

[ij]

idea journal

interior technicity:
unplugged and/or switched on

vol. 17, no. 01

2020

the journal of IDEA: the interior design +
interior architecture educators' association

learning from mars; or, facing our shit

Lydia Kallipoliti

The Cooper Union

[0000-0003-2035-3295](tel:0000-0003-2035-3295)

Jestin George

University of Technology Sydney

[0000-0002-8225-827X](tel:0000-0002-8225-827X)

The intent to inhabit Mars carries many self-contradicting intentions, especially given our clear plan to extract Martian resources, domesticate the planet, and transfer the ideological framework of establishing territory in a newly found space free from jurisdiction. To that end, research into sustaining human life on Mars is highly problematic. Interplanetary habitation is arguably an escape from Earth. The latent narrative is defeat; that is succumbing to the climate crisis, while making alternative plans for a selected privileged population. Nevertheless, research into life on Mars forces us to face our shit on Earth, where resources for sustaining all forms of life have been abundant. Not until recently have we been mandated to consider their finite worth or replacement, or deal with the excessive waste we generate as a by-product of our daily production processes. On Mars, where every resource for sustaining life is precious and rare within a fully enclosed life support, waste becomes integral to our survival. This view from afar, in the words of Claude Levi Strauss, changes our viewpoint on how to retain and recycle waste. Arguably, it is not only insightful for Mars-based habitats, but also for helping in altering daily patterns of dealing with waste and the climate crisis on Earth.

This article presents *LIFE ON MARS*, a research-design project investigating closed-loop life-support living systems for Mars as giant living machines of ingestion and excretion. It is neither a complete project, nor a 'solution' to extra-terrestrial inhabitation. *LIFE ON MARS* looks at the minimum use of in-situ resources avoiding extraction, as well as the regenerative properties of Earth-based biology and our ability to engineer and tinker with resources through the field of synthetic biology. The project also brings to light emergent forms of habitation in extreme interiorisation and the problem of sustaining life in a sealed interior when the exterior world becomes prohibitive. In this format, it is presented as an inquisitive visual narrative, which raises both existential and scientific questions for further exploration.

cite as:

Kallipoliti, Lydia and Jestin George. 'Learning from Mars: Or, Facing our Shit,' *idea journal* 17, no. 01 (2020): 29-50, <https://doi.org/10.37113/ij.v17i01.375>.

keywords:

life support, inhabitable digestive machines, excrements, colonisation, closed-loop

outer space and the problem of dominion

Is the action of the body separable from its technology, and how does the technology determine new forms of political action?⁰¹

There is something alluring about the emptiness of a blank planet; an uninhabited vast terrain, where every step demarcates the tempering of an endless unforgiving world. As Michael Marder argued for the desert, Mars, as much as it is a real planet afar, is also 'an invention, a creation of emptiness in the plenitude of existence, an introduction of barrenness into the fecundity of being.'⁰² The intent to inhabit Mars carries many self-contradicting intentions, especially given our clear plan to extract Martian resources, domesticate the planet, and transfer the ideological framework of establishing territory in a newly found space free from jurisdiction.⁰³ As space archaeologist Alice Gorman writes:

of all landscapes, perhaps space alone can claim to be a true 'wilderness'.. Interplanetary space was a real *terra nullius*, the land belonging to no-one. It was, nonetheless, a powerful associative landscape, central to diverse cultural beliefs, creation stories, mythologies and scientific enquiry.⁰⁴

Since the conception of the Mars Excursion Module (MEM) in a 1964 NASA Study, the Martian astronaut, standing firm, masked and geared over a territory unfriendly to the physiology of humans, propagates the

iconography of the heroic settler extending human life through the galaxy; though with clear effects when placed next to the fissures of terrestrial history.⁰⁵ When looking at Mark Watney, Ridley Scott's fictional character (played by Matt Damon),⁰⁶ who was left behind on Mars to grapple with the vast barren landscape of the red planet, there are clear associations between the astronaut and Caspar David Friedrich's painting, *The Wanderer*, a painting that defined the Romantic Period and the iconography of the sublime.⁰⁷ This visual narrative of the explorer as the inevitable victor of a free terrain is entirely subordinated to the burdened history of colonisation, where conflicting groups of power structures are established in their demarcation of dominion. Colonising Mars can therefore not be detached from the power dynamics of relentless capitalism. In recent years, Mars has been envisioned as a tourist destination, while the journey to the red planet has been largely commercialised and popularised. Along with Donald Trump's recent consent to and encouragement of colonising Mars,⁰⁸ private companies like Virgin Galactic, Mars One, and SpaceX are leading research, commercialisation and technical innovation in space exploration, while the military is questioning the commitments of the original Outer Space Treaty, put into force by the United Nations in October 1967.⁰⁹ These 'new developments present an ever-growing challenge in defining the laws that govern space, raising myriad questions, and rendering a treaty created decades ago obsolete.'¹⁰

So, as we find ourselves in a world of increasingly complex and contentious scientific and technological advancements, how do we evaluate and explore the premise of space travel and Martian living? How do we engage critically and meaningfully with life on Mars, not explicitly as a feat of science, technology and engineering, but also as a complex cultural, spatial and anthropological territory? Could we then rethink architectural and living modalities in a different way? Such

ventures require rigorous interdisciplinary research, which is exceptionally challenging, given the highly specialised knowledge forms that need to crossbreed with each other. Such crossovers, setting common foundations across disciplines, require the development of new shared types of language. During the Macy conferences, held in New York City from 1946 to 1953, the fields of systems theory, cybernetics, and what later became known as cognitive

Figure 01:

Artist's conception of the Mars Excursion Module (MEM) proposed in a NASA Study in 1964. Aeronutronic Division of Philco Corp, under contract by NASA. First presented in Dixon, Franklin P. (June 12, 1964). 'Summary Presentation: Study of a Manned Mars Excursion Module,' *Proceedings of the Symposium on Manned Planetary Missions: 1963/1964 Status*. Huntsville, Alabama: NASA George C. Marshall Space Flight Center p. 470.

sciences, as well as computer science, were born in open source thinktanks.¹¹ Similarly, interdisciplinary research asks scientific practitioners to exercise scenario development and speculation; tools which are outside the territory of their scientific methodologies. It also asks architects to investigate the full spectrum of life, in all its living systems, materials and components, as a complex intertwining of overlapping ecologies and the way they unfold in space and in time. In this way, the notion of a spatial environment takes on a new role. Instead of being the inactive, static, and historicised context of an architectural object, the environment quite literally becomes the object of design itself.

Here, we present *LIFE ON MARS*, a research-design project investigating closed-loop life-support living systems for Mars, commissioned by the Design Museum in London for the exhibition *Moving to Mars* (2019-2020). In its first iteration, this work was born out of a two-week intensive research investigation by a team of architecture students, professors and consultants from the field of genetic engineering. It is neither a complete project, nor a 'solution' to extra-terrestrial inhabitation. Yet, it offers a solid research-based scenario development for perceiving such a future and for asking pertinent questions to help us to explore critically and meaningfully the premise of Martian living. *LIFE ON MARS* looks at in situ resources available on Mars, as well as the regenerative properties of Earth-based biology and our ability to engineer and tinker with resources through the field of synthetic biology. In this format, it is presented as an

inquisitive visual narrative structured by four points, which raises both existential and scientific questions for further exploration.

Exploring Martian living is almost too big to fathom: from the technological aspects of supporting human life to the social and psychological impacts of a life experience that is drastically altered—both physically and mentally—to the questions around longevity and renewability of resources. This work neither attempts to answer these massive topics, nor offers holistic solutions. Instead, it provides ground for imagining possibilities with the technologies available today and uses this speculative design to ask questions about what it would mean to develop a digestive machine for living on Mars, and how the research could provide alternative routes of thinking for life on Earth.

On the one hand, research into sustaining human life on Mars is highly problematic. Interplanetary habitation is arguably an escape from Earth itself. The latent narrative is defeat; that is, succumbing to the climate crisis, while making alternative plans for a selected privileged population.¹² On the other hand, research into life on Mars forces us to face our shit on Earth, where resources for sustaining all forms of life have been abundant. Not until recently have we been mandated to consider their finite worth or replacement, or deal with the excessive waste we generate as a by-product of our daily production processes. On Mars, where every resource for sustaining life is precious and rare within a fully enclosed life support, waste becomes integral to our survival.

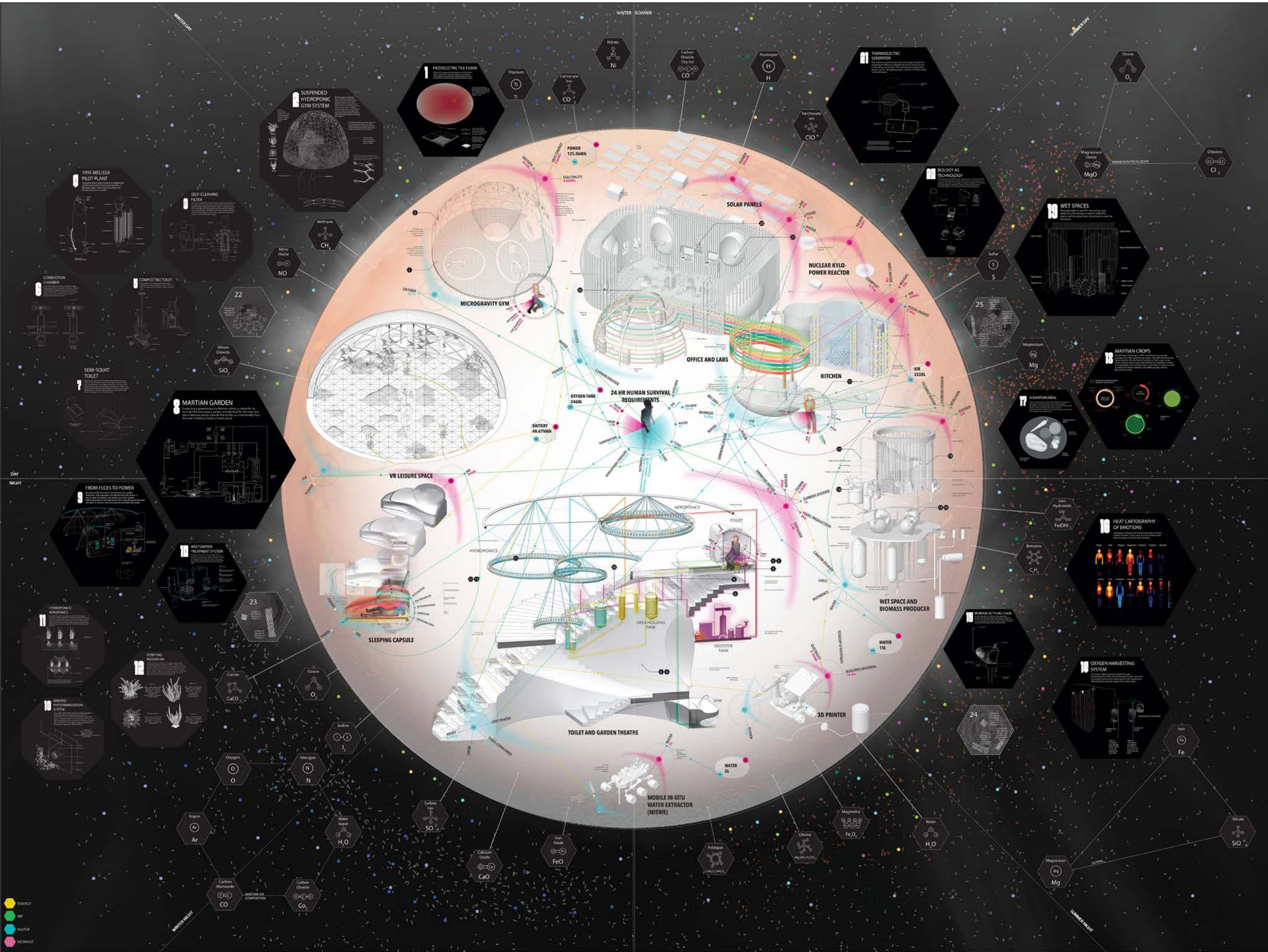


Figure 02:
LIFE ON MARS. Lydia Kallipoliti with
Jestin George (Genetic Engineering
Consultant) and UTS students Beau
Avedissian, Ka Hou Cheang, Dorsa
Fahandezh, Jialu Huang, Mariam
Mesiha and Isabella Wells, Sydney,
2019.

This view from afar, in the words of Claude Levi Strauss,¹³ changes our viewpoint on how to retain and recycle waste. Arguably, it is not only insightful for Mars-based habitats, but also for helping in altering daily patterns of dealing with waste and the climate crisis on Earth.

point 01: bodies unpacked

When and if Mars is inhabited, it will be contaminated. It will, by default, no longer be the pure wild territory. Any type of colonisation is also an infection, a blending of substances, species and materials either of biogenic or abiogenic sources. The minute a human body enters a closed-loop life-support system of any given space habitat, this capsule is compromised in the flawless operation of its feedback loops, as history has proved.¹⁴ In colonising a territory, inevitably

we exploit, extract, restrain, clear, build, pollute, infest and infect, crawling all over the 'found' ecology of any given terrain, let alone an entire planet. On Earth, colonisation has exploited Earth's people and resources. But how do we view and investigate the colonisation of a lifeless planet? As tech entrepreneur and Aboriginal Cabrogal woman Mikaela Jade proposed, 'Will the first humans on Mars be considered colonialists or First Nations?'¹⁵

Relevant to the trope of human explorers invading infinite uninhabitable lands, colonising Mars begs the question of where the body is located in this process; not as a figure seen from afar in a desolate landscape, but as a corporeal physical entity, which is no longer outside the biological preserve of the planet.

Figure 03:

Human Footprint. Feedback diagram of biomaterial and biometrical output by Lydia Kallipoliti and Bess Krietemeyer for the exhibition *Closed Worlds* at the Storefront for Art and Architecture, New York, 2016.

As a machine of ingestion and excretion, but also as the primal operator of labour and daily tasks, the astronaut is at the same time an experimental subject inside a larger experiment and the monitoring agent of the experiment itself.

The Martian explorer, therefore, is a scientist and a guinea pig wilfully inserting their body into the premises of the experiment and offering it as a testbed for further trials. In this light, bodies are no more than expressions of change, carefully mapped and monitored. Within the premises of closed-loop habitats that will ensure survival, bodies are reorganised, unpacked, and distributed in space to yield other resources. This type of dissemination requires a radical shift in our relationship with our bodily excrement and our relationship with our own shit both literally and figuratively.

Living in a machine is by no means a new desire. Le Corbusier's metaphor for 'machines for living' in 1924,¹⁶ as well as Ray Eames and Herbert Matter's question, 'what is a house,'¹⁷ reveal deep anxiety about how industrialisation forges new aesthetic and existential territories. For these authors, the tectonics of assembly/disassembly and the logic of interconnected parts were marking new paths for architectural production. In its time, this view was quite radical, relative to the canonical discourse of machines as vectors of a monolithic anti-humanism.

The ecological crisis of the 1960s and 1970s brought to the forefront a new modernist ethos announcing buildings as 'performative

machines,' foreshadowed by the replacement of function with performance. However, this turn was devoid of a tectonic expression and a set of form-giving strategies. Even Reyner Banham, in his best efforts to embrace machinic expression in his 'Environmental Bubble' (originally published in *Art in America* in 1965),¹⁸ was vigilantly critiqued as the technophile 'theorist of refrigerators.'¹⁹ In proposing a sealed interior bubble controlled atmospherically by a tower of air conditioning and heating mechanical devices, Banham's concerns were mostly hygienic; noxious atmospheric pollutants would be screened out from the domestic interior by regulating its interior climate. At the same time, Banham suggested the word 'atmosphere' be read literally;²⁰ he argued that atmosphere was not only a condition to be calculated, but also one that needed to be designed, as well as inhabited with the aid of medical practitioners.²¹

When offset to inhabiting another planet, the question of living in machines raises, more than Earthly habitats, reasons, modes and trajectories for existential change. As anthropologist Valerie Olson reasons, habitation is reconceptualised as a process of transferring and transforming spaces, where dichotomies and distinctions like inside/outside, body/habitat, habitat/environment are systemically transfigured.²²

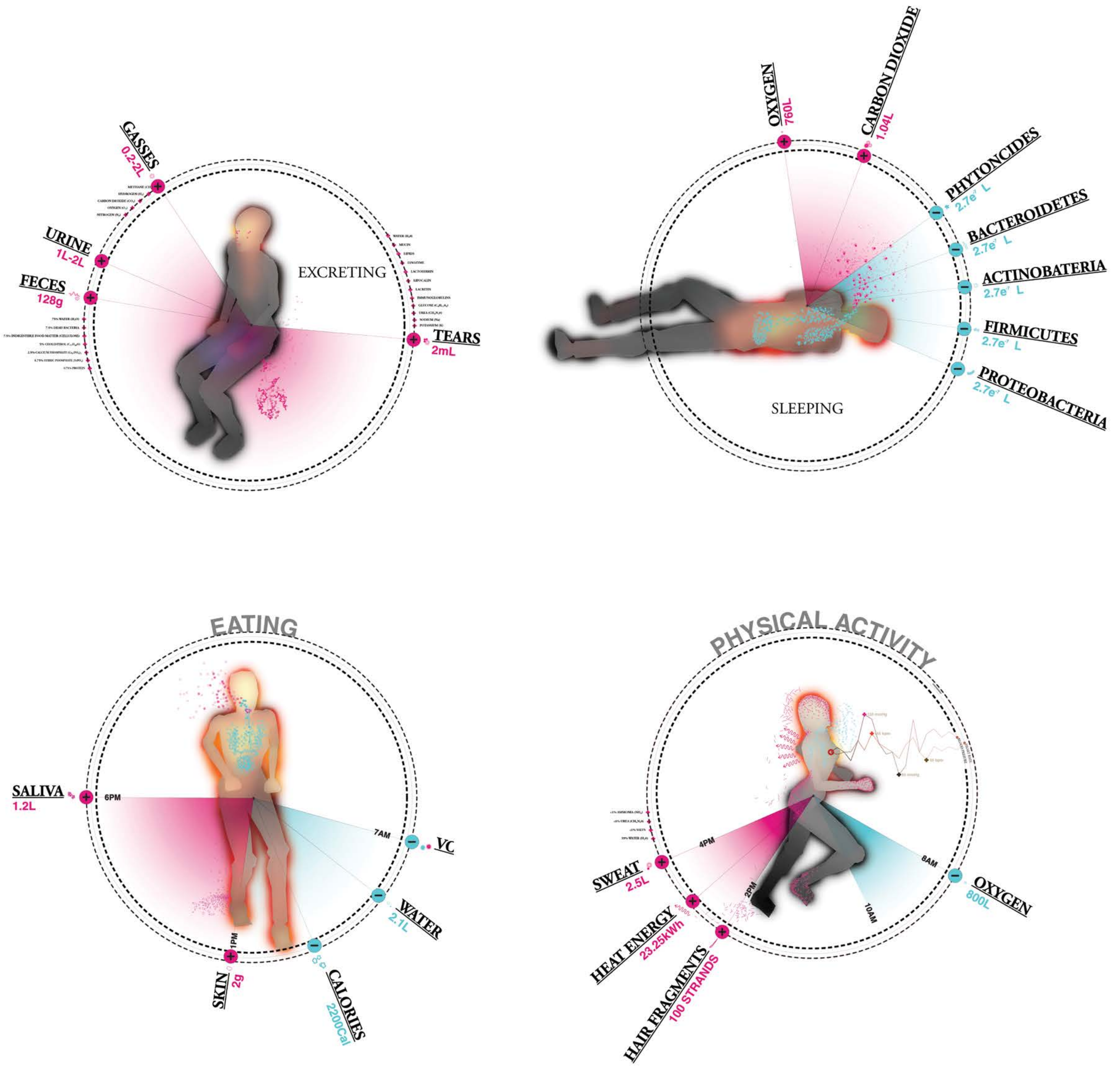


Figure 04:
Body Footprint. Diagram
by Lydia Kallipoliti and
Beau Avedissian, 2019.

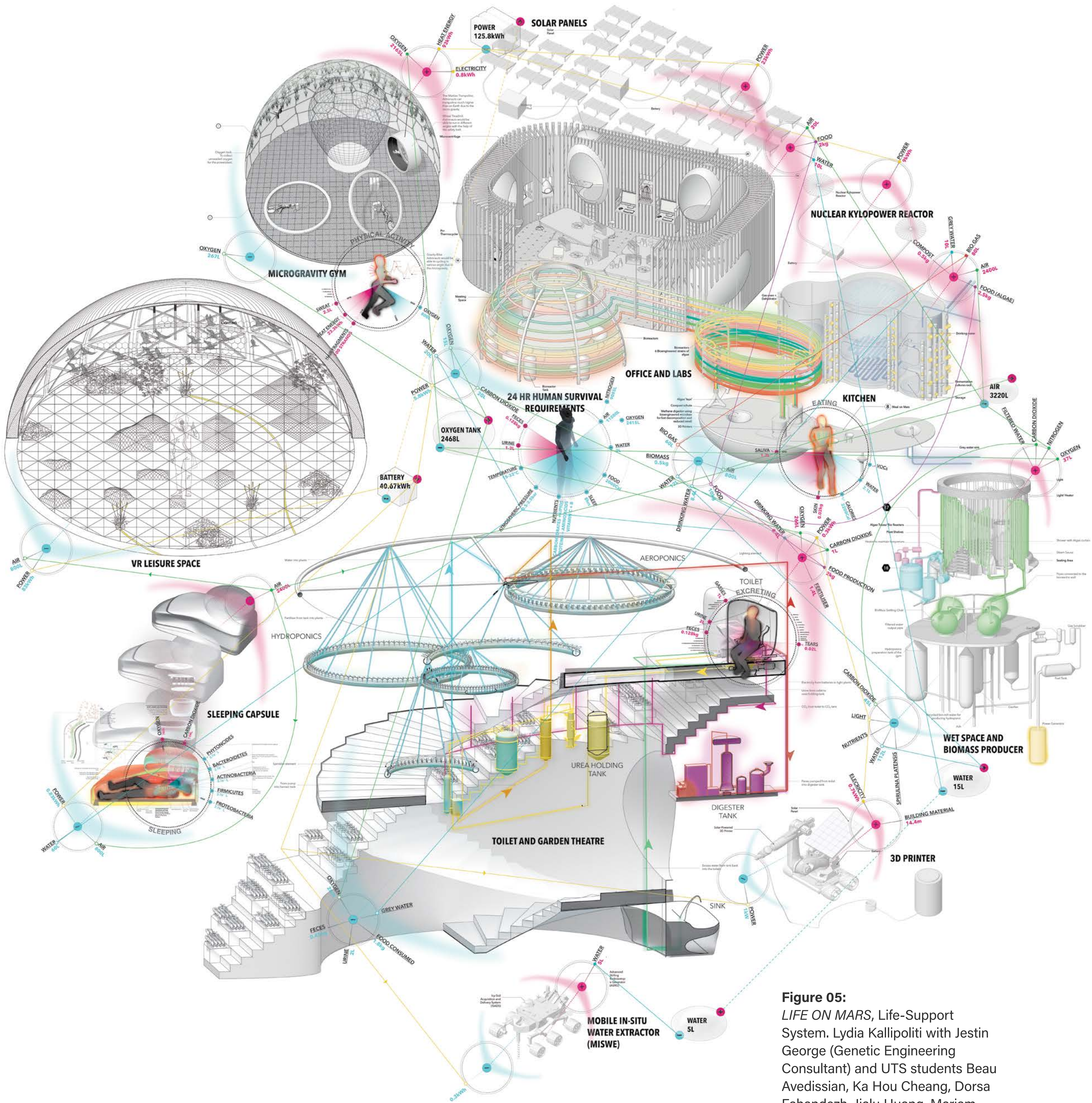


Figure 05:
LIFE ON MARS, Life-Support System. Lydia Kallipoliti with Jestin George (Genetic Engineering Consultant) and UTS students Beau Avedissian, Ka Hou Cheang, Dorsa Fahandezh, Jialu Huang, Mariam Meshiha and Isabella Wells, Sydney, 2019.

LIFE ON MARS is an attempt to reinvent the engineering flow chart, which is used for portraying regenerative life support systems in arrays of boxes and arrows. If the abstraction of this type of representation were to be removed and the diagram redrawn with further prescriptive detail, it would evidence that machines that convert waste to viable resources are not 'black boxes'—adjunct apparatuses hidden behind living quarters—but instead, spatial elements with adjustable and complex morphology which could be transfigured to accommodate biological as well as functional needs. For the settlement proposed in *LIFE ON MARS*, there is no distinction between a machine and a piece of furniture, or an inhabitable space and a mechanical space; instead, machines are profusely lived in and exhibited as vital spatial elements.

The logic of material conversions generates new spatial alliances between a toilet and a garden; a bioreactor and a bathroom; a kitchen and a laboratory; a bed and a virtual reality dome for entertainment. The possibility of converting the output of one space as input for the other generates pairings, which at first sight might seem programmatically unfit, yet forge novel typological and experiential alliances. Overall, *LIFE ON MARS* suggests a Martian habitat as a digestive inhabitable machine that captures output and converges it to various usable forms; it also proposes an integrated system where humans, their physiology of ingestion and excretion, become combustion devices and biological parts of the system they inhabit. It is the first iteration of such a complex venture and consequently, not every problem is yet solved.

Instead, *LIFE ON MARS* aims to embark on new methods and spaces for changing the way we relate to our own shit.

point 03: facing our shit

The handling of our own excrement within a closed life-support system for Mars forces us to look at questions of space colonisation viscerally, via the raw ecology of our bodies and the understanding that recycling is not simply as a statistical problem relayed to the management of feedback loops and flow charts, but also a basic bodily reality affecting the water and air available for survival in this so-called new frontier.

On Earth, cities, such as the beating heart of global finance and culture that is New York City, create an enormous amount of human excrement; piles that we cannot see, nor do we wish to see. Metropolitan environments like New York, which aspire to operate as leaders in their environmental objectives,²³ export their waste to reach their statistical goals and essentially displace problems of health to less fortunate populations. As reporter and environmental activist, Oliver Milman, writes in *The Guardian*, a substantial amount of New York's faeces is expelled to Birmingham, Alabama, causing major methane clouds 900 miles away. The treated sewage—euphemistically known in the industry as 'biosolids'—travels by a 'poo train' to a landfill west of Birmingham, causing what the locals and the mayor's office call the 'death smell.'²⁴ In Alabama, the avalanche of northern poo is part of a wider concern over the environmental risks for residents, particularly the impoverished and people of colour.

The dismissal of the environmental concerns of Alabama residents, mostly residents of African American communities, has been reported as a case of civil rights and environmental racism. These relationships of importing and exporting human waste force us to delve deeper into the geochemical affinities between capital and excrement.

While this displacement is highly curated, it transfers the problem to disenfranchised terrains. Therefore, the question of how to handle, retain, pile, decompose and redistribute waste is not simply a technical problem related to the trading of carbon emissions and the Kyoto protocol, but a matter of justice and equity. This is precisely where Mars, the faraway destination for the elite, can potentially become a useful model for handling waste whilst pressing on with technological progress. Retaining waste on site and designing the infrastructure on how to live with our excrement—enclosed in anaerobic digester—is an opportunity that may have long-term environmental and health benefits, despite the upfront cost of investing in specialised digestive infrastructural machines. Indigenous cultures have long pioneered the management of waste without ignoring and expelling it, as recently argued by Julia Watson. For example, the Bheri wastewater aquaculture wetland developed by the Bengalese in 1920 saves the city of Kolkata USD twenty-two million in waste management, and is used to produce 13,000 tons of fish and 16,000 tons rice per year. 'Every component of the food and excrement necessary for the system to thrive exists inherently within this web.'²⁵

For the most part, technological progress and our relationship with raw biological realities—in all their glory and their filth—are continuously seen as mutually exclusive and extreme ends of a binary scale. Investigating and exploring closed-loop living systems that support Earth-based life, including but not limited to human life, force those two ends to radically collide. In designing infrastructural machines that recycle waste to energy—like digesters—as inhabitable living spaces, the premise is that humans could coexist with the material consequences of their living processes. In the toilet and garden space, faeces are separated from urine and digested in an integrated toilet, garden, and social auditorium space. Human excrement becomes nutrients for soil and produces methane to power a hydroponic/aquaponic garden. The toilet, therefore, becomes a central space for the life support system and the social dynamics and attitudes towards ablution spaces would no doubt change. Foreseeably, this possibility could compel us to reinvent the politics of our territorial dimension. As Donna Haraway wrote, 'I am a compost-ist, not a posthuman-ist: we are all compost, not posthuman.'²⁶

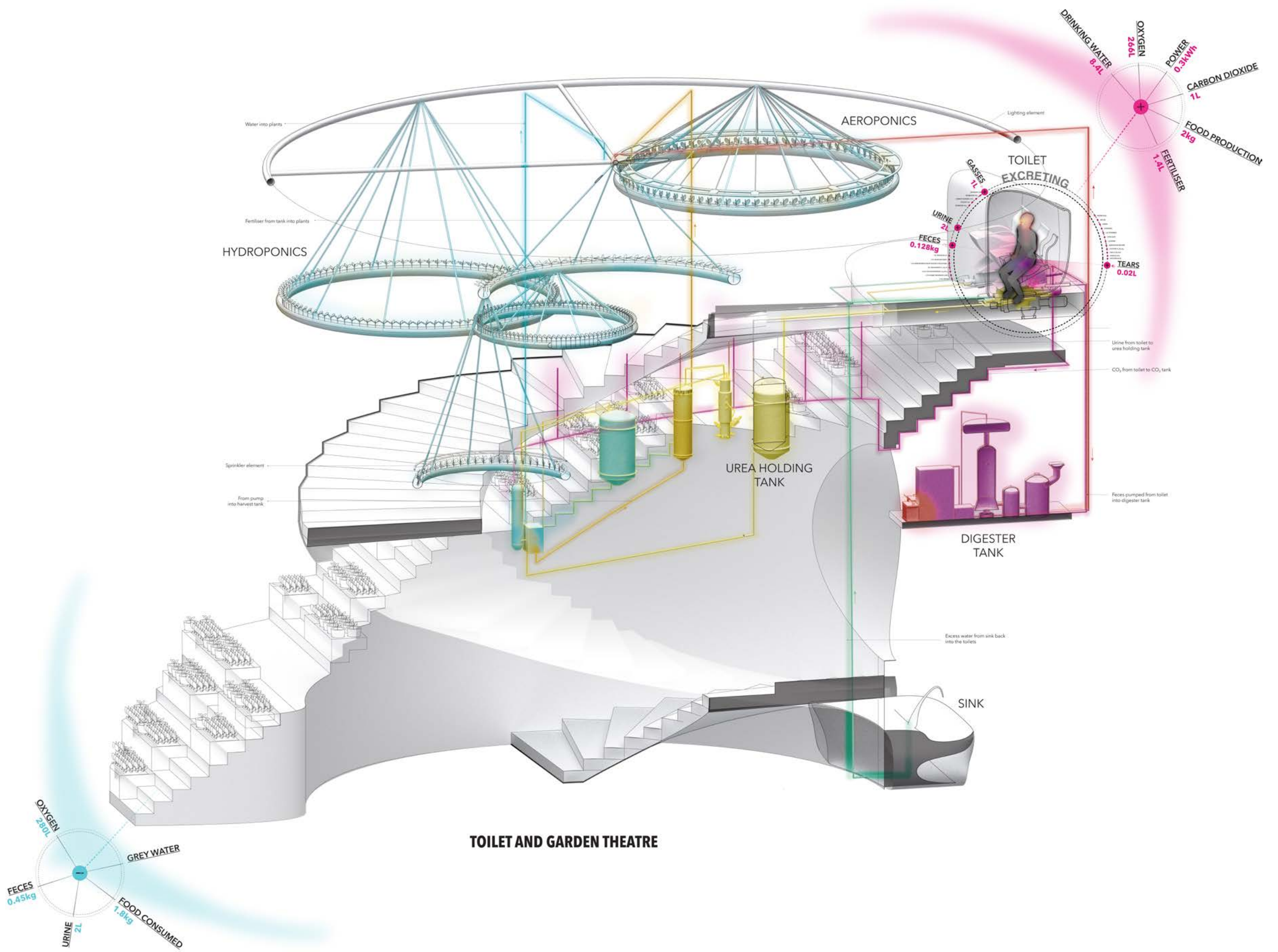


Figure 06:
LIFE ON MARS, Toilet-Garden.
Lydia Kallipoliti with Jestin George
(Genetic Engineering Consultant)
and UTS students Beau Avedissian,
Ka Hou Cheang, Dorsa Fahandezh,
Jialu Huang, Mariam Mesiha and
Isabella Wells, Sydney, 2019.

LIFE ON MARS is in many ways a project of building closed worlds;²⁷ it is a survival project, where, in order for life to exist against an unforgiving world, habitation needs not only to envelop life, but also to operate metabolically as a piece of nature extracted from the Earth and transported to another world. Habitability, therefore, renders a conceptual outline of circularity regarding the management and redistribution of resources: an artificial ecosystem as a regenerative machine, where waste is held, contained, processed and transfigured. Closed habitation systems for Mars enable scarce resources—water and oxygen—to be reused and recycled by being extracted, filtered, and recirculated; most importantly, though, they convert waste into new viable commodities. Therefore, the toilet space in the speculative Martian habitat is combined with the garden space. The garden space is vital, as it is the only space to experience the effect of ‘nature.’ The plants here help reduce carbon dioxide build-up from the crew’s respiration. They can also be engineered to detect invisible pests such as moulds and fungi that cause respiratory problems, functioning as health monitors and attractive house plants.²⁸

In projecting these lessons from Mars down to Earth, it becomes evident that the possibility of converting waste to viable resources, even with the increased cost of capital investment in infrastructure, could have multidimensional territorial ramifications. As philosopher of technology, Langdon Winner, has argued, ‘there is no idea more provocative than the notion that technical things have political qualities.’²⁹ The turn of environmental

discourses almost exclusively to the technical dimension in the past decades prevents their examination in philosophical, social and political terms, which could reflect on new collectivities in the contemporary social and urban sphere.

point 04: valuing non-human life

Framed by science fiction visual storytelling, we often imagine the futuristic technologies needed to facilitate human colonisation on Mars to be slick, sterile silver machines with robots running the show. However, some of these inorganic resources would need to be supplied from and replaced by cargo delivered from earth. While this cannot be avoided, the potential of growing our resources in situ could drastically limit the amount of resupply required and would be essential in a closed-loop system. Here, materials, resources and processes must be renewable and regenerative. In the words of synthetic biology company Ginkgo Bioworks, ‘biology is the most advanced manufacturing technology on the planet. Self-assembling, self-replicating, and self-repairing, biology builds renewably—from the molecular machines inside of cells to global ecosystems.’³⁰ Research areas like microbiology, biodesign, and synthetic biology are uncovering the role of plants and microbes in more sustainable technological practices. As such, NASA is exploring the role of microorganisms like algae, bacteria and yeast for manufacturing bioplastics, medicines, fibres and more.

Looking at the tree of life, most of the biodiversity we see around us falls into only two or three branches: metazoans (animals),

plants, and fungi.³¹ The many other branches of this tree make up microorganisms that most of us have never heard of and have certainly never seen. We often forget that we live in a world invisible to us, such as the millions of non-human microorganisms living in our digestive tracts which make up the increasingly popular gut microbiome. As described by science writer Ed Yong,

The latest estimates suggest that we have around 30 trillion human cells and 39 trillion microbial ones - a roughly even split. Even these numbers are inexact, but that does not really matter: by any reckoning, we contain multitudes.³²

He later adds,

At worst, they are passengers or hitchhikers. At best, they are invaluable parts of our bodies...They behave like a hidden organ, as important as a stomach or an eye but made up of trillions of swarming individual cells rather than a single unified mass.³³

Yong's words draw attention to the invisible beings that live within and on us, providing a reminder that each human is in fact an entire planet in itself, made up of many species and forms.

Unfortunately, microbes have acquired exclusively a pejorative cast, due to important scientific discoveries helping us control the ones that cause disease and death. Indeed, we have developed ways to keep disease-causing

microbes at bay through effective behaviours, such as sanitation and good hygiene. But like most things, our relationship to microbes is not black and white; more and more, we are discovering just how useful and important these invisible friends are and the roles they might play in future technologies, both on Earth and for Martian living.

This radical shift in modern living to using biology as technology requires both an investigation of traditional ecological knowledge (TEK) and indigenous technologies, as well as a vision of developments within biotechnology and synthetic biology, which allow us to grow vaccines and medicines from bacteria, to produce artificial meat from plants, and to manufacture spider silk from yeast cells. In order to begin to explore such potential, we designed the Office-Lab-Kitchen as a closed-loop system on Mars. The system of these three interlinked spaces is heavily reliant on biology in order to grow and ferment food and materials or digest waste. The laboratory area facilitates office-based work through digital processing and computing. However, a major aspect of this work would include laboratory-based research for testing, domesticating, and engineering beneficial microorganisms and plants; the organic, grown machines and cohabitants of the closed-loop space. Using the capabilities afforded by genetic engineering, DNA sequences encoding valuable products, such as medicines, vaccines, chemicals, fibres, fragrances, food flavourings, and more, are printed with a DNA synthesiser and used to genetically engineer microbes and plants.

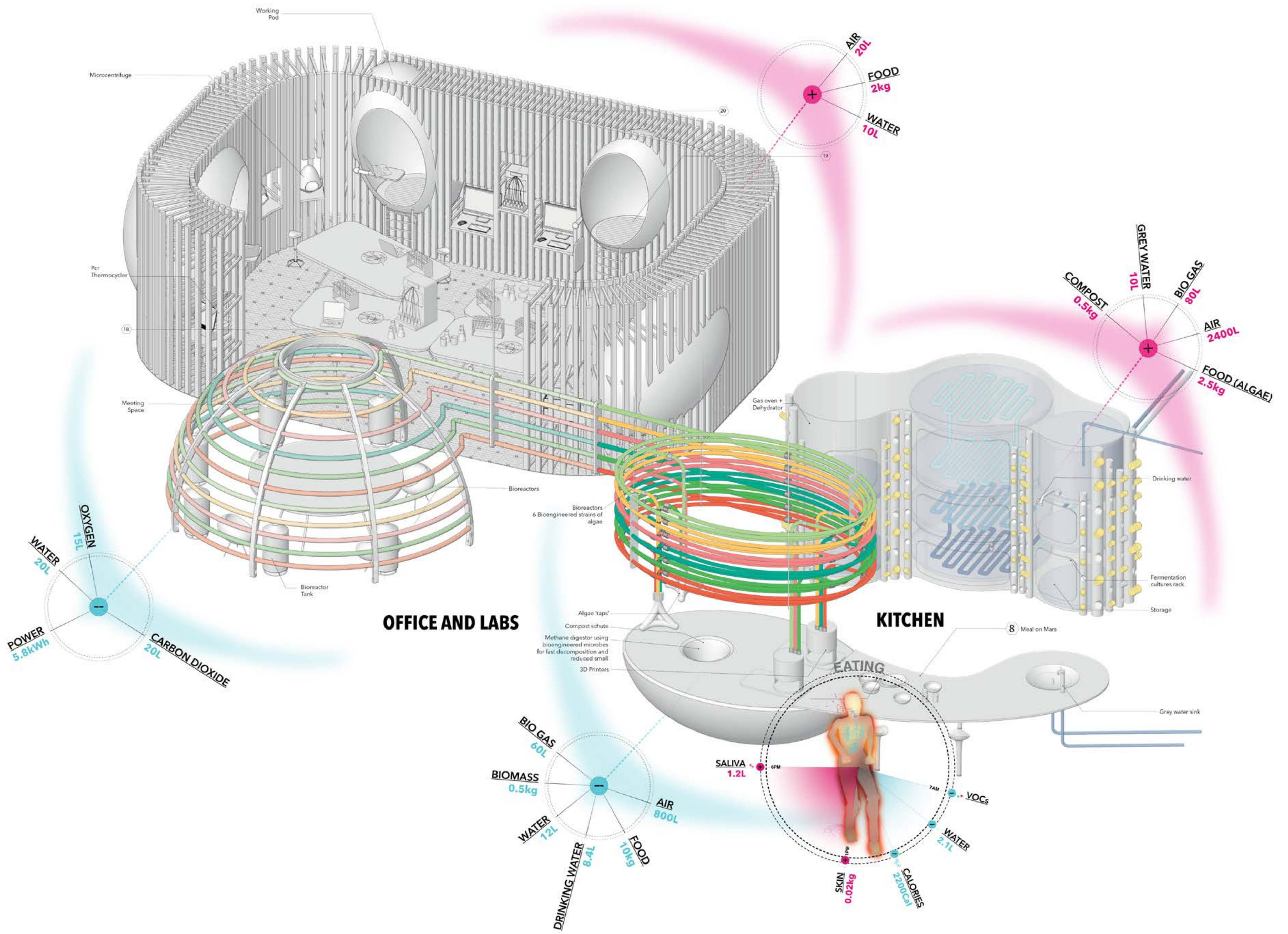


Figure 07:
LIFE ON MARS, Office-Lab-Kitchen.
Lydia Kallipoliti with Jestin George
(Genetic Engineering Consultant)
and UTS students Beau Avedissian,
Ka Hou Cheang, Dorsa Fahandezh,
Jialu Huang, Mariam Mesiha and
Isabella Wells, Sydney, 2019.

For example, some species of microalgae, such as the widely known *Spirulina*, are highly nutritious and require much less water and time to cultivate than crop plants. In the office-lab, these species are engineered to take on new flavours or forms; they grow more efficiently on a planet with less light than Earth.³⁴ The microalgae are then cultured in bioreactors, doubling every day and increasing in biomass exponentially, using carbon dioxide waste collected from human organisms. When enough biomass has been generated, the edible, flavoured algae is 3D printed into a gel-like agar—also a product harvested from the microalgae—in the kitchen. Unlike conventional kitchens today, where produce used has been grown, packaged and transported in highly unsustainable and wasteful processes, the Mars kitchen here is a mash-up of a glasshouse, a brewery and fermentation plant, a laboratory, and a factory. Some microbes in it are food and some are used to make and modify food, like yeast, fermenting sugar into kombucha and beer. Different strains of microalgae are available as protein sources offered to the astronauts as snacks via taps suspended from the bioreactor.

Similarly, the Wet Space-Biomass Producer-Lounge contains a shower and sauna connected to the biomass-digestion lounge space for human and non-human organisms to thrive and grow. The space is created by bioreactors, such as the circular sauna-like structure used to grow microalgae. Like plants, microalgae photosynthesise and make oxygen from carbon dioxide. The crew can access the oxygen generated by microalgae using a

harvesting device that separates the oxygen generated from the other gases present. The carbon dioxide collected at other points in the system and oxygen generated here are liquefied and stored at cold temperatures below zero degrees Celsius. The steam from the showers is used for the sauna and as a source of water for plant shelves. Any excess water going down the drains of sinks and showers is recycled in the system. The humans rejuvenate by cleansing and relaxation, producing carbon dioxide for plants and microalgae, which thrive in this moist, warm environment. The three spaces, linked both spatially and biologically, develop a relationship of romance and symbiosis.

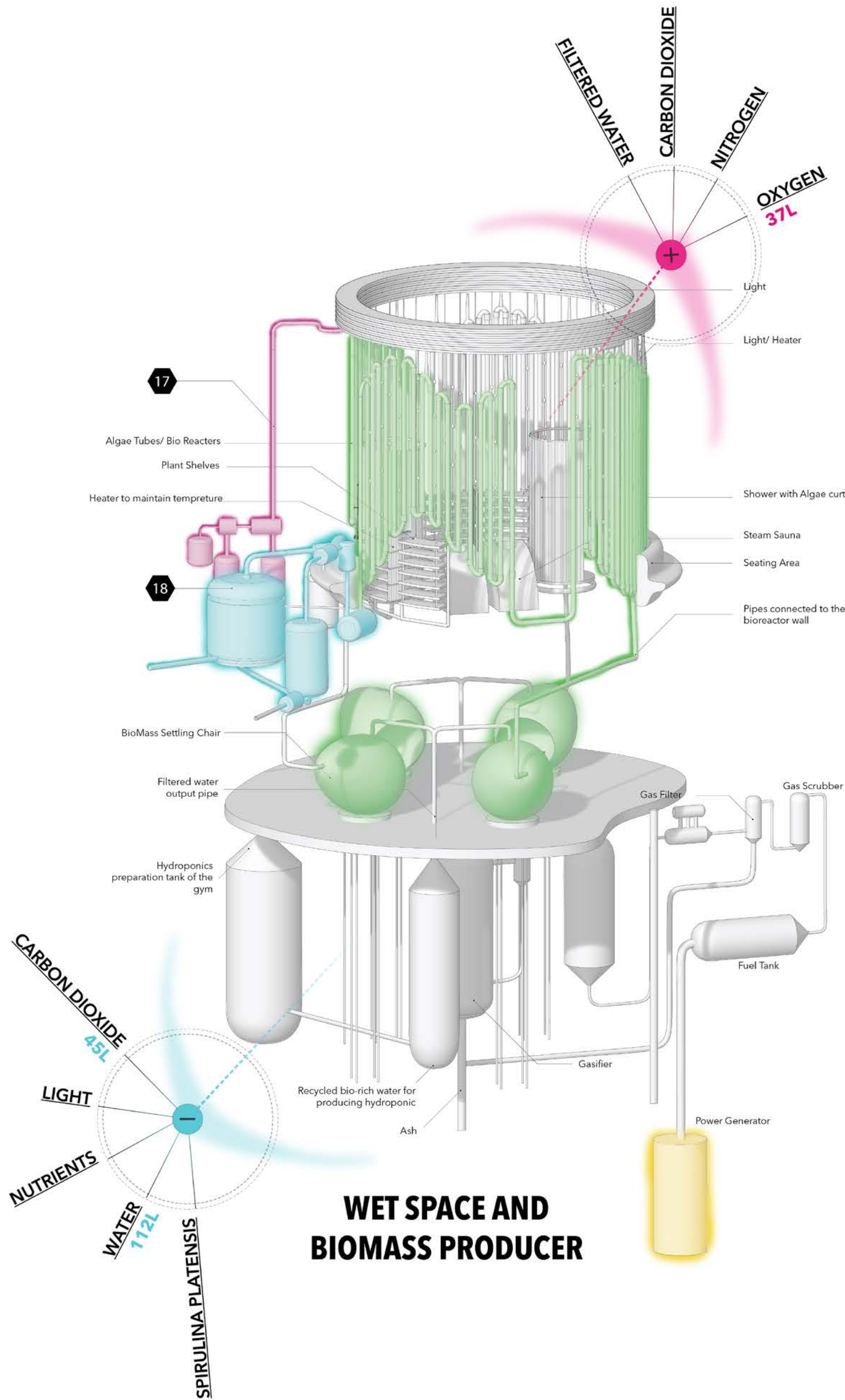


Figure 08:
LIFE ON MARS, Wet Space-
Biomass Producer-Lounge. Lydia
Kallipoliti with Jestin George
(Genetic Engineering Consultant)
and UTS students Beau Avedissian,
Ka Hou Cheang, Dorsa Fahandezh,
Jialu Huang, Mariam Mesiha and
Isabella Wells, Sydney, 2019.

on the premise of synthetic naturalism

While Mars living urges us to 'face our shit' and deal with waste in non-linear systems, it also unearths a problematic ideology: the hedonistic sculpting of an entire artificial ecosystem built entirely around the value of supporting human life on Mars. When transferring these principles back to Earth, what should we replicate and what should we reject? And at what scale do we import such systems? Downloading the logic of closed-loop systems for Mars directly to Earth could also further thin the reticulation of the biological webs on which we all depend. This is a substantial limitation of the first iteration that we have presented here. The challenge becomes: how to design protocols of collaboration with biological networks; that is, how to enlist the help of biology without succumbing entirely to unpredictability, but also without mastering the design of living systems top-down. While the hypothetical system of *LIFE ON MARS* does not 'solve' the problem of regulating this subtle balance, it sets the stage for further work to explore how this might occur or exist.

Domesticating extra-terrestrial territories has inevitably introduced into the field of design and engineering, along with synthetic life, the possibility of semi-autonomy or disobedience of matter. If *LIFE ON MARS* is in fact a gigantic digestive machine of ingestion and excretion, it is also inevitable that at points it will become disobedient; this quality is in many respects what it means to be autonomous. Even though artificial ecosystems are mostly simulated as robust circular systems, where waste equals food in an endless series of cycles

and sub cycles, the idea of self-sufficiency is impalpably idealised in the will to ceaselessly generate new life from shit. This idealisation also draws on the problematic assumption that nature is synonymous with symbiotic, pure, safe, peaceful, collaborative, and harmonious qualities. In reality, nature is also brutal, competitive, lacks any form of empathy, and values only reproduction. Somewhere between the idealization of circularity and the brutality of Darwinian evolution, the questions *LIFE ON MARS* poses expand from how to solve problems associated with the climate crisis or Mars-based living to how to sync with complex, unpredictable living systems, using life as raw matter.

acknowledgements

LIFE ON MARS was commissioned by the Design Museum in London for the exhibition *Moving to Mars* between October 2019 and February 2020. I am deeply thankful to the museum's chief curator, Justin McGuirk, for the invitation, and to curator, Eleanor Watson, for her impeccable work on this exhibition and her ongoing support. The research was conducted at the University of Technology Sydney [UTS] School of Architecture via two consecutive elective workshops between May and July 2019. I am forever grateful to the UTS Architecture Head, Francesca Hughes, for her invitation, leadership, and friendship, and the electives director, Endriana Audisho, for her intelligence, flexibility and sense of humour. Mostly, words do not suffice to thank the students who participated in this workshop. Thank you, Beau Avedissian, Ka Hou Cheang, Dorsa Fahandezh, Jialu Huang, Mariam Mesiha, and Isabella Wells, for your relentless enthusiasm and indefatigable work on this project. Finally, UTS is where I met synthetic biologist and artist Jestin George, who was finishing her PhD in biotechnology at the time. Jestin has been a source of inspiration for thinking anew our biological relationships with resources and has been a partner in this work since.

– Lydia Kallipoliti

I would like to thank Lydia for the opportunity to collaborate on this ambitious project, and acknowledge the exceptional time and effort of all the students who participated in its development. As a scientist working in biotechnology, I would like to acknowledge the non-academically affiliated indigenous scientists who have been and continue to be experts in this field, predominantly without accreditation.

– Jestin George

author biographies

Lydia Kallipoliti is an architect, engineer and scholar, also an Assistant Professor at the Cooper Union in New York. She holds a SMArchS in building technology from MIT and a PhD in history/theory of architecture from Princeton University. Her work, intersecting architecture, technology, and environmental politics, has been exhibited and published widely worldwide. Kallipoliti is the author of *The Architecture of Closed Worlds, Or, What is the Power of Shit* (Lars Muller, 2018) and the curator of the award-winning homonymous exhibition. She has also authored *The History of Ecological Design* for *Oxford English Encyclopedia for Environmental Science*, and edited 'EcoRedux,' a special issue for *Architectural Design* [AD] magazine. Kallipoliti is the principal of ANAcycle thinktank based in New York [www.anacycle.com].

Jestin George is a biotechnology PhD researcher at the University of Technology Sydney [UTS], Australia, and a freelance artist. Jestin's research has spanned plant, mammalian cell, and microalgal biotech systems across universities in South Africa, the UK, and Australia. Her recently submitted PhD thesis explores genetic engineering approaches for realising the microalga, *Phaeodactylum tricornutum*, for synthetic biology and biotech applications. Jestin continues to collaborate with artists and designers to explore, imagine, and critique biotechnological futures. In 2018, Jestin was a member of the executive committee of Synthetic Biology Australasia and worked towards advancing communication within the synthetic biology community and the public.

notes

- 01** Judith Butler, *Notes Towards a Performative Theory of Assembly* (Cambridge, MA and London: Harvard University Press, 2015), 93.
- 02** Michael Marder, 'The Desert is a State of Mind Cast over the Earth,' *Cabinet* 63 (Spring 2017), accessed July 3, 2020, <http://cabinetmagazine.org/issues/63/marder.php>.
- 03** Alice Gorman, 'The Cultural Landscape of Interplanetary Space,' *Journal of Social Archaeology* 5, no.1 (2005): 85–107.
- 04** Gorman, 'The Cultural Landscape of Interplanetary Space,' 88.
- 05** Peter Redfield, 'The Half-Life of Empire in Outer Space,' *Social Studies of Science* 32, no. 5-6 (2002): 791–825.
- 06** Ridley Scott, *The Martian* (20th Century Fox, 2015).
- 07** *Wanderer above the Sea of Fog* (*Der Wanderer über dem Nebelmeer*), also known as *Wanderer above the Mist or Mountaineer in a Misty Landscape*, is an oil painting c.1818 by the German Romantic artist Caspar David Friedrich.
- 08** On June 8, 2019, Donald Trump tweeted: 'For all of the money we are spending, NASA should NOT be talking about going to the Moon—We did that 50 years ago. They should be focused on the much bigger things we are doing, including Mars (of which the Moon is a part), Defense and Science!' The president's statement caused controversy and confusion as to why the moon is a part of Mars. See Brandon J. Weichert, 'Trump's most unhelpful moon tweet,' (June 17, 2019), accessed on June 18, 2019, <https://spacenews.com/trumps-most-unhelpful-moon-tweet/>.
- 09** The Outer Space Treaty, otherwise known as 'On Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies,' was signed in Geneva in 1966 and entered into force by the United Nations in October 1967. The Treaty has since provided the basic principles of international space law.
- 10** Ethel Baraona Pohl, 'Space—New World Colony? From Science-fiction to Legal Frameworks,' *Roca Gallery* (January 3, 2019), accessed June 12, 2019, <http://www.rocagallery.com/space-new-world-colony>.
- 11** The Macy Conferences were ten meetings of scholars from different academic disciplines held in New York between 1946 and 1953. They were initiated and organised by Warren McCulloch and the Josiah Macy Jr. Foundation. The main purpose of these meetings was to set the foundations for a general science of the workings of the human mind. The Macy Conferences brought together, among others, William Ross Ashby, Gregory Bateson, Julian Bigelow, Heinz von Foerster, Molly Harrower, Margaret Mead, John von Neumann, Arturo Rosenblueth, Walter Pitts and Norbert Wiener. 'Looking Back in History: The Macy Conferences,' *emcsr avantgarde* (2016), accessed July 3, 2020, <https://emcsr.net/looking-back-in-history-the-macy-conferences/>.
- 12** On October 8, 2019, Claudia E. Vickers, Director of CSIRO Synthetic biology Future Science Platform, tweeted: 'Dear #SynBio folks: living in space/other planets isn't a solution that will deliver in time for you/your children. Even if we get there before the Earth is unlivable, it's for the privileged few. Turn your attention to your home planet & what you can do here. Anything else is unconscionable.'
- 13** Claude Lévi-Strauss, *The View from Afar*, trans. Joachim Neugroschel and Phoebe Hoss (Chicago: University of Chicago Press, 1992).
- 14** An example of a compromised living space capsule in its feedback loop operation is the NASA Langley simulator in 1960. Lydia Kallipoliti, 'Closed Worlds: The Rise and Fall of Dirty Physiology,' *Architecture Theory Review*, 20, no.1 (2015): 67-90.
- 15** Daybill for *UTS Big Thinking Forum: Imagination and Endeavour: Fly Me To The Moon*, for Sydney Festival, 2019.
- 16** Le Corbusier, *Vers une Architecture* (Paris: Les Editions G. Cres et Cie, 1924).
- 17** Ray Eames and Herbert Matter, 'What is a House,' *Arts and Architecture* (July 1944).
- 18** Reyner Banham, 'A Home is not a House,' *Art in America* 53 (April 1965): 70–79.
- 19** James Marston Fitch, in the 'Review for The Architecture of the Well-Tempered Environment' begins his review by attempting to reverse the reputation of the author who has been misinterpreted. Despite the author's previous writings, the book, according to Fitch, deserves a second look. Fitch mentions: 'Considering the author's past work and present reputation, this is a surprising book... it is a most significant piece of work.' James Marston Fitch, 'Review for *The Architecture of the Well-Tempered Environment*,' *The Journal of the Society of Architectural Historians*, 29, no.3 (October 1970): 282–284, 283.
- 20** Reyner Banham, *The Architecture of the Well-Tempered Environment* (Chicago: The University of Chicago Press, 1969), 48.
- 21** Quoting Banham: 'The growing sophistication in the handling of air, carried further by such techniques as drawing it in from the outside only through grilles, containing, or serving, radiators, was rendered necessary by the steady reduction of sources of accidental ventilation, due to their better sealing of windows, for instance, or the disappearance of the chimney in spaces where direct combustion was not the source of heat.' Banham, *The Architecture of the Well-Tempered Environment*, 48.
- 22** Valerie Olson, *Into the Extreme: US Environmental Systems and Politics Beyond Earth* (Minneapolis: University of Minnesota Press, 2018), 146.
- 23** New York City is committed to achieving carbon neutrality by 2050, with net-zero GHG emissions citywide; accessed March 16, 2020, <http://onenyc.cityofnewyork.us/initiatives/achieve-carbon-neutrality-and-100-percent-clean-electricity/>.
- 24** Oliver Milman, "'On a hot day, it's horrific": Alabama kicks up a stink over shipments of New York poo,' *The Guardian* (March 11, 2018), accessed April 11, 2018, <https://www.theguardian.com/us-news/2018/mar/11/alabama-new-york-poo-sewage-environment>.
- 25** Julia Watson, *Lo—TEK. Design by Radical Indigenism* (Cologne: Taschen, 2020), 336.
- 26** Donna Haraway, 'Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin,' *Environmental Humanities* 6 (2015), 161.
- 27** Lydia Kallipoliti, *The Architecture of Closed Worlds, Or, What is the Power of Shit* (Zurich: Lars Muller Publishers & Storefront for Art and Architecture, 2018).
- 28** C. Neal Stewart Jr, Rana K. Abudayyeh and Susan G. Stewart, 'Houseplants as Home Health Monitors,' *Science* 361 (2018): 229-230, 229.
- 29** Langdon Winner, 'Do Artifacts Have Politics?' *Dædalus* (Journal of the American Arts and Sciences) 109, no.1 (Winter 1980): 121-136, 121.

- 30** See the website of the company 'Ginko Bioworks: Biology by Design,' accessed Monday March 16, 2020, <https://www.ginkgobioworks.com/>.
- 31** Frédéric Delsuc, Henner Brinkmann and Hervé Philippe, 'Phylogenomics and the Reconstruction of the Tree of Life,' *Nature Reviews Genetics* 6, no.5 (2005): 361–375, Figure 01 366.
- 32** Ed Yong, *I Contain Multitudes: The Microbes Within Us and a Grander View of Life* (London: Penguin Random House, 2016), 10.
- 33** Yong, *I Contain Multitudes*, 11.
- 34** Briardo Llorente, Thomas C. Williams and Hugh D. Goold, 'The Multiplanetary Future of Plant Synthetic Biology,' *Genes* 9, no.7 (2018): 348.