm above the cupola was reimagined as a vibrator toy, for stimulation while watching the Earth pass by underneath – a kind of exhibitionist fantasy of anyone on the ground looking up and seeing (but not knowingly) astronauts orgasming in space. The ties that hold items in storage so they don't float around the cabin produce a neat grid system of ordered packing. We retooled these ropes as a kink-inspired tie-down for holding partners in place during sex; helping astronauts to navigate the fact that in space where there is no friction to hold people together one might drift off without tethering. Thinking about non-sexual intimacies of cuddling, we identified a tube that ran through many of the frames, and repurposed it as a toy that would embrace the individual, squeezing tightly to mimic the caress that was so missed during isolation, fantasising that this might be a tele-toy operated through remote connections with a loved-one on Earth. Together, these interventions explore the ISS as an UFO – an Unidentified Fucking Object – a series of speculative prompts that empower us to think through intimacies, removal from collective work, and outer space.

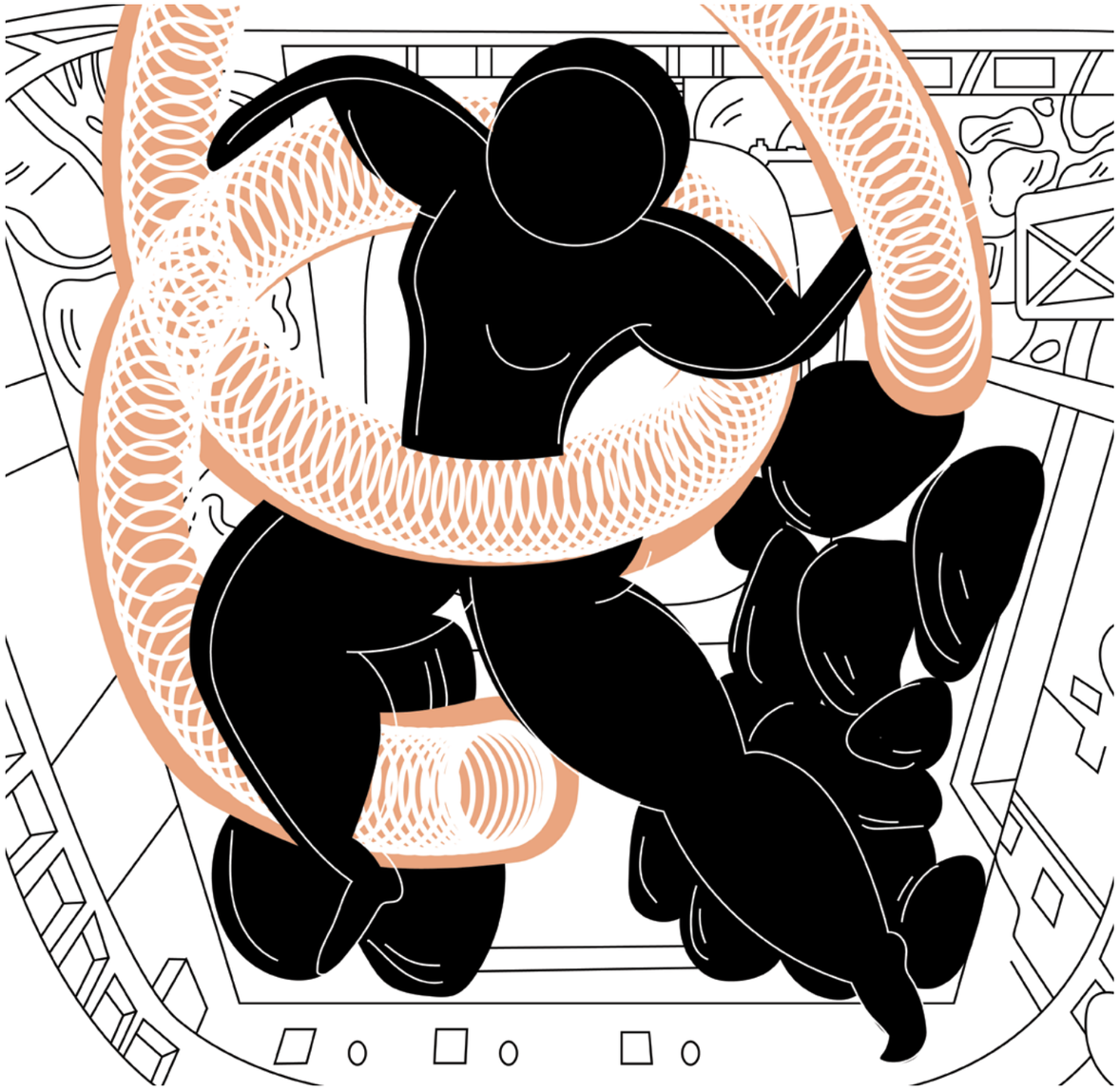
Remoteness – and by this we mean removing small groups of people from collective societies – has been a function of human space science projects for a significant period of time. Even before actually going into space, projects such as desert-based Biosphere 2 in Arizona or the underwater pod NEMO isolated individuals or groups to understand what isolation is like, how people cope, and what is needed to sustain human life. Science experiments, often in service of the state-led research agendas, have long intertwined with artistic interventions that explore the same. ANT Farm's ballooning *Space Egg* (1968) coincided with the growing popularity of space exploration in the US at the time; as did Graham Stevens' *Desert Cloud* (1972), 'blurring,' as Katarzyna Balug argues 'the boundary between subject and environment' in the construction of isolated living places.

Thick clear glass runs along one wall of the corridor that we're in. It's from the floor to the ceiling and there is a thick rail that runs along the middle of it, as if to remind us that the glass is there in the first instance, that we can't just step through into the space on the other side. The group is in a small corridor high up on the side of a large warehouse room. Most of the room is in shades of grey. The colours are echoed in the colour of the rail, floor, ceiling here on our side. But there are some departures: bright yellow runners span the enormous space; easily the largest stars and stripes banner I've seen hangs red, white, and blue on the other wall. And then there are the gleaming white and matt-silver modules of mocked up space vehicles and modules that are scattered across the floor, modelling the plan of the space station. We look down on the model. We can't see anyone moving around or working in there – so we're looking in on static, grounded version of something that is free falling in space, looking down on us as we stand there looking down on its sister.

The air conditioner rattles on in our corridor, blowing overly cold air against one of my shoulders and arms, making the fine hairs all down one side of my body stand up to try to trap some warm air close to my skin. I can't step sideways without relinquishing my view of the space station to another, and I'm too short to see over the heads of the adults on my tour. So I endure the freezing jets of air that trickle down my body, making me aware of how at odds my body is with the environment of the warehouse. It's hard to connect with the idea that these dense, metallic structures echo something that seems like it is floating up in space. The modules seem both too big and too small. How are they so large – so voluminous to get up to space, so weighed down by their materiality, so







solid, so fixed? How are they so small – so fragile to protect real people against the harsh and unforgiving nature of the vacuum of space? The nothingness that exists beyond this simultaneously thick-and-thin space station in orbit is incomprehensible. It's not like the nothingness of the air around me, as I look through the window into the warehouse. The touch of these little atoms against my body are so every day, I don't normally feel them. But the wind, the air blowing around me, the jet from a fan, the rush as I fall on a rollercoaster, the swoosh as I jump down – I notice these changes in the air around me; making me notice the experience of the air itself.

Since 2001, ISS has continuously hosted people in space. It's not the first and is unlikely to be the last habitat to do so. Preceded by space stations like Mir and Skylab and (at the time of writing in 2021) accompanied by the Tiangong space station (天宫空间站) the ISS is somewhere for people to live beyond the habitat that humans are best sustained by – Earth. The 20 years of continuous habitation have seen astronauts come and go through its modular construction, sections, parts, materials and bits that are brought in, taken out, attached, removed, used and stowed away over time. While discursive emphasis is often on the humans who are sustained by the space stations, the two – human subject and environment – are enmeshed inextricably.

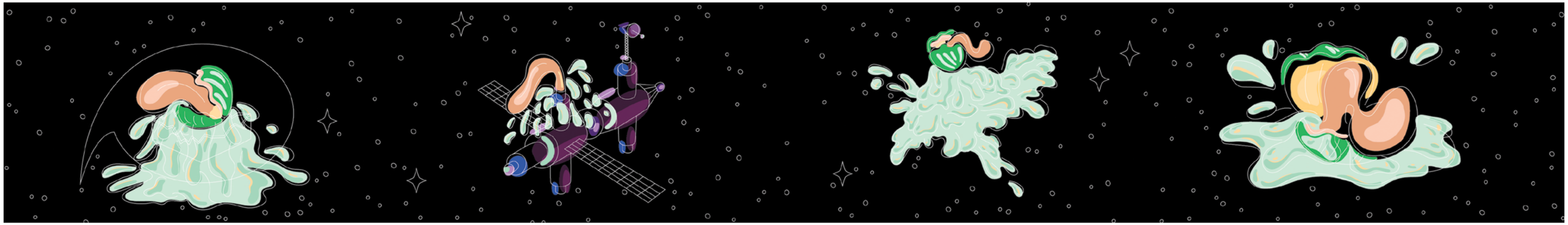
Addressing the development of boundaries between space science research sites and the locations that they are situated in, Valerie Olson, in *Into the Extreme* traces the construction of the 'system' inside the research site that is supposedly well understood against the ecosystem, conceived of as all other things *outside* the mechanised, describable system. Outer space was itself constructed as an environment outside of the environment of Earth, deliberately limited by political horizons to exclude it from being within the system. Conceptual layering isolates the human from the environment beyond and within the space station. This boundary creation between the subject and the environment could have been even more uncertain. In *Of Astronauts and Algae* Leah Aronowsky follows an alternative history of space station development which could have relied on interdependent intimacies between the oft-prioritised, isolated human and biological organisms like algae in the space station.

This might have led to radically different ideas about the relationship between somewhat unruly ecological environments in space and the human subject than those that did emerge, where a deep reliance on technoscientific system solutions extracted the astronaut subject from the ecological environment of the station.

Making the human subject in a systematised environment that is/was aesthetically in the service of technological components also did not have to be the case. Early sketches by architect Galina Balashova for the Soviet space programme, for instance, saw the creation of habitats that echoed the places where people lived on Earth. Bedrooms, living rooms, and spaces for sitting were designed to be furnished with wooden finishes, checked fabrics, and paintings of landscapes; creating a very different subject-environment relationship. Balashova's plans appear tactile – the soft furnishings, fabrics, books, and metallic and wooden elements connect these otherworldly round rooms with our lived experiences here on Earth. This is in contrast to the textures of Paolo Nespoli and Roland Miller's photographs that informed our UFO project, where we had to guess what the touch of plastics and metals that we were unfamiliar with would be like. In re-imagining tactility in our UFO project, we attempted to transgress the physically contactless environment of the space station in their photographs through a focus on one of the most intimate types of touch.

Elsewhere, science fiction had made the tangible, touchable aspects of space more real. Douglas Adams' call for always knowing where your towel is, for example, is a call to the tactile elements of space. I, Eleanor, think of my towel as the thing I reach out and grab on the way out of the shower or bath. Naked, damp, but warmed and cleaned by the water, the towel touches my skin. It's routine – I use it the same way every day. Grabbed from the rail in my right hand, I dry my left arm and hand, my face and neck, then my right arm, my torso, my legs each in turn, my feet, my back. The towels I use smell different – like fabric conditioner, like the swimming pool, the beach. They are sometimes rough; air dried in the sunshine or coated in coarse sand. They're sometimes a fluffy, deep texture that envelops my hands; sometimes they're thin and threadbare, but efficient at drying. Sometimes they are small, perfunctory rectangles; sometimes they are decadent engulfing sheets. I sometimes think about the touch of the intergalactic towels I would have, for lying out on exoplanetary beaches; for drying off after hydrocarbon showers; for wiping my hands on after cleaning them following an otherworldly hike in my spacesuit.

The messy, dirtiness of life; the need for aesthetic surroundings over a long period of time living somewhere; the places where the human meets the built environment of the space station are the



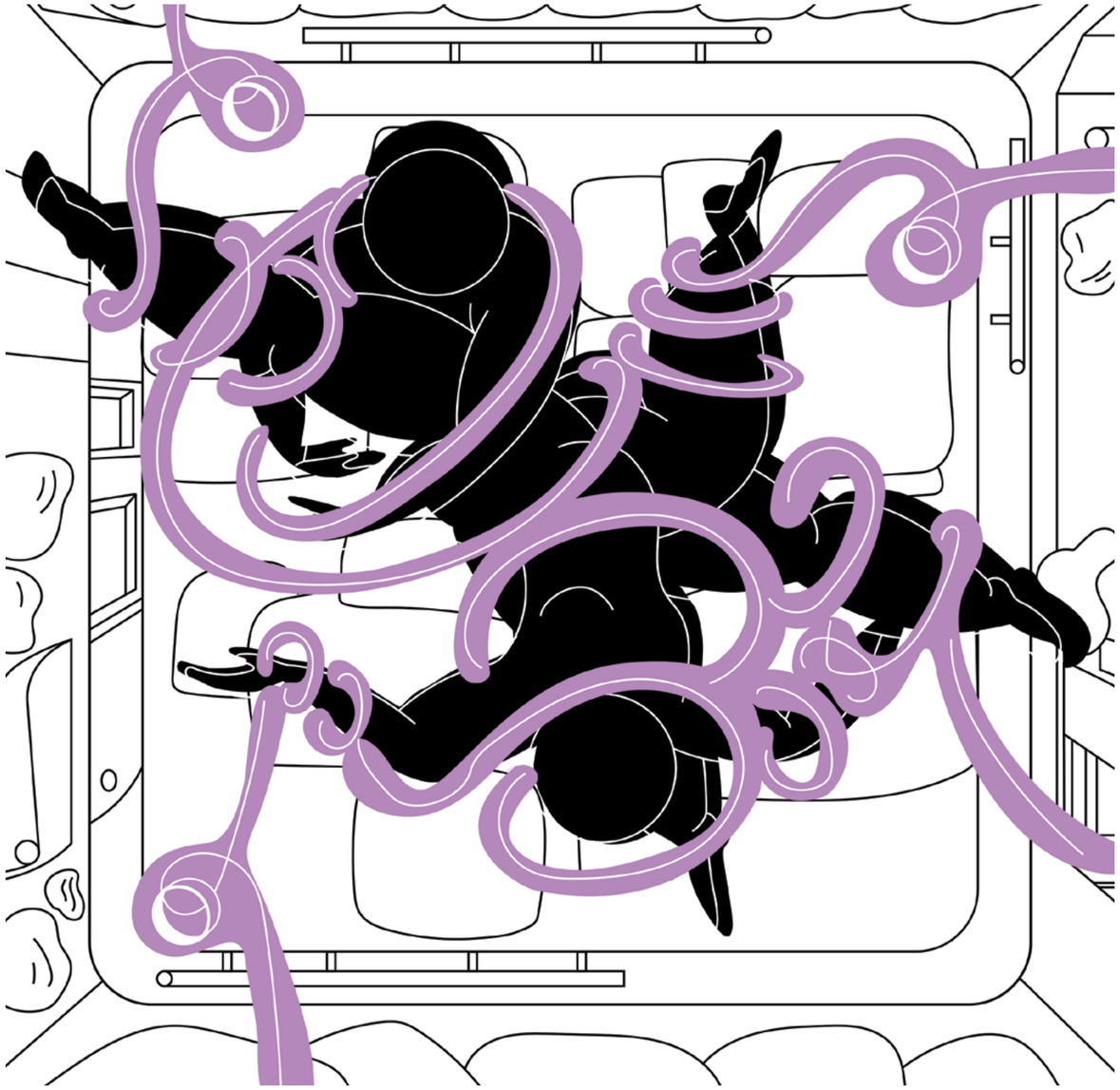
productive moments of speculation, of imagination, of creation. They are interactions that can be used to think about how the engagement could be otherwise; a moment to step through to the otherworldly, to hold these new meanings, possibilities, and relations.

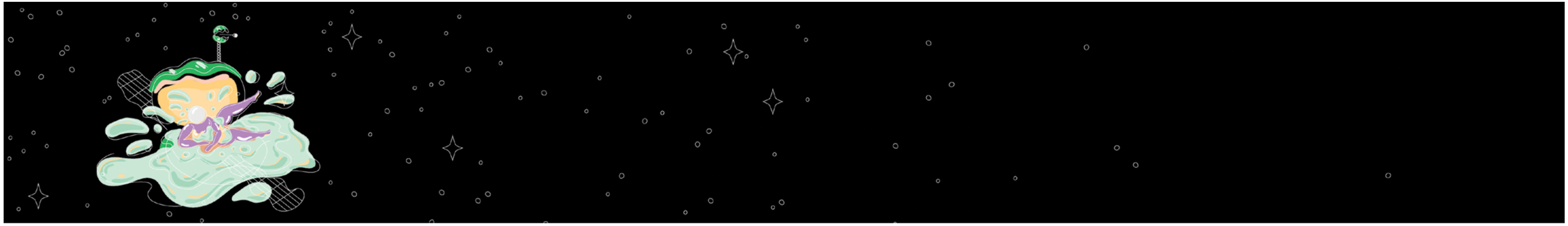
On the ISS astronauts experience the sun rise every 92 minutes, unlike the singular event that we get here on Earth each day. For astronauts, the sun rises through the blackness of space, suddenly appearing and occupying their view. On a beach I'm lying on, the sunrise creeps through a gap between clouds in the sky and the sea on the horizon, and it's light is beginning to sparkle across the shallow waves, and gleam on the sand that has been newly exposed as the tide begins its withdrawal for the day. Our towels overlap on the fine sand. We've borrowed them from the place we're staying so they're not beach towels, but soft for indoor use. It's very early – we've come for sunrise to have sex on the beach like we're in a movie. Being young, I think this is what real adults do, and (perhaps mistakenly) feel grown up. We kiss. My nose brushes their cheek; and I feel their lips push against mine. I'm self-conscious of the roughness of my lips: in my nervousness, I pulled at the skin the day before and now it is cracked. I can smell the sea, the kelpy sands, the pine-scent that fills the air after the rain that has passed in the night, intermixed with their body – pulling gently on handfuls of their curls, the scent of their hair wafts and mixes with their skin. We roll across the towels, the pressure of the sand on my back slowly eases as the small grains are deformed by our weight. I feel their body on top of mine, and touch my hand low on their back, in a dip that is collecting small droplets of sweat. I tilt my head back, looking out towards the sea, and happen to catch the moment the whole sun appears above the sunrise and am filled with the warmth of being there together.

I wished we were on the ISS. The moment is beautiful, replicable. The sand has crept across our rumpled towels and clothes, and we are coated with the salty sea spray carried to us by a gentle breeze. In 24 hours, we'd be gone – far away from the beach, from each other's arms, from the sunrise. But in 92 minutes, we'd still be here, still be the only people on the beach, and we'd be seeing the sunrise again. Perhaps it's a good thing we can't.

The motivation of cosmos as radical otherworldliness surfaces across a wide range of experiences and ideas – taking it, challenging it, developing it. Facing up to the entanglement of the subject and environment gives us, Akvilė and Eleanor, worldly guidance on how to think in radical, cosmic, and otherworldly ways. Animals as the primary space subject arises in the *Nonhuman Autonomous Space Agency* where Fred Scharmen engages space-faring manatees as the ones the spacecraft are designed for, creating a watery world interior of a space station for inhabitants to swim around in beyond Earth. Aquatic animals, entangled with the construction of rocket launch sites in Florida, motivated Julie Klinger's exploration of 'reclaiming Cape Canaveral for the turtles'. These engagements develop a sense of the otherworldly priorities that might be possible – but still hold the non-human animal at arms-length from the human, rather fundamentally intertwined. Aronowsky's exploration of a biologically-supported space station rejects what she calls 'extractive intimacies'. Instead, the mutuality of keeping-alive, the possibility of a total environment that encompasses the subject and environment whether in an algae-mouse or algae-human is tackled. Who is being looked after in a multi-species system is unclear: a 'verdant wilderness spaceship' requires imagining the human relationally with many other species, rather than in the position of the only or ultimate subject.

Across places and spaces the value of decentring the human that happens in multi-species storytelling has been imperative. Looking at how other animals, minerals, vegetables, and microorganisms live and interact directs us to investigate differently. Humans are no longer the only important subject-being, the one that must be preserved at all costs; instead humans are intimately entangled with many others. Culture no longer sits outside, or beyond, nature. This idea of a separation of nature and cultures is itself an artifice: there are probably no ecosystems on Earth that are untouched by humans, all can be thought of as intertwined Harawavain naturecultures. Moreover, we intimately construct our ideas about nature through our cultural approaches to the world: Lisa Messeri's theorising of making a cultural 'place' in a natural 'outer space' captures some dimensions of these entanglements in humanity's thinking of the contexts beyond Earth. These symbiotic





engagements help us as designers and thinkers to place ourselves within a larger system. The Mushroom at the End of the World. The Trees at the Edge of the Star-filled Lake. The Oyster at the End of the Space Station.

Intimacies can subvert the subject-environment dichotomy in other ways too. Rejecting the militarised, extractive conception of the environment-in-service-of-the-subject that has underpinned research gives us access to new cosmic possibilities. Here, the long use of environments to develop control of the space or to test weapons demonstrates how the human is prioritised. Control facilitates domination of the environment; a domination that can be instrumentalised to sustain life in outer space. Using environments in this way depicts them as disposable – spaces that can be sacrificed in the service of a larger project. In the same way, narratives of 'exploration' of space, or 'moving to Mars' prioritise making anew, rather than fixing or repairing in existing environments, such as Earth. Positioning the creation of the new as being superior to the repair, care, and maintenance of that which already exists is part of a lineage of rhetoric that favours militarised, masculine 'creation' over feminised labours of 'reproduction' and 'care'. Subversively, however, Reka Gal explores in the context of the space station how the space station represents a site that requires extensive 'care and maintenance' challenging the militarised narratives that underpin its existence, making the space station an 'opposition to a techno-utopian escape' replete with 'notions of natural insufficiency and machine invulnerability.' Intimacies require reciprocities. The give and take, the exchange between and within, the circulations of things that are required sit at odds with the total environment that sees itself isolated from the world. Care is this connection, often seen through unpaid reproductive labours and through careful and caring maintenance work done by human-subjects on the space station.

At the foundation of our orientation away from sights and sounds, and towards touch, smell, and taste is a rejection of the senses that are most commonly instrumentalised in militarised work. The UFO takes formalised parts of the space station that serve a particular purpose, and re-engages them through intimate touch; using them to care for the self or a partner, and invoking the smell, touch, and taste that accompanies this. A leap into the cosmic imagination is to think about these other sensory experiences as an essential part being human, even cosmically. It is in touch, smell, and taste we find many elements of care, and pleasure that develop interpersonal, interspecies, even inter-environmental intimacies.

As Julijonas Urbonas implores, the 'only way to access the cosmic is through our capacity to imagine cosmically, employing techniques of pretence, make-believe and simulation.' There is always a tension with thinking about the cosmic from our position on the Earth. We've not been to space and statistically, reader, neither have you (congratulations if you have!). We've not experienced the weightlessness, and isolation of being in freefall around space. We've not touched the cords and ropes; the glass that surrounds the cupola; the tubes that pipe the ISS. We must use the techniques of pretence, of play, of re-making our memories to make-believe. Through this text and narrative images, we have brought together intimacies and isolations in memories and imaginings as speculative points of departure, that bring into sharp relief the touchless, individualist nature of space stations as we experience them today. Individualism underpins using space in the service of capitalist exploitation. We reject the cosmos as a resource of exploitation and centre the cosmos as a space for care and intimacies, starting with our space stations.

We do this every summer – every summer we've been to this house, that is. My father will look up the weather in the newspapers, and we'll watch the skies in the daytime to work out which night will be clear enough for us to see the stars. It's a game: normally we'll get one really clear night over the week, one perfectly clear and easy night to look at the stars and we play to work out which one of us can guess the weather earliest in the day. One year there were no clear nights, and I insisted that we stayed out on the last night anyway – looking at the wispy grey clouds smother pinpricks of starlight and the moonshine. One year the clear night was the full moon – a moon so bright that it seemed like daylight and obscured many of the dimmer, more delightful stars in the sky with its overwhelming brilliance. This year, however, this year we are lucky. Three nights in a row it's been cloudy and wet. But tonight everything has dried in the harsh sun of the August day, and the sun sets on a clear sky. Red, the orb dips below the horizon and the blanket of stars is pulled across the sky – covering the pinks, oranges, blues, and purples with a deep blackness peppered with twinkling silver points. These nights are special to me – the sun sets late in the heady dog days of summer – and I am allowed to stay up until many hours after the drawn out dimming of the sky until it gets really, properly, deeply dark. Sometimes I find the darkness of my bedroom scary – the closed door and closed curtains make for uncertain nights. But this darkness is magical.

I'm scooped up by my father, and we take with us the scratchy blankets that live in this house. He walks across the gravel, a familiar crunch and the wobble of his stride sinking into the mass of small stones letting me know that we're on the way to our spot. Up the steps, onto the grass, his stride now even and firm. I'm wrapped in his arms, and they gently move up and down with his gait. My feet reach down, toes hitting the dried earth first, and then my whole sole rolling onto the ground with the short, rough grass poking up between my toes, around my ankles, in the arch of my feet. It's different to the grass at home. I always think it's terrible for playing games on, running through during the day. But when I'm standing surrounded by it at night, its prickliness is part of the spell that is cast over our evening. A blanket is laid out, we get on it, and lie down. My father swaddles me in another softer woolly cover, and then both of us in a third. I lie, neck over his arm, and we close our eyes and count to 30 together. As I open my eyes, the brightest stars are there first. We stare, as we always do, into a spot that looks like it doesn't have any stars until small, dim, dots populate it in our vision as our eyes adjust to the darkness. This year is special as we might see the space station, newly added to the things out there in the night sky. We look at the constellations, drawing links, telling each other the stories we know well. We wait for the fast moving constant light to pass across the sky, tentatively, alone together to see this new craft.

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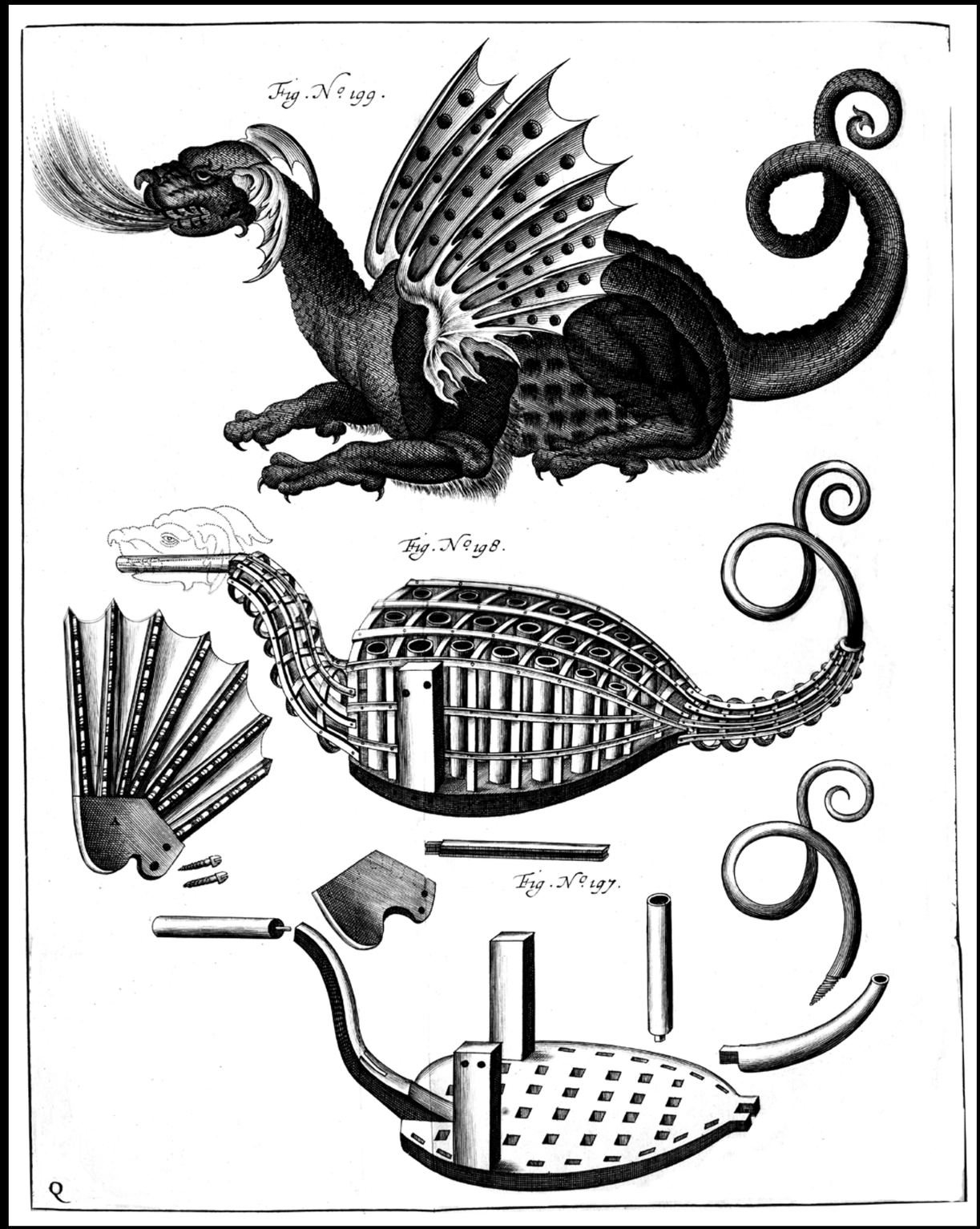

The Great Art of Artillery. K-33, Kazimieras Simonavičius, 1600–1651. Courtesy Lithuanian Museum of Ethnocosmology

Whale Space, or, The Killers in Eden

Fred Scharmen

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Author's Note: most of these things will have actually happened.

One day an architect climbed a cliff in Australia, above a deep bay.

His name was Doug Michels, he had once driven a custom car through a pile of television sets, which were all on fire. Another time, he dressed up as Jackie Onassis, as his friends staged a reconstruction of President Kennedy's assassination.[1] They had also made giant inflatable pillows together for the Altamont music festival. He designed embassies and even space stations for dolphins (more about that later). But on this temperate winter afternoon, Doug was in Eden (for that was the town's name) hoping to see some whales. On that day, he was scouting by himself for a film crew, consulting, as an amateur cetacean expert, on a television documentary to be called *Killers in Eden*.[2] Doug didn't make it to the top of the cliff. Maybe he was remembering the burning TVs, or the Rolling Stones, probably he was thinking about whales. His foot slipped, and for a moment, he found himself in the air. On 12 June 2003, Doug Michels, 59 years old, fell to his death.[3]

Picture a brain. This is not an ordinary brain, as you or I might know it, made of proteins and blood vessels, sending signals with chemicals and electricity. This is a brain that exists for a vanishingly small period of time, in some part of the distant universe in outer space unimaginably far from here. This brain, a theoretical construct known as a Boltzmann Brain,[4] is made of small fluctuations in matter and energy in the void at the quantum scale. These blips and waves are effectively random, and are happening all the time, everywhere. But the Cosmos is big, and the Cosmos is old, and lo, do many things come to pass, including a particular configuration of virtual matter and energy, diving through the Cosmic quantum ocean, that remembers something. In the flash of time before the ceaseless beating of the tiny waves that created it in the first place start pulsing with other tides, washing it away, it remembers an entire lifetime. It remembers being someone.

Tom was a swimmer. Tom didn't know his name was Tom, he wasn't human, and couldn't understand human language. Today, we might call Tom an Orca, which is what the Ancient Romans called him, a subject of the king of the dead. But in the year 1900, when he was at the height of his powers, Old Tom was known as a Killer Whale.[5] He was a member of a pod that stopped in the bay near Eden every winter, as part of their yearly migration, swimming thousands of miles across the oceans of planet Earth. Tom was not the leader, but the humans in Eden thought he was. Hardly as showy and prominent as Tom, who was small and agile even by Killer Whale standards, the leader of Tom's pod was an even smaller, female Orca, who was never given a name by the residents of this seaside Australian village. Tom's speed and brashness made him a good messenger, though, and he was well suited at communicating with the people of Eden. They were also killers, and Tom was the one that let them know when it was time for them all to do their job.

Sally jumped. As the springy twanged bounce from the board pushed her up into the slower moving layers of air near the axis, she watched the surface of the water rotate under her. The curved pool below was only half crowded, with mostly kids, in the shallower end to the north. Above her she could see their heads bobbing as they splashed and screamed, sticking out straight down towards the part of the pool she was aiming for. They wouldn't be allowed to do this until they were much older, like Sally. No one could access the diving boards until they had taken proper lessons, you had to get a feel for how the spin worked. In the low gravity up here, you fell slowly, and by the time you hit the water, it was at a spot several dozen metres west of the board you had just launched yourself from. It wouldn't do to accidentally land on top of an eight year old. But not Sally, Sally knew what she was doing. She was skilled. And this was safe. Her world was safe. It was built for her, and for the 5,000 or so close friends that she lived with here, spinning around the Sun in a rotating space habitat called a Bernal Sphere.[6] The water in the pool stuck to the walls of the space around her like paint in a swung bucket. Sally's body drifted down, picking up speed. At the last moment, she flexed her weight slightly, away from the direction of spin, swimming through the air to compensate for her angular momentum to enter the water with almost no splash. No hard transgressed boundary between one domain and the next. When she came up for air the kids were clapping. It echoed all the way around the cylinder of water, curving up over her head and back down, the kids were all clapping.[7]

The sound woke George Davidson up from a dead sleep. He turned up the gas lamp and there it was again, out in the inlet; a wet *slap* and a splash, made by something larger and stronger than a man. Old Tom the Orca was out there again, telling him there were baleen in the bay. Tom and his pod had been doing this for three generations. When they encountered the big baleen whales, probably Southern Right Whales or Humpbacks, coming north from Antarctica for winter through the Tasman Sea, the pod of 20 split into three groups, in this three-dimensional environment, the predators wanted to secure every angle. One to herd the larger whales into the bay near Eden and trap them there, one to go below the baleen and prevent them from deep-diving away, and one, headed by Tom, to alert the human whalers that their prey was here. George lit more lanterns and called his other men at the whaling station out of bed. The Killer Whales had a longstanding arrangement with the human whalers of Eden, while they would swim interference to the side and below the prey, the humans would row longboats out, bringing death from above to the massive free floating Right Whales and Humpback Whales and Blue Whales caught in the middle of it. Then they would all share in the kill.[8]

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Fred, more than a little stoned, laid down in his bed and watched the whale float.[9] This baleen whale, a Humpback, was swimming through a sea of stars, along the line of a bright pink and blue nebulae that swirled from left to right through the view. This was a poster on his wall. Fred was an architecture student, and on late nights after work in the studio, he liked to come home, put on the droney ambient show from the college radio station, and zone out for a while. After spending all day soaked

in the history, theory, and practice of design, and having a natural bent towards the science fictional side of things, his mind tended to drift in some very specific directions.

He thought of Ant Farm, a group of ex-hippie architects working in the 1970s, who, when not crashing cars into flaming TVs, or reenacting the Kennedy assassination, had once designed a floating embassy for humans to interact with dolphins. That was a project led by Ant Farm co-founder Doug Michels, who also later, working with a different group of friends, created a proposal for a space station in which humans and dolphins would live together, the latter using their natural aptitude for sound and sonics to program an underwater orbital supercomputer.

He thought of John Lilly, the psychoanalyst who wanted to talk with dolphins. Lilly used experiments with LSD and Ketamine to try to break through the barriers between the species, and one of his colleagues even lived (and loved a little, but that's another story) with a dolphin for months, trying to teach it to speak English. Lilly explored the universe by going inwards, spending hours floating in warm salt water isolation tanks under the influence of drugs, cutting himself off from the outside world like a brain floating in outer space. How to find the others? These experiences led him to suspect that humans, dolphins, whales, and other intelligent species were all collaborating with each other, subconsciously, psychokinetically, in the Earth Coincidence Control Office, E.C.C.O., which, if it acted according to plan, would make contact with the C.C.C.C., the Cosmic Coincidence Control Center. They dictated a series of instructions to the world at large, that included the assertion that "You are expected to expect the unexpected every minute, every hour of every day and of every night."[10]

And he thought of the space whale in the poster, alone in the dark night like Lilly in the tank, sending out sound and listening for echoes. As a kid, Fred had watched, again and again, three shows in reruns on television: Carl Sagan's *Cosmos, The Undersea World of Jacques Cousteau*, and Arthur C. Clarke's *Mysterious World*. The three hosts, the astronomer, the undersea explorer, and the science fiction author, shared an outlook on worlds and the beyond that linked the depths to the heights. Sagan talked about the shores of a Cosmic Ocean, that humanity had only begun to dip its toes into,[11] Cousteau told him how to lose the hold of gravity, by slipping below the surface of the sea,[12] and Clarke thought that if there was anywhere on the planet that humans might find alien spaceships and other wonders from the sky, echoes from the past and future, it would be there.[13]

In countless other remembered movies and television from his childhood, the space whale swims in the vastness. Like the Boltzmann Brain, an improbable, all but nearly impossible, image, but somehow right. Somehow statistically inevitable. Alone but singing, even if it is the last of its kind. The whale can't survive without air, or water, just like the brain can't survive without a body, or a world, but can either last without others? Sometimes a starship crew needs to save the Earth, by bringing a whale to space, in order to sing. Even if it is the last of its kind, even if the killers are there, in a Clarkian Big Dumb Object, a mute cylinder letting loose destructive sonic energy, slapping its tail on the surface of the Cosmic Ocean and threatening to swamp the frail Spaceship Earth suspended in it.[14] Sometimes a song, an attempt to communicate, can spark memory. Lo, do many things come to pass. Did the Boltzmann Brain, Fred wondered as he drifted off to sleep, floating in the nebulous blue and pink cosmic quantum foam, miss what it remembered? Did it look to deep time and long space for others to call out to? Did it expect the unexpected? Did it sing in the void?

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The whale slapped its tail down, and called out. What did Albert Thomas Junior think?[15] Thomas was a whaler, and he was also one of the Aboriginal Yeerimbine Yuin people, who had lived in this part of Australia for thousands of years before white European settlers came to this spot and named it Eden. Thomas' people remembered the Orcas as part of their extended family, and people like the Davidsons had learned to relate to the Killer Whales through them. For who knows how long, the Yuin people would listen for the whales in the bay. When they saw the Orcas herding the Humpbacks, an elder would light fires on the beach, and walk back and forth slowly, with a pronounced limp.[16] These were stories and practices from the Aboriginal Dreaming, an endless and beginingless span of time outside time, where remembrance and reality, cause and effect, human and nonhuman, blended into one. In this world, this Cosmic Ocean, the Orcas would see the man, who was their friend, their kin, old and infirm, in need of help, in need of food, and drive the whale to him, beaching it so they could all feed together.

The dolphin and the woman had sushi for lunch. They were both astronauts, in Earth orbit aboard Blue Star, the nonexistent space station designed for them by architect Doug Michels. These two were old friends. Aiko liked to toss pieces of fish to ClickSquee, sailing through the zero gravity in a dead straight trajectory, and he liked to catch them out of the air in his teeth. The dolphins didn't know that the humans had figured out that they were making fun of them behind their backs, while pretending to be hard at work on the computer in the ball of water at the station's core. The dolphins mimicked what they saw as the awkward ways that the people on the station swam through the water in their fins and scuba gear. But the dolphins weren't much better at it, they had always been thrown off by the lack of buoyancy in zero-gee, and would sometimes forget to deliberately surface and breathe. Outside the water, in free fall, people kept their fins on and dolphins got even more awkward, struggling to push against the air with their wide tails and keep swimming. Air far from dry, water not quite wet. The exhalations from the humans left static gas bubbles in the liquid, spheres within spheres, and the dolphins' blowholes sprayed bubbles of water out into the air, that would bounce into each other and combine into larger balls, air within water within air, floating and swimming and laughing and all falling around the planet together, in a curved path that never landed, always missing the hard ground below.[17]

Thomas and Tom. This was the connection that whalers like Albert Thomas Junior passed on to their white counterparts. But that pact was broken. Thomas lived long enough to see two failures of trust in Eden. What did he feel about these breakdowns? In one incident, an Orca who had accidentally beached himself along with his prey was killed for no reason by a white Australian in Eden. And in a second betrayal, white whalers refused to let Old Tom share in feeding on a kill, pulling the Humpback back to the whaling station without him. Tom tried to bite the rope and the whale, and lost a tooth for his efforts, leading to an abscess that may have ended his life.[18]

On Japanese television in 1990 Doug Michels called Blue Star 'the first thinktank in space.' 'We'll think better,' he told the host, 'in zero gravity, we'll have better ideas.' 'I hope to go there in my lifetime,' he said, 'in the year 2022, and think up a storm.' Michels died in Eden, 19 years before he could visit his thinktank that never existed. In another video, from 1976, Michels sent what he called a 'live link' from Honolulu, Hawaii to his friend Tom in Chicago. In the clip, communication breaks down, and Tom can't hear or see him. 'Hey Tom, say something?' … 'I don't even know if he's out there.'[19] This was a prank, it was a recording, a memory from the past, from the media Dreaming, not live in present reality. For Michels, the past and present weren't so important anyway (as he used to say, 'The future is all there is.') Doug Michels fell, and maybe remembered his friend Tom. Maybe he remembered being someone, being a Boltzmann Brain, being a space whale. Did he call out? Did the unexpected happen? He fell. It's statistically unlikely, but maybe he didn't? Maybe he went into free fall. Maybe he's swimming.

Endnotes

1 Michels was a co-founder of the US underground art and architecture collaborative Ant Farm, with which he produced these projects and others. For more on Ant Farm see Constance M. Lewallen and Steve Seid, *Ant Farm, 1968 – 1978*, University of California Press, Berkeley, Los Angeles, and London 2004

2 Klaus Toft, Director, *Killers in Eden*, Rubin Tarrant Productions, 2004

3 Ken Johnson, 'Doug Michels, Radical Artist and Architect, Dies at 59', *The New York Times*, 21 June 2003

4 The exact origins of the idea of the Boltzmann Brain seem to be obscure, but writers like physicist Sean Carroll use this concept to illustrate some apparently absurd consequences of the theory of statistical thermodynamics developed by 19th century Austrian physicist Ludwig Boltzmann. If Boltzmann's notion that the existing observable universe, with all its complexity and intelligence, is the result of random fluctuations over nearly infinite time, then the existence of anything is possible, including brains floating in the void. See Sean Carroll, 'Boltzmann's Anthropic Brain', *Discover Magazine*, 1 August 2006

5 Toft, *Killers in Eden*, 2004

6 For a discussion on Bernal Spheres and other designs for very large space habitats, see Gerard O'Neill, *The High Frontier: Human Colonies in Space*, William Morrow and Company, New York, 1977

7 This imagined future scene is based on the illustration by David A. Hardy reproduced for this essay: "Low-gravity Swimming Pool", © David A. Hardy 1982, www.astroart.org .

8 Toft, *Killers in Eden*, 2004

9 This is a work of fiction, any resemblance to any persons, living or dead, including the author, are purely coincidental.

10 In John Lilly and Antonietta Lilly *The Dyadic Cyclone: The Autobiography of a Couple*, Simon and Schuster, City, 1976, 20-21.

11 'The surface of the Earth is the shore of the cosmic ocean. On this shore, we've learned most of what we know. Recently, we've waded a little way out, maybe ankle-deep, and the water seems inviting. Some part of our being knows this is where we came from. We long to return.' Carl Sagan, *Cosmos*, 1980

12 'From birth, man carries the weight of gravity on his shoulders. He is bolted to earth. But man has only to sink beneath the surface and he is free.' Jacques Cousteau, *The Undersea World of Jacques Cousteau*, 1966

13 '… if there is anywhere one might expect to find crashed spaceships or other alien artifacts, it would be in the oceans that cover three-quarters of our world.' Arthur C. Clarke, in Simon Welfare, John Fairley, and Arthur C. Clarke, *The Mysterious World of Arthur C. Clarke*, Collins, London 1980

14 This is a gloss of the plot of Leonard Nimoy, *Star Trek IV: The Voyage Home*, Paramount Pictures, 1986

15 For more on Albert Thoms Junior and other Aboriginal whalers see Bill Brown, 'The Aboriginal Whalers of Eden', *ABC Local*, July 4, 2014, https://www.abc.net.au/local/audio/2013/10/29/3879462.htm, accessed 20 August 2021

16 Toft, *Killers in Eden*, 2004

17 This is another imagined scene, based on Doug Michels, Director, *Blue Star*, Media Burn Archives, 1997, https://mediaburn.org/video/bluestar/, accessed 20 August 2021

18 Toft, *Killers in Eden*, 2004

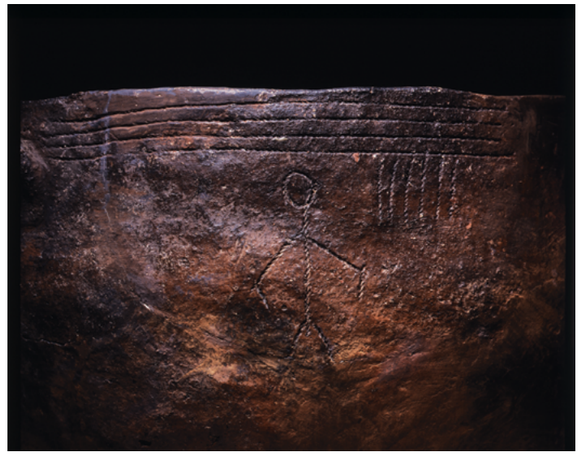
19 The quotes in this section are all from *Ant Farm's Doug Michels: Visionary Architect of the Future*, Media Burn Archives, 2009, https://www.youtube.com/watch?v=WdI6UVl5zew, accessed 20 August, 2021

'Low-gravity Swimming Pool', © David A. Hardy 1982, www.astroart.org.

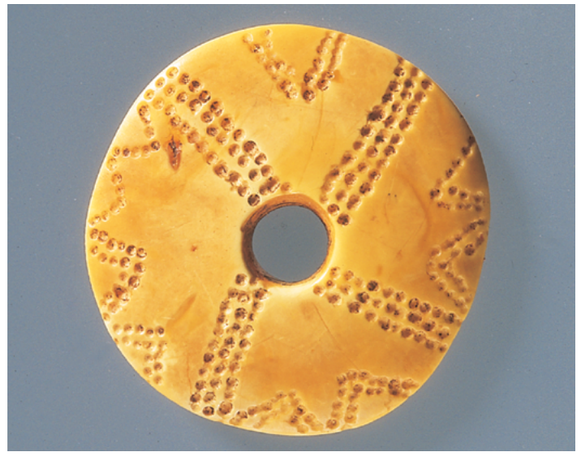
Danutė Kvietkevičiūtė, *Minties greičiu* (At the Speed of Thought), 1978. TA-866, Lithuanian National Museum of Art

Concept of Creation in Lithuanian Mythology

Radvilė Racėnaitė



Pot with the anthropomorphic figure.
Mineral-tempered earthenware. End of the 3rd millennium – 2nd millennium BC. Nida–Neringa.
LNM EM 2243:6193.



Disk–amulet.
Amber. 3rd millennium BC. Daktariškė 5 burial site.
LNM EM 2110:136

Radvilė Racėnaitė, PhD, is a senior researcher and the head of the Department of Folk Narrative at the Institute of Lithuanian Literature and Folklore, Vilnius, Lithuania. In 2011 she published the monograph *Notion of Human Fate and Death in Lithuanian Folklore* (in Lithuanian with a summary in English) and has written more than 20 articles in Lithuanian and English. She has also participated in more than 30 national and international scientific conferences in Lithuania and abroad, and has delivered lectures to the public on Lithuanian traditional culture, soviet and modern urban folklore, and oriental subjects. For more than 10 years she worked as a curator at the M. K. Čiurlionis National Art Museum in Kaunas. From 2017 to 2021 she was a member of the Lithuanian Council for Culture. Her main research interests are Lithuanian folk narrative, relicts of Pre-Christian Baltic worldview in late Lithuanian folklore and contemporary art, autobiographical narrative, soviet and modern urban folklore.

When I was asked by Julijonas Urbonas to contribute an essay about the concept of cosmos in Lithuanian mythology, I started by reading the the Lithuanian Space Agency's annual report about the project *Planet of People*, dedicated to exploring the boundaries of 'cosmic imagination' by means of artistic research. As one of the contributors of the volume Régine Debatty puts it, though *Planet of People* might be regarded as a speculative interpretation of the scientific initiative 'to send human corpses to outer space to aggregate and form a new planet', it also 'invites us to question our traditional definitions of the human species and of life in general'.[1] Urbonas refers to his project as a scientific and artistic study of gravitational aesthetics, based on extraterrestrial imagination, poetic logistics and 'alternative ways of being and imagining together both on and beyond Earth'.[2]

What surprised me most was the conceptual mythological grounding I recognised in the framework of *Planet of People*.

COSMOS AS A JOURNAL

We, high tech urban dwellers of the twenty-first century, tend to think about the ancient mythologies as romantic and old-fashioned ideas from the past that are completely uncharacteristic of scientifically oriented modern societies. We almost forget that mythology is not only about merely fanciful stories. Mythology can be considered as the archaic precursor of modern science. Like science, the main objective of mythology is to elucidate the secrets of the universe and to explain the fundamental existential questions: those about the origin of all things, the meaning of life and death and the purpose of human destiny. In this way, archaic mythologies might provide answers to these substantive questions in the form of naïve folk legends and non-scientific approaches. Mythological beliefs about the creation of the cosmos have traces in every culture and are submerged like a universal symbol in the collective subconscious.[3] These particular ways of thinking about the world are ingrained in the human mind and explain the links that 'can always be discerned between this or that creation myth and modern scientific descriptions of the origin of the universe'.[4] There is therefore nothing mysterious or surprising about these general correspondences between the ancient cosmogonies, astronomy, and the artistic interpretations of the first two. Mythology, science, and art are parallel ways to describe the world and may all contribute to a wider cultural perspective.[5]

Planet of People, initially titled *Cosmic Lithuania*, was intended to instigate public discourse about a national space culture in Lithuania and raise the national self-esteem with a provocative proposal to form a new planet from the bodies of Lithuanian citizens in outer space. The references to Lithuanian identity, cosmic creation, corporality, and death seem the most interesting to me.

Hence, in my essay I will present a short overview of some of Lithuania's cosmogonic ideas – the prehistoric milieu, the mythological notion of creation, the anthropomorphic centeredness of the origin legends, and the relationship of the realm of death and that of the sky – as contextual allusions to *Planet of People*.

Pre-Historic Context and the First Cosmogonic Concepts

The first inhabitants of Paleolithic cultures came to the present territory of Lithuania approximately 11,000 years ago when the land was freed from the glaciers that had covered it. In the Mesolithic Period (eight – fifth millennium BC) the warming of the climate created the conditions for new cultures to influx these lands.[6] The archaeological excavations of the Mesolithic burial grounds in present-day Lithuania show that these ancient people were buried with their clothes, decorations made from wild animal teeth, everyday utensils and arms in grave pits sprinkled over with dark red ochre, witnessing their belief in the afterlife.[7] A few Mesolithic artefacts, most probably amulets made of bone, were decorated with the ornaments of a circle or a cross that are now interpreted as the symbols of the Sun or fire.[8] Starting from the Paleolithic Period, an image of the sky as a mythological space over the Earth might have also been known to these people. Both the Paleolithic and Mesolithic people were wandering hunter-gatherers. Therefore, the orientation by the stars and the observation of the Lunar phases had to be of crucial importance to them. The Neolithic period was also a transition to new forms of counting time. The marking of the summer and winter solstices and the synchronisation of the Solar and Lunar calendars became an important task for these people.[9]

Researchers argue that the constellations in the sky were most probably named after different wild animals, while the Moon was symbolically imagined as the reindeer[10] – the main hunting object and the sacralised totemic animal.

Yet, the most interesting artefacts in terms of their possible connections with celestial mythology were excavated in the archaeological sites of the Neolithic Period (fourth – second millennium BC). In the territory of the present-day Lithuania there prevailed geometric, zoomorphic and anthropomorphic motifs of Neolithic art.[11] With the discovery of ceramics, new techniques of working up and decorating the items emerged. The decorations included both abstract geometric ornaments and primitive anthropomorphic figures imprinted into the clay with a cord.

On one of the pots, four lines were pressed around the neck of the pot representing the sky, while the six shorter lines next to the figure symbolise the rain and triangles below them represent the arable land. The human figure in the middle was a generalised cord-impressed silhouette with legs and hands stretched out. Archaeologists suggest that the pots were used for ritual purposes and the pose of the anthropomorphic figure stands for the praying person or a divine being.[12] It is possible that these images symbolised the archaic tripartite model of the universe: the sky with unlimited supplies of heavenly waters, the human realm, and the earth or the underworld. It is also plausible that a certain mythical plot was coded here marking the transition of the archaic society from the nomadic to the settled way of living and engaging in agriculture as their main occupation.

The Neolithic people also produced amber items. Amber appeared only in the Neolithic Period, when the prehistoric Littorina Sea washed away the soil from the shore.

In each of the forty excavated seaside Neolithic settlements, amber artefacts were numerous.

One of the widespread shapes was that of a round amber disc decorated with dotted lines forming various ornaments: triangles, crosses, and circles. The abundance of cross-decorated discs permits archaeologists to conclude these people 'had quite a uniform view of timeand perhaps the creation of the world on two cross axes'.[13] In burial sites, such amber adornments were found on the eye sockets of the deceased as 'replacements' for the eyes and symbols of light. They were also used as amulets. Thus, amber discs served for ritual purposes as ceremonial items and their ornamental symbolism was associated with a model of the world. Archaeologists, interpreting the shape, warm yellow colour and symbolic meaning of these rather complex geometric ornaments, suggest that these discs were primarily connected with the Sun, and 'the turning symmetry of these discs, the number of broken lines and hollows, which increases in one direction, evokes ideas of the cyclical path of the Sun, sunrise and sunset'.[14]
The amber artefacts in the shape of an upright human, discovered at the Neolithic settlements, are more stylised and schematic. They show that during the Stone Age people began to carry small anthropomorphic figures as amulets. The fact that these amulets were given not only a human shape but also a stylised human face support the presumption that certain essential transformations of the worldview may be associated with Neolithic communities.[15] The anthropomorphic centeredness of the religion and mythology was also manifested with the appearance of human shaped idols of gods and other mythical beings. Hence, people began to conceive of themselves as responsible for the maintenance of the world's sacral order. Overall, it demonstrates that the Neolithic people had a rich mythology and elaborate cosmological views.

It is remarkable that the prehistoric ornaments associated with the celestial bodies have not changed much during the ages. For example, the sandstone spindle whorls found in quite a few different archaeological burial sites of the Iron Age were decorated with circles and rays, circles of dots, and crosses, and those patterns were similar to the Stone Age amber amulets. These repetitive simple ornamentations are also interpreted as the symbols of celestial bodies.

It is worth mentioning, that the tradition to decorate the tools used for spinning, such as distaffs, with schematised segmental ornaments or rounds called 'little stars' and 'little suns' and to use the similar patterns for home woven sashes and textiles was vivid up to the middle of the twentieth century. In the opinion of the mythology researchers, circles with segmental stars or rounds that form the ornamental pattern of distaffs, 'might be explained not only as symbols of the Sun or some other heavenly bodies or of light but also as ones providing a more abstract meaning – that of cosmograms marking … the very spheres of the cosmos'.[16] In mythological legends of the beginning of the twentieth century, the interconnectedness of the heavens and the act of weaving was elucidated by the folk name of the rainbow – *Laumės juosta* – literally 'a woven sash of the feminine mythical being *Laumė*', a wife of the Lithuanian thunder god Perkūnas who was believed to reside in the heavens.

Understandably, it is hard to say whether the mythological concepts of the Stone Age people who inhabited the territory of Lithuania for thousands of years were directly inherited by the Baltic tribes of the historic times and, namely, the Lithuanians. However, both the reconstructed celestial imaginary of the prehistoric communities and that of the late Lithuanian mythology show a certain repetition of similar concepts and ideas that have also been characteristic of the mythology of many other neighbouring countries of the Northern Europe region.

'At the beginning of the world, there was no earth neither the sky'

Lithuanian religion belongs to the Baltic religions and is linked to the ancient Prussian and Latvian ones. It comes back to the general mythological concepts of Indo-European religions. In pre-Christian

Copy of the anthropomorphic figurine amulet from Juodkrantė hoard of the Neolithic Period.
Amber. Vytautas Galdikas, 1967.
LNDM PGd 4531

Spindle whorls.
Sandstone. 9th – 12th centuries. Požerė, Žąsinas and Žviliai burial sites.
LNM AR 469:251, AR 618:790, AR 487:14

Lithuania, from the end of the fourteenth and the beginning of the fifteenth century, mythology was an equal part of religion. With the strengthening of the Christianisation process, the archaic religious system slowly faded away and only syncretic and at times vague mythological beliefs have survived mostly in folklore, customs, and festive rituals.[17]

The late Lithuanian mythology as the inheritor of pre-Christian ideas is also distinguished by the anthropocentric orientation. The human is the measure of all things. In the Lithuanian aetiological, or origin legends, everything that exists now is understood to have sometime been created according to the analogy with familiar surroundings – quite like the usual things, except that human measures are replaced with divine ones, which are often hyperbolised. But, although being perceived from the human perspective, the world is also considered sacred at the same time, since along with all its objects it has been created by mythical or even divine beings[18]. The Lithuanian conception of the cosmogony embraces not only the origin of the sky and other celestial bodies but also the creation of the Earth. Heaven is observed as if from underneath: while standing on the solid foundation of the Earth and looking up into the sky. Hereby, the Lithuanian origin legends illustrate the words of Mircea Eliade about the 'world centre', a concept typical of traditional cultures which both explains several cosmological images and religious beliefs and helps to understand the 'traditional approach to living space'.[19]
Many Lithuanian origin legends start with the statement that upon the creation of the universe, the world had not yet acquired its usual form: 'darkness reigns everywhere', 'there is no earth neither the sky', 'no earth and no sun'.[20] The primordial state before the creation of Earth is not perceived as an abstract void. In folk legends it is just another form of substance: 'nothing except waters' or 'a syrup, then the thickness is mixed with the fluid'.[21]
It is assumed in Lithuanian mythology that the gods as creators of the universe existed before the world was formed: in the primordial waters a small boat floats with God (*dievas*) and the Devil (*velnias*) rowing. On God's command the Devil dives down into the waters and brings handfuls of dirt or 'seeds of the soil', but he also puts some dirt into his mouth. God sprinkles the grains of dirt on the water and the Earth begins to swell and grow firm. So does the dirt in the mouth of the Devil. He cannot keep it in any longer, coughs it up and vomits here and there haphazardly. This is how, the legends say, the rough surface of the Earth was formed: the mountains, the hills, the bogs, and wetlands – thus God's initial plan to create the Earth flat and smooth was spoiled.[22]

In other origin legends, at the beginning God creates the Earth as a small island and puts it on the water. Afterwards he climbs onto it and falls asleep. The sneaky Devil grabs God by the feet and drags him towards the edge of the island in an attempt to drown him. Yet, the land expands proportionately further and further away. In the end 'the island was no longer an island, but a huge plot of land with no end and no beginning' and thus the Earth was created.[23]

A conception about dualism and antagonism of the creators of the world – whereby the Devil moves from the companion to the antagonist of God, possessing the power to challenge the deity, as well as the motif of the Earth-diver – are characteristic of many cosmogonic myths across the world.

What is more, in many cosmogonic myths, the motif of the sacrifice and dismemberment of a primordial being is narrated. The world is then established from the body of this being. In the ancient Mesopotamian myth *Enuma Elish*, the god Marduk, after defeating Tiamat, the primeval

Distaff.
Carved wood. K. Urbonas. Beginning of the 20th century. Central Lithuania.
Photo: A. Baltėnas, 2018.
LNM EM 13316

Distaff.
Carved wood. End of the 19th – beginning of the 20th century.
Photo: A. Baltėnas, 2018.
LNM EM 12976

Towel.
Linen, cotton.
Beginning of the 20th century.
Eastern Lithuania.
Photo: A. Baltėnas, 2019.
LNM EMO 10061.

Counterpane
Cotton, wool. V. Žemaitytė. 1956.
Eastern Lithuania.
Photo: A. Baltėnas, 2014.
LNM EMO 2977.

Sun. A ritual sculpture used during church processions.
Carved wood. J. Petrauskas. Beginning of the 20th century. Eastern Lithuania.
LNM EMM 1150

Top with of the tomb monument with 'the rays of the sun'.
Wood. 19th century. Southern Lithuania.
Photo: A. Baltėnas, 2019.
LNM EM 11044.

mother, divides her body into two parts, one part forming the heavens, the other, the Earth. From various other parts of Tiamat's body, Marduk creates clouds, winds, mists, mountains, and rivers, etc. In the Norse *Prose Edda* the cosmos is formed from the body of the dismembered giant Ymir: other gods fashion the Earth from his flesh, the sea from his blood, mountains from his bones, stones from his teeth, the sky from his skull, and clouds from his brain. And in the *Rigveda*, the oldest Indian text, the cosmos is a result of the sacrifice of a primordial man, the *purusha*. This depiction gives an idea of the functions and mutual relations of the four social classes: the priest (*Brahman*) emerging from his mouth, the warrior (*Kshatria*) from the arm, the peasant (*Vaishya*) from the thighs, and the servant (*Shudra*) from the feet.[24]
It is more than astonishing that similar analogies of the sacrifice of the human being could be traced in the late Lithuanian origin legends about the features of different nations and lands. The story goes that God expelled and threw from heaven to the Earth a man or a sinful angel. Where the head fell intelligent people emerged, where the belly fell the Prussians appeared, where the legs fell the Russians appeared.[25] Other legends tell of a man with a very good head, a big belly, and very strong legs. People became angry with him, grabbed him by the feet and started to drag him back and forth. His head was torn apart while in Lithuania, his belly fell down in Latvia and he lost his legs near Moscow. Therefore, the Lithuanians are smart, the Latvians have big bellies, and the Russians have strong legs.[26]

In origin legends, the 'corporeal' approach to the territories of the world and the formation of character traits of the nations living there show that people 'equal themselves with the whole world and measure it with their own parameters which they find within themselves, their bodies, and their activities'.[27]

Looking up in the Sky

In Lithuanian origin legends celestial bodies are often considered to be household utensils or artificially made objects that were taken to the sky by the mythical beings. It is told, that

> 'Long ago, there lived a blacksmith. In those times, it was dark – night and night all the time. So this blacksmith decided to hammer out the sun. Taking a shiny piece of metal, … he hammered out a sun in six years. Then he climbed onto the tallest hut and threw it into the sky'[28]

In the story about the origin of the noticeable star cluster of Pleiades, called *Sietynas* (chandelier) in Lithuanian or *Sietelis* (sieve/sifter) , the main character is Mother Mary. The legend tells us that she was sifting flour. When she went outside, the Devil stole the sieve, damaged it, and left. Not being able to use the sieve anymore, Mary placed it in the sky, and to this day, the sieve still hangs there.[29] In another legend, the constellation of Pleiades is referred to as seven brothers who were taken to the skies.[30]

The spots seen on the surface of the full Moon are also interpreted in an anthropomorphic way. They are referred to as a giant face of a man or an old man with a pipe; an old woman or a girl carrying water buckets as an eternal punishment; Cain piercing his brother Abel with a fork, or the wizard Twardowski whom the Devil carried into hell, but after Twardowski said a prayer, the Devil dropped him on the Moon. They are all stranded on the Moon and will remain there until 'the Last Judgement day', according to legends[31].

The Lithuanian origin legends show that the sky is interpreted as a realm of death. The sky, the Moon, and the stars mark the mythical route to the Lithuanian land of the Afterworld, *Dausos*, which goes along the trajectory of the Milky Way. In Lithuanian, this galaxy is called *Paukščių takas* (the bird's trail). Guided by this 'ribbon of lights' the souls of the deceased fly to the place of their eternal rest and the birds migrate there to spend the cold winters.[32]

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The sky is one of the greatest panoramas to stimulate storytelling. However, ancient cosmogonies are more like dystopias than utopias: the creation of the world is a disturbing activity that refers to proto-environmental chaos and the involvement of death in the process of mythical 'terraforming'. Together, the factors of anthropomorphisation and the sacralisation of creative activities form another level for perceiving the visible universe as it emerges in front of us as a living or enlivened world, since traces of primeval transformations left by the mythical beings in the beginning of time can be seen everywhere.

Endnotes

1 Régine Debatty, 'Interview with Julijonas Urbonas', *Lithuanian Space Agency: Annual Report No 1*, Kaunas and Vilnius 2020, p.97.

2 Julijonas Urbonas, '1st Report: Introduction', *Lithuanian Space Agency: Annual Report No 1*, Kaunas and Vilnius 2020, pp.6–7.

3 Jean-Pierre Luminet, 'Creation, Chaos, Time: From Myth to Modern Cosmology', Cosmology, vol.24, 2016, p.501.

4 Ibid., p.502.

5 Nicholas Campion, 'The Importance of Cosmology in Culture: Contexts and Consequences', *Trends in Modern Cosmology*, Rijeka 2017, p.5.

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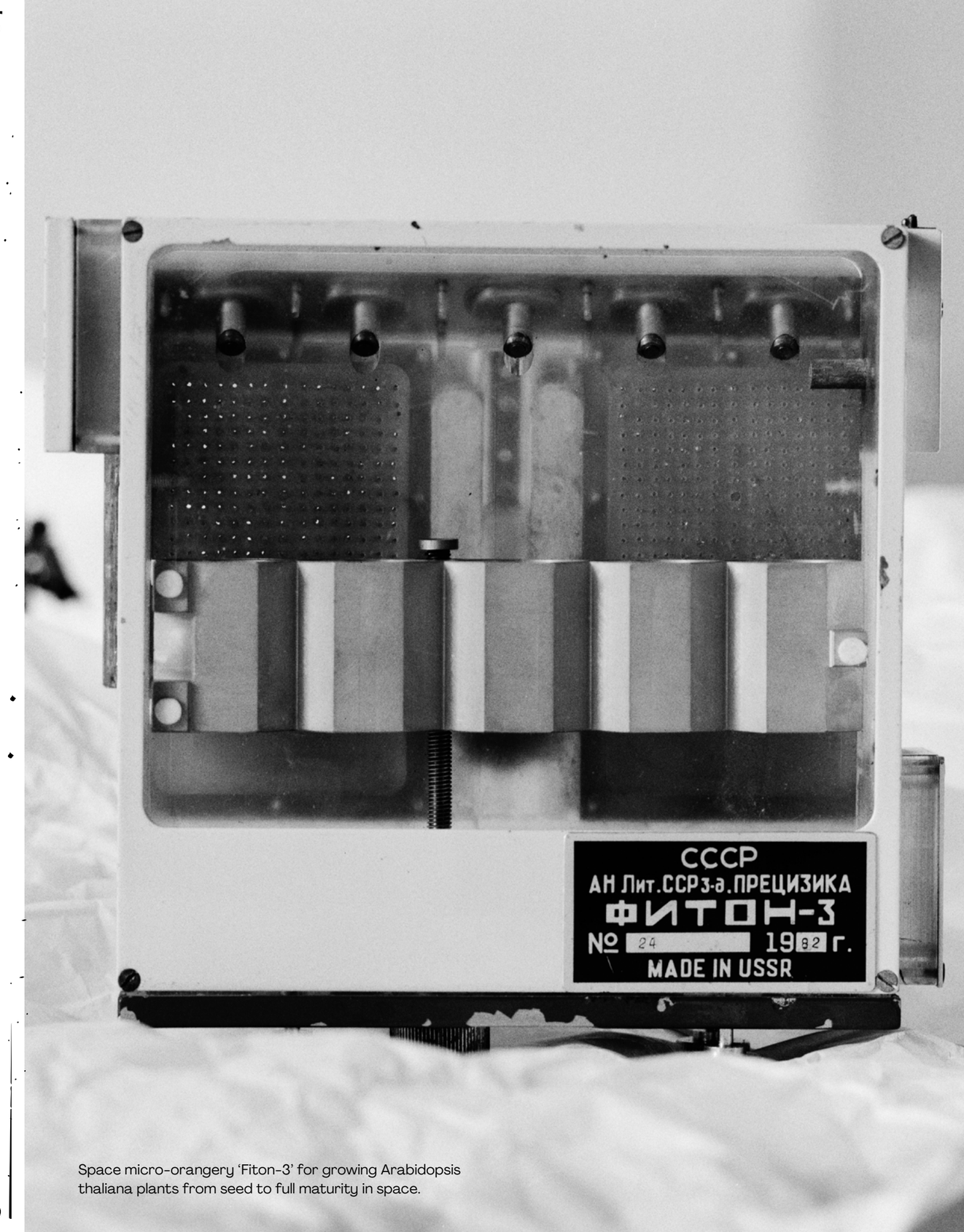
The Curious Case of Lithuanian Astrobotany

Goda Raibytė interviews
Danguolė Švegždienė
Photos:
Visvaldas Morkevičius



Space micro-orangery 'Fiton-3' for growing Arabidopsis thaliana plants from seed to full maturity in space.

Goda Raibytė is a freelance science journalist and communicator, TV & radio host, speaker at stimulating events, soon-to-be author of a book about the search for extraterrestrial life, and a proud advocate for secularism and reason.

Danguolė Švegždienė is a doctor of biological sciences. In 1973 she started working at the Laboratory of Plant Physiology at the Lithuanian Institute of Botany. In 1984 Dr Švegždienė and a team of scientists became the first in the world to grow a plant from seed to seed in space. Dr Švegždienė is a co-author of 22 experiments performed by plant physiologists of the Lithuanian Institute of Botany in spacecraft and orbital stations. She has published about 60 scientific articles, and participated in scientific conferences in France, Germany, Belgium.

In the 1970s, Lithuanian scientists started experimenting with plants and their ability to grow in microgravity conditions. Their work culminated in 1982 when *Arabidopsis Thaliana* was grown in outer space from seed to seed; a world-first achieved by Lithuanians.

The project was officially led by academic Prof Alfonsas Merkys. Although the actual work was undertaken by his team. Dr Danguolė Švegždienė was one of the scientists who made history with this astro botanical breakthrough and and to that end, created an inherent part of the Lithuanian identity. She recounts a mesmerising story of creativity, perseverance and ingenuity of a group of scientists working under a totalitarian regime.

From Enzyme Factory to Astrobotany Laboratory

Dr Švegždienė is a biophysicist. Following her PhD in 1970, she was hoping to work with the human visual system. Unfortunately, at that time under Soviet rule, scientists couldn't decide for themselves what direction they wanted to go in after graduation. The Soviets had a so-called 'attribution' system where they assigned projects to each of the graduates. Dr Švegždienė was assigned a role at the enzyme factory where she spent the next three years.

'I was fed up and realised this was not for me,' says Dr Švegždienė while laughing, 'I was thinking about learning to code or something. And by coincidence I met Dr Romualdas Laurinavičius who invited me to join a new group led by Prof Alfonsas Merkys at the Institute of Botany. Their ambition was to grow plants in space, which sounded interesting to me although I didn't quite understand what it involved.'

When Dr Švegždienė started her new job in 1973, everything was a little chaotic. The scientists of the Institute of Botany had already developed a device that had been flown into space several times. 'It resembled a hedgehog. At the time, it was not known if the plants could germinate without the usual gravity. And if they could – how the seedlings would develop. I was entrusted with preparing an experiment using this device. Placed in a special chamber, the device travelled into space with the moistened peas attached, and at the end of the mission, it was returned to us', says Dr Švegždienė.

New experiments, together with scientists from Moscow, started around 1974 during the 'Salyut' programme. At that point, the scientists were trying out what Dr Švegždienė calls 'proto-orangery' – an oasis for growing plants in space. Scientists tried to grow many different plant cultures; onions, peas, and wheat.

'Peas were our favourite because they are very resilient; they grow easily, and they have reserves of materials. We also knew from the "hedgehogs" that I mentioned earlier that something happens to peas in space, some germination occurs, – there was something for us to start from', says Dr Švegždienė.

Huge Cosmonaut Fingers and Flowers in Space

Growing a plant in space wasn't only difficult because of the absence of gravity – plants orient themselves using gravity – but also because there were no technological solutions to make it possible at the time. What seems basic today, was almost unimaginable in the 1970s.

During transportation to and from the lab, the seeds were affected by the Earth's conditions, but from the moment they were onboard the rocket going to and from space, they had to withstand a huge overload. Dr Švegždienė's team had to come up with a method to take dry seeds to space and only allow them to grow once they got there. The experiment then had to continue for say, three weeks, before their vital functions had to be stopped until they had returned to the lab in Vilnius.

To compare the differences and get the most accurate data, Dr Švegždienė's team always ran two experiments – one in space, and one analogous on Earth. They noticed that the peas in space grew very slowly; some of the processes of their growing cycles didn't even start.

'For example, we noticed that after 21 days in space, the specimens started germination but some parts dried out, others decayed. In other words, something was not right. The peas on Earth went through completely different cycles. There was nobody to tell us what went wrong so we had to analyse and understand that ourselves – maybe the atmosphere affected them, maybe there was too much water, we had no idea', explains Dr Švegždienė.

Dr Švegždienė's team thought of two new directions for the devices. One was a closed and controlled autonomous system where, aside from gravity, plant cycles were completely under control; water, oxygen, seeding. Later, it evolved into a micro-orangery that was named 'Fiton'. Another was a 'Biogravistat', a centrifuge for plant growth in microgravity.

'When cosmonauts worked on Biogravistat they had to do some of the tasks themselves, like watering the seeds using micropipettes. Imagine, cosmonauts using tiny micropipettes with their huge fingers', Dr Švegždienė remembers, 'The cosmonauts were professionals but living in a noisy, cramped and nauseous machine they needed something "human" that reminded them of Earth, like plants, thus the experiment gained an almost a religious status and that perhaps helped them look after the plants extremely well.'

The team hoped these two different devices could help them compare results and find out the effects of gravity changes in space versus the amounts of water, oxygen, etc. the specimen receives during the experiment. In 1978 the first Biogravistat and Fiton were tested on the Salyut orbital station.

'It took us a long time and many experiments, both on Earth and in space, until 1982 when aboard Salyut 7 Thale cress, a spindly plant with white flowers, flourished and formed seeds on Fiton-3', says Dr Švegždienė.

After a successful attempt, Dr Švegždienė's team continued running experiments and improving the devices and their abilities. For instance,

Device for germination of plant seeds under microgravity (the ‘hedgehog’). Explanation: The first device developed by scientists of the Institute of Botany to grow pea seedlings in space. At that time, it was not known whether plant seeds would germinate in space without normal gravity, and if so, how the seedlings would develop. Unfortunately, there are no photos of the original ‘hedgehog’ with seedlings received by Dr Švegždienė when she started working.

with Biogravistat, they tested how much gravity the plants needed. Dr Švegždienė studied lettuce, called ‘Berlin Yellow’, and it turned out that around 1/1000th of the Earth’s gravity was enough for the roots to grow in the right direction. In 1984 the findings were published in the prestigious journal *Advances in Space Research*.[1]

The Weird Reality of the Soviet Regime

Since she is considered one of the international pioneers of astrobotany, I asked Dr Švegždienė if the US National Aeronautics and Space Administration (NASA) or the European Space Energy (ESA) ever contacted her or her colleagues for advice. Turns out, the Fiton and Biogravistat devices were patented within the Soviet Union. Neither the scientists from Dr Švegždienė’s team, nor the scientists from institutions outside of the Union could access more information.

‘I only found out about the patents when I was closing the lab years later. The holders of the patents were Prof Merkys and other Soviet scientists, although they had nothing to do with the devices. We built them, we did the science and engineering. My name was only listed if they had space for it after all of the officials were listed. You know… back then I was a little disappointed but life went on, I made peace with that’

Dr Švegždienė shares that the Soviet regime was a completely different reality with different rules. All of the scientists were constantly monitored and interrogated over the tiniest details of their lives.

‘Imagine, they bring us some cosmic material – specimens that just come from space. Everything is put into a refrigerator with a lock that is sealed. Then a Soviet security guard from the Institute arrives, he takes the seal off and at the end of the day he seals the lock again. Theatre of the absurd!’

At the time, the ESA, NASA and the Soviet Union ran astrobotanical experiments. It was a part of the Space Race. Except, the Soviets kept everything they dida strict secret. The scientific resources were not even available to Dr Švegždienė’s team. They were only able to gather information from publicly available sources such as NASA’s databases or fundamental botanical research.

Prof Merkys represented the team at international conferences, where he could access useful literature for the experiments. The problem was, he didn’t share it.

‘He was the sole receiver of information, and shared it according to his own wishes. Maybe it’s hard to believe now, but it was common practice during Soviet times. We didn’t even know if the plants were actually in space. We had to deliver our devices to Moscow and then collect them from Moscow. It was both good and bad. The lack of information motivated us to be more creative’, says Dr Švegždienė.

Lost in Reforms

Before Lithuania regained its independence, Dr Švegždienė went through difficult times – dealing with family issues, while bringing up kids and writing her PhD thesis.

‘It was rough. I was only able to defend my thesis in 1991. After that, I thought – OK, so what’s next? My lab started pushing me to a more “practical” field, it was like… there was nothing left for me to do with what I started in astrobotany. No funding for the research, nothing’, says Dr Švegždienė.

Luckily, Prof Merkys and Dr Laurinavičius started collaborating with the University of Bonn in Germany who were also interested in astrobotany. The ESA and NASA were hardly collaborating at all by that point; the German Space Agency didn’t have rockets or orbital stations; thus, they needed Russian spaceships to take their experiments to space.

‘The last mutual gravitropism (a process of differential growth by a plant in response to gravity pulling on it) study was conducted in 1996. For instance, we did very short autonomous experiments with cress seedlings to explore how their roots and stalks react to different strengths of gravity. We received many acknowledgements from the scientific community’, says Dr Švegždienė.

In 1996 reforms of the scientific institutions in Lithuania began, signalling a long period of uncertainty for Dr Švegždienė. She spent most of her time analysing previously collected data and publishing academic articles. She says it takes a lot of time and effort, but science to her is ‘like life – a long game’. Meanwhile, Prof Merkys and Dr Laurinavičius retired, the funding was cut again, and many people were fired. This period ended somewhere around the 2000s.

‘When both of the initiators of space botany retired, they didn’t care about the fate of our lab. So, my colleague and I took matters into our own hands. We succeeded in attracting some funding and even started thinking about the possibility for Lithuania to join the ESA’, says Dr Švegždienė.

Dr Švegždienė’s lab was the only astrobotanical lab in the Baltic States. She visited her first international conference in 2005 and remembers how many people were surprised that the lab was still active. At that time Dr Švegždienė was collaborating with physicists to improve the clinostat centrifuge with semiconductor illuminators to find out if that would affect the plants.

‘We had one interesting project with cucumber seeds. When they germinate, they let out a little hook-like root. The development of the hook is also related to gravity. We wanted to check again – how much gravity is necessary for the hook to develop properly. This project also received funding, and was also super interesting to work on. But three years passed and the funding was over, and I was again uncertain as to what would happen next’, explains Dr Švegždienė.

Another reform of the scientific institutions began. In 2010, the Botanical Institute became part of The Nature Research Centre.

‘I was left alone, like the Last of the Mohicans. My colleague, who helped me run the lab and look for funding, passed away. I saw no purpose in starting new projects in the absence of long term funding. Proper science, as I said, takes time. I decided to close the lab’, says Dr Švegždienė.

Making Astrobotany Cool Again

Dr Švegždienė closed the lab in 2015. She had around a year to take care of the documents and the equipment.

‘I didn’t want to throw away the equipment. It was history. My husband and I brought everything home, I called various archives and museums asking them to take the artefacts but received no response. By another lucky accident I was on a guided tour at the Lithuanian Museum of Ethnocosmology in Molėtai, and the guide was showing equipment received from Ukraine and so on… And I was like – wait, I have something Lithuanian. Long story short, I donated everything to the Museum. It’s very important to me. I was a little disappointed at first that nobody cared enough to acquire the equipment’, says Dr Švegždienė.

Dr Švegždienė explains that when the exhibition in Molėtai opened she started receiving more and more attention from the media and the public.

COSMOS AS A JOURNAL

‘When Lithuania regained independence, we were sucked into projects; we needed to survive to keep the lab going. No time left for communication. I also didn’t want to talk about what had already passed. And it felt weird to talk about projects that we developed together with the Soviets. So, the exhibition helped bring astrobotany to the centre of attention again’, says Dr Švegždienė.

Not long ago, NASA astronaut Kate Rubins harvested fresh radishes on board the International Space Station. Dr Švegždienė continues to keep track of everything that is going on in astrobotany.

‘I’m so happy to see that what we were dreaming about 40 or 30 years ago, is now possible. The progress is so rapid. What used to take us years can now be done in a couple of days or even hours’, says Dr Švegždienė.

I asked her what experiment she would choose to conduct if she had the technology and knowledge available today…

‘Oooh… I know exactly what I’d do! I’ve got a dream to test my baby – clinostat – using modern technologies. I would like to check what happens with the specimens at a microscopic level from the very beginning’, says Dr Švegždienė.

According to Dr Švegždienė her job was not only scientific; it also required a lot of creativity and imagination.

‘Most of our devices looked like they were from sci-fi movies’, she laughs, ‘We had to build things that had never been made before.’

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‘I look at the night sky and think – what’s going on there? A very scientific approach, I know. I dedicated my life and my heart to that. I never counted hours, never struggled… You know, despite all of the challenges, I’ve lived an interesting and happy life. I would never change anything’, Dr Švegždienė concluded the interview with her dog snoring in the background.

Endnotes

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Space centrifuge ‘Biogravistat’ for the study and comparison of lettuce growth (comparison) under microgravity and artficial gravity simulated by centrifuge

A container model with a „hedgehog“ Explanation: Prior to the experiments in space, there was a long way to go on Earth, both in developing devices for a specific purpose and in testing their suitability for plant cultivation. The Institute of Botany developed and used devices simulating microgravity conditions for plants – clinostats. The photo shows a model of a container with a built-in ‘hedgehog’ inside.

‘Neris’ space centrifuge for plant growth studies under micro-gravity and artificial gravity of different strength

Stranger than Fiction: the Reality and Fantasy of Eating in Space

Jane Levi

Dr Jane Levi is a food historian, writer and researcher with a particular interest in space food and utopianism. A visiting research fellow at King's College London she contributes to its Georgian Papers Programme, focusing on dining and cookery in the eighteenth and early nineteenth centuries. With teaching colleagues at Birkbeck, University of London, she is co-author of the book *Food, Politics and Society: Social Theory and the Modern Food System* (University of California Press, 2018) and her writing has been published in books, journals, consumer magazines and on websites – from *Gastronomica* to *GQ*. She was co-founder of the artist's co-operative, Edible Utopia, and co-produced its creative urban growing initiative at Somerset House, London (2016–2021). Chair and trustee of the Sophie Coe Prize in food history writing, she is also Managing Editor of the children's literary magazine *Stone Soup*. She lives in London with her cat, Kimchi, and is working on her next books.

Food has always formed part of the imaginative landscape of space travel. It's the second question every astronaut is asked about their experience of being in space (the first being involved with the end results of eating), and it provides writers and movie directors with endless opportunities for playfulness. Watch any sci-fi film, and if the humans aren't themselves becoming the food for a range of ravening space aliens, they have access to all manner of futuristic devices and foodstuffs for their own dining pleasure. This isn't new. Fanciful food formed part of the vision for the pioneers of science fiction. In the short novel *Le Voyage dans la Lune*, written almost 400 years ago and first published in 1657, Cyrano de Bergerac's travellers dine on vapours (which explains why the cooks are fatter than everyone else, even though they don't physically 'eat' more), and they breakfast on larks, small birds, which when shot fall to the ground already plucked, dressed and roasted to perfection. Fast forward to the movie *Star Trek–Nemesis* (2002) where Captain Jean-Luc Picard gives a simple voice command to his replicator ('tea – Earl Grey – hot') and it materialises from nothing, steaming gently in an elegant fine china cup and saucer, while aliens drink unnervingly bright blue wine, and we can see that fictional outer space is a place where our imaginations can fly free on every level, and we can play with that most fundamental human necessity, our food.

In the early stages of research for the first real human space missions, some proposals of near-fictional outlandishness were proposed by scientists whose imaginations ran as freely as fiction writers'. Researchers in the United States investigated the use of bacteria to convert the urea in human urine into edible protein, which, they suggested, could be combined with food additives to make crackers or biscuits as a food source for astronauts. Perhaps fortunately, the results were found to cause nausea and have negative psychological effects. Others proposed making parts of the spacecraft – such as radiation shields – out of edible materials, advocated ensuring that food containers would also be edible, and even suggested using clothing fibres composed of edible materials such as soy beans, egg whites and chicken feathers. There was a strong urge to find multi-purpose solutions that would make the inedible edible, and vice versa. It was probably a huge relief to astronauts that these experiments were largely unsuccessful.

While food is fertile ground for imagination and fantasy, in both science fact and fiction, it is also a fundamentally practical matter. In more recent, realistic fantasy fictions like the film *The Martian* (2015), recognisable food is pivotal to the believability of the story, and the tension of the entire drama owes a great deal to the success or failure of our hero's crop of potatoes. Contemplation of the real possibility of space travel forces us to state the obvious. Without food and water humans cannot survive. Without adequate nourishment, humans cannot function effectively. These truths apply whether we are here on Earth or travelling in the cosmos. Any real humans actually travelling into space must have practical solutions to the problem of feeding themselves, and their food needs to do more than simply keep them alive; they are engineers and scientists, working on the cutting edge of research, who need to perform at their best. Their living conditions in general and their food in particular are key to their ability to do so.

> 'Highly acceptable foods can play a primary role in reducing the stress of prolonged space missions.' Michele Perchonok and Charles Bourland, 'NASA Food Systems: Past, Present and Future', *Nutrition*, issue 18, 2002, pp 913–20.

Beyond providing the basic nourishment our bodies and brains require to function, food and the conditions in which we consume it also influence the healthy functioning of our minds. Food forms a fundamental part of culture, our individual and collective identity, our habits and our comfort. Our ideas about it, our likes and dislikes, our needs and expectations are all part of our psychological makeup. Researchers have proposed, and our own experiences tell us, that the sensory stimulation provided by food can be as important as its nutritional benefits. At its best, food can bring pleasure, relieve stress and bring groups of people together; but it can easily do the opposite. Food is a tangible necessity that can simultaneously function on multiple intangible levels. There is a lot riding on space food.

Indeed, I don't think it is going too far to say that the entire history and future of human space flight depends on space food. Until the first pioneers went into orbit and proved it was possible, there were sincere doubts as to whether humans would be physically able to swallow food in space conditions. The first ever recorded meal in space eaten by Gherman Titov in August 1961 – purée and blackcurrant juice from tubes and meat and liver paté – and John Glenn's tube of apple sauce in February 1962, the first meal eaten by a US astronaut in space, may seem now like fun facts, almost trivial human interest angles on the larger story of space flight, but these acts of eating were actually a scheduled and important aspect of their missions. If they had not successfully proved that they could swallow their food without choking, and later astronauts on longer missions provided additional evidence that digestion and peristalsis would still operate in microgravity, the technologists who wanted none of the distractions of human participation in space missions would have won the argument, and human space flight would remain a fantastical dream to this day.

Countless projects have been undertaken during manned missions into space, but the one common to every single mission is research into the effect of space travel on the human body. It was obvious even to the public watching TV and devouring press articles that the earliest astronauts had lost weight while they were away on their mission into space. Their reduced muscle mass and bone density was less visible, and their lack of physical strength carefully hidden during triumphant landing press conferences, but the effects of even relatively short periods spent in microgravity were and are real. If the body doesn't have to work against the resistance of gravity in order to move, muscles waste and

Tubes of Soviet space food (borsch and chicken) on display in the Shymkent Museum, Kazakhstan, 2009. Photo: Jane Levi

Astronauts Thomas P. Stafford (left) and Donald K. Slayton hold tubes of Soviet space food (borsch with vodka labels jokingly pasted on) in the Soyuz Orbital Module during the joint US-USSR Apollo-Soyuz Test Project docking mission, 1975. © NASA

bones get thinner. So, resident crew at the ISS spend two-and-a-half hours on six days of every week working out on a treadmill, bicycle and weight machines to help mitigate these inevitable effects, and their food is carefully balanced to ensure adequate nutritional support.

Microgravity also affects the distribution of fluid in the body. Being in space has a similar effect to lying in a bed on a slight angle with your head downhill from your feet, sending more fluid to your head. This makes the experience of space travel a bit like having a constantly stuffy nose, or blocked sinuses, which of course affects the sense of smell (as does reduced zinc intake, often a factor in space eating). Since smell represents between 75 to 95% of what we perceive as 'taste', this has a significant effect on the flavour and desirability of foods in space. This can be hard to anticipate in advance. Astronauts have always tasted the foods on offer before departure from Earth, and continue to select their preferences from the lists of (now) hundreds of options on that basis, but because of this temporary change to their own bodies, they often find that once they get into space it doesn't taste quite the same. Astronauts on Skylab (1973–1974), the short-lived United States space station, reported that one of their menu options was a German potato salad that most of them found too spicy for their tastes on Earth; but once living on Skylab, it became the most delicious thing in the pantry, and the first crew ate the entire supply for all three missions. Crews on Mir, the USSR then Russian space station (1986–2000), ate their experimental spring onions to satisfy their craving for something strong-tasting as well as fresh. Today, crews of all nationalities on the ISS (International Space Station) get through quantities of condiments that stimulate the taste buds and make the food actually 'taste' of something. Besides salt (in pouches dissolved in water) and pepper (suspended in oil), chilli sauce is apparently especially popular with the US astronauts, while raw garlic and onion is supplied by the Russian kitchens.

These kinds of national stereotypes in food preferences, and the idea that every nationality has its own specific cuisine and national dish(es), have been played out to an almost comical degree throughout the history of human space travel. The main nations involved in the first rounds of the space race, the US and USSR, developed space-friendly versions of their most straightforward home-style food to satisfy their astronauts' and cosmonauts' need for both nutrition and comfort. For the US astronauts, this included dishes like chicken à la king, meat and mashed potatoes and frankfurters; for the Russians, beetroot soup (*borsch*), buckwheat porridge (*kasha*), various fish dishes and cottage cheese (*tvordik*). A Japanese astronaut, Soichi Hoguchi, brought 'astro-ramen,' a version of Momofuko Ando's innovative instant noodles, to Space Shuttle Discovery in 2005; the first Korean in space, Ko San, had pouches of specially formulated kimchi – its fermentation stopped by irradiation – in 2008; Italian astronaut Samantha Cristoforetti brought the ISSpresso coffee machine to the ISS in 2015; and in 2016 British astronaut Tim Peake enjoyed a bacon sarnie (sandwich) developed with chef Heston Blumenthal on the ISS. China has developed increasingly sophisticated and recognisably Chinese foods for its manned missions since they began in 1996, including *gong bao* chicken, shredded pork with garlic, 'eight treasure lotus' porridge, and moon cakes. They have spent years perfecting the provision of perfectly cooked rice for their astronauts.

The French are particularly well known for their gastronomy in space, serving splendid meals accompanied by appropriate wines – apart from on the Space Shuttle, where Patrick Baudry's wine was not allowed, though his meal of lobster, jugged hare *à l'Alsacienne* and *pâte de fruit* with cheese was. During their partnership with the Russian space agency in the twentieth century France sent several cosmonauts to Mir, all of

Mission Specialist 1 (MS1) Leland Melvin with various foods on the shuttle Atlantis Flight Deck, 2009. © NASA

Meal heating and serving tray for Skylab, 1974–1975, with food, drink and utensils. © NASA

Dehydrated asparagus and a tube of garlic paste aboard the ISS, 2013. © NASA

whom arrived with their own gourmet dinner devised, prepared and packaged by a famous chef. In 1996 Claudie Haigneré's menu included *daube de boeuf, confit de canard* with capers, pigeons in wine and tomato *confit*, washed down with wine from Alsace. Also in the late 1990s chef Richard Filippi supplied duck *confit*, squid in lobster sauce and toffee rice pudding, as well as his speciality of de-boned stuffed quails in wine sauce carefully sliced and stored in a 3½ ounce can. These dinners served to foster good on-board relations as well as providing accessible and enjoyable opportunities for communication with Earth.

> 'Having a good meal is, of course, something more than downing one's food. It's a complicated process combining physiological and psychological elements. Even in a short flight, tasty, favourite dishes can provide the cosmonauts with relaxation during their strenuous work.' Yuri Gagarin and Vladimir Lebedev, *Psychology in Space*, 1970

Astronaut biographies are full of examples of the power of food to improve morale, develop traditions and bring crews together – and, in some cases, keep them apart. Before the collapse of the Soviet Union, cosmonauts on Mir would occasionally receive treats like caviar and paté to celebrate events like birthdays and New Year. Helen Sharman, a British visitor to Mir in 1991, was welcomed aboard with the traditional Russian greeting of bread and salt, albeit in the form of packet bread and salt tablets. Jerry M. Lineger, a lone US astronaut with two Russian crewmates on Mir in 1997, found that sharing and enjoying his colleagues' traditional foods (*borsch*, *kasha* and *tushonka*, a special canned meat) fostered good relations far more effectively than any demonstrations of work ethic or technical prowess. Shannon Lucid kept morale high with a Sunday night Jell-O party when she was commander on Mir in 1996. On the other end of the scale, a French astronaut joining a US Shuttle mission in 1985 was horrified to learn that his US commander had decided against including the optional meal trays (a personal mini table held onto the leg with Velcro) for his crew, prioritising the reduction of 'clutter' and declaring set meal times a waste of time. This apparently minor food-related decision exposed and emphasised a vast cultural divide.

Although today most of the food supplied to the ISS is generic processed foods in special packaging, plus whatever quantities of fresh produce such as fruit can be kept short-term and occasionally resupplied, a lot of what we tend to think of as 'space food' is either military rations (like food in tubes developed in the early twentieth century for high-altitude pilots and MREs, dehydrated 'Meals Ready to Eat') or a relic of the twentieth-century space race. The United States in particular developed new technologies in the 1960s and 1970s as well as repurposing old ones to meet the requirements of the space programme. If asked, any US citizen over the age of 45 will immediately think of Tang, the powdered citrus drink sold to the public as the favourite drink of astronauts, and every visitor to an aerospace museum will think of the freeze-dried ice cream in foil packages sold in the gift shop. Freeze drying was an important technology for early space food, where storage space in the tiny craft was at a premium and every gram of extra weight was counted (even the Band-Aids were removed from their packaging to save on space and weight). Since water was a by-product of the fuel cells, dried foods were a truly efficient solution to the problem of feeding the crew. However, the gastronomic consequences were not always fully accounted for. The food technologists were thrilled to develop freeze-dried mashed potato; the astronauts were less excited to eat them when

Food packets for Gemini 3: dehydrated beef pot roast (with water being injected into the pouch), bacon and egg bites, toasted bread cubes, orange juice and a wet wipe. © NASA

Three crew members of the first crewed Skylab mission share dinner at the table during Skylab training at the Johnson Space Center, 1973. © NASA

rehydrated with gassy cold water (the only option on Gemini; Apollo missions were the first to have hot water, a great improvement). But no matter how long you left it to hydrate or how well you massaged the pouch, the results were not particularly appetising.

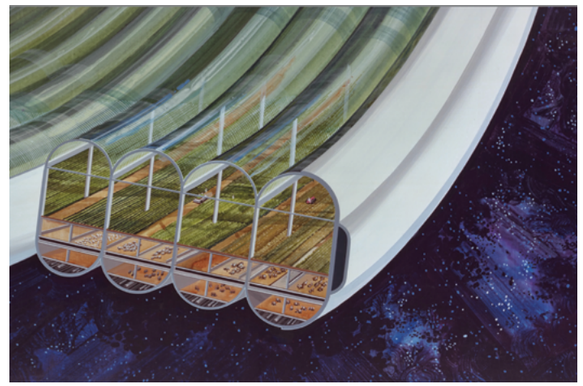
> 'This food item [turkey and gravy] was highly acceptable primarily because it was familiar in appearance, flavor and texture.' Herbert A. Hollender, Mary V. Klicka and Malcolm C. Smith, *Proceedings of The Symposium on Nutrition of Man in Space, Prague 1969*, 1970

Heatable 'wetpacks' containing thermostabilised food proved much more appealing, in particular when a package with an integrated spoon was made available, as for the turkey in gravy devised for the Apollo 8 Christmas Day meal. Not only was the food more digestible, the more realistic eating experience – spooning bite-sized pieces from pack to mouth – was found to be infinitely superior to sucking from a straw or squeezing semi-liquids from a pouch or a tube directly to the mouth. Other attempts to introduce texture into the eating experience were less successful. NASA developed a series of bite-sized cubes that would be hydrated in the mouth by saliva. Besides not looking very attractive – and the fact that without a label you would be hard-pressed to distinguish fruit cake from bacon or cheese and crackers – the edible gums coating them were either flaky, sticky or caused stomach upsets. It is tempting to look at experiments like these, made possible by generous budgets within a programme that demanded technological innovation on all fronts, as the food equivalent of the old joke that while NASA spent millions developing a ball-point pen that could write upside down, the Russians simply used a pencil.

Certainly, from the USSR's first missions onwards, cosmonauts used the existing technology of canned food alongside the liquid foods in tubes developed for high-altitude pilots, seemingly far less concerned about (or more willing to accept) the additional weight and waste of the cans in the interests of providing recognisable foods to their crews. They also seemed more willing to deal with dangers of crumbs, allowing early cosmonauts to take bite-sized pieces of real foods such as bread, salami and candied fruit jellies with them and later providing small vacuum cleaners for clean-up rather than attempting to eliminate mess from food altogether. By contrast, the United States were fanatical about the need to eliminate crumbs, and when John Young smuggled a corned beef on rye sandwich from a local deli on board Gemini 3 in 1965 for his crewmate Gus Grissom, the result was a congressional investigation and an official reprimand.

The provision of more Earth-like foods seems to be a feature of longer-term missions with more living space, and it is in space stations that we find the closest thing to a recognisable kitchen or dining experience. The Mir space station had a fridge and an oven, and a multipurpose table designed to operate as a dining table, complete with built-in heating for cans of food and suction to mitigate the escape of any crumbs or debris. When they launched their short-lived space station, Skylab, the US astronauts too had kitchen equipment including fridges, freezers, ovens and heating devices. They also adopted the idea of a dining table, a hexagonal unit designed by Raymond Loewy, around which astronauts could clip in and place their food on a heated base. The combination of conviviality and obsessive focus on their nutritional intake meant that the Skylab crews were the first ever to maintain or increase their body weight while in space. On the ISS today, efforts are still made to avoid crumbs and liquid foods are still consumed from pouches or through straws, while most foods are packed in lightweight

Hopkins welcomes in the new year on the ISS by harvesting radishes from Plant Habitat-02, 2020. © NASA



Space Colonisation regenerative life support systems showing agricultural modules by Rick Guidice, 1977. © NASA

pouches rather than in cans. However, solid foods are eaten using knives and forks from weighted trays, simulating a much more Earth-like eating experience.

In the late 1970s there was a shift away from lunar space exploration and back into the realms of fantasy when researchers' attention turned to the possibility of establishing self-sufficient colonies in space, notably in the unrealised joint Stanford NASA studies. The various technical models and literary descriptions of life beyond the Earth such as those in Gerard K. O'Neill's *The High Frontier* (1976) were made visual in an extraordinary series of specially commissioned artworks. These portray strange spheres and cylinders hovering in the darkness of deep space, with interior views showing a series of vast habitation and work modules laid out in the mode of Italian hill villages or northern Californian landscapes, with low-rise houses and lots of green space. These living quarters were to be complemented by specially designed, ultra-efficient industrial agricultural modules which would supply the colonists with fresh food, perhaps to be sold in weekend farmers' markets. The agricultural model betrays the time and the growing gulf between different factions of society on Earth. While researchers knew from their own evidence that farming meat in space was an absurd prospect, consuming more resources than it would ever provide in outputs (and who would run the abattoir?), and growing numbers of people were advocating sustainable agriculture and vegetarian diets, they felt that conservative prospective space colonists would find it culturally unacceptable to renounce meat altogether. They therefore designed complex models which used recycled water for fish farms and fed cattle and other animals on agricultural waste, while the manure and waste water from these two would feed and nourish the plants. The artist's realisations are spectacular, but it is hard to imagine that any such project could work.

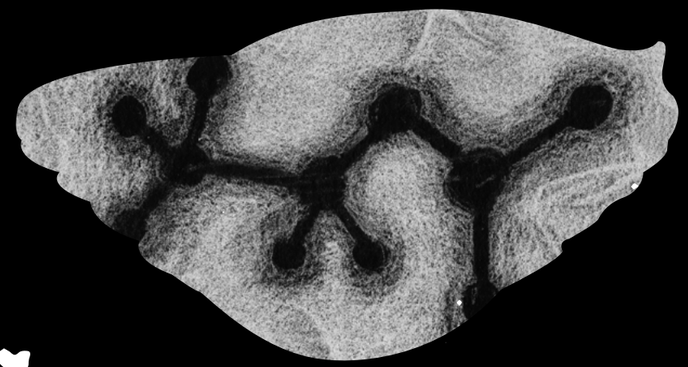
As things stand today, and despite the fact that the ISS has been continually inhabited since 2000, no current space mission grows or cooks its own food. The ISS stores about 6 months' worth of meals and snacks, and the larder is resupplied periodically with specific visits from the Soyuz, Progress and SpaceX vehicles and when new crew arrives. Each individual on the ISS uses more than 1.5kg of food every day, so food remains a significant overhead and logistical issue for any space mission. It simply isn't possible to carry sufficient supplies for multiple crew members to last for multiple years making longer term and longer distance missions a challenge. In addition, distance from Earth is a key factor in the possibilities for resupply – to state the obvious, the further from Earth you have travelled, the longer it will take for another vehicle to reach you with new supplies. And, it reaching you at all depends on your having arrived at a destination where you have settled for a period of time. If you are still on the journey, moving further away every day, the chances of any space-age supermarket supply truck catching up with you seem extremely remote. This is why any serious discussion about a mission to Mars (or other planet) must involve the options for producing and processing food both en-route and on arrival.

The technologies that could make this a reality on the scale required seem to me to remain elusive. Experiments with 3D food printing have been undertaken, but since foods are generally printed from raw ingredients, giving any space mission the challenge of storing the printing equipment and the pre-processed raw ingredients, as well as requiring cooking facilities for the end result, this proposal seems to have more technical novelty than practicality. A more plant-focused space agriculture is perhaps a more practical option. It was proved early on that plants will grow successfully in space conditions, though they tend to be smaller than usual. Projects to test plant growth both in habitation modules and in experimental desert greenhouses for other planets have been ongoing for decades, and salad-growing experiments have run successfully on the ISS. At the same time various groups of basic food plants (such as onions, tomatoes, soya, potatoes, lettuce, spinach, wheat, rice) have been formulated for potential larger scale space agriculture in self-sustaining closed-loop systems. Proponents of these systems point to their ability to process waste water and faeces and output oxygen as additional benefits that go beyond mere food supply. But the challenges to put any of these systems into live practice are formidable, not least the real estate and intensive work needed to produce a crop in the vast quantities needed to actually sustain life, and the additional inputs needed to process the produce and turn it into meals. While the next generations of astronauts may well need to add the skills of farmer and cook to their long list of accomplishments, a future of simple, home-grown, freshly prepared space food is probably still a largely imaginary one.

Pakui Hardware,
On Demand, 2017

The Whiffing Particle

Milda Dainovskytė



‘*While its shell is covered in mist and its insides pulsate with cold, you can take a breather.*

The fragile soil mixes with flames, the edges glow, and the cracks are pregnant with opaque whiteness. It steams relentlessly, bouncing off the sloping traces, each of which fades away as it is touched by a wet sigh.

Inside the nebula, I see only a splinter, in its own cosmic arrangement, stiffened by the wind of dust. It steams relentlessly, bringing with it the smells of the centuries and then carrying them away. Until the dust has fallen off it, until the cold heats up in the insides, the peat melts and the edges shine. Everything begins anew.’ (Milda Dainovskytė)

The Whiffing Particle is a scented object for travelling with your chosen vehicle, inspired by the ‘souvenirs from the sky’ returning from the dust clouds.

As the ethyl formate drizzle floats in a cloud of gas in the very centre of the galaxy, the passing bodies get slowly covered in its fractions. They carry it back to their travel shells as it settles on their shoulders and curves.

Have a fragrant journey.

Vehicle air fragrance pendant
Concept by Milda Dainovskytė
Illustration by Algirdas Jakas

Milda Dainovskytė is a curator of contemporary art and an artist. She usually chooses to hold exhibitions in spaces of personal importance or peripheral places that are not specifically intended for this purpose. Dainovskytė’s personal creative work is based on historical archives, sound, moving images, graphic technologies and smells. She is a member of acuratorial duo together with Laurynas Skeisgiela and co-founder of the meeting space Lokomotif, which combines contemporary art practices and strategies for the formation of urban identities.

COSMOS AS A JOURNAL

The Space Rose: How the Sense of Smell Mediates Human Futures in the Cosmos

Claire Isabel Webb

Claire Isabel Webb is a historian and anthropologist of science and holds a PhD from the Massachusetts Institute of Technology. She researches the history of, and current practices around, the search for life beyond Earth. She is currently a Fellow at the Berggruen Institute and the University of Southern California in Los Angeles, California. Webb is also a Visiting Assistant Research at the University of California, Berkeley, where she collaborates with Breakthrough Listen scientists as they pursue evidence of extraterrestrial technology.

In 1998, International Flavors & Fragrances, Inc. (IFF), a commercial perfume designer and biochemical research hub based in New York City, collaborated with NASA-affiliated scientists to study a miniature rose plant, a variety aptly named 'Overnight Scentsation', on the International Space Station (ISS). Although previous NASA experiments had shown that plants could grow there, this was the first to investigate how outer space's lack of gravity might in turn change a secondary characteristic: the flower's aroma. Would microgravity cause Overnight Scentsation to produce chemicals in a different combination than its sister plants Earth-side and give rise to a novel fragrance? The subsequent IFF analysis revealed that it had. Researchers there synthesised the scent – the so-called 'space rose note' – and later integrated it into a perfume by the Japanese cosmetics company Shiseido called Zen, a product that promised to give terrestrial consumers a whiff of the otherworldly.[1]

Recent projects have diffracted outer space media through humans' sense of smell, from the perfume Eau de Luna that was formulated on the basis of an astronaut's interpretations of Moon dust ('like spent gunpowder,' as Apollo 17 astronaut Gene Cernan described it), to the Center of the Galaxy lip balm that mimicked the scent of nebula Sagittarius B2 (the compound ethyl formate there smells like raspberries, according to Arizona State University researchers who developed it).[2] If such projects propose that extraterrestrial material can be made familiar through Earthly analogues, then the IFF-NASA experiment instead stages the possibility that outer space can facilitate unfamiliar and otherwise imponderable biochemistries.

Following the story of the space rose, this essay explores how humans' sense of smell mediates humans' sense of being in the cosmos. Often described as the archetypal mode of memory, the sense of smell offers the possibility of time travel. Scents are seemingly ephemeral yet lingering, momentary yet monumental. They both reconjure recollections of some previously entombed, eternal past of the sniffer (e.g., in the key of taste that is intertwined with smell, the novelist Marcel Proust's famous description of the madeleine), but can render interlinking temporalities that concatenate the future (e.g., the muskiness of a grandmother's mink coat that is passed down through generations). I consider how the sense of smell's perceived temporal dimensions are joined to spatial dimensions of the cosmos through the vehicle of the space rose. That is, I explore how the sense of smell tugs phenomenologies of senses of time – backward and forward; *alongside* senses of place – experiences of Earth and the extraterrestrial.

Smell mediates memories of the past and expectations of the future by bridging one's inner impressions to the outer world – and beyond – raising these questions: As the catalyser of past worlds whose uncanny powers unlock the cupboards of the mind, how could the sense of smell be important for humans who become extraterrestrial to remember Earth? (How would a settler of Mars transmit the sensory experience of Earthly flora to her baby born off-world?) Alternatively, how could new scents that humans could detect and create in outer space become untethered from Earth-bound biological comparisons, shaping perceptions of unexplored terrains? (How could the scent of a Titanian bloom in spring become its own idiosyncratic reference?) In other words, how could scents, and the biologies from which they spring, become both repositories for impressions of Earth and foreshadows of a future beyond it?

To consider these questions, I pose three vignettes that narrate how the sense of smell orchestrates human perceptions of outer space. Think of them as analytic petals that bloom through time as you read, transporting you from the ISS in outer space to the IFF laboratory on Earth and then, achieving new escape velocity, to Mars. The first story, a deeper dive into the NASA experiment, is about how the milieu of outer space entwined with Overnight Scentsation's life cycle; that is, how the environment in which the rose plant bloomed could not be disentangled from the sensory perceptions it stimulated. It is a story about *rearranging nature.* The next is about technoscientific processes that, back on Earth, abstracted the rose's materiality as its chemistry was reconstituted and then synthesised to create the commercial perfume Zen. It is a story about *approximating nature*. The third vignette considers how the Western imaginary of the rose intersects with a deep cherishment of one's personal past. It is a story about *symbolising nature*. This final story – set in a future in outer space about remembering a past on Earth – tracks smell's suggestibility not only to time travel, but to space travel.

This narrative structure mirrors how we use our sense of smell. Small stories – like different scents – waft through the essay, each grazing the reader from 'different points of smell.' Each smell story ends with a question that orbits the speculative modes of sensing (in) outer space. Like a perfume that deepens and changes as it is worn, these stories are *amuse-nez* to suggest how the sense of smell might liaise human futures of perceiving the cosmos.

Smell Story #1 (Base Note)
Rearranging Nature: Overnight Scentsation and the Milieus of Outer Space

Overnight Scentsation was bred to be a particularly fragrant rose varietal – a good choice for IFF researchers who hoped to study possible changes in the plant's scent. From several specimens in their New Jersey greenhouse, the team selected a rose plant that had both an unopened bud and an inchoate bloom, allowing for it to more fully flower over the course of its journey. It was placed in ASTROCULTURE™, a miniature laboratory that hosted collaborations between NASA and industry partners seeking to commercialise biology in outer space.[3] As testbeds for future bioregenerative systems that could support plant life on long duration space journeys or on lunar or Martian bases, ASTROCULTURE™ regulated various plants' access to light, nutrients, temperature, and humidity. One condition on Earth, though, is dramatically different from outer space: gravity. Stems on Earth often grow against the gravitational pull of the planet, an aspect called 'negative gravitropism' that shapes how plants develop and reproduce. In a previous ASTROCULTURE™ experiment, scientists had shown that *Arabidopsis thaliana*, a plant related to cabbages and radishes, could complete a full life cycle from seed to seed despite outer space's lack of gravity.[4] For the space rose experiment, scientists were interested to study gravity's effects at a molecular level. That is, they wanted to know if zero gravity would alter how the rose plant produced essential oils – the chemical ingredients that shape scent.

NASA's Space Shuttle Discovery Flight STS-95 carried ASTROCULTURE™ to the ISS in late October 1998. Once in outer space, the astronauts (among them John Glenn, the first American to orbit the Earth in 1962) harvested the rose plant's molecules four times during the ten-day flight. They used video equipment to see inside the ASTROCULTURE™ facility and manipulated small fibres situated around the plant. These fibres soaked up the plant's volatile molecules, the vaporised chemicals that the bloom's essential oils exuded. When Overnight Scentsation returned to Earth, IFF chemist Dr Braja Mookherjee's analysis found that microgravity had indeed dramatically altered how the plant had produced essential oils – and thus how it smelled. Mookherjee remarked that while the Earth-bound control plants exhibited 'a very green, fresh rosy note,' the outer space flower instead produced a 'floral rose aroma' that he found more pleasing.[5] Mookherjee's smell experience of the outer space rose does not simply point to a relation between the sniffer and the object, but the experimental conditions that created them. Although IFF scientists might have had knowledge about all the same compounds before the rose's flight, outer space unlocked a novel combination and ratio. That is, microgravity did not cause the plant to develop previously unknown substances, but to arrange molecules in previously incomprehensible ways.

IFF's framing of the space rose hinges on the concept that experimenters were able to adjust one *environmental* lever that affected the rose plant – turning 'off' gravity – but we might also consider how the *sniffer* is implicated in a sensory milieu. Attending to a 'milieu' draws our attention not merely to two interacting entities (flower, human), but how the environment conditions the possibilities of a sensory experience. Dr Rick Gerkin, a neurobiologist at Arizona State University and an affiliate of the Smell Lab there, explained, 'When you smell something, it's a function of the molecules and the environment.'[6] A smeller, the chemicals, and the place are all entangled. For instance, although methane is odourless in everyday life, the atmospheric pressure in ocean depths – relatively higher than at the Earth's surface – can cause the gas' molecules to become perceptible to a diver. There, methane molecules dissolve into the diver's mucus on their olfactory epithelium inside their nose, prompting them to perceive a camphoraceous odour (a medicinal smell akin to Vicks Vaporub). So, the question of 'How does a Mars rock smell?' is really, 'How does a Mars rock smell on Earth?', given the two planets' different conditions and a sniffer's sensory capabilities in each environment. As Gerkin put it: 'The environment determines whether the *subject* can access the *object*' – if they can sniff tulips in Holland or a rock on Mars – and 'whether the *object* can access the *subject*' – if molecules can become volatile and travel through a medium like air at a certain pressure to a sniffer's sensory receptors.

The IFF experiment proposes that outer space milieus are poised to intervene on humans' perceptions of biologies in novel ways. We might imagine a habitable exoplanet where gravity, say, is a fraction of Earth's, but also, where clouds precipitate not water but some other liquid and ecosystems flourish with weird microbes and alien animal pollinators. These entities would all impact a human's immersion in – indeed their collaboration with – the sensory milieu of which a fragrant extraterrestrial flower is just one component.

> *How could different outer space milieus – the murky methane lakes of Titan, the thick Venusian atmosphere clotted with carbon dioxide, the violent tumbling of a passing asteroid – show scientists unexpected combinations of molecules, revealing previously inaccessible – even currently unimaginable – scents?*

Smell Story #2 (Heart, Note)
Approximating Nature: Scents Touch Your Brain

Deaccelerating from outer space to Earth, I return to the IFF laboratory. Mookherjee and the IFF team transferred the samples that the astronauts had taken of the rose's essential oils into a machine called a gas chromatography-mass spectrometer (GC-MS). This process separated the different molecules in real time, allowing Mookherjee to obtain a computer reading of the flower's odorous molecules. In addition to smelling Overnight Scentsation's scent profile by nose, Mookherjee used the GC-MS to pinpoint the quantity and composition of all the compounds in the sample. Although each sample, taken at four points of time in outer space, had yielded different chemical compositions, Mookherjee then decided to average them together to create the space rose note. That note, a compression of the flower's dynamic biochemical expression, was then mixed with others for the Zen fragrance. In creating it, perfumers tamped down some molecules and amplified others to create a final, pleasurable chemical concoction whose ingredient list could be reproduced. Such distillations of nature, once pried away from their biological origins, get regularised into synthetic versions of their biological references. These discrete, identifiable notes (e.g., powdery, amber, heliotrope) can then be infinitely recombined. By leveraging the GC-MS's processes of digitisation and inscription, a biologist can approximate a flower's essential oils to render its biology not only mutable, but marketable.

Dr Christina Agapakis, a Boston-based biologist and artist, ruminated with me on the strangeness of translating humans' 'very messy, very complicated' sensory experiences of biological objects like flowers into synthetic distillations 'that are meant to abstract that complexity' – and do not always line up with their natural points of origin.[7] That is, she told me, a scent abstracted from the flower smells different, even though it is considered to be 'purer' or 'cleaner.' Perfumers take the intimate, internal experience of smelling a rose and then 'decompose it into something that then becomes tangible…in a laboratory environment,' a process that increases its mobility.[8] That synthetic note then becomes a tool, a stabilised chemical compound that circulates through perfumers' communal parlance and the industry's economies of production. As 'natural' scents get smoothed over, their remixed biologies travel from the laboratory into global networks of exchange as a commodity.

Shiseido discontinued that version of Zen, but one can find the scent on eBay for under $100. Agapakis and I exchanged an email about the moral implications of the IFF's process of abstracting nature for commercial purposes. As she wrote, 'While I think it's true that these technologies by necessity flatten the experience and abstract it to make it work, I'm not sure that's necessarily…bad? There is something quite interesting in having this incredibly rare experience (a rose in SPACE!!?!) be something you can buy on eBay.'[9] Like NASA posters emblazoned with images of Saturn taken by the Cassini spacecraft, or Vincent Van Gogh's *Starry Night* depicted on a coffee mug, the circulation of the space rose scent is implicated in larger economies of abstraction and reproduction.

The commercialisation of the space rose also illustrates the technical processes of remaking nature to choreograph humans' intersubjectivities to suggest an out-of-this-world experience. As the IFF company's website advertises, Mookherjee and his team created in the laboratory 'a variety of heavenly fragrances previously unknown to the human senses of taste and smell.'[10] They extracted, distilled, and then selected one particular balance of molecules to synthesise and later mass-produce a note that

Alexandra Daisy Ginsberg
The Wilding of Mars, 2019

Alexandra Daisy Ginsberg, *Saxifraga oppositifolia* from *The Wilding of Mars*, 2019

Alexandra Daisy Ginsberg, *Saxifraga oppositifolia martia subsp. sim-1-035* from *The Wilding of Mars*, 2019

Human dreams of colonisation are not limited to Earth. We see Mars, untouched by Earth life as barren, treacherous, beautiful; another planet to colonise. But humans invariably become exploiters. Instead, could we imagine Mars colonised only by plants, flourishing without us? The Wilding of Mars *was a project by the British South African artist Alexandra Daisy Ginsberg to simulate the growth of a planetary wilderness, seeded with Earth life forms.* The Wilding of Mars *simulates the growth of a planetary wilderness, seeded with Earth life forms. In the exhibition, a wild garden on Mars thrives over millennia, its growth visible over human hours. The pioneers are seeded in stages as conditions become more tolerable. The plants spread north from the South Pole, developing an ecosystem determined by global and local parameters of water, temperature, and nutrients.*

Like other 'frontiers', Mars is seen by some humans as open for exploitation, whether or not indigenous life exists there. The Wilding of Mars *instead prioritises a non-human perspective with plants visibly growing and colonising the terrain, while voyeuristic camera angles heighten the sense of human intrusion.*

The aim is not to terraform Mars; here it is simply a repository for the mechanism of life. Plant life takes Mars in a different direction and Mars may take life elsewhere. In the installation, multiple simulations run in parallel; endless possible worlds emerge, challenging the assumption that the outcome of space colonisation must be human benefit. There are other paths life could take. Might leaving the planet to other life forms be the ultimate unnatural act for humans? Can we imagine Mars except as a place for ourselves?

The Wilding of Mars *was commissioned by the Vitra Design Museum and the Design Museum.*

Alexandra Daisy Ginsberg, *Pioneers and Descendants: seeded and generated species (Simulation 1)* from *The Wilding of Mars*, 2019

they called 'spiritual' for the Zen fragrance.[11] Descriptions of the scent as 'heavenly' and 'spiritual' evoke the notion that the transubstantiation of the rose in outer space could cause the wearer themself to be remade, unshackled from the terrestrial as they touch the celestial. Such a framing might also suggest that the perfume's wearer not only could transcend the sublunary mundanity of Earth-bound living, but also the calculated and very worldly processes of commodification and advertising required to bring the perfume to market and distribution. Perhaps as a testament to the IFF and Shiseido's successful branding of Zen, on the perfume's entry on Fragrantica, an online community and encyclopedia of fragrances, commentor La DameDeNoir described the perfume as 'terribly elegant' and wrote that 'there are no words to express such unearthy [sic] beauty'; ilikefragrantica wrote that it 'remind[ed] me of all those oriental [sic] things in movies, which also could calm me down immediately.'[12]

For these users, the intimate experience of smelling and wearing the Zen perfume in which 'the actual material of the thing is touching your brain' that 'causes you to have feelings,' in Agapakis's words, is contrasted by the commercial process that alienated the space rose from its biology. The technoscientific processes of creating the Zen perfume I have described here paradoxically abstracted Overnight Scentsation's nature to bring a wearer closer to an 'authentic' experience of outer space.

In some distant future, as humans' sensory organs adjust to, or even evolve on, other worlds, how could extraterrestrial perfumers assemble fragrances of alien flowers, and what new emotions might they invoke?

Smell Story #3 (Top Note)
Symbolising Nature: In Search of Lost Earth

The NASA-IFF experiment illuminates how outer space can transmogrify Earthly biologies, and human perceptions of them; the IFF's commercialisation of the rose suggests novel ways for scents to be abstracted from their referents, suggesting new ways to interpret and experience natures even beyond this world. I finally consider the symbolism of the rose that emerges from such materialities. The rose is the ur-flower of romance and chivalrous love in Western modernity. We find a root in the *Iliad*, in which Aphrodite, the Greek goddess associated with love, anoints the fallen Trojan hero Hector with the 'ambrosial oil of roses' to protect his body.[13] The symbolic freight of that flower, from Shakespeare's telling of the War of the Roses in *Richard III* to the magical rose in the Disney film *Beauty and the Beast* whose shedding petals threaten to trap the Beast in his monstrous form, has now sedimented into the droopy drugstore bouquet – a last-minute token of stereotypical, heteronormative love on Valentine's Day. How could the rose's symbolic resonances endure or mutate in extraterrestrial environments?

I ponder that question below. To end, leaping forward in time and propelling the reader back into outer space, I pose a vignette that is a mangled retelling of a passage from Marcel Proust's sprawling work *In Search of Lost Time* often celebrated as a foundational exploration of the senses and memory.[14] When his mother offers him a madeleine, the novel's narrator is transported back to his childhood home in Combray, France. He remembers how his aunt had dipped the spongy, shell-shaped cake in lime blossom tea and let him taste the crumbs; an experience that unraveled other moments of his boyhood home. The passage is an exploration of taste's ability to trigger an involuntary memory: confronted by a confusing, half-glimpsed recollection that the madeleine's immediate flavour had called forth, the narrator strains to go deeper, blockading the interfering perceptions of his current world to summon the objects, people, and places of his childhood in his mind.

Below, my imagined Martian biologist inhabits a future not yet realised just over the horizon of our now. She remembers moments on Earth in a scene that could take place soon, as projects to travel to and inhabit extraterrestrial sites gather momentum and materiality. Proust's story of the taste of madeleine vivifies *fin de siècle* France, a past world; the Martian's experience of smelling the rose evokes a possible future beyond this familiar one. Contemplated together, the passages suggest the spacetime-bending power of the human sensoria.

A catalyst for embodied ways of knowing, how is the sense of smell positioned to and, in some possible future, (re)familiarise Earth, or symbolize the experience of that planet, to extraterrestrial humans?

For a long time, I have gone to bed late. Or, at least, I linger in the Biolab hours after evening's blue hands steadily choke the feeble sun over the Martian horizon, ending another sol on this bleak planet. I count each sol slowly, but it is already year 24. Or, year 2256 in Terratime, although it is often difficult to keep track because of Earth and Mars' asynchronous orbits around their common sun. In the Biolab, I work alongside my mother, a botanist and biologist like me. Our primary task is to grow food for the settlement in the greenroom, a vestigial name from Earth that I like to think rebels against the monochrome of this red planet. From my mother, I learned how to tenderly lever plants' predilections, nurturing fine tendrils into monstrous, sinewy stalks, and how to winnow seedlings' thirsty desires from the watery planet of their origin. We crossbreed and cultivate hardiness, creating plants whose fruits and roots are better to eat than the freeze-dried supplies that arrive on the annual transports from Earth, but are victuals that are far from tasty. Occasionally, though, my mother and I harbour biology experiments in secret. We torque plants' DNA in curious ways to break the monotony of the proscribed farming projects, trying to one up each other with our novel creations.

On one of these long Martian nights, my mother, shuffling slowly through the Biolab because of the gravity here, pulls something from a drawer in her work bench. 'I have a surprise for you,' she says, smiling with conspiracy. She hands me an alien rose. 'I had these seeds smuggled in on the last transport,' she explains. I carry to my nose that plump and fatly sensual flower and quiver, for it awakens a deep but veiled memory. I prick my finger on its jutting thorn, and the viscous blood of my body seeps out in pearls, mixing with the rubied color of the rose and hazy vermillion vista of Mars that stretches interminably, unbroken by trees and flowers and birds and clouds of the planet of my birth. I sniff again, clearing an empty space in my mind, and suddenly the memory appears. That smell was the smell of the little piece of rose-scented soap which on Sunday evenings in Cambridge my aunt Leona brought for my baths when I was a young child. Like a waiting soul, the scent that had long laid dormant now conjured all the ancient corporeal pleasures of Earth– of girlhood, of joy in the abandon of watery submersion of my baths long forgotten and indeed forbidden on this arid planet, of order and play in the Sunday ritual with my favourite aunt, how she gently soaped my hair, her softly glowing jade necklace she would let me wear, my mother's laughter with her in our yellow kitchen when they were both young, memories gathering structure and flesh, all of this, emerged from my mother's furtive rose.

Endnotes

1 'Space Rose Pleases the Senses', NASA, 2002, https://spinoff.nasa.gov/spinoff2002/ch_1.html, accessed 1 September 2021.

2 Tony Phillips, 'The Mysterious Smell of Moondust', NASA, 30 January 2006, https://science.nasa.gov/science-news/science-at-nasa/2006/30jan_smellofmoondust, accessed 1 September 2021; Nicole Sherwood, 'ASU scientist created a lip balm that is truly out of this world', *The State Press*, 28 August 2018, https://www.statepress.com/article/2018/08/spscience-asu-scientist-created-a-lip-balm-that-is-truly-out-of-this-world, accessed 1 September 2021.

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5 'Space Scents', *NASA*, 18 December 2002, https://science.nasa.gov/science-news/science-at-nasa/2002/18dec_scents, accessed 1 September 2021; 'Our History', International Flavors & Fragrances, Inc., https://www.iff.com/index.php/about/history, accessed 1 September 2021.

6 Conversation with the author, 9 September 2021.

7 Agapakis has also explored the time-warping nature of smell. In an art project with collaborators Dr Alexandra Daisy Ginsberg, Sissel Tolaas, and Gingko Bioworks, Resurrecting the Sublime, Agapakis extracted DNA from flowers that had become extinct due to colonialism and reconstructed their scents. This project might be seen as complementary to the space rose; instead of creating novel combinations of molecules in outer space, Resurrecting the Sublime recovers experiences of lost plants on Earth. See: https://www.agapakis.com/work/sublime.

8 Conversation with the author, 31 August 2021.

9 Correspondence with the author, 23 September 2021.

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13 Homer and Robert Fagles, *The Odyssey*, New York, Penguin Books, 1990, 23.216.

14 Marcel Proust, *Swann's Way: In Search of Lost Time*, Volume 1, trans. Lydia Davis, New York, Penguin Random House, 2004, pp. 47–52.

M. K. Čiurlionis. *Rex*. 1909. Tempera on canvas.
M. K. Čiurlionis National Museum of Art

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Cover image
The Great Art of Artillery. K-33, Kazimieras Simonavičius, 1600–1651. Courtesy Lithuanian Museum of Ethnocosmology

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The third issue of * *as a Journal* will be dedicated to sound: as art; as vibrations in space; and as a constituent component of our experience of the world around us. Guest edited by Damian Lentini (curator at Munich's Haus der Kunst), the forthcoming edition probes sound's ability to shape and generate effects. This evolving exchange between transmitter and receiver aligns our experience of sonic encounters with that of dramaturgy; sound is never experienced in isolation but is in fact contingent upon a range of cognitive factors that are both dynamic and mutable. Using this notion as a point-of-departure, the issue will invite leading artists, writers and scholars to investigate sound's ability to shift back and forth across times and spaces; incorporating traditional and contemporary positions, digital and analogue technologies, as well as that which emanates from both organic and inanimate bodies.

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